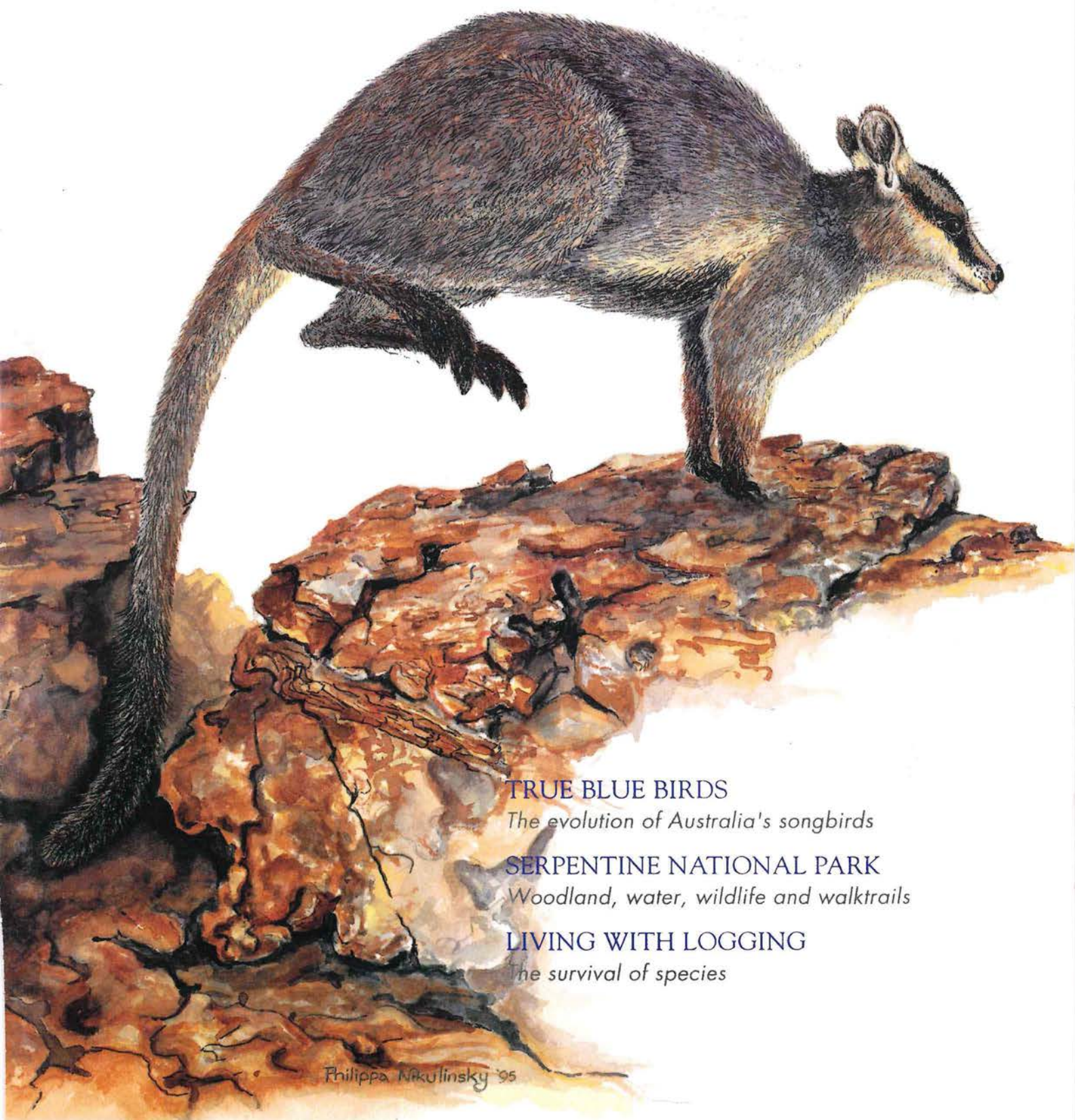


SUMMER 1995-96

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LANDSCOPE

W.A.'s CONSERVATION, FORESTS AND WILDLIFE MAGAZINE



TRUE BLUE BIRDS

The evolution of Australia's songbirds

SERPENTINE NATIONAL PARK

Woodland, water, wildlife and walktrails

LIVING WITH LOGGING

The survival of species

Philippa Nikulinsky '95

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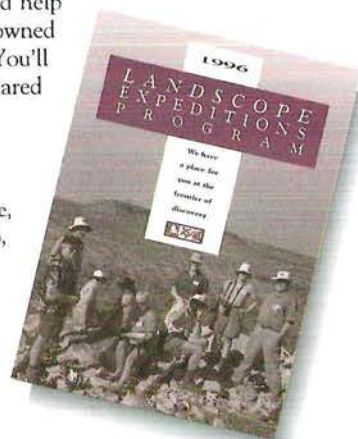
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DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT, WESTERN AUSTRALIA

in association with



UWA EXTENSION, THE UNIVERSITY OF WESTERN AUSTRALIA



Visitors can walk in the treetops along a series of walkways, platforms and stairways at the new Forest Heritage Centre in Dwellingup. (See page 10.)



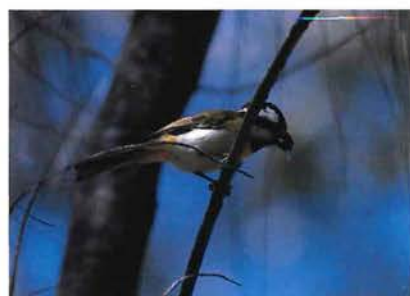
A major survey of the Carnarvon Basin has recently been completed by staff from CALM, the WA Museum and the University of WA. What did they find? (See page 15.)

LANDSCOPE

VOLUME ELEVEN No. 2 SUMMER ISSUE 1995-96



It was a very good year in the Wildflower State. Find out just how good in our story on page 38.



Australia has its own families of songbirds that are very different from their European namesakes. See 'True Blue Birds' on page 45.



Quokkas were once widespread on WA's mainland, but the most visible populations are now found on just two islands. 'Where Have All the Quokkas Gone?' (See page 49.)

FEATURES

THE FOREST HERITAGE CENTRE
TAMMIE REID & MANDY CLEWS 10

PATTERNS IN NATURE
ALLAN BURBIDGE & NORM MCKENZIE 15

LIVING WITH LOGGING
IAN ABBOTT & PER CHRISTENSEN 21

SERPENTINE NATIONAL PARK
DAVID GOUGH, PAUL BROWN,
DAVID LAMONT & WAYNE TAYLOR 28

ROCK WALLABIES OF YARDIE CREEK
JACK KINNEAR 36

THE WILDFLOWER STATE
NEVILLE MARCHANT 38

TRUE BLUE BIRDS
LES CHRISTIDIS & ALLAN BURBIDGE 45

WHERE HAVE ALL THE QUOKKAS GONE?
ELIZABETH SINCLAIR & KEITH MORRIS 49

REGULARS

IN PERSPECTIVE 4

BUSH TELEGRAPH 6

ENDANGERED McCUTCHEON'S GREVILLEA 44

URBAN ANTICS 54

COVER

Western black-footed rock-wallabies are on the increase in Yardie Creek, thanks to a CALM fox-baiting program. Their numbers are being monitored by local tour operators Neil and Rhonda McGregor. See our story on page 36.

Illustration by Philippa Nikulinsky



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INTEGRATION IS THE KEY

We make no apology for the fact that 'integration' is a theme that is constantly repeated in LANDSCOPE articles. Like the producers of *Sesame Street*, we believe in the educative power of repetition. The concept of integration is simple. But although it is the key to us developing a future that is sustainable (perhaps because of our penchant in Australia to be gladiators), our society constantly seeks to isolate objectives, institutions and philosophies when attempting to deal with environmental issues.

This issue of LANDSCOPE reports on some projects that are classic examples of the benefits of an integrated approach to conservation and land management.

The opening of the Forest Heritage Centre at Dwellingup (see page 14) represents one more milestone in the development of a world-class, skills-intensive, fine wood industry based on ornamental Western Australian hardwood timbers. But the centre also is an example of how we can integrate the tourist and wood production functions of our forests.

I am confident that the centre, appropriately nestled in beautiful regrowth jarrah forest, will become a major tourist attraction—a centre for marketing our fine timber species and a national centre of excellence for woodcraft.

Increasingly, we are seeing examples of the potential for nature-based tourism and conservation to benefit from one another. There is no reason why the unique and beautiful animals of Western Australia cannot be as big a drawcard as the animals of Africa. The principal reason why most Western Australians are not aware of the beauty of our native fauna is that they haven't been there to see. Courtesy of the fox, many of our animals have been restricted to hard-to-get-to places on the mainland (see 'Where Have All the Quokkas Gone?') and in some cases, many only exist on islands off the coast.

The story of how rock-wallabies at Yardie Creek are returning to abundance because (with the assistance of the tour operators) we are controlling foxes will, I am confident, be repeated around the State as the impact of our massive fox control program begins to bite. If we continue to see the spectacular response to fox control we are seeing in places like Yardie Creek, Batalling and Dryandra, there is no reason why our kids will not be more familiar in the future with a host of beautiful Western Australian animals, than they are today with animals from Africa.

There is much more research to be done and there is much more to be found out about how we will rehabilitate our landscapes and our fauna. But increasingly we are identifying the means to achieve the restoration of our environment. Finding the reasons for our environmental problems and the way to overcome them is just the first step. We also need to develop an integrated approach to ensure that we have the funding to carry out the programs.

One way to guarantee that conservation programs will be implemented is to design them so that they create wealth. In the April 1988 issue of LANDSCOPE ('Restoring Nature's Balance') it was proposed that one way of addressing our massive salinity problem was to use tree crops to lower water tables on farmlands. It is with some pleasure to record in this issue (see 'Blue Gums, Salt and Rising Damp' on page 8) the success of a bluegum planting program in reducing groundwater tables on a farm threatened by salination in the south-west of this State.

Of course, there will be many conservation programs that have no immediate wealth-creating potential. But funding for these programs can be obtained from the private sector, because there are many enlightened companies (see 'Resources for Critically Endangered Species' on page 9) who recognise that it is in their interest to maintain biological diversity.

Sybil Allen

The Publisher

DREAMING ON THE MOUNT

I read the [Mt Augustus] article while at Mt Augustus recently and wondered from whom you got the Dreaming story about the young boy. I was told the story by an old full blood by the name of Kimberley, who had lived in that area all his life. He said the 'mount' had been a serpent who had strayed from his place of Mt Clere, and while trying to get him back, they had broken his tail as they were beating him.

Also, when researching my book [Winning the Gascoyne], I was fortunate enough to have had access to some old records at the court house in Carnarvon. I would like to have seen these records placed in the Battye Library, but someone told me that they had been thrown away with lots of police files—I suppose that's why no one bothered to sort them out. I hate to see history lost.

RHONDA McDONALD
SWANBOURNE

The story of the young boy was one of three Dreaming stories I tracked down. It was told to our mobile ranger Tony Tapper by the late Jim Edney. Although there are several stories, including the serpent version you mention, they have many similarities, and it seems that there is seldom a definitive story, only variations on a common underlying theme. — David Gough

THE WET AND THE DRY

What a coincidence, to arrive home from a trip to Mt Augustus, to find it featured in LANDSCOPE.

Burringurrah is so very good at hiding her secrets. Exploring Beedoboondy or Kotka Gorge, one is led on and on, up and up, but somehow the heart of

the rock remains elusive. One is left slightly dissatisfied, and with a puzzled backward glance, resolves to return one day and try again.

On our first visit, in 1991, the region was in the grip of severe drought. It was too hot to enjoy climbing. The leaves on the mulga were yellow-brown and curled in on themselves, and the ground was bare. At each tourist spot, we came across the smelly carcasses of kangaroos. The water in Cattle Pool was very low and the corpse of a cow lay where it had been caught in the mud.

This year, rain had transformed the countryside—acres of yellow beneath green mulga. So many flowers of shades of violet, mauve and purple—the flannel bush; mulla mulla, both tall and short; camel bush and masses of purple peas at Edneys over 1.5 metres high. Edney's Well was full to the brim and surrounded by lush green growth. The creek beside the well was still running and I found my favourite plants, bright green nardoo. Birds were everywhere and golden orb spiders hung in their huge webs.

Humans have a great habit of loving places to death, and as Mt Augustus becomes better known and better roads are constructed, the greatest care will have to be taken to ensure that we do not destroy the very thing we go to see.

Nature has some of the answers. In a drought situation, a visit isn't recommended, and during 'the wet' it's impossible anyway.

OBVIOUS ...?

I am a LANDSCOPE buff. I have been a subscriber since day one. My set is complete; I have every copy of the magazine and have read nearly every article. Nearly always,

your text is accurate, informative and very interesting.

However, your feature article 'Looking Beyond the Obvious' (Vol.10 No.4), I found disturbing. The article comes across as a blatant exercise to justify controversial forestry policy. I found the story intimidating. The excessive array of percentages, statistics and other indisputable facts presented numerically was obviously designed to bamboozle the reader and forestall any query or criticism. Little room was left for dissenting opinion, even though a lot of opinions expressed are at odds with current research and thinking on this subject.

I was disappointed that this feature article did not adopt the usual even handed approach that makes *LANDSCOPE* such an appealing magazine.

M J WOODROW
KYOGLA NSW

... OR NOT?

I was puzzled by the claim in the article 'Looking Beyond the Obvious' by Drs Abbott and Christensen in that we have adequate knowledge of the biota of WA's south-west forests and of the ecological impact of logging and prescribed burning. For example, the authors refer to the 75 771 trap-nights of mammal surveys in State forest between 1972 and 1982 as though this was a substantial figure. By comparison, a single researcher used 75 000 trap-nights in a study of a 16km² area near Gingin, north of Perth (Bamford 1986), while the small team of Wooler et al. (1993) amassed 27 037 trap-nights over just three years in one small area of the Fitzgerald River National Park. It seems that the mammal sampling in

State forest is not intensive, especially considering the areas involved. Dr Christensen himself recently acknowledged the shortcomings of the data base in the karri forest, observing that '...data on the distribution of most forest vertebrates are inadequate to define changes in status or be useful for predictive modelling of the effects of disturbance' (Wardell-Johnson and Christensen 1992).

CALM scientists working on other aspects of the biota are also concerned about the adequacy of data, and their work can be read in CALM's Occasional Paper No.2/92, published in July 1992. Mr Wardell-Johnson and Dr Christensen argue that 'The poor taxonomic base of invertebrate work urges that high priority be given to such work in the Warren Botanical Subdistrict in general and the karri forest in particular'.

With specific regard to streams, Dr Halse and Mr Blythe observe that 'The invertebrate fauna is poorly known' and urge that the research into the effects of timber harvesting and regeneration on this fauna should have priority. The invertebrates are the most numerous forest animals, both in abundance and number of species, and many of them are unique to the region. Many are geographically restricted and hence may be vulnerable to logging and fire.

Turning to the plants, Dr Hopper and Messrs Keighery and Wardell-Johnson point out that a thorough survey of the flora of the Warren Botanical District has yet to be undertaken, despite the fact that the region '...is the most important centre of endemism for conservative relictual high rainfall taxa in the State'. In this context, Dr Shearer raises the disturbing issue of plant diseases in south-west forests (omitted almost entirely from

Drs Abbott and Christensen's article) and emphasises how little is known of some of them. The incidence of disease in regeneration plots is a significant concern, as is the potential for diseases to spread between strict forest stands and the heathlands and swamps where most endemic species occur.

Overall, there seems a consensus that there are significant gaps in our knowledge of the forest biota which could have profound management implications. Until these are filled, there is a clear need for a strong precautionary policy in management. Drs Abbott and Christensen's article did little to convince me that this is the case.

DR MIKE CALVER
MURDOCH UNIVERSITY

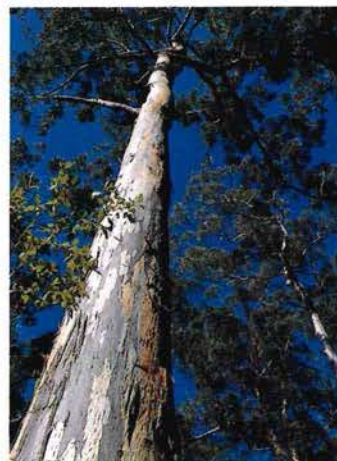
In our article we wanted not to 'bamboozle the reader' but to bring a science-based perspective to the issues of burning and logging in WA forests. Knowledge of our forest ecosystem is hardly perfect; however, you don't need to know everything about every species present in order to manage the forest. It is scientifically valid to discover the key principles of the ecological and evolutionary processes at work, then to apply them to specific cases.

It is also valid to conduct a number of surveys, not just one (see Dr Calver's letter above), over a number of years, not just one, and to spread all available trap-nights among various locations, not just one. It is the number of our surveys, years, trap-nights and locations, not just the trap-nights in one survey, that give us the confidence to generalise about the number of mammal species in the southern forests.

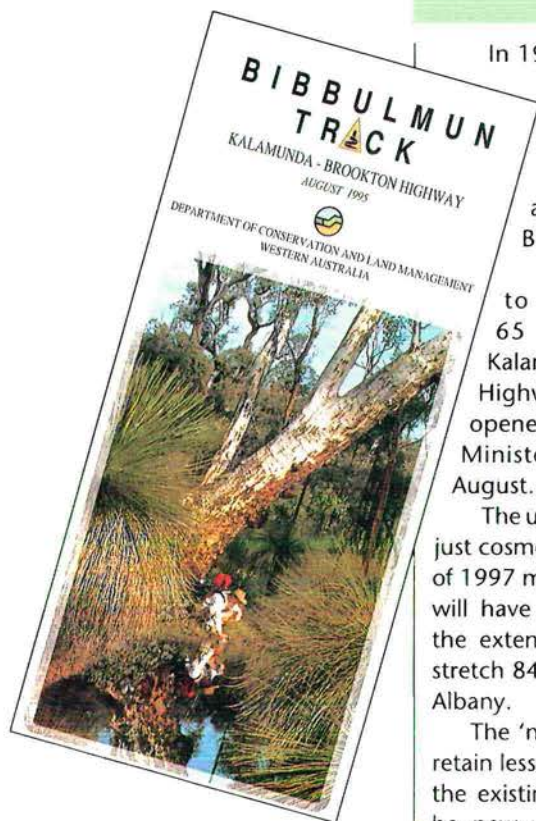
Dr Calver's references to CALM Occasional Paper 2/92 are selective. We can easily point to others. For example, the paper

also states that 'Coastal heath, granite outcrops, swamps and woodlands contain the majority of endemics and threatened taxa. The main karri forest has few of the endemics, and none of the Declared Rare Flora nor those requiring monitoring (p. 1); that a "pre-logging survey" approach to ecological research is not considered to be profitable use of limited resources' (p. 48); and that 'In all cases changes can be prevented by retaining adequate buffer strips of undisturbed vegetation and by careful design and construction of road crossings over streams' (p. 129). The paper was created as a review of knowledge so that woodchip licensees could be asked to fund necessary work; and the authors of the reviews identified gaps in our knowledge because CALM specifically asked them to.

*Since that review, a number of projects relevant to the issues raised by Dr Calver have begun or been published. These include a multidisciplinary integrated study of logging impacts on jarrah forest vertebrates and plants ('Forest Focus', *LANDSCOPE*, Summer 1994-95); a synthesis of information on the distribution of insect species in jarrah and karri forests (*CALM Science* 1: 365-464, 1995); and the book *The Karri Forest: Its Conservation Significance and Management*, published by CALM in 1992. — Ian Abbott and Per Christensen*



NEW MAP FOR NEW BIBBULMUN



In 1993, the Building a Better Bibbulmun Track Project was launched to upgrade, realign and extend the Bibbulmun Track.

The first section to be realigned—65 kilometres from Kalamunda to Brookton Highway—was officially opened by Environment Minister Peter Foss last August.

The upgrade is more than just cosmetic, and by the end of 1997 more than \$1 million will have been injected into the extended track that will stretch 840 km from Perth to Albany.

The 'new' Bibbulmun will retain less than 20 per cent of the existing track. There will be new campsites, sleeping shelters, toilets, picnic tables,

barbecues, route markers and other facilities, all designed to make it easier for people to use.

CALM will also produce a new series of maps, especially designed for Bibbulmun walkers. By the end of the project there will be maps covering the northern section of track through to the Blackwood River (due for completion by the end of 1996) and the southern section through to Albany (due for completion by the end of 1997). The first in this series, covering the 65 km section between Kalamunda and the Brookton Highway, is now available*.

According to Ray Lawrie, the cartographer in charge of the project, the map represents a departure from CALM's usual format, with track notes, background information and

profiles included for the benefit of walkers.

"This time the information has been weighted towards the track—making that the focus and the main feature," he said.

Elements of the design were borrowed from maps of the Appalachian Trail in America, while others are a CALM innovation.

"Initial feedback on the map has been very positive, and given that it was the first of its kind, I think the response has been really good. There will be some refinements to the reprint, but the base material and design will remain the same," Mr Lawrie said.

*The map, Bibbulmun Track, Kalamunda-Brookton Highway, costs \$6.50 and is available from outdoor shops, RAC shops and selected bookshops.

FAT CATS

If you need proof that cats are a serious threat to populations of small to medium sized native animals, take a look at this graphic photograph supplied by Neil Hardman of Wanneroo.

The photograph, taken by

John Read, an ecologist with the Olympic Dam Mine at Roxby Downs, shows the stomach contents of a cat shot near the mine. The cat's stomach contained 29 dragon lizards, three skinks, a mouse and a zebra finch. Another cat shot

nearby had four dragon lizards, 15 skinks and a zebra finch in its stomach.

Cat predation is believed to have caused the local extinction of a number of vertebrate species. It may also seriously affect the continued survival of

many native species persisting at low population densities.

Control of feral cats is one of the most pressing problems in the conservation of threatened vertebrates in Australia today. However, hope is on the horizon in Western Australia, with CALM scientists involved in exciting developments that may eventually provide a practical method of feral cat control.

As part of *Project Eden*, CALM's wildlife conservation program on Shark Bay's Peron Peninsula, work continues on the development of a series of baits that are attractive to feral cats.

Large-scale trials of these baits on the peninsula early next year will provide CALM scientists with important new information in their fight against the feral predation threat.



Photo - John Read

DESIGN AWARD FOR CALM SOLAR KILN

A Western Australian-developed solar kiln to dry timber has won the nation's highest design accolade—an Australian Design Award.

The kiln, designed and developed by the Department of Conservation and Land Management (CALM) at its Wood Utilisation Research Centre in Harvey, stemmed from a \$4.6 million, four-year research project, and is a breakthrough in low-cost, energy-efficient methods of processing and adding value to native hardwoods and plantation timbers.

The award judges said: "This innovative, patented design provides energy-efficient, environmentally-sensitive, wood-drying kilns at low capital cost."

They were particularly impressed by the innovative use of relatively low-cost technology, the kiln's modular form, its simplicity of construction and the significant cost savings in the use of solar energy.

Because the kilns use solar energy, power consumption is greatly reduced with power savings from 30 to 50 per cent less than that used by conventional timber driers. The use of solar kilns also means it is now economic to use short length and lower grade sawlogs, which formerly would have been used as firewood.

Already there are more than 20 of the solar kilns in operation throughout Australia.

An Australian Design Mark was also awarded to



CALM's Valwood process, which uses short lengths of timber to produce laminated, solid wood for high value products such as furniture and benchtops.

Marketing Manager of Forest Resources Terry Jones accepts the Australian Design Award from Dana Read, the WA design consultant for Australian Design Services, a division of Standards Australia. Photo – Bryan Smeath

OPERATION BEACH CLEAN-UP

John Galvin High School students Rebecca Slobe and Renae Bruning proudly display signs they designed for use after a recent cleaning up operation at Bornholm Beach in West Cape Howe National Park, west of Albany.

While Bornholm Beach is a popular fishing spot, it is definitely four-wheel drive country—difficult to reach. Unfortunately, many fishers tend to leave fish heads on the beach and after a good salmon season the beach is untidy and decidedly unfragrant.

The beach cleanup was a joint venture between South Coast Regional staff of the Department of Conservation and Land Management (CALM) and the school. The lead-up to the clean-up included a competition in which students were required to design signs, the best two of which were to

be manufactured by CALM and erected at the beach. Rebecca and Renae were the winners.

CALM recreation and tourism officer Terry Passmore said that each sign included the name and age of its designer, in the hope that those seeing this commitment to caring for the

environment by young people will be encouraged by the example and act responsibly when using the beach.

According to Mr Passmore, judging the entries proved to be a daunting task.

"The standard of designs was excellent, making the task

of selecting the best two signs so much more difficult," he said.

In the weeks leading up to the clean-up day, CALM ranger Richard Pemberton spoke to the students on the importance of protecting the beach environment, and on the day itself, ranger Tony Smith supervised the clean-up and erection of the signs.

"The operation turned out to be a great day for everyone—the students, the parents and the beach—and culminated in a barbecue. And, yes, Bornholm lived up to its reputation as a great fishing spot, with many salmon caught, cooked and consumed," Mr Passmore said.



Photo – Tony Smith

BLUEGUMS, SALT AND RISING DAMP

Some rising water tables on the south coast are being brought under control thanks to bluegum plantations established by CALM and private investors.

Underground water levels are rising in many agricultural areas because shallow-rooted crops consume less water than native vegetation, upsetting the natural balance. This imbalance brings the threat of increased salinity, as the water dissolves salts in the soil and brings them closer to the surface.

In some areas, productive land has already been ruined by salinity and waterlogging. Hydrologists with Agriculture Western Australia estimate that 1.6 million hectares in the south-west land division are affected by salt and that this area may double if remedial action is not taken.

Broad scale tree planting is known to restore the hydrological balance by drawing up ground water in similar quantities to the original vegetation.

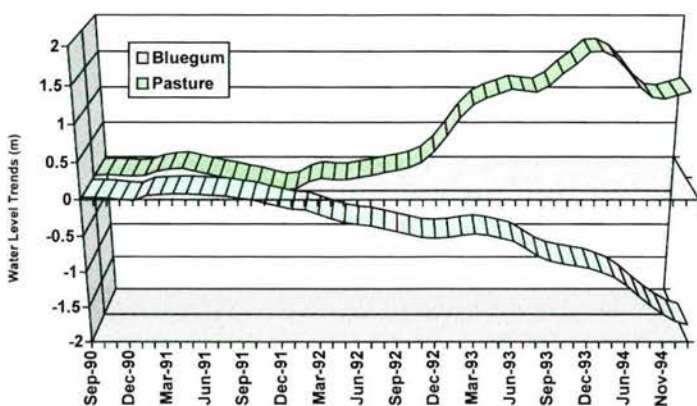
The success of such a rehabilitation strategy has been demonstrated in a monitoring project undertaken by Agriculture WA on Crystal Brook, near Mt Barker, since 1990. CALM began planting

bluegum trials here five years ago. These trials were followed by commercial plantings in sharefarming contracts with Albany Plantation Forest Company. APFL was set up in 1993 to establish up to 20 000 hectares of bluegum plantations in the Albany region, in a joint venture between three of Japan's largest trading companies: New Oji Paper Company, Itochu Corporation and Senshukai Company.

APFL's plantation project, including a program to plant some non-commercial trees in areas too saline for bluegums, earned it the 1995 Ansett Landcare Business Award for Western Australia.

Agriculture WA scientist, Don McFarlane, and technical officer, Arjen Ryder, have measured groundwater levels and soil salinity on the property. Taking seasonal variations into account, the water table under the trees has dropped by 1.5 metres and risen by one metre under pasture since 1990.

The bluegums began to lower groundwater levels in the area around their roots about 18 months after planting. Deep groundwater continued to rise during this period, but then dropped



when the trees were three years old.

One of the pasture bores located 80 metres downslope from a plantation also showed a drop in groundwater levels, indicating that trees can help surrounding areas.

The salinity meters show that the lower groundwater levels around the tree roots have not yet led to salt leaching from the soil.

Dr McFarlane said this was possibly because the rain soaking into the soil was not getting in deep enough to leach the salts. However, the saline seeps in the two creeks have dried out substantially and now contribute little salty water to the main stream.

The project includes

monitoring at four other sites in the region, where similar results are being obtained. Readings will be taken until the trees are harvested when they are 10 years old.

Above: The graph shows ground water trends beneath annual pasture and bluegums at Crystal Brook. Note how the water levels have dropped under bluegums, but continued to rise under pasture.

Below left and right: Bluegum plantings on Crystal Brook began in 1990. The landowner believed it would help prevent salt water from contaminating a stream to be used to irrigate grapes. Plantings have been designed to protect and improve stream water quality and to shelter stock.



RESOURCES FOR CRITICALLY ENDANGERED SPECIES

The Minister for the Environment, Peter Foss, has announced the immediate allocation of \$300 000 for the first year of a program to conserve critically endangered Western Australian plants and animals. The allocation of this money was in response to a review of the conservation status of Western Australia's threatened species carried out by a panel of experienced scientists, which was chaired by Dr Andrew Burbidge,

Director of CALM's WA Threatened Species and Communities Unit.

Mr Foss said that the funding came from payments to CALM's bio-prospecting program by Victorian company AMRAD for the right to use one of WA's native plants in its search for a cure for AIDS.

The panel assessed 375 threatened species and identified 38 plants, three mammals, two birds, one reptile and two spiders,

totalling 46 species, as being critically endangered, and a further 78 species as endangered.

This was the first time the new World Conservation Union (IUCN) category of 'critically endangered' had been used in ranking WA wildlife. The rest of the species were classed as vulnerable, except the woylie, which was classed as conservation dependent.

The results indicate that

while many species are not immediately threatened, urgent action is needed to prevent the small number of critically endangered species from imminent extinction. We can then concentrate on the 'endangered' category.

By carefully reviewing priorities and ensuring that research and management resources are allocated first to those species most at risk of extinction, CALM scientists can minimise the chance of additional extinctions in Western Australia, where too many have occurred in the past. Twelve species of mammal, one species of bird and 37 species of flowering plant are presumed to have become extinct in the State during the past 150 years.



Three of WA's endangered species to benefit from funding.

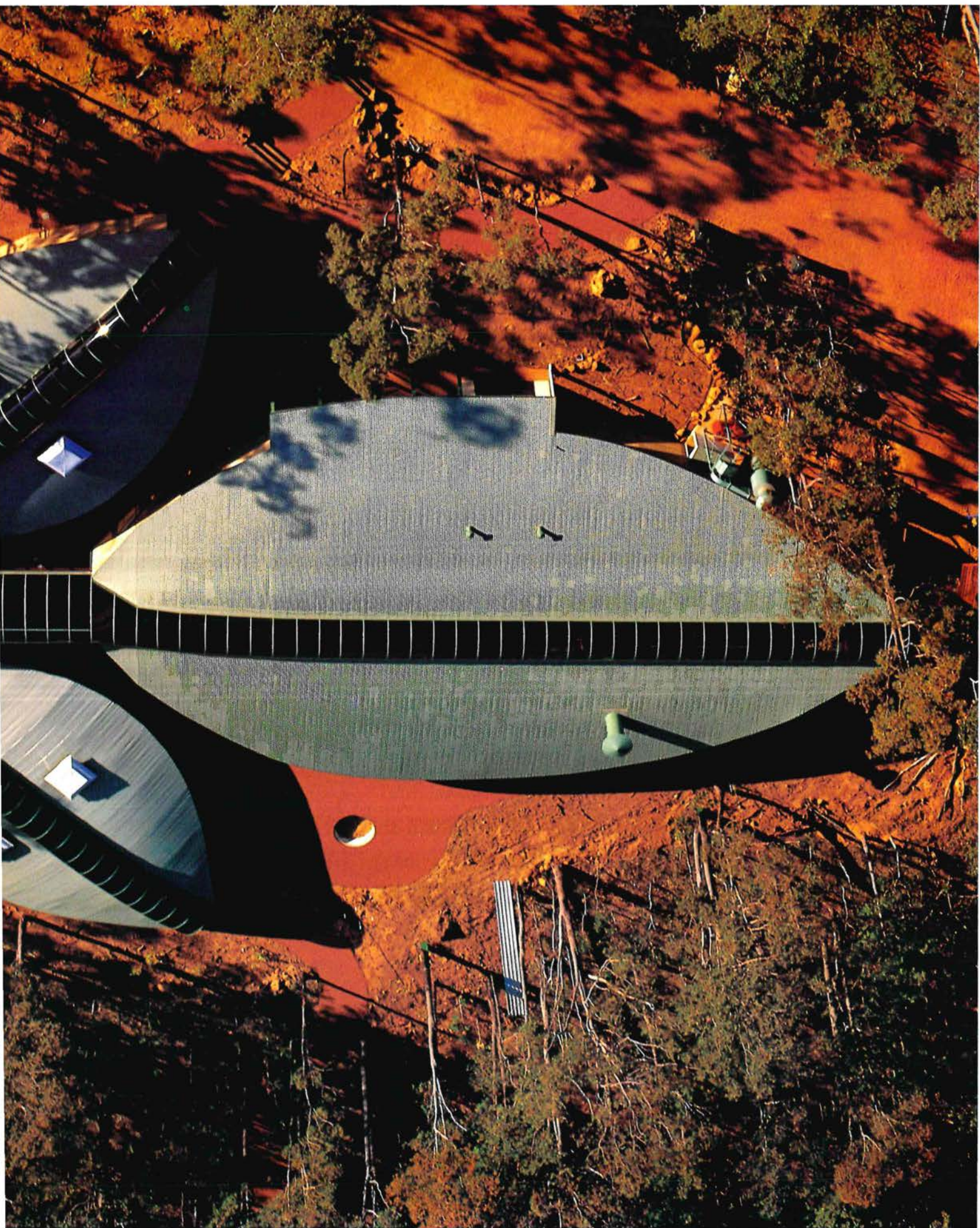
Left: Western swamp tortoise

Below left: Rose mallee

Below: Chuditch

Photos - Babs & Bert Wells/CALM







THE FOREST HERITAGE CENTRE

a
**New Leaf
for Dwellingup**



People who have lived in a forest environment, and those who still do, have a close affinity with the domain of the tree. They know the living canopy as a home, a provider and an entertainer. They know its feel, its touch, its smell. And they have an understanding of the ecosystem to which it belongs. Nowadays, with most people living in urban sprawl, there is a need to have places where we can go to learn about our forests. The new Forest Heritage Centre at Dwellingup is just such a place.

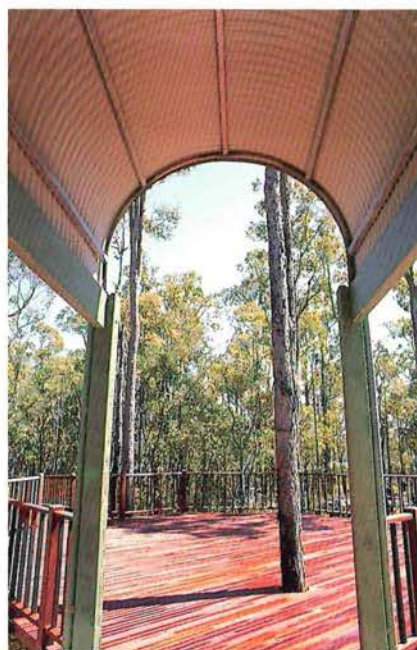
**By Mandy Clews and
Tammie Reid**

It tends to be taken for granted, but if you look around, you will see it close to you, in every room. Wood forms a component of most of our buildings, furniture and hand tools, and the aesthetic detail of our lives. The human relationship with wood is primal and enduring, even through the technological revolution of minerals, plastics and synthetic fibres.

This summer, a new forest development at Dwellingup, only about an hour's drive from Perth, is expected to touch the lives of thousands of visitors. Industry and State and Commonwealth governments have joined forces to develop a first-class facility for the interpretation of the jarrah forest and its management, and the advancement of Western Australia's fine wood industry.

The Forest Heritage Centre is unique. While there are many interpretive facilities set in forests around Australia, none contains the intricate machinery of industry, a museum of social, industrial and natural history, and a working school of fine wood crafting, in one establishment. At the Forest Heritage Centre, it is all on display—for history buffs, craftspeople, conservationists and the curious. The Forest Heritage Centre celebrates the splendour and complexity of the natural environment, embracing at the same time the fascination of how we have worked, and continue to work, within it.

Here, visitors can ponder the complexity of the forest ecosystem one moment, and the next, marvel at the ingenuity and skill of craftspeople in the



design and creation of exquisite fine wood products. The centre provides a rich experience suffused with a sense of both history and perpetuity.

FOREST HERITAGE

Deep in Western Australia's jarrah forests, there is a practical relationship with wood stemming back thousands of years. The Nyoongar Aboriginal people exploited the forest to provide all the basic needs of life. Plants and animals provided food and medicine; wood was the raw material for shelter, fuel, weapons and tools; and the forest environment provided spiritual nourishment.

A different scale of exploitation came with European settlement. Thriving on infertile soil, the jarrah forest remained

Previous page

Main: The Forest Heritage Centre is nestled in regrowth jarrah forest. This bird's eye view highlights the jarrah leaf-inspired architecture.

Photo – Jiri Lochman

Inset: The tree tops are visible from inside the building, emphasising its bond with the forest.

Photo – Marie Lochman

Left: Visitors arrive by way of a wooden walkway and elevated deck, constructed of timber cut from Dwellingup forests.

Below left: The rammed-earth, curvilinear walls of the gallery 'leaf' are inset with picture frame windows.

Photos – Marie Lochman

Below right: Timber platforms and stairways through the forest canopy provide an aerial dimension to the walktrails.

Photo – Barb Giles

largely uncleared for agriculture. But commerce was developing. In the early part of the century, the need for wood to feed a hungry export market and to provide railway sleepers for a growing State, saw the development of a booming timber and sawmilling industry in the more accessible forests. In the 1920s, timber was being produced and exported at incredibly high rates.

Today, the timber industry has slowed, to be managed at a sustainable level. While the resource continues to be extracted, our relationship with wood has taken another turn. WA hardwoods, such as jarrah, karri and marri, have become highly prized for their rich grains and handsome colours, prompting a steady growth in WA's fine wood industry.



This industry has gone from strength to strength in the manufacture of elegantly crafted furniture and decorative artefacts, and has the potential to become a major export earner and job creator for the State. Recent developments in kiln drying techniques for karri and marri have meant that furniture manufacturers are now able to capitalise on the unique ornamental properties of these timbers, creating individual, high value, pieces.

HEART OF THE FOREST

Dwellingup is nestled in a valley, surrounded by regrowth forest. This prime location near the Murray River was a traditional Aboriginal camping place long before European settlement.

With the establishment of the rail link from Pinjarra, Dwellingup soon became a regional centre of forest activity, and has remained so ever since. It was at the edge of the first State Flora and Fauna Reserve—which, at 160 000 acres, was the largest at that time anywhere in Australia. But intense lobbying by sawmilling concerns saw its conversion to a Timber Reserve in 1911, and it soon became the natural convergence for the network of railways and roads carved out by the expanding timber industry.

Later, in 1928, the establishment of the first Forests Department office in the town ushered in a new era of forest management, where timber cutting was based on regeneration and sustaining yield in the forest. Dwellingup also became the site of the first established Forestry Cadet School.

Through decades of intense activity—fuelled by economic development, industrial growth, an increased understanding of nature conservation, and policy and management reforms—Dwellingup has kept in touch with the natural environment, so it is fitting that it should have been chosen as the site of the Forest Heritage Centre.

A JARRAH ADVENTURE

Built in the shape of a giant jarrah bough, the complex nestles peacefully in its forested surroundings. Three leaf-shaped, rammed-earth buildings extend from a welcoming, stem-like foyer. The largest, central 'leaf' houses the School of Wood—a facility for demonstration and training in the art of fine wood processing and quality furniture production. The smaller 'leaf' extending

THE SCHOOL OF WOOD

One of the most significant functions of the Forest Heritage Centre is to provide a training base for Western Australia's growing fine wood industry. The School of Wood has been operating at the Forest Heritage Centre since September 1995. It offers weekend workshops and longer-term courses in specialist subjects to professional craftspeople, hobbyists, manual arts teachers, high school and TAFE students. The tradition of learning about the forest will live on for those seeking inspiration among the trees, birds and wildflowers of the jarrah forest, just as it did for the young foresters of the past.

Accommodation is available at the former Forest Cadet School, now leased to the centre by CALM. Some 400 forestry cadets went through the school between 1952 and 1991, when it closed following the development of tertiary courses and on-the-job training. The newly renovated building has a lecture theatre, kitchen and dining room, recreation room with television and pot belly stove, and 16 rooms catering for up to 32 people. It is available for national and international conferences and for use by other industrial organisations, educational institutions, government departments, community groups and tourists.

Recently, the board of management of the Forest Heritage Centre appointed the first Director of the School of Wood, Malcolm Harris: A respected fine wood craftsman, Malcolm has designed and made commissions for private and corporate clients, as well as having worked collaboratively with other designers on projects such as furnishings for Parliament House in Canberra, Australia Post and HBF. He is also an experienced teacher in the fields of wood-craft design and manufacture.

The School of Wood will foster the expertise and marketing acumen that will place luxury items, skilfully crafted from exquisite Western Australian timbers, among the most sought-after aesthetic products in the world.



Malcolm Harris, the Director of the School of Wood, working with Bunnings New Talent Scholarship holders.

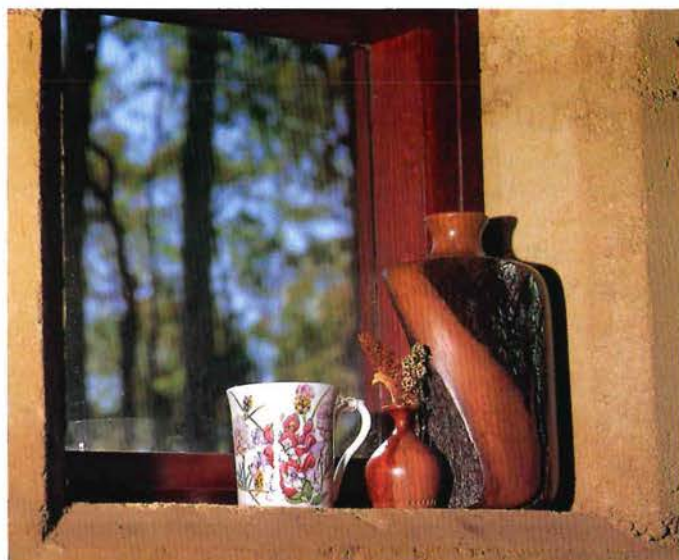
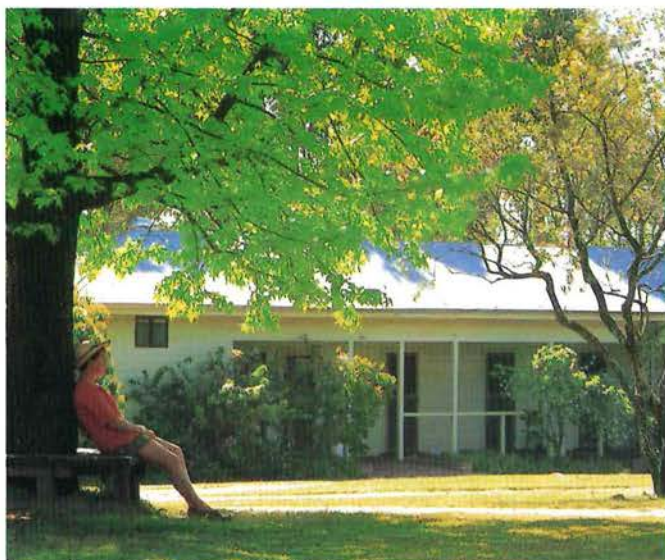
Photo – Marie Lochman

to the west provides a gallery for exhibition and sales of fine wood products, while the 'leaf' to the east introduces the visitor to the ecology of the jarrah forest, offering interactive displays as a prelude to an interpretive walk.

Although it stretches only 400 metres, the fully wheel-chair accessible Heritage Centre Walk takes the visitor through a cross-section of the jarrah forest. Starting from the east leaf, the first phase of the walk simulates what is happening beneath the forest floor. A rammed-earth wall depicts the soil structure of the forest and the complex root system of the trees.

A stroll through the forest at ground level shows the effects of the ecologically sustaining elements of water and fire. An alternative biodiversity loop offers seasonal information on the plants and animals of the forest system. Finally, a short canopy walk takes visitors up to the tree-tops, for an aerial perspective on the forest system. Along the canopy walk, visitors also get a bird's-eye view of the craftspeople at work in the School of Wood.

A five-year business plan anticipates that the Forest Heritage Centre will cater for an estimated 75 000 visitors a year and, together with revenue generated by



THE FOREST HERITAGE CENTRE BENEFACTORS

- ❖ Adelaide Timber Co.
- ❖ Alcoa of Australia
- ❖ B & B Timber Trusses
- ❖ Bunnings Forest Products
- ❖ Bushmill Timbers
- ❖ Colli Timber Products
- ❖ Colli & Sons
- ❖ Commonwealth Department of Tourism
- ❖ Corinthian Industries
- ❖ Cullity Timbers
- ❖ Department of Environment, Sports and Territories
- ❖ Don Stone
- ❖ Eldon Metal Industries
- ❖ Fine Wood Industry Project
- ❖ For Wood Tools and Machinery Sales
- ❖ Forest Industries Federation of Western Australia
- ❖ Gandy Timbers Pty Ltd
- ❖ Gunnar Hornum
- ❖ GW & NL Saunders
- ❖ Hamilton Sawmills
- ❖ Independent Timber Supplies
- ❖ Inglewood Joinery
- ❖ KD Power Sawmilling Co.
- ❖ Kevin Bourke Machinery
- ❖ Murray Joblink
- ❖ NG & LB Thomson
- ❖ Peel Development Commission
- ❖ Pickering Brook Sawmills
- ❖ Shire of Murray
- ❖ South West Development Commission
- ❖ Stefanelli Sawmillers Pty Ltd
- ❖ Timber Traders Cockburn
- ❖ TJ & MB Waugh
- ❖ V & D Ridolfo Pty Ltd
- ❖ Vanessa Horner
- ❖ WA Department of Commerce and Trade
- ❖ WA Department of Conservation and Land Management
- ❖ WA Department of Resources Development
- ❖ WA Lotteries Commission
- ❖ Wesfarmers Limited
- ❖ Wesfi
- ❖ Wespine Industries Pty Ltd
- ❖ Whittakers Ltd
- ❖ Worsley Timber Pty Ltd
- ❖ Youth Options, Mandurah

the School of Wood, it will soon be paying for itself. But as non-profit venture, it is ultimately an asset of the people of Western Australia. Its real legacy is intangible, creating a lasting bond with our natural, industrial and aesthetic heritage.

As the centre's literature explains, forests are complex, dynamic ecosystems, nowadays managed to maintain what has been described as the most important heritage of all: the ecological processes that sustain the forest itself. Heritage is what we have inherited and what we intend to pass on to future generations. But these elements are not meant to be static. The forest has been in continuous use for thousands of years and subject to heavy-duty demand since the turn of the century. The Forest Heritage Centre is edifying to tourists and industry workers alike, for in these surroundings it is impossible for those who use forest products—and this is all of us, whether we are creators or consumers—to lose touch with the precious origins of the resource.

The Forest Heritage Centre is the

outcome of a unique partnership between the Fine Wood Industry and CALM, with sponsorship from numerous State, Commonwealth and private agencies. Managed by an independent board as a non-profit making venture, the centre's mission is to increase awareness and understanding of how Western Australia's forest heritage can be conserved, managed and used most effectively. It carries the message that the natural environment is not a museum, set apart from human presence, to be visited occasionally and observed under glass. The Forest Heritage Centre presents a living, breathing example of how we fit into the whole. It is an instructive model of forests and forest use as it is happening now and, with long-term sustainable management of our forests, long into the future. Whether by a sense of nature, a fascination with forest products, or the lure of old-fashioned lore of the early timber-cutting days, visitors will be drawn irresistibly into the experience of the centre, and will leave with an enriched sense of heritage.

Top left: The old Forest Cadet School tradition of living in and learning about the forest lives on in its new function as a conference and accommodation centre.

Top right: The Forest Heritage Gallery will display and sell craft pieces made from fine wood, as well as other art and craft pieces inspired by the forest.
Photos – Marie Lochman

Tammie Reid is a Community Education Officer with CALM's Corporate Relations Division and is based in Dwellingup. She can be contacted on (09) 538 1078. For the past two years Tammie has been developing the visitor displays and walktrails for the Forest Heritage Centre.

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The Forest Heritage Centre is off Acacia Road, Dwellingup, past CALM's District Office in Banksiadale Road. It is open to the public from 10 am to 5 pm daily. The telephone number for enquiries is (09) 538 1395.

Patterns in Nature

the Biodiversity of the Carnarvon Basin

We see patterns in landscapes, but do plants and animals see the same patterns? To manage for conservation, we need to adopt an organism-centred perspective of environmental patterns. Contemporary biological surveys aim to quantify these relationships. One such survey, of the Carnarvon Basin, has recently been undertaken by the Department of Conservation and Land Management, the Western Australian Museum and the University of Western Australia.

Compiled by
Allan Burbidge and Norm McKenzie
from contributions made by members of the survey team.

The Carnarvon Basin extends from near Cape Range in the Exmouth area, south to the Murchison River and inland to the Kennedy Range. It is one of the major sedimentary basins of Western Australia and has a geological history spanning much of the last 450 million years. Because of its geographical position, the basin is influenced by both the winter rainfall of the south-west and the summer rainfall of the north. The region has an arid to semi-arid climate, with a mean annual rainfall as low as 200 millimetres in places. Severe droughts are prominent elements of the climate.

Low, open woodlands of *Acacia* species, such as snakewood and bowgada, with an understorey of shrubs, such as poverty bush (*Eremophila*), cassias (*Senna*) and saltbush, occur on the extensive plains dominating the basin. Shrubs and hummocks of spinifex grass grow on the low sand ridges that are scattered across these plains. In northern parts, the plains grade into red sand dune fields, supporting spinifex and mulga communities that are reminiscent of Australia's red centre. In the south, the plains support *Eucalyptus-Callitris* woodlands, with mallee, *Banksia* or *Actinostrobus* scrubs and heaths on greyish and yellow sand dunes. Low-lying areas, such as the fringes of Lake MacLeod and the coastal flats, support rich samphire communities. Extensive areas of coastal limestone, partially mantled by pale yellow to grey sands, support low heaths with emergent



thickets of *Banksia* and mallees, such as illyarrie. A particularly impressive feature of the area to the south of Shark Bay is the Zuytdorp Cliffs, which are topped with windblown, almost prostrate shrubland.

Previous page:

Satellite image of the lower reaches of the Gascoyne River, showing the outflow of sediment after Cyclone Bobby. Photo – DOLA WA, SPOT © CNES (1995) – SPOT Imaging Services, Sydney.

Above: An undescribed species of *Eremophila*, confined to the Shark Bay Heritage Area.

Photo – Greg Keighery/CALM

Below: This aerial view of the Gascoyne River shows the characteristic wide, sandy bed typical of Carnarvon Basin rivers.

Photo – Marie Lochman

Below right: The recent record of a kultarr in the Carnarvon Basin represents a major range extension for the animal.

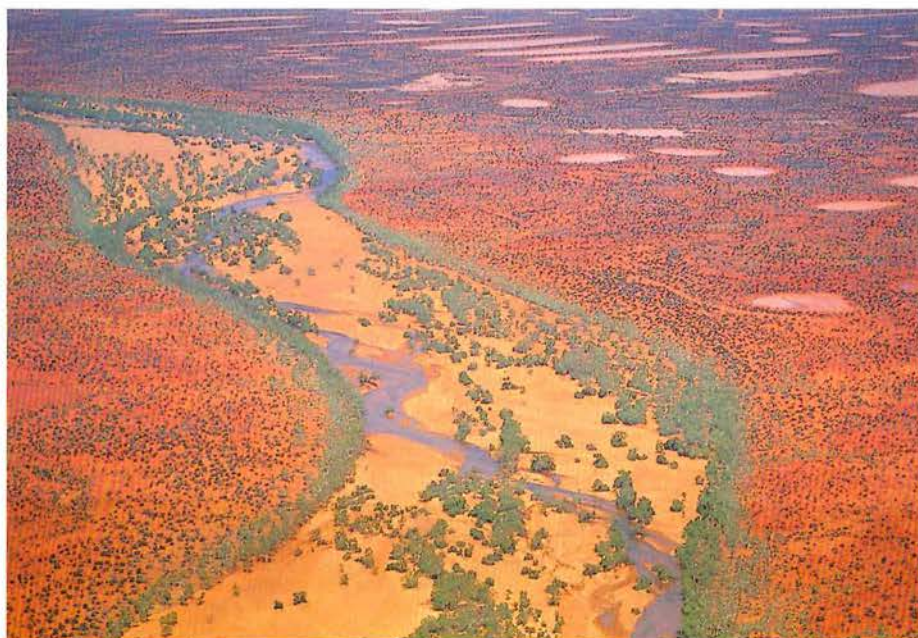
Photo – Babs & Bert Wells/CALM

EARLY EXPLORATIONS

The first recorded landing by a European in Western Australia was at Cape Inscription, at the northern end of Dirk Hartog Island, in Shark Bay, where Dirk Hartog landed in 1616. Hartog and the other early Dutch sailors made only passing reference to natural history observations they may have made. On the other hand, William Dampier, who explored the Shark Bay islands in 1699, compiled some of the earliest botanical collections by Europeans in Australia. These are still preserved in the herbarium at Cambridge University. He illustrated four birds he saw in the Shark Bay area (red-necked avocet, pied oystercatcher, bridled tern and common noddy) in his book *Voyage to New Holland*. Important plant collections were also made by the French, during voyages in the early 1800s, and by several English expeditions (sea and land) in the mid to late 1800s. The German expedition led by Michaelsen and Hartmeyer in the early 1900s produced significant collections of invertebrates. Numerous studies have been made since the mid-1900s, but these have all been opportunistic collections or observations, or have been confined to a relatively narrow range of animals or plants.

Exploration of the interior for agricultural and development reasons began in 1839, when George Grey explored the coast in the vicinity of the Gascoyne River and present day Carnarvon.

Francis Thomas Gregory explored the



Gascoyne, Lyons and Murchison Rivers in 1858, and pastoral settlement followed soon after.

THE SURVEY

Our knowledge of the patterns of distribution of native species across the study area was still fragmentary in 1993, and strongly biased towards birds and large plants in the vicinity of main roads. The data gleaned from localised studies, and from opportunistic collections held by institutions such as the Western Australian Museum and CALM's WA Herbarium, while significant, were insufficient for sound management of the native plants and animals of the region. Also, while we knew of ecosystems and ecological communities that were not represented in the area's conservation reserve network, there was no satisfactory basis for planning a representative, yet cost-effective reserve system.

Against this background, the Australian Nature Conservation Agency (ANCA), CALM, the WA Museum and the University of Western Australia (UWA) began a systematic ecological survey of the region in 1994, as part of the National Reserve System Co-operative Program. The study area extends from Lake MacLeod to the Murchison River. We included landscapes south of the Carnarvon Basin to learn more about the complex biological boundary with the wetter areas to the south.

Such a survey is a difficult and time-consuming task—the ecological systems are complex and the study area is about the size of Tasmania. To provide a perspective on the geographical patterns in biodiversity, we sampled the plants, mammals, birds, reptiles, amphibians and terrestrial invertebrates at 60 'dry-land' quadrats, and aquatic invertebrates at 60 'aquatic' quadrats, all carefully chosen to provide a cross-section of the region's environments.

Field work for the project has involved almost 30 people, including zoologists, botanists, a soil scientist and a geomorphologist. Field work is now mostly complete, and will be finished this summer. Because the region is so poorly known biologically, many of the plant and animal species have been difficult to identify—a process that is still continuing. Next, we face the challenging task of analysing and interpreting the



data so it can be used to understand biogeographical patterns in the study area, and to make recommendations for management. Even though there is still a lot of work to be done, much interesting information has already come to light.

LANDFORMS

The Carnarvon Basin is generally a region of low relief, although erosional upland regions do occur in the eastern parts. It is drained by a number of large ephemeral rivers, which carry large volumes of bed load sediment. Extensive alluvial deposition has occurred in the lower reaches of the Wooramel and Gascoyne rivers, where large deltaic complexes have formed at their coastal margins.

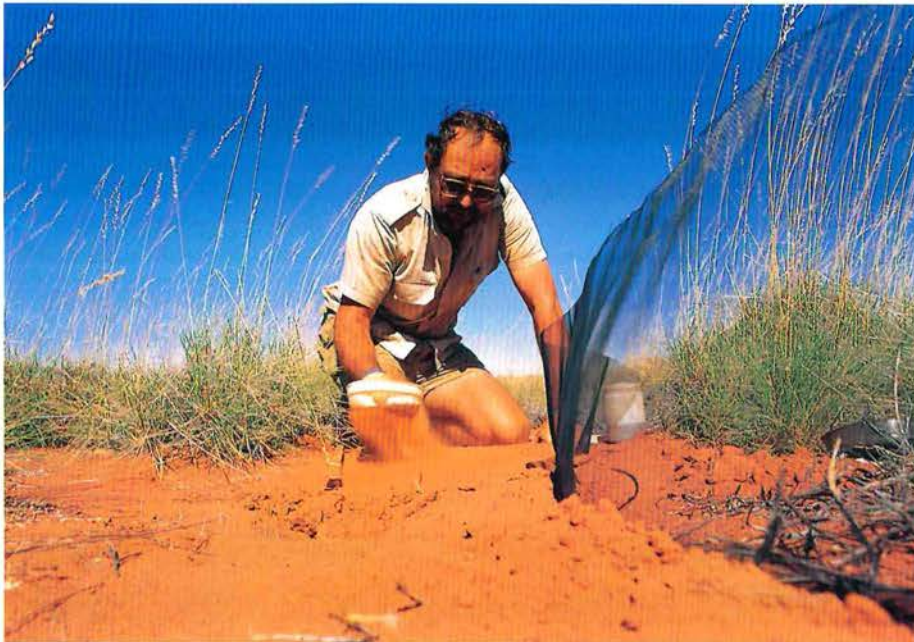
Other processes have modified the contemporary geomorphology of the region. Deep weathering during the last 50 million years has led to the formation of silcretes and laterites, which have provided a strong control on the

contemporary geomorphology of the region. Extensive dune fields attest to the extreme arid climates the region has experienced in the last few hundred thousand years. Small anticlinal ridge structures near the coast indicate recent tectonic activity that probably persists today.

The coastal regions of the Carnarvon Basin also bear a strong imprint of the changes of sea level that have occurred during the present Ice Age. The remains of coral reefs, beaches and coastal dune fields, formed during periods of higher sea levels in the past, can be seen throughout much of the region. Shark Bay and Lake MacLeod are the result of unique combinations of these geomorphological processes and changes in sea level.

PLANTS

More than 1 200 species of flowering plant are known from the Carnarvon Basin. The area is a major biogeographical change-over zone between the south-western and



Above: The odd-clawed scorpion is a common nocturnal hunter of the region.
Photo – Douglas Elford/WA Museum

Left: CALM senior technical officer Bill Muir sifting small burrowing lizards and insects from sand that was in the bottom of a pit trap.
Photo – Jiri Lochman



Left: Low shrublands of *Acacia drepanophylla* with a carpet of yellow pompom heads (*Cephalopterum drummondii*) following the exceptional rains of 1992.
Photo – Greg Keighery/CALM

desert plants. This change is especially notable between Zuytdorp and Shark Bay (see *LANDSCOPE*, Summer 1993–94).

During the course of the survey, we discovered a number of new species, including a flying duck orchid, a pigface and a one-sided bottlebrush. Taxonomic work on the collections will also result in names for several new species of coppercups (*Pileanthus* spp.) from the area. Very large range extensions were recorded for a variety of plants, especially in the wetlands—the most impressive to date being for an *Eremophila* at Shark Bay, previously thought to be confined to Cape Range.

Flora lists for most of the major conservation reserves are being compiled to help assess the conservation status of the plant species of the study area. Some plant species previously thought to be confined to Shark Bay were found further afield—the daisy *Sondottia glabrata* and *Trachymene elachocarpa* near Cape Cuvier, and the yellow-leaf newcastelia (*Newcastelia chrysophylla*), north-east of Kalbarri National Park. These species, along with more than 80 other perennial

plants, are still only known from the study area. Other examples include two undescribed species of poverty bush, in Zuytdorp National Park, together with Shark Bay mallee (*Eucalyptus roycei*) and *Halgania littoralis*, which are also Shark Bay endemics.

INVERTEBRATES

This was the first systematic collection of terrestrial invertebrates on a large scale to be carried out in the region. Twelve months of collecting produced thousands of specimens. The sorting of this material is under way at the WA Museum, where the larger invertebrates—spiders, scorpions, centipedes and beetles—are being separated for further analysis. Some smaller invertebrates will then be isolated using microscopes. So far, more than 33 orders of terrestrial invertebrates have been collected. Identification of many species will be extremely difficult, and we estimate that more than half of the invertebrates collected will represent undescribed species, never before collected by scientific surveys.

However, previous work on the larger centipedes has enabled us to identify collections to species level. Of these, *Ethmostigmus curtipes* and *Arthrorhabdus paucispinus* have had their known ranges extended westward.

Scorpions are also relatively well studied. An interesting find was the long-tailed scorpion (*Urodacus megamasticus*), which until now, had only been known from a few museum specimens from the central interior of WA. This is a significant range extension for the species. We also now know that they are probably only active for a short time during summer (maybe explaining why so few specimens had been collected previously!). Many other scorpions were collected, including the odd-clawed scorpion (*Urodacus hartmeyeri*), a common inhabitant of these areas.

Spiders were widespread in the study area and are an important part of invertebrate fauna in the region. The huntsman spider *Pediana tenuis* was found at night, climbing on tree trunks near the ground—this record extended its known range westward. Many species of trapdoor spider were collected, and sandgropers (*Cylindracheta* sp.) were unearthed at several sites.

The aquatic invertebrates were also diverse, with more than 20 orders of insects, crustaceans and other microscopic organisms occurring at many sites. At the species level, the diversity is higher; for example, up to 10 species of ostracod, many of which are undescribed, occur in claypans and rock pools. Ostracods, sometimes called seed-shrimps or shell-shrimps, are an order of microscopic crustaceans with a thin bivalved carapace, that mostly feed on organic matter from the bed of the pool or claypan. They vary between a half and three millimetres in length. Other groups still have to be identified to species level.



Above: The sandhill frog is restricted to dunefields of the basin. It can often be seen abundantly on tracks and dunes in the Shark Bay area after rain and dew.
Photo – Jiri Lochman

Right: CALM zoologist Norm McKenzie looking for wildlife among the spinifex and other vegetation on the Kennedy Range.
Photo – Jiri Lochman



REPTILES AND AMPHIBIANS

The complex mosaic of soils and vegetation types found in the Carnarvon Basin plays host to an exceptionally rich and diverse population of reptiles. More than 120 species were recorded during the survey. Around the Shark Bay region, reptiles typical of south-western, northern and inland desert habitats live in close proximity to each other, giving a total regional diversity as high as any area of equal size in Australia.

Especially complex reptile assemblages were found within the thick litter beds that accumulate beneath dense stands of *Acacia* across the region. Searching in these habitats revealed several dozen species of lizard and small snake, including as many as 10 species of burrowing and sand-swimming skinks of the genus *Lerista*.

Sampling also resulted in extensions to the known ranges of several reptile species, including two skinks, *Ctenotus calurus* and *C. rufescens*, found at Mardathuna and the Kennedy Range. The nearest they were known from previously was in the Exmouth region.

Frogs are less diverse in these relatively dry habitats. However, a heavy fall of cyclonic rain during the course of the second field trip brought out large numbers of several species. One of these was the sandhill frog (*Arenophryne rotunda*) of the Shark Bay region. This species is one of the most arid-adapted frogs in the world. It becomes active after heavy rain, but its eggs are laid in moist sand and develop directly into froglets without any free-swimming tadpole stage.

Right: White mangroves (*Avicennia marina*) line the western shore of Lake MacLeod, in the northern part of the survey area. This is one of the few occurrences of mangroves inland from the coast.
Photo – Greg Keighery/CALM

Because reptiles have low mobility, their distribution is more closely determined by aspects of the physical environment (such as soil type) than are more mobile groups, such as birds. This characteristic, together with the relatively high numbers of reptile species in the Carnarvon Basin, means that we expect reptiles to show patterns of distribution at a relatively fine scale, thereby giving us an insight into detailed biogeographic patterns. To take full advantage of this high biogeographical resolution, special effort is being put into 'fine-tuning' the classification of this group of animals prior to the final analysis. So far, the survey has found at least six undescribed species of reptile, some of which are probably not found outside the Carnarvon Basin. Many of these additional species have probably evolved only recently (in geological terms), possibly in response to environmental change over the last million years or so.

BIRDS

More than 120 species of terrestrial birds were recorded during the first (spring 1994) sampling session. The sites supporting the greatest numbers of bird species were along the major river systems—the Gascoyne and Wooramel. These included species such as the red-browed pardalote, which is restricted to riverine and similar



habitats, and the chiming wedgebill and little crow, which are widespread throughout the study area. The river systems also provide nest sites for a number of species, particularly parrots, which nest in the hollow limbs of river gums.

Letter-winged kites normally breed in the Lake Eyre basin, following rodent plagues associated with prolonged good seasons, then disperse. Our records represented the first from the study area for about 100 years.

A number of uncommon or rare species occur in the study area, but the most interesting of these is the thick-billed grasswren (see *LANDSCOPE*, Summer 1991–92). This species was formerly widespread across arid parts of southern Australia, but is now restricted to less than five per cent of its former range. Shark Bay is one of its remaining strongholds, and we found it on most of our sampling sites there, as well as on Woodleigh Station east of Shark Bay.

Fifty-five species of waterbird were recorded during the first aquatic survey in spring 1994. This included counts of

30 000 migratory waders and other waterbirds on Lake MacLeod, and 1 300 waterbirds on a large birrida at the northern end of Peron Peninsula. Both areas are important waterbird habitats. The numbers of waterbirds on river pools and other claypans were comparatively low, but up to a dozen species occurred at some sites.

MAMMALS

We recorded twenty-eight species of native mammal and nine species of introduced mammal in the study area. Of the native mammals, 10 were recorded in the region for the first time, although the kultarr (*Antechinomys laniger*) and mulgara (*Dasyercus cristicauda*) were already known from sub-fossil bones deposited long ago in caves and hollow trees by predators such as owls. Alex Baynes of the WA Museum has found that these deposits also include bones of a further 18 native mammals, comprising three wallabies, five bandicoots, four carnivorous marsupials (dasyurids) and six rodents, that appear to have become extinct in the region since European settlement. Fortunately, five of these species survive on islands in Shark Bay.

Despite the extinctions, the area is still rich in small native insectivores. We captured 10 species of dasyurid marsupial in the pit traps, and recorded eight species of small bat. Bats were identified from recordings of the high frequency sonar calls they use to locate their prey. The other extant native mammal species comprise four native rodents, three kangaroos, the honey possum (in the extreme south of the study area), echidna and dingo. The nine introduced mammals ranged in size from house mice to camels.

PRELIMINARY IMPRESSIONS

Results to date show that plant and animal species are not uniformly distributed across the study area. There is a north-south change from tropical arid species (Torresian crow, little red kaluta and the lizard *Ctenotus saxatilis*) to temperate species (western yellow robin, honey possum and south-western spiny-tailed gecko). Also, at more local scales, certain species associate with sands, like the flat-bellied lerista (*Lerista planiventralis*), spotted sand-dragon (*Ctenophorus maculatus*), rufous-crowned emu-wren and lesser hairy-footed dunnart (*Sminthopsis youngsoni*). Others, such as



A new species of flying duck orchid (*Paracaleana* sp.) discovered on Nerren Station during the survey.
Photo – Greg Keighery/CALM

the cinnamon quail-thrush and kultarr (*Antechinomys laniger*), prefer heavier soils, while a few, including djoorri or common rockrat (*Zyzomys argurus*), long-tailed dunnart (*Sminthopsis longicaudata*), ring-tailed bicycle-dragon (*Ctenophorus caudicinctus*) and spotted dtella (*Gehyra punctata*), are confined to rocky outcrops. Although the different groups of organisms show similar geographic patterns at broad scales, their ecological responses to landscape mosaics at more local scales are visibly different. The significance of these differences will be quantified during the analysis phase of the study.

CONCLUSIONS

The region has supported a pastoral industry for a century, and been invaded by pervasive pests such as buffel grass, rabbits, goats and foxes. Many native species have declined or become extinct, although some persist on adjacent islands. The survey data-base will provide managers with a scientific basis for conservation decisions relating to land-use and land-care in the future—both on conservation reserves and on other land. It provides much useful information on the biodiversity of the region, including knowledge of the ecological communities that are centres of endemism. Equally, it provides information on the conservation

status of the region's indigenous species, gaps in the region's reserve network, distribution of a wide range of introduced and feral species (such as weeds and feral predators and herbivores), a basis for searching for additional populations of rare species and a regional framework for future environmental impact assessments.

Such detailed data on the distribution of each species in relation to the region's physical environments, provide the first explicit basis for designing a cost-efficient reserve network and for assessing conservation priorities in the region.

There are several conservation reserves in the study area, the major ones being Francois Peron National Park, Kennedy Range National Park, Toolong Nature Reserve and Zuytdorp National Park (which will be extended to include the present Cooloomia Nature Reserve).

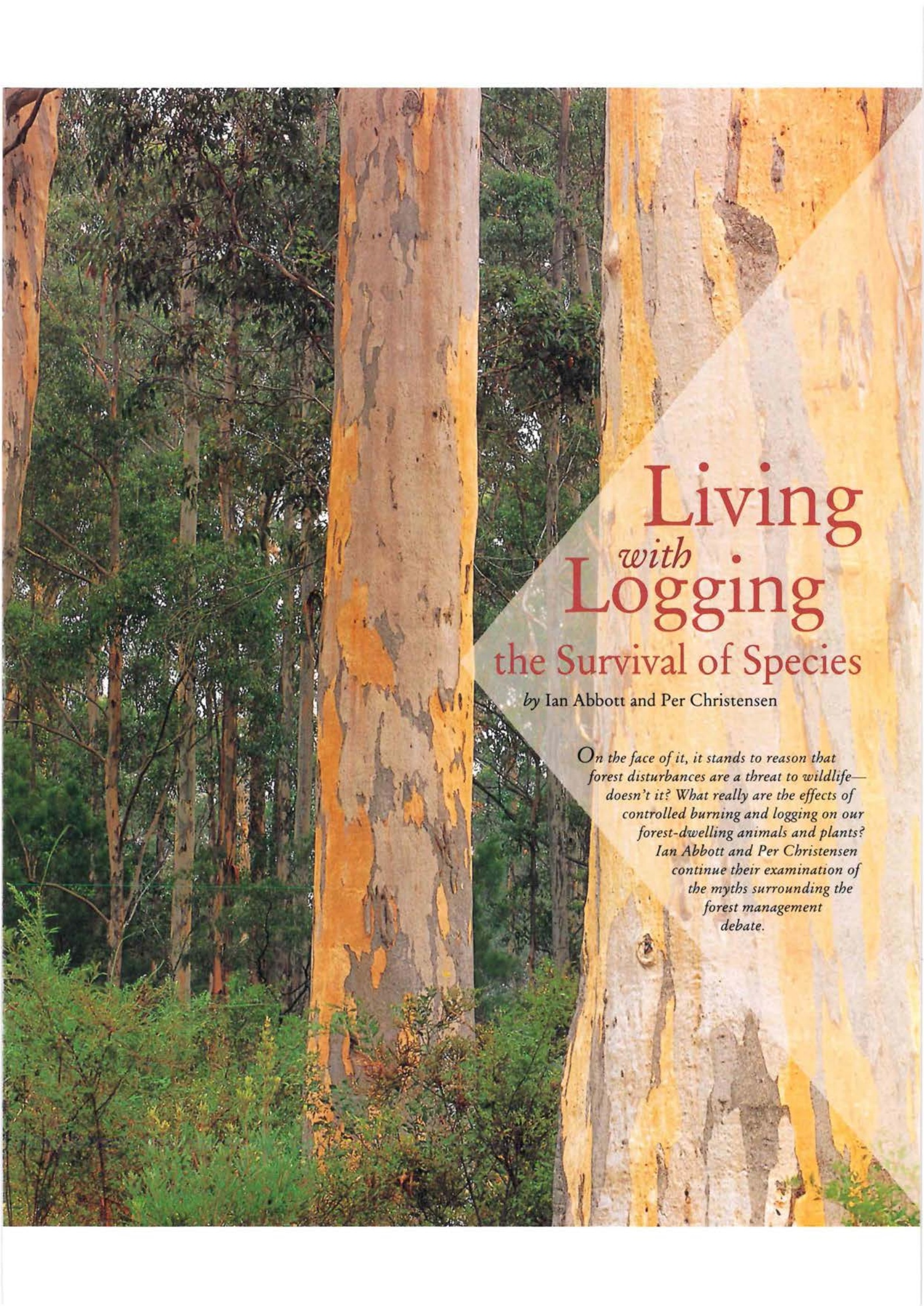
However, while including important and interesting ecological communities and rare or unusual species, these reserves are all at the margins of the study area. They do not include some of the major ecological communities (and therefore significant aspects of the biodiversity) of the region. In particular, the floodplains of the Wooramel and Gascoyne Rivers, and the extensive snakewood-bowgada communities on the undulating plains are not represented in the conservation reserve system. There are also other, less widespread—but nevertheless important and interesting—ecological communities that are not in the reserve system. These include the mallee scrubs in the southern part of the study area and the samphire communities around Lake MacLeod. In addition, many interesting species occur outside the conservation reserve system. A future challenge will be to ensure the conservation of these species and communities.

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Living *with* Logging the Survival of Species

by Ian Abbott and Per Christensen

On the face of it, it stands to reason that forest disturbances are a threat to wildlife—doesn't it? What really are the effects of controlled burning and logging on our forest-dwelling animals and plants? Ian Abbott and Per Christensen continue their examination of the myths surrounding the forest management debate.

In 1633 in Italy, Galileo was forced to withdraw publicly his support for the startling theory that the Earth revolves around the Sun. When the judgement was delivered by the Inquisition, Galileo is reputed to have whispered 'Eppur si muove' ['All the same, it does move']. More than 350 years later in the Western Australian forests, we must be equally watchful that what seems obvious (as the apparent movement of the Sun around the Earth did to 17th-century civilisation) does not blind us to the truth.

In a previous article ('Looking Beyond the Obvious', *LANDSCOPE*, Winter 1995), we discussed some widely held beliefs about scientific knowledge of WA's forests, the cherished status of old growth forest, the adequacy of the reserve system, and the effects of clearfelling. By looking behind what seems obvious, we found that the reverse was often true: appearances frequently bear little relation to the facts.

In this article, we shall look at the effects, both real and supposed, of controlled burning and logging in our South West forests.

UNDISCOVERED SPECIES

In 1994, a new species of frog was discovered in State forest near Walpole. This provided a new occasion for an often-repeated criticism of logging and controlled burning: that it harms vertebrate or plant species as yet undiscovered by science. In this example we might



Quenda now live in very dense, swampy places, where they find shelter from foxes.

Photo – Jiri Lochman

formulate the argument as follows:

1. Many areas around Walpole have been logged or burned in the past.
2. The new frog species has been found only in three forest sites (about five hectares).
3. Therefore, it became extinct elsewhere because of logging or burning.

This conclusion does not follow. The significant factor about this new species of frog is not that it occurs in forest (burned or unburned), but that it does so in a much more restricted habitat—peat swamp. It has survived because there has been little gross disturbance of this habitat, which occurs in non-forest flats between forested areas. A more valid conclusion here might not find against controlled burning, but for it: those forest blocks had been the site of spring burning, which has helped protect the frog's habitat



Tammar wallabies have vanished from most of their range, but they thrive when protected from foxes.

Photo – Babs & Bert Wells/CALM

from summer fires.

The evidence is that most vertebrate fauna of the forest has already been discovered and named by scientists. Nearly all of the reptile, bird and mammal species were collected and described by 1850, before any logging took place. With the sole exception of Lewin's water rail (a bird that lived in swamps, not forests), these species are still present. Only five new vertebrate species (some two per cent of the total known vertebrate fauna) have been found in WA forests since 1970. By the law of diminishing returns, few new vertebrate species await discovery in the forest.

The lure of discovering new species sometimes prompts calls for more biological surveying. Superficially this may seem an attractive idea. However, it has been shown that most vertebrate and plant species in jarrah and karri forest occur over relatively large areas, so it is unlikely that the surveys already undertaken would not have identified nearly all species in these groups. For example, when fifteen surveys of southern forests for mammals, birds, reptiles, amphibians, freshwater fishes and vascular plants were tabulated, the first few surveys in different parts of the forest resulted in the recording of many species. After the twelfth survey, the number of previously unrecorded species diminished markedly. There is almost no likely reward for increased survey effort.

Previous page

Karri (*Eucalyptus diversicolor*) in State forest.

Photo – Jiri Lochman

Left: Numbat. This species experienced a marked decline in distribution and abundance before a program of fox control was begun.

Photo – Bert & Bert Wells/CALM





The carpet python is rarely found nowadays on mainland Western Australia, though it is common on several islands.
Photo – Babs & Bert Wells

All this brings us to the fundamental issue. Should the State halt a well-managed and necessary activity on the slight chance that a new species remains to be found, one which, rather improbably, might be threatened by current methods of controlled burns and logging? This is a question for the community, not for scientists; but the answer should not be sought without the perspective that science can bring.

SPECIES EXTINCTION

It may seem at first that logging or burning might permanently reduce the biodiversity of native State forest. (State forest is designated by Act of Parliament for a number of uses, including recreation and logging. Up to two per cent is actually logged each year, and only a part of this is clearfelled.) Scientific research continues to study the effects of controlled burns and logging, but the results so far tell us that they cause only temporary disturbances. Any local disappearances of species are made good as animals and plants return. There is little in the extensive scientific literature to suggest any permanent or irreversible changes to the ecosystem.

From the evidence available, species survival has little to do with forest disturbance, whether natural or artificial. Life and death are part of nature's cycle; many young animals and seeds die in



Baudin's cockatoo is a magnificent and noisy forest bird that breeds in tree hollows.
Photo – Jiri Lochman

undisturbed forest for many reasons, often because there is no space for them. In the latter case, indeed, any disturbance to the forest—including logging and burning—can actually enhance the survival of some species by modifying the habitat to accommodate them.

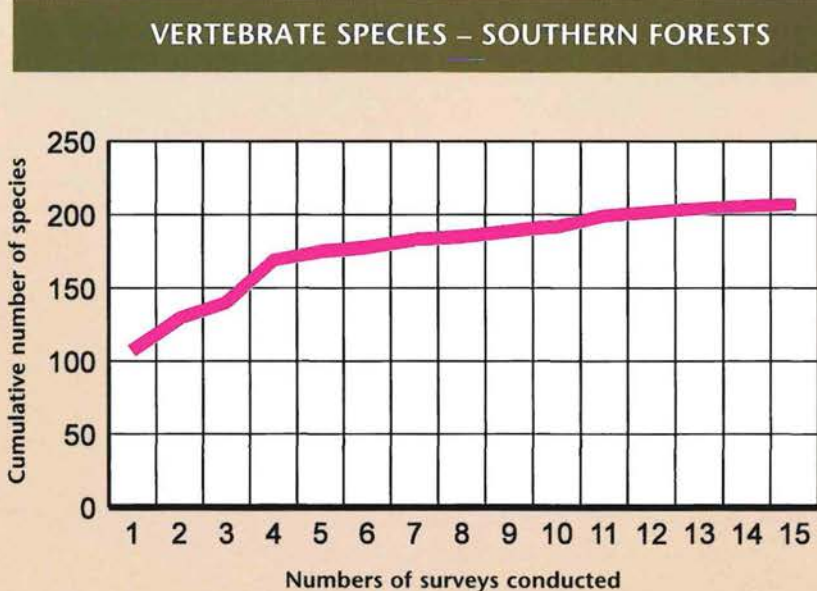
The South West forests are among the few places in Australia where we can still find the pre-European vertebrate fauna almost completely intact, even though some mammals have declined in distribution in the forests because of fox predation. This fact alone suggests that current forest management must be working. Indeed, only one species of vertebrate or plant has apparently become extinct in State forest. This species, Lewin's water rail, was last recorded in State forest in Western Australia in 1932, and also disappeared from its habitat



Red-eared firetail is a seldom seen but perhaps common inhabitant of dense vegetation, often along streams.
Photo – Babs & Bert Wells/CALM

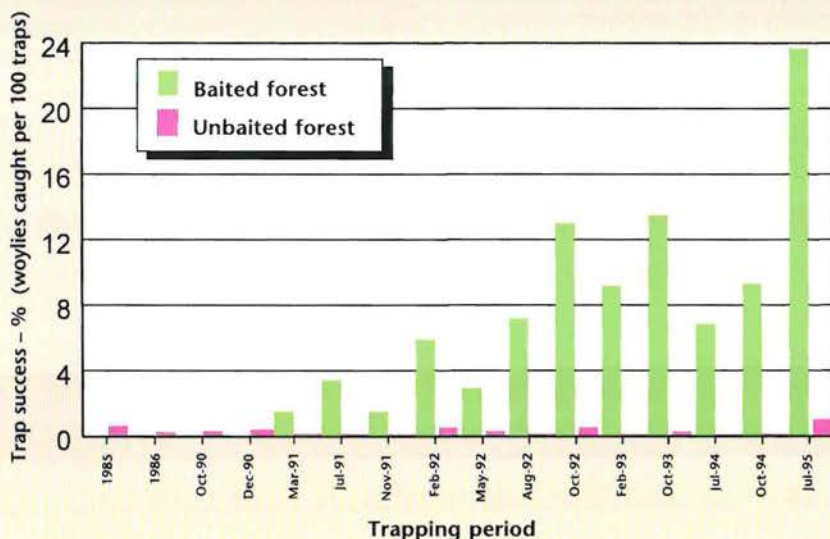
(swamps) outside State forest. As swamps in State forest were not logged (or subjected to protective burning until the 1950s), neither factor can have caused the species' apparent demise.

In contrast, 26 species have become extinct on the Swan Coastal Plain, probably due to the clearing of nearly 80 per cent of its native vegetation for agriculture and urban development. An astonishing 43 species have disappeared from the Wheatbelt, because more than 90 per cent of its native vegetation has been cleared for cereal growing. Of the original forest, 42 per cent has been cleared for farming; 12 species have been lost from this part. In State forest, however, only two per cent of forest has been permanently cleared for public utilities such as highways, railways, power grids and dams.



A cumulative curve for vertebrate (mammal, bird, reptile, frog, freshwater fish) species in southern forests of WA.

MEAN DAILY TRAP SUCCESS RATES(%) OF WOYLIES IN BAITED AND UNBAITED JARRAH FOREST



The argument about species extinction is sometimes applied also to plant communities. It might be thought, for example, that every patch of forest is unique because it contains a mixture of plant species not quite the same as anywhere else. At best, however, these patches are unique only in the sense that a kaleidoscope image is unique. One patch may be fractionally different from others, but its elements are amply represented elsewhere.

The reason that extinctions of species have been few in WA forests is that sustainable use of natural resources, if properly managed, helps conserve the natural environment. This insight seems to have first been recorded in WA by the eminent WA geographer Dr Joseph Gentili, who wrote:

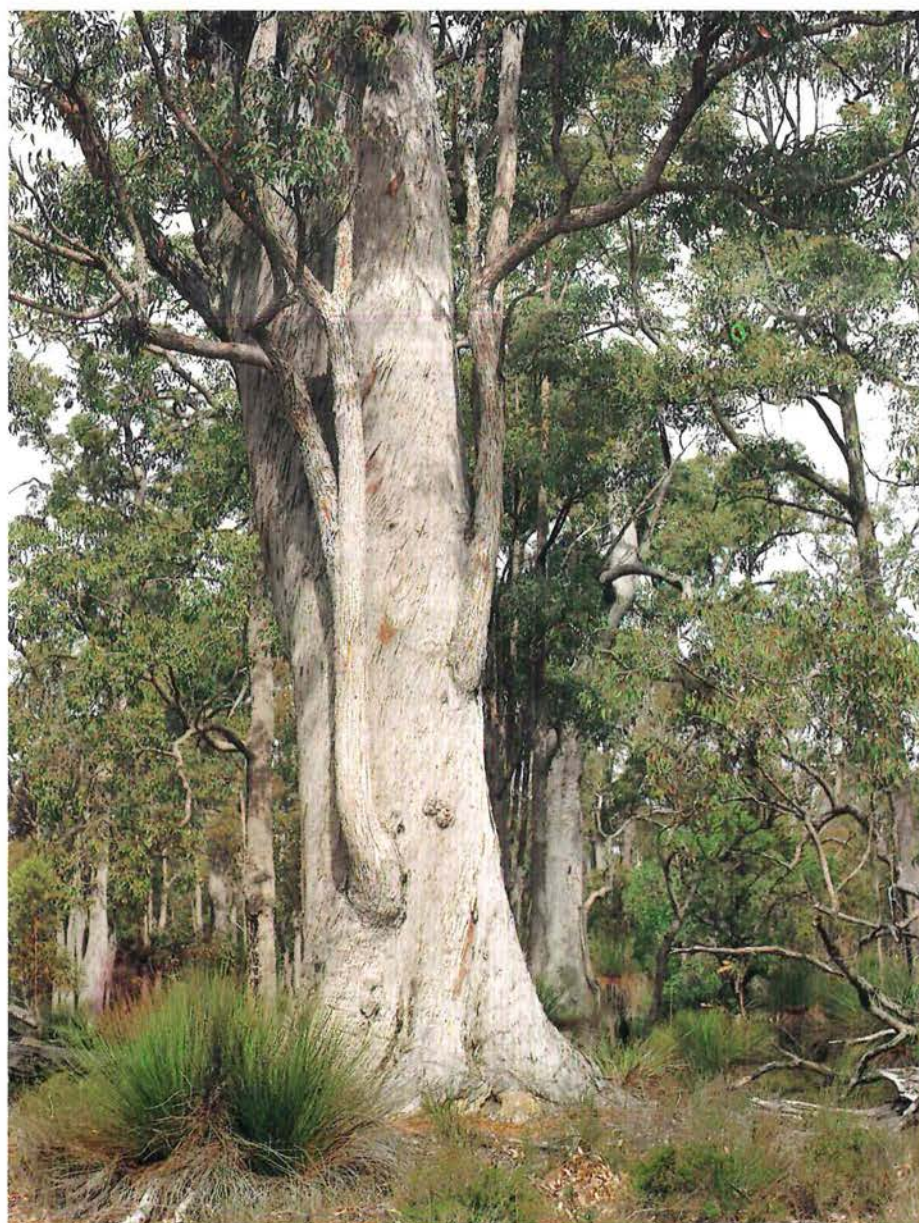
'Good forest stands are well preserved as areas of natural environment for the very simple reason that they are well protected because of their economic value.'

No matter what value is the motivating factor, protection is protection. All the evidence suggests that species are safe in the forest, whether it is logged or not.

Ironically, the people often criticised for allegedly harming the forest are the people who feel they have done most to protect it. The foresters of Western Australia laid the foundations for forest management in the State, which has helped to ensure that these species are still present in the forests. In a series of policies made possible by the Forests Act of 1919, the forests have been looked after in ways that have sufficiently sustained them. Managed burning has reduced the threat and impact of wildfire, large areas have been placed into reserves, and areas designated for timber production have been logged on a sustainable basis. Without such controls, our forests would presumably have gone the way of many other forests elsewhere in the world—taking many species with them.

Above: At Batalling, scientists record the number of woylies caught in areas where foxes have been controlled since 1991, as well as in adjacent areas.
Data – Keith Morris

Left: Example of a large jarrah tree damaged by wildfire.
Photo – Jiri Lochman



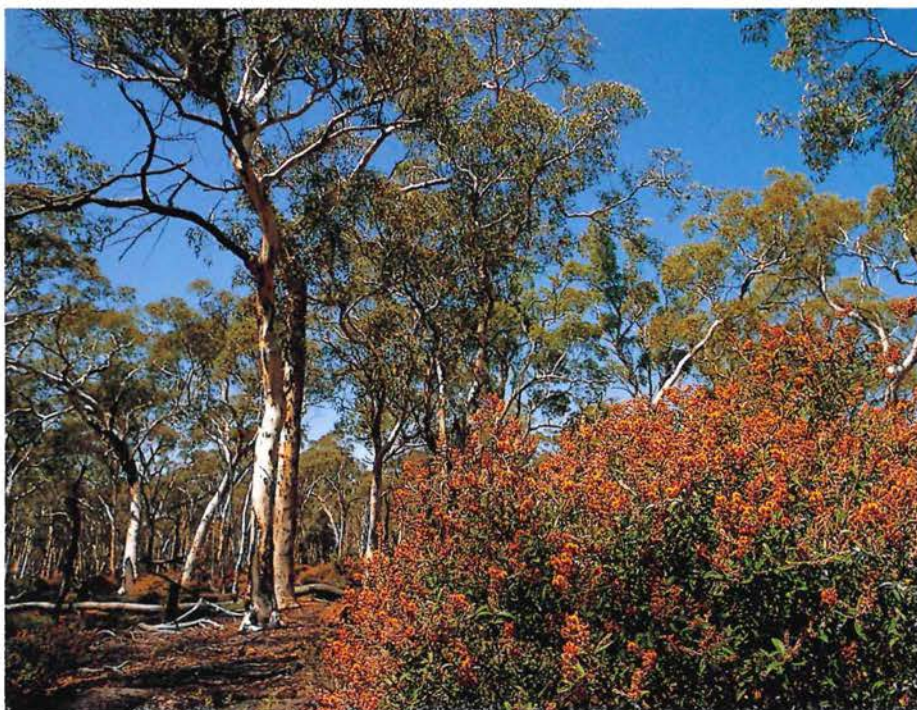
RARE SPECIES

Decline in populations of native mammals such as the chuditch (*Dasyurus geoffroii*), woylie (*Bettongia penicillata*), numbat (*Myrmecobius fasciatus*), quenda (*Isoodon obesulus*), western ringtail possum (*Pseudocheirus occidentalis*) and tamar (*Macropus eugenii*) is often attributed to logging and burning. The implication is that if logging and burning were stopped, such species would respond by becoming more common.

The culprit, however, is not forest management. Before the 1920s, these threatened native mammal species occurred throughout the South West, including the Swan Coastal Plain and Wheatbelt, and several even ranged into the deserts and interstate. It was the arrival of the introduced red fox that virtually eliminated them from outside State forest. These species were protected within State forest by the forest's dense understorey and the presence of poison peas (*Gastrolobium* spp.). Experimental baiting in regrowth jarrah forest since 1991 has demonstrated large increases in the abundance of chuditch (see 'Return of the Chuditch', *LANDSCOPE*, Summer 1992–93) and woylie. Baiting in Dryandra (just east of State forest) began in 1982, allowing the numbat to resurge in numbers after being close to extinction.

State forest, the traditional source of most of the State's timber, not only seems to be no threat to threatened or specially protected species, but is actually a haven for them. Other than Lewin's water rail (presumed extinct), six rare bird species either live or breed there: the mallee fowl (*Leipoa ocellata*), the peregrine falcon (*Falco peregrinus*), Carnaby's cockatoo (*Calyptorhynchus latirostris*), Baudin's cockatoo (*C. baudinii*), the crested shrike-tit (*Falcunculus frontatus*) and the red-eared firetail (*Stagonopleura oculata*). Other rare animals found in State forest are two frog species, the white-bellied frog (*Geocrinia alba*) and the orange-bellied frog (*G. vitellina*), and two species of snake, the woma python (*Aspidites ramsayi*) and the carpet python (*Morelia spilota*). All of these took refuge from cleared areas into areas of forest which, in many cases, have been logged for the past century.

Most of these bird and reptile species occur more widely than State forest.



Significantly, however, State forest seems to be the place where they thrive. Carnaby's cockatoo and the woma python are Wheatbelt species, which breed in wandoo woodland in the eastern extremity of State forest. The white-bellied frog occurs mainly on private property, where its habitat has to be protected against grazing; in State forest it is secure without such protection. The crested shrike-tit occurs mainly in wandoo and other woodland. Since 1971 it has colonised the karri forest and is now widespread there, occurring in regrowth as well as old growth forest. The mallee fowl also appears to have colonised karri forest near the Frankland and Deep Rivers—evidently the dense thickets of regenerating karri after clearfelling provide a safe haven from fox predation. The only species on the list that are uncommon in the forest are the peregrine falcon and carpet python, but they are widespread.

What is true for animals seems also to be true for plants. Only 30 species of Declared Rare Flora (DRF) are known to exist in State forest. By contrast, 132 species in the Wheatbelt have been designated as DRF. Locations of known populations are recorded on operational plans, and are not disturbed without Ministerial approval. Field staff from the Department of Conservation and Land Management (CALM) have also searched for and located many populations previously unknown to scientists. Before logging roads are constructed, the forest

Wandoo woodland with the poison pea (*Gastrolobium microcarpum*) in flower.
Photo – Marie Lochman

is searched systematically for the presence of any DRF known in the region.

HOLLOWS

It is sometimes said that logging and burning operations place stress on species dependent on tree-hollows, which occur only in older trees. In jarrah forests, hollows are scarce in trees smaller than 50 centimetres in diameter (about 90 years old). Hollows in jarrah become common in trees broader than 80 centimetres in diameter (about 150 years old).

Fifteen of the 29 mammal species present in State forest use hollows. Only two species, the brush-tailed wambenger (*Phascogale tapoatafa*) and western false pipistrelle (*Falsistrellus mackenziei*), are largely restricted to State forest. Furthermore, eight of the hollow-using species are very small (weighing less than 15 grams, the weight of a 50 cent coin). As there are plenty of small hollows throughout most of the forest, it is unlikely that these and the two next smallest (25–35 grams) species are limited in distribution or abundance by the supply of hollows.

The other species that use hollows in live trees (brush-tailed wambenger, western ringtail possum and brushtail possum) live in home ranges varying from 2.5 hectares to 40 hectares. In jarrah forest, therefore, CALM's policy is to leave



Left: The wambenger is an arboreal species of mammal formerly widespread in the south-west, but now restricted mainly to State forest.

Below: The tree martin, one of the smaller species of hollow-using birds widespread in the south-west, does not require large nesting hollows. Photos – Babs & Bert Wells/CALM

DISTURBANCE AND GONDWANAN SPECIES

Many invertebrate species in south-west WA are thought to be survivors of ancient species present when Australia was part of the supercontinent Gondwana, which broke up about 65 million years ago. These species require cool wet habitats. Most occur in freshwater streams and swamps. Terrestrial species appear to be confined to moist or water-gaining sites, such as soil and litter around granite outcrops, and in tingle and karri forest in the wettest part of WA.

It is frequently presumed that terrestrial Gondwanan species are ultra-sensitive to any disturbance—such as burning, logging or road construction—which tends to open the canopy or reduce the amount of litter in the forest. The facts are otherwise.

Natural climatic changes in the past few thousand years have temporarily decreased the abundance of karri forest. Past wildfires (essential for the natural regeneration of senescent karri forest) must have incinerated relatively large areas of forest. Rather than being sensitive to environmental change, therefore, Gondwanan relict species may well be

three hollow-bearing trees per hectare—a choice of 7–120 habitat trees per home range for a suitable nesting hollow. In addition, trees with hollows occur in streamside reserves, which are not logged. In karri forest, some 40 000 hectares of mature forest are set aside in National Parks, Nature Reserves and Conservation Parks, with a further 18 000 hectares protected in road, river and stream zones. All clearfelled sections (with an average area of 50 hectares) are close to mature forest containing hollow-bearing trees.

Two other mammal species use hollows, but not in live trees. Female numbats and chuditch spend most of their lives in an area of 50 hectares and 90 hectares, respectively. There, hollows in fallen limbs, burnt-out stumps and suitable waste sections of logs are available for refuge and nesting. Logging increases the abundance of suitable hollows on the ground for these species.

The increases in abundance of these medium-sized, hollow-requiring mammal species, following widespread fox-baiting of forests, suggest it is this predator that limits their distribution and abundance, not the availability of hollows.

Nesting hollows are required by 21 of the 113 bird species present in State forest, though 19 of these species occur widely or nearly solely outside State forest. Only two species (Baudin's cockatoo and the forest red-tailed black cockatoo *Calyptorhynchus magnificus naso*) are dependent upon State forest. Small species such as the tree martin and

striated pardalote need small holes, which are in plentiful supply. Larger species (for example, the barking owl and the red-tailed black cockatoo) have larger home ranges, and the provision of three habitat trees per hectare in jarrah forest allows a choice of large hollows from about 150 trees per home range. Species found most frequently in karri forest (such as the purple-crowned lorikeet, the western rosella and Baudin's cockatoo) have available 40 000 hectares of mature forest (46 per cent of karri forest) reserved from logging.

None of these hollow-dependent species is therefore considered to have been put at risk by logging operations in State forest.



Right: Varied-leaf grevillea (*Grevillea cirsiifolia*), an example of a rare plant that grows in State forest.

Photo – Andrew Brown/CALM

Below: Purple-crowned lorikeet is particularly common in karri forest, where it sups nectar from the karri blossom.

Photo – Babs & Bert Wells/CALM

resilient and capable of coping with change; their patchy distribution may be caused by naturally discontinuous habitats. As part of its nature conservation policy, CALM leaves up to 5-metre zones of uncut forest around any rock outcrops more than 0.2 hectares in size, and also leaves a 60-metre-wide minimum zone along streams. Almost all of these species occur in non-forest types that are a part of CALM's reserve system and not subject to logging.

Since 1978, ecologists have recognised that 'intermediate disturbance'—such as occasional fire in the forest—promotes species diversity. That is how our forests and wildlife have evolved. The extremes (no disturbance or very frequent disturbance) actually reduce biodiversity.

PRECAUTIONARY PRINCIPLE

The precautionary principle asserts that decisions should be guided by careful evaluation to avoid, wherever practical, serious or irreversible damage to the environment, and by an assessment of the risks and benefits of various options. Stated thus, few would disagree with the principle.

Regrettably, however, it is too easily interpreted as 'Do nothing until everything is known'. Some people who are worried



about logging and controlled burns in forests would like to see surveys of every square metre, so as to detect rare, hidden species presumed to be on the verge of extinction. Because such minute scrutiny would be hugely expensive, time consuming and impractical, the approach adopted by CALM has been to conduct regional biological surveys, to develop an understanding of the major vegetation types. This, together with more detailed studies of key species and the impact of management practices, enables CALM to make decisions in accord with the precautionary principle. If there is a compelling reason to make a minute study, one is made—as happened, for example, in the cases of *Grevillea cirsiifolia* and

Acacia aphylla in the jarrah forest.

Forest management is like any other area of science. While it cannot be based on perfect knowledge, it is supported by a broad and robust body of scientific concepts, empirical facts and scientific principles. There is an ongoing need to refine or modify these concepts and principles, and to acquire further facts; indeed, about one third of CALM's current science projects concern research in native forests. Such research will never finish, and its results will always influence forest management. That is what it is for.

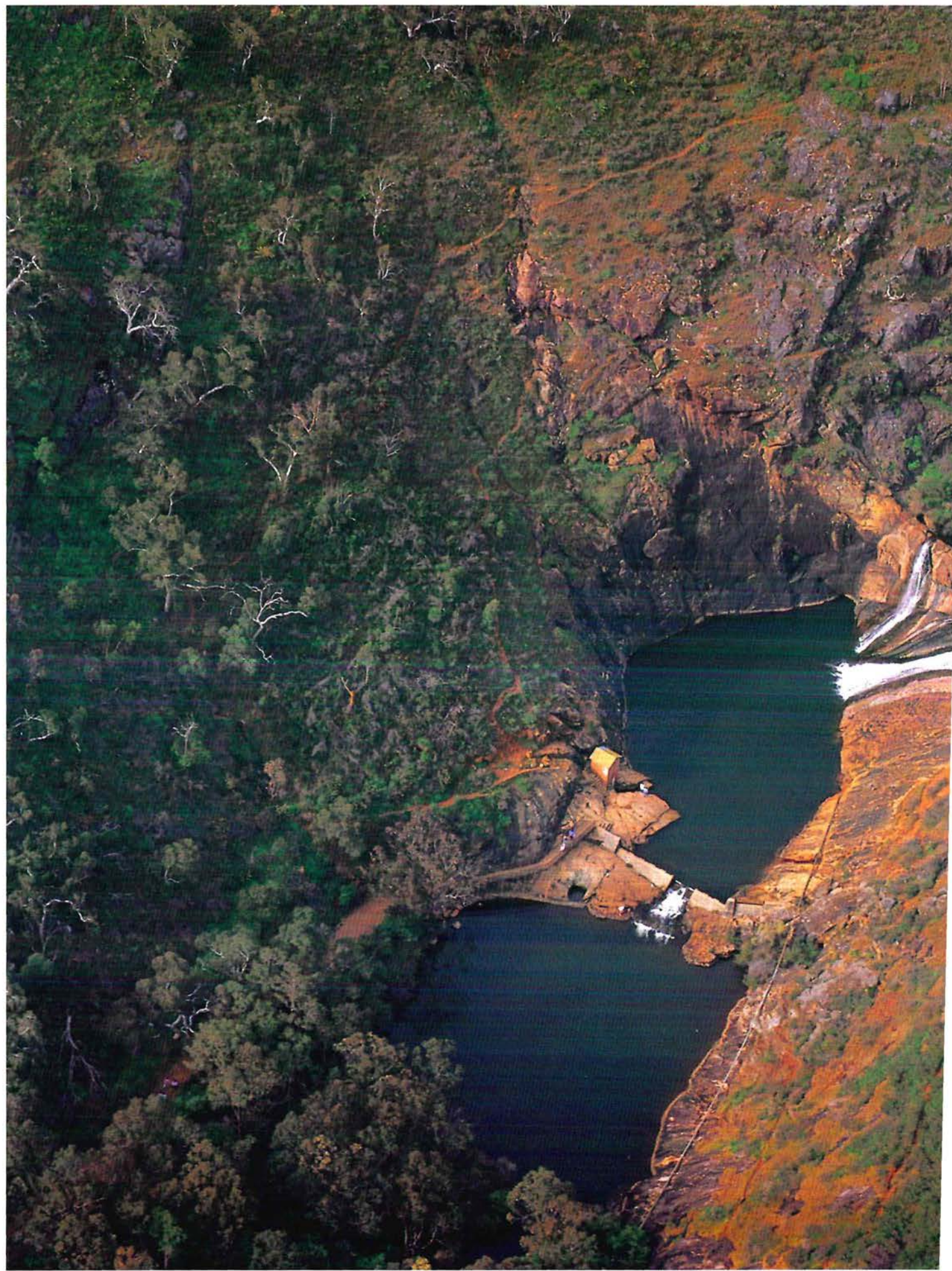
As the example of Galileo shows, we must welcome the truth exactly as it is—even if the evidence of our own eyes makes it difficult at first to believe.



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The research data referred to are available from the library at CALM's Como Research Centre on (09) 334 0314.



Serpentine

NATIONAL PARK

Serpentine National Park, best known for the waterfall that cascades over a sheer granite face, abounds with the scenic beauty of ancient landforms and verdant forests. These features, together with its nearness to Perth, have attracted day visitors for almost a hundred years.

A draft management plan, prepared by the Department of Conservation and Land Management, will help ensure that the plants, animals, landscapes and cultural heritage that have attracted so many people in the past, remain for generations of future visitors.



by David Gough, Paul Brown,
David Lamont and Wayne Taylor

The Serpentine National Park is located on the Darling Scarp, about 30 kilometres inland from Rockingham and 50 kilometres south-east of Perth. The scarp is the titled western edge of a huge ancient plateau that is the foundation of much of the south-western part of Australia. It is composed mainly of granite, with some dolerite, gneisses and quartzites up to 2 500 million years old. An overlying layer of laterite rock formed about 10 million years ago, when wetter and more humid conditions leached minerals from the soil to form an insoluble hard crust.

Set in a naturally beautiful cleft at the foot of the scarp, the park stretches up the steep slopes of the Serpentine River valley past a sheer face of granite polished smooth by the rushing waters. Here, in winter, the white waters of the Serpentine River cascade into a swirling, rock-rimmed pool beneath. Serpentine Falls has been one of the main focal points of the area since the early European settlers came in droves to swim, picnic and enjoy a day out in the bush.

ABORIGINAL HISTORY

But long before European settlement, Nyoongar Aborigines of the *Whadjuk* and, probably, *Bindjareb* tribes hunted and camped in the woodlands between modern-day Perth and Pinjarra. Like most Nyoongars of the south-west, they used fire-sticks to burn parts of the forest, and over thousands of years, the scrub fires created some areas of open forest and patches of grassland.

Previous page

Main: Aerial view of Serpentine Falls, one of the major attractions of Serpentine National Park.

Photo – Dennis Sarson/Lochman
Transparencies

Inset: The splendid fairy-wren is one of several birds commonly seen around the picnic areas.

Photo – Babs & Bert Wells/CALM

Right: Spencer's Cottage—once home of one of the area's earliest settlers—is listed on the Register of Heritage Places.

Photo – Dennis Sarson/Lochman
Transparencies



The Serpentine River, the surrounding hills and the coastal plain wetlands provided the Nyoongars with fresh water, fish and other food resources such as tortoises, lizards and birds. Fish traps were frequently constructed on the river downstream of the falls, and where it flows through a chain of small lakes on its journey to the Peel Inlet. Each year, at the start of the winter rains, tribal groups from the north, east and south would gather near Barragup to catch the fish that were driven downstream by the fast flowing waters.

Many of the streams flowing off the scarp supported family groups during different seasons of the year. The two streams that flow into the Serpentine above the falls were named *Carralong* and *Gooralong*, and an area between them, later known as Spencer's Flats, was reputed to have been used for

One of the newly constructed footbridges on the realigned Kitty's Track walktrail along Gooralong Brook.

Photo – Dennis Sarson/Lochman
Transparencies

corroborees. Mr Frank Baldwin, now in his 70s, has a property adjoining Falls Road and he remembers, as a child, seeing Nyoongars clambering among the Scarp rock digging out the fleshy tubers of warrine (*Dioscorea hastifolia*).

For the Nyoongars, life in the hills and on the plain was generally good; they had sufficient food and resources for their needs and they moved about freely from season to season. But with the coming of the settlers, their lives changed dramatically.



EXPLORERS & SETTLERS

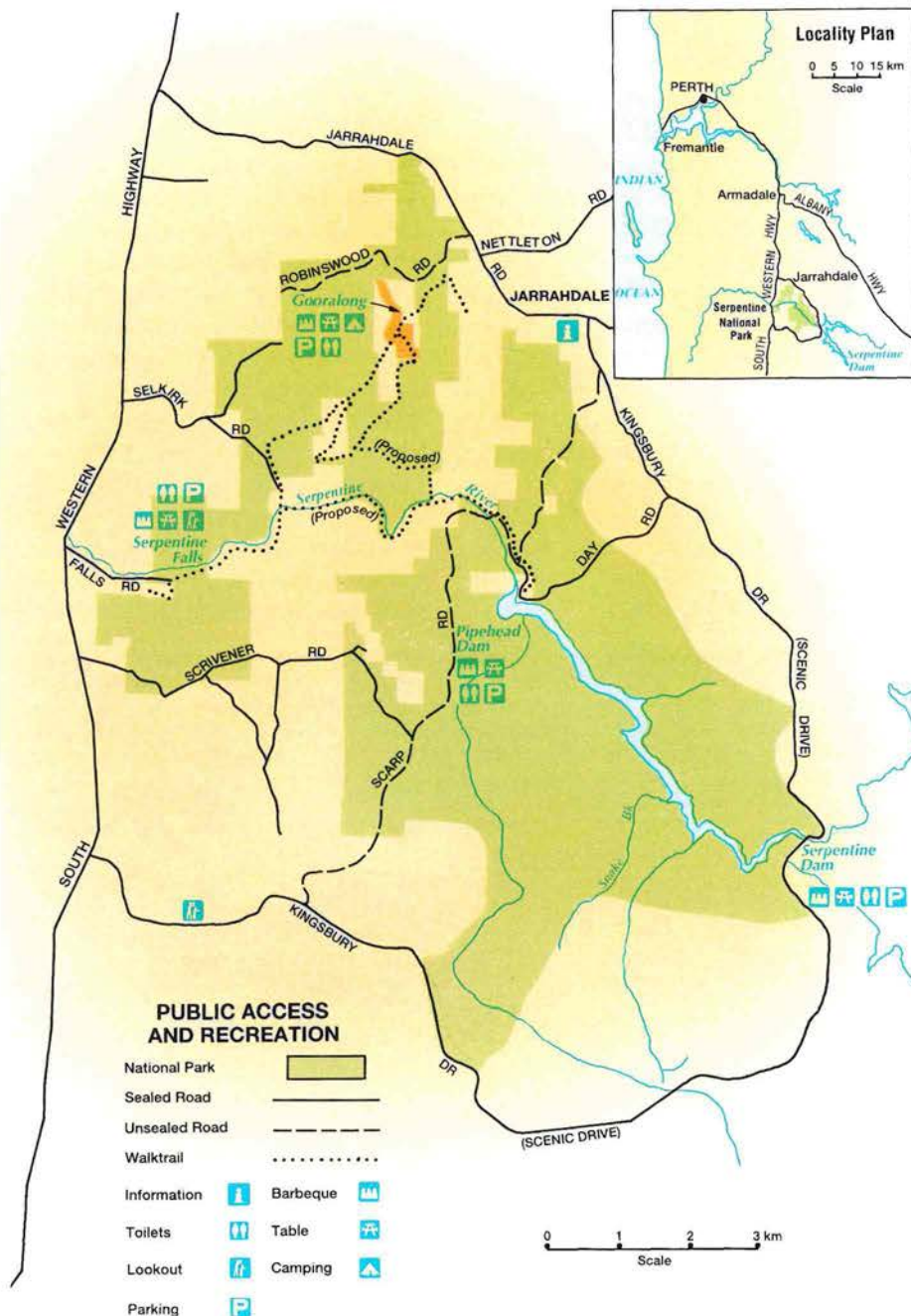
In late July, 1829—two months after the Swan River settlement was founded—Captain Mark Currie led a party, which included botanist James Drummond, 'to ascertain whether any river ran' in the area south-east of Mangles Bay. They sailed south on *HMS Challenger* and, leaving the ship on 30 July, headed inland to camp overnight at Tamworth Hill. The following morning, after walking some three miles [4.8 km], the party came across a river '...of some magnitude, but could not pursue it to its mouth, owing to a man knocking up with fatigue' [diary of Jane Currie]. Currie's journal does not mention the river being named. The first use of 'Serpentine' to refer to it appeared on a map published for the *Journal of the Royal Geographic Society* in September 1832.

Much of the land on the coastal plain between Lake Cooloongup and Pinjarra was originally given over to Thomas Peel in late 1829. His plan, which was supported by the then Governor Stirling, was to colonise the area with 400 settlers brought over from England. The scheme, although apparently sound, was fraught with disaster. (See also 'Yalgourp: A Place of Lakes', *LANDSCOPE*, Autumn 1995.)

CLEARING, CUTTING & MINING

Between 1850 and 1865, a new wave of settlers began to establish themselves at Pinjarra and along the Serpentine and Murray Rivers. They cleared areas of land near permanent water, built makeshift cottages and began farming for their own supplies. In the mid-1850s, Joseph Batt built a large, water-powered flour mill at Gooralong Brook and a smaller wheat gristing mill at Carralong Brook. In 1860, the Spencer family bought the Carralong Brook property and built 'Spencer's Cottage', which still remains and was placed in the Register of Heritage Places in October 1994.

In 1870, a lease was negotiated to cut timber from the 100 000-hectare Jarrahdale Timber Concession, part of which is now included in the eastern section of the park. Over the next 50 years, a number of mills and a network of wooden railways were built. Very soon, large quantities of timber were being taken from the Serpentine valley—in fact,



in the booming timber days, Jarrahdale was the largest centre of population between Fremantle, Bunbury and York.

Also around that time, part of the area now within the park was mined for gold and silver, although there is doubt as to whether the reported gold strike was genuine. Remains of the old mines persisted until 1981, when several open shafts were filled because they were considered dangerous.

EARLY RESERVES

By the 1890s, so much land had been cleared for farming, cut for timber or mined, that people began to realise the native vegetation and animals were disappearing. Three years after its

formation in 1891, the Western Australian Natural History Society petitioned the State Government to set aside a reserve to protect native vegetation, wildflowers and animals. In February 1894, the State's first Reserve for Fauna and Flora—160 000 acres between Pinjarra, North Dandalup and Bannister—was proclaimed. But it didn't take long before there were demands to reduce this area to provide more timber.

Surveyor Absalon visited the area in 1902 and reported that the Reserve was entirely unsuitable. He recommended it be cancelled and opened up for orchard blocks and timber leases. Despite local protests, the reserve was cancelled in 1911. However, Absalon also visited the

Serpentine Falls area and commented on the wide variety of flowers in this natural beauty spot. He recommended a 'permanent caretaker' be placed at the falls to preserve the flora and protect it from the 'trainloads of excursionists who visit the Serpentine Falls every flower season'. The falls themselves were already in a Reserve, gazetted for public recreation in August 1900, but the area was subsequently enlarged as three other nearby blocks were set aside as parklands in 1903. Control and management of the falls area was handed to the State Hotels Department in November 1914, and the Serpentine-Jarrahdale Roads Board took over responsibility in 1922.

Over the next few decades, various blocks of land were added and the area was managed by the State Gardens Board, renamed National Parks Board in 1956. A year later, all the Serpentine Reserves were vested together in the board and renamed Serpentine National Park.

By October 1961, some development had begun in the park—change-rooms, toilets and barbecue facilities were constructed at the falls. Although there had been a caretaker since the mid-1950s, the first ranger was not appointed until 1964. Even then, he was only on duty part-time. A full-time ranger was appointed in 1976, when the National Parks Board became the National Parks

Authority. A new path and elevated walkway were constructed in 1980, to provide easier access to the falls and pool, and in 1988, the size of the park was increased to 4 500 hectares.

RECREATION

There are now two main recreation areas with visitor facilities at Gooralong and at the Serpentine Falls.

Vehicle access to Gooralong is not possible from the national park entrance off South-Western Highway. Instead, it is reached from Jarrahdale by following signs to Gooralong picnic area. Wildlife abounds here, with western grey kangaroos and several bird species to be seen. There is a large shaded picnic area and campground in an open grassed area, surrounded by jarrah and pine forest. Several walktrails begin here.

Kitty's Track provides a gentle two-hour walk down the Darling Scarp into the Gooralong Brook valley and back.

Left: The picnic area near the falls is particularly popular with families.

Photo – Dennis Sarson/Lochman
Transparencies

Below left: Wilson's grevillea thrives in the jarrah forest, especially after fire.

Photo – Babs & Bert Wells/CALM

Below: The Darling Range ghost gum is geographically restricted, but can be seen in areas above the falls.

Photo – Dennis Sarson/Lochman
Transparencies





Visitors can get a good view of the Serpentine Falls and river from the viewing platform.

Photo – Dennis Sarson/Lochman Transparencies

The track has recently been realigned closer to the brook and new wooden platforms and bridges have been built. You cross the brook at a small gauging weir and return to the carpark through jarrah forest and pine plantation. This part of the trail provides good views to the ocean. If you're short of time, you can cross the brook about halfway down to the gauging weir and return along the other bank. But if you have a few hours to spare, follow the wilderness track from the gauging weir along the gorge to the Serpentine Falls.

No camping is allowed at the falls, but there are two trails. The Falls Trail is a short 500-metre interpretive trail that leads to the falls and is accessible by wheelchair. The longer Baldwin's Bluff Nature Trail runs uphill from the picnic area along a small tributary of the Serpentine River to the top of a 180-metre granite outcrop. From here you can clearly see the falls to the east—especially picturesque in late afternoon as the sun goes down. Looking out over the coastal plain, you can clearly see the tall buildings of Perth's city skyline to the north-west, Rockingham to the west and the ocean near Mandurah a little farther south-west.

There are also plans for a new walktrail to be constructed between the Serpentine Falls and the Pipehead Dam.

Away from the main picnic areas, walkers can explore fire breaks and management tracks to discover some remote and beautiful parts of the park. If you decide to explore some of these less visited areas, be sure to let the ranger know where you are heading and what time you are likely to return. And don't forget to tell him or her when you get back!

The most comfortable time to go walking in Serpentine National Park is from late autumn to mid-spring, when temperatures are lower and fewer people visit. But its closeness to Perth makes it an attractive park at any time of the year, providing walking, wildlife observation, picnicking and camping. During summer, the number of visitors rises considerably, but in winter and spring, there is no doubt the main attraction is the stunning displays of wildflowers.

PLANTS

The best time to see the wildflowers is from July to November, with September presenting the finest displays; when the hillsides and wooded areas become a blaze of colour.

Jarrah, marri and wandoo are the most common species of tree to be found within the park and they occur together and as discrete communities. But the park is important for two geographically restricted tree species. The Darling Range ghost gum (*Eucalyptus laeliae*), is restricted to an area between Darlington and Harvey, and can be seen in the north of the park above the falls. It is generally associated with drainage lines near granite outcrops. The salmon white gum (*Eucalyptus lane-poolei*) is found at the foot of the scarp. Wilson's grevillea (*Grevillea wilsonii*) is a small shrub with brilliant red flowers that thrives in the jarrah forest, particularly after fire. Tucked away in various gullies along the hillside, from where streams feed into the Pipehead Dam, are tall tree ferns. These introduced plants give a rainforest feel to the sometimes deep and mysterious gullies.

The slopes above the falls are covered

in spindly grevillea (*G. endlicheriana*), which is restricted to the scarp between Bindoon and Serpentine. From July to November, white flowers are held about a metre above the main plant on almost leafless stems. Coral vine (*Kennedia coccinea*), with its brilliant red-orange flowers, rambles over other plants in the jarrah forest.

Granite outcrops support diverse and often unique plant communities. They act as water catchments for fire-sensitive ephemeral or resurrection plants such as pincushions (*Borya* spp.). These clumpy perennial herbs are prickly with white flowers between August and October. As moisture is depleted, the plants appear to die, becoming brittle and turning bright orange. After the first rains, they 'resurrect' and flower again.

Donkey orchids (*Diuris* spp.) are often found around the granite outcrops, with spider orchids (*Caladenia* spp.) and greenhoods (*Pterostylis* spp.) being abundant in other areas. Trigger plants (*Stylidium* spp.) form pink carpets in spring.

Sundews are common in the park, with the giant sundew (*Drosera gigantea*) being found south of Scrivener Road. Cut-leaf dryandras (*Dryandra praemorsa*), with their yellow flowers, are common on the rim north of the falls. Other dryandras include pingle (*D. carduacea*), a large shrub similar in appearance to parrot bush (*D. sessilis*) and a favourite with black cockatoos, and couch honeypot (*D. nivea*), a small plant with fern-like leaves and large orange flowers.

Although there have been no formal flora surveys of the area, one threatened plant—the rare summer pimelea (*P. rara*)—and the priority listed *Acacia horridula*, have been found in the park.

ANIMALS

The park abounds with birdlife. Often seen are red-capped parrots, western rosellas, red-tailed and white-tailed black cockatoos, and yellow robins. Red-eared firetails are sometimes seen below the falls. In all, some 70 of the 100 species known to occur on the Darling Scarp



Left: The fat-tailed dunnart is one of several small mammals believed to inhabit the park.

Photo – Jiri Lochman

Below left: Red-capped parrots provide flashes of colour as they shoot about in the forest and woodland areas of the park.

Photo – Babs & Bert Wells/CALM

Below right: Orchids, such as these jug orchids, are abundant throughout the park.

Photo – Babs & Bert Wells/CALM



have been recorded in the park. Parrots, owls and tree-martins require hollow trees for nesting. Smaller bush birds such as fairy-wrens and robins thrive in the dense thickets of hakea and grevillea found around the granite outcrops. Creek and streamline vegetation not only provides additional habitat for the wrens and robins, it's also important for the grey shrike-thrush and red-eared firetail, which feeds on sedges and introduced grass (*Paspalum* sp.).

Little eagles and wedge-tailed eagles are commonly seen in summer, soaring on thermals high above the scarp. Owllet nightjars can be seen by

patient observers near the Gooralong camping area. These little birds with big eyes and even bigger mouths sit motionless on paths and tracks at night, allowing you to approach quite close.

Yellow robins, white breasted robins, scarlet robins and splendid fairy-wrens are commonly seen around the main picnic area near the falls, where they pick at food scraps.

While picnicking here, it is quite common to be joined by western grey kangaroos. Other, less visible mammals that have been recorded in the park include the echidna, mardo, quenda, brushtail possum, western brush-

wallaby and possibly the quokka. It is also believed that chuditch, brush-tailed phascogales, fat-tailed dunnarts, honey possums and water rats occur here, together with several species of bat—including Gould's wattled bats, which are often seen swooping for insects attracted by the light near the park gate.

Twenty-four species of reptile and three of frog, including the quacking frog, have been recorded in the park, together with a number of snakes. Lizards, including the gecko *Gehyra variegata*, inhabit areas near granite outcrops. Death adders inhabit the jarrah country, but tend to be very cryptic, moving only at night and lying in wait for their prey under leaf litter. Dugites are common, preferring to curl up in cool places during the summer. Carpet pythons are less common, but have been found near the park entrance on Falls Road. The wetter areas of the park provide habitat for several reptile species, with tiger snakes being found along the river and streams, and long-necked tortoise below the falls.

Gilgies are quite common, and their remains can often be seen beside streams—remnants of a meal for herons and water rats, which are particularly fond of these crustaceans.

Bothriembryon snails are generally widespread in the south-west of Australia, but the *B. serpentinus* is not so abundant and is thought to have quite a limited range. Little is known about this snail, but it is believed to be associated with dolerite (for calcium extraction) and wandoo. It is able to survive the long dry summers by sheltering in rock crevices and aestivating.

MANAGEMENT

One of the major management concerns surrounding Serpentine National Park is the threat of the spread of *Phytophthora cinnamomi*, the organism that causes dieback. Some areas are badly affected, with trees and wildflowers dying off. As in other CALM-managed areas, a full survey of the effects of dieback in the park will be completed and management strategies implemented to protect those areas not affected and minimise further spread.

Weeds are a problem in some areas of the park, particularly around the creeks. Weeds displace native plants by successfully competing for light, nutrients and water, and consequently have serious effects on animal habitats. Watsonias, arum lilies, castor oil plants, cotton bush and blackberries are the main culprits. The draft management plan proposes a five-year weed management program to control weed invasions in areas of greatest conservation value and environmental threat, and to rehabilitate areas denuded by these control measures with appropriate local species.

Visitor numbers and patterns of use will be monitored using traffic counters at the Serpentine Falls and Gooralong recreation sites. In addition, visitor surveys and interviews will be conducted to determine use, preferences and satisfaction, so as to investigate alternative or additional recreation uses and make appropriate modifications to management practices, to ensure visitors enjoy their visit in a safe, clean and tidy environment.

Historically, one of the most popular recreation activities at the Serpentine Falls has been swimming in the pool beneath the falls. Although swimming is discouraged by CALM for health and safety reasons, numerous accidents have still occurred at this site with visitors diving, jumping or falling onto submerged rocks. Steps will continue to be taken to discourage these dangerous activities through additional signs and public education programs.

These and other management issues are discussed in detail in the draft management plan. Take the time to read it and put forward your ideas and



concerns. The Serpentine Falls National Park has attracted recreational visitors for nearly a century and it continues to offer many of the features that attracted our ancestors. Through careful management and public consultation, CALM aims to help ensure the park retains those features for our children and our children's children.

The quacking frog (*Crinia georgiana*) is one of three frogs recorded from the park.

Photo – Jiri Lochman

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Fence skink

Photo – Babs & Bert Wells/CALM

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The authors acknowledge the valuable assistance of CALM's Serpentine National Park planning team members Denise Allen and Rob Towers; author Neil Coy; Steve Corsini at the Aboriginal Affairs Department; the Department of Land Administration and the Battye Library.

Much of the historical information was obtained from Neil Coy. His book, *A History of Serpentine-Jarrahdale*, is published by the Shire of Serpentine-Jarrahdale.

The Draft Management Plan for Serpentine National Park will be released for public comment soon.

ROCK-WALLABIES

of Yardie Creek

RESEARCH AND TOURISM GO HAND IN HAND

*Soft brown eyes no longer gaze in numbers down the canyons of Cape Range.
The inhabitants of the limestone 'fortress' have been plundered
by aliens over the last 50 years leaving a small,
timid population of the Western black-footed rock-wallabies. Thanks to local tour guides,
there is now a key to eradicate the predator and return the sentinels to their platforms high above.*

by Jack Kinnear

Neil and Rhonda McGregor, who operate Yardie Creek Tours in the Cape Range National Park, were winners of the Environmental Tourism category in the 1995 Sir David Brand Award for Tourism.

The award not only recognises the McGregors above others in the industry for the service they provide to tourism in the area, it also acknowledges their valuable contribution to the conservation of the environment—a contribution much valued by scientific staff with the Department of Conservation and Land Management (CALM).

For the past five years, the McGregors have been involved in collecting data for a fox-control experiment that had been implemented by Science and Information Division staff at the Woodvale Research Centre, in conjunction with staff from CALM's Environmental Protection Branch and Exmouth District. CALM staff had previously surveyed Cape Range National Park for western black-footed

rock-wallabies (*Petrogale lateralis lateralis*) to estimate their abundance and distribution. What was found was typical; once abundant throughout the entire range, the animals had become restricted to some gorges within the park, and on Ningaloo Station to the south. Moreover, their numbers were few, probably because of predation by foxes.

Seeking to be cost-effective, the next asked question was: 'How often do we have to bait such a large area to control foxes?'

Studies by CALM indicated that two baitings per year might be sufficient to control foxes, thus enabling the rock-wallabies to increase their numbers, and this is where the McGregors have made a vital contribution. They became involved when they were asked to record all rock wallabies sighted during the course of their nature tours along Yardie Creek, and since 1990, they have diligently entered their sightings into a computer database.

When Neil and Rhonda count rock-wallabies during a tour along Yardie Creek Gorge, they're essentially carrying out a line transect, which is a technique employed by ecologists to estimate the abundance, or changes in abundance, of plants or animals.

Thus, if the experimental two-baitings-a-year program has worked according to plan, the McGregors would have recorded more rock-wallabies each year, and this trend would be clearly evident from their database.

With such a large amount of data, there still is a great deal of analysis to be done, but the outcome can be surmised.

There was good news and there was bad news. The good news was that the sightings of rock wallabies had steadily increased for three years following the implementation of twice-yearly baitings. However, from Neil and Rhonda's database, it was clear that the 1994 sightings were down; there was a mini-

A popular tourist destination, Yardie Creek cuts deep into the Cape Range, in the southern part of the National Park.

Photo – Marie Lochman





Left: Fox-baiting in the Cape Range is helping to increase the numbers of western black-footed rock-wallabies.
Photo – Geoff Taylor/Lochman Transparencies

Below left: Tour operators Neil and Rhonda McGregor regularly count rock-wallabies during their boat tours.
Photo – Tony Tapper

Below: Neil McGregor enters the day's count on his home computer.
Photo – Tony Tapper

Bottom: Western black-footed rock-wallabies are a key attraction for visitors to the Cape Range.
Photo – Jiri Lochman

population crash as 30 per cent of the animals seen during 1993 went missing during the tourist off-season. Fortunately, the decline was only temporary, as the trend throughout 1994 and 1995 is upward.

We know the decline was real because of the quality of the data. This is because the line transect along Yardie Creek is so highly replicated—a statistician's dream.

Given the above scenario, what can we conclude about the effectiveness of CALM's twice-yearly baiting experiment? Is it adequate?

The Yardie Creek data, being so extensive, allows scientists to conclude, with certainty, that the population did increase following the introduction of fox control. But what caused the mini-crash of 1993?

Briefly, the evidence suggests that the six-month interval between baitings is too long. This lengthy interval allows foxes to re-invade an area, and provides ample time for them to kill enough rock-

wallabies to reverse previous gains. But this does not happen every year; bouts of predation can happen sporadically, and there is no way to predict when such events will happen. The solution is to increase the baiting frequency to four times a year, thereby removing offending foxes before they do too much damage.

There are good reasons to continue fox baiting in the Cape Range, not only from a conservation viewpoint, but also for economic reasons. A conspicuously abundant population of rock-wallabies contributes to the tourism potential of the Exmouth region.

The tour along a spectacular, picture-postcard gorge is a memorable experience in itself, but even more so when visitors see at close range, infant rock-wallabies peering out of pouches or snuggled up next to proud mothers.

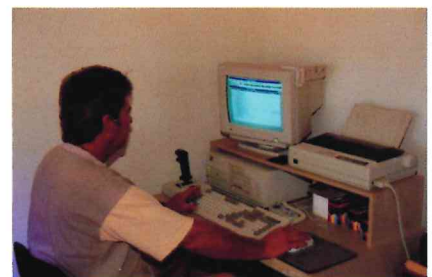
Neil and Rhonda readily concede that the presence of rock-wallabies is one of the key attractions of their tour. It's

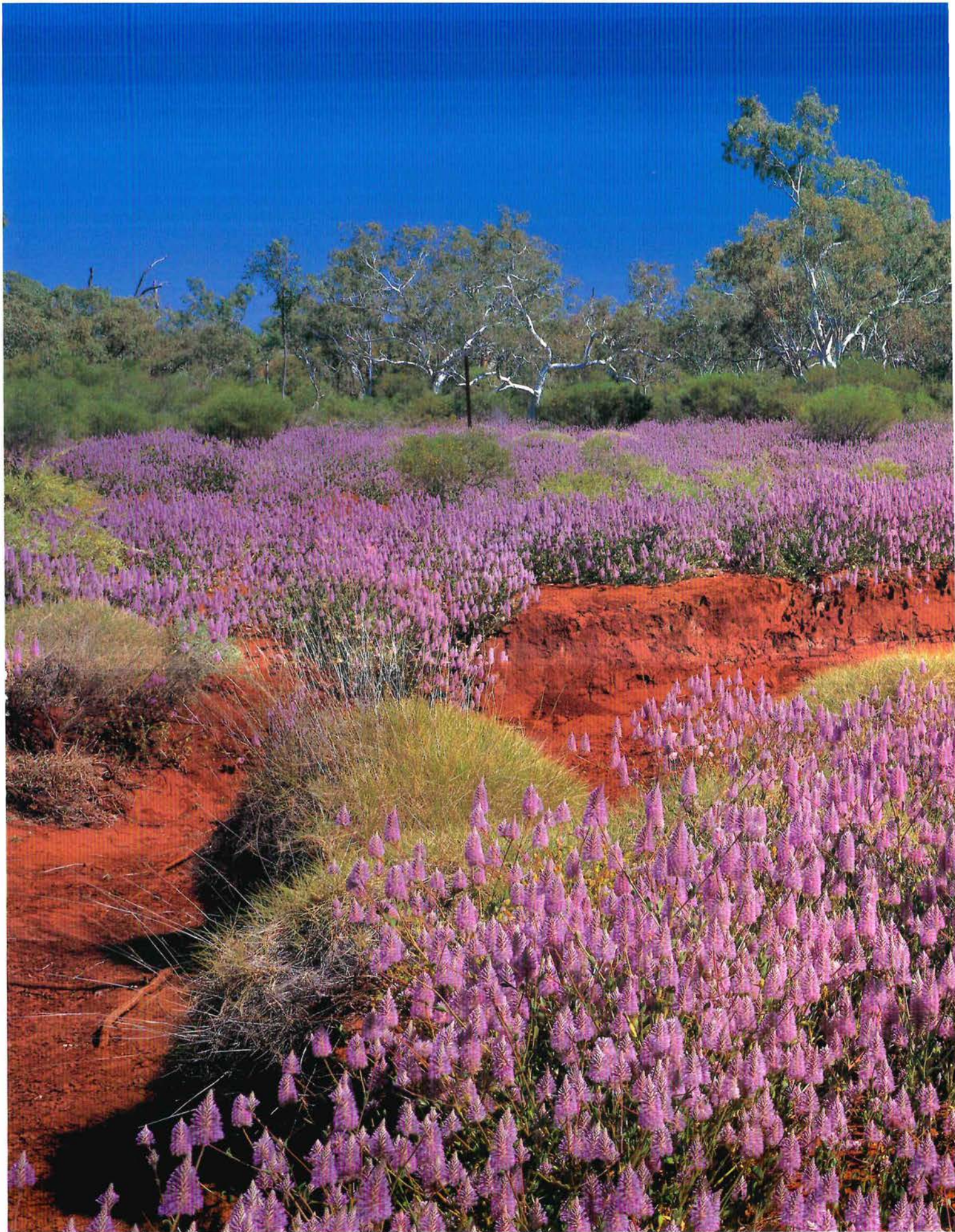
good for business to have more rock-wallabies about, and from CALM's viewpoint, its good conservation as well.

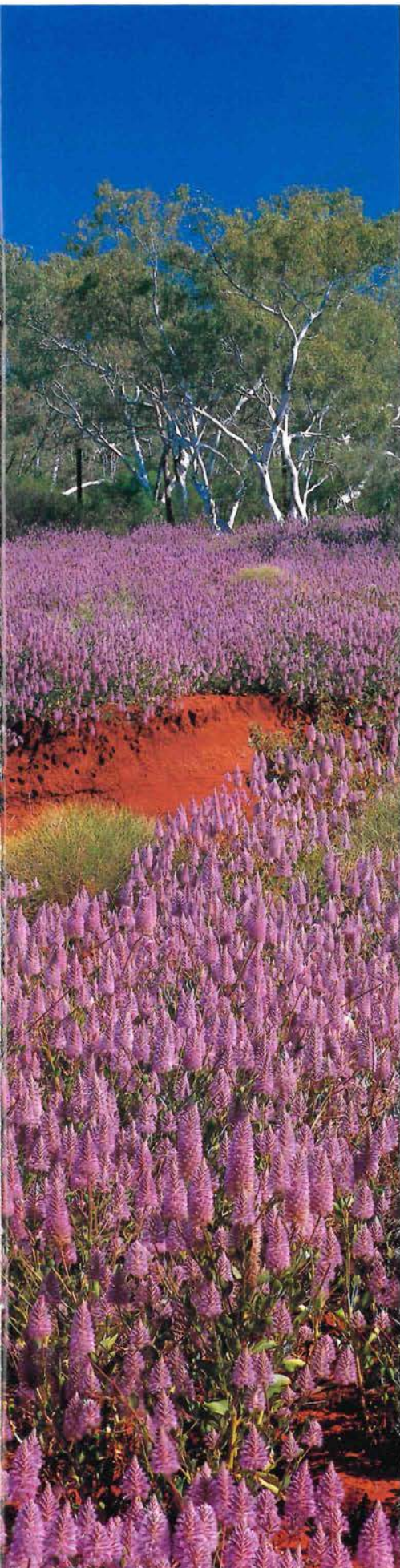
This is eco-tourism at its best; an example of a government agency and the private sector having a common interest in promoting the welfare and abundance of wildlife.

Jack Kinnear is a principal research scientist with the Department of Conservation and Land Management's Science and Information Division (Woodvale), and has been carrying out research into the causes of the decline of western black-footed rock-wallabies since 1979.

Jack can be contacted on (09) 405 5100.







*It was a very
good year in...*

THE WILDFLOWER STATE



THERE IS LITTLE DOUBT THAT
WESTERN AUSTRALIA HAS JUST
ENJOYED ONE OF THE BEST
WILDFLOWER SEASONS FOR DECADES.
THE WINTER OF 1995 WAS WET,
COLD AND PROTRACTED, AND OUR
WORLD RENOWNED NATIVE PLANTS
RESPONDED IN THEIR VARIOUS WAYS.
NEVILLE MARCHANT, FROM CALM'S
BIO-RESOURCES GROUP, DESCRIBES
WHAT MADE THIS YEAR SO
SPECTACULAR.

BY NEVILLE MARCHANT



Wildflower displays can be seen in Western Australia at any time of the year, but the peak flowering period, commonly known as 'the wildflower season', depends on a variety of environmental factors such as the timing of the rains, the levels of rainfall, the length and timing of dry spells after the rains begin and how cold the winter becomes. This year, the cold beginning and middle of winter were sufficient to delay growth and the activities of the pollinators to which the plants are attuned. This led to an extended season, with an overlap between the early and late-flowering plants.

THE NORTH-WEST

In January 1995, Cyclone Bobby dropped rain over the Pilbara and areas to the east and south. This resulted in one of the best displays ever of the mulla mullas, Sturt peas and the wealth of other flowers that characterise the interior of the State.

The perennial plants of the dry interior from the Pilbara to the Goldfields are incredibly hardy. Like the ubiquitous mulga, the poverty bushes, spinifex grasses and wattles are able to cope with successive dry seasons. But when the rains come, they respond quickly and flower profusely, setting their seed to add to a bank of propagules in the soil. Spinifex responds immediately to rain, with leaves changing from dull to vivid green and yellow-stemmed flower spikes appearing.



In a good year, the wildflowers of the dry interior comprise annual species that complete their life cycle—from germination to setting seed—in very a short time.

There are many more annuals in the Pilbara and Goldfields than in the south-west. They cover the open ground between the scattered perennials, have short lives and make full use of the brief growing season to reproduce and ensure a good supply of seed for the following year.

The justifiably famous carpets of everlastings, which grow as pure stands or mixed with relatives of the lechenaultia family, are annuals that are well geared to the vagaries of the climate. In a dry year, with a short growing season, the

Previous page

Main: Tall mulla mullas in Millstream-Chichester National Park, with wattle shrubs and the coolibah *Eucalyptus victrix*. Photo – Bill Bachman

Inset top: Common in the South West, milkmaids (*Burchardia umbellata*) have waxy, six-petalled flowers.

Inset Bottom: The fringe lily is a delicate, short-lived flower, lasting only for a few hours in a single morning.

Photos – Chris Garnett

Left: The red beak orchid is commonly seen flowering after fire in the forests and woodlands of the South West.

Photo – Ann Storrie

Below: *Helichrysum macranthum*, one of the large everlasting daisies of the south-west. In this open habitat, its seeds are dispersed by the wind.

Photo – Alex Bond

everlastings flower at the usual time, around late July and August. But their stems are short, often with slightly smaller blooms, the individual plants are far apart and the displays are only spectacular in localised areas—where there has been enough prolonged moisture to ensure better growth to maturity.

In wet years, like 1995, the main displays of everlastings are to be found in the Murchison, especially in an area between Mt Gibson, Yalgoo and Cue.

In the Wheatbelt, everlastings can form spectacular carpets during July and August. They attract many tourists, particularly to the northern Wheatbelt around Perenjori and Morawa and up to Northampton. Usually, they occur as drifts under the mulga and other wattles.

In areas closer to Perth, they occur in pockets in the forests and, because the growing season is longer as we go farther south, they usually flower around September. This year, they were still flowering in November.

THE SOUTH-WEST

The south-west corner of Australia—the area below a line drawn from Shark Bay to Israelite Bay, east of Esperance—is known as the South West Botanical Province and is recognised throughout the world as an area of megadiversity—that is, an area characterised by a high number of species. It is largely characterised by shrubby species, which shelter the many annuals, making them less obtrusive. Shrubby species, many of which do not occur in other parts of Australia, are also common components





Above: An open plain at the base of Mount Augustus with mulga, sennas, the pink-flowered cotton bush, pale yellow goodenias, daisies and the straggling burra (*Eremophila fraseri*), with its pink flower bases.

Photo – Bill Bachman

Right: One of a few species of vine which dwell in southern forests, the coral vine can climb many metres into the tree canopy, or clamber on the ground. It is spectacular because of its brilliant heads of red, pink and yellow pea flowers.

Photo – Alex Bond



of the low heathlands or the understorey of the dry forests and woodlands.

Grass-like plants and the famous kangaroo paws abound. Orchids, too, are well represented, but these are mostly ground-dwelling species and not ones that have evolved in the tree tops and mossy rock faces of the eastern rainforests.

Many of the wildflowers near Kalbarri, farther inland and on the spectacularly species-rich sandplains between Perth and Geraldton are, like the species in the wetter parts of the South West, mostly shrubby species such as *Melaleuca* and the wax genus *Chamelaucium*, which flower during early to mid-August. This year, flowering extended into October, and the winter-flowering species were still displaying as the early summer flowers came into bloom. That is what made 1995 so special, the whole flowering season was extended so that species normally separated in flowering time were seen blooming together.



THE FORESTS, WOODLANDS AND HEATHLANDS

In the South West forests, woodlands and heathlands, the real wildflower season begins with the shortening days of April and May. The woody shrubs belonging to the heath family, Epacridaceae, are the first to display their usually cream or white-coloured blooms. They brighten up the bush even before the first rains set in.

After the woody shrubs have bloomed, the early-flowering wattles start their display, increasing to a peak in September and October. The grevilleas, dryandras,

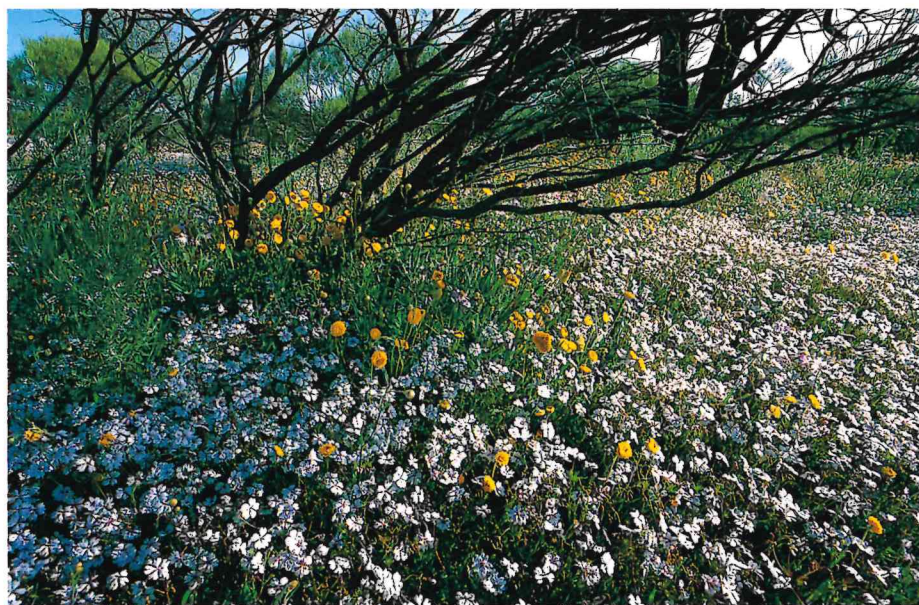
hakeas and a host of other proteaceous plants generally have bright colours in massed clusters. Exceptions are the grey blooms of the smokebushes, which dot the landscape from July to early summer. Eucalypts, wax flowers and other myrtles have bright colours and frequently have their flowers aggregated into compact cauliflower-like heads or bottlebrushes.

The cold winter of 1995 delayed the onset of some of the spectacular spring-flowering plants, such as the tree hovea, so their peak was about October to November.

The verticordias are some of the most

striking wildflowers in the middle or upper level of the heaths. Like most myrtles, they enjoyed a longer flowering season this year, with excellent displays even in late October. The Stirling Range is often at its peak in late September and early October, but it too was delayed a few weeks. Even the inland districts still supported their displays of annuals—most of which were in early fruit development, but still offered colourful displays under the late flowering shrubs.

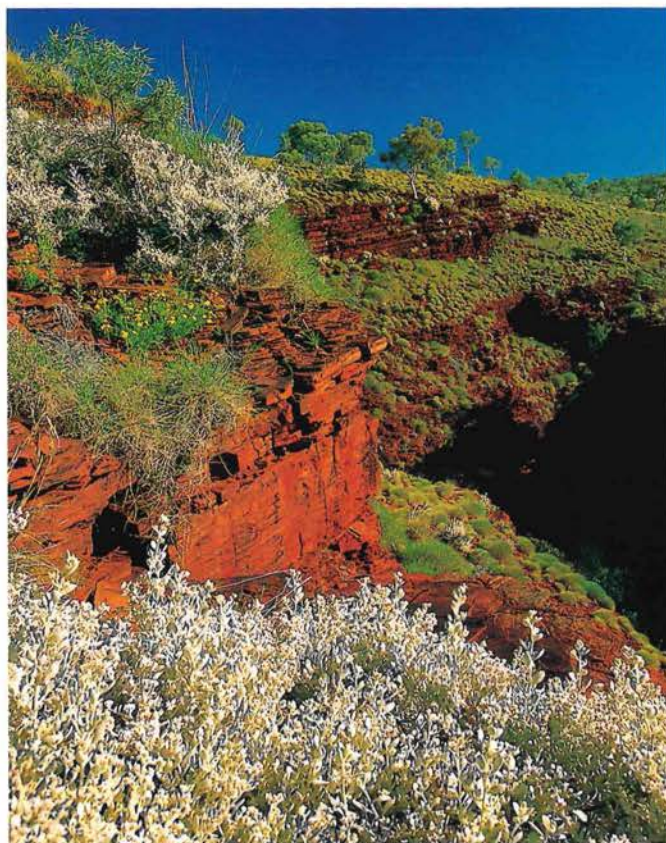
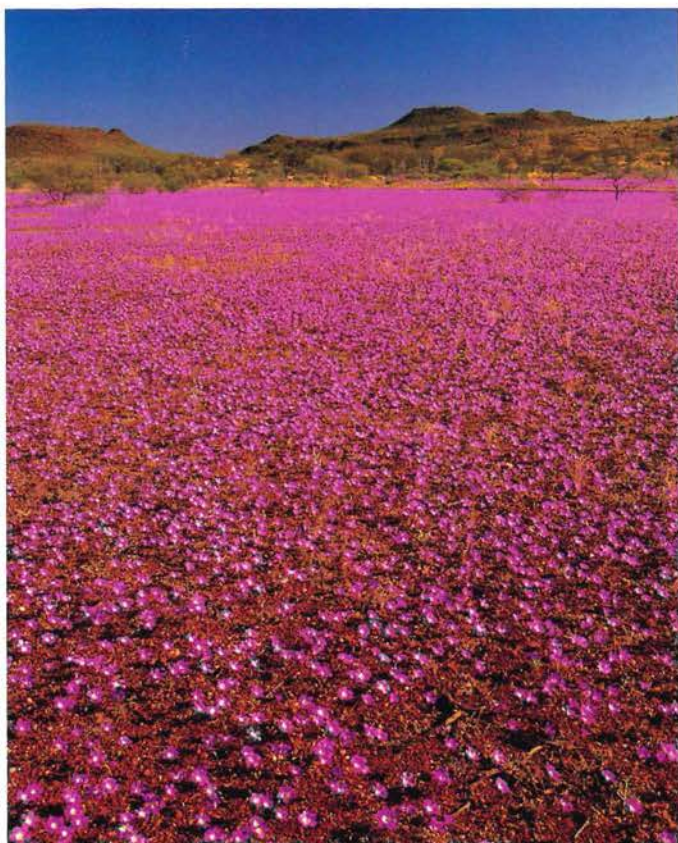
After a bumper wildflower year, there will be plenty of seeds and a replenishment



Top left: Provided there is enough winter moisture, even disturbed situations, like this fence line near Mount Magnet, will provide a spectacular show of the large papery flowered everlasting *Rhodanthe chlorocephala*. The purple daisy is a *Brachycome*. Photo – Chris Garnett

Top Right: One of the mulla mullas with an amazing ability to thrive on bare red sand is *Ptilotus appendiculatus* a tangled shrub with pale coloured stems forming a clump up to a metre across. Photo – Richard Woldendorp

Left: *Velleia*, a member of the lechenaultia family, frequently grows with everlastings or it may form an almost pure carpet. The yellow daisy seen here growing under wattle is a *Myriocephalus*. Photo – Chris Garnett



of the seed supply in the soil. The numerous animals, especially the birds and insects that depend either directly or indirectly on the nectar or the seeds are attracted by the extra food of a bumper year. But it is not just the native animals that benefit. Western Australia's wildflowers attract thousands of visitors each year. They come from overseas and interstate to revel in the magnificent displays captured so graphically on these pages. It is during seasons like this that Western Australia can truly boast the title 'The Wildflower State'.

Succulent plants are not characteristic of Australian arid zone vegetation. Exceptions are the pigfaced and this parakeelya, a species of *Calandrinia* which dominates the alkaline soil of this clay pan in the Murchison.

Photo – Bill Bachman

The introduced rosy dock (*Rumex vesicarius*) is so common it is often mistaken for a native. Its bladdery flowers and fruits are red-veined, hence the common name.

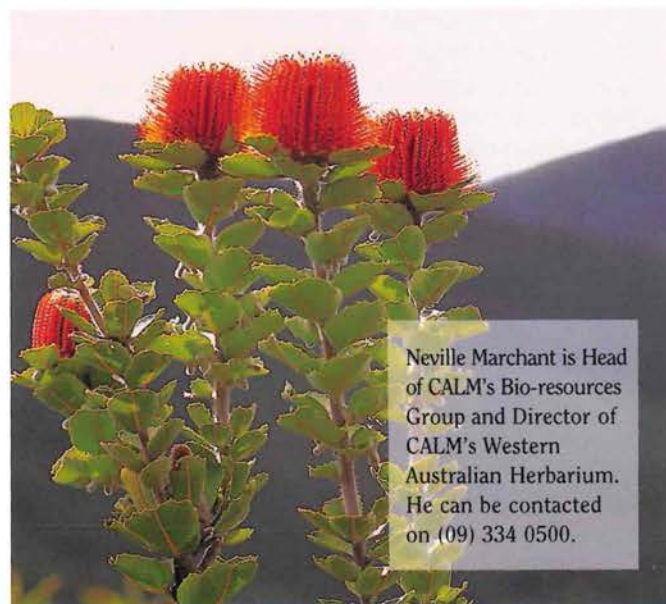
Photo – Bill Bachman

This species of mulla mulla clings to the southern rim of Weano Gorge near Oxers Lookout in Karijini National Park. Apart from the yellow *Senecio* and the snappy gums, the rocky slopes are dominated by hummocks of spinifex grass, which have become green in response to recent rain.

Photo – Bill Bachman

The spectacular scarlet banksia (*B. coccinea*), photographed here in the Stirling Range National Park, has a few stems each topped with a head of hundreds of small flowers.

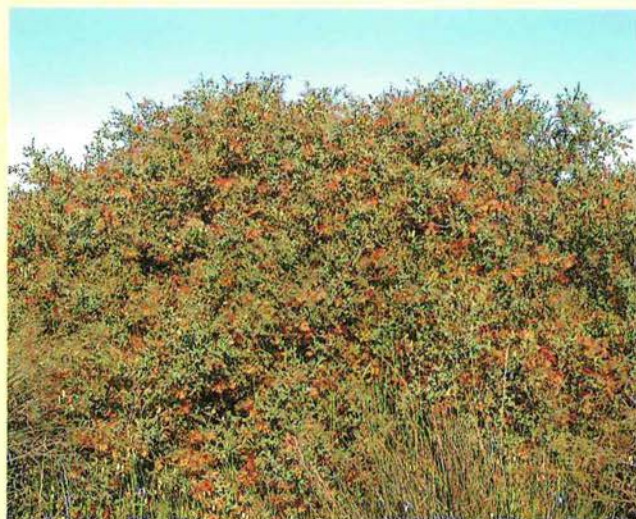
Photo – Alex Bond



Neville Marchant is Head of CALM's Bio-resources Group and Director of CALM's Western Australian Herbarium. He can be contacted on (09) 334 0500.



ENDANGERED



MCCUTCHEON'S GREVILLEA

The winter-flooded, shallow loams that occur over small areas of ironstone outcropping at the base of the Whicher Range, near Busselton, support many plant species found nowhere else. One such species is the critically endangered McCutcheon's grevillea (*Grevillea mcutcheonii* ms).

The first collections of this recently discovered species were made in 1991, by a local farmer interested in cultivating grevilleas. After several unsuccessful attempts to propagate it, he took a sample to Graham McCutcheon, then a member of CALM's Environmental Protection Branch in Bunbury and now retired. On examination, it was clear to Graham that it was an undescribed species (a formal description will be provided in a future edition of *Nuytsia*, published by CALM).

McCutcheon's grevillea is a dense shrub growing up to two metres, with large, handsome, red flowers and distinctive, three-lobed leaves that encircle the stem (a cultivated plant is established in the Endangered Species Garden at Kings Park and Botanic Garden). It is distantly related to

Grevillea manglesioides, which grows in the same area, but differs in its smooth, hairless leaves, rigid, stem-clasping leaves and larger, hairless flowers. Flowering occurs between May and December, peaking from July to November.

The vegetation type in which McCutcheon's grevillea grows was probably once a dense shrubland, but is now very degraded. Plants are growing in a seasonally wet area in shallow loamy soil over ironstone. Now regionally rare, it is estimated that just seven hectares of these wet ironstone communities remain intact on public lands in the southern Swan Coastal Plain.

Surveys in 1993 found 27 plants—five on a road verge and 22 on the adjoining private property. By early 1994, the private property plants had disappeared. This was possibly due to partial clearing and grazing by cattle. Further extensive surveys failed to locate any new plants. As only a single population is known, with just a few plants confined to a

narrow degraded roadside, the species was declared as rare flora in 1994.

At present, the population consists of just three mature plants. These have now been fenced, along with some adjoining private farmland, to protect them from accidental destruction and grazing by rabbits. It is hoped that the plants will spread into the fenced farmland.

In September 1995, CALM pledged \$300 000 for conservation of critically endangered flora and fauna (see 'Bush Telegraph'). Using a combination of these funds and funding from the Australian Nature Conservation Agency (ANCA), CALM has engaged a consultant to coordinate the implementation of urgent recovery actions for 38 critically endangered plant species, including McCutcheon's grevillea.

The benefits of protecting McCutcheon's grevillea in the Busselton area will extend to other threatened plants found nearby. For instance, *Grevillea elongata* is located in the same area and is a species which may be proposed for declaration as Rare Flora in 1996.

By Andrew Brown
Photos by Andrew Brown



True *Blue* BIRDS

THE
GENEALOGY
OF
AUSTRALIAN
BIRDS

When ornithologists first studied the birds of Australia, they found an array of unusual and intriguing forms.

In attempting to classify these newly found species, they tried to think of the most similar looking bird they knew from the Northern Hemisphere, and assumed that the Australian species would be most closely related to that species. In many cases this caused no problems.

But more recent research, using DNA and protein testing, has thrown up some interesting and surprising results for our songbirds.

by Les Christidis and Allan Burbidge

Up to the 1970s, the prevailing view was that most songbirds of Australia, New Zealand and Papua New Guinea were simply curious relatives of Northern Hemisphere groups of birds such as robins and warblers. Nevertheless, the fact that they have been seen as 'curious relatives' encouraged a lot of research into the relationships and evolutionary history

Previous page

The singing honeyeater, one of the most common birds in Perth gardens, is typical of the birds that evolved in and are confined to the Australian region.

Photo – Jiri Lochman

Below: The western spinebill displays a nectar-feeding habit that has evolved independently in Australian honeyeaters.

Photo – Babs & Bert Wells/CALM

Bottom: The western thornbill is typical of the thornbill family, one of the major families that evolved in this region.

Photo – Babs & Bert Wells/CALM

Below right: Australian chats, like this spectacular orange chat, are known to be in the honeyeater family, but their exact relationships are still being debated.

Photo – Babs & Bert Wells/CALM

(the 'genealogy') of Australasian birds. Today, it is believed that Australian birds such as thornbills and honeyeaters evolved in Australia, have been around for a very long time, and are not closely related to any Northern Hemisphere 'look-alike' groups.

Morphology (shape, size, colour) is an obvious source of evidence for evolutionary relationships because we expect related plants or animals to be similar in structure. The traditional morphological approach for classifying Australia's birds was therefore sensible, but had problems.

DIVERGENT OR CONVERGENT

Closely related animals may, through evolutionary time, come to look very different from one another if they live in dissimilar environments and their bodies have to cope with different conditions, such as temperature or aridity. For example, seals have some obvious adaptations for living and hunting in water, but are more closely related to dogs than one would expect from outward appearances. This is called divergent evolution.

Conversely, unrelated animals can

evolve to look very similar if they live in similar environments. This is known as convergent evolution. Our gliding possums, for example, are remarkably similar to flying squirrels from the Northern Hemisphere and the thylacine was extremely 'dog-like'. But the presence of a pouch reveals that possums and the thylacine are, in reality, more closely related to kangaroos and other marsupials. Therefore, interpreting evolutionary histories and relationships from morphology alone is subject to some serious pitfalls. If it were not for pouches, the early classifications of marsupials would have been difficult.

The evolution of Australia's songbirds is also a remarkable example of convergence, which parallels that of the marsupials. However, unlike the marsupials' pouches, no obvious features distinguish Australia's songbirds from their Eurasian counterparts.

DISTANT COUSINS?

The first ornithologists to study Australian birds were very familiar with Northern Hemisphere birds and naturally tried to 'pigeon-hole' any new bird they



encountered in the system they were using at the time—which was a classification of Northern Hemisphere birds. (It would be interesting to consider what would have happened if ornithology had started in Australia. The history of our knowledge of bird evolution and relationships may have been very different!) In determining the classifications of Australian birds, the ornithologists used the assumption that birds similar in behaviour and appearance were related, but this caused a number of anomalies. They also assumed that southern birds would be relatives of, and probably derived from, northern birds. In hindsight, they would have been better off starting from scratch.

Until quite recently, it was believed that Australia had received its birds from waves of immigration from the Northern Hemisphere, using the Indonesian islands as stepping stones. Our robins and warblers were supposed to be descendants of these early waves of migration from the north. Even such unique birds as lyrebirds and scrub-birds were thought to have been descendants from now extinct Northern Hemisphere forms. The idea that Australia may have had its own separate and diverse fauna that was not of Eurasian origin was anathema to most scientists. Some, however, speculated that convergent evolution may have been obscuring the true origins of Australia's birds.

BREAKING THE CODE

To overcome the problems of morphological convergence, researchers have turned to DNA and the genetic code—the building blocks and blueprints of life. It is reasonable to suggest that species with very similar DNA structures and genetic codes are more closely related. Conversely, species with very different DNA structures and genetic codes are unlikely to be related, even though they may look or behave similarly.

One method of analysing DNA is through hybridisation. In essence, what happens is that a solution of DNA is heated to near boiling so that the molecular structure—the two strands of the DNA double helix—are broken apart and float loose. If the solution is then cooled slowly, the complementary strands can find each other again, and the DNA is reconstituted.

Wrens, such as the red-backed fairy-wren, are not related to the Northern Hemisphere wrens; their closest relatives are our thornbills and honeyeaters.

The white-winged triller is a member of the cuckoo-shrike family. It is still not certain whether this group evolved in Australia or not.

Named the scarlet robin, because it reminded colonists of the European robin, this bird is actually from an entirely different family.

This rufous treecreeper is superficially like European treecreepers, but is more closely related to other bird families that evolved in Australia.
Photos – Babs & Bert Wells/CALM

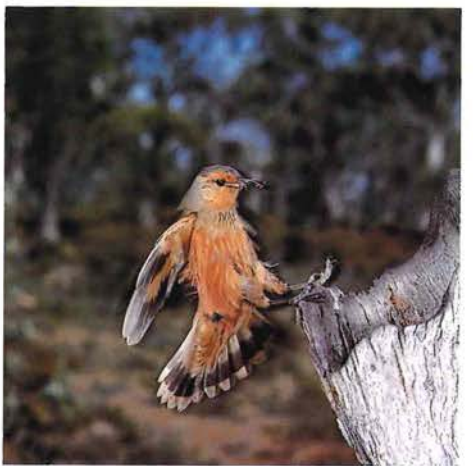
This property of DNA makes it possible to form 'hybrid' DNA molecules from single strands of two different species, and therefore determine the degree of genetic similarity between them. If the DNA from two species are processed together, and the separated strands from each connect with one another, the degree to which they connect is an indication of how closely related the species are.

If they do connect, this also provides a measure of the genetic change in the two species since they diverged from a common ancestor. If DNA from two species combines to a greater extent than that from two other species, it is because the first two species have more similar DNA, and, therefore, are more closely related to each other.

TRUE BLUE AUSSIES

This technique has been used extensively to examine the relationships of the world's birds. Some of the most exciting results have involved Australia's songbirds. The DNA experiments provided the first clear evidence that our songbirds were not descendants from their northern 'look-alikes', but that they had, in fact, evolved independently on the Australian continent.

Despite not displaying any obvious similarities, our robins, wrens, honeyeaters, scrub-birds and treecreepers were all found to be more closely related to one another than to their northern name-sakes. Many of these findings have since been confirmed by the use of other techniques, such as the comparison of proteins in different species.





The DNA results have also encouraged a more critical look at the morphological evidence. The results of this 'fresh look' have often turned out to be consistent with the DNA evidence—it was simply that the early ornithologists had a Northern Hemisphere perspective and therefore came to erroneous conclusions. They were blinded by familiarity.

HOME-GROWN ANOMALIES

The role of convergence in obscuring the true relationships of birds is evident even within Australia. Our insect-eating robins, whistlers and shrike-thrushes were always classified together. DNA and protein data indicate that whistlers and shrike-thrushes are more closely related to magpies and crows, while our robins are related to nectar-feeding honeyeaters. Furthermore, we now know that honeyeaters evolved from the same insect-eating birds as the thornbills and scrubwrens. The nectar-feeding habit of honeyeaters evolved in Australia and was not a habit brought here by descendants of groups that also gave rise to the sunbirds of Africa and Asia. These new insights allow us to investigate further the intricate co-evolution between honeyeaters and Australia's unique plants.

Although we now have a clear picture of the origin of Australia's songbirds, many questions still remain. Within Australia, the relationships of bowerbirds, scrub-birds, treecreepers and lyrebirds are still controversial. They may represent the earliest groups of Australian songbirds. Robins, honeyeaters, wrens, thornbills and scrubwrens have evolved and remained on the Australian continent, but what of our flycatchers, cuckoo-shrikes and fantails? These occur also in Africa and Asia. Did they colonise

these continents from Australia or vice-versa? Swallows and finches are relative newcomers to Australia, but may have evolved from earlier forms that originated here. Some scientists now believe that the southern continents were the place of origin for the world's songbirds, but much more evidence needs to be gathered to examine this controversial hypothesis.

To unravel some of these questions, DNA in birds is still being examined, but by the more refined technique of DNA sequencing. This method provides a direct reading of the genetic code. Exact comparisons of parts of the DNA code can then be compared across species. What is more important is that, for sequencing, DNA can be extracted from bones and museum skins, which means that extinct species can now be included in these exciting studies.

For professional and amateur ornithologists, the DNA evidence concerning Australian songbirds highlights the unique and important nature of Australian birds as a whole.

Bird groups such as pardalotes, thornbills, fairywrens and honeyeaters, which are common birds to us, are found only in Australia, New Guinea and New Zealand. They are not simply the quaint relatives of the major Northern Hemisphere groups. We can finally shed the idea that our birds are 'second-hand' derivatives from the north. They have a significant place in the evolution of the world's birds, and make an important contribution to world's biodiversity. They are an integral part of this continent and have evolved here in concert with the changing geology and climate of this land. It follows that Australia is the only place where these groups can be conserved effectively.

The Department of Conservation and

Above left: Golden whistler. Because of their general appearance and insect-eating habits, whistlers were once thought to be closely related to our robins. They are, in fact, more closely related to magpies and crows.

Above: This male redthroat is another member of the thornbill family—a large family of small insect-eating birds common in Australia.

Photos – Babs & Bert Wells/CALM

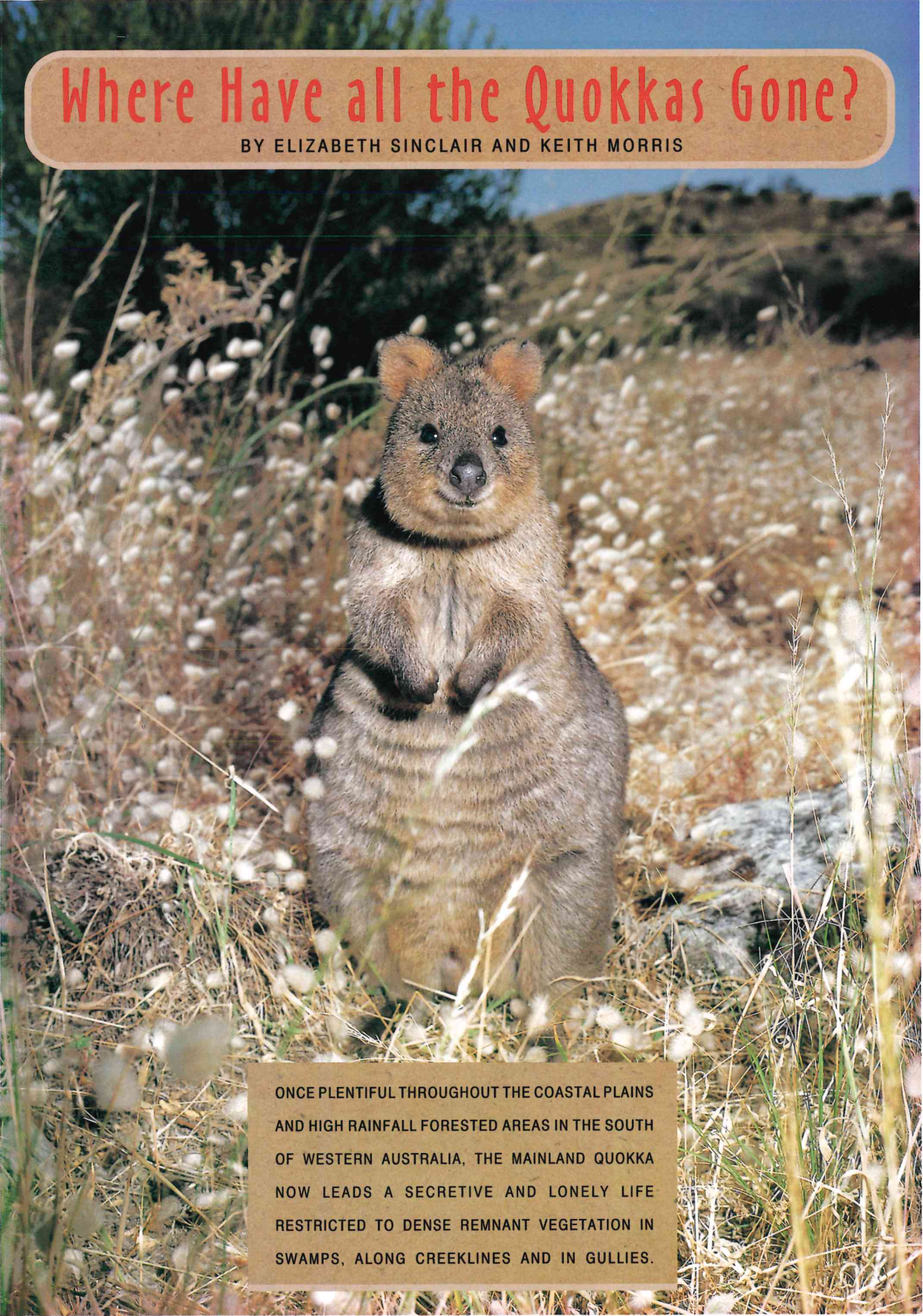
Land Management (CALM) is, therefore, concerned that this important segment of the world's biodiversity is conserved in a way that will enable all Western Australians, as well as visitors to our State, to see as many of these unique species as possible in their natural environment. Research into the genealogy of our birds continues to help scientists understand the relationships and interdependencies the birds have with their environments. The results of such research can be enormously helpful in the planning of recovery programs for rare or threatened species, because the loss of these species would close a unique chapter in the history of bird evolution and severely diminish global biodiversity.

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Where Have all the Quokkas Gone?

BY ELIZABETH SINCLAIR AND KEITH MORRIS

A photograph of a quokka, a small marsupial, standing upright in a field of tall, dry grass. The quokka has greyish-brown fur and is looking directly at the camera. The background shows a hilly landscape under a clear blue sky.

ONCE PLENTIFUL THROUGHOUT THE COASTAL PLAINS AND HIGH RAINFALL FORESTED AREAS IN THE SOUTH OF WESTERN AUSTRALIA, THE MAINLAND QUOKKA NOW LEADS A SECRETIVE AND LONELY LIFE RESTRICTED TO DENSE REMNANT VEGETATION IN SWAMPS, ALONG CREEKLINES AND IN GULLIES.

The quokka (*Setonix brachyurus*) was one of the first Australian marsupials to be recorded by Europeans. It was described by Dutch navigator Samuel Volkertszoon in 1658, as 'resembling an Asian civet cat, but with browner hair'. Another Dutch navigator, Willem de Vlamingh, described a quokka in 1696 as 'a kind of rat as big as a common cat, whose dung can be found all over the island'; not very flattering! The quokka was finally recognised as a marsupial in 1830 by two French naturalists, Quoy and Gaimard, who collected specimens during d'Urville's expedition to King George Sound in Western Australia in 1826.

Today, quokkas are familiar to most Western Australians because of their abundance on Rottnest Island. However, they were once widespread throughout the coastal plains and high rainfall western side of the forested areas of mainland south-western Australia, from Moore River in the north to Bremer Bay in the south east.

An account by John Gilbert in 1840 makes mention of 'immense numbers being killed in a few hours' by Aboriginal hunting groups. This account referred not only to Gilbert's potoroo, but also to the quokka. Shortridge reported that between 1904 and 1907 the 'quokka was very plentiful among the coastal thickets and swamps in the South-west'.

Bald Island, off WA's south coast, is the only other place where quokka numbers remain high. Both the Rottnest and Bald Island populations are safe from predation by the introduced fox; however, feral cats do present a threat on Rottnest.

There was a drastic decline in the numbers of many small marsupials in WA's south-west in the late 1930s. In fact, quokkas were thought to have become extinct on the mainland. A number of reasons were put forward to explain their apparent disappearance; these included loss of habitat through clearing and bushfires, spread of foxes, feral cats, competition with rabbits, and disease. Although there is no direct evidence of any one factor being responsible, it is clear that in combination they contributed to the species' decline.

Quokkas were rediscovered on the mainland in the late 1950s at an area near Byford, 40 kilometres south-east of Perth. They have now been identified at a few locations in the jarrah forest and on the south coast, but their numbers are apparently very low, especially when compared to those of the early 1900s.

Once frequently seen at dusk along roadsides, in paddocks and along slopes in the Darling Range, today's quokkas lead secretive lives within the protection of dense vegetation in swamps, along creeklines and in gullies. Sometimes the

only signs of their presence are the characteristic runs that dissect the swamp vegetation and their scats. The introduced fox may well be responsible for the quokkas being restricted to these habitats.

A POPULAR HOLIDAY DESTINATION

Rottnest Island is one of the most popular holiday destinations in the State for both locals and tourists. Quokkas are just one of the many attractions that the island has to offer. Thousands of years ago, though, the island was the northern tip of a peninsula, which connected many of the small islands in Cockburn Sound to the mainland. When the sea level rose, approximately 7 000 years ago, a chain of islands from Penguin Island to Rottnest Island was formed. Tammar wallabies were stranded on Garden Island, a little to the south, while quokkas were the only marsupial that survived on Rottnest Island.

Many changes have taken place on Rottnest since its settlement as a penal colony in 1838. Land has been cleared, timber felled and salt mined from the lakes. The island has also suffered three major fires. Quokka numbers fell last century, probably due to massive habitat modification, but since the 1920s their numbers have increased dramatically. Several attempts have been made to determine the size of the population on the island and estimates range from 4 000 to 17 000. Their selective grazing of palatable plants has changed the island's vegetation composition and there is some concern that the present high numbers are not sustainable. Many quokkas lose condition at the end of summer through drought, starvation and vitamin deficiencies.

Quokkas are synonymous with Rottnest: 'one cannot visit the island without encountering these endearing creatures.' They inhabit all parts of the island, but are most readily observed around settlement areas and at the tourist 'quokka stops'. Maintaining a balance



Previous page

The quokka persists despite loss of habitat, predation by foxes and feral cats, competition and disease.

Photo – Jiri Lochman

Left: The quokka was initially described as a civet cat in 1658.

Photo – Dennis Sarson/Lochman Transparencies

between recreation and conservation (of the environment and the quokkas) is an important part of the Rottnest Island Authority's management plans.

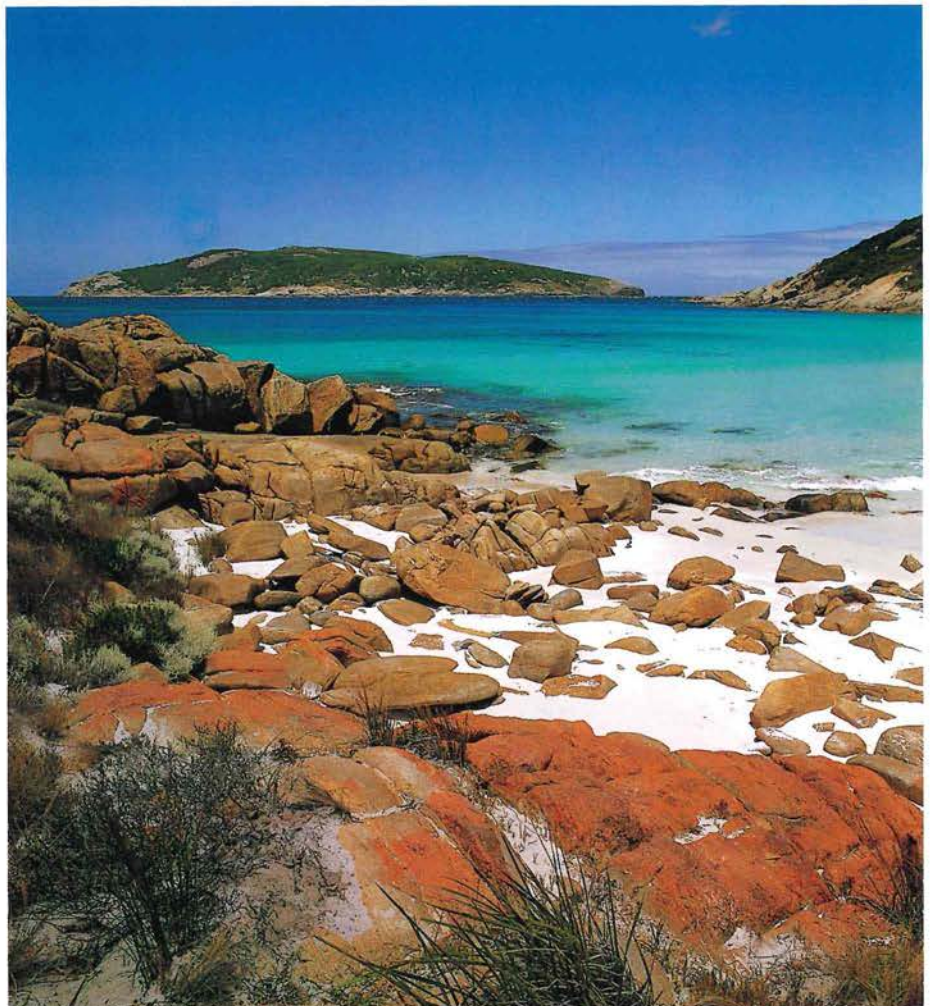
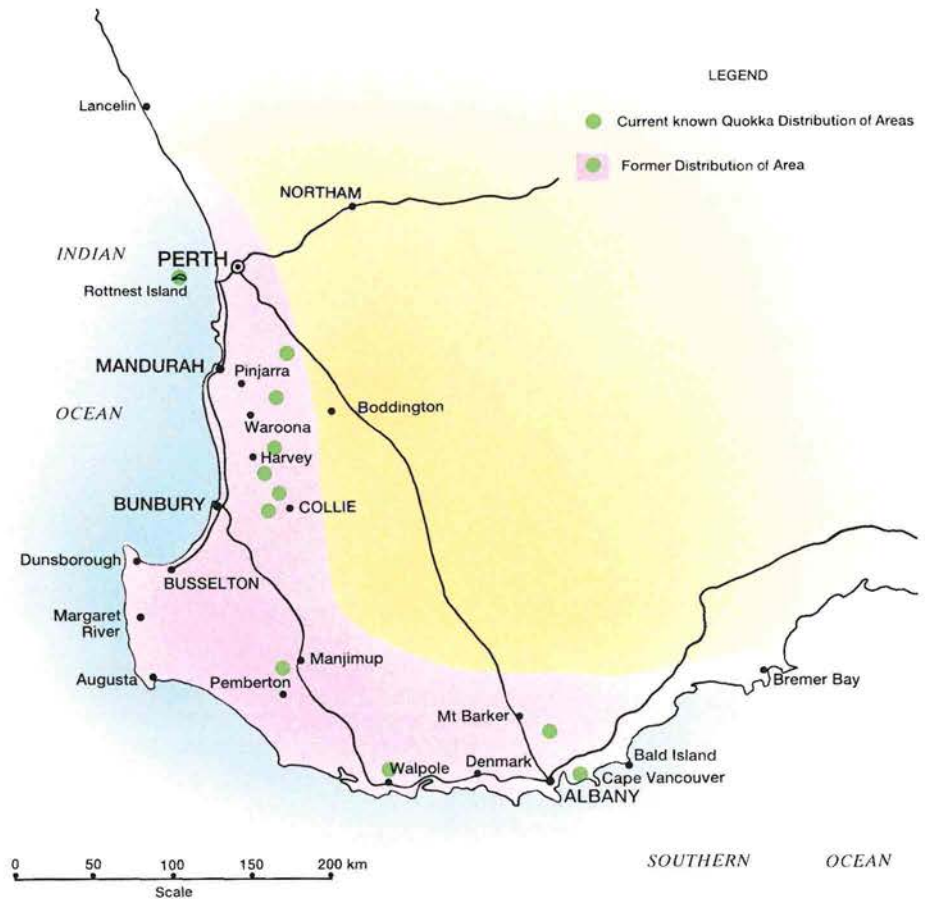
BALD ISLAND

Bald Island quokkas live a tranquil existence by comparison. Their home is one of many small islands off the Western Australian coast supporting remnant populations of marsupials. The island has had little disturbance from humans and remains in relatively pristine condition. It provides safe nesting grounds for many sea birds including shearwaters, petrels, oystercatchers, Caspian terns and fairy penguins and is now home to the recently introduced noisy scrub-bird. Several species of lizard are readily observable on the island's granite slabs. Quokkas were stranded there by the rising sea level around 10 000 years ago and their numbers on the island remain relatively high.

Following a short visit in November 1994, it was noted that the distribution of quokkas on Bald Island, unlike that of Rottnest, was very patchy. Indeed, some parts of the island showed absolutely no evidence of quokka activity at all. The steep limestone slopes on the eastern part had no ground cover and no trace of quokkas, while the grassy northern peninsula was dissected by a large number of runs. Animals could readily be seen there at dusk, feeding on grasses and succulents. Bald Island quokkas are likely to experience similar seasonal problems to those on Rottnest, including severe dehydration, starvation and vitamin deficiencies over the summer months.

THE MAINLAND SITUATION—ARE THEY THREATENED?

Even until the early 1970s, the then Forests Department and Department of Fisheries and Wildlife surveys indicated that quokkas were reasonably widespread in forest swamps around Dwellingup and Manjimup. More recently, searches for



Above: Map showing the former and current known distribution areas of the quokka.

Right: Bald Island, off the south coast of Western Australia, where quokka numbers remain high.

Photo – Jiri Lochman



remnant mainland quokkas suggest that many of the previously known populations are now extinct. Mainland quokkas are secretive animals, not like their Rottnest relatives. The dense vegetation to which they are restricted makes it very difficult and time-consuming to detect and monitor their populations. Researchers must be guided by the presence of distinctive tunnels and scats among the vegetation.

The damaging effects of feral animals on our native fauna have been known for some time and solutions are not always easy to find (see 'Vandals in a Vulnerable Land', *LANDSCOPE*, Spring 1990). It is possible that the remaining swampy areas provide the last fox and cat-proof refuges for our quokkas. In 1994, the Department of Conservation and Land Management (CALM)—with support from Alcoa—began a program to control foxes over 500 000 hectares of the northern jarrah forest. 'Operation Foxglove' is the first time in Australia that an attempt has been made to control foxes over such a large area in order to benefit threatened species. An extensive monitoring program by CALM scientists has shown that reducing fox numbers makes it easier for medium-sized marsupials (including bandicoots, woylies, numbats and chuditch) to survive and increase their populations. Quokkas are part of this monitoring program and it is anticipated that they will also benefit from Operation Foxglove.

Quokkas are known to persist in low numbers in the creek systems of a few jarrah forests. Trapping suggests that these refuges are rarely home to more than ten individuals. Small populations



Above left: Feeding quokkas has long been a favourite pastime on Rottnest Island.

Photo – Brian Downs/Lochman Transparencies

Above: Balancing the needs of recreation and conservation is a challenge facing the Rottnest Island Authority.

Photo – Eva Boogaard/Lochman Transparencies

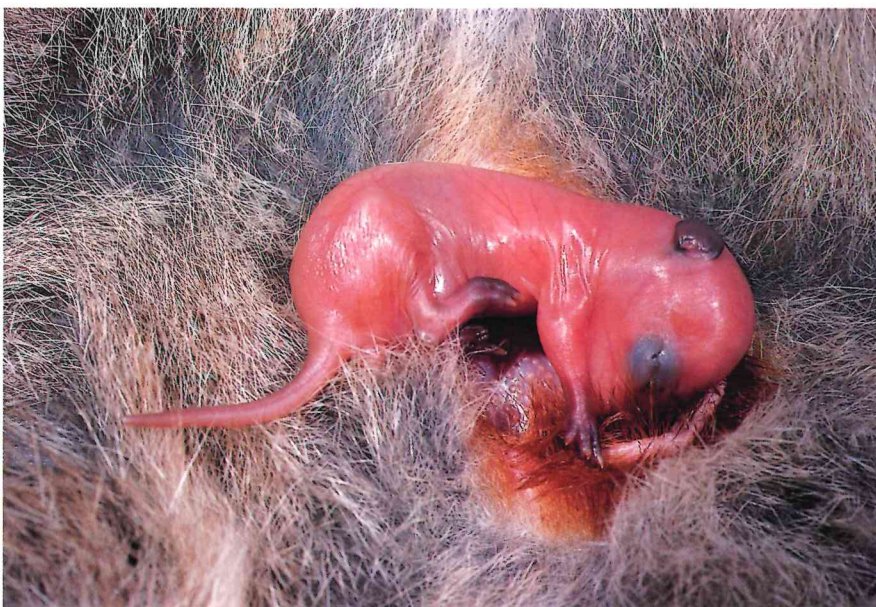
Below: Like all marsupials, quokkas are born in an immature state and develop in a pouch.

Photo – Babs & Bert Wells/CALM

are being monitored at sites near Jarrahdale, Dwellingup, Harvey, Collie and Two Peoples Bay. Radio tracking shows that these animals are restricted to the swampy vegetation along creeklines. They do not move across open forest areas or paddocks the way they used to. If a local extinction occurs, it is unlikely that the area would be repopulated from a neighbouring swamp unless the two were joined by a corridor of suitable habitat through which individuals could move safely.

Quokkas probably occur at other sites in the South-West and a survey by CALM is under way to determine their current distribution. Populations are thought to persist near Manjimup, Mt Manypeaks, Green Range and possibly along the Pallinup River and in the Stirling Range. Information from this survey will be used to determine the appropriate conservation status of the quokka, and whether additional management actions are required to ensure their survival.

A survey of potential quokka sites

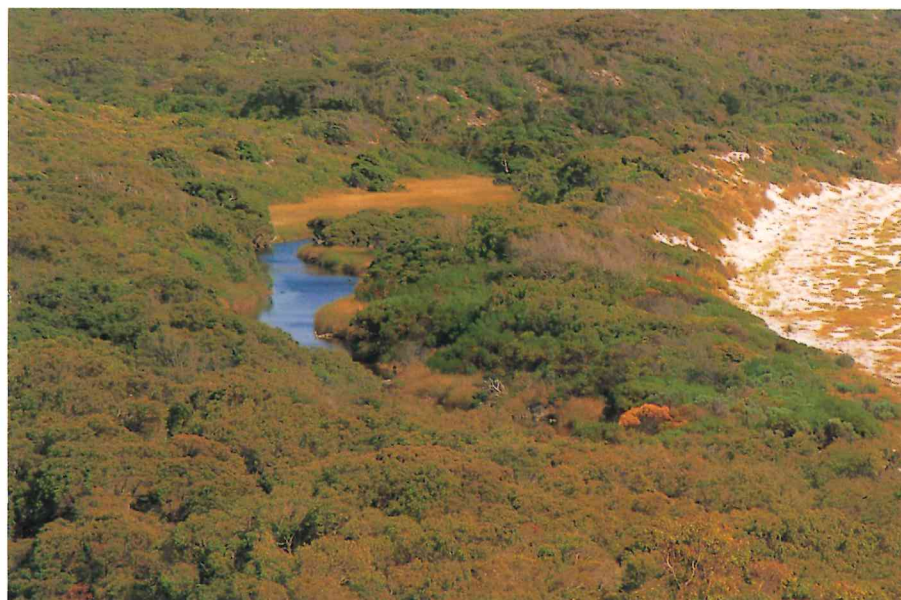


along the south coast was undertaken in November 1994 by The University of WA. This included creeklines and swamps between Torndirrup National Park and Cape Riche, as well as many of the areas known to be inhabited by quokkas at the time of European settlement. Unfortunately, none was found. However, quokkas have been located at Two Peoples Bay.

The current restricted distribution of quokkas on the mainland makes them vulnerable to wildfires. The burning of their small, swampy refuges, particularly by intense summer fires, not only eliminates their food and cover but makes them vulnerable to predation by foxes. Known quokka sites currently gain some protection from these destructive burns through CALM's prescribed burning program; vulnerable habitats are surrounded by areas with low fuel loads that minimise the risk of wildfire.

CURRENT RESEARCH

Many aspects of the Rottnest Island quokka have been extensively studied by staff and students from the Zoology Department, University of WA. However, little is known about the biological requirements and behaviour of the Bald Island and mainland animals, or their relationship to the Rottnest animals. Due to the length of time the island populations have been separated from the mainland, and the extent to which the mainland populations are fragmented, it is possible that a significant amount of genetic differentiation has occurred. The sedentary behaviour of



Above: Coastal thickets and swamps, such as here at Two Peoples Bay, are typical quokka habitat.

Photo – Marie Lochman

Below: Are mainland and island quokkas sufficiently different to be regarded as separate subspecies?

Photo – Babs & Bert Wells/CALM

quokkas could also contribute to any differences that have evolved; they have a strict home range with limited movement between populations. Some important physiological and morphometric (shape, size, colour) variations exist. For example, mainland animals are larger. Understanding the relationships between these different groups of animals is important when considering management and conservation issues.

A FUTURE?

Little attention has been focused on mainland quokkas. While older generation forest workers and farmers can relate stories of their abundance, most people have never seen a quokka in the wild on the mainland. We believe that their numbers are extremely low and that this decline may be continuing.

However, steps are now being taken by CALM and other researchers to find out more about mainland quokkas and to implement strategies that will ensure their long-term survival.

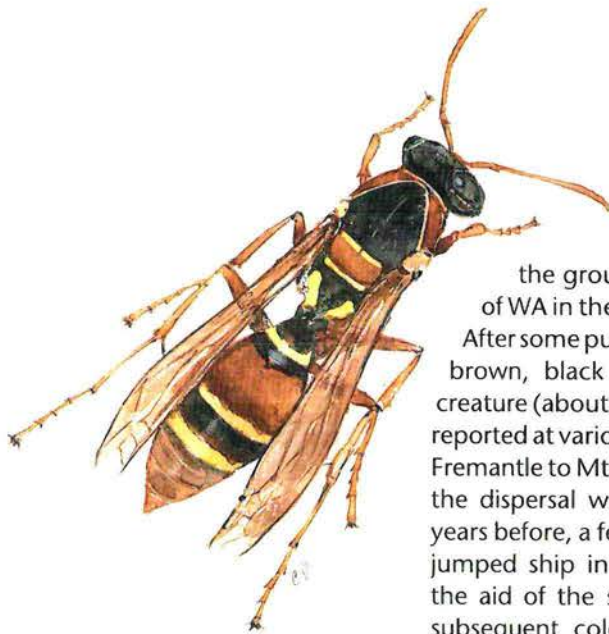
If quokkas have, in fact, declined, they may be recognised nationally as a threatened species and mainland populations may be granted special protection. Further information is being gathered on the extent of their populations and their relationship with other quokkas.



Elizabeth Sinclair is a PhD student with the Department of Zoology, at The University of Western Australia. She is studying the genetic relationship between island and mainland quokkas, and her research is being partly supported by ALCOA of Australia. Elizabeth can be contacted on (09) 380 1468.

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URBAN ANTICS!



THE PAPER-NEST WASP

Drowsy, summer afternoons in the garden can be intoxicating affairs in more ways than one. But, whether you are in your own backyard or in Kings Park, if you don't watch your step while admiring the scenery, you can end up right in 'it'...excruciating pain that is.

At this time of the year, life is thriving and the atmosphere is a swarming soup of manouvering insects, each with a motive to eat, or be eaten.

Although the aroma is at times exquisite, don't carelessly close your eyes and sink your face amongst the foliage of your favourite shrub or ...thwhack!!...*Polistes humilis*, the common paper-nest wasp, will zap your nose like you've been hit with a well aimed 3-iron.

There are two species of paper-nest wasp or paperwasp that frequent our gardens, both alien creatures, which were accidentally introduced to the State. They are typical of the order Hymenoptera which includes ants and bees, have a highly developed social organisation and will not hesitate in angrily pursuing any poor schmuck (hapless victim) that bumps into their nest.

The common paperwasp, a native of the eastern States was first discovered in the grounds of the University of WA in the summer of 1949-50.

After some publicity on the find, the brown, black and yellow banded creature (about 15mm in length) was reported at various nest sites from East Fremantle to Mt Lawley. The theory of the dispersal was that two or three years before, a fertile queen wasp had jumped ship in Fremantle and with the aid of the summer sea breezes, subsequent colonies quickly spread north-east.

A repeat situation probably occurred in 1977 when a similar insect, the yellow paperwasp (with yellow and black bands) was found at Fremantle.

Although the nests of both paperwasps are similar in colour and construction, it is more likely that the common paperwasp nest is the easier to locate. It resembles an up-turned toadstool of hexagonal cells, suspended by a short stalk to the branch of a tree or bush or sometimes a domestic structure. The yellow paperwasp prefers hidden sites such as fence capping, downpipes or under tiles.

After hibernating over winter, a fertile queen scrapes wood fibres from weathered power poles or fences with her powerful mandibles and with a mixture of saliva and chewed wood, constructs the stalk and the first few cells of her grey-brown, papery nest. An egg is laid in each cell and the young larva, which hatches a few days later, is fed on masticated nectar and caterpillar.

The stout white legless larvae mature and spin silken cocoons within their cells. After pupation, mature adults emerge. The first progeny are all infertile female workers which take over nest construction, food gathering and feeding the developing brood while the queen continues egg-laying.

Some nests may reach 15cm across and be home to several hundred wasps. Later in the season, males, recognised by their yellower faces, are produced and mate with those females destined to be future queens.

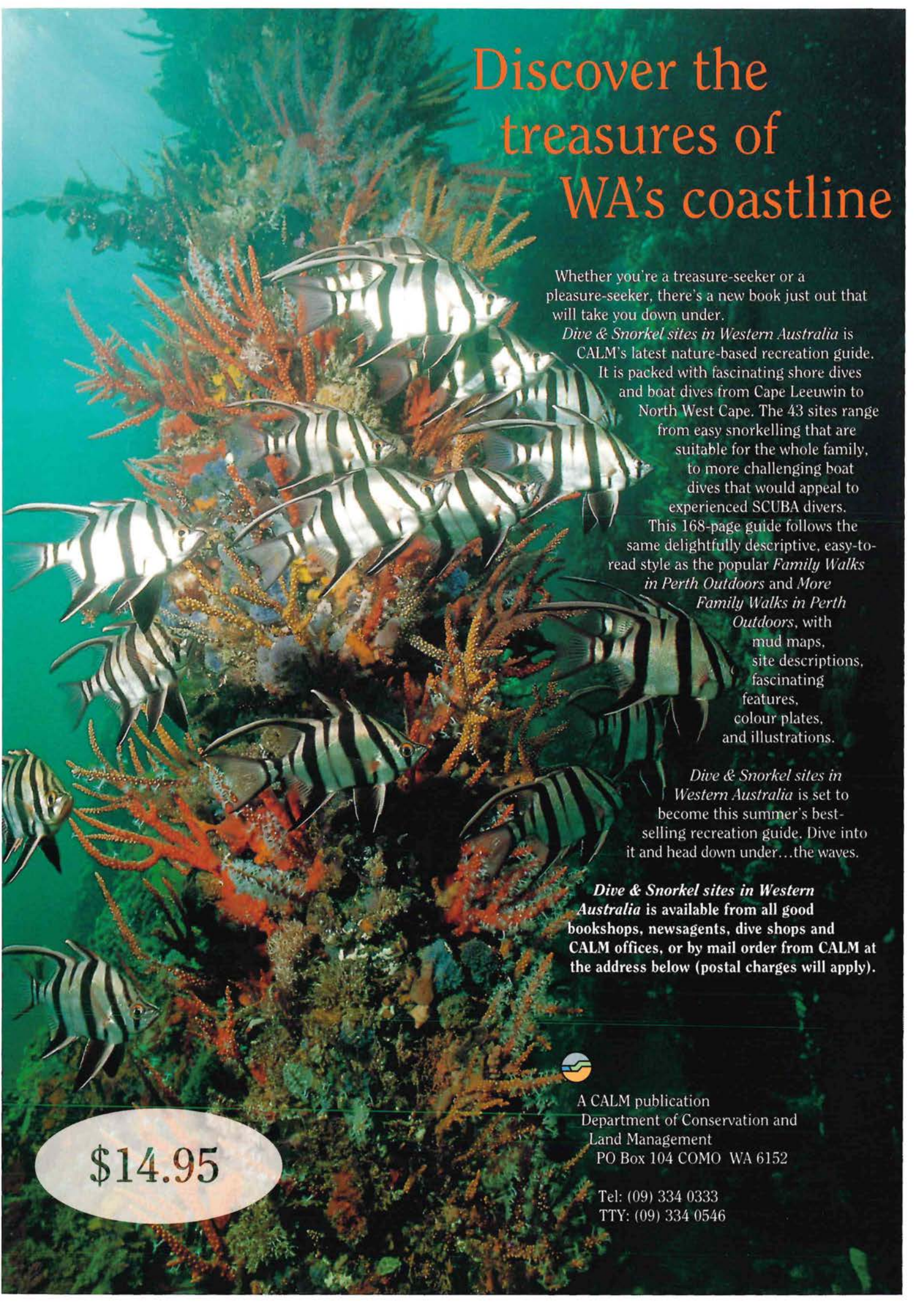
Late in the Autumn, the new queens fly off to hibernate and the workers and males die off around their declining colony. Nests may be located and reactivated next year.

The papernest wasp, apart from its aggressive nature and its capability of being able to repeatedly sting, is a useful insect in that it helps to control garden caterpillars. Watch them away from their nest, as they hover, legs dangling, seemingly to dance on the afternoon rays of a summer sun and then swirl effortlessly around sweet smelling foliage.

BY JOHN HUNTER

DID YOU KNOW

- *The Hymenoptera receive their name from the two pairs of glassy membranous wings, the fore and hind wing of each side, being coupled together in flight by a row of small hooks.*
- *Paperwasps have a narrow waist, are more slender and slightly longer than a bee. They also have orange-brown antennae.*
- *BEWARE of European wasps. They look like the yellow paperwasp only more solid. They fly fast with legs held close to the body and have black antennae. Because of our moderate climate, they could continuously reproduce in hidden colonies of hundreds of thousands. Please report any such sightings to the nearest Agriculture WA or CALM office.*



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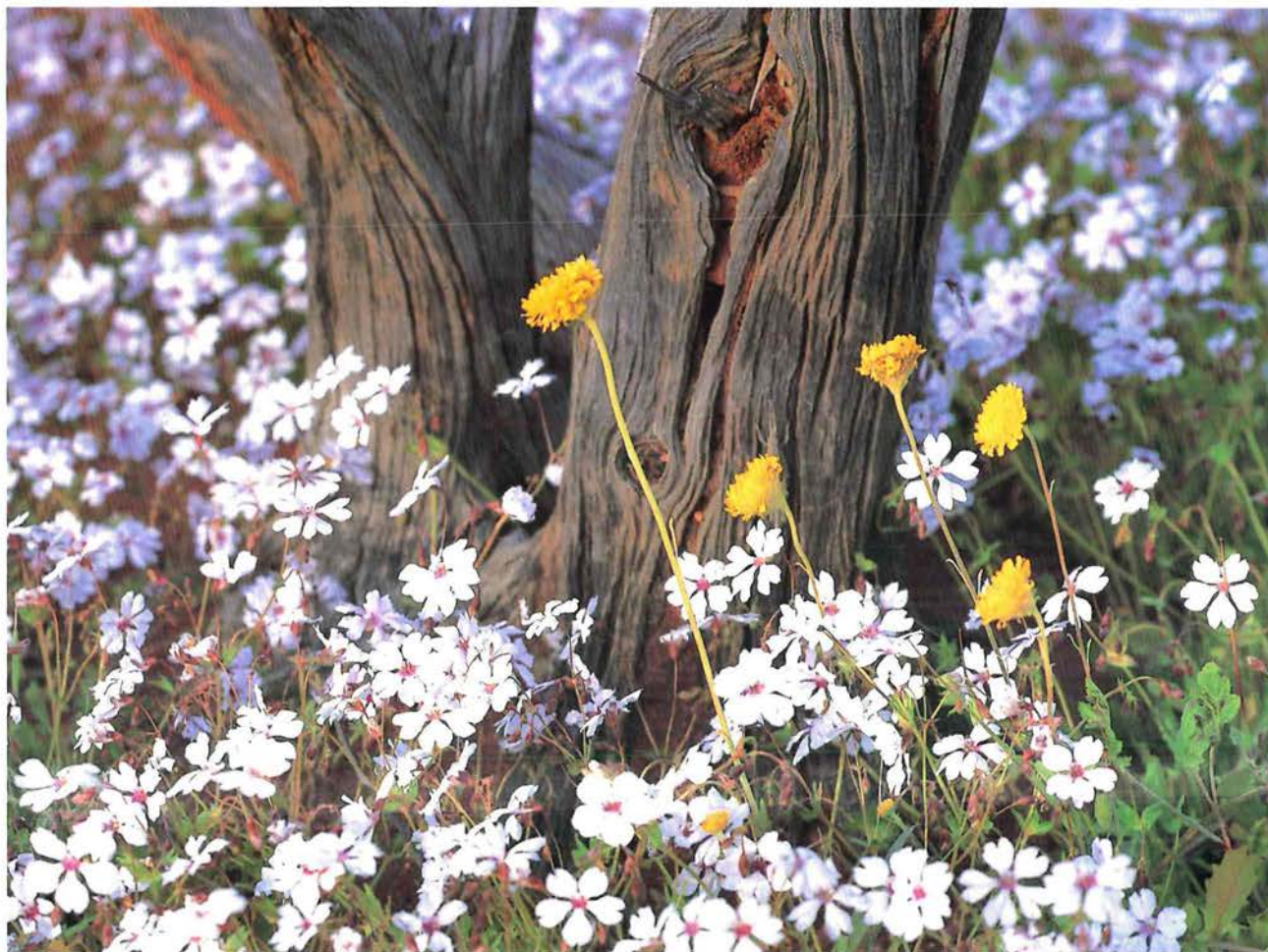
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*These delicate yellow daisies and pale pink velleias,
photographed near Mt Magnet,
contrast against the gnarled trunk of a mulga.*

Photo - Chris Garnett



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