WA's conservation, parks and wildlife magazine

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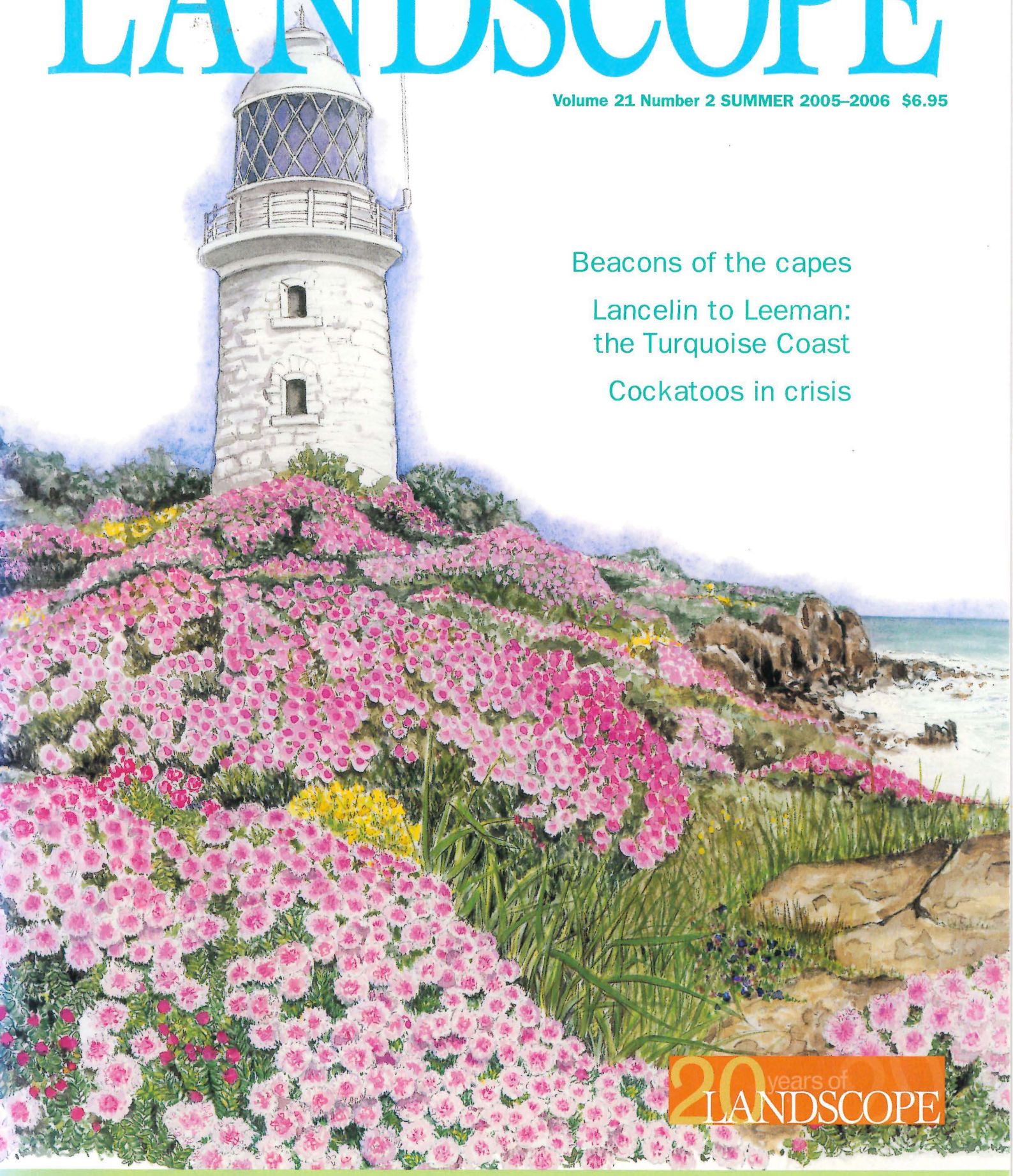


Beacons of the capes

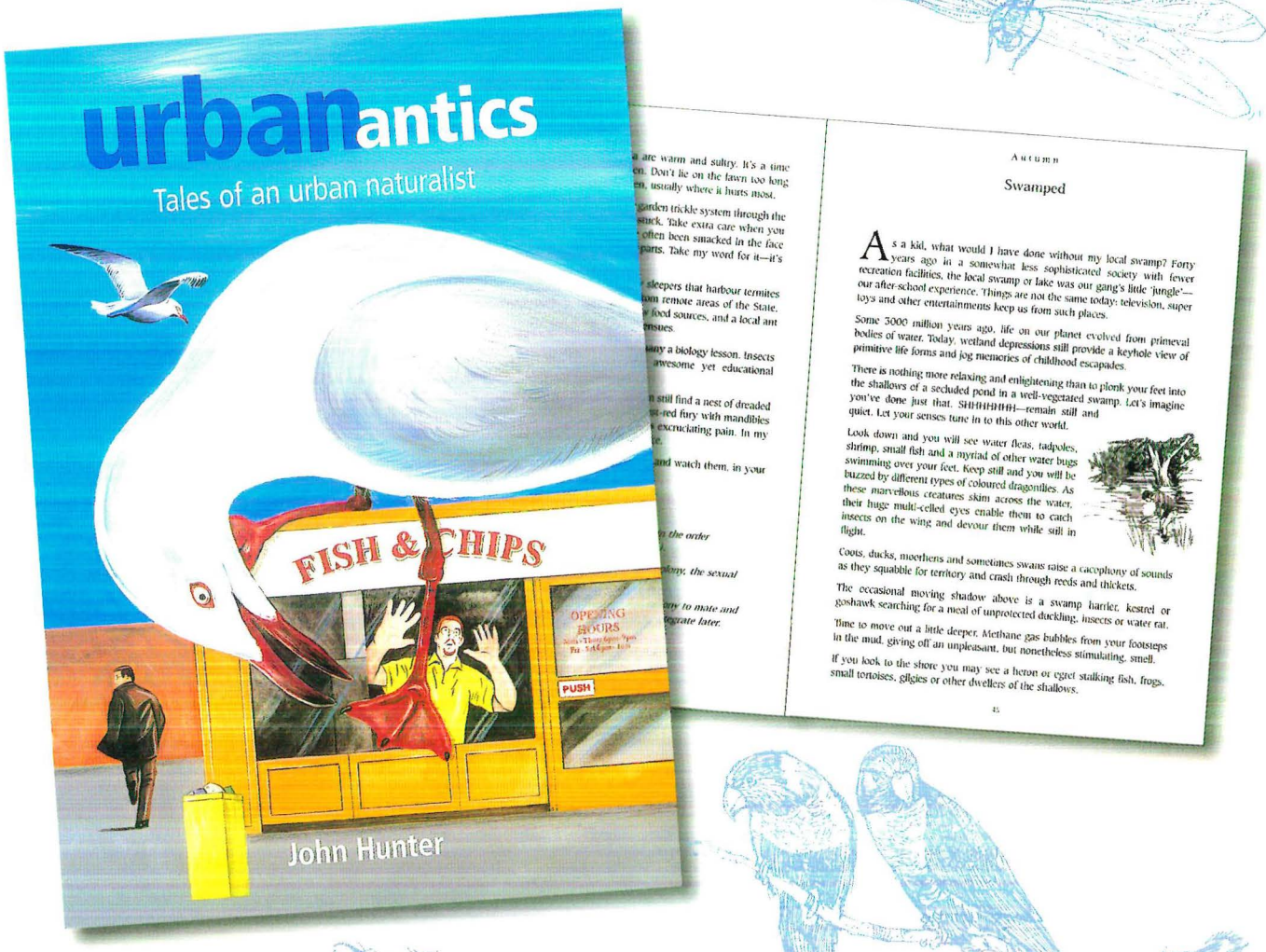
Lancelin to Leeman: the Turquoise Coast

Cockatoos in crisis

20 years of LANDSCOPE

Rare Kalgoorlie butterfly **Rockingham Lakes Regional Park** Extraordinary orchids

HOT OFF THE PRESS



A new compendium of the greatly loved column, 'Urban Antics' from the award-winning *LANDSCOPE* magazine. They are essentially tales of an urban naturalist, John Hunter, who has loved and worked with Western Australia's national parks and wildlife for his entire life. John's colourful, irreverent, humorous and insightful style of writing will appeal to everyone who picks and up delves into this book.

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GOVERNMENT OF WESTERN AUSTRALIA
DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA


Anne Storrie


Joanna Moore

contributors

Ann Storrie, when not busy on her day job at Royal Perth Hospital, is a freelance photographer and writer, specialising in diving and underwater photography, but lately branching out to photographing and writing about wildflowers and the terrestrial landscape. Despite experiencing severe seasickness, Ann has dived in many exotic and challenging diving locations all around the world. With long-time friend and dive buddy, Sue Morrison, Ann has written and photographed several books published by CALM: *The Marine Life of Ningaloo Marine Park and Coral Bay* (1998), *Wonders of Western Waters* (1999) and *Beneath Busselton Jetty* (2003). They are currently working on *The Turquoise Coast*, to be published early in 2006.

editor's letter

For most of us, acacias are as iconically Australian as kangaroos—both species of course feature on the Australian coat of arms. Acacias, or wattles, have become part of our national consciousness in many other ways, from the green and gold colours worn by our national sports teams to the Golden Wattle Cookery Book. My local street directory lists a dozen entries under 'Acacia' and the telephone book gives details for florists, caterers, furniture makers and a prison with the name 'Acacia'.

Given this, some people are surprised to learn that acacias are not unique to Australia—some acacia species are native to parts of Asia, Africa and the Americas. While the vast majority of acacias are found in Australia—955 of the 1350 or so known species—another 185 species occur naturally in the Americas, 144 in Africa and 89 in Asia.

However, it turns out that these 1350 species don't have as much in common as was once thought, and should not all be classified as *Acacia*. This is not the first time that a species has been divided into new groups and there are internationally-adopted rules to follow. For plant species, this means the International Code of Botanical Nomenclature, a rule set that doesn't usually cause headlines in newspapers across Australia, as happened earlier this year.

Under the Code of Botanical Nomenclature, when a species is divided and new groups are formed, the first plants described under that classification keep the original name. In the case of *Acacia*, the first plant described was *A. nilotica*, endemic to Africa and Asia and now part of a group that represents only 13 per cent of the approximately 1350 species being reexamined. Most of Australia's 955 species faced being given the new generic name, *Racosperma*. Implementing the name change would have meant an enormous amount of work and disruption for botanical institutions, the forestry and horticultural industries, community groups and others.

Instead, Bruce Maslin from the Department of Conservation and Land Management and Tony Orchard from the Commonwealth Department of Environment and Heritage put up a proposal that would keep the *Acacia* name for the Australian group of wattles. This was a controversial move, sparking debate and lobbying in botanical circles around the world, but eventually it was accepted at this year's XVII International Botanical Congress in Vienna.

The result received considerable media interest, but you'll want to read all about it in 'The great wattle debate' by Danielle Le Moignan in this issue of *LANDSCOPE*. What's in a name? Quite a bit really...

Caris Bailey

Caris Bailey
Executive Editor

20 years of LANDSCOPE

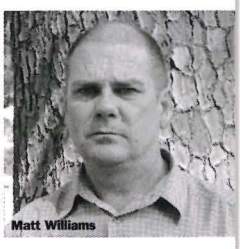
Joanna Moore is a graduate in Communication and Cultural Studies at Curtin University of Technology, majoring in Professional Writing and Presentation. She really enjoyed her work placement experience at *LANDSCOPE*, where she could creatively bring together her love of writing with her appreciation and concern for the conservation of the natural environment.

Matthew Williams has been a biometrician in the Science Division since he joined CALM in 1987. Apart from experimental design and analysis, his other major work interest is the conservation and ecology of Western Australia's native butterflies. Five years ago he began a PhD project on butterflies in urban bushland remnants, the results of which are helping to determine the causes of their decline.

Danielle Le Moignan is also a graduate in Communication and Cultural Studies at Curtin University of Technology. She completed a six-week professional placement with CALM's Strategic Development and Corporate Affairs Division in 2005. Danielle has focused her studies on research, professional writing, editing and desktop publishing, completing a major in Publishing Practice with a supporting minor in Cultural Studies. Raised in the central Wheatbelt, she moved to Perth to continue her education, which has given her the opportunity to explore her interests in literature and history.

also contributing...

Sue Morrison, Gillian Stack, Andrew Williams, Brad Durrant, Ron Johnstone, Tony Kirkby, Anne Cochrane, Sarah Barrett, Brent Barrett, Verna Costello and John Hunter.


Matt Williams


Danielle Le Moignan

Features

Cover illustration by Philippa Nikulinski
The Cape Naturaliste lighthouse sits above an area of natural bushland that bursts with wildflowers throughout spring and early summer.

Back cover photo by David Bettini
The beach at Cape Naturaliste.

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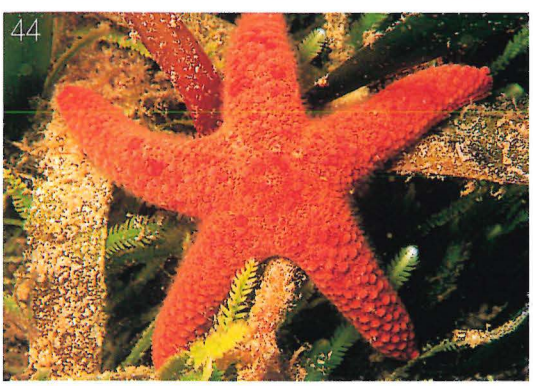
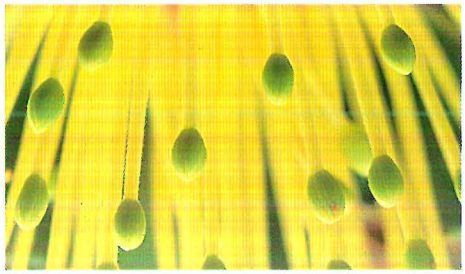




Extraordinary orchids

Each spring, Western Australia comes alive with thousands of species of colourful and vibrant wildflowers. One of the State's richest areas for wildflowers is the south-west, with the Dunsborough–Cape Naturaliste region accommodating a number of native spider orchids found nowhere else.

by Danielle Le Moignan

Facing page
Top far left Aniseed boronia (*Boronia crenulata*).
Photo – Andrew Davoll/Lochman Transparencies
Top left centre Cape Naturaliste Lighthouse.
Photo – Andrew Davoll/Lochman Transparencies
Top left Holly-leaved banksia (*Banksia ilicifolia*).
Photo – Jiri Lochman
Left Dunsborough spider orchid (*Caladenia viridescens*).
Photo – Andrew Brown/CALM

Above Cape spider orchid.
Photo – Andrew Brown/CALM

Wildflower season in Western Australia is one of nature's true spectacles of colour and diversity. More than 75 per cent of the 11,000 Western Australian wildflower species grow in the State's south-west corner, between Geraldton and Esperance. The area around Busselton, Dunsborough and Margaret River, is particularly diverse in its wildflowers. Species commonly seen in the area include the grey-blue smokebush, boronia, wattle, red grevillea, banksia, white myrtle and numerous orchids.

The Ambergate Reserve, in the Dunsborough-Cape Naturaliste region 10 kilometres from Busselton, has more than 170 species of wildflowers located within 70 hectares alone. Spider orchids are particularly well represented in the Dunsborough region, which supports many orchid species.

There are also several extremely rare wildflower species found only within the Dunsborough area. These species are often confined to areas of only a few kilometres. Their rarity and restricted habitat places them at significant risk, and constant care must be taken to ensure that each species is protected from possible threats. Bussell's (*Caladenia busselliana*), Dunsborough (*Caladenia viridescens*) and cape (*Caladenia caesarea* subsp. *maritima*) spider orchids are among the rarest. However, they can occasionally be seen along the coastal walktrails near Meelup and on the Cape to Cape Walk Track that runs north-south between Cape Naturaliste and Cape Leeuwin.

Bussell's spider orchid occurs further inland to the east of Yallingup.

Brilliant blooms

Bussell's spider orchid is found in winter-wet areas, on sandy loam over clay soils and beneath canopies of jarrah and marri. The plant is able to survive the long, dry summer period

Left Red-tailed tropicbird.
Photo – Dave Watts/Lochman Transparencies

Far left Bussell's spider orchid.
Photo – Andrew Brown/CALM

by dying back to underground, potato-like storage origins (tubers) and re-emerging in autumn as a single hairy leaf. When flowering in spring (September to October), the plant produces one to three pale yellow, spider-like flowers on a flowering stem 20 to 30 centimetres in height. Bussell's spider orchid is one of only three clubbed king spider orchids in Western Australia that lack a red apex to the labellum (the distinctive median petal of the orchid).

This species can be found on the Leeuwin-Naturaliste Ridge around the Dunsborough area. It was discovered as early as 1954, but was only collected and recognised as a new species in 1990 by Greg Bussell, after whom the flower is named. Threats to the orchid include degraded habitat, weeds, accidental destruction during roadworks, poor survival of offspring and death of adult plants. Because of these threats, Bussell's spider orchid is ranked as critically endangered and declared as rare flora under Western Australia's Wildlife Conservation Act.

Another rare orchid specific to the region is the Dunsborough spider orchid. The plant is a small, fine, single-leaved orchid that grows between 25 and 40 centimetres in height. Flowering in September–October, it produces one to three attractive, spider-like flowers. These flowers are pale green (the scientific name *viridescens* is taken from the Latin *viridis* meaning green) and grow in well-drained, lateritic and sandy soils in the Yallingup area. The species has been recorded in just four locations.

The Dunsborough spider orchid was discovered in 1985 and ranked as critically endangered in 1995. As well as facing threats from weed invasion and accidental destruction from road maintenance, clearing of native vegetation has significantly reduced suitable habitat and is probably the major factor contributing to the plant's rarity. Fire can also pose a threat to the plant, if it occurs during its active growing period. In the summer of 1994–95, the population of the species near Cape Naturaliste Lighthouse was burnt by wildfire. No population has been recorded in the area since then.

A third rare orchid species found in the Dunsborough–Cape Naturaliste area is the cape spider orchid. The scientific name of the subspecies is derived from the Latin word *maritimus*, meaning 'growing by the sea', due to its coastal habitat. The plant grows to between 15 and 20 centimetres high and bears one to three flowers with stiffly held petals and sepals and a prominent yellow and brown striped labellum. The cape spider orchid differs from other *Caladenia caesarea* subspecies in having smaller flowers, a coastal granite habitat and an earlier flowering period, between August and mid-September.

The plant usually grows among low heath and herbs on shallow soil pockets of reddish-brown sandy loam soils. Its distribution is limited to the coastal granite areas near Cape Naturaliste, and over a geographic range of just five kilometres. Unlike the Bussell's and Dunsborough spider orchids, the cape spider orchid is listed as endangered rather than critically endangered. Despite this, conservation is still extremely important for the species.

The spider orchids growing in and around Dunsborough are just a few examples of the many unusual plants and animals that abound in the Cape Naturaliste region. Other rare species, such as the Meelup mallee (*Eucalyptus phylacis*) or the red-tailed tropicbird (*Phaethon rubricauda*), which visits Sugarloaf Rock, further enhance the region's appeal for its many visitors. Together with attractions like the Cape Naturaliste Lighthouse (see 'Beacons of the capes' on pages 32-38), annual whale sightings and world-renowned surf beaches, cliffs, walks and wineries, Dunsborough's wildflowers contribute to the area's wealth of beautiful natural scenery, and its status as one of the State's leading tourist destinations.

Danielle Le Moignan is a final-year student in the Department of Communication and Cultural Studies at Curtin University of Technology.

endangered

by Gillian Stack

Wongan cactus

The genus *Daviesia* includes 135 species and subspecies, all of which occur only in Australia. More than 70 per cent of these are endemic to the south-west of Western Australia. They are short-lived shrubs, which typically set a lot of seed in a relatively short time. This seed persists in the soil for many years, and germinates in response to disturbance such as fire.

Wongan cactus (*Daviesia euphorbioides*) is a striking plant, with abundant, colourful flowers from June to July. Its cylindrical pithy branches and scattered, spiny 'leaves' give rise to its common name. The grey-blue branches of the Wongan cactus grow to 80 centimetres in height. The orange-yellow and deep red flowers cluster together along the stems.

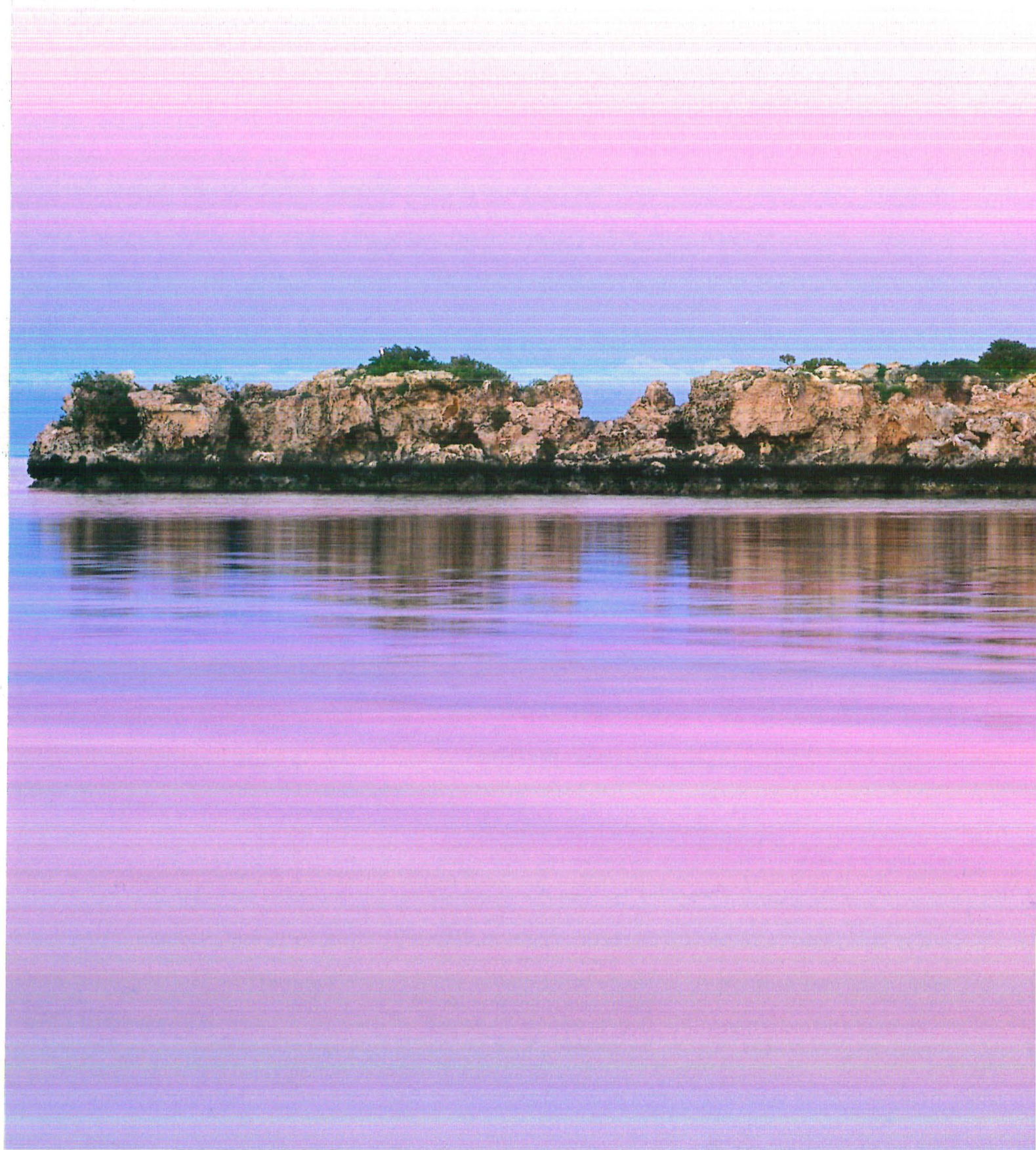
Wongan cactus occurs from Wongan Hills to the Dowerin-Goomalling area. There has been broadscale vegetation clearing for agriculture over the whole of its range, with only six per cent of vegetation remaining in the three shires in which this species occurs. Only some of this remnant vegetation is suitable habitat for Wongan cactus, which occurs on sandplains, in heath dominated by sheoak (*Allocasuarina campestris*) and sandplain cypress (*Actinostrobus arenarius*). There has been a reduction in the occurrence of fire associated with the settling of this area for agriculture, and this has reduced the ability of Wongan cactus to regenerate from seed.

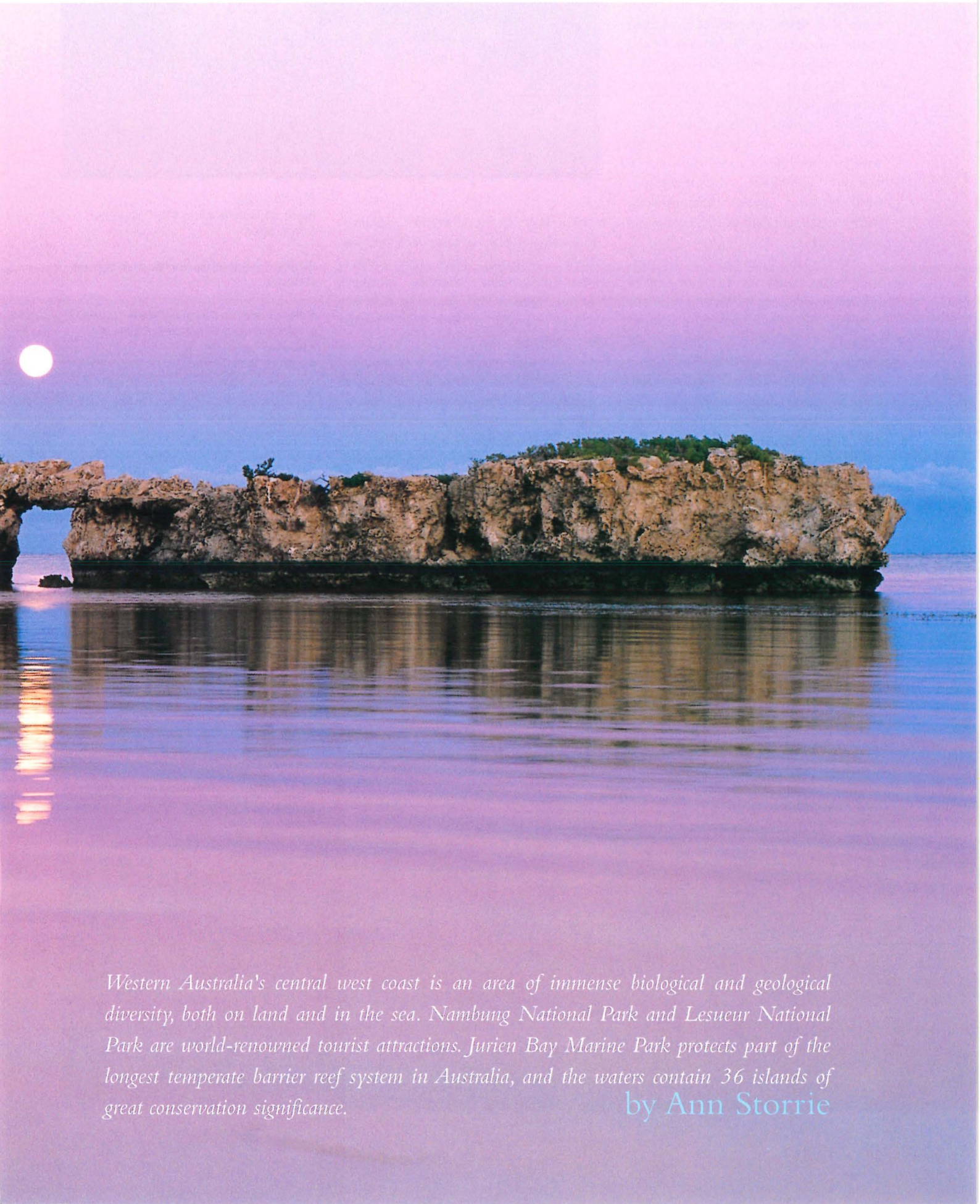
The species is known from 107 mature individuals in 14 populations. Fifty-six plants occur in a single population on a nature reserve managed by the Department of Conservation and Land Management (CALM), but the remaining 51 occur in 13 different populations, mainly located on narrow road and rail reserves. These narrow reserves are typically highly degraded, and plants are vulnerable to road and rail maintenance, and weeds. Because of the low number of plants and severe ongoing threats, Wongan cactus is ranked as critically endangered.

An interim recovery plan has been prepared for this species, and the Merredin District Threatened Flora Recovery Team is coordinating actions that address threats to the survival of the species. The Natural Heritage Trust has provided funds to undertake recovery actions, including attempts to stimulate germination, and translocation of plants into a nature reserve, ensuring security of land tenure and support for good land management.

Photos by Steve Hopper

the Turquoise Coast





Western Australia's central west coast is an area of immense biological and geological diversity, both on land and in the sea. Nambung National Park and Lesueur National Park are world-renowned tourist attractions. Jurien Bay Marine Park protects part of the longest temperate barrier reef system in Australia, and the waters contain 36 islands of great conservation significance.

by Ann Storrie

Previous page
Main Window Rock in the Turquoise Coast area.

Above A local jewel beetle on a *Kunzea* species.

Below A western grey kangaroo on the grasstree-studded slopes of Lesueur National Park.
Photos – Ann Storrie

Western Australia's central west coast is one of the most diverse wildflower areas in the world, with more than 2600 species of flowering plants—an amazing 30 per cent of the species found in the south-west. The low kwongan (a Nyoongar word meaning sandy country with open, scrubby vegetation) heathland bursts into flower in late winter and spring, with perennial herbs and shrubs such as acacias, grevilleas, bottlebrushes, smokebushes, peas, coneflowers, starflowers, leschenaultias, featherflowers and orchids.

Many plants grow only in the area, and some, such as Lesueur hakea (*Hakea megalosperma*), Mount Lesueur grevillea (*Grevillea batrachioides*) and star orchid (*Thelymitra stellata*), are threatened. It is likely that several more species will be declared rare, as more than 50 species found in this area are on the Department of Conservation and Land Management's (CALM's) Priority List for further survey to assess their need for declaration.

Orchids are abundant and include the spectacular northern Queen of Sheba (*Thelymitra variegata*), Cleopatra's needles (*Thelymitra apiculata*) and Arrowsmith spider orchid (*Caladenia crebra*). Red beaks (*Pyrorchis nigricans*) and several species of large leek orchids flower profusely after fire. Other beautiful spider orchids, donkey orchids, blue orchids and tiny, delicate midge, mignonette and shell orchids are common.

Although colourful flowers are most prolific in spring, the kwongan contains flowering plants and other features of interest all year round. WA Christmas trees (*Nuytsia floribunda*), woody pear trees (*Xylomelum angustifolium*) and many eucalypts and banksias flower at the height of summer. The small white flowers of quandong (*Santalum acuminatum*) are followed by bright red round fruits on pendulous stalks in summer. The edible fruits are a favourite food for emus, which play an important role in spreading the seeds.

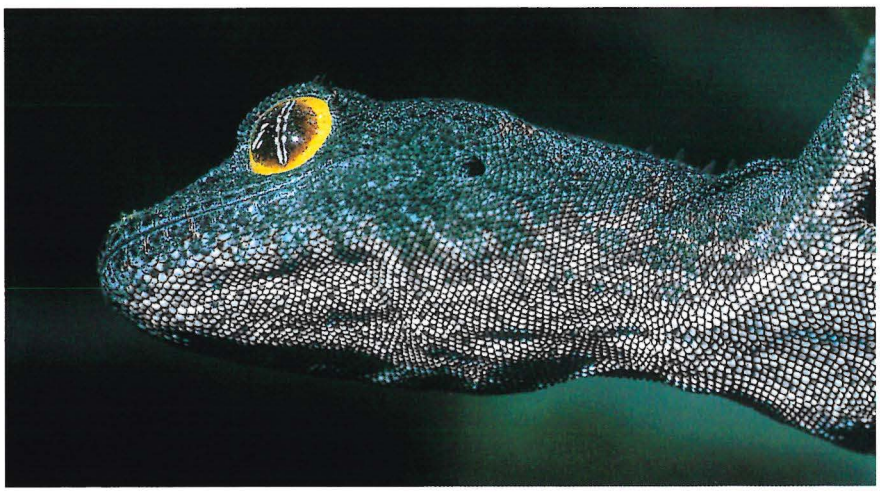
Nearly all plants of the kwongan have special adaptations that enable them to survive in the ancient, infertile

soils that are largely nutrient-poor and sandy. The various leaf forms help the plants to cope in the harsh environment by assisting in water conservation, more efficient nutrient production, and by deterring grazers. Many leaves are needle-like or have waxy outer cuticles that retard water loss, while others have their pores sunk below the surface. Some have spiky ends and unpalatable cuticles to keep grazers away, while one of the hakeas produces two kinds of leaves, one of which looks like a seed pod. Cockatoos tire of finding the few real pods among the many false lookalikes.

Many plants utilise bacteria or fungi that live among their root systems to take up nutrients. Some of these microorganisms convert nitrogen from the air into a usable fertiliser. Another method of obtaining nutrients is to steal them. The quandong and Christmas tree parasitise other plants through their roots.

Habitat and wildlife

Salt lakes, woodlands, mallee shrublands and swamps also provide important habitats for wildlife. Woodlands of several different types occur in sandy valleys and areas with heavier soils. Wandoo (*Eucalyptus wandoo*) and other tree species provide important habitat for cockatoos, including the endangered Carnaby's cockatoo (*Calyptorhynchus latirostris*) (see 'Recovering the rainbird', *LANDSCOPE*, Spring 2005). The birds use hollows that form in the older trees for nesting sites and feed on marri fruits, dryandra flowers and insects such as moth larvae that live in banksia cones. Jarrah (*Eucalyptus marginata*) grows in this region as a small mallee shrub, sometimes only a metre tall. It is at its extreme northern limit in the Lesueur area, with the next stand occurring more than 100 kilometres further south.



Right Spiny-tailed gecko.
Photo – Ann Storrie

Breakaway country is formed when the softer sides of a laterite-topped hill erode away. The remnant laterite breaks away from the edge in chunks and rolls down the hill, forming a scree, or boulder, slope. The additional water run-off from the rocks allows slightly taller shrubs to grow here. Many breakaways overlook the low undulating plains of this region, and provide good cover for many reptiles and small mammals, including echidnas.

The rough limestone country of the Turquoise Coast has produced many subterranean caverns. Many are deep, dangerous to negotiate and hold delicate cave formations. Hence, they are closed to the public. The Stockyard Gully Tunnel is a spectacular cave that can be negotiated with care. An excellent walk, around and through the tunnel, has been constructed for visitors. At least four species of bats

Top left Wandoo at Coomallo Nature Reserve.

Centre left Abundant melaleuca blossoms at Beekeepers Nature Reserve.

Left Stockyard Gully Tunnel is an accessible cave.
Photos – Ann Storrie

Above Firewood banksia (*Banksia menziesii*).
Photo – Sue Morrison

have been found in the region, and many swallows build their nests on the ledges at cave entrances.

Some remarkable wildlife is found in the region. East Beagle, North Fisherman and Buller islands are the only Australian sea-lion (*Neophoca cinerea*) breeding sites on the west coast of Australia, apart from some small colonies on the Houtman Abrolhos Islands. The endangered dibbler (*Parantechinus apicalis*) is now found on three islands in the area, having been introduced to the mouse-free Escape Island in Jurien Bay. The threatened Boullanger Island dunnart (*Sminthopsis griseoventer boullangerensis*) is known only from Boullanger Island in Jurien Bay and the threatened Lancelin Island skink (*Ctenotus lancelini*) is known only from the 7.6-hectare Lancelin Island.

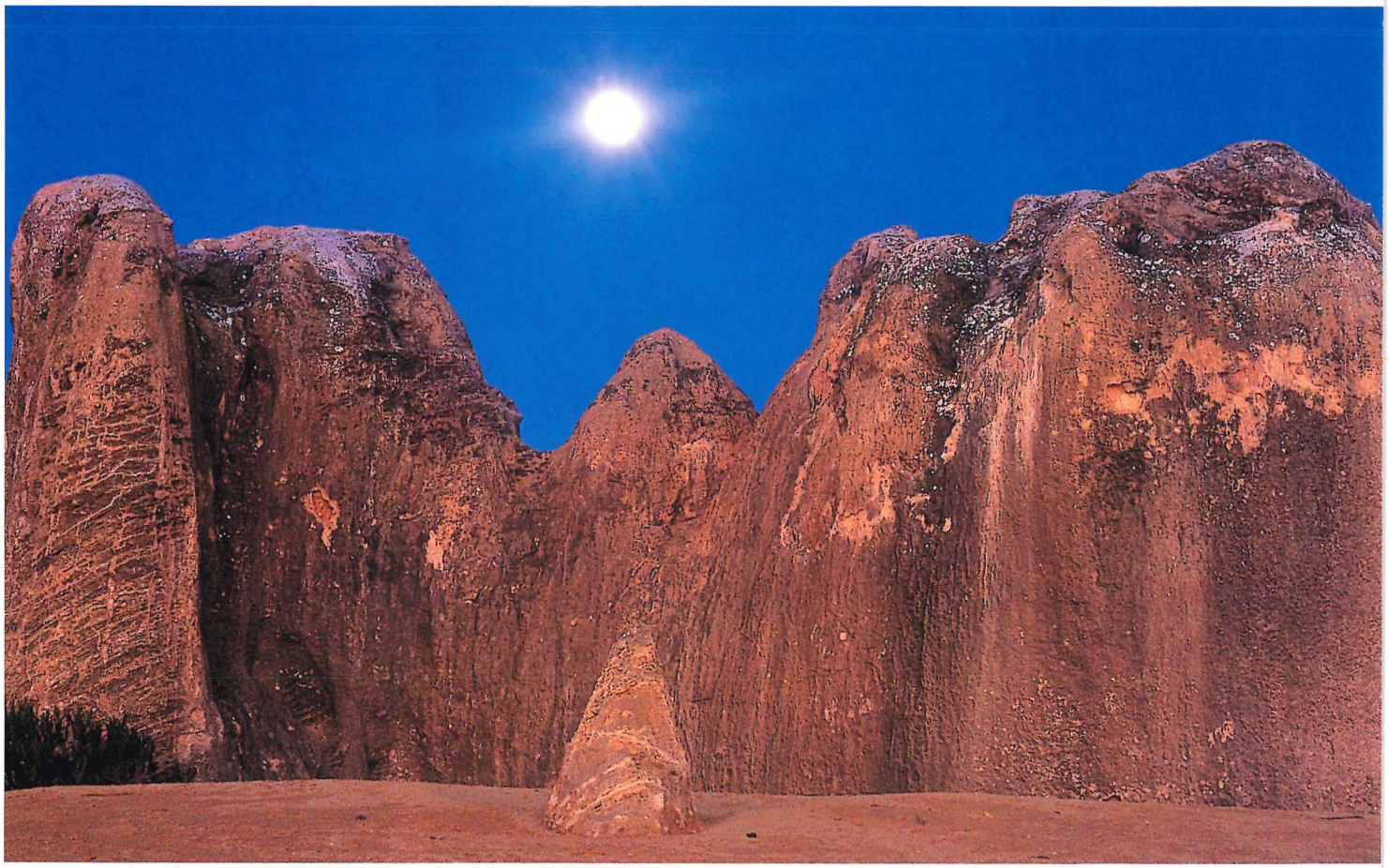
Pinnacle of scenery

One of the most scenic attractions in WA is the Pinnacles Desert in Nambung National Park. More than 200,000 visitors (many on day trips from Perth) view these amazing pillars of limestone every year. The pillars formed over thousands of years as a result of chemical, water and wind erosion, that left all but the most resilient limestone standing. Some pinnacles reach nearly four metres high and can be two to three metres wide at the base. They are sculpted into fantastic shapes and forms. Watching the sunset from the pinnacles, looking west to the ocean, can be spectacular, along with sunrises, full moons, thunderstorms and lightning flashing through the surreal forest of limestone.

The shifting yellow sands surrounding the pinnacles are fascinating in themselves. Photographers are drawn to the mobile dunes, and the shadows and windswept patterns that cascade down their steep leeward sides. These naturally mobile sand dunes can advance up to 10 metres a year, smothering vegetation in their path. They stabilise as plants recolonise the trailing dune slopes.

Right The Turquoise Coast is the only breeding site on the west coast of Australia for Australian sea-lions.

Below The Pinnacles in moonlight.
Photos – Ann Storrie



To obtain the most sweeping views of this area, climb Mount Lesueur. On a clear day, you can see west to the ocean while surrounded by the hills and valleys that make up the many different vegetation systems of Lesueur National Park.

Underwater wonders

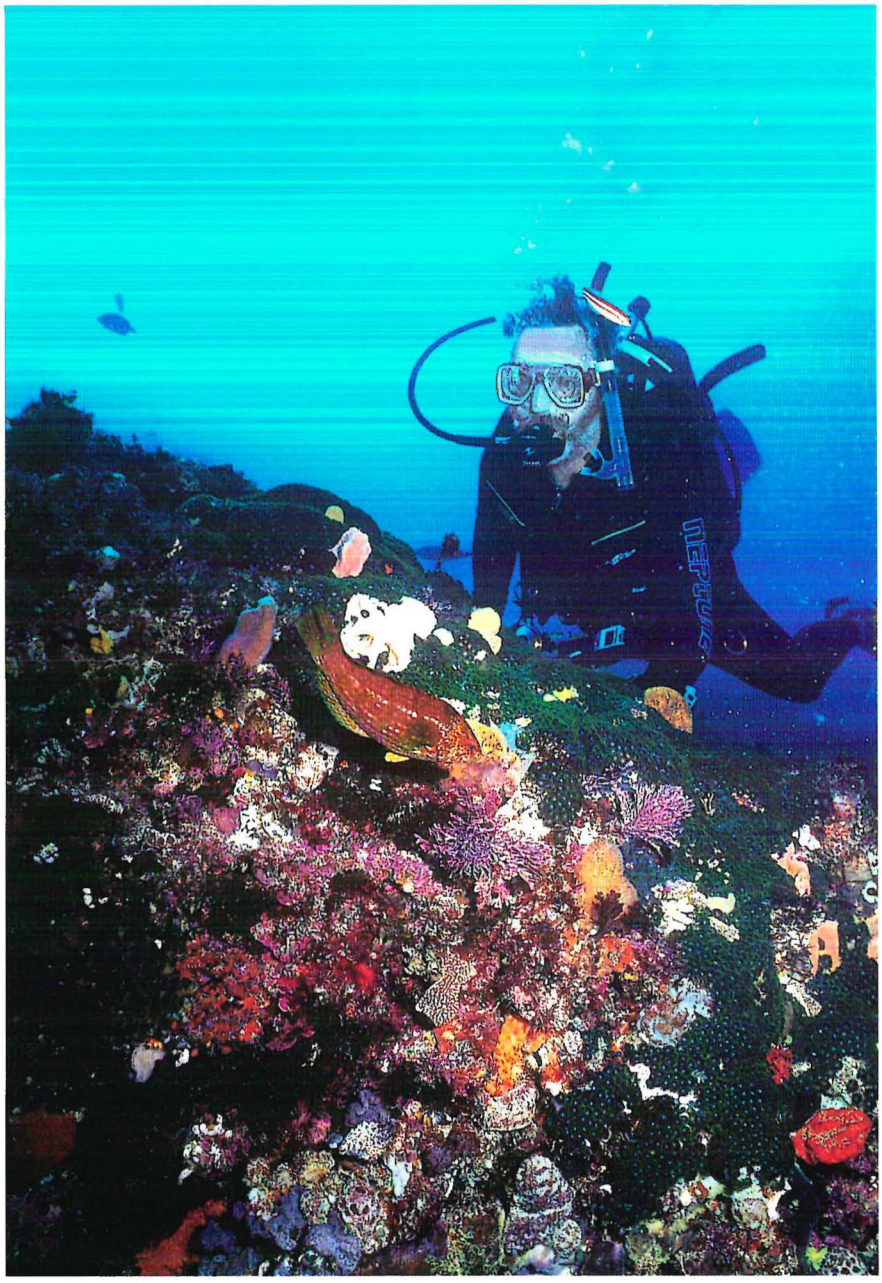
The coast between Wedge Island (north of Lancelin) and Green Head (north of Jurien) was declared a marine park in August 2003 (see 'Vision Spendid', *LANDSCOPE*, Spring 2003). The Jurien Bay Marine Park surrounds many offshore islands and protects limestone reefs, lagoons, seagrass meadows, and rocky and sandy shores.

Jurien Bay Marine Park has been described as a temperate version of Ningaloo Reef. Its extensive limestone reefs contain breathtaking caves, walls and overhangs. Colourful sedentary invertebrates such as sponges, hard and soft corals, hydroids, bryozoans and sea squirts densely cover the limestone walls and provide food and shelter for thousands of mobile invertebrates such as banded coral shrimp (*Stenopus hispidus*), crabs, cowries, nudibranchs, sea stars and urchins. Western rock lobsters or crayfish (*Panulirus cygnus*) crowd beneath crevices and overhangs, waving their long antennae to detect danger.

Species from warm, tropical northern waters and those more typical of cool, temperate waters of the south overlap in the park's biologically diverse marine environments, and the waters are relatively pristine. Divers can marvel at the presence of tropical fish such as red firefish (*Pterois volitans*) and Miller's damselfish (*Pomacentrus milleri*) living side by side with temperate water harlequin fish (*Othos dentex*) and western scalyfin (*Parma occidentalis*). Tropical sabretooth blennies (*Aspidontus dussumieri*) and blue-striped cardinalfish (*Apogon cyanosoma*) are at the most southerly limits of their distribution, while Jurien Bay Marine Park is at the northernmost limits of the range of temperate species such as queen snapper (*Nemadactylus valenciennesi*), moonlighters (*Vilodon sexfasciatum*) and King George whiting (*Sillaginodes punctatus*).

Primary producers

Rocky reefs make up around 33 per cent of the marine park. As well as the colourful invertebrates and fish life



Left Jurien Bay Marine Park is packed with spectacular marine life.

Below The beautiful Spanish dancer, one of the larger nudibranchs, swims by undulating its mantle.
Photos – Ann Storrie

Right At night, western rock lobsters emerge to feed amongst algae and seagrass.
Photo – Sue Morrison

Below right Common seadragon.
Photo – Ann Storrie

that congregate on the reefs, their solid surfaces are essential for the growth of many types of algae (seaweeds) that are, in turn, an essential part of the ecosystem. Preliminary results from current survey work indicate that there are at least 300 species of algae in Jurien Bay Marine Park, making it one of the more diverse areas for seaweeds in Western Australia. Algae produce energy by photosynthesis (they use energy from sunlight to convert carbon dioxide into food) and, in turn, provide energy for the many animals that eat them. Algae also provide huge surface areas and a wide variety of nooks and crannies in which animals can live and hide. Although often overlooked by divers, many algae are very colourful with unusual textures and shapes.

More than 25 per cent of the park contains seagrass meadows (see 'Microcosm in the ocean meadows' in this issue). At least 11 seagrass species occur here, some of which are at the northern and southern limits of their distribution. The seagrass beds provide important habitats and nursery areas for many marine species including important commercial fish species and western rock lobsters. Like algae, seagrasses are primary producers, supplying food at the bottom of the food web. Some animals such as spider crabs, swimmer crabs, garfish and leatherjackets graze directly on living seagrass, while a host of animals such as shrimps, amphipods, molluscs, sea stars, sea cucumbers and worms feed on decaying seagrass leaves.

Another important food source in the seagrass beds is the algae that grows on the seagrass. The seagrasses provide the only substantial site for the attachment of algae in sandy areas. These epiphytic algae are eaten by a huge range of invertebrates that attract many predators such as small fish, crabs and lobsters, which in turn attract larger predatory fish. Invertebrates such as sponges, anemones, corals, hydroids, bivalves and sea squirts also live in the seagrass beds.

Seagrass beds also stabilise sediments and shorelines with their root systems. They absorb dissolved nutrients and convert them into plant material. The filter-feeding invertebrates living in the seagrass meadows are estimated to be able to filter the overlying water at least once a day. As seagrasses are very susceptible to any decrease in water clarity, these invertebrates help the seagrasses survive, by reducing turbidity in the water.

Above Australian pelican near Milligan Island.
Photo – Ann Storrie

Below Variety of red algae and a yellow sea star (*Fromia polypora*).
Photo – Sue Morrison

Exceptional marine life

Bizarre and fascinating sea creatures found in the Jurien Bay Marine Park include weedy seadragons (*Phyllopteryx taeniolatus*) and leafy seadragons (*Phycodurus eques*), which shelter in the beds of kelp and seagrass. These amazing plankton-eating fish are camouflaged so perfectly among the waving fronds that they can disappear within the blink of an eye. Divers tempted to hold the dragons and take them to the surface to show fellow divers and snorkellers could rupture their delicate swim bladders. If you are lucky enough to find a dragon and cannot attract your buddies to it, savour the experience all for yourself.

If you dive anywhere within Jurien Bay, don't be surprised if you are being watched. Lying in the seagrass or on the sand just behind you may be an Australian sea-lion. These curious mammals delight in watching and playing with divers. Divers may be startled by a huge dark shadow zooming past, just metres in front of them. Sea-lions usually come back for a second look, and will often play in your bubbles and follow you around for part of the dive. Australian sea-lions—the rarest sea-lions in the world—are given special protection under WA's Wildlife Conservation Act. Although sea-lions rarely show aggression underwater, people have been bitten. If approached in the water, the Act states that you must maintain a distance of at least 10 metres from the animal. Don't try to follow or touch and never attempt to feed them. If a sea-lion becomes aggressive, it is best to leave the water.

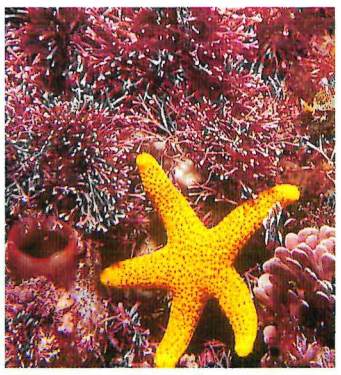
Park management

To protect this important marine environment, CALM has implemented a 10-year management plan developed by a community-based committee. This includes setting up areas for scientific monitoring of fish stocks and puerulus (the tiny, post-larval stage of the rock lobster), high-protection sanctuary zones, general purpose areas and aquaculture. Recreational and commercial fishing of fish species, abalone and rock lobsters are being monitored, along with ecotourism activities. Public education and participation activities, school programs and research programs are well under way.

Effective management of Jurien Bay Marine Park is vital to preserve its unique marine environments and ensure sustainability of our fisheries. It will depend largely on cooperation and participation from local communities and visitors. Management of the marine park can be undertaken in parallel with the adjacent land-based national parks of the Turquoise Coast, where research and ecotourism play a big part in education and general appreciation of our wonderful landscape, wildflowers and wildlife.

Ann Storrie, a freelance writer and photographer, has coauthored the CALM books *The Marine Life of Ningaloo Marine Park and Coral Bay*, *Wonders of Western Waters* and *Beneath Busselton Jetty*. She is a regular contributor to *LANDSCOPE* and can be contacted on (08) 9385 9355.

A forthcoming book, *The Turquoise Coast*, written and photographed by Sue Morrison, Ann Storrie and Peter Morrison, will be published by CALM in the near future as a guide to the wildflowers, wildlife, history, towns, sights and industry of this area.



Endangered or extinct?

Kalgoorlie's arid bronze azure

The attractive arid azure butterfly was discovered near Kalgoorlie in 1982, but has not been seen since 1993. Department of Conservation and Land Management (CALM) scientists are trying to establish whether it is endangered or extinct, and are appealing to the public for help.

by Andrew Williams
and Matthew Williams,
illustrations by Brad Durrant

There are 131 butterfly species and subspecies recorded from Western Australia, 51 of which belong to a family known collectively as the lycaenids or 'blues'. They are so-named because, in many species, the upper surface of the wings is a metallic blue or purple colour. Within the lycaenid family are the 'azures', a group of spectacular blue and purple butterflies endemic to Australia. Seven species of these are found in WA.

South-western Australia has relatively few butterfly species, and many of them are small, sombre in colour or restricted in distribution. However, several butterflies found in this region are of great scientific interest. The arid bronze azure (*Ogyris subterrestris petrina*) is one such species. This species was discovered by Professor Alan Graham in 1982 near Lake Douglas, where it occurred in a very restricted area of mixed mallee woodland, 12 kilometres south-west of Kalgoorlie.

At first, the butterfly was thought to be an unusual form of the widespread large bronze azure (*Ogyris idmo*) but, before long, Alan and others realised

that this was a new species. However, the insect was not described and officially named until 1999. During the process of naming this new species, museum collections around the world were searched to determine if any other specimens had been collected before. Only one was found, in the British Museum of Natural History. This had been collected by W Subiaco and was labelled 'S.W. Australia, Kalgoorlie District, 23 October 1911'. This demonstrated that the butterfly had been present in the area for more than 80 years.

The scientific name given to the butterfly was *Ogyris subterrestris petrina*. The genus *Ogyris* contains all the azures, and the specific name *subterrestris* alludes to the fact that the immature stages (caterpillars and pupae) spend all their time under the ground. The subspecific name *petrina* means 'small rock', on which the female butterflies often choose to lay their eggs. The other subspecies, *Ogyris subterrestris subterrestris*, is found in south-eastern and southern Australia, where it is currently known from four locations. The subspecies *petrina* is very distinct, and is known only from Lake Douglas near Kalgoorlie.

Sugary associates

An interesting feature of lycaenid butterflies is that the immature stages of many species have a close association, or symbiotic relationship, with ants. Both the ants and the butterflies derive benefit from the arrangement. The butterfly larvae are protected by the ants, which ward off parasitic wasps and potential predators such as spiders. The ants are rewarded with sugary nectar, produced by a specialised 'nectary organ' or 'honey gland' on the back of the larva. The degree of larvae-ant association varies considerably between different species. Some lycaenid butterfly larvae have only limited ant attendance, while for others it is extreme. This is certainly the case for the azure butterflies of WA, where the species have developed differing levels of ant dependence.

The seven species of azure butterfly in WA are: the satin azure (*Ogyris amaryllis*), silky azure (*Ogyris orocles*), northern purple azure (*Ogyris zosine*), southern purple azure (*Ogyris genoveva*), small bronze azure (*Ogyris otanes*), large

Previous page
Main A female arid bronze azure on the trunk of a mallee tree close to the entrance to a sugar ant nest.

Above Sugar ants drinking.
Photo – Jiri Lochman

Left Known habitat of the arid bronze azure, near Lake Douglas, Kalgoorlie.
Photo – Andrew Williams/CALM

Top The arid bronze azure as seen from above. The female is on the left and the male is on the right.

Above Underside of the arid bronze azure butterfly.
Photos – Andrew Williams

bronze azure (*Ogyris idmo*) and the arid bronze azure (*Ogyris subterrestris*).

The larvae of the satin, silky, northern purple and southern purple azures all feed on foliage and flowers of stem parasitic mistletoes. The larvae of the small bronze azure feed at night on foliage and flowers of the root parasitic plants: common sour bush (*Choretrum glomeratum*) and Preiss's leptomeria (*Leptomeria preissiana*). The larvae of all these butterflies are associated to a greater or lesser extent with sugar ants (*Camponotus* spp.).

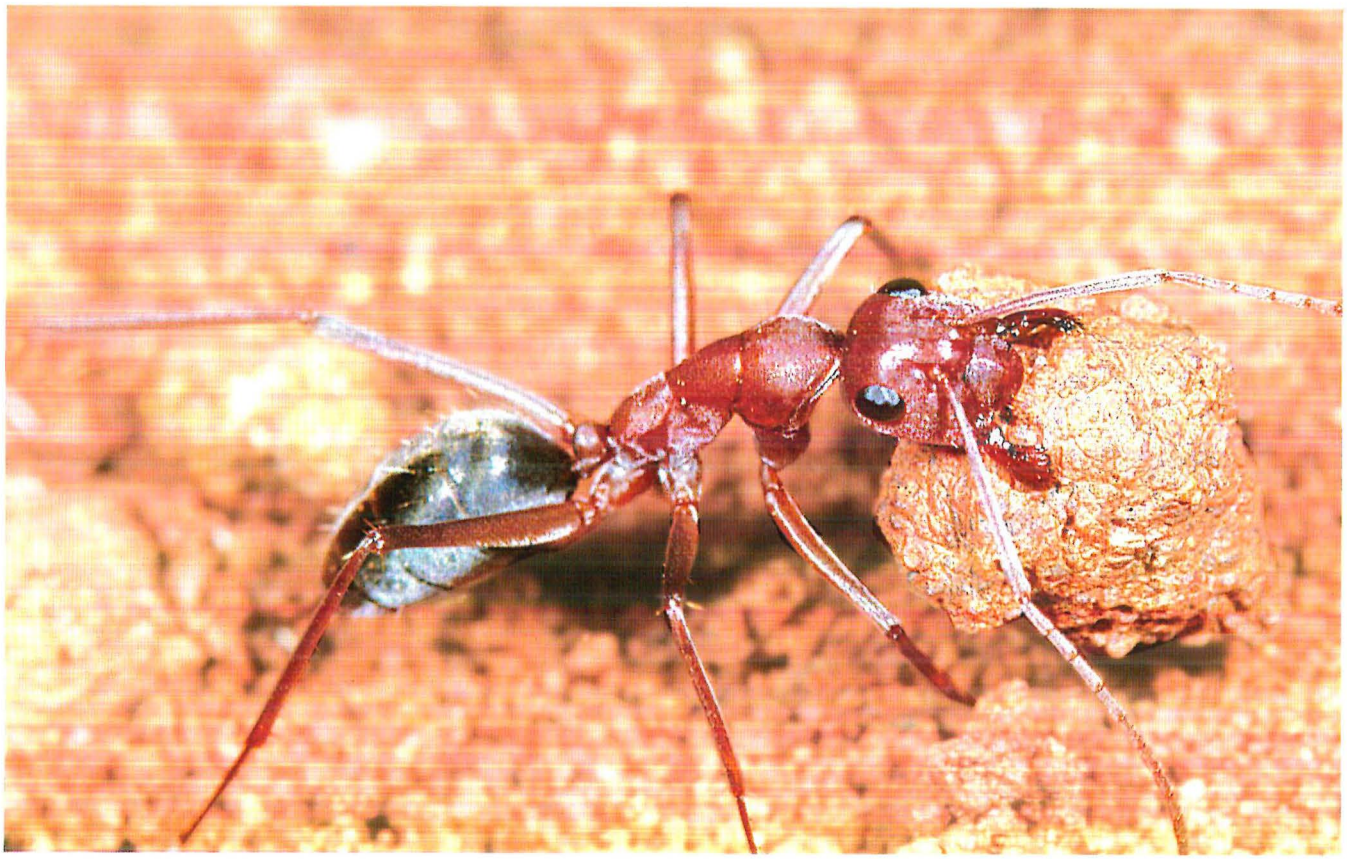
While the larvae of satin, silky, northern purple and southern purple azures are cryptically coloured, those of the small bronze azure are white, having lost the need for camouflage. This is because they reside during the day in the dark confines of an ant nest, and emerge only at night to feed on the *Choretrum* or *Leptomeria* food plant. Before dawn, the larvae return to the nest underground.

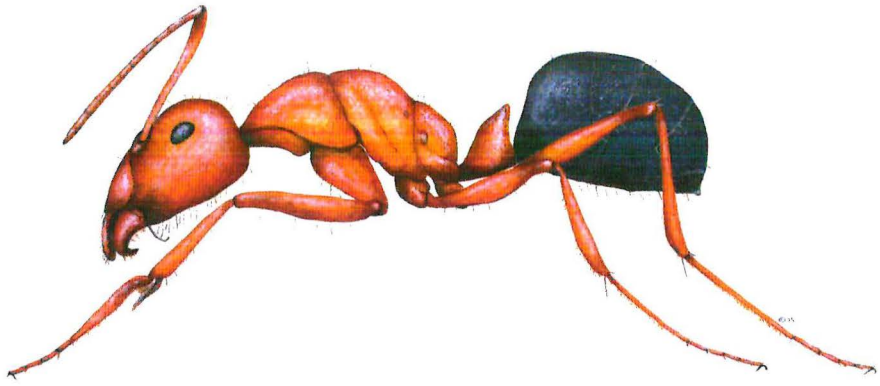
Ant nest cocoon

This evolutionary path has been taken a step further by the large bronze azure and the arid bronze azure. The larvae of both these butterflies no longer depend on plant foliage for nourishment. They do not feed on vegetation at all, spending their entire time inside sugar ant nests. They are believed to feed on the ant brood, or may be fed by the ants, just as the ants feed their own brood.

The larvae grow and develop, completing their life cycle underground, then pupate within the nest. When the butterfly finally emerges from the pupa, it makes its way to the nest entrance and clambers up the nearest shrub or tree trunk. Only then does it pump fluid into its soft, crumpled wing veins to make the wings expand. Within a few minutes, its wings will harden, enabling the insect to fly away.

The habitat of the arid bronze azure at Lake Douglas is a mallee-dominated woodland growing in undulating country on rocky soils. Several tracks and pathways intersect the site. Within this area, nests of the sugar ant





Above Sugar-ant worker moving a piece of rock.
Photo – Jiri Lochman

Left Host ant.

(*Camponotus* sp. *wiedekehri* group) are frequently found at the bases of the mallee eucalypts. These ant colonies are crucial to the survival of the arid bronze azure.

Adult life

The flight period for the adult butterflies is unusually long. They have been seen flying at Lake Douglas from September to May, with numbers usually peaking in mid-spring and late summer. The males are dark purple above and sometimes appear almost black in flight. They patrol pathways and tracks, usually flying close to the ground. They settle frequently with wings closed, the greyish-brown patterning on the underside of their wings perfectly matching the rocky ground. Males have also been seen hill-topping on low rises. The females, generally larger than the males, are purple above and have a small but distinct white patch on the forewing that is quite noticeable in flight. The male butterflies seek out the females to mate. Having mated, the female then seeks out a suitable sugar ant nest, where she will lay her eggs on a rock or on the trunk of a tree adjacent to the nest entrance. When the eggs hatch, the tiny larvae either walk down into the nest or are carried in by the ants.

Caged females will lay their eggs readily, but only between 11:45 am and 1 pm. During the heat of the day the predominantly nocturnal sugar ants tend to retreat further underground. The female butterflies are therefore better able to approach the entrance of the ant nests and lay their eggs undisturbed.

Crisis at Lake Douglas

The decline of the arid bronze azure at Lake Douglas has been well documented by Alan, who visited the site regularly between 1982 and 2001, except for a period between January 1990 and February 1992, when he was overseas in Java. In 1982, the butterflies were locally abundant, and remained very common until 1990. The population then crashed, and in 1992 and 1993 only two individuals were observed. The butterflies have not been seen since, despite careful searches

Above left Azure butterfly larvae with attendant ants.
Photo – Peter Marsack/Lochman Transparencies

Above Sugar ant workers and soldier ants at their nest entrance.
Photo – Jiri Lochman

being undertaken at Lake Douglas and around the Kalgoorlie area by Alan, the authors of this article and many other butterfly enthusiasts.

The Lake Douglas site has been subject to considerable disturbance. It is crossed by numerous tracks and suffers from use by off-road vehicles and motorcycles. The butterflies and the sugar ants may be particularly susceptible to this kind of disturbance. The plight of this rare butterfly was recently highlighted in the *Action Plan for Australian Butterflies*, which recommended that the butterfly be listed as critically endangered under the Federal Environment Protection and Biodiversity Conservation Act.

Formal listing has not yet been approved; so federal funding is not yet available to implement a recovery plan for the butterfly. In the meantime, the Department of Conservation and Land Management (CALM) has set up monitoring transects at the location where the butterflies were originally so abundant. Monitoring over spring, summer and autumn has so far failed to reveal any sign of the butterflies. Regular searches have also been conducted in the area for the sugar ants, without which the butterflies cannot survive. These ant colonies have declined enormously, and this may be linked to an apparent increase in the numbers of very aggressive meat ants (*Iridomyrmex purpureus*), which are known to invade and occupy disturbed areas.

So what's the way ahead? First, we need to find a population of the arid bronze azure. *LANDSCOPE* readers who are willing to look out for this elusive butterfly, are encouraged to be part of this search, and report any possible sightings to the authors, CALM researchers Andrew Williams or Matthew Williams.

Andrew Williams is a senior technical officer at CALM's Woodvale Research Centre. He can be contacted on (08) 9405 5117 or by email (andyw@calm.wa.gov.au).

Matthew Williams is a senior research scientist, based at CALM's Kensington Research Centre. He can be contacted on (08) 9334 0399 or by email (mattw@calm.wa.gov.au).

The illustrations for this article were done by CALM research scientist Brad Durrant, who can be contacted on (08) 9405 5148 or by email (bradd@calm.wa.gov.au).

A safe haven for threatened plants

Over the past few years, several of the south-west's most endangered plant species that normally inhabit the mountain tops of the Stirling Range National Park have found a new home just north of the Porongurup Range, near the southern coastal town of Albany.

by Anne Cochrane and Sarah Barrett

Southern Western Australia has a rich endemic flora that is highly threatened by habitat fragmentation, salinity and waterlogging, invasion by exotic pests and diseases, and climate change. The threats facing this floral diversity are increasing in type, severity and scale, demonstrated by the rising numbers of species threatened with extinction. In particular, dieback, which is caused by the pathogen *Phytophthora cinnamomi*, is a biological disaster that is wiping out many of the region's unique plants. Some species have suffered such dramatic declines in recent years and are so threatened in their natural habitat that they have been selected as candidates for a special recovery program. This recovery program includes the collection of seed for *ex situ* conservation, the use of vegetative propagation to create new living plants and the establishment of a seed orchard. Although *in situ* conservation of wild plants is considered the most essential component of a conservation program, it is sometimes not possible to adequately conserve natural communities jeopardised by high impact threats such as encroaching disease. Many populations of threatened species require management intervention to prevent further declines. This is the story of one such intervention.

Mountain dryandra (*Dryandra montana*) and small-flowered snottygobble (*Persoonia micranthera*), both members of the banksia family, and Stirling Range beard-heath (*Leucopogon gnaphalioides*) from the heath family are found only in the Stirling Range National Park, on some of the highest peaks of the range. This region is one of the biodiversity hotspots of the world, and the national park supports some 1500 plant species, many of which are known from nowhere else in the world. All three species have been listed as critically endangered since the mid to late 1990s. Mountain dryandra, small-flowered snottygobble and Stirling Range beard-heath are highly susceptible to the effects of dieback. The three species are also vulnerable to short fire intervals due to long juvenile periods, and fires in both 1991 and 2000 contributed to their decline. Grazing by introduced rabbits and native quokkas has also adversely affected seedlings that regenerated after the 2000 fire. By late 2005, less than 50 mature plants of the mountain dryandra and only a few hundred plants of each of the small-flowered snottygobble and Stirling Range beard-heath remained in their natural habitat. Given their current status, the long-term prognosis for these plants in the wild is poor. Application of the fungicide Phosphite® is an effective short- to mid-term strategy for halting the advance of the killer disease, but establishment of new plants in a *Phytophthora*-free site is considered crucial to the long-term viability and recovery of all species.

Searching for land

'Critical habitat' for species is often as limiting as the biology of the species itself, and no sites suitable for translocation within the historical distribution of the species were found, due to the extent of disease infestation on the peaks of the Stirling Range. The site selected was therefore a

Previous page
Main Stirling Range National Park viewed from Toolbrunup Peak.
Photo – Marie Lochman

Top Mountain dryandra.
Photo – Sarah Barrett

Left Grazing by rabbits and some native animals, including quokkas, may threaten some plant species in Stirling Range National Park.
Photo – Jiri Lochman

Above Mountain dryandra growing in Stirling Range National Park.
Photo – Greg Freebury

Above right Small-flowered snottygobble ready for planting.

Right Planting the first mountain dryandra seedlings in the seed orchard in 2003.
Photos – Anne Cochrane

considerable distance from the natural populations, in an area considered 'safe' from disease. Several choices were available but, eventually, a remnant patch of revegetated bushland was selected on private property just north of Porongurup National Park. The site had well-drained gravelly loam soils, on a gentle north-facing slope, that were considered ideal for the seed orchard. Healthy adjacent vegetation should provide habitat for a range of pollinators as well as wind protection and some shade. In addition, the owner of the property has had extensive experience in restoration ecology and has been involved in seed collection and seed orcharding for many years. The landowner's presence on site would also allow for early detection and action if a wildfire was to threaten the new plants. The kind donation of the use of a portion of land for the threatened species seed orchard was gratefully accepted, with all parties recognising the benefits of such a partnership acting as an interim measure to prevent extinction of these three species.

Ex situ conservation of the mountain dryandra is currently limited to a small collection of less than 800 seeds in the Department of Conservation and Land Management's (CALM's) Threatened Flora Seed Centre, collected over the past decade. The aim of seed collection is to preserve the wild populations and, at the same time, represent them genetically. As the frequency and intensity of harvest can impact on wild population survival, a limited amount of seeds were taken on each visit. Low seed numbers, no success with tissue culture and very limited success with propagation of cuttings meant that only a few mountain dryandra plants could be placed in the seed orchard in the first year. The initial planting in 2003 therefore consisted of only 14 seedlings. More seeds were collected and germinated the following year and, in 2004, a further 90 mountain dryandra plants were added to the seed orchard. Unfortunately, no seeds had been collected from either the small-flowered snottygobble or the Stirling Range beard-heath, despite a number of attempts. Challenges in collecting seeds from these species included few reproductively mature plants, low seed production, grazing by vertebrates and invertebrates, abortion of flowers and fruit, and difficulty in accessing populations. The solution was to create plants using vegetative propagation techniques. Cuttings were collected from a range of different plants in 2003 and 2004 and given to the Botanic Garden and Parks Authority nursery staff for propagation. By 2005, approximately 100 plants from each of the small-flowered snottygobble and the Stirling Range beard-heath were available for planting.

Top left Stirling Range beard-heath.
Photo – Sarah Barrett

Above left Small-flowered snottygobble.
Photo – Ellen Hickman

Above Assistant conservation officer Renee Hartley plants a mountain dryandra seedling.
Photo – Sarah Barrett

Community involvement in planting

At the seed orchard site, the owner prepared the ground by deep-ripping the soil and preparing firebreaks. On the planting days, community volunteers and CALM staff, including translocation expert Leonie Monks, planted the seedlings and placed small cages of rabbit netting around each plant to prevent possible grazing by large herbivores. Each new plant was identified by a metal tag and some vital measurements were taken so that the progress of the plant's growth could be monitored in the future. Those involved in the planting days included members of the Albany Rare Flora Recovery Team (RFRT), which is coordinated by CALM Conservation Officer Sarah Barrett. The team meets twice yearly to ensure that recovery actions for threatened flora are in place that aim to conserve the region's unique floral diversity.

The initial plantings survived well over the summer of 2003–2004 with a small amount of hand watering proving the merits of good site selection. The landowner regularly monitors the progress of the plants and keeps CALM staff advised about their condition.

After a hot dry start to the 2004–2005 summer, it was decided to install irrigation at the site to facilitate watering on a fortnightly basis while avoiding watering in the heat of the day. Heavy invertebrate grazing by weevils, locusts and various caterpillar larvae also occurred in January 2005, and prompted the removal of invertebrates by hand. While the use of pesticides was considered, the plants weathered the insect infestation and, following record rains in April, produced healthy new growth to compensate for any defoliation. Fortunately, there have been no weed problems at the site due to the healthy nature of the remnant.

Despite drought, grazing and floods, there was a continued high survival rate after the second summer, and it appears that mountain dryandra can cope well under warmer and drier lowland conditions. The number of mountain dryandra plants in the seed orchard now represents a doubling of the known wild population. It remains to be seen how the other two species fare over the next year.

Ex situ cultivation of mountain dryandra, small-flowered snottygobble and Stirling Range beard-heath in a seed orchard should give us opportunities to maximise seed production and provide material for research into vegetative propagation, relieving pressure from the wild populations. Material from the seed orchard will be used in the future for research aimed at better understanding the unique and diverse flora of WA. With more material available, it is possible that research may be able to detect some resistance to dieback within populations of these species and develop this for future restocking of existing populations or reintroductions to the wild.

Right 'Caging' seedlings protects them from possible grazing.

Below right A caged mountain dryandra at the seed orchard.
Photos – Anne Cochrane

The site will be intensively managed, allowing for necessary research into reproductive biology, and may even involve pollination experiments to maximise seed production. Translocated populations will be monitored in conjunction with of the original populations to provide essential baseline data for assessing the performance of the new populations. This will include data on survival and growth, reproductive information, as well as general health of the plants. Strict dieback hygiene protocols are in place to ensure that the soil-borne pathogen *Phytophthora* is not introduced to the site. Access is restricted to dry soil conditions and foot baths containing methylated spirits are used on the property boundary to ensure that infected soil containing the pathogen spores is not inadvertently carried in on footwear. Fortunately, vehicle access is not required and this also decreases the risk of soil transfer. Monitoring visits will be kept to a minimum to further reduce the risk of spreading the disease.

A number of other Stirling Range plants are in a similar predicament to those discussed here, and it is likely that more critically endangered species will be introduced to the seed orchard site. An additional *ex situ* site will also be considered for the future and would provide even more security for these species.

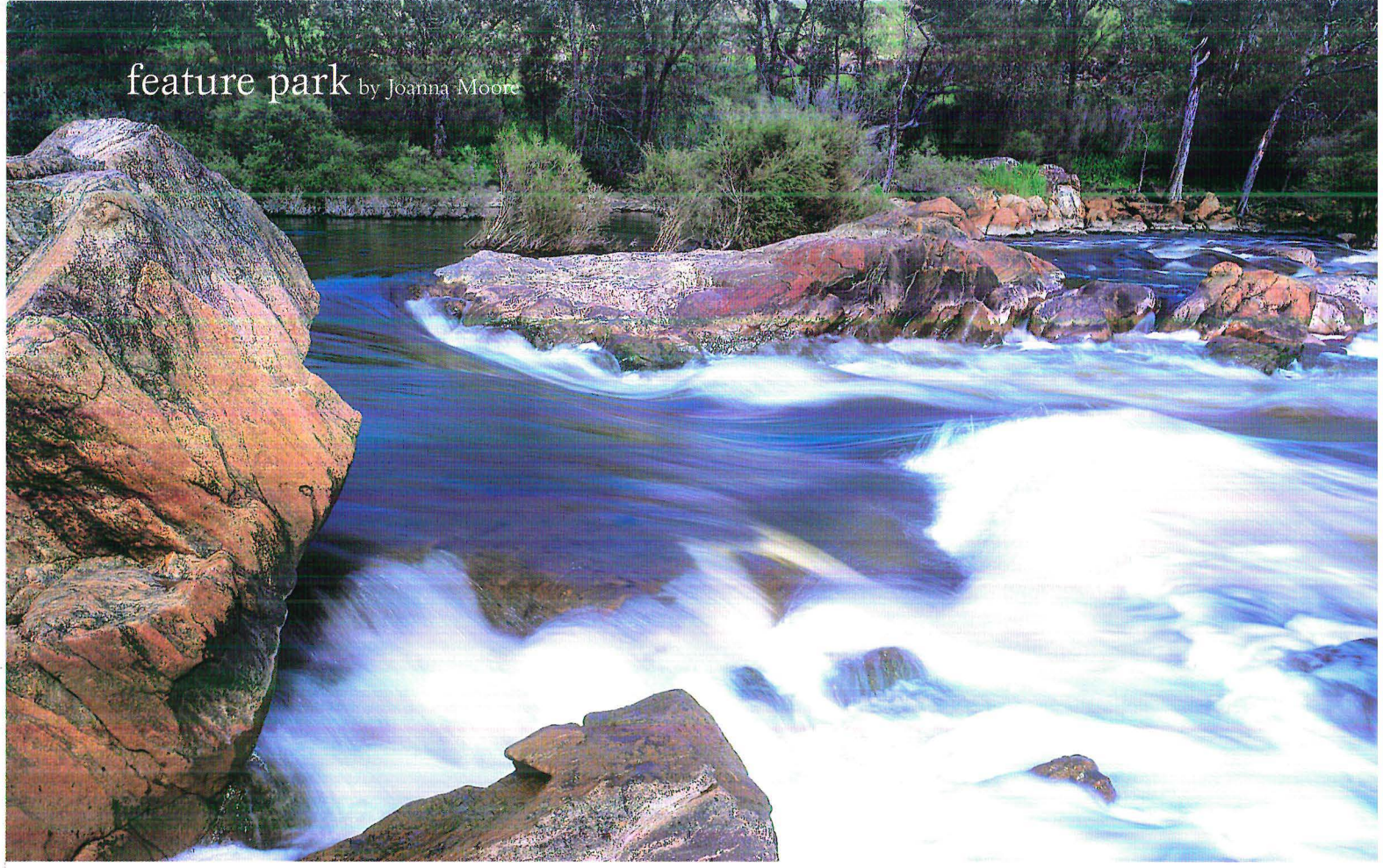
Only time will tell

The growing significance of *ex situ* conservation to the recovery of plant species in southern WA is evident. Thinking laterally and considering a range of options for recovery should ensure species survival. The collection and conservation of seed supplies over time has allowed us to begin to understand our species, site and resource limitations and make alternative interim decisions (such as the need for vegetative propagation to create new plants) that give us a positive outcome. In essence, we have bought time. Only time will tell whether these mountain species will reproduce successfully in their new lowland home and provide the valuable sought-after seed. We anticipate that these young plants will flower much sooner than on the mountain tops. In their mountain homes, first flowering only begins some 10 years after fire for the mountain dryandra and the small-flowered snottygobble, due to the harsh environmental conditions they experience.

In May this year, the Albany RFRT met on site to assess the progress of the seed orchard plantings and to plan for future actions that can ensure the survival of these and other plant species in the wild. Community involvement in these types of conservation activities is vital, with dedicated volunteers helping to drive important conservation actions. Our *ex situ* efforts and our growing awareness of the issues faced should make a critical difference between extinction and survival for these three unique WA species.

Anne Cochrane is a senior research scientist based in Albany. She manages CALM's Threatened Flora Seed Centre and can be contacted on (08) 9892 8444 or by email (annec@calm.wa.gov.au).

Sarah Barrett is CALM's Threatened Flora Officer and is also based in Albany. She can be contacted on (08) 9842 4521 or by email (sarahba@calm.wa.gov.au).



Walyunga National Park

Walyunga National Park is just a short drive from Perth, provides a picturesque bushland setting and is immensely important to local Indigenous people.

Above The Swan River flows through Walyunga National Park.
Photo – David Bettini

Facing page
Top Sacred kingfisher.
Photo – Hans and Judy Beste/Lochman Transparencies
Far right Bushwalkers on the Syds Rapids walktrail.
Photo – Jay Sarson/Lochman Transparencies

Less than an hour's drive north-east of Perth, just behind the Darling Scarp, awaits the bushland of Walyunga National Park. The nearly 1800-hectare park covers both sides of a steep valley through which the Swan River flows, just after its formation from the convergence of the Avon and Brockman rivers.

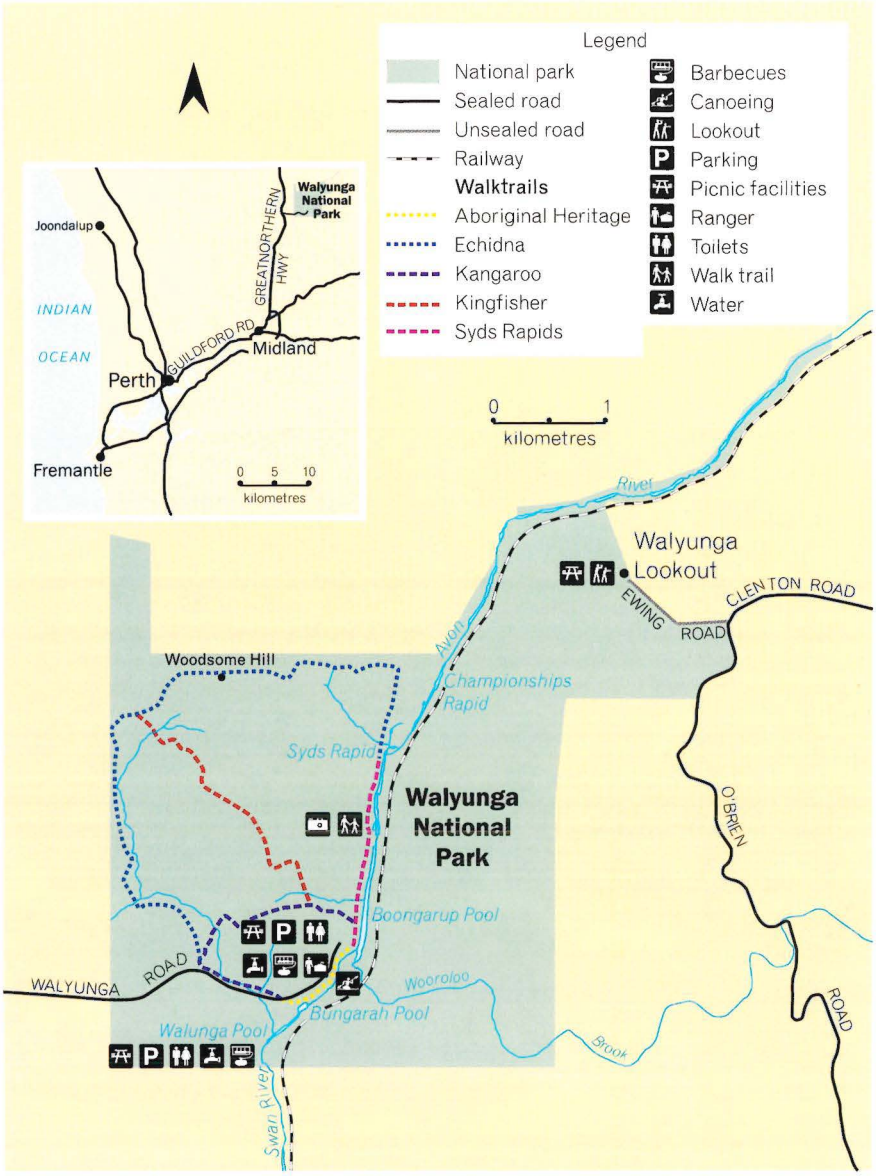
The river flows down the valley—as calm pools during summer and torrential rapids during winter—making a deep dissection that creates picturesque landforms throughout Walyunga National Park. Grey granite and darker dolerite can be seen along these valley sides, while red laterite tops the hills.

The natural values of the park are particularly obvious in spring, when delightful and abundant wildflowers blossom from the mosaic of granite outcrops, woodlands and heaths. At least 12 orchid species can be found within the park and extensive heath communities are particularly well developed along the scarp edge.

A significant cultural site

Walyunga National Park contains the largest known Aboriginal heritage site within 80 kilometres of Perth. This former campsite and tool-making area by the side of Walyunga Pool is an important historical site and retains significant Indigenous cultural heritage value, particularly important because most other such sites near the city have been destroyed by urban and industrial development.

It is estimated that the area has been occupied intermittently for more than 6000 years; used as a common ground by several Aboriginal groups for meetings, settling disputes, initiations and ceremonies, and as a trail through the Darling Scarp. Here, plant food was abundant, tool-making supplies were accessible and the nearby water brought game such as grey kangaroos (marlerup) and goannas (karrda). Despite European settlement along the Swan River from 1829, it is estimated that Aboriginal use of the campsite and workshop area continued until the late 1800s.



Today, the site remains as a large sandy area, over which hundreds of partially made stone tools and scraps from the tool-making process are scattered. These artefacts include axes (kodjer), knives (tabba) and spear-heads (gidgie borigle). While visitors are permitted to visit the site, it is very important that these cultural artefacts are not removed or disturbed.

Walktrails

Visitors to Walyunga National Park can find out about Aboriginal culture by walking the 1200-metre return Aboriginal Heritage Trail along the bank of the river, linking Walyunga and Boogarup pools. This journey through traditional Aboriginal Dreaming explains how the original inhabitants used the river, landscape, plants and animals.

The four-kilometre Kangaroo Trail crosses granite outcrops that overlook the landscape and provide homes for the small animals, such as lizards and geckos. Flooded gums and wandoos shade the 5.2-kilometre return Syds Rapids walk that meanders along the grassy floodplain of the Swan River.

The two longer walktrails in the park are the 8.5-kilometre Kingfisher Trail, which leads walkers past dryandras, melaleucas, hakeas and banksias, and the more strenuous 10.6-kilometre Echidna Trail. But the effort is certainly worth it—this track across the marri, powderbark and jarrah wooded ridges provides spectacular panoramic views across the park, and particularly the Swan and Avon valleys.

Native animals

As the Echnida Trail's name suggests, echidnas are found in Walyunga National Park, particularly among wooded areas and rocky outcrops. Grey kangaroos still abound on the forested slopes, as do euros and brush wallabies. In 2004, officers from the Department of Conservation and Land Management (CALM) released tammars, woylies and rock-wallabies as part of a reintroduction program in the park (see 'Reviving the Avon Valley', *LANDSCOPE*, Spring 2004).

As well as a scenic delight, the river provides a home to long-necked tortoises and waterbirds, including sacred kingfishers, little black and little pied cormorants and black, grey teal and wood ducks, and the park is a haven for bush birds.

park facts

Where is it? 40 km north-east of Perth. Access is via Great Northern Highway and Walyunga Road.

Total area Almost 1800 hectares.

Naming 'Walyunga' is an Aboriginal name but its meaning is uncertain, possibly 'northern Nyoongar' or 'northern group'.

What to do Bushwalking, canoeing, picnicking, wildlife observation and photography.

Must see sights The wildflowers in spring. The Avon Descent each August.

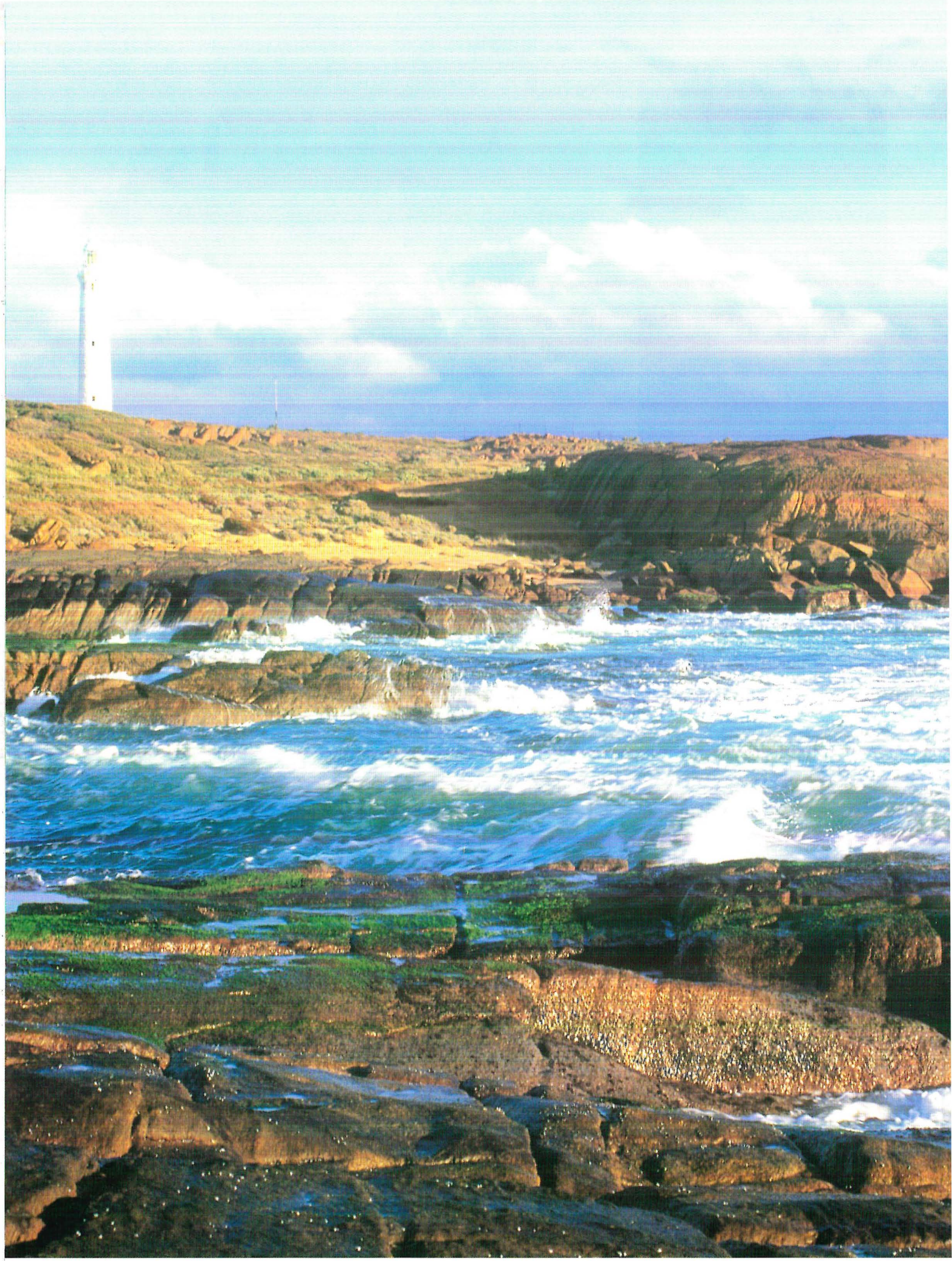
Facilities Picnic areas, barbecues, toilets, water.

Best seasons Spring and winter.

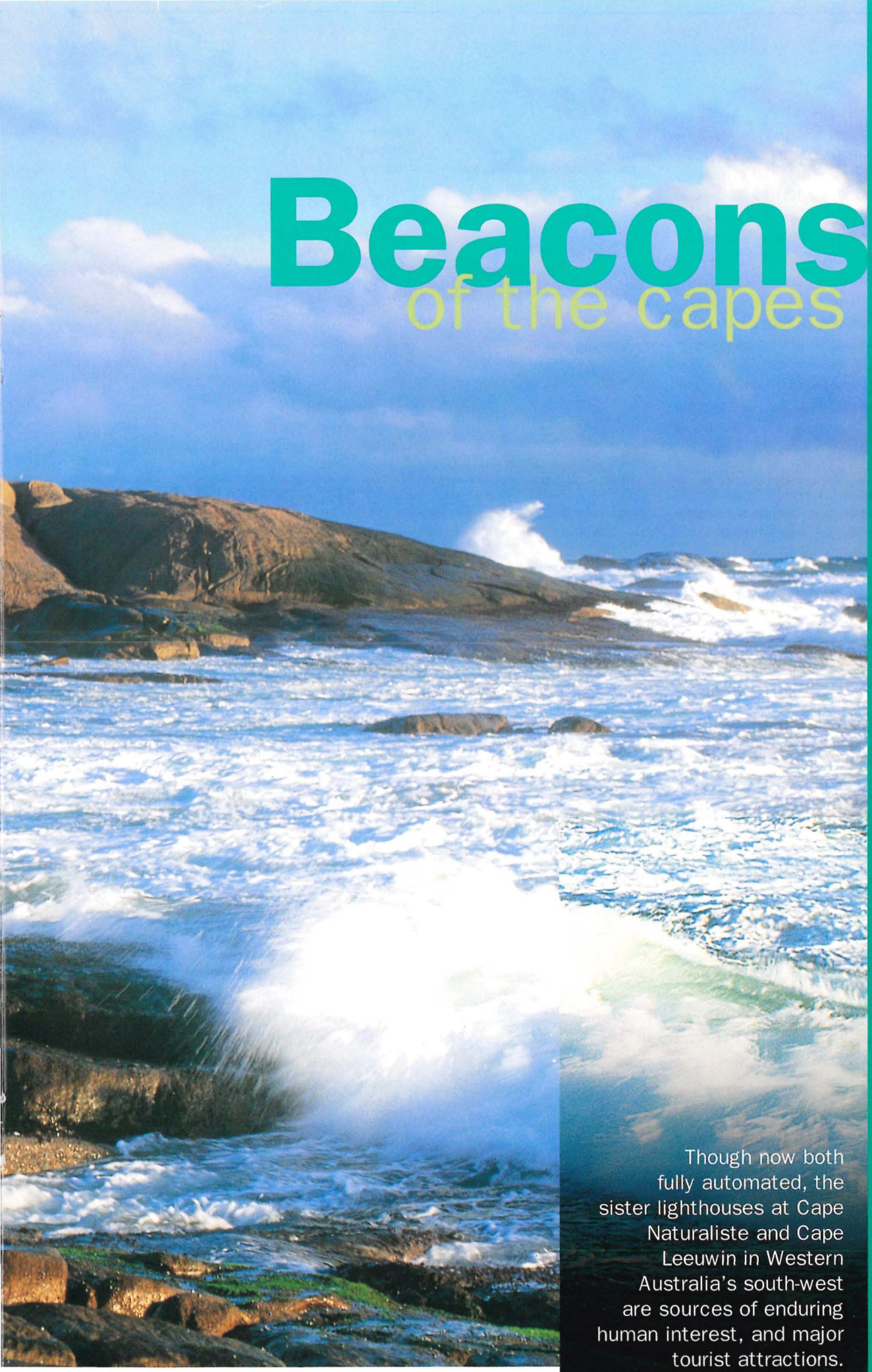
Park hours 8 am to 5 pm.

Information On-site ranger (08) 9571 1371.

Nearest CALM office Mundaring District Office, Weir Road, Mundaring (08) 9295 1117.

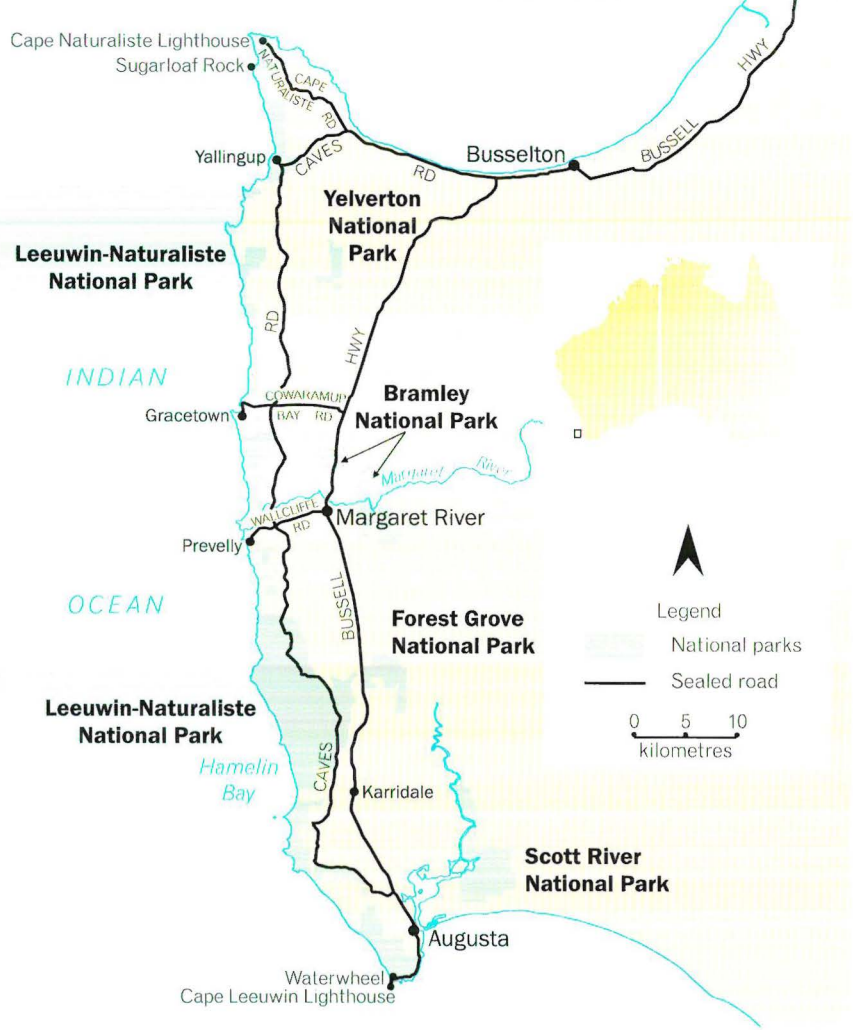


Beacons of the capes



Though now both fully automated, the sister lighthouses at Cape Naturaliste and Cape Leeuwin in Western Australia's south-west are sources of enduring human interest, and major tourist attractions.

by Joanna Moore



The Leeuwin-Naturaliste National Park covers nearly 20,000 hectares and stretches along 120 kilometres of coastline between Cape Leeuwin and Cape Naturaliste, which is known for its dramatic cliffs, sheltered bays and punishing swells.

These dangerous ocean swells, which pound treacherous reefs, led to the construction of lighthouses at either end of the Leeuwin-Naturaliste ridge more than 100 years ago. Today, they still operate as navigational aids, and are also signposts of achievement for the many walkers who take up the Cape to Cape challenge—to walk the 135-kilometre track that traces its way from lighthouse to lighthouse (see 'Cape to Cape', *LANDSCOPE*, Summer 2001–02).

Cape Naturaliste and Cape Leeuwin are located 260 and 320 kilometres from Perth respectively. The region between them is a heavily frequented tourist destination, rich in natural, cultural and historic features—magnificent caves and beaches, tall karri forests, award-winning wineries and restaurants, and historic sites such as the two lighthouses.

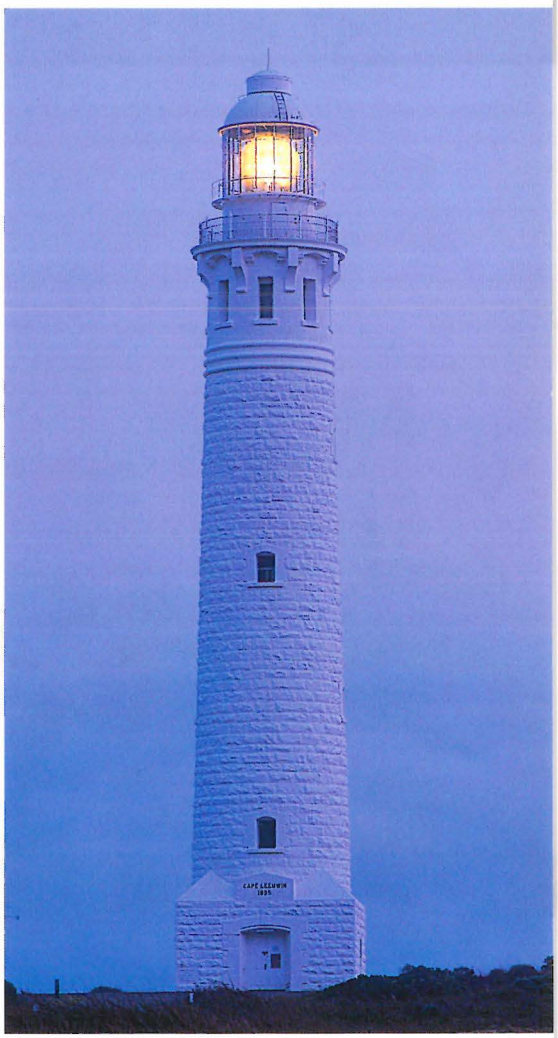
Two oceans touch

When you stand, windswept, at the top of Cape Leeuwin Lighthouse near Augusta you will probably gaze seaward, maybe trying to work out exactly where the Indian and Southern oceans meet. The 39-metre-high lighthouse, which provides you with such a magnificent view, was constructed on the most south-westerly tip of the Australian coast in 1896. Since then, it has safely guided many ships past the dangerous coastal point. Despite the lighthouse's presence, some 22 shipwrecks lie beneath the waters surrounding Cape Leeuwin. The *Pericles*, for example, sank in 1910 when passing Cape Leeuwin, though this wreck is not as famous as another White Star Liner—the *Titanic*—that came to grief in the Atlantic at the beginning of last century.

The Cape Naturaliste Lighthouse is the tallest lighthouse anywhere on the Australian mainland, and it still operates essentially as it did when it was designed and built 110 years ago. The identifying character of the Cape Leeuwin Lighthouse beam—one flash every seven-and-a-half seconds—is still important for those navigating their way from Perth to Albany or across the Indian Ocean. Though its illuminating apparatus and its designer, William T Douglass, came from England, the limestone from which the lighthouse was constructed was mined from nearby Quarry Bay. The tender for its construction was won by Australian company Davies and Wishart, whose contract also included one granite and two limestone cottages for the lighthouse keepers and the nearby waterwheel, at a total cost of £18,000.

Previous page
Main and inset Cape Leeuwin Lighthouse, Augusta.
Photo – Alex Bond

Left A bullock cart with wood passing one of the three lighthouse keeper's cottages at Cape Leeuwin.
Photo – courtesy of Very Much on Watch: The Percy Willmott Photos *and the Willmott family*



First of its kind

The Cape Leeuwin Lighthouse's magnification lens was originally turned by a clockwork mechanism. This mechanism operated by a counterweight that dropped through the centre pole of the tower and was rewound by the keeper every two hours. It seems unbelievable that this, or the tiny quarter-horsepower motor that has now replaced it, was enough to turn the nearly four-tonne lens. The lens floats on a 170-kilogram bath of mercury that virtually prevents all friction, heat and therefore wear on the rotating parts. It is an amazing and enduring design that was, in 1896, the first of its kind to be used in Australia.

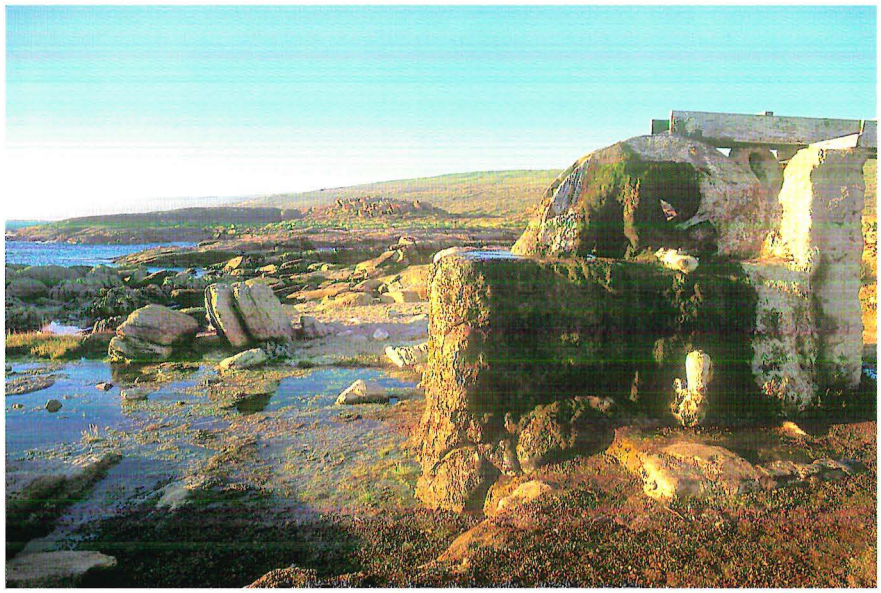
The light that emanates from the Cape Leeuwin Lighthouse—latitude 33°22' south, longitude 115°08' east—has a range of 26 nautical miles, which is about as far as one can see on a clear day from the top of the lighthouse. Partial automation occurred in 1982, when the kerosene burner was replaced with a 1000-watt halogen lamp running on mains electricity. In 1992—in comparatively recent times—the Cape Leeuwin Lighthouse became fully automated, enabling it to run without a keeper.

Leeuwin's first keeper, Percy Willmott, who served from 1896 to 1909, was a keen photographer. His hobby left us with insightful images of life at this time at the isolated post. His photograph collection and other historical information can be found in one of the former lighthouse keeper's cottages that has been converted into a visitor centre.

Top Cape Leeuwin Lighthouse.
Photo – Bill Belson/Lochman Transparencies

Above left A photo of the Cape Leeuwin Lighthouse keepers and their families taken by its first keeper, Percy Willmott, in 1903.
Photo – courtesy of Very Much on Watch: The Percy Willmott Photos *and the Willmott family*

Above Cape Leeuwin Lighthouse at dusk.
Photo – Alex Bond



Above left Part of the mechanism used to turn the Cape Leeuwin Lighthouse lens. *Photo – Bill Belson/Lochman Transparencies*

Above A timber channel carried water from a spring to a wheel (now calcified) that operated as a hydraulic ram to supply water used in the construction of the Cape Leeuwin Lighthouse. *Photo – Alex Bond*

Left Cape Naturaliste Lighthouse on the day of its opening on 21 April 1904. *Photo – courtesy of Cape Naturaliste Lighthouse*

Cast in stone

The historic waterwheel, only a short drive away, was built just before the Cape Leeuwin Lighthouse, to supply the water needed for its construction. Once the work was completed, the wheel continued to provide water to the keepers and their families.

The water for the now 109-year-old wheel came from a limewater spring above sea level. The water drawn from the spring was carried by a timber channel, or flume, to the wheel, which it turned, operating as a hydraulic ram pushing a supply of water towards the construction site. But as well as turning the wheel, the limewater, which is high in calcium carbonate, calcified the wheel and gradually prevented it from turning. It is now an ancient, petrified relic, a sign of times past and lifestyles long gone.

Even now, the lighthouse at Cape Leeuwin feels desolate and remote. So, for those living and working there at the beginning of the last century it would have been an isolating way of life. Even the keepers' cottages are surrounded on three sides by sea. The tour guides who work at the visitor centre marvel at the ever-changing mood of the place, and the accompanying winds that rarely seem to rest.

Contentious waters

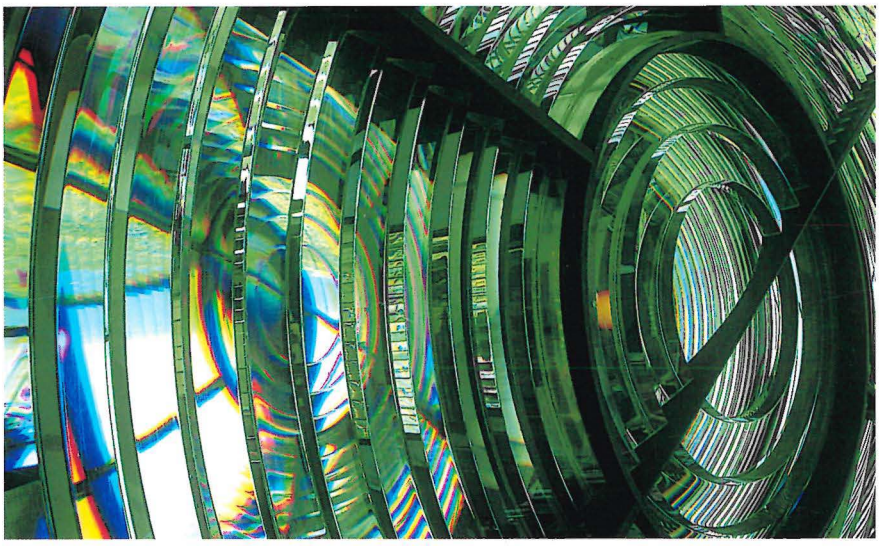
Well before the turn of the century, the necessity of a lighthouse further north at Cape Naturaliste was apparent, though disputes between the Commonwealth and State governments over funding delayed construction. The first Cape Naturaliste 'lighthouse'—a barrel and lantern on top of a pole—was certainly not enough.

Had the £4800 required for the real lighthouse's construction been supplied earlier, some of the 12 shipwrecks that occurred before its completion along the small but treacherous coastal point may have been prevented. When the State-funded building began in 1903, limestone was quarried from nearby Bunker Bay, and carted by bullock wagon to the site.

Because of the height of the headland on which it sits—the 100-metre-high bluff overlooking Geographe Bay and the coastal towns of Dunsborough and Busselton—the Cape Naturaliste Lighthouse is not as tall as its big sister at Cape Leeuwin, and stands at only 20 metres.

The lens and its turntable, which weighed more than 12 tonnes, were shipped to Quindalup Bay from England. They were valued at £5500 in 1903, equivalent to about $5 million today. In a similar system to that of the Cape Leeuwin Lighthouse, the nine-tonne, 4.6-metre-diameter prism crystal lens and turntable rest upon a pedestal filled with a mercury bath. The original mantle and magnification of Cape Naturaliste Lighthouse provided 755,000 candlepower (candela) that was upgraded in 1924 to 1.2 million candela, creating a warning light beam that, like Leeuwin, had a range of 26 nautical miles. Two flashes of this

Right Cape Naturaliste Lighthouse has become a popular tourist attraction.
Photo – Andrew Davoll/Lochman Transparencies



Below right Detail of the lens in Cape Naturaliste Lighthouse.
Photo – Jiri Lochman

light—emanating from latitude 33°32' south, longitude 115°02' east—are emitted every 10 seconds.

The light was fuelled with whale oil from 1904 to 1924, then by vapourised kerosene until mains electricity was connected in 1978. Burning kerosene fumes is dangerous over long periods of exposure, so the keepers each took a four-hour shift through the night, during which they maintained the kerosene pressure and rewound the 190-kilogram counterweight mechanism. Weather reports were sent to Perth by Morse code three times each day, the kerosene-residue-stained lens-glass had to be regularly cleaned and every four-gallon drum of kerosene had to be carried to the top of the tower. There was no paid annual leave or travel assistance. Often, the fortnightly delivery of supplies would bring the only visitor to the three families.

In 1996, the lighthouse on Cape Naturaliste became fully automated, losing its last keeper (the last lighthouse keeper in Western Australia).

Preserving history

All of the original stone structures of the Cape Naturaliste Lighthouse remain, a testimony to West Australian Engineer-in-Chief C S R Palmer's design and contractor Anderson's construction. Apart from the replacement of windows, the addition of safety measures and changes required to automate the lighthouse, all architectural aspects remain intact, and the lighthouse looks essentially the same as it did when it was first built. Even the interior fittings are in good condition, especially the dowelled teak blocks that form the lighthouse's steps, the only set of their kind in Australia.

One of the three keeper residences nearby, also built in 1903, has been made into a shop and maritime museum that is well worth exploring, for the Cape Naturaliste Lighthouse has its share of shipwreck and ghost stories to discover.

In 1907, the *Carnarvon Castle* caught fire while at sea, forcing its crew to abandon ship. The 14 passengers survived on lifeboats for 27 days until they reached Cape Naturaliste, where Patrick Baird, one of the lighthouse keepers, rescued and looked after them. You might also hear the story of the ghost of a young ship's apprentice who

Above Cape Naturaliste.
Photo – Geoff Taylor/Lochman Transparencies

Below left Stairwell at Cape Leeuwin Lighthouse.
Photo – Bill Belson/Lochman Transparencies

was rescued from a shipwreck only to die soon after—some say he now haunts one of the keeper's cottages, unable to rest peacefully because of his traumatic passing.

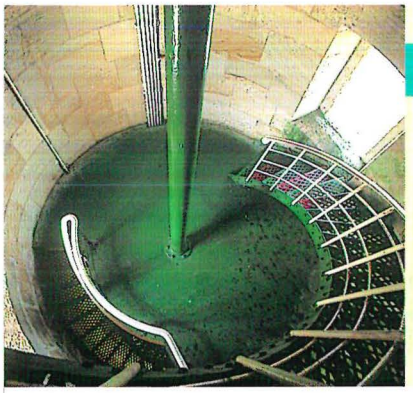
Responsibility for both the Cape Leeuwin and Cape Naturaliste lighthouses was recently transferred back to the State government. They have been vested with the Department of Conservation and Land Management (CALM) as heritage sites because they lie within the Leeuwin-Naturaliste National Park. The Augusta-Margaret River and Cape Naturaliste Tourism associations lease the light stations and have authority from CALM and the Australian Maritime Safety Association (AMSA) to run tours. AMSA continues to maintain and operate the lighthouses.

Popular destination

Climbing the Cape Leeuwin and Naturaliste lighthouses are among many recreational activities that draw more than a million visitors to the Leeuwin-Naturaliste National Park each year. Between the capes there are waters that offer fishing, diving, snorkelling, boating, swimming and surfing opportunities, beautiful beaches to walk along and caves and forests to explore (see 'The Capes Coast', *LANDSCOPE*, Summer 2002–03).

The fit and adventurous can walk the Cape to Cape Track from end to end, which usually takes five to eight days. It is challenging as a whole, with some difficult sections of extended beachwalking, but is dramatic and very rewarding. Many choose to walk short sections of the track, from a short stroll, to half a day or overnight. Walkers should watch for whales during their annual migratory period between late June and December. Last year, more than 900 whales were spotted from the balcony of the Cape Naturaliste Lighthouse, including occasional sightings of blue whales (see 'Not your typical whale tale', *LANDSCOPE*, Autumn 2005).

Though the track officially finishes at the waterwheel, 'end-to-enders' often walk on to touch Cape Leeuwin Lighthouse, and so complete the full journey, from lighthouse to lighthouse. Their experience of the region is vastly different to that of the old lighthouse keepers, but the landscape continues to provide an amazing backdrop to the human lives that come and go, merely flashing past, like transient lighthouse beams across an always-present ocean.



Discovering the lighthouses

Tours at Cape Naturaliste Lighthouse run half-hourly every day between 9.30 am and 4 pm, for $8 per adult and $4 per child, which includes entry to the maritime museum. For further information phone (08) 9755 3955.

The Cape Leeuwin Lighthouse precinct is open between 8.45 am and 5 pm, with tours running every half hour or 40 minutes. For further information phone Caveworks on (08) 9757 7411. Cost is $10 per adult and $5 per child.

Joanna Moore is a final-year Professional Writing and Presentation student at Curtin University of Technology who spent four months on work placement experience at *LANDSCOPE*. She can be contacted on (08) 9474 1017 or 0401 523 184 or by email (josyphine@hotmail.com).

The full collection of Percy Willmott's photographs can be seen in *Very Much on Watch*, available at the Cape Leeuwin Lighthouse Visitor Centre.

bookmarks by Verna Costello

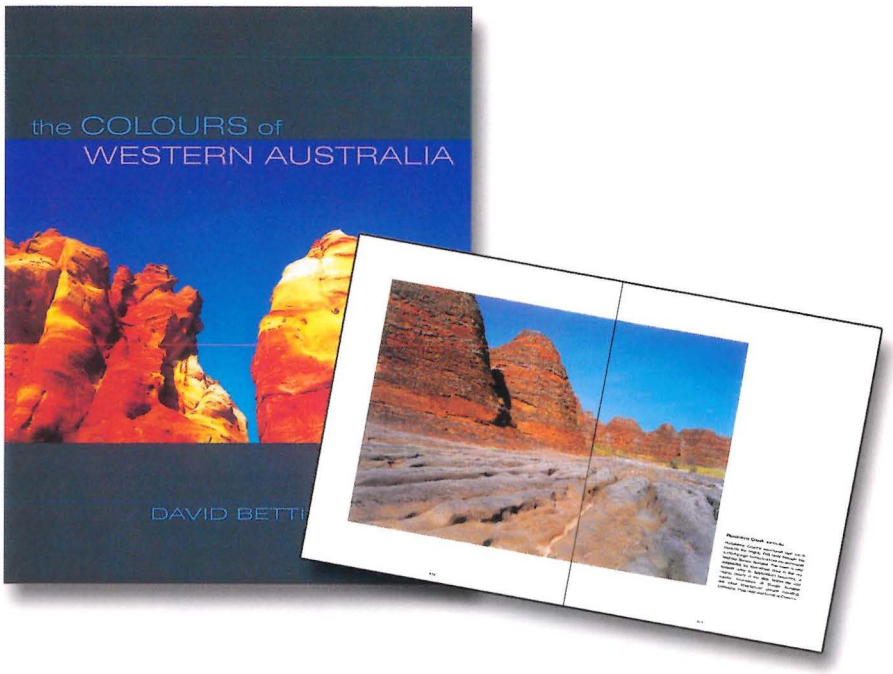
The Colours of Western Australia

Author: David Bettini
Publisher: Self-published
144 pages, hard cover, full colour
ISBN: 0-9579197-1-9
RRP: $60.00

What strikes the reader first is the exquisite quality of David Bettini's colour photography. What is even more astonishing is that it is the work of a self-taught photographer.

This book is balanced with succinctly descriptive information that renders it so much more than an attractive book for the coffee table.

Colours of Western Australia is available from most major bookshops or by phoning David Bettini on (08) 9387 3193.



Coral Reefs – Nature's Wonders

Author: Walter and Jean Deas
Publisher: Western Australian Museum
289 pages, soft cover, full colour
ISBN: 1 920843 18 3
RRP: $39.95

That coral reefs are in grave danger is borne out in a foreword to this important book by British conservationist Sir David Bellamy, who notes that: "43 per cent of the world's great reefs have been degraded through misuse and only one per cent are protected".

The aim of these multiple award-winning authors, photographers and natural history documentary producers is to arouse the reader's sense of wonder at these colourful 'underwater gardens', to encourage divers to move through them responsibly, and to lobby for the greater protection of coral reefs.

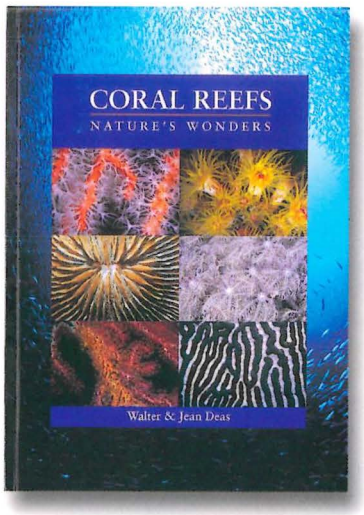
A measure of their experience and vast store of knowledge can be gleaned from the fact that their documentary *Where the Fish are Friendly*, narrated by Sir David Attenborough, attracted 14.9 million UK viewers.

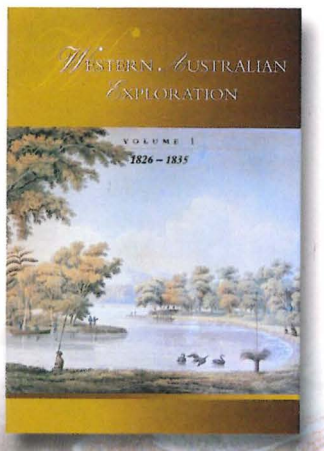
Western Australian Exploration

Volume 1 1826 – 1835
Principal Editor: Joanne Shoobert
Published by Hesperian Press
610 pages, hard cover
RRP: $96.00

Produced as part of the Western Australian Explorers' Diaries Project, this is the first in a planned series. Its production was supervised by an editorial committee of volunteer researchers, scholars and authors and stands as a reliable and well-authenticated historical record that is expected to become a much-valued addition to researchers' collections.

Part-funded by the Heritage Council of Western Australia, with the Department of Land Information (DOLA) in a supporting role, this volume features all known documents that describe expeditions of discovery in Western Australia during the period. These include diaries, private letters, journals, reports, newspaper articles, rare books and other relevant documents.





Australia's official floral emblem, the wattle, has been at the centre of a recent debate over the application of its scientific name: *Acacia*. The resulting decision, regarded as one of the most significant in several decades, will benefit both Australian and international botanical communities.

by Danielle Le Moignan

Acacia or Racosperma?
The great wattle debate

One of the most significant developments in botanical nomenclature in recent years occurred in July 2005 at the International Botanical Congress in Vienna. In a somewhat controversial decision, the congress voted to allow the Australian group of wattle species to keep its current scientific name, *Acacia*. The decision, based on the need to provide stability of naming, as well as logistical considerations, has avoided considerable scientific disruption and saved millions of dollars.

There are more than 1350 species of wattle recognised throughout the world, distributed through warm and temperate areas of the globe. *Acacia* is the second largest genus in the pea family. It is the largest genus of flowering plants in Australia and is an iconic national floral group. Of the 1350 or so species of wattle recognised, Australia is home to about 955, while the Americas host 185, Africa 144 and Asia 89. There are two main areas of richness for wattles in Australia: the arid inland region of south-west Western Australia and the tablelands associated with the Great Dividing Range in eastern Australia.

Wattle we call it?

Over the past few decades, it has become clear to scientists that most Australian wattle species are dissimilar in many ways from those found in Africa, Asia and the Americas. The results of recent molecular studies confirmed morphological evidence that a formal division of the genus *Acacia* into a number of separate genera needed to take place. This division would trigger the need for several new generic names, and result in considerable nomenclatural disruption. One of the most important questions relating to the issue was: to which group should the original name *Acacia* be applied?

Since 1986, considerable work has been undertaken to reassess the generic status of wattle. The previous system of classification recognised three subgroups: subgenus *Acacia*, subgenus *Aculeiferum* and subgenus *Phyllodineae* (the 'Australian group'). New research suggests that there should really be five subgroups rather than three.

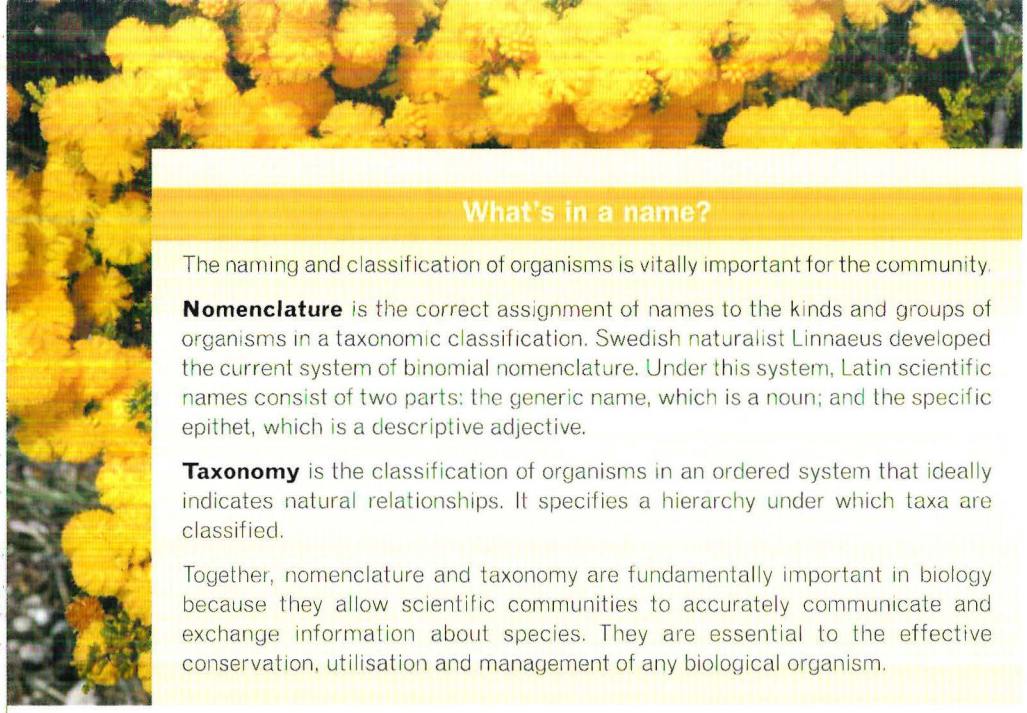
The rule of priority followed by the International Code of Botanical Nomenclature means that, under usual circumstances, in the event of a genus being split, the group containing the 'type species' retains the name of the genus. The 'type species' is usually one of the first species to be named in the genus and, in the case of *Acacia*, this has long been accepted as *A. nilotica*, which is a native of Africa and Asia. Thus, in the event of *Acacia* being split, and with *A. nilotica* regarded as the 'type species', the name *Acacia* would have to be applied to subgenus *Acacia*, which is one of the smallest groups with only 163 species, 13 per cent of the total genus.

Under this scenario, most of the Australian species would have to be given a new generic name, *Racosperma*. However, in circumstances that are regarded as exceptional, the International Code of Botanical Nomenclature allows for the 'type species' to be changed. These exceptional circumstances must be ones that are judged to be in the best interest of stability for the group concerned, and a formal process must be followed.

Left *Acacia multispicata.*
Photo – Marie Lochman

Above right Winged wattle (*Acacia alata*).
Photo – Jiri Lochman

Right Section voting on one of the many proposals.
Photo – courtesy of the XVII International Botanical Congress Organising Committee.



What's in a name?

The naming and classification of organisms is vitally important for the community.

Nomenclature is the correct assignment of names to the kinds and groups of organisms in a taxonomic classification. Swedish naturalist Linnaeus developed the current system of binomial nomenclature. Under this system, Latin scientific names consist of two parts: the generic name, which is a noun; and the specific epithet, which is a descriptive adjective.

Taxonomy is the classification of organisms in an ordered system that ideally indicates natural relationships. It specifies a hierarchy under which taxa are classified.

Together, nomenclature and taxonomy are fundamentally important in biology because they allow scientific communities to accurately communicate and exchange information about species. They are essential to the effective conservation, utilisation and management of any biological organism.

Left *Acacia lasiocarpa.*
Photo – Tom Chvojka

Below The official photo of the full complement of scientists attending the 2005 Nomenclature Section of the International Botanical Congress.
Photo – courtesy of the XVII International Botanical Congress Organising Committee.

Australia needs *Acacia*

In 2003, Bruce Maslin, Senior Principal Research Scientist with the Department of Conservation and Land Management (CALM), and Tony Orchard, from the Commonwealth Department of Environment and Heritage, put forward a proposal to change the 'type species' of *Acacia* from *A. nilotica* to *A. penninervis*, which occurs in the 'Australian group' of wattle. If accepted, this proposal would mean that species of the 'Australian group' would retain the name *Acacia* in the event of the genus being split. On a global scale, the Australian group (subgenus *Phyllodineae*) is the largest by far, with almost 1000 species. Applying the name *Acacia* to the largest group would result in the least amount of change, and would minimise nomenclatural disruption and uncertainty around the world. The alternative to this solution, recognising subgenus *Phyllodineae* as the genus *Racosperma*, would create a mass of work, which could cost the forestry and horticultural industries, community groups, botanical institutions and many others millions of dollars.

Alex Chapman, Research Scientist from CALM's Western Australian Herbarium represented the State at the XVII International Botanical Congress in Vienna. On 16 July 2005, the Nomenclature Section of the Congress, after considerable debate, voted to accept the proposal put forward by Tony Orchard and Bruce Maslin. This means that the name *Acacia* will be retained for almost 1000 species of Australian wattle.

While the decision was based on scientific, practical and logistical considerations, it is also significant in economic and historic contexts. Australian species of *Acacia* are grown in more than 70 countries and cover about two million hectares in plantations. A large international forestry industry utilises Australian wattles, producing large-scale commercial plantations for industrial timber, fibre and tannin, and smaller-scale plantations for fodder, soil conservation, human food, firewood and floriculture.

Wattles are also highly significant to Australia's cultural heritage, used symbolically on the Australian Coat of Arms, in the Australian Honours System and the official Australian national colours: green and gold. The golden wattle (*Acacia pycnantha*) is our official national floral emblem, and 1 September is celebrated as National Wattle Day.

The decision made at the International Botanical Congress has ensured that Australia's *Acacia*, internationally significant in scientific, economic and historic frameworks, continues to blossom.

Danielle Le Moignan completed professional placement with CALM's Strategic Development and Corporate Affairs division as part of a Communication and Cultural Studies degree at Curtin University of Technology.

She would like to thank the following CALM staff: Senior Principal Research Scientist Bruce Maslin and Research Scientist Alex Chapman, both from the Western Australian Herbarium, for their time and assistance.

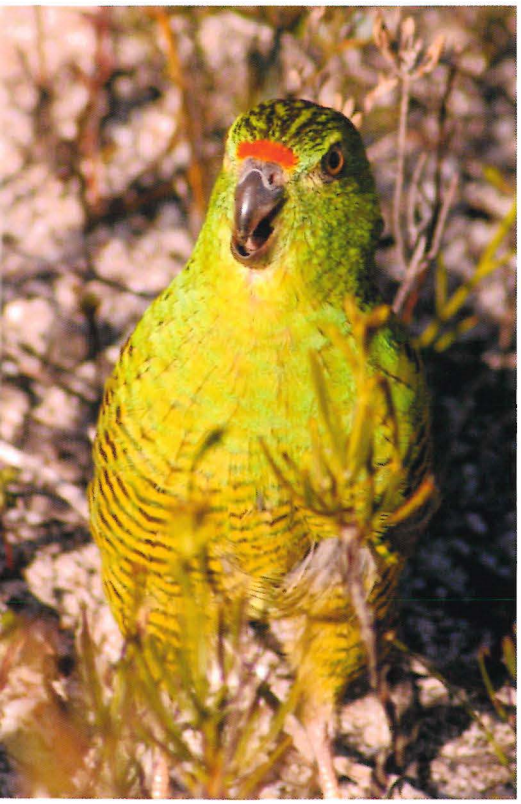
For more information on the *Acacia* name issue, visit www.worldwidewattle.com.

Wild with delight

by Brent Barrett

The lack of photographs of the western ground parrot has always hampered efforts to raise public awareness of this elusive, critically endangered bird, and to understand the plumage difference between the eastern and western subspecies. On 5 October 2005 this all changed.

Following two years of intensive research (see 'The secret life of the western ground parrot', *LANDSCOPE*, Spring 2005), the western ground parrot recovery project's knowledge curve was rising exponentially. We had collated and analysed the entire call repertoire of this subpopulation; retrieved more than 80 western ground parrot feathers from various abandoned nests belonging to other small birds; and made the first recordings of three new, previously-unknown calls. Two of these calls related directly to a nesting event; one was an adult calling a chick, and the other was made by the chick responding to the adult.



Despite these great advances, my last field season was drawing to a close and I was beginning to pack down our field-based operations for the last time, feeling disheartened by the fact that we had not actually located a western ground parrot nest. Then it happened.

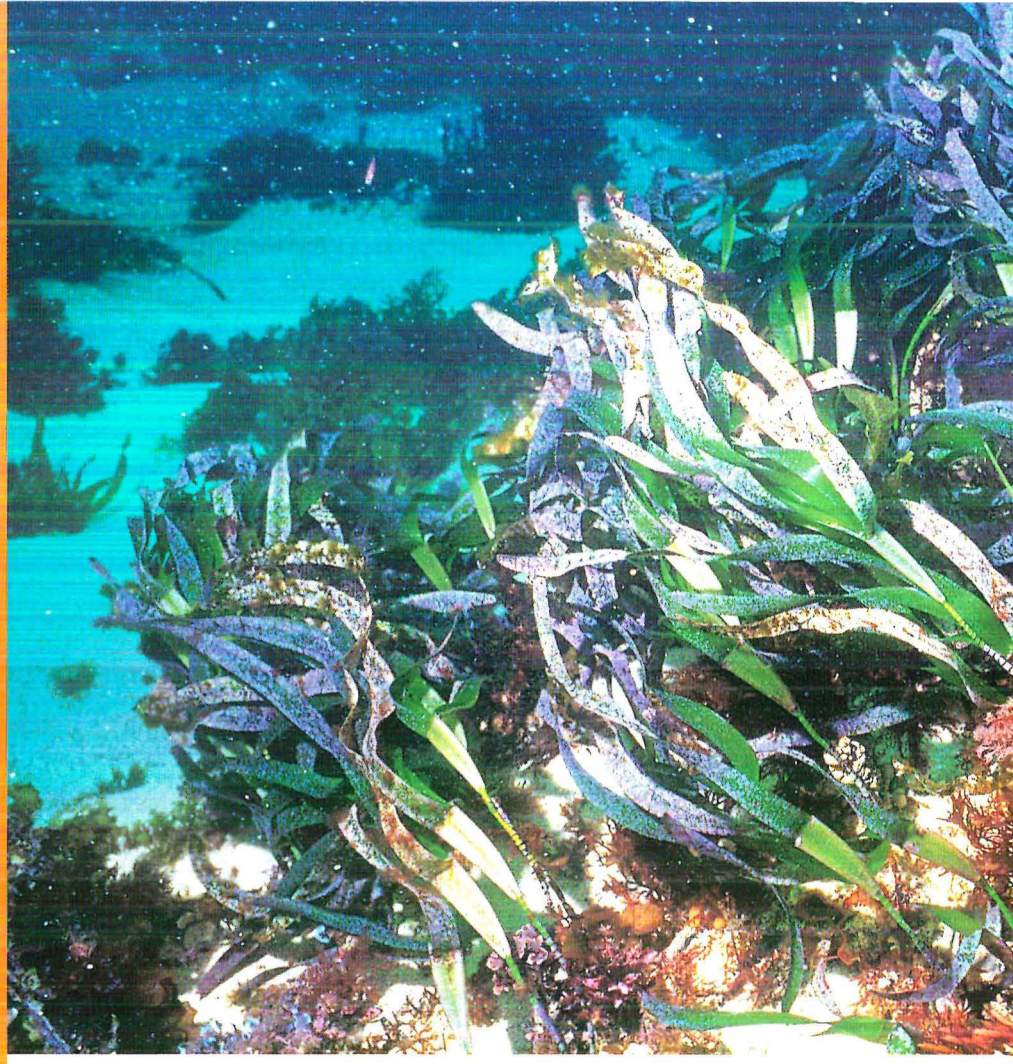
After two years of working on this species, I took the first-ever photographs of a wild adult in full plumage, bathed in a radiant glow emitted from its feathers under the afternoon sun. Through the lens of my camera, I observed the bird calling in all its emotive splendour. There I was, looking a gift bird in the beak, so to speak, and clicking away, frame after frame. The bird moved through the vegetation with such astonishing speed and ease it was often instantly lost and would then appear in a completely different location. The event was the culmination of two months of hard work and unwavering dedication from my team. The bird was photographed in an area known to have produced at least one chick in the recent breeding season. In a bizarre twist, it is quite possible that it was the parent of the chick that last year became the first wild unrestrained western ground parrot ever to be photographed.

The entire experience lasted for an hour, and was a poignant send off to a team that had been rising every morning at 4.20 am to a freezing cold and often soaking start to the day—an amazing moment to commemorate my time with the project.

Above and left The first-ever photographs of an adult western ground parrot in the wild.
Photos – Brent Barrett

Brent Barrett was the project leader of the Department of Conservation and Land Management's Western Ground Parrot Recovery Project for two years. Brent recently returned to New Zealand.

Healthy seagrass meadows thrive in the nearshore waters between Wedge Island and the Beagle Islands of the Turquoise Coast region. The Jurien Bay Marine Park fulfils an important role in the conservation of these seagrasses, which form such a characteristic part of the shallow coastal regions of Western Australia.



Sometimes, the only encounter people have with seagrass is with smelly piles of rotting brown 'wrack' washed up on the beach, a most unpleasant experience! This is unfortunate because, when alive in their underwater 'meadows', seagrasses form attractive, vibrant green stands of flourishing plants. Seagrasses are vital to the health of coastal ecosystems in Western Australia, playing an important role in the complex nearshore marine web of life. Seagrass meadows harbour a wealth of marine life, from simple sedentary sponges to foraging fish, and many marine algae. Seagrasses play an essential role in stabilising sandy areas and shorelines, as their strong, intricate root systems trap and bind sediments, and reduce the turbidity of the water. Compared with many land plants, seagrasses grow rapidly, with some species shedding their leaves every few months.

Grasses of the sea

The seagrass meadows of the Turquoise Coast are generally in excellent condition. They are predominantly found inside the fringing limestone reefs, and tend to be dense stands of one to three species of strapweed and/or wireweed. Seagrasses associated with smaller and more exposed sand patches are usually much sparser and tend to be dominated by paddleweed, with patches of strapweed, wireweed, eelgrass and manatee grass.

Paradoxically, seagrasses are more closely related to flowering land plants than to seaweeds (algae or macroalgae). Seagrasses are unusual plants because they are thought to have evolved on land and adapted to the sea at a later stage. They have retained the ability to flower and produce seeds, and the plants consist of rhizomes, roots, stems and leaves, similar to those of terrestrial grasses. Since there are no animals that pollinate underwater, seagrasses have developed incredibly large pollen grains that sink slowly in the water, thereby increasing their chances of falling on female flowers and fertilising them. Seagrass leaves have a very thin outer protective layer (cuticle) that allows the direct uptake of nutrients and gases from seawater, that are vital for production of food and energy by photosynthesis.

Most seagrasses are well adapted to living in soft sediments in nearshore areas along both tropical and temperate

Microcosm
in the ocean meadows

by Sue Morrison

Above Thick-rhizomed thalassodendron.

Facing page
Left Pheasant shells graze on tiny plants that grow attached to seagrass.
Photo – Sue Morrison

coastlines. The greatest density and diversity of seagrasses in Western Australia is found in areas with semi-enclosed embayments (such as Shark Bay and Exmouth Gulf) and fringing coastal limestone reefs, such as those along the Turquoise Coast. Here, seagrass meadows, interspersed with patches of sand, form a broad and almost continuous band—one to five kilometres wide—along the shoreline from Wedge Island to Beagle Island. The region has a high diversity of seagrasses, with at least 11 of the 25 species known to occur in Western Australia. The Turquoise Coast region has predominantly temperate seagrass species.

Seagrasses are especially sensitive to three physical factors: water turbidity, water depth (and therefore light penetration) and water movement. Some seagrass species, such as southern strapweed (*Posidonia australis*), can only survive in shallow waters with abundant sunlight. Others, such as paddleweed (*Halophila australis*), require less light and can therefore live in deeper, less clear waters. The physical impact of water movement in extreme conditions, such as storms, affects different species of seagrass to different degrees. Strapweed species have dense networks of rhizomes and roots deep in the sand, so they can tolerate strong wave action, and are infrequently uprooted in large quantities. Wireweed (*Amphibolis*) species have strong roots and stems, and can withstand a reasonable amount of rough water. However, paddleweed (*Halophila*), eelgrass (*Heterozostera*) and manatee grass (*Syringodium*), are shallow-rooted and relatively weak in structure, so are easily washed away in storms. Consequently, strapweeds and wireweeds are found in areas most exposed to wave action, while paddleweeds, eelgrasses and manatee grass thrive in more protected places. Areas that are deeper, and therefore have less wave action, tend to have denser beds of seagrasses.

Microcosm in the meadow

Although they are generally unremarkable in appearance, organisms that are attached to seagrass leaves play an extremely important role in seagrass ecology. These organisms include microscopic bacteria and single-celled plants (periphyton), algae and attached animals (epiphytes). Tiny animals also live in the sediment between the seagrass rhizomes (infauna), and slightly larger animals live among the leaves above the sediment (epibenthic fauna). There are complex, finely balanced interactions between these organisms. They all depend upon one another for survival, food and health.

Left Strapweed and wireweed.

Below left Dove shells (*Pyrene bidentata*) graze on plants and animals that grow on seagrass (epiphytes) but not on the seagrass itself.
Photos – Sue Morrison

The epiphytes, and some of the periphyton, growing on the seagrass leaves photosynthesise and, therefore, produce more plant material. However, if these organisms grow big enough to heavily shade the seagrass leaves from direct sunlight, they will limit photosynthesis in the seagrass leaves and be detrimental to the seagrasses. Dense epiphytes also weigh down seagrass leaves and make them more susceptible to being ripped out of the sediment during heavy storms. One way in which seagrasses overcome this problem is by regularly shedding old leaves and their attached organisms. Seagrasses are assisted in the control of algal epiphytes by the epibenthic fauna. These small animals, which include tiny top shells, small crustaceans and worms, graze on the epiphytes and usually maintain them at population densities that enable the seagrasses to survive. These small grazers, especially the crustaceans, are very important food for larger invertebrates and fish, because they convert plant material into matter that is easily digested by their predators.

Grass grazers

In tropical waters, dugongs and turtles are the primary grazers of seagrasses, but in temperate waters no large animals—and very few small animals—feed directly on seagrasses. Seagrass grazers along the Turquoise Coast include sea urchins (*Amblypneustes pallidus*), carrot shells (*Campanile symbolicum*), spider crabs (*Naxia aurita*), swimmer crabs (*Nectocarcinus integrifrons*), juvenile rock lobsters (*Panulirus cygnus*), rough leatherjackets (*Scobinichthys granulatus*), fan-bellied leatherjackets (*Monacanthus chinensis*) and juvenile toothbrush leatherjackets (*Acanthaluteres vittiger*). The omnivorous leatherjackets are thought to target epifauna, but incidentally consume moderate quantities of seagrass leaves. It is estimated that only around 10 per cent of seagrass carbon is eaten directly. These animals also need to include other food—such as periphyton (diatoms and bacteria) and epiphytes (coralline algae and small seaweeds)—in their diet, because seagrasses don't supply all of their required nutrients.

Some animals feed only on nitrogen-rich periphyton and epiphytes which grow on the seagrasses. These include the tiny top shells (*Cantharidus, Thalotia, Prothalotia* and *Phasianotrochus* species), pheasant shells (*Phasianella australis*), dove shells (*Pyrene bidentata*), turban shells (*Astralium squamiferum*), some polychaete worms and small crustaceans such as amphipods, isopods and shrimps.

These animals are important, as they limit the growth of epiphytes and prevent them from 'smothering' the seagrasses. This balance can be upset by nutrient enrichment of the waters, enhancing the growth of epiphytes. There may be insufficient grazers to control the increased epiphytes, and the seagrasses eventually die due to lack of light and nutrients (used up by the epiphytes). Nutrients may increase due to natural causes or, more often, human activities, such as fertiliser run-off from

land adjacent to rivers, or sewage outfalls. Once destroyed, some seagrasses can be extremely slow to re-establish, such as some *Posidonia* and *Amphibolis* species, or fail to re-establish at all.

Wrack and ruin

Another important facet in the seagrass food web is the fate of dead seagrass material. As the leaves decay, they break down into small particles. Up to 80 per cent of seagrass detritus remain in the seagrass beds, while the rest is washed away. Detritus is rich in nutrients, including carbon, and is consumed by microorganisms, worms and small crustaceans (detritivores) that live in or on the sediment. The faecal matter from these animals often contains more nutrients than the seagrass leaves because of additional microorganisms in it. Larger detritivores, such as the soft sea cucumber (*Stichopus mollis*), consume this faecal matter, and in turn other invertebrates eat their faeces. These invertebrates are preyed upon by carnivores, and so on along the food web.

Dead seagrass leaves are frequently washed onto beaches as wrack, where they, along with algal wrack, fulfil an important part of the food web cycle. The fibrous material from southern strapweed is very tough, and by means of wave action is often rolled into curious oval-shaped fibre balls that can persist for some time on the seabed, or end up on beaches.

A small number of invertebrates are able to live in the deep black, smelly, sulphide-rich sediment that is very low in—or devoid of—oxygen, frequently found under weed beds. These include the small heart urchin (*Echinocardium cordatum*) and the bivalve *Divalucina cumingi*. They can survive because special bacteria in their gut utilise chemical energy released when sulphides and oxygen react to form sulphates. These chemoautotrophic bacteria produce organic matter from this process.

Seagrass inhabitants

Along the Turquoise Coast, bivalves such as the razor clam (*Pinna bicolor*) and pearl oyster (*Electroma georgiana*) live partially buried in the sediment among the seagrasses. Solitary sea squirts including the sea tulip (*Pyura australis*), the large red-lipped ascidian (*Herdmania momus*) and the small *Polycarpa viridis* also anchor themselves in the sediment among seagrasses. However, colonial ascidians, particularly *Botrylloides* species, frequently grow as epifauna attached to seagrass leaves. Bryozoans also grow as epiphytes. Encrusting bryozoans (*Membranipora* species) are hard to see and form thin, whitish films over the leaves. The tufted bryozoan

Top Fan-bellied leatherjacket.
Photo – Ann Storrie

Above Paddleweed.
Photo – Sue Morrison

Left Hermit crabs, such as *Paguristes purpureantennatus*, are common in seagrass beds.

Centre left Colonial ascidians (*Botrylloides* species).

Below left Southern dumpling squid.
Photos – Sue Morrison

(*Orthoscuticella ventricosa*) resembles brown seaweed, with its clusters of delicate curled branches. Another epiphyte common on seagrasses in the region is the foraminiferan *Marginopora vertebralis*. These are the tiny disc-shaped structures often seen attached to strapweed. They are single-celled organisms called protozoans. Much of the fine calcareous sand on beaches is comprised of dead foraminiferan shells.

Some animals feed on a combination of epiphytes and mobile epifauna (small mobile invertebrates). Small crustaceans, particularly a shrimp (*Macrobrachium intermedium*), are important predators on the smaller grazers, and are themselves extremely important in the diet of fish and larger crustaceans. Hermit crabs, such as *Paguristes purpureantennatus*, are common in seagrass beds. They are easily spotted, as they like to live in the huge carrot shells, and can be seen lumbering along in their protective, if heavy, homes. Hermit crabs mainly feed on algae, but can also be predatory or scavenge.

Some sea stars are opportunistic feeders and have a varied diet. *Nepanthia crassa*, for example, feeds on epifauna, algae and decaying animals and plants. Similarly, the short-spired sea star (*Meridiastra gunnii*) feeds on red algae, sponges, molluscs, ascidians and dead matter.

The celebrated western rock lobster (*Panulirus cygnus*) leaves the security of the reef at night to search for food among seagrass and algae. It is omnivorous, consuming algae, small invertebrates and large molluscs such as limpets and abalone. It also excavates some bivalves from the sediment, detecting these buried molluscs with

Right The swimming anemone (*Phylctenactis tuberculosa*). *Photo – Ann Storrie*

chemosensory receptors on its front legs. The western rock lobster only remains close inshore for part of its life history. After hatching, near the edge of the continental shelf, the juvenile larvae drift in the open ocean up to 1000 kilometres offshore for eight to 10 months. In late winter or early spring, they are carried back to shore by currents, and settle on inshore reefs where they develop into adults. Most of the commercial catch is about four years old. At five years of age, they migrate to slightly deeper waters (30 to 150 metres), where they live and breed for up to 20 years.

Some of the more cryptic carnivores inhabiting seagrass beds are the cnidarians, such as anemones and hydroids. Hydroids, such as *Stereotheca* species, often grow on seagrass leaves, whereas the sand anemone (*Heteractis malu*) usually buries itself in sand near the base of seagrass leaves, with just the tentacles visible. The swimming anemone (*Phylctenactis tuberculosa*) is able to move around rapidly on the seabed or drift in the current. At night, it crawls to elevated spots to facilitate catching passing prey. It uses stinging cells on the tentacles to trap animal plankton, which is then conveyed to the central mouth.

Many of the carnivores found in seagrass meadows are larger, mobile animals that move in and out of the meadows. They are known as epibenthic fauna, and include crustaceans, molluscs, echinoderms and fish. The popular edible blue manna crab (*Portunus pelagicus*) is common in seagrass areas. It is an active carnivore, but also scavenges dead material.

Cephalopods are extremely active predators with good eyesight and are particularly active at night. The southern calamary squid (*Sepioteuthis australis*) is a fast, voracious predator that hunts fish and crustaceans. Smaller squid, including the southern bottletail squid (*Sepiadarium austrinum*) and striped pyjama squid (*Sepioloidea lineolata*), hunt among the seagrass fronds. Giant cuttlefish (*Sepia apama*), the largest of all cuttlefish, can reach a metre long. They are abundant, as can be seen by the large numbers of cuttlebones washed up on beaches along the Turquoise Coast. The gloomy octopus (*Octopus tetricus*) eats crustaceans and shellfish, and piles of discarded mollusc shells often surround its home.

The estuary catfish (*Cnidoglanis macrocephalus*) is often seen foraging at night for bivalves and crustaceans. The long-headed flathead (*Leviprora inops*) and southern blue-spotted flathead (*Platycephalus speculator*) are predatory fish that often ambush their prey from lying half-buried in sand, with just their eyes and mouth visible. They are frequently found in shallow sandy areas among seagrass beds. A larger predator is the western wobbegong (*Orectolobus* species), which lives in coastal reef and weed areas. It actively hunts small fish and invertebrates.

While seagrasses might not look as interesting as reefs to the untrained eye, we must treasure these grasses of the sea, not just for their intrinsic value, but for supporting a rich diversity of plants and animals, which are in turn driving forces of the marine ecosystems of south-western Australia.

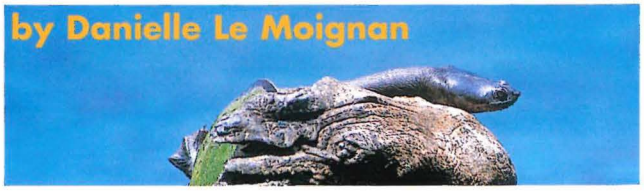
Sue Morrison, a scientist at the WA Museum, has coauthored the CALM books *The Marine Life of Ningaloo Marine Park and Coral Bay*, *Wonders of Western Waters* and *Beneath Busselton Jetty*. She can be contacted on (08) 9427 2700.

A forthcoming book, *The Turquoise Coast*, written and photographed by Sue Morrison, Ann Storrie and Peter Morrison, will be published by CALM in early 2006 as a guide to the wildflowers, wildlife, history, towns and marine and terrestrial reserves of the area.

Rockingham Lakes
Regional Park

Nestled in an area undergoing rapid urban expansion, Rockingham Lakes Regional Park shelters a community representing one of the earliest forms of life on Earth. This network of environmentally significant coastal, wetland and woodland ecosystems provides an important sanctuary for native wildlife.



by Danielle Le Moignan

One of the most striking visual features of Cape Peron, in Rockingham Lakes Regional Park, is the array of vivid greens dispersed among the dense vegetation. Coupled with the almost ethereal presence of the cape's rugged limestone cliffs, this array of colour provides a captivating scene for the area's many visitors. Peaceful, idyllic and picturesque, Cape Peron provides a space for an often much-needed escape from the bustle of city life.

Cape Peron, or Point Peron as the locals more affectionately know it, is part of the Rockingham Lakes Regional Park, one of eight regional parks in and around the Perth metropolitan area. The park was established in 1997 and is managed by the Department of Conservation and Land Management (CALM) in collaboration with the Rockingham Lakes Community Advisory Committee and the City of Rockingham. Located just 39 kilometres south of the central business district, and occupying 16 per cent of the entire area of the City of Rockingham, the park is part of a network of environmentally significant lands, including coastal, wetland and woodland ecosystems.

Left Coast bonefruit (*Threlkeldia diffusa*).
Photo – Michael James/CALM

The park's 4270 hectares cover the areas of Cape Peron, lakes Richmond, Cooloongup and Walyungup, Lark and Tamworth hills and the Port Kennedy Scientific Park, as well as the Paganoni, Anstey and Tamworth Hill swamps. Located in an area undergoing rapid urban development, the park houses internationally and regionally significant reserves, featuring two threatened ecological communities, and provides opportunities for recreation, as well as educational and scientific research.

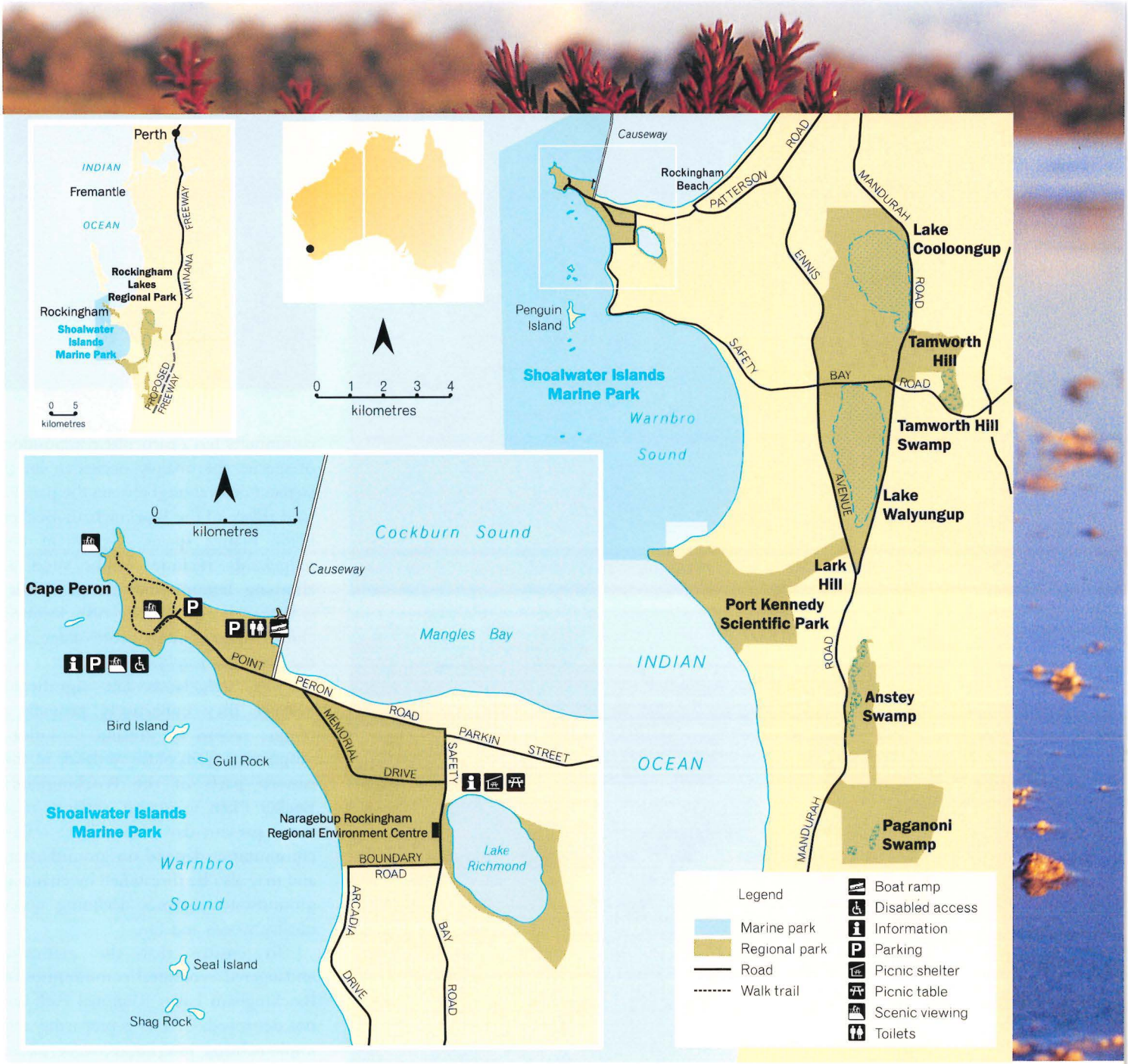
Conservation significance

Rockingham Lakes Regional Park is located on the Quindalup Dune System. Part of this system is the Rockingham-Becher Plain, a globally unique land formation that represents the evolving coastal environment of the region. The plain's vegetation exhibits a clear sequence from west to east: from coastal shrubland to permanent and temporary wetlands and into the Quindalup woodlands, which contain abundant tuart, jarrah and marri trees.

The area is regarded as having 'outstanding significance', due to its extensive coastal ridge (dune) patterns. The Rockingham-Becher Plain has evolved over the Holocene period (10,000 years ago to present) and is one of the world's best examples of consistently developed beach ridge plain. The dune patterns give scientists

Previous page
Main Lake Walyungup.
Photo – Michael James/CALM
Insets from left The sedgelands that surround Lake Richmond are a critically endangered community.
Thrombolites in Lake Richmond.
Photos – Val English/CALM
Enjoying the water at Rockingham Lakes Regional Park.
Photo – Michael James/CALM
An oblong tortoise sunbathing.
Photo – Jiri Lochman

Left View across native coastal groundsel (*Senecio* sp.) at Point Peron to Shoalwater Islands Marine Park.
Photo – Jiri Lochman



an insight into changes that have occurred in shoreline positions and sea levels during this time.

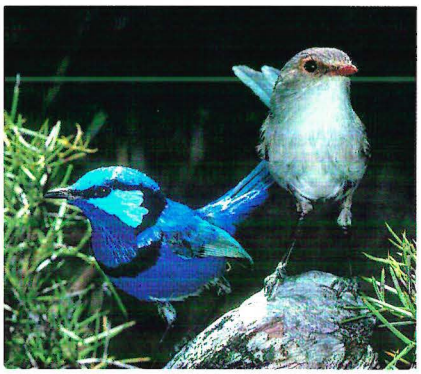
The park also accommodates an extremely rare natural phenomenon: a group of rock-like structures known as thrombolites—living structures produced by the growth and metabolic activity of microscopic creatures that live in communities on the lake floor. Sunlight and fresh water rich in calcium, bicarbonate and carbonate are essential to their growth and survival.

Thrombolites have a limestone colour and rounded shape. They have a similar external appearance to other microbial communities at Hamelin Pool in Shark Bay (see 'Lilliput's Castles', *LANDSCOPE*, Summer 1991-92). The thrombolites at Lake Richmond have a clotted internal structure ('thrombus' means clot), as opposed to the layered internal structure of Hamelin Bay's stromatolites.

Microbialites are found in few areas of the world; including the Bahamas, Bermuda, Mexico and Western Australia—where they are particularly well represented. These microbial communities are similar to the earliest forms of life on Earth found in fossils dating back at least 2.8 billion years. It is believed that these communities may have been involved in generating the first atmospheric oxygen, making the biosphere (the part of the Earth where living organisms are found) suitable for other forms of life on Earth. This may be the most critical event in the planet's history.

Thrombolites can be found in a 15-metre-wide band around the rim of Lake Richmond, as well as in Lake Clifton in Yalgorup National Park south of Mandurah (see 'Yalgorup National Park, coastal escape', *LANDSCOPE*, Autumn 2005). While the international significance and unusual scientific origin of thrombolites are a drawcard for sightseers, it is important to preserve this community from potentially threatening and damaging processes. Thrombolites are listed as a critically endangered threatened ecological community.

Rockingham Lakes Regional Park also houses a second critically endangered threatened ecological community, known as Sedgelands in Holocene Dune Swales. This



community has a particular composition of species that mainly occurs in linear wetland depressions between the parallel sand ridges of the Rockingham-Becher Plain. Native species typical of the sedgelands include shrubs such as climbing lignum and orange wattle, sedges such as bare twig-rush, knotted club-rush and coastal sword-sedge, and the grass *Poa porphyroclados*.

The sedgelands are significant because they collectively provide a unique record of wetland evolution, progressing from older wetlands in the eastern parts of the Rockingham-Becher Plain to young wetlands near the present-day shoreline. The communities depend on groundwater, and may also be threatened by changed groundwater regimes, declining water quality, weeds and fire.

To ensure that the critically endangered ecological communities of Rockingham Lakes Regional Park are not destroyed, CALM is preparing and implementing interim recovery plans, which outline actions needed to address urgent threats to the communities. Representatives from CALM, the City of Rockingham and community organisations such as the

Above Splendid fairy-wrens.
Photo – Babs and Bert Wells/CALM

Top left Pelicans on the boardwalk at Lake Richmond.
Photo – Jiri Lochman

Centre left Coastal vegetation in Port Kennedy Scientific Park.
Photo – Michael James/CALM

Left Lake Richmond viewed across flowering wattles.
Photo – Marie Lochman

Naragebup Rockingham Regional Environment Centre have collaborated to form recovery teams committed to conserving and repairing these critically endangered communities.

Wetland wonders

The wetlands of Rockingham Lakes Regional Park are a valuable environmental asset, supporting diverse ecosystems and contributing to the State's biodiversity. Most wetlands on the Swan Coastal Plain have been dramatically modified by surrounding development, so conservation is a priority in managing them. Pollution, salinisation, weeds, insects and fire also pose threats to the wetlands.

Lake Richmond, arguably the most significant lake in the area, is a perennial freshwater lake that can reach up to 15 metres in depth. This is unusual as lakes of the area are generally shallower. Because of its depth, the lake holds water in summer when other waterways dry up. This is significant for the multitude of waterbirds residing around the lake. Lake Richmond is a marine relic, historically containing seawater. It was previously part of the Cockburn Sound, which was filled within the last 4000 years. In 1968, inlet and outlet drains were built to provide drainage for new housing developments, reducing the lake's salinity.

Wildlife

More than 100 bird species use lakes Richmond, Cooloongup and Walyungup and their surrounds, including transequatorial migratory birds that fly between Western Australia and Siberia, arriving around August-September and leaving around March-April. Several of these birds are protected under international agreements between Japan and Australia. Waterbirds, like musk ducks, black swans, Australasian coots and reed warblers, as well as seabirds and bush birds, such as splendid wrens, singing honeyeaters and silvereyes, also use the lakes.

Lake Richmond also supports three types of fish: native freshwater-tolerant varieties, exotic freshwater varieties originally from Central America, and sea mullets. Lakes Cooloongup and Walyungup support native fish species and koonacs, a type of freshwater crayfish native to Western Australia.

The open tuart and marri-jarrah forests surrounding Lake Cooloongup and Tamworth Hill Swamp provide a sanctuary for mammals such as western grey kangaroos, western brush wallabies, echidnas and quendas. The park also houses more than seven frog species, as well as the long-necked tortoise, various lizards, and black-striped snakes, tiger snakes and dugites.

Above The shallows of Lake Walyungup across rushes.
Photo – Marie Lochman

Above left A musk duck.
Photo – Babs and Bert Wells/CALM

Aboriginal heritage

The wetlands and woodlands of the Rockingham Lakes Regional Park are particularly significant for the Nyoongar Aboriginal people of the south-west, as sources of abundant food and as places of ceremony and trade. While Lake Richmond was traditionally used for food gathering and camping, lakes Cooloongup and Walyungup have special significance, as they were places where the Sea Waugal laid her eggs in the Dreaming. Both the names Cooloongup (place of children) and Walyungup (place where Nyoongars talk) are Aboriginal in origin. The

significance of these names is evident in the geographic features of the lakes. Lake Cooloongup, the lake of the children, is a smaller, shallower lake, while Lake Walyungup, the place of adult Nyoongar people, is larger and deeper.

Lakes Cooloongup and Walyungup, as well as freshwater Lake Richmond, provided a plentiful and generally reliable food source of wild fruits and fish for the Nyoongar people. Rockingham Lakes Regional Park is rich in cultural significance for the Nyoongar people, and provides opportunities to promote awareness and educational research into the region's Aboriginal heritage. Three sites within the park are listed as significant by the Department of Indigenous Affairs, and it is likely that there are other significant sites in the park.

European history

The Rockingham coastline was first charted between 1801 and 1804 by French explorer Nicolas Baudin. His expedition named Cape Peron and other significant sites such as Ile Buache (Garden Island) and Ile Bertollett (Carnac Island). The area has a long maritime history: the name Rockingham commemorates a ship that ran aground in 1830 opposite the present location of Governor Road. During the 1830s, farmers settled in the eastern parts of the Rockingham area, moving south to find more arable soils than those offered in the vicinity of Woodman Point. Mangles Bay was deemed a suitable port for shipments of timber, a growing industry for the region. Later, ports at Fremantle and Bunbury would make the need for a Rockingham port unnecessary.

Many historic buildings and sites have been retained in Rockingham and within the park's borders. During

Top left The Naragebup Rockingham Regional Environment Centre.
Photo – Jiri Lochman

Centre left Bobtails can sometimes be seen sunning themselves on warm days.
Photo – Michael James/CALM

Left Quenda.
Photo – Marie Lochman

Above Point Peron beach and rocks at dusk.
Photo – Sallyanne Cousans

World War II, the HMAS Stirling Naval Base was established at Garden Island. Gun placements were built at Cape Peron in 1942 and formed an integral part of the State's coastal defence system during World War II. The guns were technically advanced in their design, and formed the most southerly artillery battery of the Perth-Fremantle defences. They were decommissioned in late 1944, and are now listed on the Municipal Heritage Inventory and on the Register of National Estate.

Recreation

Rockingham Lakes Regional Park has a range of interesting recreational opportunities, from birdwatching to thrill seeking. Cape Peron is by far the most popular area, attracting almost three quarters of the park's annual visitors. Recent developments in the area, including new walktrails and an interpretive snorkelling trail, have added to the existing lookout, parking areas and boat ramp to provide a variety of activities and conveniences for the cape's visitors. The fragile coastal environment around Cape Peron is the perfect location for relaxing walks along the beach, or more involved activities such as snorkelling or windsurfing.

Lake Richmond is a serene expanse of water in an otherwise urban setting. Popular activities include walking, birdwatching and nature observation. There are picnic tables in the north-west corner, and a walktrail along part of the lake leads to a boardwalk on the northern shore. The Naragebup Rockingham Regional Environment Centre, adjacent to Lake Richmond, provides visitors with educational and scientific information on the park. The centre has a thrombolite display and the opportunity to see loggerhead turtles from the WA Marine Turtle Rescue and Rehabilitation Program.

Lake Cooloongup is a visually dominant feature of the landscape. A trek through the dense woodlands surrounding the lake offers an escape from urban influence and the rare opportunity to connect with nature within the city's bounds.

Some of the most unusual recreational opportunities in the park are at Lake Walyungup: model aeroplane flying and land yacht sailing. Land yachting is a fast-paced, high-intensity activity involving a three-wheeled base, similar to that of a go-kart, and a large windsurfing-like sail. With relatively low impacts on the environment, both land yachting and model aeroplane flying are authorised under permits from CALM, as part of registered clubs. The area is also used for walking and birdwatching, but the primary focus is conservation.

Other areas of Rockingham Lakes Regional Park include Tamworth Hill, with its notable diversity of landforms and vegetation, and Port Kennedy Scientific Park, which provides a glimpse of undeveloped coastline and the area's wealth of plants and animals.

The Rockingham Lakes Regional Park is a rare natural haven within an urban environment, providing a broad spectrum of geographical features, unique ecological communities and an array of wildlife, lying only minutes from Rockingham and half an hour from Perth. CALM's *Healthy Parks, Healthy People* campaign (see 'Healthy Parks, Healthy People', *LANDSCOPE*, Winter 2005) encourages people to visit their local nature reserves to reap some of the health and well-being benefits of the natural environment. Rockingham Lakes Regional Park is the perfect place to do just that.

Danielle Le Moignan is a final-year student in the Department of Communication and Cultural Studies at Curtin University of Technology.

She would like to thank Reserves Officer Tony Eddleston and Planning Officer Jacinta Overman from CALM's Fremantle Regional Parks Unit, for their time and assistance.

Cockatoos in crisis

Western Australia's south-west is host to three species of black-cockatoo, but extensive changes in the landscape, as well as the rapid expansion of some native species and introduced pests, have impacted on their distribution and prospects for survival. A program initiated by the WA Museum and the WA Water Corporation is helping to raise awareness of and increase public support for the plight of the State's cockatoos and collect data for their conservation.

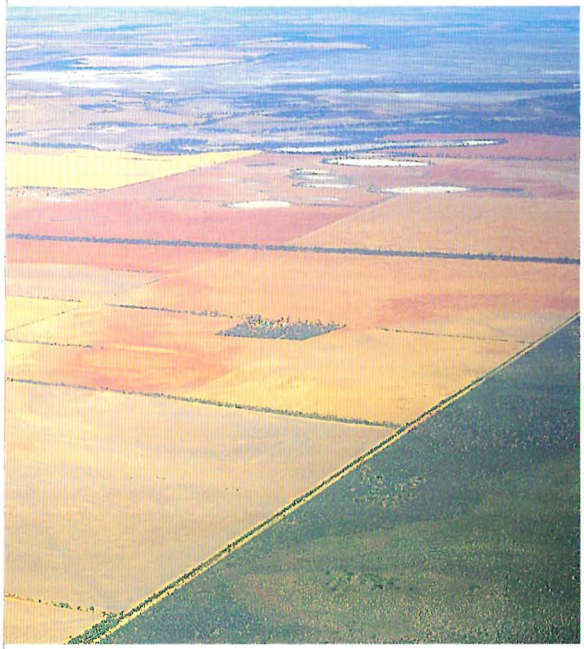
by Ron Johnstone and Tony Kirkby

The south-west of Western Australia is one of the world's 34 biodiversity hotspots. The region is also home to two species of white-tailed black-cockatoo—Baudin's cockatoo (*Calyptorhynchus baudinii*) and Carnaby's cockatoo (*Calyptorhynchus latirostris*)—and the forest red-tailed black-cockatoo (*Calyptorhynchus banksii*). The glossy and yellow-tailed black-cockatoos occur in other parts of Australia.

During the past century, forests and woodlands in the south-west have been cleared on a scale and at a rate with few parallels anywhere else in the world. Almost 90 per cent of the original vegetation in the south-west has been cleared for agriculture, mining, or for cities and towns. Extensive tracts of uncleared land remain only in the larger nature and forest reserves, and even these are disturbed to varying degrees.

This change in the landscape, along with the rapid expansion of some native species and the introduction of some exotic pest species, has greatly influenced the distribution and prospects for survival of all of WA's south-west species. Of particular concern is the future of the State's black-cockatoos.

Carnaby's and Baudin's cockatoos are currently listed as endangered and the forest red-tailed black-cockatoo as vulnerable. Based on recent studies, nominations for upgrading the listing of Baudin's cockatoo to endangered and forest red-tailed black-cockatoo to vulnerable are currently being assessed.



Previous page
Main Forest red-tailed black-cockatoo.

Left Baudin's cockatoo.
Photos – Tony Kirkby

Below left Clearing for agriculture in the Wheatbelt has contributed to the loss of habitat for WA's black-cockatoos.
Photo – Jiri Lochman

About the cockatoos

Baudin's cockatoo, named after French explorer Nicolas Baudin, is found mainly in heavily forested areas of the south-west corner, and Carnaby's cockatoo, named after WA naturalist Ivan Carnaby, lives mostly in the woodlands and scrubs of the semi-arid interior. It is difficult to tell the two species apart, especially in southern forests where both species regularly occur and sometimes feed and roost close together. Their bill size and shape (Baudin's cockatoo has a long, narrow upper bill and Carnaby's has a short, thick upper bill) and different contact calls (the short 'witcha-witcha' and 'bunyip-bunyip' flock calls of Baudin's versus the longer 'weeeloo-weeeloo' of Carnaby's) are the only reliable means of identification. In most of the south-west and throughout most of the year, Carnaby's cockatoo outnumbers Baudin's by at least five to one.

An estimate of the total population of Baudin's cockatoos is 10,000 and, currently, illegal shooting by orchardists and loss of feeding and breeding habitat are the major threats. Like Baudin's cockatoos, the major threats to Carnaby's cockatoos are loss and fragmentation of habitat, especially in the Wheatbelt, and competition for nesting hollows, especially from galahs, corellas and feral honey bees. Interestingly, galahs and western long-billed corellas have greatly increased their range and numbers since the 1950s. Originally, both were absent from much of the Wheatbelt until the 1970s. The impact of European feral honey bees has also greatly increased since the 1970s.

The forest red-tailed black-cockatoo is confined to the lower south-west humid zone, mainly the hilly interior. Once common, but now rare to uncommon and very patchily distributed, this species has disappeared from about 30 per cent of its former range. The total population is about 10,000, with less than 10 per cent capable of breeding in any one year, and it is threatened by loss of feeding and breeding habitat, competition for nesting hollows, especially from feral bees, and from invading galahs at the edges of forests.

All three cockatoo species live for about 50 years, begin breeding at four years of age, mate for life, tend to nest in the same hollow each breeding season, and lay one or two eggs but rear only one young in each breeding season. In many areas, the cockatoos you see are from an ageing population with little or no recruitment.

Baudin's, Carnaby's and forest red-tailed black-cockatoos are very conspicuous forest birds. But, apart from a study of the breeding biology of the Carnaby's cockatoo in the Wheatbelt during the 1970s, little was known about their breeding, feeding and/or habitat preferences until research began in the past decade or so. Programs conducted by conservation groups, government departments and volunteers are providing important information about these species that is being used to aid their conservation.

Above left Ron Johnstone checks a nest box.

Above Female (left) and male (right) forest red-tailed black-cockatoos.
Photos – Tony Kirkby

Cockatoo Care

The Cockatoo Care program is a conservation partnership between the WA Museum and the Water Corporation. Launched on Threatened Species Day in 2002, the research and public awareness program continues to gain public support to help the survival of these iconic birds.

The program is made up of four main components: research into the distribution and ecology of each of the three species and the threats to their survival; habitat enhancement through habitat planting and installation of artificial nest boxes; assessing and responding to the impact of feral honey bees; and community education and involvement.

The program is promoted by a website, brochures and other publications, displays and a comprehensive program for schools. It relies on volunteers and museum staff, as well as the support and involvement of the community. Of particular importance is the use of 'Observation Cards' and 'Frequent Sighting Forms', which enable members of the public to contribute information to the research of WA's black-cockatoos by documenting sightings of Carnaby's, Baudin's and forest red-tailed black-cockatoos.

Cockatoo Care has a full-time Coordinator at the Water Corporation and a full-time Field Research Officer, based at the WA Museum. So far, hollows used by 64 forest red-tailed black-cockatoos, 14 Baudin's cockatoos and 85 Carnaby's cockatoos have been found in the south-west and these are monitored regularly. Six 'hotspots' have been observed in the south-west and about 50 nest boxes and PVC pipe hollows have been mounted in trees, with assistance from Water Corporation rangers, to encourage breeding. An important role associated with the nest boxes is to protect them from the damage caused by invading feral bees—at some study sites up to 50 per cent of nest hollows were lost to feral bees in the past year. Scientists are trialling techniques to discourage and eradicate them, including the use of a range of pesticides, including citronella. The nest boxes are important to the survival of black-cockatoos because studies have shown that it takes at least 230 years for trees to develop a suitable hollow and some nest trees are up to 450 years old.

Two volunteers also contribute to the Cockatoo Care program by collecting and databasing information, and mapping flock sizes and distribution. So far, 4500 records have been entered into a database with a further 4000 yet to be entered. The distribution maps have provided important information about the reduced numbers of forest red-tailed black-cockatoos and the significant decline of Baudin's cockatoos as well as the increase in distribution of Carnaby's cockatoos in areas where they did not occur previously.

Cockatoo Care, and the research and operations it involves, is helping to build a profile of these charismatic birds that, while commonly seen in areas of the State's south-west, are declining significantly in number.

Ron Johnstone is a Curator of Ornithology at the WA Museum and can be contacted by email (ron.johnstone@museum.wa.gov.au).
He would like to acknowledge the Water Corporation for its continued support and help with this project.

Tony Kirkby is the Cockatoo Care program's Field Research Officer and can be contacted by email (akirkby@vtown.com.au).

For more information on Cockatoo Care, visit www.cockatoocare.com or contact Barbara Jones by email (barbarajones@watercorporation.com.au).

urban antics by John Hunter

Swan spray and osprey

I've been working on Matilda Bay for some 27 years now and, I admit, have been blessed to work in such an environment earning my daily bread and reporting on the comings and goings of all creatures great and small.

There's been a lot said about the Swan River lately, top of the list being algal blooms in areas where, at times, there is little water flow, large amounts of nutrients and plenty of sunlight to enhance the growth of amoeba-like life forms. Some of these can be toxic or simply deplete the water of oxygen which, either way, can kill fish.

While it's obvious that the 'burbs' and population of Perth are now in 'the big league', with thousands of out-of-staters flooding in to sample what was 'our' little Swan River Colony, the resultant protection of the city's greatest icon, the river, must be second to none. Mind you, at the time of writing, mid-November 2005, the water clarity in and around Matilda Bay Reserve is stunningly clear, with dolphins, cormorants and fish species clearly visible in their underwater dashes and clashes. Because of the continuing winter rains, seawater tides and seasonal jellyfish populations have not reached here yet.

The Swan River is actually a marine estuary fed by winter run-off from the Darling Range, and is arguably the second biggest estuarine environment on the south-west coast. It has provided a magnificent stage for human inhabitants for thousands of years and has always had a healthy and diverse wildlife population from equatorial wading birds through to visiting sea-lions.

Perhaps one of the moderately common but rarely seen of the larger animals that live and breed in the environs of the Swan River is the osprey (*Pandion haliaetus*). While often referred to as a 'fishing eagle', this magnificent bird is a true fishing hawk of the family Accipitridae, which comprises all the diurnal birds of prey except the falcons and kestrels.

Ospreys are found throughout the warmer parts of the world, with the subspecies *cristatus* ranging from the Indonesian Archipelago south-eastwards to Australia. Here, it is found thinly spread around the mainland coastline, except for Tasmania and the south coast of Victoria.

Second only to the white-breasted sea-eagle in majestic plunges to capture surface-visiting fish, the osprey, with its compact plumage and long powerfully built legs, quite often drops from about 30 metres and temporarily disappears below water in its attack. Within a second, the bird resurfaces and, more often than not, rises powerfully skyward with long razor-like talons deeply embedded in its prey.

Usually found on small islets and islands close offshore and on Rottnest Island, both the Swan and Peel estuaries are lucky to have their resident small populations of ospreys. Now and then, people travelling around the estuaries will glimpse a lone bird either flapping in true hawk style or perched proudly on favourite artificial structures.

In the last few weeks, two adults and a juvenile osprey have together rested atop the Norfolk Island pines outside my office and raised my heartbeat with their incessant, high pitched, quavering whistle. Maybe it's an omen for us all to keep an eye on our grubby human habits around our fabulous waterways. Maybe the tide has turned and the beasts are having their say.

DID YOU KNOW?

- Nest sites are around the area of the confluence of the Swan and Canning rivers and also in the area of Devils Elbow at Mosman Park.
- Ospreys no longer breed in Tasmania, Victoria and New South Wales, maybe because of pollutants causing breeding failure and death or through tree clearing removing nest sites.
- Huge nests are added to each year, with sticks, flotsam, seaweed and driftwood being built up to two metres high.

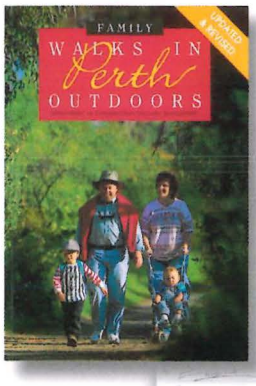
Discovering Perth's outdoors

Perth and its surrounding areas have a range of outdoor recreation sites that are perfect for visitors and locals alike. Here are some books packed with ideas for a great day out.

Perth Outdoors $21.95

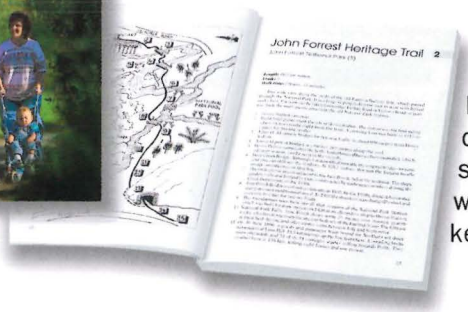
Perth Outdoors contains information on almost 300 nature-based recreation spots. Each is described in detail, with information about what to do there, facilities, travelling time, and the best time to visit. Full colour photographs, features and maps make it an essential guide for planning weekend or holiday outings.

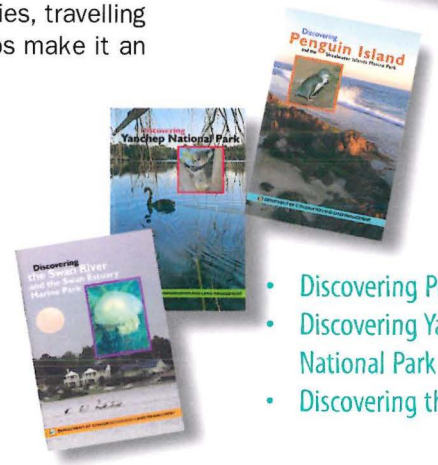
Family Walks in Perth Outdoors $16.95



Updated and reprinted

Few capital cities have such a variety of natural areas right on their doorstep. This book sets out 48 walks to explore Perth's forests, woodlands, wetlands and coastal environments, ranging from a few hundred metres to 20 kilometres. Each walk is described stage-by-stage and illustrated with a mud map to keep you on track.

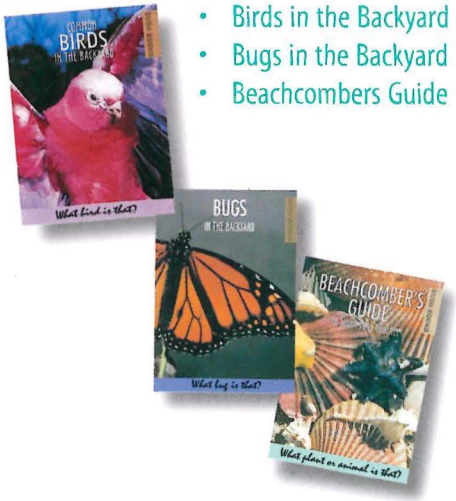




- Discovering Penguin Island
- Discovering Yanchep National Park
- Discovering the Swan River

Pocket size guides $6.50 each

Each pocket guide is 64 pages, full colour and packed with information and spectacular photographs.

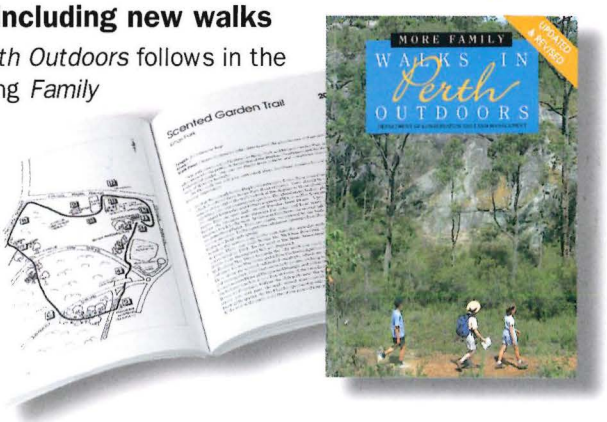


- Birds in the Backyard
- Bugs in the Backyard
- Beachcombers Guide

More Family Walks in Perth Outdoors $16.95

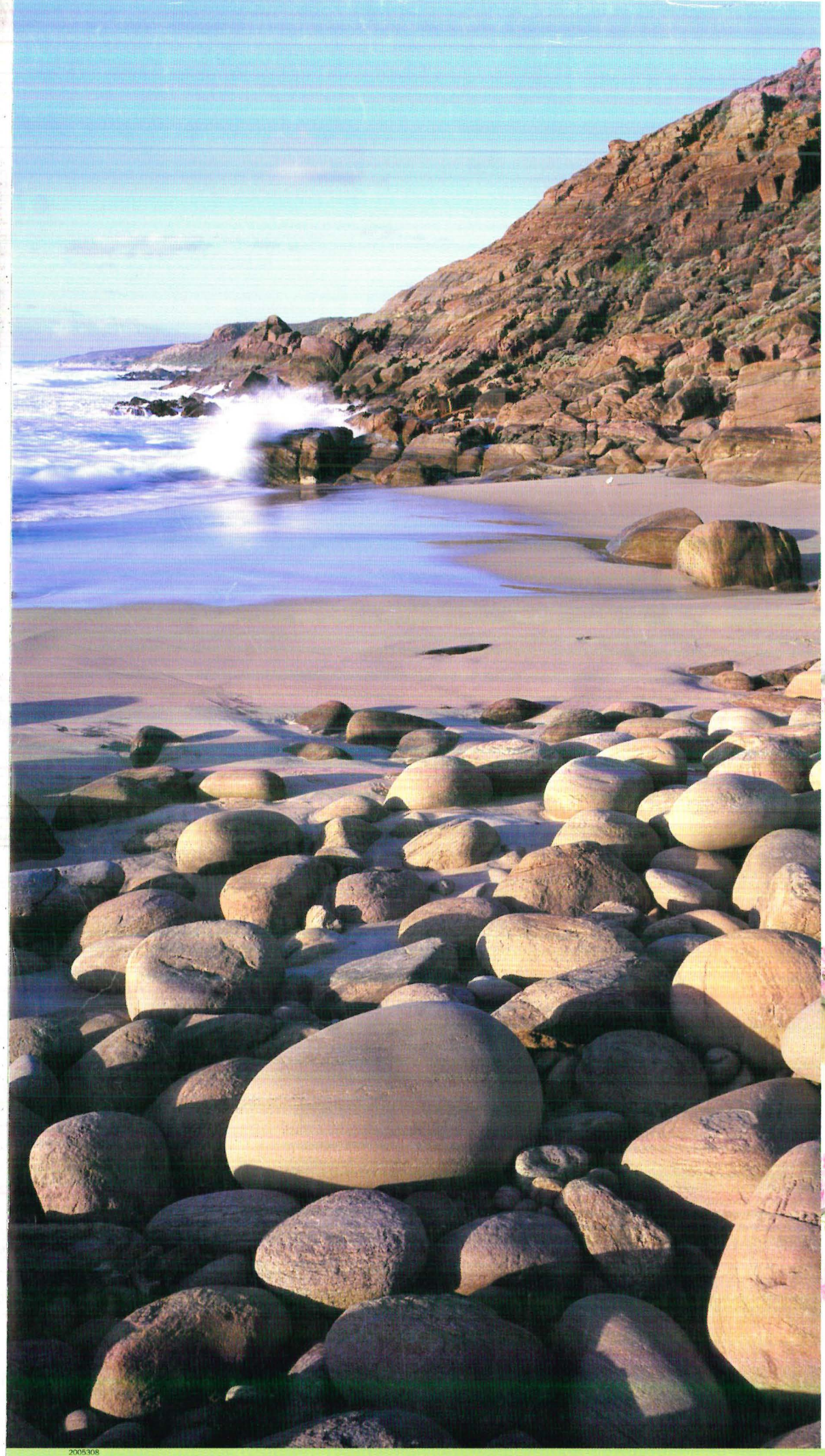
Completely revised, including new walks

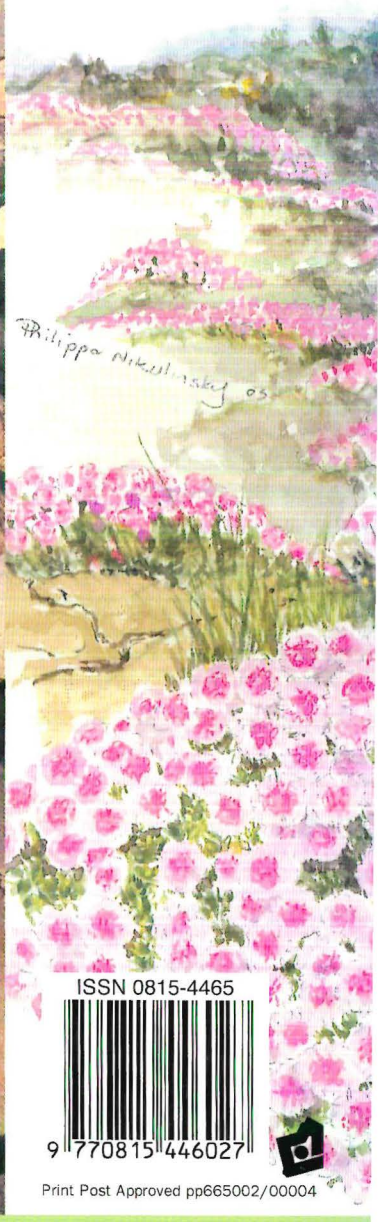
More Family Walks in Perth Outdoors follows in the footsteps of the bestselling *Family Walks in Perth Outdoors*. It contains maps and descriptions of another 50 walks, as well as features on some of the plants and animals you might see while out walking, and a list of common birds of the Perth area.



Available from good bookshops, newsagents and CALM offices, by mail order from CALM (postal charges apply) at Locked Bag 29, Bentley Delivery Centre, Western Australia, 6983.
Tel: (08) 9334 0333, Fax: (08) 9334 0498, TTY (hearing impaired) facility available: (08) 9334 0546
or order online through the department's NatureBase website (www.naturebase.net).

GOVERNMENT OF WESTERN AUSTRALIA
DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA





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