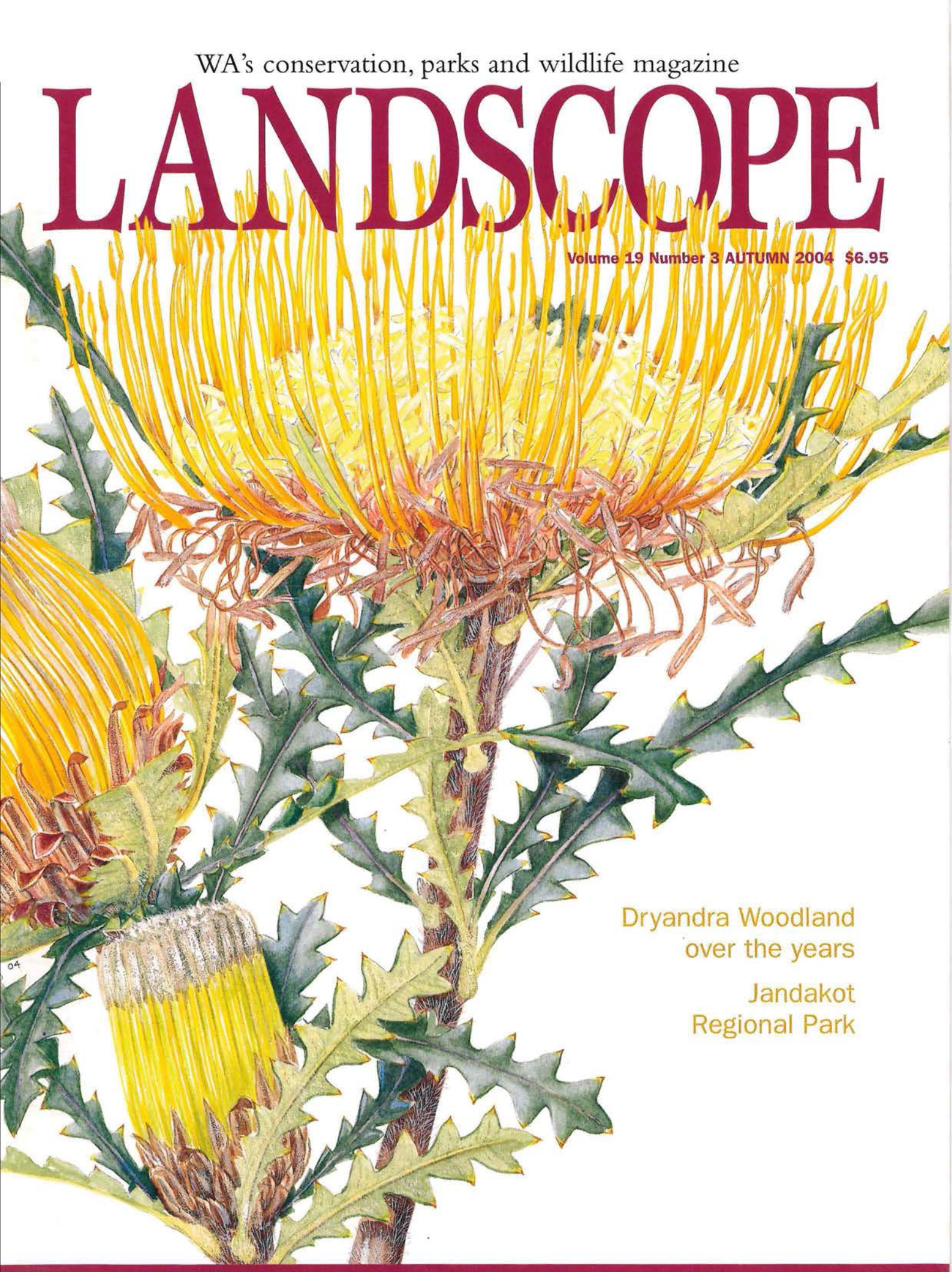
WA's conservation, parks and wildlife magazine

LANDSCOPE

Volume 19 Number 3 AUTUMN 2004 $6.95



Dryandra Woodland over the years

Jandakot Regional Park

Remarkable Rowley Shoals **Saving desert rock-wallabies** Exploring the karri forest

Making a world of difference with *LANDSCOPE* Expeditions

Expedition members checking pit traps in the Gibson Desert, Western Australia. Photo – Graeme Liddelow

Join our scientists in the cause of conservation and discover the secrets of the Australian outback.

Conserving the Cape—Wildlife of Cape Arid

May 9–16, 2004

Superb white beaches, rocky headlands and clear blue seas provide a stunning visual backdrop to granite hills, dense coastal heaths and the open woodlands of Cape Arid National Park. Search for the elusive heath mouse and threatened bird species, including the western ground parrot and the Cape Barren goose; and assist with a comprehensive survey of an array of reptile and mammal fauna, several of which are rarely encountered. Includes a half-day cruise to islands of the Archipelago of the Recherche.

Where Deserts Meet—Conserving Vanishing Wildlife

August 9–20, 2004

So much of Australia's culture and history is based on the outback. Yet most Australians live on the perimeter of the continent and know little about the country's vast heartland. Australia's deserts are not vast areas of sand, but contain many different landforms and vegetation types that are home to many different and unique animals. This expedition contributes to the ongoing Western Shield program and will carry out vital wildlife research in a region bounded by the Little Sandy Desert, the Gibson Desert and the Great Victoria Desert.

Secrets of the Black Range—Prospecting for Wildlife

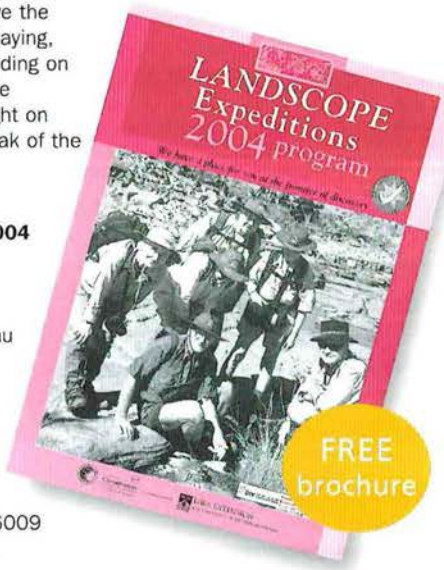
September 13–22, 2004

Part of the mystique of outback research is the opportunity to travel to little known areas of the State and view some of Western Australia's most secretive animals in their natural surroundings. This *LANDSCOPE* Expedition will carry out the first formal biological survey of the plants and animals of Black Range and Lake Mason, in the Murchison region. Travel with us through historic gold rush country, renowned for its carpets of spectacular everlasting wildflowers and scenic breakaways.

Loggerhead Turtles of Dirk Hartog Island, Shark Bay

(a) January 10–17, (b) January 17–24, 2005

The sandy beaches of Turtle Bay, at the northern end of Dirk Hartog Island, are among the few key nesting sites in Western Australia for the loggerhead turtle (*Caretta caretta*). The species is considered to be the most endangered turtle that nests in the Australian region and is declared threatened under the Western Australian Wildlife Conservation Act. Expedition members will have the opportunity to observe egg laying, hatchling emergence (depending on season), and help tag female loggerheads that nest at night on Dirk Hartog Island at the peak of the summer season.



Send for your *LANDSCOPE* Expeditions 2004 brochure now.

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Department of Conservation and Land Management
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THE UNIVERSITY OF WESTERN AUSTRALIA


Cliff Winfield


Jonica Foss

contributors

Cliff Winfield is the Parks and Visitor Services Regional Leader of the Department of Conservation and Land Management's (CALM's) Warren Region and is based in the Manjimup work centre in the south-west of the State. Cliff is a veteran *LANDSCOPE* contributor, having written many articles and photographic essays on natural history. He was also involved in the establishment of the award-winning Tree Top Walk in the Walpole-Nornalup National Park.

Jonica Foss is a primary school teacher with an interest in natural history, and is a volunteer at the WA Herbarium. She is part of the team that identifies plants sent in from the regional herbaria, and she also collects specimens for the State herbarium. With her sister, Patricia Gurry, she helps to curate the *Eremophila*. Jonica and Patricia are two of the authors of a forthcoming book on the wildflowers of the Dryandra Woodland.

Carolyn Thomson-Dans is a senior projects officer for CALM. She has written and edited numerous publications about WA's natural environment and wildlife, including *LANDSCOPE*. Carolyn has a special interest in the marine environment. She collaborated in and edited the book *Dive and Snorkel Sites in Western Australia* and CALM's successful Bush Book series.

Richard Robinson is a research scientist with CALM, based at Manjimup Research Centre. He is principally involved in fungal biodiversity and ecology, and the management of native forest diseases. He has written several articles on Western Australian fungi for *LANDSCOPE*, as well as for specialist journals and books. He has studied and worked on fungi in Tasmania and Canada and co-authored *Rainforest Fungi of Tasmania and South-East Australia* prior to moving to WA.

Margaret McNally is a final year Professional Writing and Publishing student at Curtin University of Technology. Her previous careers in hospitality and broadcast, print and electronic media span 24 years and have ensured her success as a communications professional. Attending university as a mature-age student is Margaret's most rewarding experience and a launch pad for a new career where she can indulge her passion for the written word.

editor's letter

The West Australian landscape is a face of almost incomprehensible depth and complexity.

If one were to walk for several days, for example, among the tall river gums, common rock figs, shady acacias and the ancient layered rock formed more than 2,500 million years ago in what are now the gorges of Karijini National Park, stepping from flood-polished stone slabs and ledges to loose sand and gravel, and then were to step off to the Stirling Range, with its woodlands, swamps, thickets and showy mountain bells in what is otherwise a sea of mallee shrublands and heath, and then head west a short distance to explore the rivers, high sand dunes, limestone cliffs and delightful beaches of D'Entrecasteaux National Park, you would be reeling under the sensations.

The contrast is not only one of plants and landforms, or of the hundreds of different bird species. The shock to the senses comes from the very nature of colour and light, from the different experience of solitude and serenity, each of these places provides.

And this journey to only three of Western Australia's special places still leaves one with an almost infinite choice of other places to explore—the unbroken Baxter Cliffs of Nuytsland Nature Reserve, the turquoise waters of Roebuck Bay, the red sandy plains and breakaway areas of the Tanami Desert, and much more.

None of these places, of course, can be entirely captured in words or pictures. However, we try to give readers of *LANDSCOPE* a taste of the enchantments and mysteries that Western Australia has to offer.

Jonica Foss was one of the dozen or so children who grew up at the Dryandra Forest settlement in the 1940s and 1950s. In 'Dryandra over the years', she gives a personal account of the history of Dryandra Woodland and of how its management has changed over the years. She also provides an insight into the diversity of the more than 800 plant species that can be found there.

Because of their isolation, the large and spectacular reefs that make up the Rowley Shoals Marine Park provide one of the best chances to preserve a pristine coral reef system anywhere in the world. In 'Remarkable Rowley Shoals', Carolyn Thomson-Dans, Andrew Hill, Keiran McNamara and Allen Grosse outline a new management plan and proposals to extend the marine park and to secure the future of these amazing 'aquariums' in the middle of the ocean.

In 'Jandakot Regional Park—understated beauty'. Margaret McNally skillfully describes the ecologically sustainable environment that enables visitors to experience year-round enjoyment of this regionally significant conservation haven.

Just a few of the places awaiting your visit. Enjoy the read and we'll see you again in winter.

Ron Kawalilak

Ron Kawalilak
Executive Editor

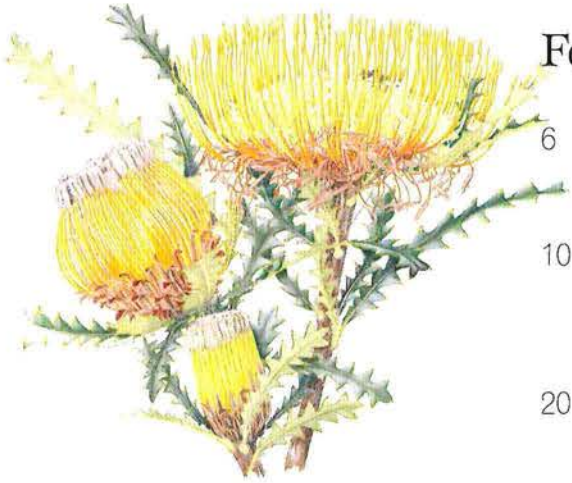
also contributing . . .

Sarah Barrett, John Blyth, Margaret Byrne, Anne Cochrane, David Gough, Alan Grosse, Andrew Hill, Keiran McNamara, Brett Molony, Mike Paxman, David Pearson.


Carolyn Thomson-Dans


Margaret McNally

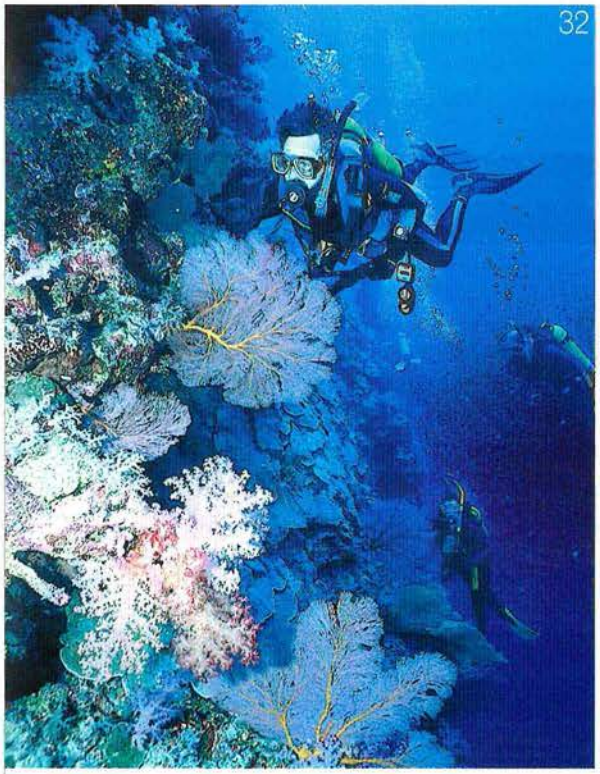

Richard Robinson



Cover illustration by Philippa Nikulinski
Dryandra stuposa grows between York and Broomehill, including Dryandra Woodland. It flowers in summer and occasionally at other times of the year.

Back cover photo by Patricia Curry
Wandoo in Dryandra Woodland.

Features



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A rare hybrid beauty

Albany woollybush

Genetic detective work by a Department of Conservation and Land Management (CALM) scientist Margaret Byrne and her honours student Esther Walker provided the key to a better understanding of the nature of the unique and beautiful plant, Albany woollybush (*Adenanthos cunninghamii*).

by Anne Cochrane, Sarah Barrett and Margaret Byrne

Facing page
Main Albany woollybush showing the flattened leaf segments that differentiate it from coastal woollybush.
Inset The red flower of the Albany woollybush.

Above Birds, such as this red wattlebird, feed on the nectar of the Albany woollybush flowers and transfer pollen from plant to plant.
Photos – Sallyanne Cousans

Albany woollybush is an erect, spreading shrub of up to one-and-a-half metres high from the banksia family (Proteaceae). The first plant was collected in 1827 from King George Sound (near Albany) by Charles Fraser, colonial botanist of New South Wales, during a survey voyage with Captain James Stirling. The species was named after brothers Richard and Allan Cunningham, early colonial botanists from New South Wales. The single, dull red flowers can be held at the tips or in the axils of the branchlets. The leaves are deeply divided into three parts, like a trident. Each part is further divided into two, so there are generally six segments. The segments are soft to the touch and hairy, hence the common name 'woollybush'. It is very similar to the common coastal woollybush (*Adenanthos sericeous*), but differs in having flattened leaf segments rather than the terete (cylindrical or slightly tapering) leaf segments of coastal woollybush.

In 1973, the Irish botanist E Charles Nelson found only three plants when collecting in Western Australia. He noted that it grew in low scrub on sandy soil, in association with coastal woollybush and coastal jugflower (*A. cuneatus*). On his recommendation, the species was declared 'rare'.

Since then, a range of specimens has been collected from near the south coast city of Albany. The plants were never found in large numbers and were usually scattered among plants of the common woollybush. Some plants found at Two Peoples Bay occurred among plants of coastal woollybush and coastal jugflower. But there were also a large number of plants that had wide variation in leaf shapes, from the terete leaves of coastal woollybush to the broad, only slightly divided leaves of coastal jugflower. The wide variation in leaf shape suggested that this was a site of hybridisation between coastal woollybush and coastal jugflower, where the hybrids were then crossing back to the parental species. This is known as a hybrid swarm.

The presence of Albany woollybush among these plants led botanists to suggest that Albany woollybush was possibly the first generation hybrid of the two species, whereas the other plants with various leaf shapes were later generation hybrids. Both coastal woollybush and coastal jugflower are pollinated by bees and birds, such as honeyeaters, which also feed on the nectar, so hybridisation could easily occur. Coastal woollybush only regenerates from seed and coastal jugflower is a resprouter, but Albany woollybush itself is killed by fire and regenerates from seed.

In Spring 2001, seed traps were erected around five Albany woollybush plants in Torndirrup National Park, near Albany. These seed traps (described in 'The defiant seed', *LANDSCOPE*, Summer 1999–2000) were used to collect seed for both germination and genetic research. Albany local Peta Ireland spent many hours over the following six months collecting material that fell into the traps, and sending the bags to CALM's Threatened Flora Seed Centre in Perth. The material, which contained mainly old flowers, twigs and leaves, was carefully sieved to find the seed. The seed was germinated but the seedlings did not have the flattened leaf segments characteristic of Albany woollybush. Instead, they showed a range of leaf shapes, from broad, slightly divided leaves to fine terete leaves (see photo).

Above Leaves of several seedlings grown from seed collected from a single Albany woollybush plant. Note the range of leaf shapes in the seedlings.
Photo – Carole Elliott

Above left Albany woollybush plants grow scattered throughout Torndirrup National Park on the south coast.
Photo – Rob Olver

Left New leaf growth on Albany woollybush has a pinkish colour.
Photo – Sallyanne Cousans

Around the same time, geneticist Margaret Byrne and Murdoch University Honours student Esther Walker visited two populations of Albany woollybush to collect leaf material for DNA analysis. They also collected material from the suspected parents, coastal woollybush and coastal jugflower. Genetic analysis showed that the samples of the two parental species were different from each other, and each species contained DNA variation that was specific to that species. In comparison, the Albany woollybush samples contained DNA variation from each of the two parental species, and no DNA variation that was unique to these plants. This confirmed that Albany woollybush is not a genetically discrete species, but a hybrid between coastal woollybush and coastal jugflower!

Some hybrids can be stable—that is, they produce seedlings that consistently look like the parent plants. But Albany woollybush is not a stable hybrid, because the seedlings produced from seed collections did not have the same appearance as Albany woollybush. Albany woollybush plants were never found in large numbers, indicating that hybridisation, and establishment of plants from seed produced through hybridisation, is a random effect.

Now that we know that Albany woollybush is not a true species, it does not fit the criteria for Declared Rare Flora and will be removed from the rare list. Nevertheless, this hybrid is unique and interesting, the result of evolutionary processes occurring right before our very eyes, and it will remain a protected plant under the CALM listing of Priority 4. Plants under this listing are monitored regularly to ensure their survival in the wild is not compromised.

Anne Cochrane is Manager of CALM's Threatened Flora Seed Centre, and is based in Albany. She can be contacted on (08) 9892 8501 or by email (annec@calm.wa.gov.au).

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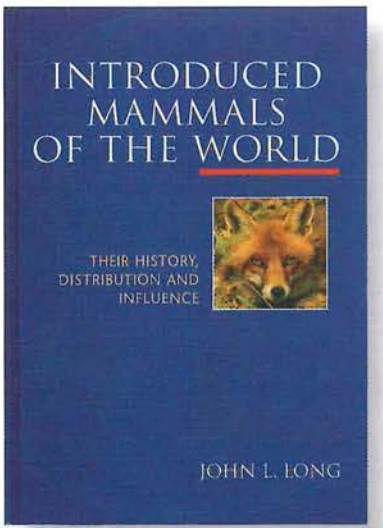
bookmarks by Verna Costello

Introduced mammals of the world. Their history, distribution and influence

by John L Long (2003)
Publisher: CSIRO publishing.
640 pages RRP $135.00
ISBN: 0643067140

Introduced mammals of the world provides a concise and extensive source of information on the range of mammals removed by humans from their natural habitats and introduced into other habitats throughout the world. The book also indicates which of these mammals have resulted in adverse outcomes.

Scientists will find *Introduced mammals of the world* a highly valuable tool with which to assess potential introductions (or reintroductions) so that costly mistakes can be avoided. The introduction of the European fox into Australia to meet the 'sporting' needs of fox hunters is only one example that produced devastating consequences far beyond the original objective. The book offers tangible proof of the need for decision-makers to consider sound advice and make wise and cautious decisions.

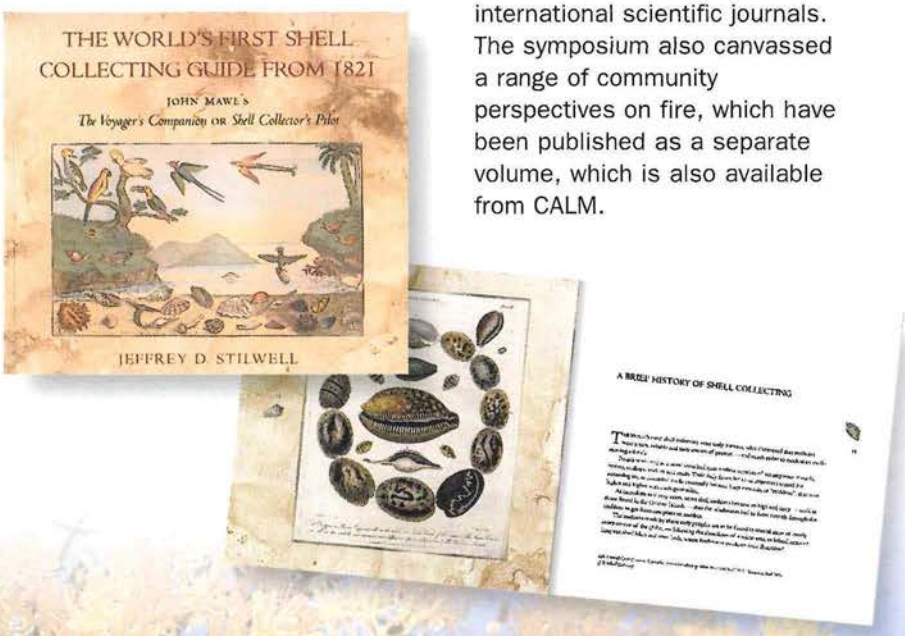


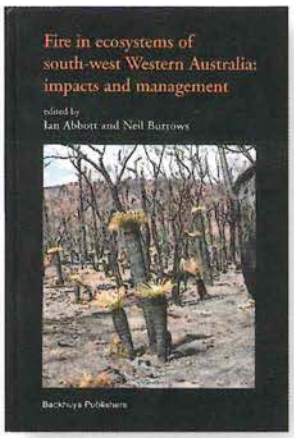
The world's first shell collecting guide from 1821. John Mawe's The voyager's companion or shell collector's pilot

by Jeffrey Stilwell (2003)
Publisher: Western Australian Museum. 81 pages RRP $39.95
ISBN: 1 920843 04 3.

Monash University palaeontologist Jeffrey Stilwell has two passions—rare books and shells—and they have led him into the world of popular publishing. The latter came about as a result of finding a rare, exquisitely produced leather-bound volume: *The Shell Collector's Pilot* in a tiny bookshop in Cambridge. His find was the third edition of a book written by an adventurous nineteenth century shell collector and dealer, John Mawe.

With encouragement from shell collectors worldwide, Stilwell has reproduced in facsimile John Mawe's 11-page pamphlet of 1804, together with his complete edition of 1821, *The Voyager's Companion, or Shell Collector's Pilot*—the world's first true shell collecting guide. Stilwell has also added much fascinating biographical material on Mawe himself.

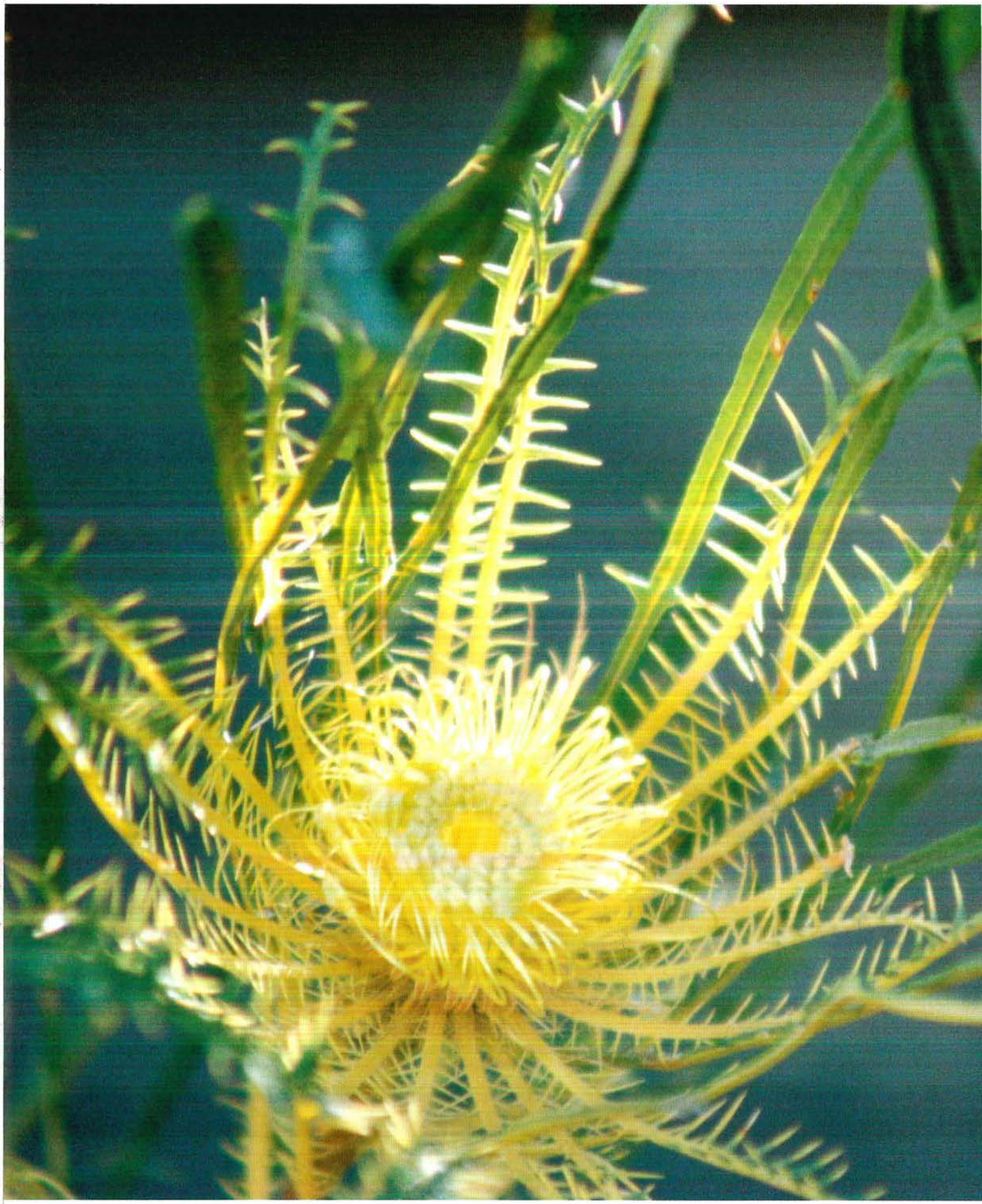




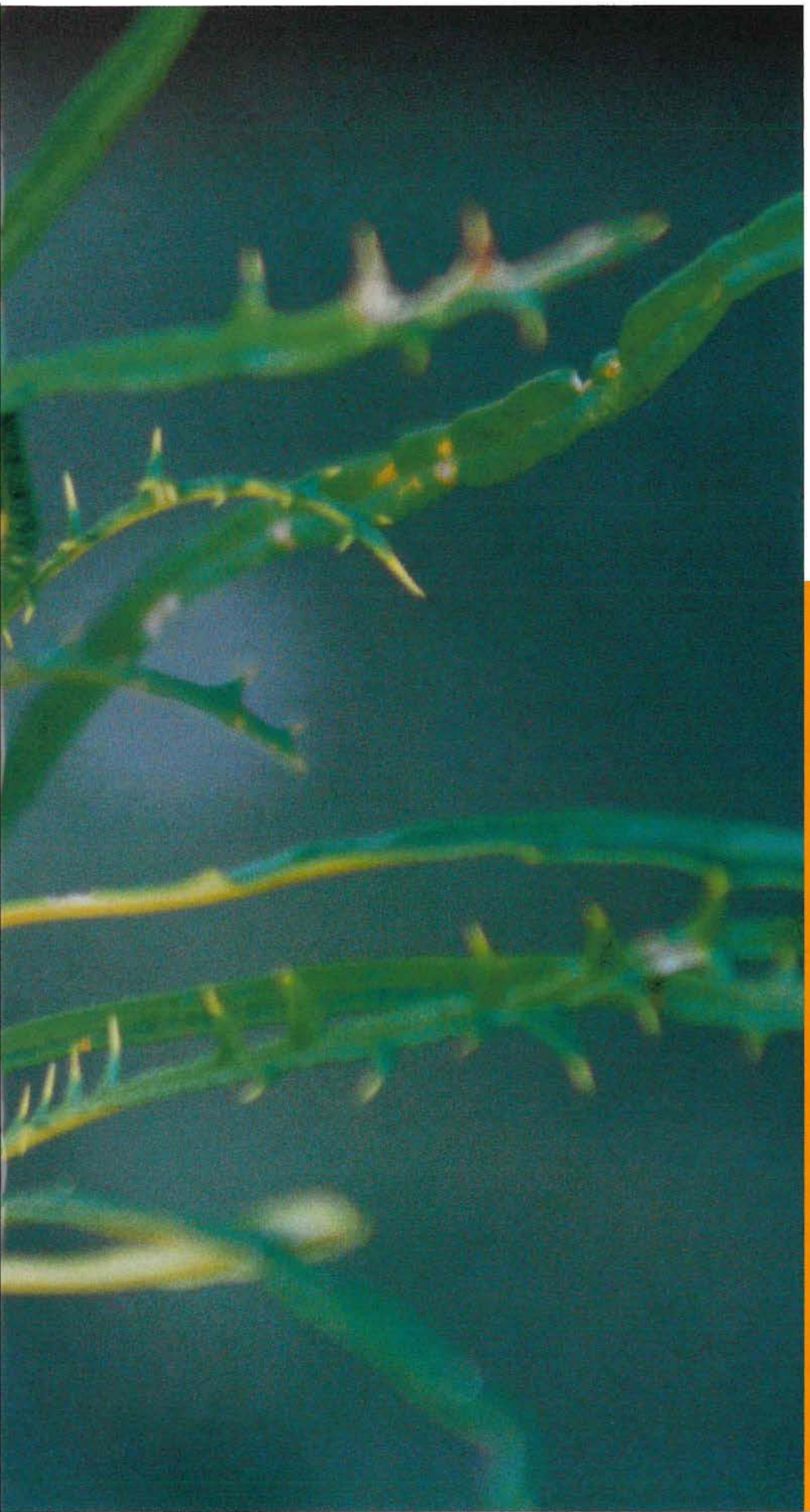
Fire in ecosystems of south-west Western Australia: impacts and management

Edited by Ian Abbott and Neil Burrows (2003)
Publisher: Backhuys Publishers, Leiden, The Netherlands. 465 pages RRP $89.00 ISBN: 90-5782-131-1

This book comprises the scientific proceedings of a symposium organised by the Department of Conservation and Land Management (CALM) in April 2002 to provide a synthesis of knowledge of fire in south-west Western Australian ecosystems. The book chapters are written by renowned experts in their field and deal with a wide range of fire ecology and management topics. The book has received positive reviews by national and international scientific journals. The symposium also canvassed a range of community perspectives on fire, which have been published as a separate volume, which is also available from CALM.

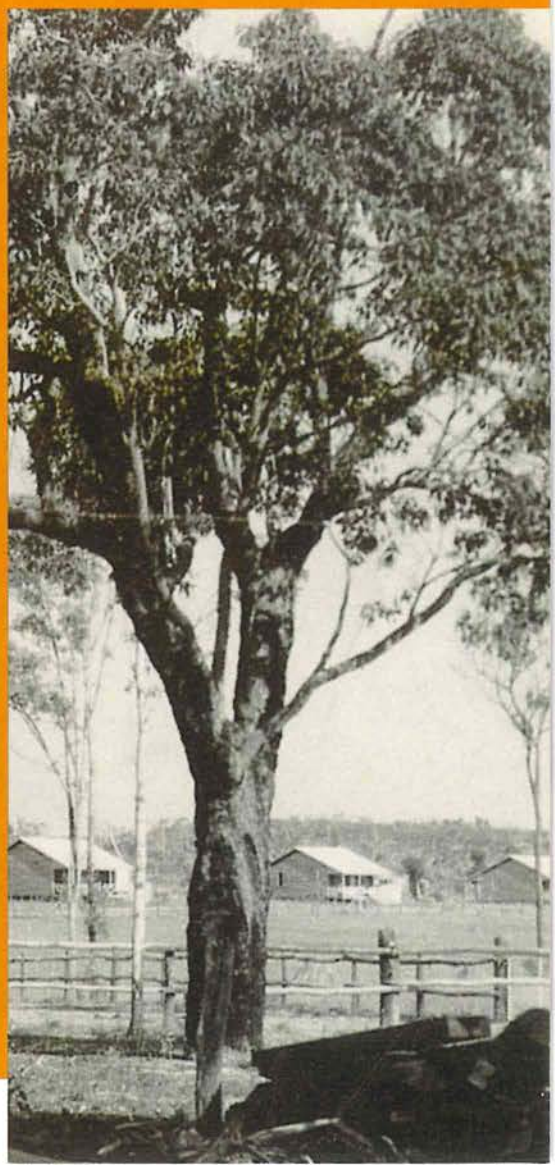


Dryandra over the years



The author of a forthcoming Bush Book on the wildflowers of Dryandra Woodland grew up in the woodland. Her story is a personal account of Dryandra's history and how its management has changed over the years.

by Jonica Foss



I was one of the dozen or so children who grew up at the Dryandra Forest settlement in the 1940s and 1950s. At the time we had no idea we were living in a naturalist's paradise. For us, the most important things were to be able to ride our bikes for miles every weekend, to whiz down gravel hills at high speed, to make 'cubbies' in huge laterite outcrops and to eat our sandwiches in a shady sheoak glen surrounded by rock ferns, orchids and pink everlastings. It was a life of freedom and independence that few children nowadays enjoy.

I was born in 1948, the youngest of four children of John (Jack) Currie, the senior forester at Dryandra from 1936 until 1969. To me, it was an accepted part of life to creep through the scrub to glimpse a malleefowl working its nest—removing or adding soil to adjust the temperature of the mound, or to ride up to the fire tower and see a numbat scampering across the track as we passed. At night, we would watch woylies come in to be fed scraps of bread by the towerman, and shiver when we heard the mournful cry of the curlew.

What was then an experience enjoyed by only a few of us is now enjoyed by thousands of visitors each year—scientists carrying out research, enthusiastic amateur naturalists and tourists struck by the beauty and peace of Dryandra's natural surroundings. Having improved the conservation status of the woylie and numbat, scientists and conservation managers from the Department of Conservation and Land Management (CALM) are reintroducing five more species of rare marsupials to the woodland. Botanists recognise the area as a unique and rich remnant of Wheatbelt vegetation.

Previous page
Main A hybrid of spiny honeypot (*Dryandra subpinnatifida*) with pingle (*Dryandra squarrosa*).
Photo – Patricia Gurry
Inset The original Dryandra cottages viewed from across the horse paddock, circa 1937.
Photo – John Currie

Below left A numbat (*Myrmecobius faciatus*) emerging from a hollow wandoo log.
Photo – Michael and Irene Morcombe

Establishment of Dryandra

The large tracts of land that later became the Dryandra Forest were saved from being cleared for farming by a lucky combination of economics, poison bushes (*Gastrolobium* spp.) and topography.

In the early 1900s, the bark of the brown mallet tree (*Eucalyptus astringens*) was found to contain up to 60 per cent of water-soluble tannins. This valuable product was used in the making of high quality leather. Mallet was then a common tree of the central western Wheatbelt, but in the ensuing 'Mallet Bark Rush' in 1903 and 1904 it was cut out almost to the point of extinction. The species only survived in small pockets of regrowth. These were usually on steep scree slopes beneath rocky breakaways, often growing in association with dense gastrolobium bushes that were poisonous to stock. These two factors made the land unsuitable for farming.

The Forests Act of 1918 created the Forests Department, which began implementing plans to both preserve the species and develop new plantations of mallet to provide a sustained yield of bark for local and export use. This idea of growing plantations of native eucalypts was, in the 1920s, a stunningly new initiative and one of the first of its kind in Australia.

A survey of suitable areas found a large block of mixed wandoo (*E. wandoo*), powderbark (*E. accedens*) and mallet country west of Cuballing and south of Pingelly. An additional block

Above A track through wandoo woodland at Dryandra.
Photo – Marie Lochman

Right Forester John Currie inspecting mallet bark stacks.
Photo – Alec Currie

of forest near Highbury, south of Narrogin, and an area for water catchment on the Congelin Brook were also reserved, and subsequently these all became known as the Dryandra Forest. The name Dryandra was derived from the dryandra plants, which grow prolifically on the breakaways. The forest now covers an area of 27,000 hectares, of which 8,000 is mallet plantation.

The Dryandra settlement

The Dryandra settlement was a busy community in the 1940s and 1950s. There were few luxuries. Electricity from a 220-volt lighting plant was only available from 6 pm to 10.30 pm, and the only drinking water was conserved rainwater. For entertainment, there were dances in the local hall at Codjatotine. The highlight of the year for the children was Guy Fawkes night (November 5), with a huge bonfire on the firebreak near the tennis court.

The houses, which now constitute the Dryandra Lions Village, were the forest workers' homes. They were built beside a 16-hectare paddock that was first used as a horse paddock for a two-horse grading maintenance team. Later, it became a stock paddock for employees. My mother had experience in farming and kept cows there that provided all the milk for the residents. Most people were able to grow their own vegetables and fruit, using water from the two dams, and many kept chickens and ducks. Rainwater for drinking and cooking was stored in a 22,000-litre tank. Rubbish was disposed of in a large hole dug in the backyard for bottles and cans. As there was no plastic in those days, everything else was biodegradable or could be burnt.

My father's job was to regenerate the mallet in plantations and to protect existing plantations from fire. Mallet, unlike many other species of eucalypt,

is extremely fire sensitive and, according to old bushmen's lore, you could not even boil your billy within a chain of a mallet tree without killing it. During the cooler spring and autumn months, my father would organise the controlled burning of wandoo and powderbark areas surrounding the mallet to reduce the fuel load. Laterite plateaux were burned less frequently—and only in the autumn, when there were no nests in the tall shrubs that were havens for birds and small mammals.

Later, areas of wandoo and powderbark were cleared and new plantations of mallet were sown in their place. A hot fire sterilised the soil and the seed was sown in the ashbeds by hand. In all, some 8,000 hectares of mallet plantations were established from 1925 to 1962.

My father's other jobs included fighting bushfires, maintaining roads and tracks, keeping good relations with neighbours and trying to control pests such as rabbits and foxes. He planted some small experimental plots of sandalwood, which had once occurred widely in the area. He also supervised the operations of the sawmills in the district.

A sawmill for the production of wandoo sleepers and scantling (smaller pieces of timber) operated for about 10 years at Dryandra, and ceased when it became too difficult to obtain skilled workers. This site is now the picnic area by the old mill dam.

In 1958, the Forests Department's inland tree nursery was transferred from Kalgoorlie to Dryandra. It supplied farmers and local government bodies with thousands of dry area eucalypts and other seedlings every year. One of our holiday jobs was to

Top left Honey possum (*Tarsipes rostratus*).
Photo – Michael and Irene Morcombe

Centre left A malleefowl (*Leipoa ocellata*) tends its nesting mound.
Photo – Jiri Lochman

Left Echidna (*Tachyglossus aculeatus*).
Photo – Michael and Irene Morcombe

Right Brown mallet (*Eucalyptus astringens*) plantation on laterite breakaway.
Photo – Peter Foss

Below right Carpet python.
Photo – Jiri Lochman

Below far right The woylie (*Bettongia penicillata*) makes its nest in the base of dryandra shrubs.
Photo – Babs and Bert Wells/CALM

water the plants, as well as to put the clay chocks and a handful of charcoal for drainage in the bottom of the pots.

By the end of 1960, the world market for natural tannins had collapsed, and the role of Dryandra changed to its present one, with the emphasis on recreation and conservation.

Wildlife

The introduced European fox became common in the Wheatbelt region during the 1940s, but for many years, the small marsupials at Dryandra managed to thrive despite its predations. Workers at the settlement owned cats and dogs, so few native animals were seen near the houses. But in the bush, it was common to see woylies, numbats, tammar wallabies, malleefowl, echidnas, possums and even honey possums in the dryandra blossoms. There were dozens of different species of birds. For a while, we had a resident carpet python in the feed shed. My mother encouraged it to stay there—it helped to keep down the mouse population.

By the 1970s, the populations of small marsupials at Dryandra had crashed. Trials of fox baiting with 1080 poison were carried out and led to a marked increase in the number of numbats and woylies. Recovery has continued, and the woylie has been removed from the threatened species list. It is now classified 'conservation dependent', with the proviso that it needs ongoing protection from foxes. Other animals that once used to live at Dryandra have been reintroduced into the woodlands. Visitors walking the trails at night can, once again, glimpse dalgytes (also known as bilbies) and boodies (burrowing bettongs). In the new Barna Mia visitor centre, they can view other endangered marsupials like the mala and western barred bandicoot. The ground-dwelling malleefowl, however, has still not recovered in numbers, despite the reduction in foxes. While malleefowl mounds can still be found in the bush, the birds do not appear to have been active there for many years.

Trees and wildflowers

One of the beauties of Dryandra is that, being an open woodland rather than a deep forest, it undergoes a transformation during the course of the day because of the effect of the sunlight on the trees. As forester Roger Underwood stated in his article 'The Mallet Plantations of Dryandra Forest' (*The Forester*, June 1994):

> "Powderbark ... and brown mallet are two of Australia's most beautiful trees ... the open woodland is full of birds, animals and wildflowers, and is easy walking with excellent vantage points up on the breakaways and granite outcrops."

This sunlight also brings a profusion of flowering plants and, in springtime, Dryandra is a wonderland of wildflowers.

Dryandra lies in the transitional zone between the semi-arid Wheatbelt and the moister jarrah

Left Sandplain poison (*Gastrolobium microcarpum*) is one of the commonest understorey plants at Dryandra.

Above Pink coneflower (*Isopogon crithmifolius*).
Photos – Peter Foss

forests. This change from one vegetation system to another gives rise to an unusually high number of plant species in a small area. More than 800 species have been found at Dryandra so far. Each different soil type and terrain supports its own distinctive group of plants, and they are uniquely adapted to survive in the harsh climate. The many different methods they use to attract pollinators make a fascinating study in itself, showing the ways the plants and animals have co-evolved.

One of the main plant families at Dryandra is the Proteaceae family, which includes the dryandras, banksias, grevilleas, hakeas, isopogons and petrophiles. Many of these produce copious amounts of nectar and pollen, and are an important source of food for birds, insects and many small mammals. Their prickly leaves and dense foliage provide valuable cover and nesting sites. The minute honey possum feeds solely on pollen and nectar, and can survive at Dryandra because there are flowering plants present all year round. Many dryandra blossoms, such as those of king dryandra (*D. proteoides*), are hidden inside the bush, and have a musky smell, which is thought to attract small mammals.

Members of the Epacridaceae family, like the astrolomas and styphelias, flower in autumn and winter, making them highly sought after at a time when there is little other food available. They have developed another evolutionary advantage, in having specialised roots containing symbiotic fungi. These can extract nutrients from leaf litter in otherwise nutrient-poor soils. The sundew (*Drosera* spp.), of which there are at least ten species at Dryandra, form another genus with a strategy for these soils. They have specialised leaves that capture insects to supplement their diet.

A species not to be missed, but easily overlooked, is the black toothbrush grevillea (*G. hookeriana*). As the name suggests, it has unusual wiry, black flowers topped with maroon-red knobs. One of the commonest plants of the Dryandra Woodland is the sandplain poison bush (*Gastrolobium*

Top Black toothbrush grevillea (*Grevillea hookeriana*).

Above left Pygmy sundew (*Drosera hyperostigma*).
Photos – Patricia Gurry

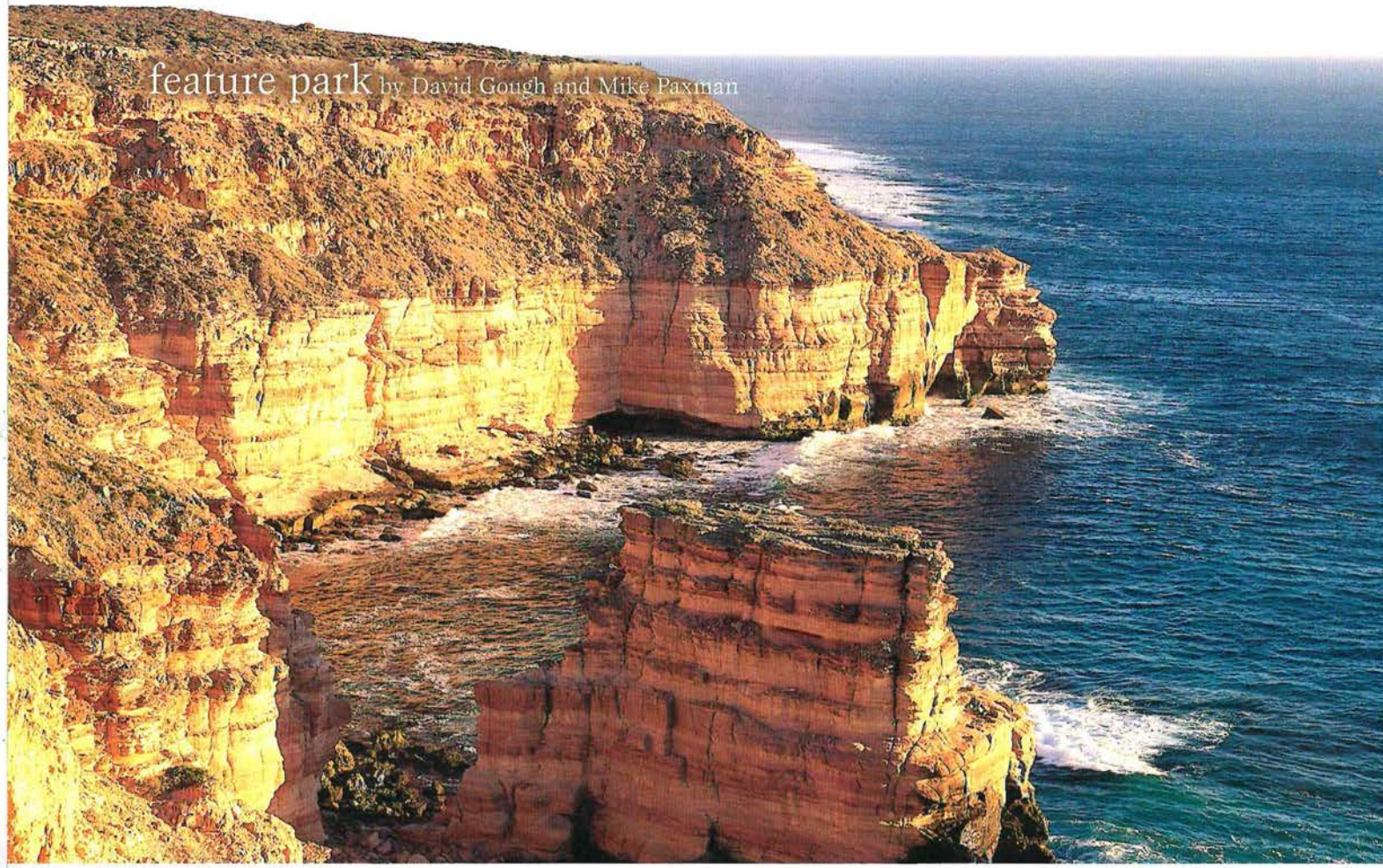
Above King dryandra (*Dryandra proteoides*) has its flowers hidden inside the foliage.
Photo – Jiri Lochman

microcarpum), a member of the pea family. There are five different poison bushes found there, and they all contain sodium monofluoroacetate—the same chemical used in the synthetic 1080 poison. Because the local animals have co-evolved with the poison bushes, they are immune to its effects and also to the effects of the poison baits set for controlling foxes. The poison bushes also provide thick cover and shelter for small animals.

The most significant feature of the flora at Dryandra is its amazing diversity of form and colour. For a wildflower enthusiast, or a beginner with a small amount of information, it is a place where you can happily spend hours enjoying the beauty of the Western Australian bush.

Through the preservation of mallet for forestry use, many other species of plants and animals have also been preserved at Dryandra, although the populations of several species of small mammals were severely reduced by the depredations of foxes. With careful management, these have now increased and others are returning. Dryandra is becoming an attraction for a new breed of tourist—one that strives to be as close to nature as we were as children growing up in this very special place.

Jonica Foss is a primary school teacher with an interest in natural history. She is a volunteer at the WA Herbarium and is one of the authors of a forthcoming book on the wildflowers of the Dryandra Woodland. Jonica can be contacted on (08) 9271 9601.



Kalbarri National Park

Kalbarri National Park, between Geraldton and Shark Bay, offers spectacular deep gorges and majestic cliffs that look out over the Indian Ocean.

Above Island Rock.

Facing page
Top right Wedgetail eagle (*Aquila audax*).
Photos – Jiri Lochman
Above right Porcupine banksia (*Banksia lindleyana*).
Photo – Andrew Davoll/Lochman Transparencies

The spectacular scenery of Kalbarri National Park is the result of many millions of years of geological formation. Beneath the landscape are deep, horizontal bands of multi-coloured sands, which were deposited in layers some 400 million years ago. Over time, the Murchison River cut magnificent red-and-white-banded gorges through the park, as it carved its way for 80 kilometres to the Indian Ocean.

The thinly bedded, banded rocks seen through most of the river gorge and at the foot of Red Bluff were deposited on tidal flats. Rippled surfaces can be seen in many places, such as around Nature's Window. The ripples were formed by waves moving over the tidal flats. Some beds (such as on the way down the Z-Bend and in overhangs at The Loop) look as if they have been riddled by plant roots, and often have a 'can of worms' appearance. These are actually burrows left by worms sheltering in the sand. Tracks and trails on flat surfaces show where animals crawled across the damp sedimentary surface (see 'Footprints on the Sands of Time', *LANDSCOPE*, Winter 1993).

The sedimentary rock formation found in the gorge and on the coast is called the Tumblagooda sandstone. Along the coast, wind and wave erosion has exposed the layers of the coastal cliffs that rise more than 100 metres above the ocean. From Red Bluff, extensive views south overlook colourful coastal limestone and sandstone ledges. There are scenic sites at Mushroom Rock, Rainbow Valley, Pot Alley and Eagle Gorge, to name but a few.

Wildflower wonderland

Kalbarri is also famous for its wildflowers, most of which bloom from late July through spring and into early summer. The species-rich heathlands provide a spectacular floral display. There are vivid gold and orange banksias, green and red kangaroo paws, grevilleas in white, yellow and red, featherflowers in a variety of colours and shades, smokebushes, starflowers and many more.

Twenty-one plant species are found only here, mainly in the coastal cliff tops and gorge country. One of the best known is the Kalbarri catspaw (*Anigozanthos kalbarriensis*), a small yellow or red plant that is usually seen on recently burnt country from August to September. It is confined to the Kalbarri area. There are also several orchids that can only be seen in and near the park, including the Kalbarri spider orchid (*Caladenia wanosa*) and the Murchison hammer orchid (*Drakaea concolor*).

Kalbarri animals

Kalbarri is also a rich environment for reptiles, birds and other animals. Most of the native mammals are nocturnal, but western grey kangaroos and emus can be seen during the day. Emus are Australia's largest native bird and the second largest flightless bird in the world. Ospreys soar from the sea cliffs and wedgetail eagles patrol the gorges. The bizarre and ferocious-looking thorny devil, which is only about nine centimetres long and eats ants, thrives in the park and is commonly seen sunning itself along the sandy roadway into the Loop and Z-Bend. Sightings of the rare malleefowl have become more frequent since the start of fox baiting in the park in 1996. CALM's Western Shield wildlife recovery program has also seen the reintroduction of woylies and chuditch to the park. Planning is under way for the translocation of other native species including tammar wallabies and black-footed rock-wallabies, which, although once abundant, have not been sighted in the park for many years.

Park facts

Where is it? 550 km north of Perth.

Total area 183,004 hectares.

What to do Wildflower watching, walking, wildlife observation including whale watching, photography, rafting and canoeing, abseiling, rock climbing, fishing, snorkelling, picnicking.

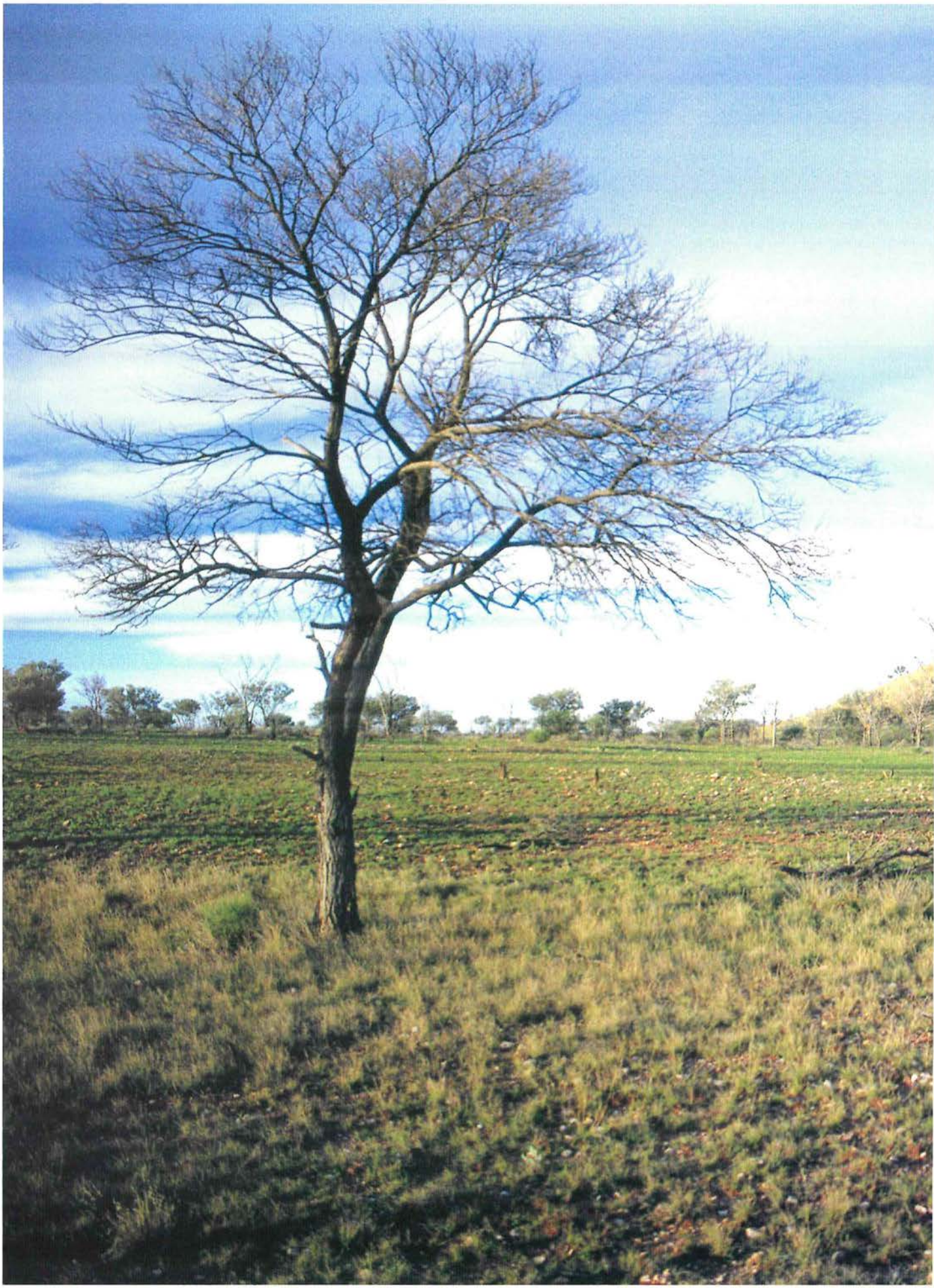
Walks For those eager for adventure, the eight-kilometre Loop Trail from Nature's Window provides an unforgettable gorge experience. Z-Bend is a moderately easy 500-metre walk to a rock lookout that overhangs the Murchison River. Visitors should take extreme care in this gorge risk area.

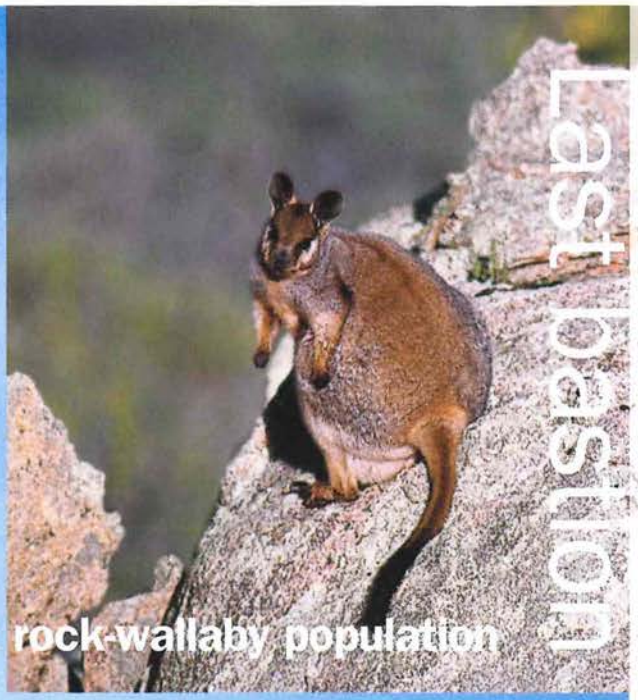
Must see sites Coastal Cliff lookouts, Hawk's Head, Z-Bend and Nature's Window.

Naming The park is named after the nearby town of Kalbarri. The name of Kalbarri was chosen from a list of Aboriginal words compiled by Daisy Bates in 1913. It is a man's name from a Murchison tribe, and also the name of an edible seed. (Information courtesy of Department of Land Information.)

Nearest CALM office The Kalbarri National Park office is located two kilometres from Kalbarri along the Kalbarri-Ajana Road.

The Mid-West Regional Office is located on the 1st Floor of The Foreshore Centre, 201 Foreshore Drive, Geraldton. Phone (08) 9937 1140.





Lennard Bastion

the battle to save a desert rock-wallaby population

When explorer Frank Hann named a remote and rugged desert rock outcrop 'Lennard Bastion', he could not have known it would stand as a silent sentinel in a battle 100 years later. Now, a local Aboriginal community, staff from the Department of Conservation and Land Management, the Department of Agriculture and Macquarie University have combined forces in the fight to prevent the extinction of a distinct race of rock-wallabies. The same species Frank Hann enjoyed eating on more than one occasion!

by David Pearson

Ribs Ward and Victor Lane, Pintupi and Ngaanyatjarra men from Warburton, walk deliberately along the edge of an immense quartzite cliff towering above a sea of red sand-dunes. Their eyes scan ahead looking for the tracks of foxes and dingoes attracted to a trail of 1080 poison baits encircling the last remaining colony of a distinct genetic race of the black-footed rock-wallaby or warru (*Petrogale lateralis*).

These two desert Aboriginal men form the front-line in a battle to prevent the extinction of the rock-wallabies. This task has brought together staff from the Department of Conservation and Land Management (CALM), the Ngaanyatjarra Land Management Unit (NLMU), the Department of Agriculture and Macquarie University to work alongside local Aboriginal communities. Of particular importance was the need to rapidly turn around the decline of rock-wallabies and to get the population growing again. This would prevent inbreeding and also help the animals to cope with unpredictable events such as drought.

A problem identified

Australian desert mammals have been decimated since European settlement. Eleven species are now extinct and a further 34 are threatened in Western Australia. A number of different factors have been implicated in these declines: competition from feral and domestic herbivores (rabbits, sheep and cattle), predation by foxes and cats, changes to fire regimes, and disease. Data available to analyse the cause and effect of many of these factors are typically old and of limited value. It is probable that these factors worked in synergy, and the relative influence of each factor depended on the nutritional, shelter and population characteristics of each mammal species. For instance, native herbivores living around rock outcrops and salt lakes were severely impacted upon by rabbits that invaded and denuded these productive habitats as they spread across Australia. This, in turn, reduced the ability of such habitats to support sizeable populations of native species and provide refuge during droughts.

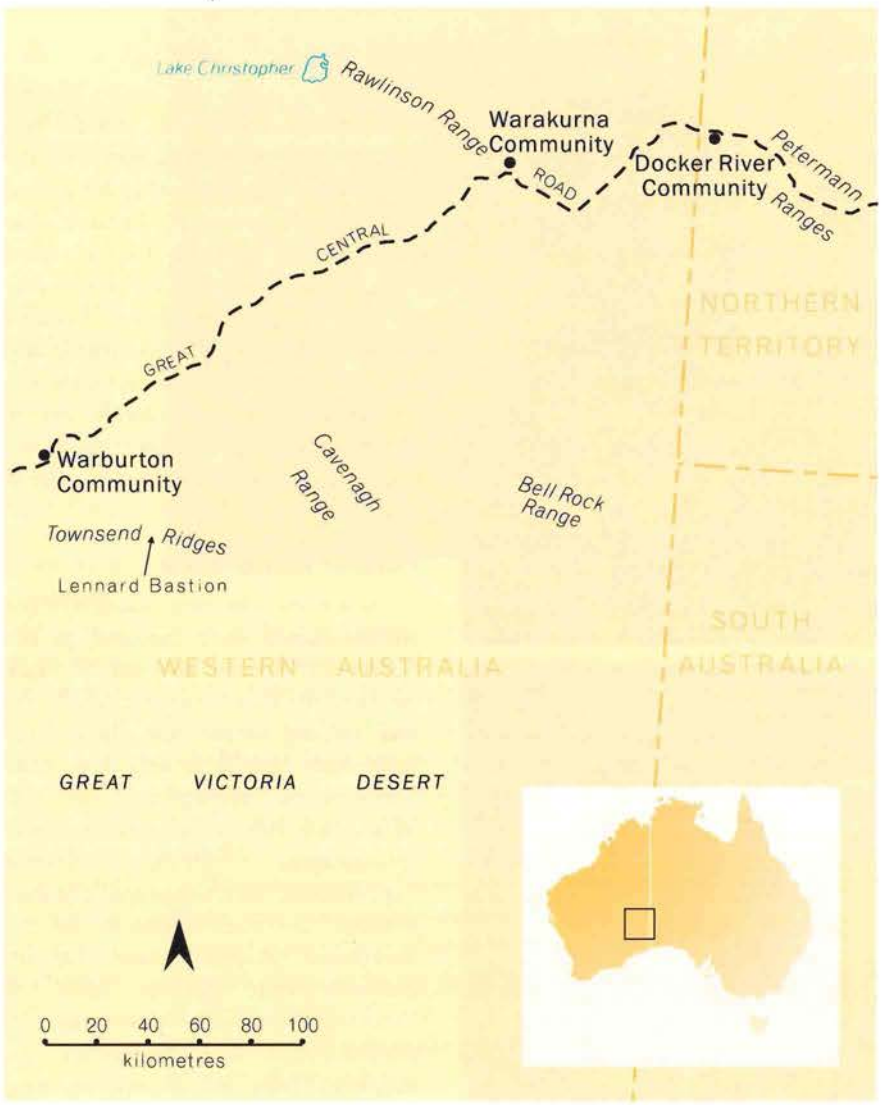
Even though rock-wallabies suffered, they were one of the survivors of the wave of desert mammal extinctions that followed European colonisation. Their rocky habitats gave them some protection against introduced interlopers, but it was only temporary relief. During the last 50 years, desert rock-wallaby populations have been whittled away continuously, largely unnoticed. In a few areas, such as Heavitree Gap in Alice Springs, they remained conspicuously visible, giving the impression that they were surviving successfully throughout desert areas. The eminent mammalogist H H Finlayson noted, during his fieldwork in central Australia in 1932–3, that rock-wallabies were the most abundant mammal and described them as 'swarming' in some rocky ranges. However, by 1961, he observed that there had been a serious population decline.

Now-retired CALM researchers Andrew Burbidge and Phil Fuller conducted interviews with Aboriginal people in the 1980s (see 'Vanishing Desert Dwellers', *LANDSCOPE*,

Previous page
Main Lennard Bastion stands as a sentinel on the northern side of the Townsend Ridges.
Inset A black-footed rock-wallaby (*Petrogale lateralis*).

Above left Looking west along the western portion of the Townsend Ridges; a baiting trail is visible along the base of the cliffs.
Photos – David Pearson

Left Black-footed rock-wallaby.
Photo – Jiri Lochman



Above Researchers taking a blood sample from the base of a rock-wallaby tail.
Photo – CALM

Winter 1987). Their conversations indicated that rock-wallabies still survived in the desert ranges abutting the Northern Territory and South Australian borders. A survey of this region was undertaken between 1988 and 1992 by local Aboriginal communities and CALM. It found that rock-wallabies were present at only 14 of the 80 sites where Aboriginal people used to see them or where explorers had recorded them. But, even at these sites, populations were typically small, fragmented and confined to the most rugged rock-piles.

When I first visited the imposing Lennard Bastion in the Townsend Ridges in 1990, I was surprised to see a rock-wallaby (a rare event during the survey). There were enough fresh droppings on the rocks to convince the Aboriginal people with me that rock-wallabies were persisting in reasonable numbers. The following day another rock-wallaby and fresh droppings were seen on a nearby cliff.

Another search of the cliffs of the Townsend Ridges to the east and west of Lennard Bastion in 1992 failed to locate any other sign of rock-wallabies. It then became evident that this population was small and very isolated from the nearest known population in the Cavenagh Ranges, 100 kilometres to the east.

In 1992, Mark Eldridge and Jane Bell from Macquarie University began studies into the genetic identity of the WA desert rock-wallaby populations. Field trips in conjunction with CALM researchers and Goldfields regional staff were made to collect blood and tissue samples from as many populations as possible. Rock-wallabies were trapped with 'Bromilow' traps, baited with apples. Each rock-wallaby was weighed, its head and foot length measured, a numbered tag placed in the ear, parasites that live on the body collected and a blood sample taken from a vein at the base of the tail. A small biopsy of ear tissue was also collected before the rock-wallaby was released at the site of its capture.

The ear biopsy was incubated in a special solution to culture cells for later examination. These biopsies had to be kept warm for 12 hours, which meant those on the expedition were required to share their sleeping bag with test-tubes during cold winter nights! Back at the Macquarie University, blood and ear tissue samples were analysed by Mark and his team to look at the composition of their DNA. The ear biopsy was used to observe the number and arrangement of chromosomes and their configuration when they lined up during cell division (meiosis).

The surprising old male

The first rock-wallaby trapped in the Townsend Ridges was a gnarled old male who, judging by his ragged ears and facial scars, had been around for many years and survived numerous scuffles. He weighed a substantial 5.1 kilograms, a monster in local terms, and was referred to as '5.1' thereafter. He was captured on several occasions over subsequent years, but it was 5.1's

ear tissue sample that really excited researchers. When the tissue was cultured, stained and examined in the laboratory, it was found that this animal had 21 chromosomes, because one copy of chromosome 10 had fused with chromosome 9. This was a very unusual configuration because chromosomes are typically paired and an even number of chromosomes was expected (since they divide evenly between two cells during replication). Old male 5.1 was dismissed as a freak individual.

Further discoveries

Some months later, another three rock-wallabies were captured in the Townsend Ridges, and when Mark prepared their chromosome samples he was amazed to see that these three individuals shared exactly the same chromosome arrangement as 5.1. What did this weird chromosome arrangement mean? Several explanations were thought possible. Perhaps the rock-wallabies in the Townsend Ridges were hybrids between two genetic races of rock-wallabies, one possessing 20 chromosomes and the other 22. Rock-wallabies are known to have variable numbers of chromosomes that have evolved as they have spread to new habitats and become isolated from other populations. The black-footed rock-wallabies in the West Kimberley near Fitzroy Crossing, for example, are known to have 20 chromosomes and those in the ranges along the Northern Territory border have 22. However, this explanation appeared unlikely, as the nearest Kimberley population was more than 1,000 kilometres away and

Top left David Pearson and Ribs Ward with a Townsend Ridges rock-wallaby. *Photo – CALM*

Centre left Clearing a bait trail at the Townsend Ridges with a tractor and hand tools from the Warburton Community.

Left Jim Stevens from the Department of Agriculture explains 1080 bait laying techniques during a course in April 1995 at the Townsend Ridges.
Photos – David Pearson

Right Ribs Ward laying 1080 baits by attaching them to low shrubs to prevent them from being removed by birds. *Photo – David Pearson*

separated by the immense and predominantly sandy Gibson and Great Sandy deserts.

Or maybe there was a population, now extinct, to the west that had 20 chromosomes, and hybridisation had occurred in the Townsend Ridges where these two races interfaced. Since all the rock-wallaby populations have disappeared from the 1,000 kilometre-wide area to the west of Townsend Ridges, this hypothesis was impossible to test. A more likely explanation was that the unusual chromosome number arose from a rearrangement that occurred in the Townsend Ridges population that did not lead to any deleterious effects on survival or breeding. Consequently, this genetic variation was able to spread through the population. Until we are able to collect further samples, this tantalising situation will remain an unsolved mystery.

Need for urgent action

The work by the Macquarie University team indicated that the Townsend Ridges population was a unique genetic race of rock-wallabies and called for urgent action to prevent their extinction. Foxes are known predators of rock-wallabies, and research in the Wheatbelt by now-retired CALM scientist Jack Kinnear shows that foxes are able to strongly suppress rock-wallaby populations. Our hunch was that foxes, and possibly dingoes, were responsible for suppressing the tiny population of rock-wallabies at the Townsend Ridges, but we did not have the time to test this hypothesis because the rock-wallabies were teetering on the edge of extinction.

The use of sodium mono-fluoroacetate (1080) baits had been very effective in the control of foxes at other sites, so we decided to adapt these techniques for the Townsend Ridges. Baiting for foxes provides protection for a period of time, but eventually foxes reinvade from other areas, so baiting operations need to be regular and systematic. The remoteness of the Townsend Ridges posed major financial costs and logistical problems if CALM staff from the nearest office in Kalgoorlie (915 kilometres by road) were required to visit the site every few months.

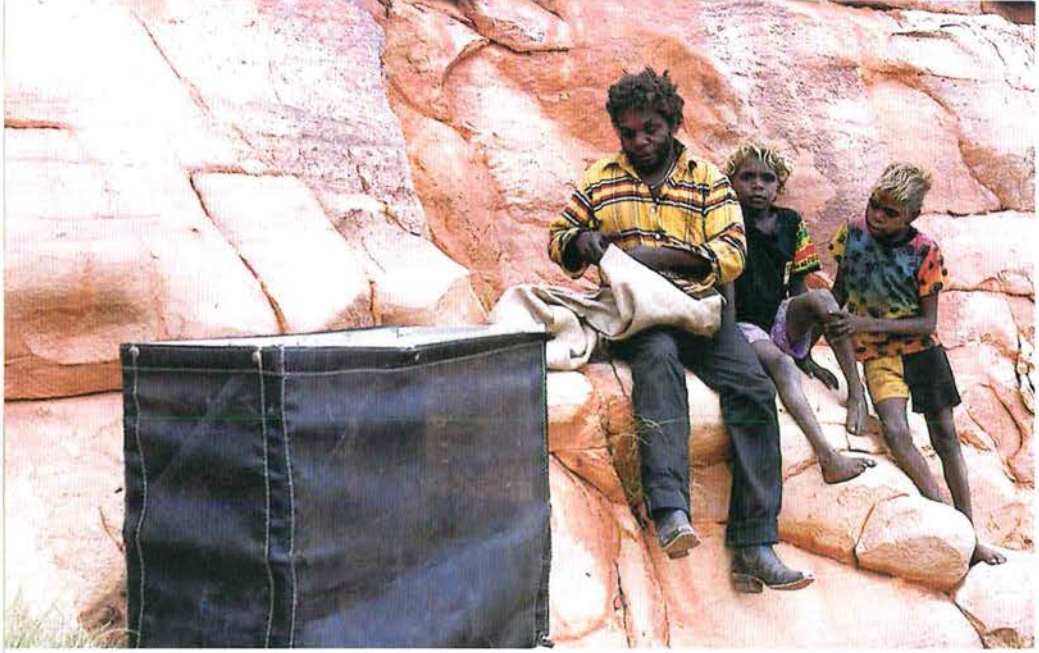
The situation was discussed with the Warburton community—an interesting process because the reasons that CALM scientists advanced for the disappearance of rock-wallabies did not concur with local Aboriginal explanations. Scientists believed that predation by foxes (and perhaps feral cats) was the problem, while Aboriginal people saw the disappearance of rock-wallabies as a consequence of a lack of specific ceremonial activity and altered management, especially the use of fire. Both viewpoints are valid and the issues were discussed around the fireplace late into the night.

However, the idea of baiting foxes raised a number of other issues. Many people in the Warburton community were concerned about the effects of baits on non-target species such as goannas and their pet dogs. It was important for them to establish whether they could be poisoned by eating a goanna that had eaten bait. Baits are attractive to dingoes and, at present, there is no reliable way to bait foxes without killing dingoes. Aboriginal people value both foxes and dingoes. Fox meat, despite its strong odour, is eaten as a powerful cure for colds, while dingoes are camp pets and important in the Dreaming (Tjukurrpa). They were also once a food source and economic item when people traded dingo scalps in exchange for tea, sugar and flour.

Once local Aboriginal people had seen that rock-wallabies had disappeared from most of their former haunts, they were willing to see foxes and dingoes removed to give the rock-wallabies a better chance. The remoteness of the Townsend Ridges made the employment of local Aboriginal people to conduct the baiting a sensible and cost-effective option. Staff from the Department of Agriculture and CALM flew up to Warburton and ran a 1080 handling and safety course with a practical field component at the Townsend Ridges. The course taught techniques to store, transport and lay baits safely, so as to minimise risk to people, camp dogs and wildlife.

Baiting school

Following the 1080 course, local Aboriginal people were contracted though NLMU to conduct fox baiting at monthly intervals. This work was funded under a variety of programs by the Commonwealth Department of Environment and Heritage. Contractors would revisit the site a few days after bait laying and use their tracking skills to determine how many foxes and dingoes were taking the baits. Refresher courses were provided every few years to renew skills and to train new contractors. A lockable freezer was transported to Warburton so that a supply of baits was always on hand, and this supply was regularly topped up by visiting CALM staff.



Above Ribs Ward, Amos Simms and Bruno Jennings prepare to release a rock-wallaby from a Bromilow trap. *Photo – David Pearson*

Baiting has now continued for 10 years, and the rock-wallaby population has grown from an estimated six to eight animals to around 30 to 40. Rock-wallaby numbers are monitored annually by trapping with Bromilow traps. Female rock-wallabies are almost always carrying pouch young when captured, indicating that breeding is still occurring and a rapid increase in rock-wallabies is possible if baiting is maintained. The area of habitat being used by the rock-wallabies is also calculated each year by mapping the distribution of fresh rock-wallaby droppings. The distinctive appearance of their droppings provides an easy technique to work out how far rock wallabies are moving along and away from the cliffs to feed.

Regular trapping provides valuable information on the biology of these little-studied rock-wallabies. For example, in July 2003, a female rock-wallaby, ear-tagged in 1993, was recaptured. She was an adult in 1993 with a pouch young and, when captured 10 years later, she again had a pouch young. Such records indicate that, for such a small mammal, rock-wallabies live comparatively long lives. The reliable recapture of adults suggests that the reason the population has not been growing quickly is that high rates of predation on juvenile rock-wallabies prevent them from being recruited into the adult population. Studies on other species of rock-wallabies have shown that feral cats may be destructive predators of juvenile rock-wallabies. The role of cats in the decline of rock-wallabies in the Townsend Ridges is unclear, as they seem to be relatively rare.

The project in the Townsend Ridges has shown that it is possible to reverse the decline of a rock-wallaby population by carrying out a program to reduce the number of their predators. The challenge is to continue baiting in the Townsend Ridges and expand the program to other desert areas where rock-wallabies, as well as other threatened species such as bilbies (or nirnu) and malleefowl (or ngarnamarra), persist. The involvement of local Aboriginal people in running the baiting operation and assisting with monitoring has been essential for the success of the project.

With the declaration of the 9.8-million-hectare Ngaanyatjarra Indigenous Protected Area in August 2002 (see 'Common Ground' in *LANDSCOPE*, Summer 1999–2000), CALM will be working with the NLMU to help conserve threatened species such as rock-wallabies, by promoting suitable fire regimes for nature conservation and providing employment opportunities in local communities.

Implications for other rock-wallaby populations

The management of rock-wallaby populations poses unique problems for CALM. These animals inhabit some of the most rugged and inaccessible country in the State, including offshore islands, desert ranges without road access and remote gorges in the Kimberley. CALM has neither the staff nor the resources to provide the level of management and monitoring necessary to maintain a close watch on more than a few rock-wallaby populations. By working with local landholders, it is possible to achieve better conservation outcomes for the rock-wallabies at a lower cost to the public. Furthermore, projects to conserve rock-wallabies provide an avenue for landholders to be directly involved in managing the wildlife resources on their land. Only through such cooperative arrangements can we hope to reverse the slide of rock-wallaby populations across Western Australia.

David Pearson is a principal research scientist at CALM's Wildlife Research Centre in Woodvale. He can be contacted on (08) 9405 5100 or by email(davidp@calm.wa.gov.au).

David thanks the Ngaanyatjarra Council for their ongoing interest and permission to work in the Central Australian Aboriginal Reserve. Many people in the Warburton community have assisted with the rock-wallaby project over the last 10 years by providing advice and accommodation, conducting baiting or follow-up predator surveys; especially Cyril and Queenie Simms, and the late T Simms, Ian (Ribs) Ward, Damian McLean, Chris Paget, Gerald Porter, Victor Lane, John and Beth Winchbuist, Jan Turner and the late M Jennings. The Ngaanyatjarra Land Management Unit (Keith Noble, John Simmonds, Rodney Edwards, Madeline Hourihan and Andrew Drenen), has been very supportive of the project and assisted in obtaining funding, and organising and undertaking baiting.

CALM Goldfields regional staff helped with rock-wallaby survey work, the preparation of baiting lines, baiting and the transport of baits. Roger Armstrong (CALM Bunbury), Jim Stevens and the late Dennis King (the Department of Agriculture) ran courses for Ngaanyatjarra people on the safe use of 1080 poison. Many CALM volunteers have contributed to the program. Dr Mark Eldridge and Jane Bell of the Macquarie University undertook the collection of samples and their analysis.

Voyage to the bottom of the ocean

Until recently, the privilege of viewing the aquatic wonders beneath the Busselton Jetty has mostly been limited to divers. Now, everyone can experience the jetty's brand of unique magic—without getting wet!

by Margaret McNally

For people of the seaside resort town of Busselton, 220 kilometres south of Perth, the recent opening of the Underwater Observatory at Busselton Jetty is a dream—27 years in the making—come true. And it is all thanks to the devotion and determination of locals who helped Busselton Jetty get more than a reprieve. It is not a bad effort, to say the least, considering the jetty itself came close to demolition after its somewhat turbulent past.

A lengthy history

When the jarrah timber jetty began operation in 1865, it is doubtful whether settlers of the Busselton region could have predicted its near fate. Fulfilling its primary purpose of linking prosperous trade between ship and shore, it was not long before the 158-metre-long jetty was almost rendered unsuitable for use. An accumulation of drifting sand, building up under the jetty, necessitated adding another 129 metres within the first ten years of its construction. This ongoing problem saw five more extensions to the jetty between 1884 and 1896.

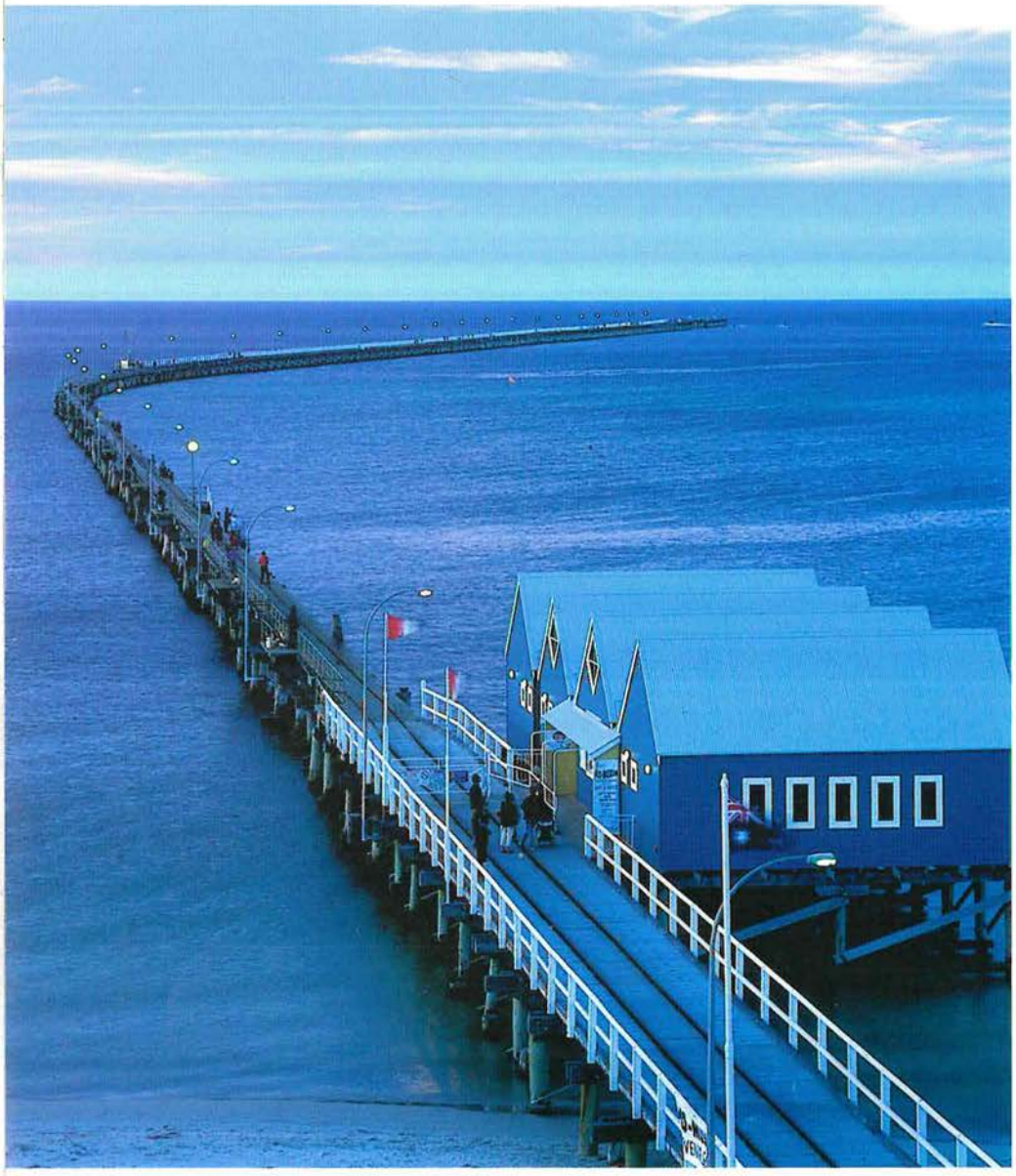
Horse-drawn carts travelled back and forth along the jetty, carrying timber, food and other goods to people in the town. They soon gave way to trains, with the construction of a railway jetty in 1911. Extensions to the now 1,277-metre-long jetty continued until 1960, when it reached its current length of 1,841 metres. The jetty was—and still is—the longest wooden jetty in the southern hemisphere. But it was officially closed to shipping in July 1972, as ships began using Bunbury Harbour as a port of call instead of Busselton.

The human touch

Following its closure, maintenance on the jetty was discontinued. In March 1976, at a public meeting held in Busselton to discuss fundraising ideas to restore the jetty, the seed for an underwater observatory was planted. The idea had barely found its sea legs when, in 1978, Cyclone Alby destroyed a large section of the shore-end of the jetty.

In the years immediately following the cyclone, Alf Bussell, a descendant of the first family to settle in the Busselton area in 1834, became involved in the campaign to save the jetty. A vocal public figure, Alf also garnered the support of the local townspeople.

Once the Jetty Preservation Society (now the Busselton Jetty Environment and Conservation Association) was formed in 1987, a rigorous fundraising program began. Generous donations and the dedicated efforts of many Busselton residents helped the committee to raise more than $5 million for jetty



Previous page
Main Fascination at every window: looking out from the Busselton Underwater Observatory.
Inset The attractive Underwater Observatory entrance building at the far end of the jetty.
Photos – Ann Storrie

Left Busselton Jetty Interpretive Centre, where tickets are bought for the Underwater Observatory.
Photo – Andrew Davoll/Lochman Transparencies

Above Interpretive displays and viewing window on the second level.
Photo – Ann Storrie

maintenance and reconstruction projects. The committee also secured several State and Commonwealth government grants that contributed to the project.

However, it still took a fire that ravaged 70 metres of decking at the jetty's seaward end in December 1999, and a redirection of committee funds to repair it, before the idea, planted in 1976, would bear fruit.

Allie Scott, who, like others, worked tirelessly—and voluntarily—for the jetty, chaired the committee for 11 years. He became legendary for his tenacious lobbying for funding to support jetty projects. Sadly, at the age of 90, Allie Scott passed away in December 2002 —just months ahead of him realising his long-held dream of seeing the Underwater Observatory completed.

Today, the $3.6-million observatory, located at the seaward end of the jetty, has not only revamped a local icon, but also created an ecotourism facility of international standard. The jetty's 200,000 visitors per year, plus an estimated 60,000 visitors to the observatory from around the globe, can collectively witness the prolific marine life below the sea's surface.

Constructing colonies

With an internal diameter of nine metres, and descending eight metres to the bottom of the ocean below the jetty, the Underwater Observatory is a feat of engineering. Cylindrical in shape, it was prefabricated on land before being towed from Henderson, south of Fremantle, and effectively sunk into position and fixed to the sea floor.

Several of the existing timber piles were removed to accommodate the cylinder's concrete shell. Other piles from the edge of the previously burnt section of the jetty were relocated to most of the 11 picture windows that frame the spectacular underwater scenery. Additional steel piles were installed to support the structure, producing a new marine habitat.

These newer piles are already becoming coated with marine life. During the internal fit-out phase of construction, colonisation of the piles began and this will continue for many years to come.

The concrete cylinder itself also attracts marine life like a magnet. In time, it too will be colonised, much to the sightseeing delight of divers.

A two-way fish bowl

The railway that had once transported goods to the end of the jetty now carries passengers from the shore to the observatory. Inside the observation chamber, visitors come face to face with the inhabitants of the marine world, as colour and life floods their view.

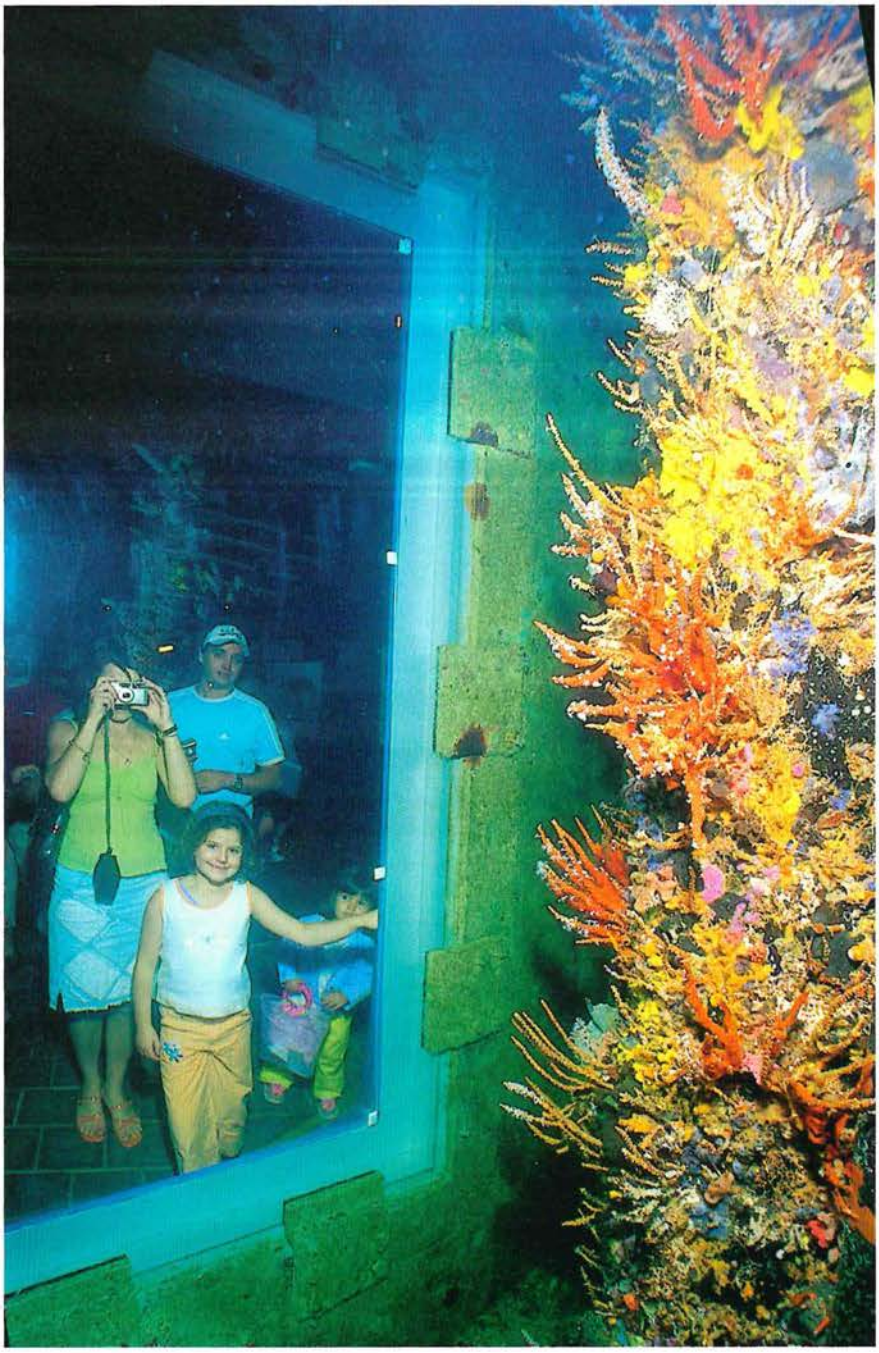
But the sightseeing opportunities are two-way, as fish and a curious octopus alongside the glass seem equally fascinated looking into the chamber full of people looking out at them.

There are three levels to the bottom of the observatory via a spiralling staircase. On each of these platforms, visitors can view hundreds of marine species encrusting the piles, and colossal schools of fish that gather in the area. Additional windows are located halfway between the levels next to the staircase and provide opportunities to view marine life at different depths.

Life beneath the waves

The vibrant marine species encase the entire lengths of most of the jetty piles. The quantity and biological diversity changes up and down the pile, largely depending on conditions in the water.

From the first windows, as you descend into the observatory, you can see the area immediately beneath the decking of the jetty where pigeons and swallows frequently nest or shelter from the wind or rain. The next window



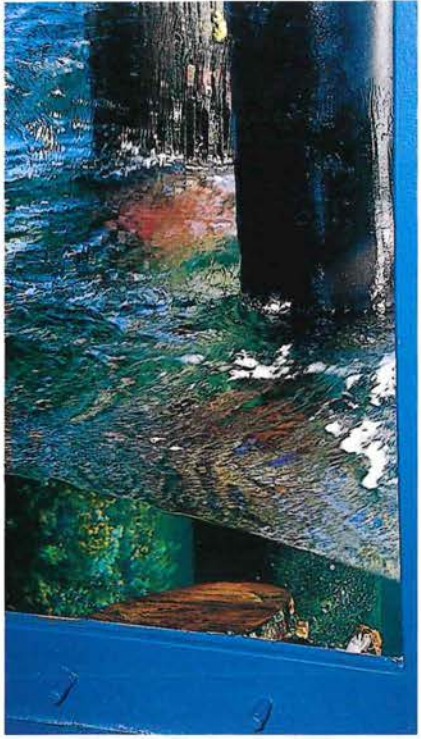
allows you to explore the intertidal zone. Up to a metre of the piles may be exposed during low tides, when many marine animals become vulnerable to extreme heat. Few can survive without water to aid breathing and feeding. Which is why barnacles and mussels are mostly found here. These animals can close up to wait for the high tide to return. At low tide, the water just laps the bottom of the window.

Moving downwards into the subtidal zone (about two-and-a-half metres below the surface), you will find three windows that look out to the north and at the 'Piles of Life' display. These are some of the non-structural piles that had either fallen or been removed and subsequently fastened to the new piles. Sponges and sea squirts, and the delicate tangled tubeworms and telesto soft coral are present in this zone. Many of these species live here because they would be easily dislodged by waves in the intertidal zone.

Above left Schools of old wives are often seen beneath the Busselton Jetty.

Above An amazing tube anemone with divers seen in the background.
Photos – Peter & Margy Nicholas/ Lochman Transparencies

Left Life in a fish bowl. Everyone can now share the magical underwater world that divers have enjoyed for so long.
Photo – Ann Storrie



Above Interpretive displays and the viewing window between the first and second levels.

Above left The water rises and falls at the intertidal zone window.
Photos – Ann Storrie

The next window before you reach the bottom of the observatory is in the mid-water zone, about five metres below the surface. From this south-facing window, you might see yellowtail scad, leatherjackets, old wives, wrasse, sweep, moonlighters and globefish. A large pile displays telesto soft coral, which balloons out from the structure and dominates this window.

Seven-and-a-half metres below the surface, and about a metre above the ocean floor, we reach the base of the observatory. There are four large windows looking north and through them you can clearly see the rubble environment beneath the jetty. Old fallen piles, rails and other debris from the jetty's years of use now provide habitat for bottom dwellers like cuttlefish, octopus, wobbegong sharks, gurnard perch, cobbler, flatworms and nudibranchs. Schools of silver drummer, long-finned pike and tarwine can also be seen here.

The final window of the ground floor is the west-facing window that looks out onto the meadows of seagrass that dominate Geographe Bay. Standing quietly below the ocean and peering out through the thick glass windows you can only marvel at the natural wonders of our marine environments.

Where different species meet

Considering the precarious history of the 138-year-old Busselton Jetty, the Underwater Observatory is a monument in which two worlds—above and below the water—benefit. Whether you scuba dive or snorkel, or soak in the view from the indoor comfort of the viewing chamber, the observatory bridges the gap between land-faring human colonies and our underwater counterparts. With the spotlight now on the once lesser-seen marine world, the Busselton Jetty Underwater Observatory illuminates Allie Scott's legacy, and brings dazzling new marine life into sharper view.

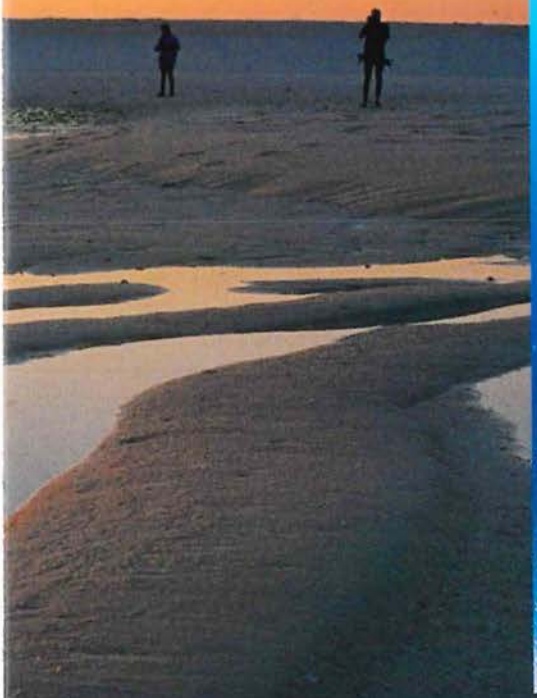
Margaret McNally is a final-year student in the Department of Communications and Cultural Studies at Curtin University, where she is completing a double major in Professional Writing & Presentation and Publishing Practice.

The full colour book *Beneath Busselton Jetty* by Ann Storrie, Sue Morrison and Peter Morrison, was used in researching and writing this article. It is available for purchase at the Underwater Observatory bookstall, CALM offices, and selected bookstores.

Margaret wishes to thank Grant Henley, Underwater Observatory Manager, and Barry Brown, General Manager of Cape Naturaliste Tourism Association, who provided additional information for this story.

Remarkable
Rowley Shoals

Because of their isolation, the large and spectacular reefs that make up the Rowley Shoals Marine Park provide one of the best chances to preserve a pristine coral reef system anywhere in the world. The reefs also offer some of Australia's best and most spectacular diving. A new management plan and proposals to extend the marine park aim to secure the future of these amazing 'aquariums' in the middle of the ocean.



by Carolyn Thomson-Dans, Andrew Hill, Keiran McNamara and Allen Grosse

Lying some 260 kilometres west of Broome or about a day's boat ride from the Kimberley coast, the three reefs that make up the Rowley Shoals rise almost vertically from depths of 230 to 500 metres above the sea floor.

Clerke and Imperieuse reefs form the Rowley Shoals Marine Park, declared in 1990 and managed by the Western Australian Department of Conservation and Land Management (CALM). The nearby Mermaid Reef Marine National Nature Reserve is managed by the Commonwealth Department of the Environment and Heritage with the assistance of CALM. The WA Department of Fisheries manages fishing activities in the State and Commonwealth waters around the Rowley Shoals, while both Coastwatch and tourism operators also assist with management.

The Rowley Shoals are considered to be the most perfect examples of shelf edge platform reefs in Australian waters, and offer some of the most spectacular underwater scenery found anywhere in Australia. When you consider that most coral reefs throughout the world are being severely degraded by human activities, the Rowley Shoals—because of their isolation—provide one of the best chances to preserve a pristine coral reef system anywhere in the world.

Before Europeans ventured near the Rowley Shoals they were no doubt visited by Indonesian fishermen seeking beche-de-mer (sea cucumber), trochus shells, clam meat and scale fish. The Indonesian name for the Rowley Shoals is *Pulo Pulo Dhoali*, which means 'Far Off Islands'.

The shoals were named in 1818 by Captain Philip Parker King, who first described their relative positions and named Mermaid Reef after his ship. He named Clerke Reef after Captain Clerke, who had reported it from a whaler some time between 1800 and 1809, and named Imperieuse Reef after the vessel from which it was sighted by Captain Rowley in 1800.

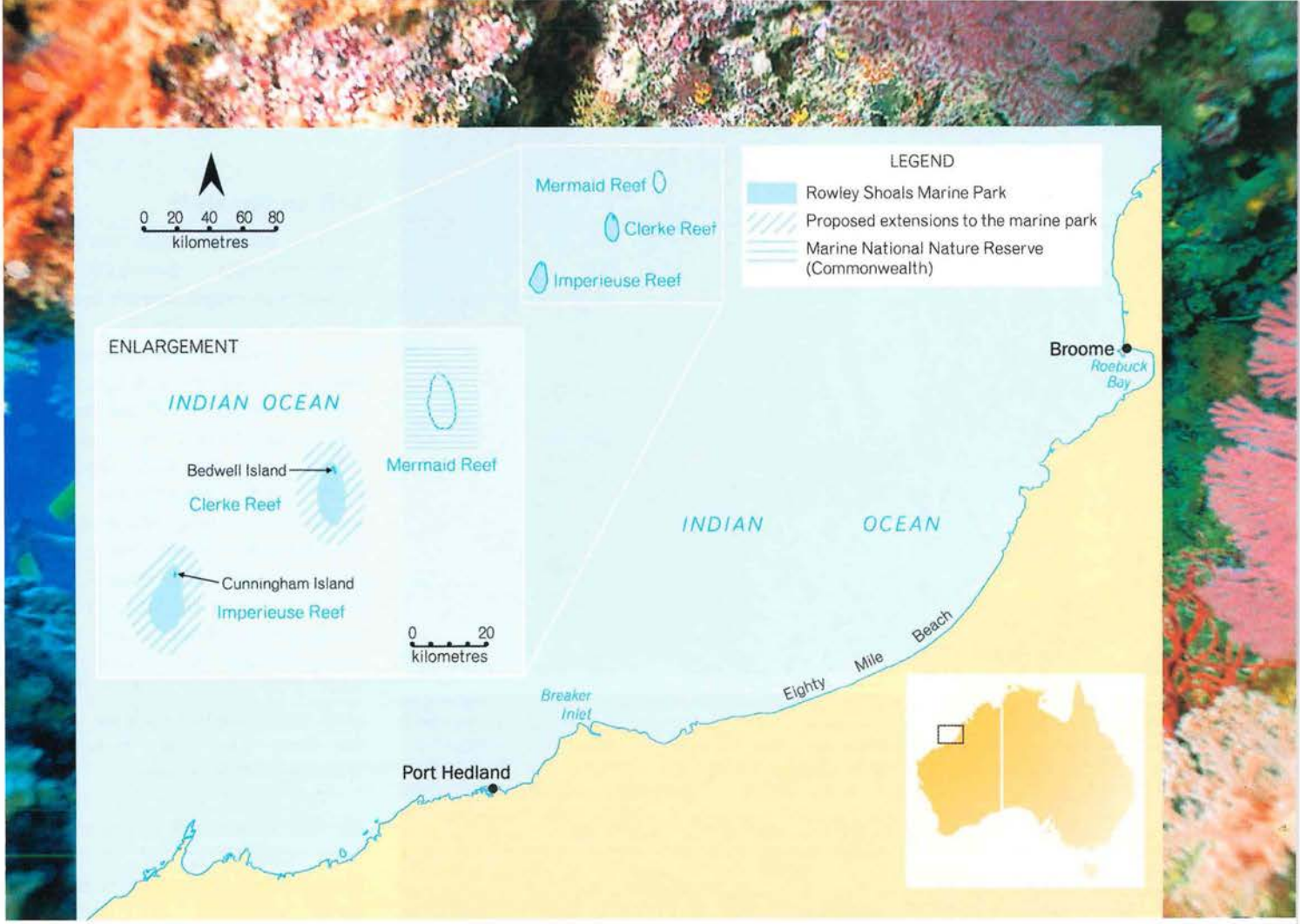
Grand isolation

The relatively close proximity of the shoals to the so-called 'coral triangle' in Indonesia, and their isolation from large coastal populations, has contributed to their high scientific and conservation values. The marine environment of the Rowley Shoals Marine Park is characterised by high water quality, abundant and diverse aquatic fauna and coral reefs that are in pristine condition. This, coupled with exceptionally low visitation, especially to the two shoals that make up the marine park (during the 2002 season five commercial vessels

Previous page
Main Bedwell Island at Clerke Reef in the Rowley Shoals.
Insets from top Sea star; corals and other invertebrate life cling to the outer walls of Mermaid Reef.

Left The incredible species diversity of the Rowley Shoals makes them a diver's paradise.
Photos – Ann Storrie

Above Divers on the charter vessel *True North* about to take the plunge at the Rowley Shoals.
Photo – Courtesy of North Star Cruises



Right Gorgonian corals grow in the low light on the outer walls, or 'drop-offs'. *Photo – Ann Storrie*

made a total of 23 trips carrying only 230 passengers), means that they are virtually pristine marine wilderness areas. In fact, Imperieuse Reef had even less visitation because of limited access to the lagoon for overnight anchoring. The shoals host an impressive array of marine tropical wildlife, unsurpassed in WA in terms of diversity or spectacle. The wildlife of the Rowley Shoals has similarities to that found in Indonesian waters, and a large number of the species recorded here are not found anywhere else in the State's waters. For instance, of the 688 species of fish recorded by scientists at the shoals, 220 species are not recorded elsewhere off WA. The Rowley Shoals are famed for the huge potato cods (*Epinephelus tukula*), which have been fished out from most other parts of the world. Taking their name from the potato-shaped markings on their bodies, these fish can weigh up to 100 kilograms and reach more than two metres long. They are often curious and may even approach divers for a closer look. They are protected in WA waters and may not be taken.

Because they lie at the edge of one of the widest continental shelves in the world, the oceanic waters surrounding these atolls are crystal clear and ideal for luxuriant coral growth.

The Rowley Shoals are remarkably similar in shape and physical features, but appear to be in slightly different stages of development. All three atolls are north–south orientated and slightly teardrop-shaped, with their narrower ends towards the north. Clerke and Imperieuse reefs both have small sandy islands at high tide in similar positions (Mermaid Reef has a sandy cay in a similar position that is only exposed during low water spring tides). The enclosing reef of all three shoals is broken (by one or more narrow passages) in the same place, about two-thirds of the way up the eastern side.

Left on the shelf

The Rowley Shoals are amazing structures—the remarkable story behind their origin extends back many millions of years. They lie at the very edge of Australia's continental shelf. Around 15 million years ago, the shelf formed the shore of the mainland, which was fringed by a reef. It is believed that the three shoals were once reefs surrounding former headlands. As a result of changes in sea level and other momentous geological processes (probably related to the northward drift of Australia towards Asia), these subsided into the sea, slowly enough for the fringing coral reefs to be maintained. As a result, the three reefs gradually built up from the sea floor like high turrets, each enclosing a shallow lagoon.

The growth of similar reefs along the shelf was not sufficient to keep pace with subsidence, and there is a 'graveyard' of drowned reefs along the shelf, including one south of Imperieuse Reef. Further north, similar processes have formed the Scott and Seringpatam reefs.

It is astonishing to think that—although they cradle shallow shoals crammed with gardens of corals and tropical fish—their western sides plummet to unimaginable depths.

The shoals have an unusually high tidal range for oceanic islands. When the tide is low, their reef flats stand like dam walls enclosing huge lakes, several metres above the surrounding sea. Water gushes from the narrow channels

Top left Under a new park plan, about 95 per cent of the existing Rowley Shoals Marine Park will become a sanctuary area.
Photo – Peter and Margy Nicholas/ Lochman Transparencies

Centre left Three-spot dascyllus (*Dascyllus trimaculatus*) guard their host anemone.
Photo – Eva Boogaard/Lochman Transparencies

Left Biodiversity in a lagoon at the Rowley Shoals.
Photo – Clay Bryce/Lochman Transparencies

Above Massive, but approachable, potato cod have largely disappeared from most other parts of the world but can still be seen at the Rowley Shoals. *Photo – Peter & Margy Nicholas/ Lochman Transparencies*

Left Red-tailed tropicbirds (*Phaethon rubricauda*) nesting on Bedwell Island. *Photo – Ann Storrie*

in the atolls in powerful torrents, like fast-flowing rivers. At high tide, the reefs disappear beneath the sea, with only the sandy islands of Clerke and Imperieuse visible.

Park plan

The pristine and unspoilt condition of the Rowley Shoals is one of the main reasons that divers and other visitors continue to be attracted to them. However, because of the unique nature of the shoals, they are similar to 'aquariums' in the middle of the ocean. If they were overfished, replenishment of wild fish stocks could take many years. To ensure that these fragile areas are carefully managed, a draft management plan for the marine park was released in January 2004.

The plans aim to ensure that:

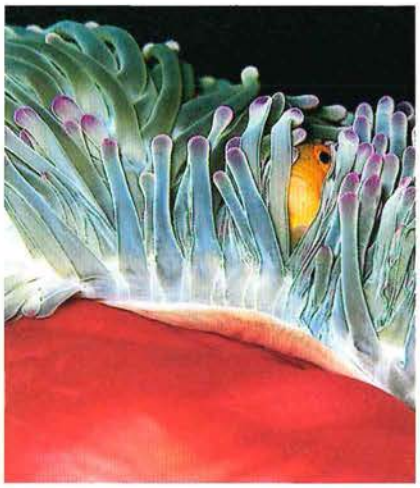
> "In the year 2024, the marine plants and animals, habitats and water quality of the Rowley Shoals Marine Park will be in the same or better condition than in the year 2004. The area will support ecologically sustainable recreation and nature-based tourism and the marine park will be considered to be an important ecological and social asset by the local, national and international community. It will be a highly valued reference area to compare the health of intensively used reefs in the Indo-West Pacific Region."

The Rowley Shoals Marine Park currently extends over 21,912 hectares. The draft management plan proposes that 20,802 hectares, or 95 per cent of the existing park, will be a sanctuary ('look-but-don't-take') zone, with the remainder zoned for recreation.

Proposed extension

Importantly, the plan also incorporates an indicative management plan for proposed extensions to the existing Rowley Shoals Marine Park. The current park boundary (100 metres from the reef edge) does not fully encompass the area of human use of the shoals. To ensure that all of the marine park's ecological and social values are managed in a consistent manner, it is proposed that the park boundary be extended to the three-nautical-mile limit of State waters, to include the areas around the lagoons that are popular for game fishing. This would increase the area of the park to more than four times its present size, to just more than 87,500 hectares. Of the total area, 26 per cent is proposed as sanctuary zone, 17 per cent would be zoned for recreation and 57 per cent would be available for general use.

The recreation zone will provide priority areas for tourism and recreational activities, including diving and recreational fishing. It is proposed that most of the outer waters of the reefs will be zoned for general use. These areas will accommodate a range of sustainable commercial and recreational uses, including game fishing.



The proposal to extend the Rowley Shoals Marine Park is part of the State Government's program to expand the existing system of marine parks and reserves (see 'Vision Splendid', *LANDSCOPE*, Winter 2003) to achieve a world-class multiple-use marine conservation reserve system. The Jurien Bay Marine Park, the State's seventh marine park (there is also one marine nature reserve in Shark Bay), was declared in August 2003, but the 1994 Report of the Marine Parks and Reserves Working Group identified about 70 areas as candidate marine conservation reserves.

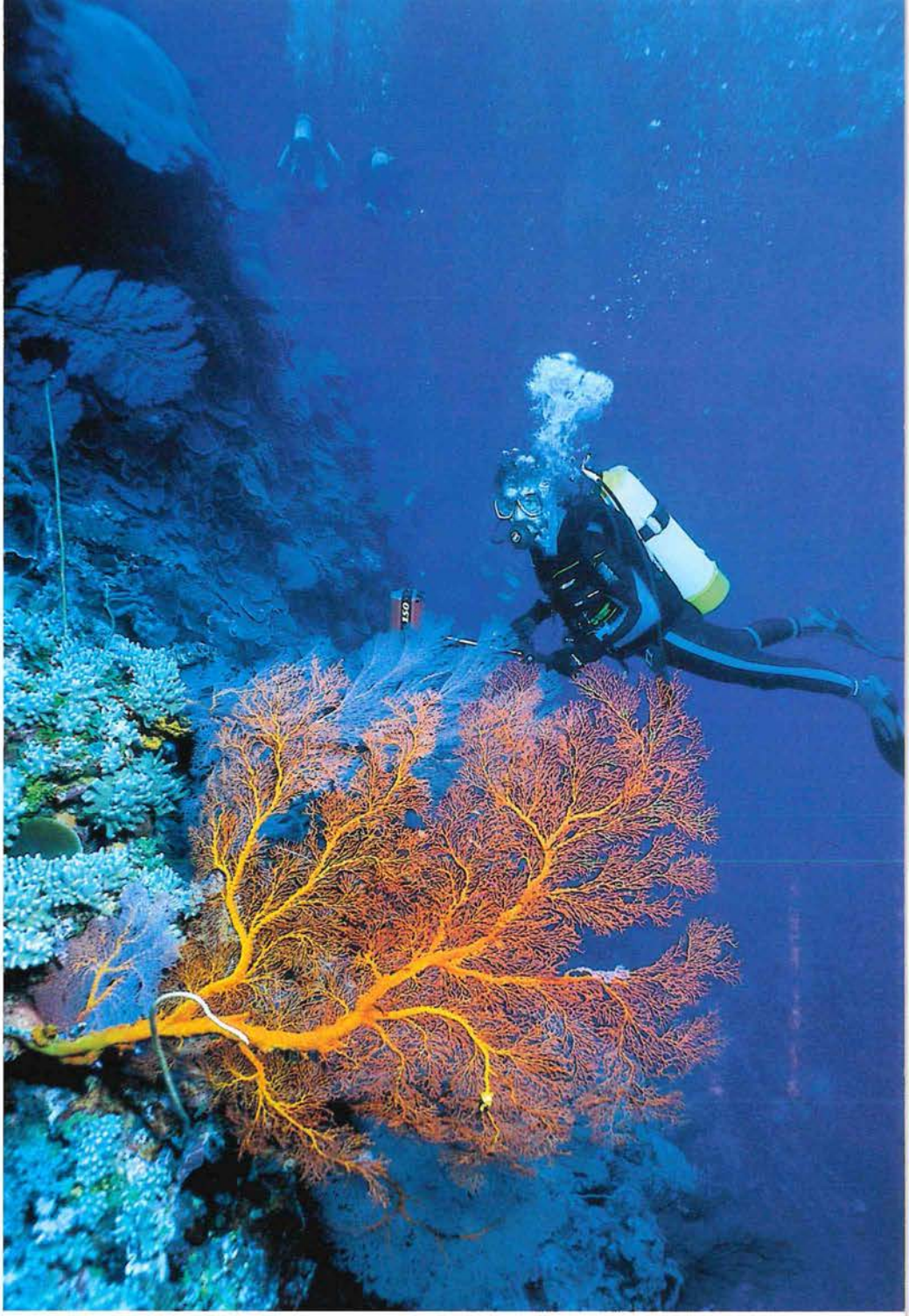
Several new marine conservation reserves are in the pipeline, at Montebello-Barrow islands, Dampier Archipelago-Cape Preston, the Geographe Bay-Cape Naturaliste-Cape Leeuwin-Hardy Inlet area and the Walpole-Nornalup inlets. Extensions to the Ningaloo, Shark Bay and Shoalwater Islands marine parks are also planned.

Above An anemonefish (*Amphiprion* sp.) in its home.

Top left Ribbon sweetlips (*Plectorhinchus polytaenia*) beneath a plate coral.
Photos – Ann Storrie

Centre left The shallow lagoons enclosed by the Rowley Shoals provide perfect conditions for gardens of corals.
Photo – Alex Steffe/Lochman Transparencies

Left The shells of living egg cowries are almost hidden by their equally striking black mantle.
Photo – Ann Storrie



Right Diving the 'drop-offs' on the outer edge of Mermaid Reef is an unforgettable experience.
Photo – Ann Storrie

Visiting the shoals

Why do people visit the Rowley Shoals Marine Park? According to Chris Tucker of Kimberley Escape, who is one of seven tourism operators currently licensed by CALM to conduct trips to the Rowley Shoals Marine Park:

> "The main reason that people visit the shoals is the diving 'exclusivity'. It is pristine diving, there is amazing fish life and you don't see anybody else out there. There are lots and lots of small tropical fish and the coral gardens are some of the best you'll see. We take out some very experienced divers to the shoals, many of them from overseas, and they rate it as having some of the best diving in the world. A group of Germans did one trip. They came back to Broome for four days, then they booked their next visit to the shoals and went straight back out. We get a lot of return visits."

Craig Howson, another licensed operator who skippers the vessel *True North*, made similar comments:

> "People come to the Rowley Shoals because it is a pristine coral environment with wilderness qualities. There is great megafauna, with lots of different types of sharks and other large fish, and corals. There is really good diving off the outer walls and great snorkelling as well. Visitors also enjoy spending time on Bedwell Island at Clerke Reef."

The big challenge at the Rowley Shoals is to preserve the main attractions that people come to see at this unique and incredibly fragile area, without those very attractions being spoilt by human visitation. Because of the remoteness of the Rowley Shoals, managers cannot always be present to make sure that visitors are doing the right thing. Conditions are attached to the licences of tourism operators, to ensure that the activities of the operators do not impact on the values of the marine park. However, having obtained a licence, it is very much in the interests of these operators to look after the area, to preserve their own livelihoods.

It is just as important to provide high-quality information to visitors to increase awareness and understanding of conservation and management issues in the Rowley Shoals Marine Park. Every single person who visits the park can do their bit to ensure the park is just as pristine in 2024—and beyond!

Carolyn Thomson-Dans is a long-time writer and editor for *LANDSCOPE*, with a special interest in the marine environment.

Andrew Hill is Senior Marine Planning Officer for CALM's Marine Conservation Branch and is responsible for coordinating the planning and establishment of new marine conservation reserves.

Keiran McNamara is Executive Director of CALM and has been a driving force in the marine parks program.

Allen Grosse is Manager of CALM's West Kimberley District and has had a 15-year association with management of the Rowley Shoals Marine Park.

Stay ... just a little bit longer

The Karri Forest Explorer self-drive tour winds through a patchwork of towns, forests, farmland and vineyards in and around Pemberton. Visitors explore the area and, with innovative interpretation including sculpture and radio, explore the stories and fables of the people whose lives have been touched by the forest .

by Cliff Winfield

The steam whistle blows. Its quaint sound, from another era, echoes off the trunks of the tall karri trees on the north side of the valley. Then, along with the dawn sun, it pervades the workers' cottages nestled in the cleft on the south side. It's 6.00 am and the whistle is calling workers for the first shift at Pemberton Mill, as it has done for around 80 years.

Pemberton Mill is the largest karri sawmill and was once the main source of jobs for the area. It provided employment for those who lived in the rows of weatherboard cottages in Pemberton. It also provided extra work to help supplement farmers struggling to establish orchards, dairy and beef herds or potato crops on small farms hacked out of the towering karri forests surrounding the township.

Small town, big changes

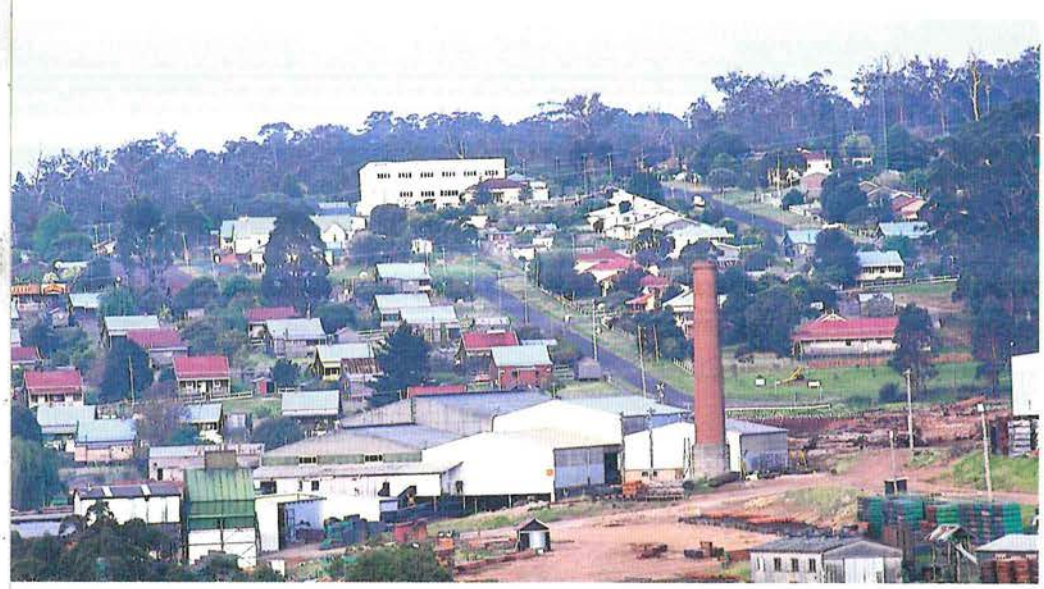
Pemberton is a sophisticated village these days, but remnants of a mill-town psyche still linger in the town. Established in the 1930s, when almost everyone worked in the one industry and most things you needed to live were available in the town, the social fabric still echoes the days when the farmers joined the timber workers on Saturday nights for the dance at the mill hall and stayed for the footy on Sunday. A healthy parochialism lingers in the Pemberton community and, with the steady growth in tourism, horticulture and viticulture, it has been weaning itself from dependence on the timber industry for the past 20 years or so.

Nevertheless, when the Regional Forest Agreement (RFA) and Protecting Our Old Growth Forest policy proposed drastic reductions in the level of karri forest available to the timber industry, the Pemberton community bore the economic brunt. Five years ago, the Pemberton Mill cut about 120,000 tonnes of karri, most of it large logs from old growth forests. When the new Forest Management Plan is implemented, the mill will process only about 60,000 tonnes of karri, mostly smaller logs from regrowth forest.

Road to success

By way of compensation, a number of economic, employment and community benefits were proposed. One of the initiatives was the allocation of $1 million in capital funding to the Department of Conservation and Land Management (CALM) to create a new tourist drive through the forest. When the CALM planning team met to discuss how to achieve this, it was quickly identified that it would be better to try to upgrade and use existing roads and popular places in the forest around Pemberton, rather than attempt to create a set of new ones. But could renovating forest visitor facilities really create tangible and sustainable community benefits?

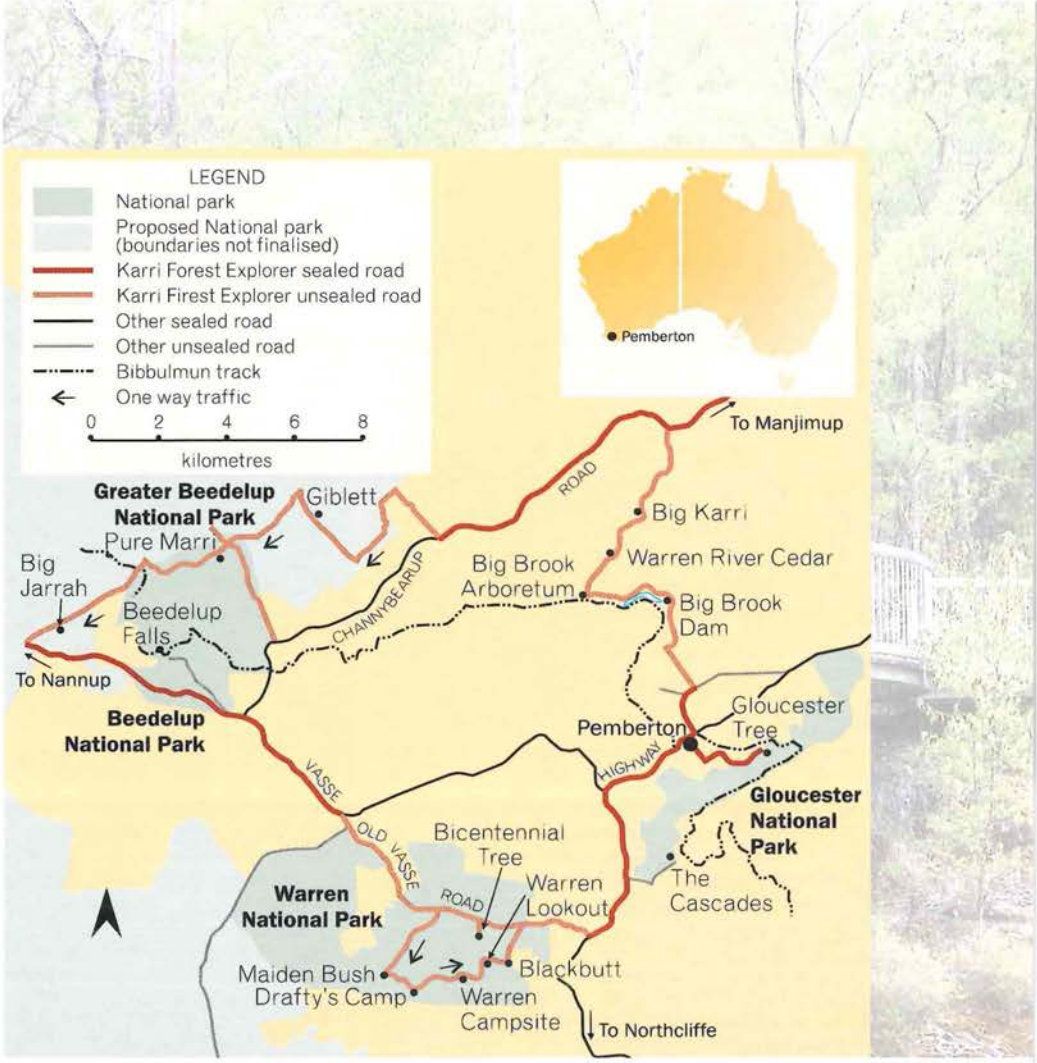
In the short term, employment, tenders and supply contracts would obviously benefit the local communities during the construction phase. Recent research on the economic benefits of tourism in the southern forest by the Cooperative



Previous page
Main The north-eastern part of the drive winds through the Giblett Forest, an important site for the area's recent history.
Inset The bark of a karri tree.
Photos – Cliff Winfield

Above left The Pemberton Mill sits in front of the town and was once the main source of jobs for the area.
Photo – Jiri Lochman

Left The mill hall was once one of Pemberton's prominent social features.
Photo – Cliff Winfield



Below right Boardwalks like this one at Warren River Cedar lead visitors to information and interpretation sites along the way.
Photo – Cliff Winfield

Research Centre for Sustainable Tourism indicates that visitors to the southern forests spend around $75 per person per day.

Increasing visitor numbers to an area is a difficult task and, in many cases, has more to do with marketing than the provision of facilities. On the other hand, creating reasons for visitors to stay longer is relatively easy, and has the same net result in terms of 'visitor nights'. If the creation of a tourist drive could entice visitors to the region to stay a few days longer, or to return to see more, the flow-on to the tourist-based businesses and, hence, the wider community would be substantial and continuing.

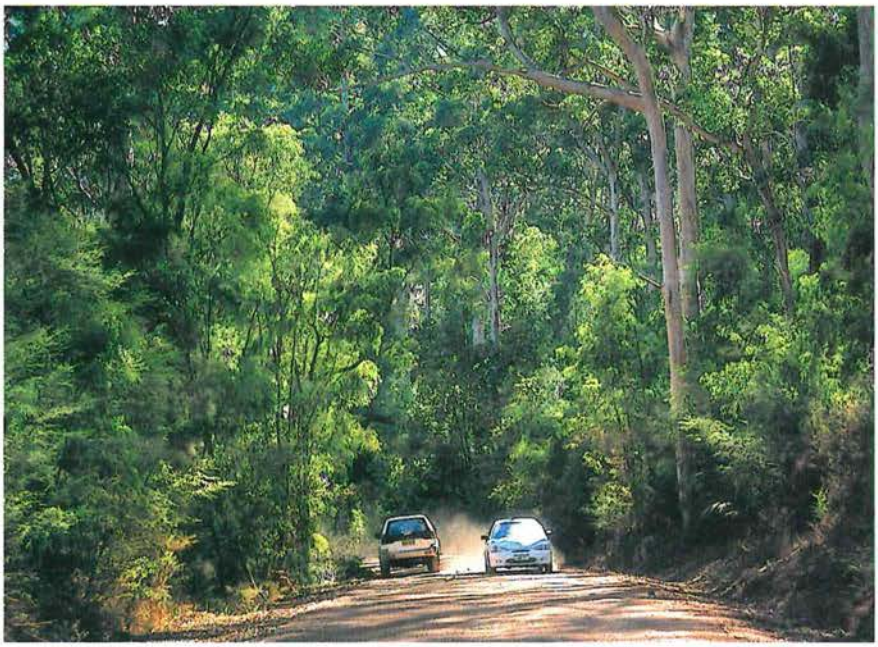
The notion that the investment of a relatively small amount of public money into visitor facilities could bring substantial, tangible and sustainable benefits to a community had been well-illustrated 100 kilometres away in Walpole. The construction of the Tree Top Walk at the Valley of the Giants in 1996 did not dramatically change visitor numbers to the area, but it changed the visitation pattern (see 'Saving the Giants', *LANDSCOPE*, Spring 1996). People stayed in the area longer, and other tourism products emerged to create an even greater choice of things to do. Supply businesses—grocery stores and fuel stations—increased their turnover, and a bakery, pharmacy, souvenir shop and accommodation developments followed. All these businesses, and more, were already operating in Pemberton, but the community faced the uncertainty of whether or not they would remain viable, considering the imminent downturn in the timber industry.

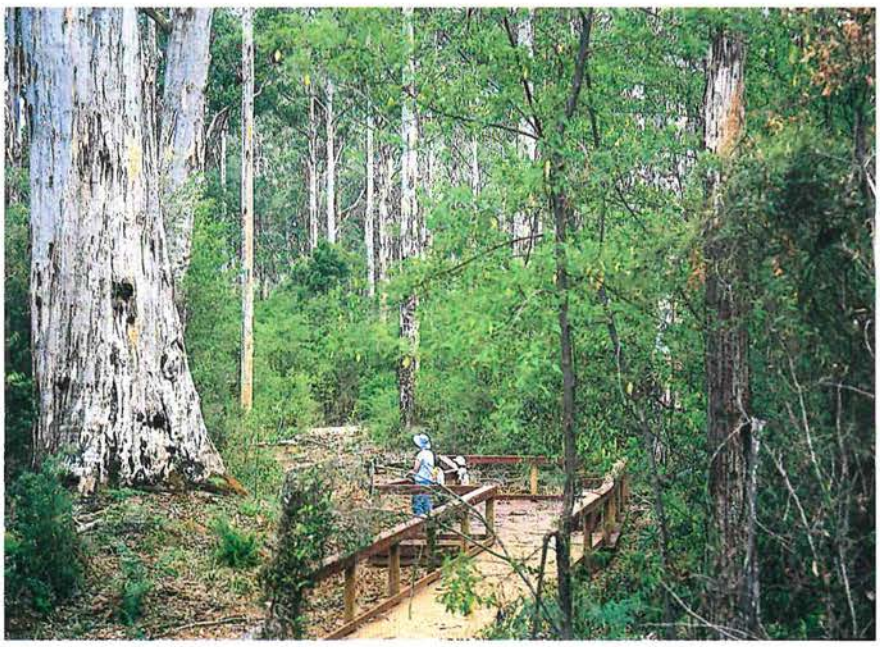
The key to creating a new tourism product seemed to lie in linking the renovated sites into a package, so instead of just visiting one site, visitors would be 'hooked' and want to take in a whole range of experiences and stories.

Planning the journey

There was already a drive-tour not so far away. The Great Forest Trees Drive, in Shannon National Park, traverses forest for its entire length. However, the drive around Pemberton would be different. Rather than just focusing on the forest, it would weave through a patchwork of towns, forests, farmland and vineyards.

Planning began when a line was drawn on a map that linked those recreation sites in national parks and State forest in need of renovation that were also within driving distance of Pemberton. Work had already begun on providing new facilities at Beedelup Falls, Gloucester Tree and Big Brook Dam, and sites along Heartbreak Trail in Warren National Park were suffering environmental damage and needed to be redesigned. These sites were obvious choices to include on the drive. The planning team looked at the feasibility of joining these into a loop road suitable for conventional vehicles and





small coaches. In addition to the existing experience, there was a commitment to create some new experiences in Giblett Block, the focus of anti-logging protests prior to the halt of cutting in old growth forests, and the proposal for the area to become a national park.

Working with communities

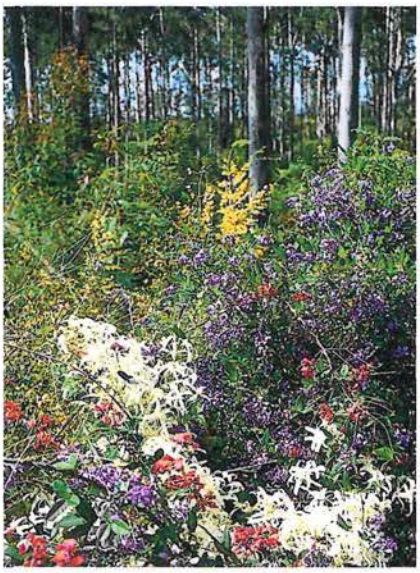
There were many people with a close interest in the proposed drive tour. Tour operators, accommodation proprietors, and café and winery operators put in submissions or attended public meetings to discuss the draft master plan for the proposed drive and, because the route was taking in Giblett Forest, there was close scrutiny and contribution by the green movement. In some cases, people who a year or so before had been in opposite camps during anti-logging

Above Vineyards are now a feature of the Pemberton landscape.

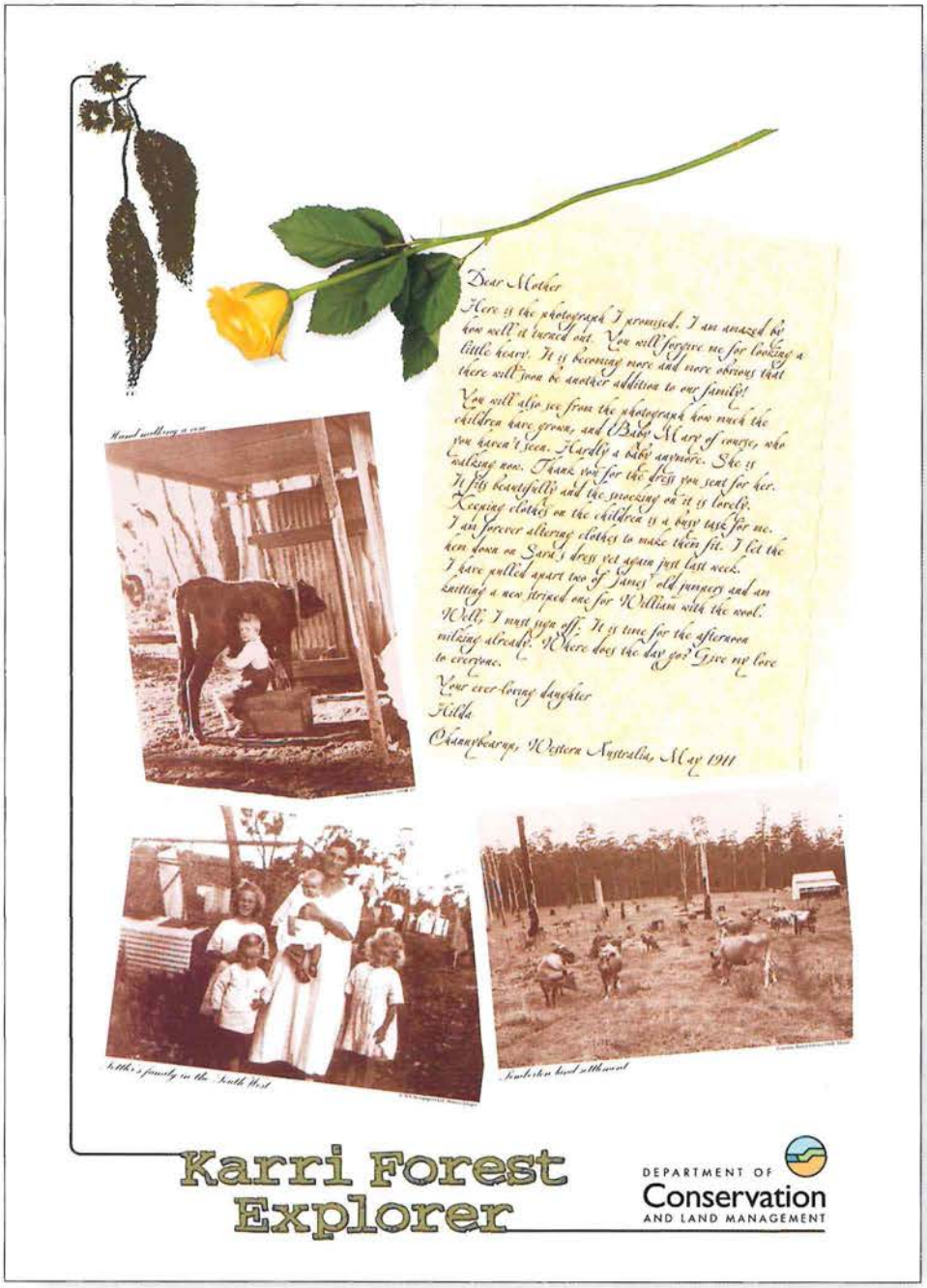
Above left The views along the drive are spectacular, like this one from the Warren River lookout.

Centre left The Karri Forest Explorer drive takes visitors through areas of dense forest.

Left A 'Big Karri' in the Big Brook Forest gives visitors a sense of the enormity of its giant residents.
Photos – Cliff Winfield



Above Spring wildflowers blanket the floor of the karri forest.
Photo – Cliff Winfield



Right Innovative techniques were used to bring the interpretive panels to life.
Image by Graphic Source

protests, found themselves working together to fathom best outcomes for management, conservation and tourism. At ground level, CALM recreation officers and representatives of green groups had site meetings to discuss options for making roads safer and creating new environmental experiences, while protecting environmental values.

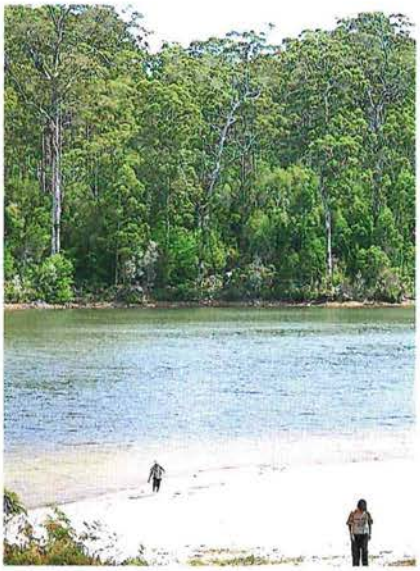
Journey through time and space

The Karri Forest Explorer journey begins when you hop into your car in Pemberton and head along Vasse Highway, turn left at the railway crossing and begin a voyage that is both real and imaginary. Almost immediately, you feel the presence of the karri forest, or at least a sense of its enormity and the challenges it presented to settlers trying to hack a hole in it to establish pasture. You wonder how they did it. There are so many stories to be heard about the people whose lives were touched or altered by the forest.

These sentiments make the experience much more than just a scenic drive. It is an interpretive journey through people's lives—Aboriginal people, settlers and their families, foresters and timber workers, environmentalists and religious cults. The natural values are revealed through recreations of history seen through the eyes of these people as they responded to the effects of the forest.

And now for something completely different . . .

Creating the interpretation and visitor information presented an opportunity to do something different. Writer Jill Griffith was given plenty of background information, but was also given a clean slate for the style of the on-site interpretation. She spent time driving the proposed route through the forest and talking to locals, and then experimented with various written models. Finally, she settled on the approach of creating a number of fictitious characters, who expressed how they felt about the landscape, events and experiences through a series of letters, diaries and notebooks. In this genre, for example, the fictitious character of Hilda, a settler's wife, comes to life when we read a sequence of private letters, written to her mother over a period of years, describing the joys and despairs of farm life in Pemberton during the 1920s. Similarly, fictional journals by foresters, and notebooks of national park rangers



Above left Visitors can walk along a bridge suspended under Beedelup Falls in Beedelup National Park.

Above Big Brook Dam is a popular spot along the Karri Forest Explorer drive.

Left Sculptures, like this one of the bullocks and whim, illustrate the stories of the area's history.
Photos – Cliff Winfield

tell both historical and contemporary accounts of life in the karri forest. At one stop, a Nyoongar Dreaming story explains the creation of the big trees.

Places on the drive were chosen specifically because they gave particular meaning to a story. For example, Big Brook Forest was the first karri forest to be regrown for timber after cutting in the 1920s and 1930s (prior to this, land had been released for farming once commercial timber had been removed). The interpretation there tells the story of the cessation of karri forest being cleared for farmland, and the surrounding forest demonstrates karri can regrow into an impressive forest once again. The protest site in Giblett Forest was an obvious place to tell of the relatively recent struggle to halt logging in old growth forest and have more forest set aside as national parks.

Innovation and technology

At Big Brook Dam a steel sculpture of a bullock team and whim introduce the visual interpretation. Other written and visual interpretation along the Karri Forest Explorer drive is presented on state-of-the-art panels. The preparation of the panels employed 3D scanning techniques, so objects, such as the foresters' measuring instruments, books, diaries, feathers, pressed flowers and other mementos, appear to be sitting on the panels, rather than just part of the artwork. A number of historic images from the Battye Library bring the past days poignantly to life. The finished art is printed onto special weatherproof film and mounted on metal panels placed at chosen settings in the bush. The visual and written interpretations are complemented by a series of short presentations transmitted from six narrowcasting, solar-powered FM radio stations, placed at strategic stopping points along the drive. Transcripts and oral histories from people whose lives were touched by the forest, fictional re-creations of other events such as fires or the anti-logging protest, and topical information on seasonal wildflowers and geological features run on continuous programs received through a car radio tuned to 100MHz FM.

At a leisurely pace, taking in the interpretation and stopping at one of the cafés or wineries along the way, exploring the 80-kilometre drive can occupy a full day. However, the route is designed so that those who prefer to break their drive into smaller sessions,

Right A new viewing platform, Beedelup Lookout, offers visitors views into the beautiful national park.

Below right Phil Goldring, of Hidden River, says the drive has significantly increased traffic and passing trade outside his vineyard and cafe.

Bottom Many visitors take advantage of the opportunity to stop and explore areas of interest on foot.
Photos – Cliff Winfield

or only do an abbreviated version, can do so without losing the thread of the interpretation.

The Protecting Our Old Growth Forests policy allocated funding for capital works in proposed new national parks. Given the pristine nature of some of the areas set aside for the new parks, it was more appropriate in some cases to invest in upgrading existing facilities nearby, rather than to create new ones. For example, proposed Hawke National Park is just over the river from existing facilities at Warren National Park. So some new parks funding was allocated to finishing the Karri Forest Explorer drive in Warren National Park. Taking into account the works in progress at Beedelup Falls and the above capital funds, around $3 million has been invested in the project.

So, has it worked?

It's hard to gauge the success of the drive, but as Andy Russell, a hiking tour operator and member of the Warren Environment Group, says:

> "I see people out there in Giblett Forest often, and we didn't see that before. The presentation of the drive gives them the confidence to be a bit more adventurous, to go exploring for themselves I suppose."

Phil Goldring owns Hidden River vineyard and café, which is on the route. He says the road outside his business is the busiest gravel road in the Shire. The Karri Forest Explorer drive seems to be used by locals too:

> "We often have locals taking visiting friends and relatives around the drive. It seems to give a focus to the forest stories," he said.

Sue Mountford of Mountford Wines says much of their cellar door traffic now comes via the Karri Forest Explorer.

Vehicle counts are another way to test whether or not people are using the drive. During October, in a remote location in Giblett Forest where we would not expect vehicles other than those doing the drive, a traffic counter recorded more than 185 passes. Using data gathered from a variety of locations throughout the south-west forests, we can extrapolate that the annual visitation is probably around 2,500 vehicles. If we accept the premise that experiencing the drive would add an extra day to the visitor's stay in Pemberton, using other visitor data and the recent research work, it seems fair to conclude that more than 6,000 visitors stayed an extra night in the area, at an average spend of $75 per person per day. It is fair, then, to conclude that an extra $450,000 per annum is circulating in local Pemberton businesses.

So, what was set up to compensate for the downsizing of an industry, that provided an important social and economic framework for Pemberton and surrounding areas, has now become an important tourist attraction that protects and showcases the area's natural values and history, and in turn assists in providing economic stability.

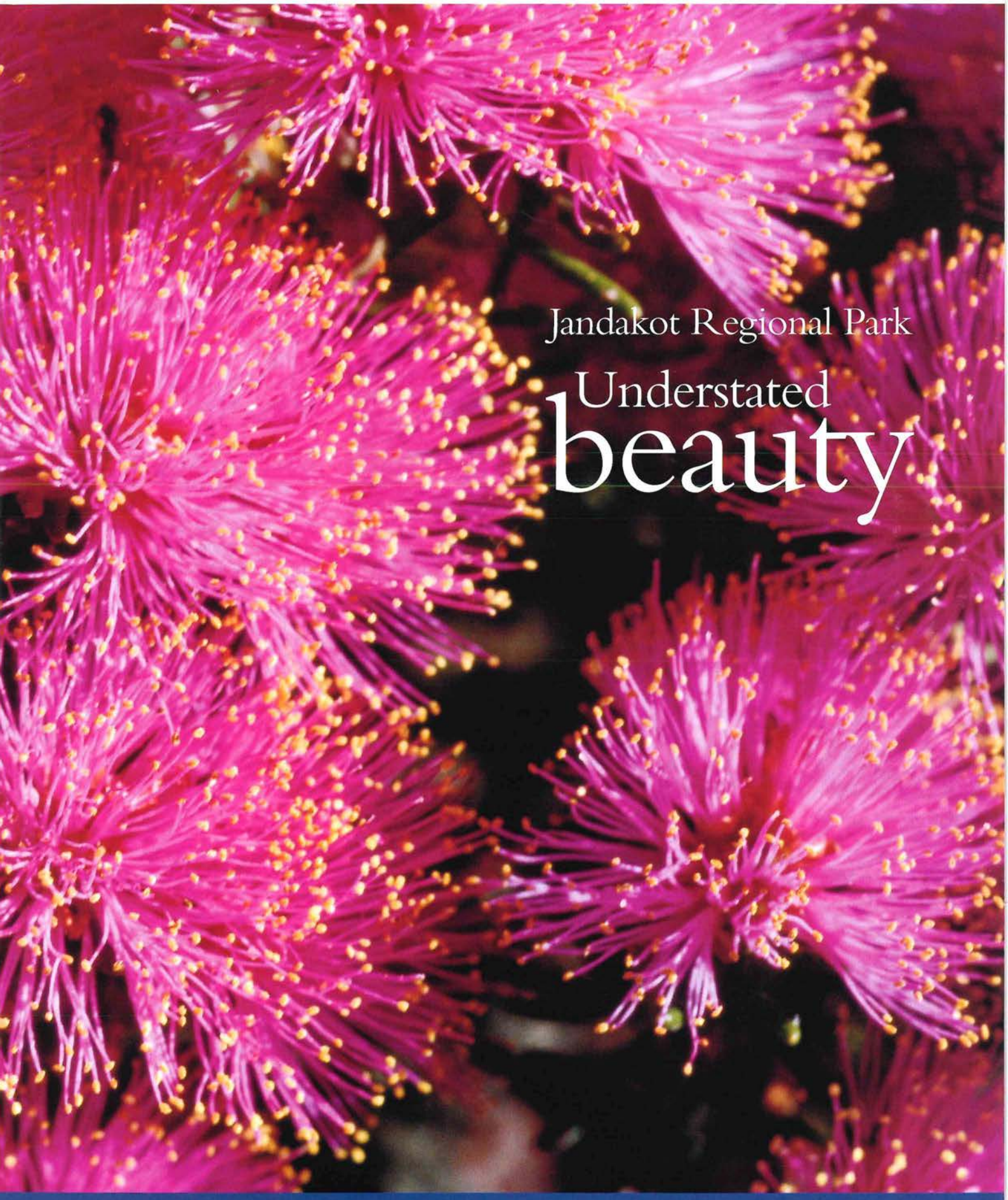
Cliff Winfield is Parks and Visitor Services Coordinator for Warren Region, based at Manjimup, and a long time writer for *LANDSCOPE*.

He can be contacted on (08) 9771 7944 or by email (cliffw@calm.wa.gov.au).

At Jandakot Regional Park, a gentle breeze whistles through the botanically-rich environment of woodlands and wetlands.

Within its vast areas of pristine vegetation, the pervasive silence accentuates the park's distinct features and invites the simple observation of nature.

by Margaret McNally


Jandakot Regional Park
Understated
beauty

On low-lying land in Perth's Swan Coastal Plain, banksia woodlands crown a mosaic of parklands that make up Jandakot Regional Park. Situated in the south-east metropolitan area, the park's 3,800 hectares span across numerous wetland and woodland estates that support rare and endangered plants and animals. The park is renowned for its colourful sprinkling of spring wildflowers. The fact that many bushland reserves adjoin its widespread boundaries enables year-round enjoyment of this regionally significant conservation haven.

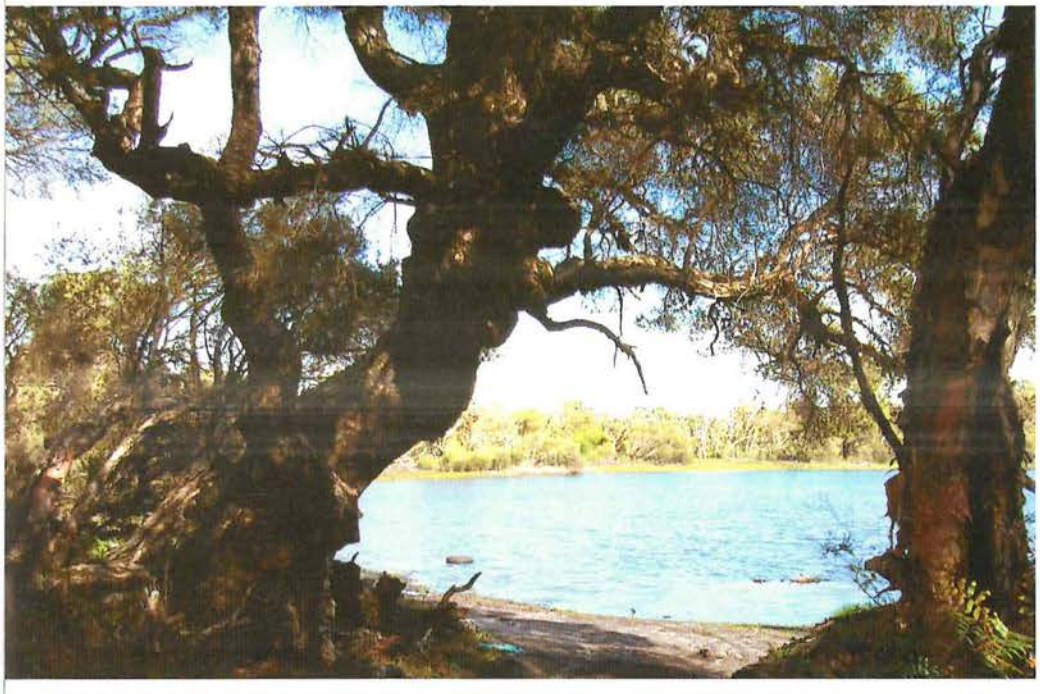
Management and protection of the park's ecologically rich environment is shared by the Department of Conservation and Land Management (CALM), the Department of Justice, and the City of Armadale, City of Cockburn and Town of Kwinana. CALM is responsible for the coordinated management of the park, and has prepared a draft management plan due for release soon. The draft management plan invites public comment on the proposed ten-year management strategies that aim to preserve the park's diverse plant and animal life, and enhance recreation facilities.

Spiritual beginnings

For tens of thousands of years, the Jandakot area has played a key cultural role among Aboriginal people. Known by Nyoongars as the Beeliar district, the land, lakes and wetlands in and around the park were once a valued source of food, water and shelter for a tribal group of 58 people led by Midgegooroo. Jandakot—a Nyoongar name meaning 'place of the whistling kite'—also provided travel routes for groups visiting from the south-west regions. Wetlands were especially appreciated for their plentiful supplies of fruits and fish. They were also sites of trade and ceremonies that continue to hold special significance.

Forrestdale Lake, which adjoins the park, has particular spiritual meaning for Aboriginal people. According to tradition, it is home to the powerful rainbow serpent (Waugal) associated at this site with rain. The tradition warns against disturbance of the native reeds (*Baumea articulata*) around the lake's edge, as this could unleash the Waugal's destructive power. As a campsite, the lake was also valued for its supply of oblong tortoises (*Chelodina oblonga*).

One Aboriginal site, registered by the Department of Indigenous Affairs, is located inside the park in Sandy Lake. A number of other registered Aboriginal sites are located close to the park.



Previous page
Main Swamp honeymyrtle (*Melaleuca seriata*) occurs at Jandakot.
Photo – Michael James
Inset Inundated throughout most of the year, the wetlands of Harrisdale Swamp provide secluded focal points within the park.

Above left The seasonally inundated wetlands of Shirley Balla Swamp support a variety of vegetation communities, including banksia and melaleuca woodland.
Photos – Jacinta Overman

Left Oblong tortoises (*Chelodina oblonga*) were an important traditional food source for Nyoongar people.
Photo – Jiri Lochman

Flourishing farms

In 1885, William and Alfred Skeet became the first European settlers to settle the area after being granted a 'Special Occupation' licence for 100 acres (approximately 40 hectares) of land near Forrestdale Lake to the east of the park. Jandakot's low-lying and swampy peat areas proved useful for settlers, who developed the land for market gardens and honey production.

By the early 1900s, the Jandakot area produced generous supplies of fruit and vegetables—and later, dairy produce—that were sold to markets in Fremantle and Armadale. As competition increased with the proliferation of market gardens closer to those markets, the importance of the Jandakot region gradually declined.

The use of land for intensive agriculture soon gave way to broad-scale grazing of sheep and cattle, a practice that continued from the 1920s to the 1970s, resulting in the loss of many low-growing native plants.

Some of the estates within the park have been reserved for their conservation value since the early 1980s. However, it wasn't until 1987, following a review of the Corridor Plan for Perth, that the establishment of a regional park to protect a network of representative areas of banksia vegetation and wetlands at Jandakot was proposed. The concept, objectives and boundaries for the park were confirmed in 1995, following a process of public consultation and planning. The Western Australian Planning Commission has been acquiring land on behalf of the State to include within the park, and the responsibility for coordinating its management was given to CALM in 1997.

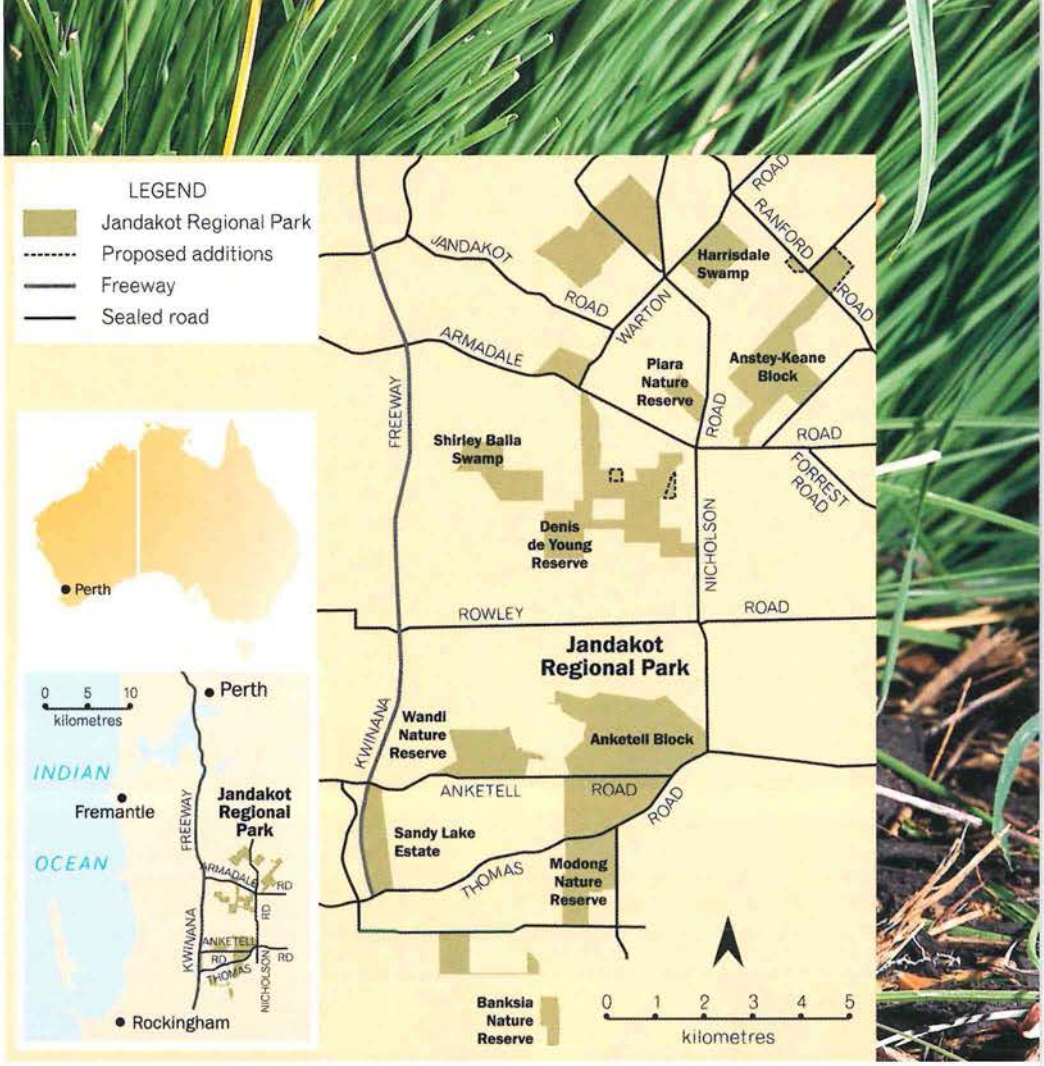
Linking landscapes

Despite its distinctly flat landscape, and estates fragmented by rural and urban land uses, the park teems with biodiverse vegetation and sustains important ecosystems.

Jandakot Regional Park is a vital link in a series of reserves in the south-east metropolitan region. The State Government has declared many areas bordering the park as Bush Forever sites, noted for their distinct conservation qualities. Beeliar Regional Park is located to the west of the park, and the Darling Range Regional Park lies to the east. Nearby, Forrestdale Lake Nature Reserve is a protected and internationally recognised wetland. The lake provides a habitat for a range of waterbirds, including 21 species listed under international agreements.

Linkages to bushland in adjoining reserves within Jandakot Airport and Southern River are also vital. A considerable number of small birds frequent these areas, including splendid fairy-wrens and hooded robins, and rely on the park's native vegetation for food and shelter.

The park overlies now subdued ancient sand-dune systems. The Bassendean Dune System was originally part of the coastline and is thought to have formed between 225,000 and 115,000 years ago, during



Above The park provides important habitats for a range of waterbirds, including purple swamphens.
Photo – Jiri Lochman

the Pleistocene geological period. Over time, winds have flattened the topography normally associated with coastal dunes, resulting in the low sand hills that typify the park's landscape today.

The region's porous sands allow the storage and movement of groundwater, and the Jandakot Groundwater Mound underlies the western areas of the park. Protection of this groundwater is essential because it is a significant source of metropolitan Perth's drinking water, storing a volume of approximately 2,700 million cubic metres.

From secluded wetlands and sedgelands to open heath communities, low woodland and forest, the diversity and complexity of the park's ecosystems is made more valuable because of their poor representation on the Swan Coastal Plain—the result of past land clearing and development. For instance, the Gibbs Road Swamp System within the park—listed on the Directory of Important Wetlands in Australia—is a remnant example of the formerly extensive swamps in the area. It is also a known nesting site for freckled ducks (*Stictonetta naevosa*).

Brimming with banksias

A diverse range of banksia species dominates the landscape. Slender banksias (*Banksia attenuata*), firewood banksias (*B. menziesii*) and holly-leaved banksias (*B. ilicifolia*) proliferate in upland areas including Modong Nature Reserve to the south, as well as Anketell block and Banksia Nature Reserve. Taller coastal blackbutts (*Eucalyptus todtiana*) and saltwater sheoaks (*Casuarina obesa*) are scattered through the park with a dense understorey of native shrubs.

Top left Spectacular wildflowers on display in the park during spring include the firewood banksia.
Photo – Marie Lochman

Centre left Donkey orchid (*Diuris corymbosa*).
Photo – G. Saueracker/Lochman Transparencies

Left Christmas tree *(Nuytsia floribunda).*
Photo – Jiri Lochman

Right Carnaby's black-cockatoos (*Calyptorhynchus latirostris*) frequent the Jandakot area to forage on banksia seeds.
Photo – Jiri Lochman

Below right There is a wide variety of vegetation within the park.
Photo – Jacinta Overman

Below far right The sandhill dragon is at the southern limit of its distribution in the Jandakot region.
Photo – Jiri Lochman

Several species of declared rare flora are also present, including king spider orchids (*Caladenia huegelii*), Purdie's donkey orchids (*Diuris purdiei*) and warty hammer orchids (*Drakaea elastica*). Weed infestation and the plant disease dieback (*Phytophthora*) are among the main threats to their survival.

Seasonal treats

Springtime boasts wonderful wildflower displays that colour the parkland with common donkey orchids (*Diuris corymbosa*), parrotbushes (*Dryandra sessilis*), acacia shrubs and mass showings of golden slender banksias. During early summer, a profusion of Western Australian Christmas trees (*Nuytsia floribunda*) decorate the scenery with clusters of orange stars bursting through their foliage.

The park's many seasonal wetlands support native sedgelands and wildlife habitats. In winter and early spring, these wetlands attract large numbers of waterbirds when water levels are highest. Here, Pacific black ducks and purple swamphens breed extensively.

Bird sightings in the Jandakot area were documented in 1998 in a study by ecologists Michael and Mandy Bamford, and avid birdwatchers are likely to spot most of the 76 waterbird species that have been recorded. These include black swans, little pied cormorants and dusky moorhens, which are also thought to breed in the park's wetlands.

On land, the banksia woodlands support native bushbirds, where birdwatchers can further indulge their passion eyeing 89 different recorded species including painted button-quails, scarlet robins and the rarer square-tailed kites.

Peregrine falcons are also known to visit the area, while Carnaby's black-cockatoos retreat to the park to forage on banksia seeds. These birds are specially protected under the State's Wildlife Conservation Act, with the latter also among the threatened bird species listed as endangered under the Commonwealth's Environment Protection and Biodiversity Conservation Act.

Mammals and more

A notable number of habitats inside the park support upwards of 30 mammal species. The decline of mammals in the Perth region makes Jandakot Regional Park a fundamental refuge and breeding ground.

The park's vastness provides a haven for western grey kangaroos, western brush wallabies and honey possums. Bats, including white-striped bats and lesser long-eared bats, roost high in the park's trees.

Closer to the ground, visitors may spot up to 43 recorded species of reptiles and nine species of amphibians. Turtle frogs, (*Myobatrachus gouldii*) western blue-tongued skinks, (*Tiliqua occiptalis*), and sandhill dragons (*Tympanocryptis adelaidensis*) are of special interest, being at the southernmost limit of their distribution around Jandakot. Rosenberg's goannas (*Varanus*

Above Flowering spokes of the grasstree (*Xanthorrhoea* spp.)
Photo – Brett Dennis/Lochman Transparencies

rosenbergi) and crowned snakes (*Elapognathus coronatus*) also have a restricted distribution and are at their northernmost range in the region. The venomous dugites and western tiger snakes are typical of bushland areas. And carpet pythons (*Morelia spilota imbricata*), specially protected under the Wildlife Conservation Act, are also likely to inhabit areas of the park.

Doing what comes naturally

Open landscapes characterise the park and create a sense of spaciousness. Its sprawling nature also means the park enjoys high visibility from adjoining roads, with Nicholson Road forming the spine that passes through many of its disjointed parklands.

Each of the intriguing parcels of land offers a range of scenic experiences, from secluded wetlands and banksia woodlands to rural landscapes. An unmarked network of challenging sand tracks awaits intrepid bushwalkers. The provision of nature trails, interpretive signs and displays proposed in the draft management plan aims to introduce visitors to diverse vegetation communities and provide an understanding of the park's defining characteristics.

The flat terrain is ideal for horse riding, which is a popular recreation activity in the park. Tracks and firebreaks take visitors past thickets of melaleuca shrubs and through banksia woodland.

While there are, as yet, no facilities within the park, given its existing informal use, visitors can lay a blanket on the ground in a number of areas fringed by banksia woodland in the more attractive Anketell block. Here, a walk through the changing scenery offers distant views of the Darling Scarp across the park. Pockets of dense woodlands and shady alcoves create a tranquil experience. In open spaces, visitors may encounter kangaroos grazing. Meanwhile, the odd, gnarled trunk of a paperbark adds an architectural dimension to the setting and provides excellent opportunities for the burgeoning photographer. So, too, do grasstrees (*Xanthorrhoea* spp.) and woollybush (*Adenanthos sericeus*), and the native ferns and shrubs that flourish in the understorey of flooded gums (*Eucalyptus rudis*) in gradient shades of green.

At Harrisdale Swamp and Shirley Balla Swamp, urban development hugs the park's boundaries. The draft management plan proposes walktrails in these areas, bringing proud stands of banksia and melaleuca woodlands to the front doors of neighbouring residents. Designated nature trails are also proposed to explore the woodland of tuart, marri and jarrah at Sandy Lake Estate.

A park for the future

Stretching for an estimated 17 kilometres north to south, and nine kilometres east to west, Jandakot Regional Park presents an open invitation to explore nature in all its understated charm. With urban development slowly rising, proposals contained in the draft management plan will make the park more accessible to the growing numbers of residents, and raise awareness of its dynamic biodiversity and important Aboriginal and non-Aboriginal heritage.

Protecting banksia woodlands from plant diseases, and stemming the spread of weeds and wildfires is all part of ongoing management measures in the park. Future management requires the joint efforts of park managers and the broader community to maintain the integrity of wildlife habitats, wetlands and woodlands—and Perth's water supplies.

Public comment on the draft management plan is the first step people are encouraged to take to help formulate a final management plan committed to exploring recreation opportunities, while also sustaining the park's inherent values. Active participation by volunteers in research and park management programs is also welcomed, since rehabilitation of degraded areas is only possible with their efforts.

Accommodating the community's needs and preserving the park's botanical richness requires the delicate art of balance. By embracing a dual approach, the draft management plan will go a long way to harness the future growth of plant, animal and human communities in an environment where both nature and culture coexist in harmony for generations to come.

Margaret McNally is a final-year writing and publishing student at Curtin University of Technology.

Margaret used *The Jandakot Regional Park Draft Management Plan 2003–2013* to help write this article. She also wishes to acknowledge and thank Jacinta Overman, and Peter Batt of CALM's Regional Parks Unit for their assistance.

A free downloadable screensaver featuring Perth Regional Parks is available on CALM's NatureBase website (www.naturebase.net/screensavers).

endangered

by John Blyth and Brett Molony

The hairy (Margaret River) marron

Over the last 15 or so years, fisheries officers and zoologists working on Western Australian freshwater crayfish realised that marron in the Margaret River (from which the type specimen had been collected) had a consistently hairier carapace and several other structural differences from other marron (commonly known as 'smooth' marron). It became common practice to refer to it as a separate subspecies (the Margaret River or 'hairy' marron). However, it has recently been described as a separate species, based on morphological and genetic differences and minimal hybridisation in mixed populations with the smooth form.

During that time it was recognised that the hairy species had been joined in the Margaret River by the widespread smooth species, probably accidentally released, and the distribution and abundance of hairy marron was declining.

The hairy marron is now only found in the unmodified upper reaches of Margaret River, within State forest. In the middle and lower reaches, only smooth marron are present and it seems that hairy marron are being outcompeted by smooth marron in degraded sections of the river, where riverside vegetation has been lost or modified. In addition, degraded sections of river are often adjacent to farmland containing dams, many of which may have been seeded with smooth marron that may 'leak' into the river.

In March 2003, the WA Threatened Species Scientific Committee recommended that the hairy marron be classified as Critically Endangered.

The departments of Fisheries and Conservation and Land Management are developing and implementing an interim recovery plan for the hairy marron, with Fisheries being the lead agency. This follows precautionary changes to the marron fishery in 2003 to protect the remaining hairy marron, and the establishment of a captive breeding population at Pemberton, in case active re-establishment is required.

Threats to the hairy marron include clearing of the catchment and introduced species, including yabbies, mosquito-fish, carp and smooth marron, in the river and private dams. Actions to recover the hairy marron will benefit other endemic species in the Margaret River and complement ongoing restoration projects in the catchment.

Community support is critical to the success of the recovery program for hairy marron and a public workshop in Margaret River late last year canvassed public interest. Community groups and members of the public are keen to assist in recovery projects, and provided many ideas at the meeting. These ideas are being drafted into an Interim Recovery Plan, and a Recovery Team will be established shortly.

We can still reverse the decline in hairy marron. The species may be used as a local icon and monitoring tool for Margaret River, and as a flagship species for river and catchment restoration and management. Furthermore, the recovery project will provide an example of a whole of Government approach to managing natural resources. Our two agencies will work closely with the Margaret River community and other agencies and non-Government organisations to recover the hairy marron.

Photo by Brett Dennis/Lochman Transparencies

Keeping our forests in check

by Richard Robinson

The study of Western Australia's diverse range of flora and fauna has been undertaken in State forests for many years. These studies have generally focused on individual species or communities. Recently, however, a fully integrated monitoring program that aims to better understand and manage the amazing biodiversity of our forests was initiated.

In 2002, the Department of Conservation and Land Management (CALM) set up a new program to record and monitor the dynamic biodiversity of Western Australia's south-west forests and woodlands. Called 'FORESTCHECK', it combines the monitoring of invertebrates, fungi, lichens, flowering plants, vertebrates and the physical attributes of forest structure into one integrated program to gather more cohesive information on the status of the State's forest biodiversity. The program ensures that data are gathered on all groups of organisms from the same point in time and space, and uses standardised collection methods. This uniform approach allows for more accurate studies on the interactions between these organisms and the effects of management on biodiversity as a whole, without having to make assumptions about the varying environmental and climatic conditions that are inevitably recorded in separate studies.

Collective care

Developed through CALM's Science Division, with significant input from a wide range of scientists from other agencies, FORESTCHECK provides forest managers with information about changes and trends occurring in key elements of forest biodiversity associated with forest activities. The program stems from State, national and international obligations to ensure that our forests and woodlands are managed in an ecologically sustainable manner. It is a long-term project that aims to have a network of permanent sites—some of which will be monitored every five years or so—to continue to provide information on our forests for future generations. The first major analysis of information collected from the project since 2002 will be undertaken in 2006.

Considering the vast number of species that inhabit WA's south-west forests, the new monitoring program is an ambitious one. At present, the FORESTCHECK team is concentrating on the jarrah forests, with future plans to extend into other ecosystems. Up to 20 research, technical and office staff from CALM's Science Division are directly involved in gathering and analysing information on the abundant plants and animals—including mammals, reptiles, birds, fungi, lichens and insects—living in the forests, and on forest attributes such as structure, soil nutrients, soil disturbance, litter and woody debris. Staff members from local CALM districts in Donnelly, Wellington and the Perth Hills have also assisted with the establishment of monitoring sites.

Logging forest activities

Since the program started two years ago, FORESTCHECK researchers

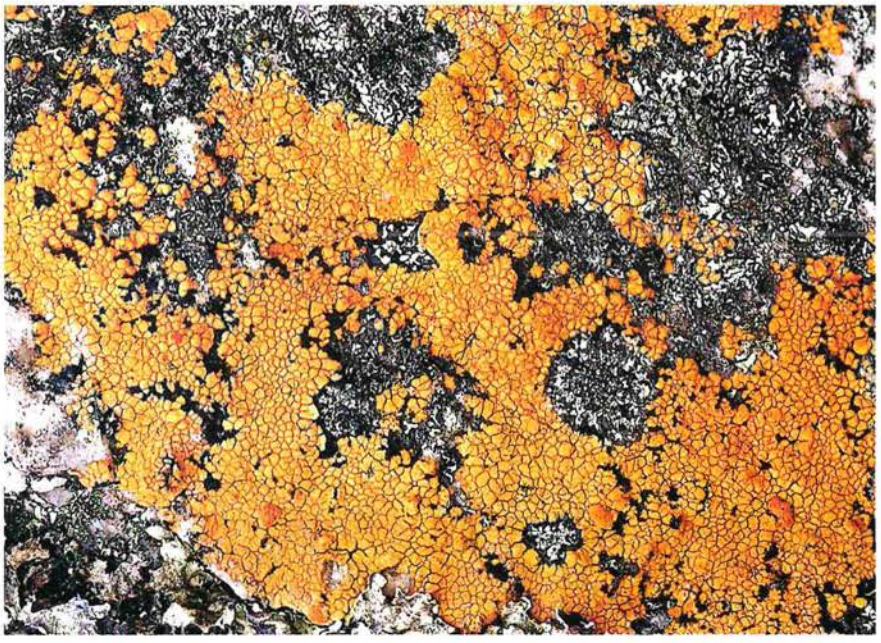
Facing page
Main Coral vine (*Kennedia coccinea*) with jarrah trees in the background.
Photo – M & I Morcombe

Above The distinct brown and grey-banded fan-like fruit bodies of the turkey tail fungus (*Trametes versicolor*).
Photo – Richard Robinson

Left Western pygmy possum (*Cercartetus concinnus*).
Photo – Jiri Lochman

have set up permanent monitoring sites in the southern and central jarrah forest regions around Manjimup and Collie. Now, as FORESTCHECK enters its third year, sites are being set up for this year's monitoring in the northern jarrah forest surrounding Dwellingup and east of Kelmscott.

The sites in the jarrah forest are designed to monitor the effects of logging on biodiversity and the forest's recovery following logging. These sites include plots in unlogged forest, and forest that has been subjected to shelterwood and gap harvest methods. Shelterwood harvesting occurs when the trees are ready to be felled but there is not an adequate number of saplings established to take their place. The technique involves the partial removal of trees to encourage seedlings to establish and develop within the forest stand. Gap creation occurs when the stocking of saplings is adequate, and involves the near-complete removal of the overstorey to allow the saplings to develop without obstruction, and to eventually become a new forest.

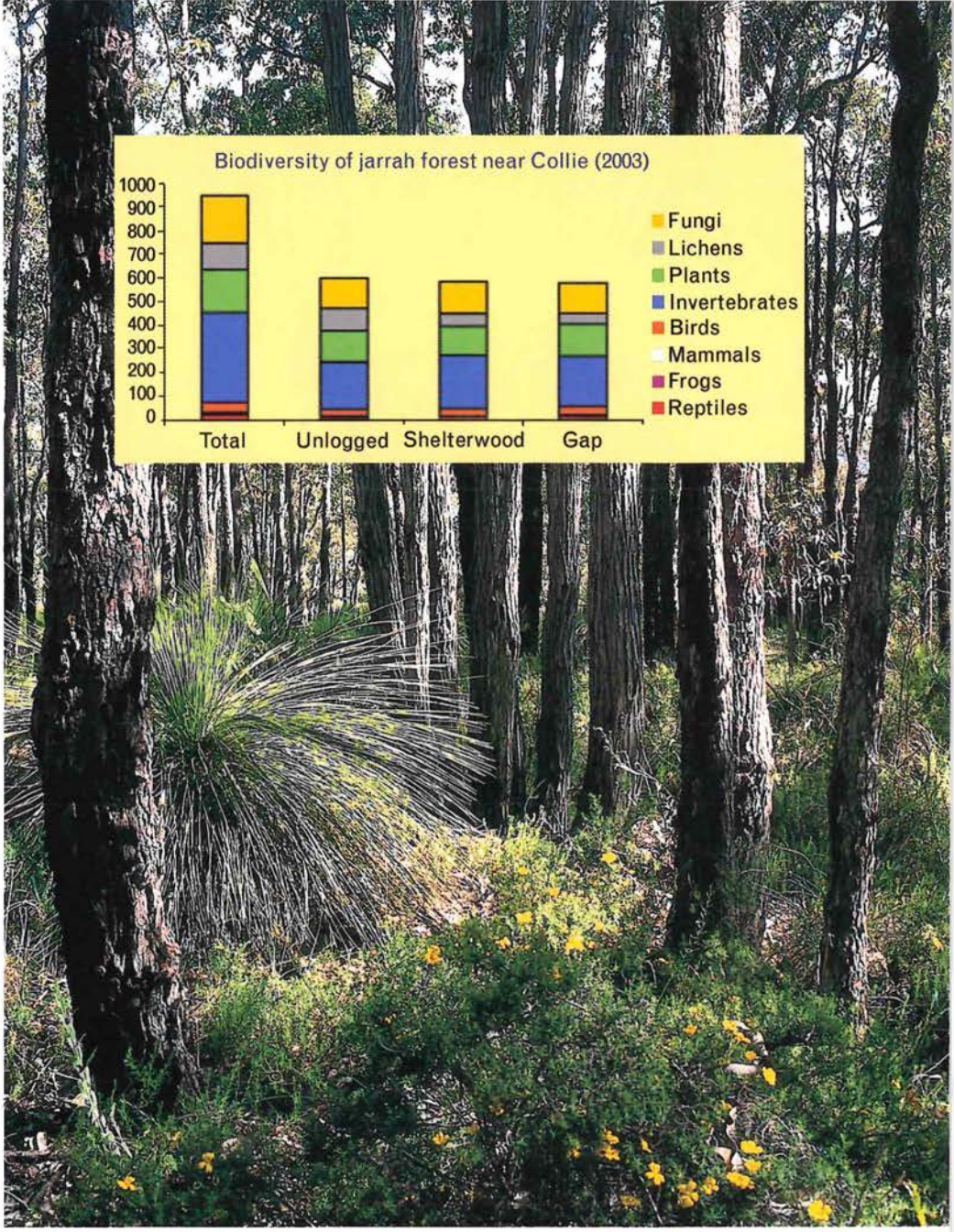


Top left Southern boobook owl (*Ninox boobook*).
Photo – Jiri Lochman

Above A nesting box in jarrah shelterwood near Collie.
Photo – Lachie McCaw

Centre left The red and white mushroom of Cleland's russula (*Russula clelandii*).

Left An orange crust lichen, *Rhizocarpon polycarpum*, found on small granite rocks.
Photos – Richard Robinson



Right Regrowth jarrah forest. *Photo – Dennis Sarson/Lochman Transparencies*
Inset graph Preliminary results from FORESTCHECK indicate that the numbers of species inhabiting logged and unlogged jarrah forest are similar, and that the majority of the species are in the little known invertebrate, fungi and lichen groups.

Variety—the spice of forest life

Information gained from data collected so far highlights the extraordinary diversity of life forms that flourish in our jarrah forests. In the jarrah forest surrounding Manjimup and Collie alone, the FORESTCHECK team has recorded the presence of 1,670 species—and that's after only two monitoring periods. The wide range of plants and the unique animals have always been a drawcard for people who want to explore the south-west jarrah forest. But team members have discovered an abundance of relatively unknown species of invertebrates, fungi and lichens. Combined, these three groups account for three quarters of the total diversity recorded, and species in each group number in the hundreds. Compared with flowering plants and vertebrates, study on the classification of invertebrates, fungi and lichens is limited. The majority of them are yet to be named, and many specimens have been collected and recorded for the first time. Insects, alone, are so numerous that it would take a disproportionate amount of time to sort them into their respective species, so only those larger than a centimetre are recorded, unless they are a distinctive or targeted species. Fungi are also plentiful, but only those that produce visible fruiting bodies late in autumn, following the start of the soaking winter rains, are recorded.

Functional fungi, invertebrates, lichens

Fungi are important in forest ecosystems because they decompose dead plant and animal material and recycle nutrients. The striking red and white Cleland's russula (*Russula clelandii*) belongs to a group of fungi that bind to the roots of plants and help them take up and absorb nutrients from the soil. Other fungi, such as the turkey tail fungus (*Trametes versicolor*) and the orange-footed mycena (*Mycena carmeliana*), decay wood and initiate the natural recycling process.

Recording the presence of fungi relies on them producing mushrooms or coral, puffball, cup and bracket-like fruiting structures (see 'Forest Fungi', *LANDSCOPE*, Spring 2002). But the majority of fungal fruiting bodies are short-lived and only produced over a short period of time, making them a challenge to monitor.

Invertebrates are also important as a food resource for other organisms such as reptiles, birds and mammals. Insects, like native bees and jewel beetles, are important because they pollinate the flowers of plants. Many insects are well hidden or only come out at night, so recording the presence of species like the Dryandra moth (*Carthaea saturnioides*) requires capturing them using light traps. Ground-dwelling insects, like crickets, and other invertebrates, like scorpions, are caught in small pitfall traps. Other insects, such as weevils, that live in the foliage of understorey trees and shrubs, necessitate the beating or shaking of branches to dislodge them onto a large sheet or tarpaulin. For large, dominant trees, it is difficult to record what insects are present in the canopy, and this is perhaps why we know so little about which species inhabit them.

Lichens are also important colonisers of harsh habitats such as rocks and bare soil. Because they absorb most of their nutrients from the atmosphere, or from the surface of the object or plant on which they grow, they are good

indicators of ecosystem health. Many lichens are obscure, blending well into their surroundings, and seeing them requires a keen eye. Others are brightly coloured (see 'Lichens', *LANDSCOPE*, Autumn 2003). Some are found on tree trunks, while others, such as species of *Usnea*, commonly called 'old man's beard', grow on the branches of many shrubs. Flat crust-like species of *Buellia, Rhizocarpon* and *Lecanora* can be found on the surface of rocks, and the leafy *Thysanothecium hookeri* is found exclusively on termite mounds.

Early findings

While preliminary results from FORESTCHECK suggest that logging in the jarrah forest has not had a major impact on the number of species present, they do show that different species inhabit the logged and regenerating sites compared with sites that have not been logged. How important this change in species

Top left A syrphid fly feeding on the nectar of a jarrah flower.
Photo – Tom Chvojk

Above Small mushrooms of the orange-footed mycena (*Mycena carmeliana*) on a jarrah log.
Photo – Richard Robinson

Centre left The spectacular Dryandra moth (*Carthaea saturnioides*) is caught in light traps.
Photo – Alan Wills

Left The echidna (*Tachyglossus aculeatus*) and other native animals rely on invertebrates as a food source.
Photo – Jiri Lochman

Right Gnarled veteran jarrah trees provide essential habitat for many native animals.
Photo – Lachie McCaw

composition is, will be the focus of the major data analysis planned for 2006.

Certainly, logging produces a general increase in compacted soils due to log landings (where logs are stockpiled in the forest for transport) and extraction tracks that are used to retrieve them—and mapping these tracks shows that, together, they cover about 16 per cent of the cut block.

The southern area of jarrah forest supports greater numbers of plant species and a higher proportion of marri trees. These forests tend to be denser and, probably because they are wetter, contain a few more species of weeds than the forests further north. Results show that gaps in the forest tend to be densely stocked with saplings, but their density in shelterwoods that have a high component of banksia and/or sheoak trees in them tends to be variable. This is likely to be due to the thick cover of leaves and needles that prevent the successful germination and establishment of jarrah seed.

No rare plants have been recorded so far, but some rarely seen mammals such as echidnas, pygmy possums and dunnarts have been captured and released. However, numbers of mammals were very low or not recorded in areas that had not been baited for foxes. Both boobook and masked owls have also been recorded during night spotlight studies. Scorpion flies (*Austromerope poultoni*), caught in both light and pitfall traps, are endemic to Western Australia and a relict species that has survived in the south-west from the time of the ancient Gondwanan forests.

Forests for the future

Forests are important habitats that harbour much of the biodiversity of south-west Western Australia. They are also necessary for human recreation and social well-being, while some areas are an important source for forest products such as timber and minerals. Management of our forests—whether for nature conservation, recreation, timber production or mineral extraction—has some impact on the ecology, and the plants and animals living there. Programs like FORESTCHECK, that are committed to monitoring these impacts, produce the necessary information to help protect our native forests and inhabitants, so that they will survive and thrive well into the future.

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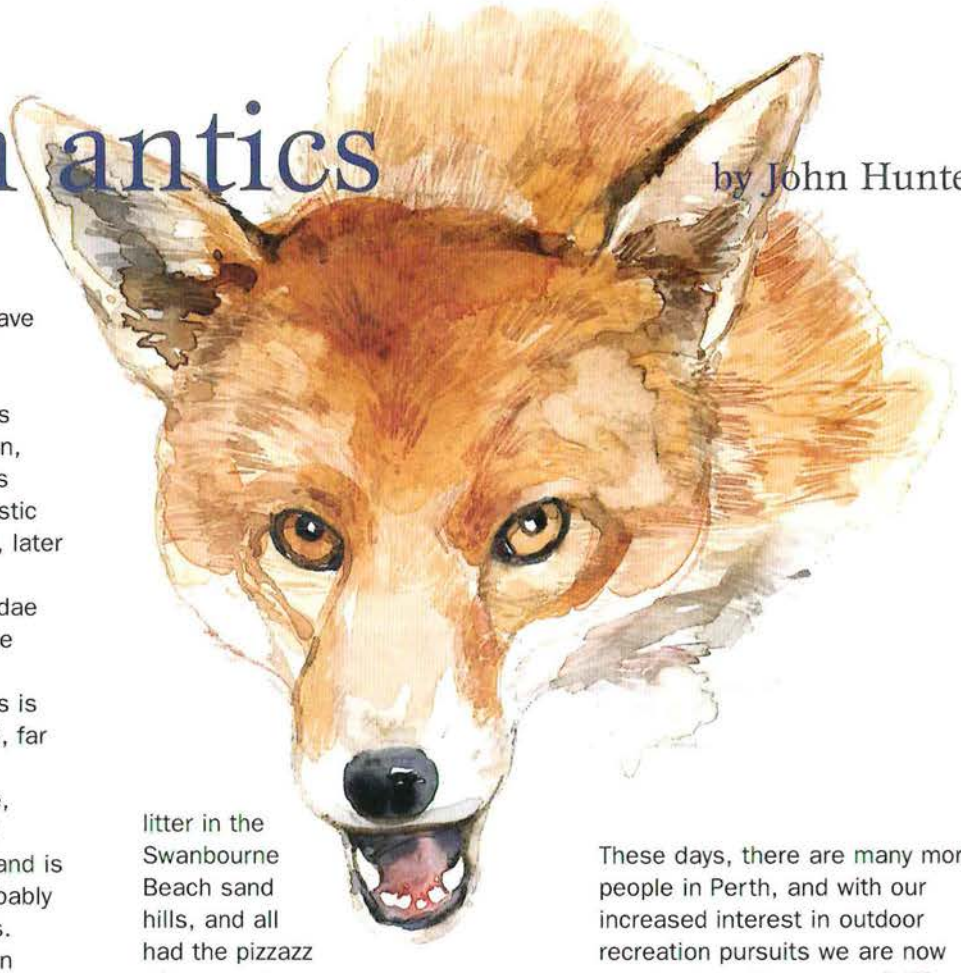
The FORESTCHECK concept was originally proposed by the Science Division's Director Neil Burrows and Science Adviser Ian Abbott, and is now coordinated through the Science Division Research Centre at Manjimup. Staff involved can be contacted at the centre on (08) 9771 7985.

Annual FORESTCHECK Reports can be viewed and downloaded from the Science Division website at: www.naturebase.net/science/science.html

urban antics

by John Hunter



Who dunnit?

It is thought that dogs have been part of the Australian landscape since Aboriginal travellers introduced dingoes about 4,000 years ago. Then, with the arrival of Europeans some 400 years ago, domestic dogs that became feral and, later still, foxes were added to members of the family Canidae that were at large across the entire continent.

By far the most villainous is the fox. Cunning personified, far larger than any carnivorous marsupial, extremely nimble, nocturnal, rests in a hidden refuge or underground den and is at home in the suburbs probably more so than in the deserts.

First released in southern Victoria for sporting purposes in the 1860s, the fox soon spread to the region west of Kalgoorlie by about 1917. The rabbit plague across Australia at about this time helped the quick dispersal of foxes by providing a ready food source. By about the 1930s, severe predation and extinctions of some mainland native animal species was occurring.

While CALM's Western Shield predator control program is reducing fox numbers and re-establishing some species of native animals in their former ranges throughout country areas of the State, 'brer fox' has been quietly going about 'business' in urban Perth for years.

Astute hunters, able to live on feral rabbits, rodents, small insects and open caged poultry, and quite happy to scavenge rubbish tips and bins, foxes have been observed patrolling the suburbs since about 1935. In his book *A Fortunate Life*, Albert Facey mentions the loss of poultry through foxes at Wanneroo in the late 1940s.

In 1961, some members of the Western Australian Naturalists' Club captured six fox cubs in one litter in the Swanbourne Beach sand hills, and all had the pizzazz of true cartoon characters. They had already learned to run at full crouch on their tummies and to hide to their eyes behind small objects thinking they couldn't be seen. Because it was, and still is, obligatory by law to eradicate the species, they were handed over to the appropriate authority. It was at about the same time that foxes were also seen walking the open drain north and west from Herdsman Lake through to the Wembley golf course. They were regularly coming and going to where rabbits infested coastal dunes, and were probably picking up the odd domestic chook and someone's pet guinea pig on the way through.

These days, there are many more people in Perth, and with our increased interest in outdoor recreation pursuits we are now starting to notice more wildlife. In recent times there have been sightings and evidence of foxes around Lake Monger, Wembley golf course, Willagee, Kings Park, Bold Park, along the freeway near Woodvale, and even along the railway line between Claremont and Karrakatta. I wouldn't be surprised if there were at least one family of foxes in every suburb of Perth, including the central business district.

Is the fox taking on a higher urban profile? Do we really have an increasing fox problem in the suburbs and is this having an effect on populations of native species there, or does the cat, too, have to take some of the blame for recent domestic pet and wildlife disappearances?

DID YOU KNOW?

- Foxes have highly tuned aural and visual senses. They can hear the sound of a mouse squeak more than 30 metres away and can quickly detect moving objects.
- They often leave a pungent territorial odour from a scent gland on their tail.
- When on the run, a fox's bushy tail is held horizontal and when walking, they tread their back paws neatly into the front paw marks.

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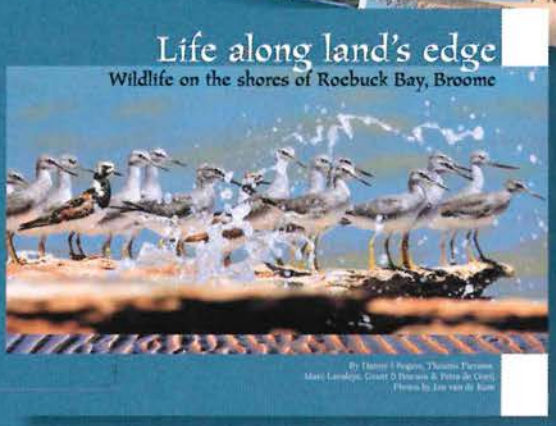

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