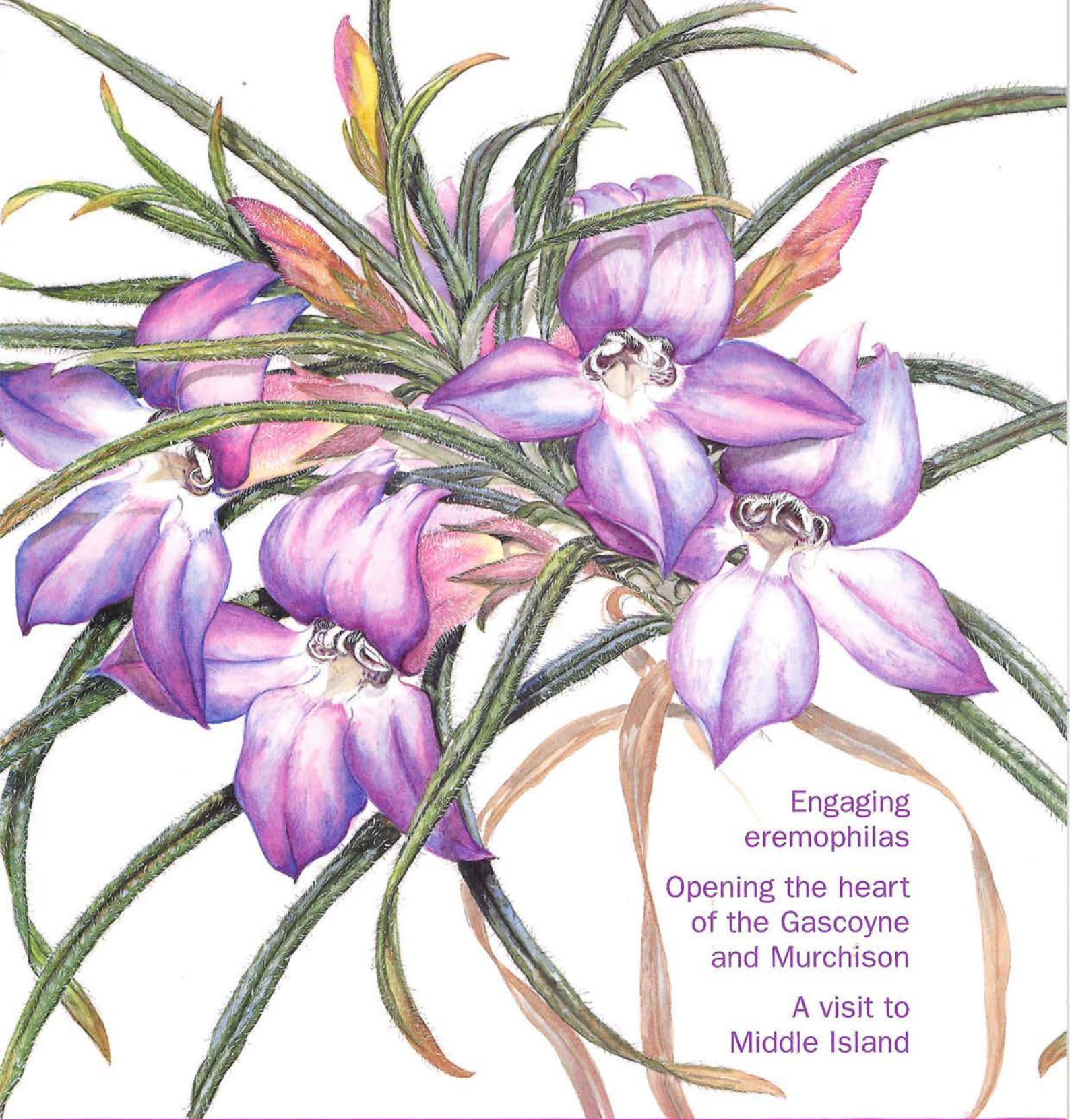


WA's conservation, parks and wildlife magazine

LANDSCOPE

Volume 22 Number 1 SPRING 2006 \$6.95



Engaging
eremophilas

Opening the heart
of the Gascoyne
and Murchison

A visit to
Middle Island

Enjoy the sights of WA... all year round

Photo – David Bettini

This stunning *Western Australia 2007 Calendar*, presented by *LANDSCOPE* magazine, casts a number of different lights on some of Western Australia's most breathtaking areas as well as a pelican right at the time of take off.

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Western Australia 2007 Calendar is available from bookshops, newsagencies and card shops around WA for only \$16.95. It can also be purchased direct from the Department of Environment and Conservation for \$16.95 plus postage and handling costs (Australia add \$3.55, overseas add \$9.55). All prices are GST inclusive. A sturdy envelope is provided for postage and gift presentation.

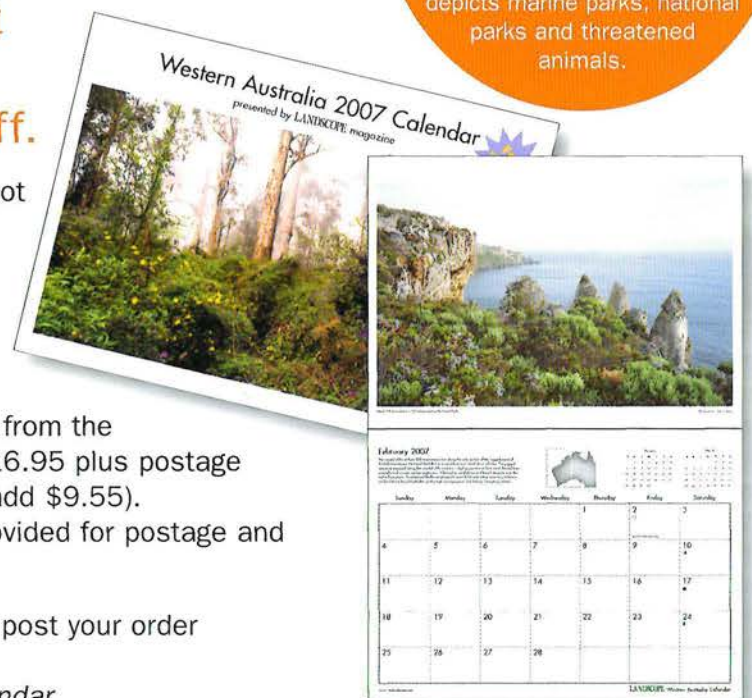
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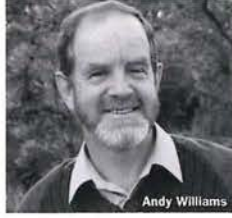
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Preview and download colourful and stunning screen savers from NatureBase website when you purchase a copy of the *Western Australia 2007 Calendar*. The collection of screen savers depicts marine parks, national parks and threatened animals.





Leonie Monks



Andy Williams

contributors

Leonie Monks has, since 1998, been employed as a Research Scientist with the Science Division of CALM, which was recently incorporated into the new Department of Environment and Conservation (DEC). She is based at Kensington with the Flora Conservation and Herbarium Program and her role involves implementing a series of experimental translocations for critically endangered flora. Prior to this she spent a year with the WA Threatened Species

and Communities Unit (now Species and Communities Branch) of DEC implementing recovery actions for critically endangered flora. She is also a committee member for the Australian Network for Plant Conservation.

Andy Williams is a Senior Technical Officer with the Department of Environment and Conservation's Science Division, and has worked at the Wildlife Research Centre at Woodvale since 1979. He has wide

experience in nature reserve management and wildlife conservation, having worked extensively on the department's marine turtle and python research programs. Apart from his current work on woylie predation at Dryandra, Andy's other major work interest is the conservation of Western Australia's native butterfly fauna. He has written numerous scientific papers and is a regular contributor to *LANDSCOPE*.

Andrew Brown, who has worked on Flora Conservation since 1981, is the Department of Environment and Conservation's Threatened Flora Coordinator based at the Wildlife Research Centre in Woodvale. He is an internationally recognised authority on Western Australian orchids and this, along with his knowledge in the genus *Eremophila*, has resulted in him becoming honorary curator of the Orchidaceae and Myoporaceae at the Western Australian Herbarium. Andrew is a regular contributor to *LANDSCOPE* and has prepared many taxonomic papers, including coauthoring the naming of more than 100 new orchid species with well-known WA botanist Steve Hopper. Andrew is also coauthor of *Orchids of South West Australia* and *Western Australia's Threatened Flora*.

Maria Duthie has been a senior member of the award-winning team of *LANDSCOPE* designers for the past 12 years and still loves working on the magazine as much as when she started. Maria has also designed the full-colour book *Threatened Animals of Western Australia*, the *Flora of the South-West* volumes, *The Best of the North West* *LANDSCOPE* special edition, several Bush Books and numerous other Department of Environment and Conservation (formerly CALM) publications. One of her favourite aspects of her role is learning from and working with the scientists who, like her, are passionate about the environment.

Also contributing...

Brent Johnson, Peter Orell, Verna Costello, Bevan Buirchell, Rohan Swan, Ann Storrie, Mitzi Vance, Samille Mitchell, Robert Powell, Sarah Comer, Allan Burbidge, David Pearson and John Hunter.



Andrew Brown

Sorry!

In last issue's Contributors we mistakenly claimed that Ian Abbott coauthored the book *Marine Green and Brown Algae of the Hawaiian Islands* with John Huisman. Apologies to Isabella Abbott, the book's coauthor.



Maria Duthie

editor's letter

The diversity of our amazing State is one of its greatest attractions. This edition of *LANDSCOPE* provides insights into just a few of Western Australia's native animals, plants and natural areas.

While many of these are in remote regions of the State, others are in readily-accessible areas right on Perth's doorstep or within easy reach of popular holiday destinations such as Kalbarri. The coastal town is an easy day's drive north of Perth, and is a great base from which to explore the surrounding areas, including the famous Murchison River Gorge in Kalbarri National Park.

It's an area where wildlife once flourished, although the introduction of other animals such as cats and foxes has threatened certain native animals living in the park. Considerable work has been done to turn the process around, and this edition of *LANDSCOPE* looks at the heartening results coming from a program to reintroduce selected native mammals including the woylie and chuditch.

We also take a wider look at the Gascoyne and Murchison areas where three self-drive trails have been developed. The Outback Pathways cross the amazing country from Geraldton in the west to Sandstone in the east and back to the coast at Exmouth. Taking the time to stop and read the signs along the routes provides a rare insight into the ancient landscape and its extraordinary natural features.

Other articles take us to the south of the State and what's happening at Mount Manypeaks Nature Reserve. Department of Environment and Conservation (DEC) scientists there are gaining new knowledge following a fire that affected areas where there had been long-running recovery programs for threatened species including the noisy scrub-bird.

We also go offshore to some of the islands just off the WA mainland. There's particular focus on Middle Island in the Recherche Archipelago off the southern coast where DEC scientists have been carrying out detailed studies of the island's butterflies and invertebrates as well as its vegetation. We also take a close look at corals that flourish in the tropical and temperate waters right along the coast.

This edition also includes a feature on snakes—there are about 110 snake species in WA and they occur in just about every habitat from tall trees in the south-west to sandy coastal plains and arid spinifex deserts.

With vast tracts of the State now bursting into colour with spring wildflowers, it is fitting that our cover picture features one of the remarkable plant groups that fascinated early botanists in WA, the *eremophilas*. Their big and colourful flowers come in many shapes and forms and, once established, the plants are very drought tolerant so can be found in some of the most remote parts of WA.

Kaye Verboon
Executive Editor

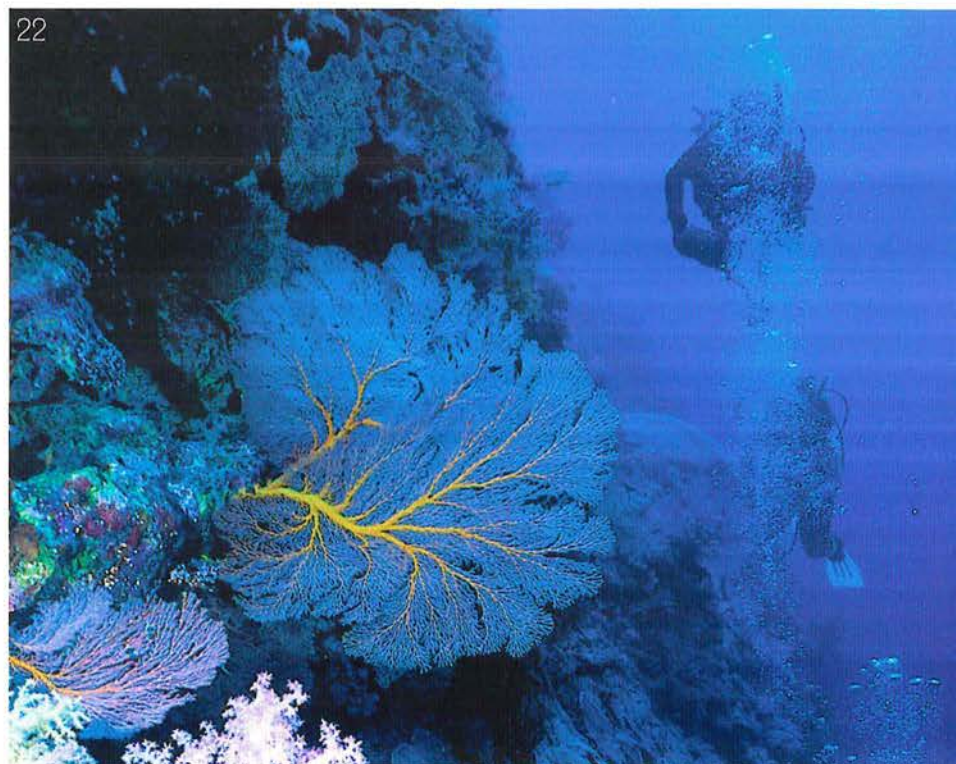


Cover illustration by Philippa Nikulinski
 Eremophila enthusiast Andrew Brown was about 20 kilometres north-west of Cue examining a many-leaved poverty bush (*Eremophila foliosissima*) when his mobile phone rang. It was botanical illustrator Philippa Nikulinski, calling to ask Andrew some questions about the same species, while preparing our beautiful cover illustration. Poverty bushes are so called because, in some arid pastoral leases in times of drought, they were the only green things around. Hence, they were prevalent in times of poverty.

Back cover photo David Bettini
 Everlastings near Carnarvon.

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 Woylies and chuditch have made a comeback at Kalbarri National Park.
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When large numbers of threatened noisy scrub-birds and western whipbirds perished in a wildfire at Mount Manypeaks scientists also gained some valuable insights.
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WA is blessed with a great variety of snakes, from tiny worm-like blind snakes to enormous olive pythons more than five metres long.

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Department of Environment and Conservation





High hopes for

Kalbarri wildlife



A recent wildlife survey has revealed that woylies and chuditch now appear to be thriving at Kalbarri National Park, an area from which they were once extinct.

by Brent Johnson and Peter Orell

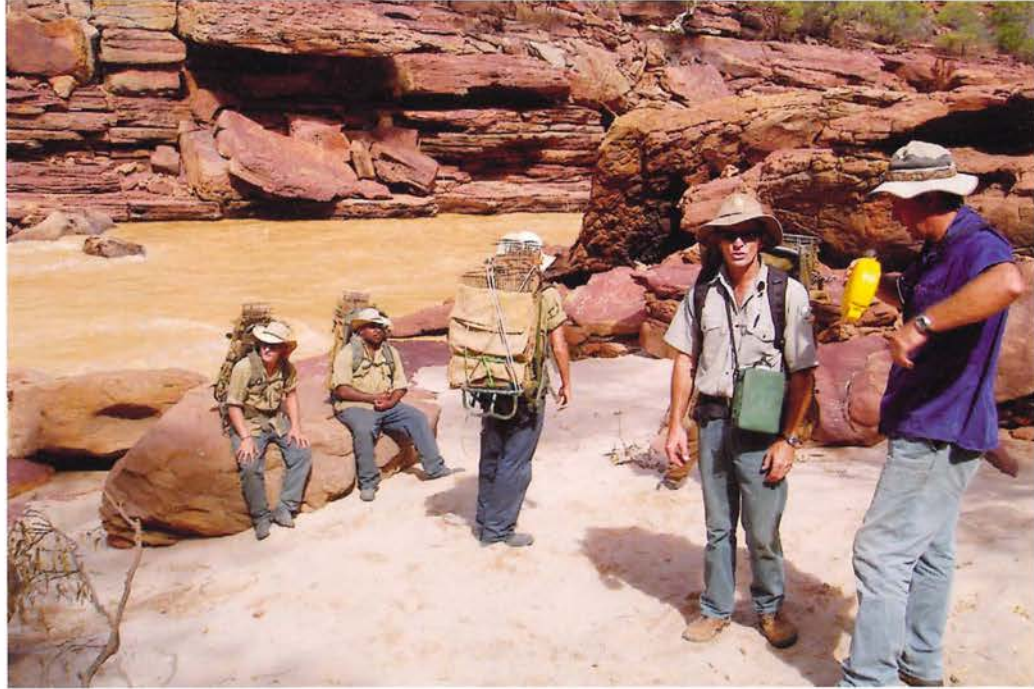
The town of Kalbarri is a popular destination for holidaymakers. No visit to Kalbarri is complete without a trip to the famous Murchison River Gorge, some 30 kilometres to the east. This 80-kilometre stretch of river, within Kalbarri National Park, winds through etched cliffs of 400-million-year-old Tumblagooda Sandstone.

Reintroductions

Wildlife once flourished throughout Kalbarri National Park but, in recent times, the invasion of introduced cats, foxes, pigs and goats has threatened native animals living in the park. The Chuditch Recovery Plan and the Department of Environment and Conservation's (DEC's), formerly CALM's, *Western Shield* program identified the park as a site that would be suitable for reintroducing selected native species once fox numbers were reduced.

Following three years of fox baiting in the park, an assessment of its effectiveness in reducing fox numbers was undertaken. This involved establishing wildlife monitoring sites and track count transects through a range of habitat types in the park. A variety of live traps were used to catch, identify and record a range of small mammals, amphibians and reptiles, while the track counts involved smoothing over many kilometres of sandy tracks and then returning in the morning to identify and count footprints. This provided information on the existing native species and introduced animal activity, and showed that several small mammals such as honey possums (*Tarsipes rostratus*) still occurred in the park and that fox activity was reduced by baiting.

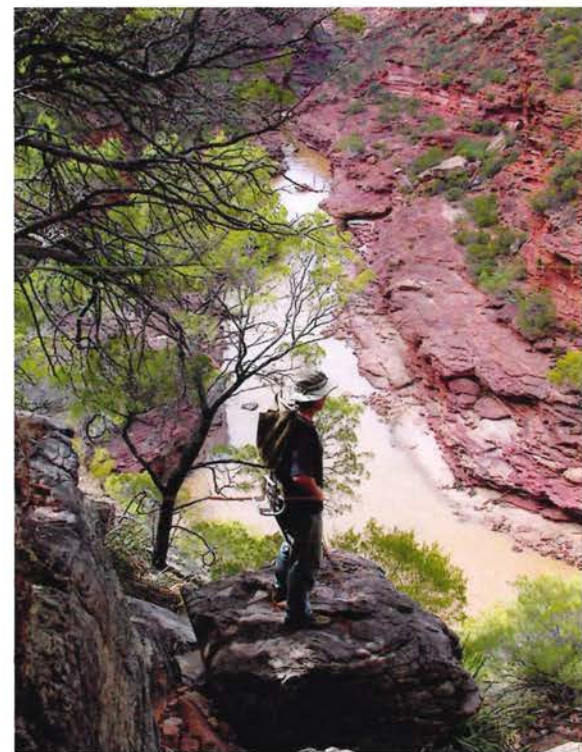
The next stage was to reintroduce native mammals. The woylie (*Bettongia penicillata*) and chuditch (*Dasyurus geoffroii*) were ideal candidates for reintroduction, as Kalbarri lies within their past distributions. Both had suffered significant population declines over the past 100 years and vast reductions in available suitable habitat. Considerable information was available from previous reintroductions of both species into other areas. In the case of the chuditch, the release of captive-bred individuals to a semi-arid site was seen as an



Opposite page
Main Layered Tumblagooda Sandstone and river gums along the Murchison River in Kalbarri National Park.
Photo – Alex Bond
Inset Baby chuditch (left) and woylie (right).
Photos – Jiri Lochman

Above Lack of vehicle access to the Kalbarri National Park gorge meant that traps and other gear had to be carried in.

Right Brent Johnson scans the gorge for potential trapsites.
Photos – Lucie Southern



important step in the Chuditch Recovery Plan.

The first releases took place in 2000. A total of 113 woylies, sourced from areas in the south-west with good populations, were released in successive batches, with the latest animals coming from Karakamia Sanctuary (owned by the Australian Wildlife Conservancy) in September 2005. Forty nine chuditch, from a captive colony at Perth Zoo, arrived in two main batches, with the last being released in March 2001. Both species were monitored intensively for an initial period. Twice-yearly trapping has since been conducted by park staff, assisted by the Bush Rangers from Kalbarri District High School.

At first there was some doubt about the success of these reintroductions, as the difficult nature of the terrain and lack of track access made it hard to assess whether either species had persisted and established viable populations. Because the park is so vast, released animals can disperse over large areas. Occasionally,

however, individual animals were captured in the *Western Shield* traplines.

In March 2006, a more thorough survey was undertaken, and the findings were heartening. A team of Department of Environment and Conservation (then CALM) staff, volunteers and Green Corp workers combined to carry traps into both the rugged gorge terrain and the extremely dense and difficult-to-traverse vegetation on the sandplain to the south. The work in the gorges was further hindered by record floodwaters that had risen many metres above the normal river height. In fact, the floodwaters had even threatened the town of Kalbarri itself only a week before the visit.



Wildlife revival

There were encouraging signs on the very first morning, as the gorge team completed the steep descent to the river. Several chuditch droppings were seen close together on a flat rock ledge. This latrine site indicated the presence of nearby chuditch and is also evidence of a type of territory marking that, while common with the closely related tiger quoll of the eastern states, is very rarely recorded in its Western Australian relative.

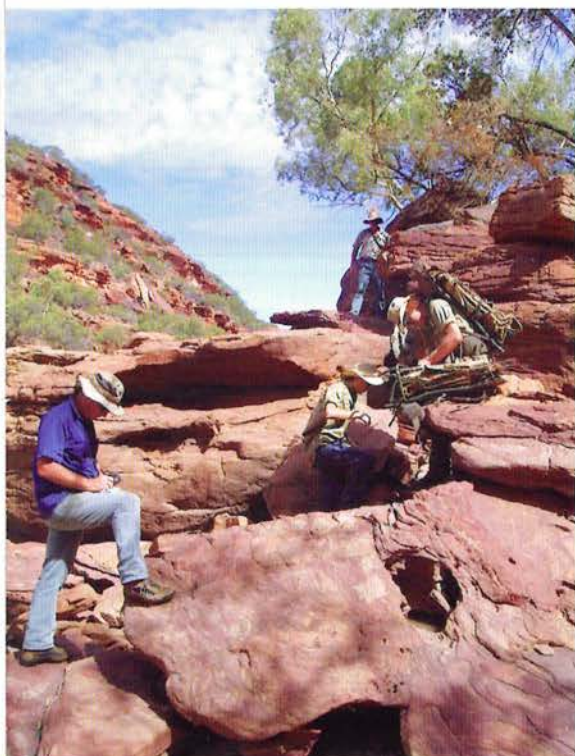
The team's efforts were rewarded

on the following three mornings with the capture of eight individual chuditch in the gorge and two chuditch and nine woylies in the sandplain heath and scrubland. The captured animals had an even male to female ratio, and were a range of ages. Some chuditch were recaptured several kilometres from the original trapsite, indicating that they were able to quickly cover long distances through rugged terrain. None of the chuditch captured on this trip had been caught previously, a good indication that the population

is reproducing successfully. Seven of the nine woylies were individuals released in 2005 and all four females, including two new captures, were bearing pouch young. This was also encouraging, as it suggested that the animals were surviving well and reproducing successfully.

These two populations will continue to be monitored through DEC's *Western Shield* program, and further targeted surveys may be undertaken to complement the results of routine monitoring. With the positive results from the recent survey, it is also anticipated that other locally extinct mammal species will be reintroduced over the coming years. DEC hopes to reestablish both the black-flanked rock-wallaby and the tamar wallaby as iconic species in the park.

With the continuation of fox baiting and good wildlife management practices within the park it is possible that these two pioneer species will be at the forefront of a native wildlife revival at Kalbarri.



Above The rugged terrain meant that trapping along the gorge was exceptionally hard work.

Photo – Lucie Southern

Above right Volunteer Lucie Southern measures a captured chuditch.

Photo – Brent Johnson/DEC

Left Green Corp assistance was invaluable during the 2006 wildlife survey of Kalbarri National Park.

Photo – Lucie Southern

Brent Johnson is a Principal Technical Officer with DEC's Wildlife Research Centre, based at Woodvale. He can be contacted on (08) 9405 5106 or by email (Brent.Johnson@dec.wa.gov.au).

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Peter and Brent led the team that undertook the wildlife survey at Kalbarri earlier this year. They wish to thank Senior Ranger Mike Paxman and Kalbarri National Park staff for their assistance with many aspects of this wildlife recovery and monitoring program.

bookmarks by Verna Costello

Exposing Nature A Guide to Wildlife Photography

Author: Frank Greenaway
Publisher: CSIRO Publishing
150 pages, soft cover, full colour
ISBN: 0 643 09290 0 RRP: \$49.95

Covering film and digital photography, this book is for all nature photographers, amateur and professional alike, who would like to learn more about capturing images of wildlife in its natural environment. Discover strategies for understanding your subject and how to take accurate photographs in even the most challenging situations. Those who would rather look at excellent photos than take them will also find plenty to admire among the many superb examples.

Exposing Nature is available from CSIRO Publishing, PO Box 1139, Collingwood, Victoria, 3066, by calling 1300 788 000, or emailing (publishing.sales@csiro.au).

Perth Plants

Authors: Russell Barrett and Eng Pin Tay
Publisher: Botanic Gardens and Parks Authority (Kings Park)
383 pages, soft cover, full colour
ISBN: 0-8764 7907-8 RRP: \$44.95

This highly detailed field guide covers the bushland and coastal flora of Kings and Bold parks in Perth. Colour photographs of each species accompany the text. This is an invaluable guide for botany students and a well-laid-out reference book for both expert botanists and home gardeners interested in maintaining a 'native species' garden.

Perth Plants is available from Aspects, Kings Park and Botanic Gardens, the WA Museum bookshop and select outlets.



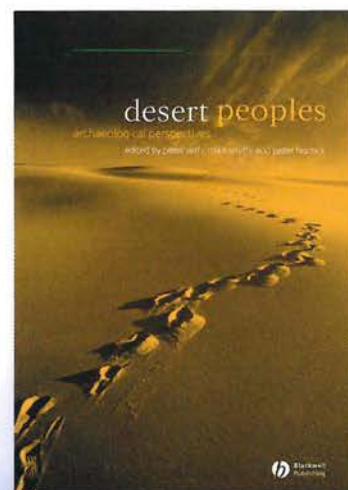
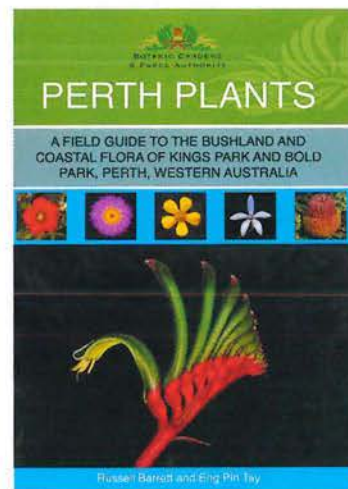
Desert Peoples Archaeological Perspectives

Edited by: Peter Veth, Mike Smith and Peter Hiscock
Publisher: Blackwell Publishing
108 pages, soft cover, some illustrations
ISBN: 1-4051 0091-5 RRP: \$65.95

It is believed that about 313 million people (about 13 per cent of the world's total population) currently live in the world's arid zones, with 92 million alone residing in hyper-arid deserts.

The emphasis of this book is squarely on deserts as a major world habitat (they range from semi-arid to hyper-arid). It describes their extreme variability, the various hunter-gatherer people inhabiting them (including a chapter on hunter-gatherers of coastal north-west Australia), and the rapidly growing body of archaeological data concerning their history.

Desert Peoples Archaeological Perspectives is available from TL Distributors by calling 1800 333 678.







Eremophilas

lovers of lonely
desert places

Eremophila species abound on desolate rocky hills, open spinifex plains, sparse woodlands, barren dry watercourses and inland sand dunes that stretch to the horizon, where the only signs of human habitation are occasional fencelines, rusted remains of vehicles or rough winding tracks that meander into the distance. Aptly, their generic name, when translated, means 'lover of lonely or desert places'.

Text by Andrew Brown and Bevan Buirchell
Photos by Andrew Brown

Commonly known as poverty bushes, emu bushes and native fuchsias, *Eremophila* species are the best known members of the Myoporaceae family, a group of plants largely confined to Australia that also includes the genera *Boutia*, *Calamphoreus*, *Diocirea* and *Myoporum*. Many species are cultivated and readily available from native plant nurseries. With their colourful flowers, forms and range of growth habits, they are a valuable addition to any garden.

Bounty for botanists

In the 196 years that have elapsed since Robert Brown named *Eremophila oppositifolia* in 1810, more than 250 different species have been discovered. They are particularly abundant in Western Australia, where at least 200 species are found and about 80 per cent are confined to the State. Less than half of these are named, however, South Australian botanist Bob Chinnock, who has previously named 19 *Eremophila* species, will soon formally describe a further 94 species, 88 of which are found in WA.



Prior to modern times, the most influential naturalist to take a keen interest in the genus was Ferdinand von Mueller. Mueller lived at a time when teams of explorers crossed the continent and collected the many new flora species that they encountered. From these collecting trips Mueller described 40 *Eremophila* species, 39 of which are found in WA. Round-leaved eremophila (*Eremophila muelleriana*) was named in his honour. Mueller was fascinated by eremophilas. In 1858, he wrote:

"A traveller in the extensive Desert-tracts of Australia is often well rewarded for his

toils and privations by the enjoyment which the sight of the varied works of the Creator must ever cause to contemplative minds; more especially when it is observed that, with the increase of the country's barrenness, variety and beauty in the vegetation increase in proportion.

"Prominent amongst the attractive plants to be met with in the solitudes of the interior are those of the Myoporinous order, and amongst these again are the genera, *Stenochilus*, *Eremophila* and *Pholidia*, comprising forms exquisitely ornamental." [Both *Stenochilus* and *Pholidia* are now considered synonymous with *Eremophila*.]

Anyone who has travelled to the interior of Australia, where the large colourful flowers of eremophilas are a particularly noticeable part of the landscape, cannot help but agree with Mueller.

Other notable naturalists who named species of *Eremophila* include George Bentham, Robert Brown, Ludwig Diels, William Fitzgerald, Charles Gardner, Ludwig Kraenzlin and Spencer Moore.

Previous page

Main In good seasons, many eremophilas such as wedge-leaved poverty bush (*E. cuneifolia*) burst into bloom, with plants covered in large, attractive flowers.

Above left Western weeooka (*E. oppositifolia* subsp. *augustifolia*).

Above The pink-flowered cumquat eremophila (*E. denticulata* subsp. *trisulcata* ms) is known from a few populations north-east of Esperance and is declared rare.

Left Native fuchsia (*Eremophila latrobei*).





Above Some eremophilas have prominently spotted flowers, such as this form of Wilcox bush (*E. forrestii*) found south-east of Exmouth.



Right Poverty bush (*Eremophila alternifolia*) was amongst the first species to be named when Robert Brown described the genus in 1810.

New discoveries

Given the remote distributions of most *Eremophila* species, new ones are regularly discovered. Some 40 new species, and many more subspecies, have been discovered during the past 10 years, with eight previously unrecorded species found in 2005 alone. One of these, *Eremophila* sp. Wanna, was discovered on a single rocky hill in Wanna Station (recently acquired by CALM, one of the Department of Environment and Conservation's predecessors), north-west of Mount Augustus (see 'Wanna know a secret?', *LANDSCOPE*, Autumn 2005).

Other recently discovered species include *E. sp.* Warriedar, which occupies rocky hills west of Paynes Find and has very large, attractive blue, mauve and brown flowers, and *E. sp.* Landor, which is confined to rocky plains below a low range of hills north of Landor Station and has unusual red tubular flowers.

Desert delights

In WA, the main area of distribution encompasses the southern Pilbara, Gascoyne, Murchison, Goldfields, the interior and the Nullarbor. More than 155 species are found in these regions and, in some places, are easily the most dominant shrubby plants. Eremophilas are also common in the deserts of South Australia and the Northern Territory and extend east into Queensland, Victoria and New South Wales.

Less well known is that 28 species occur in the WA Wheatbelt and that two (*E. glabra* subsp. *albicans* ms and *E. glabra* subsp. *chlorella* ms) grow naturally in the Perth area. The former is cultivated and its grey-coloured foliage and ground-hugging habit make it ideal for planting on verges.

In the Meekatharra-Wiluna area, there are more than 50 species, and they are among the most common shrubs to be seen. Here, in late July 2004, some 30 species were found in flower during a single day of survey. One of the most beautiful and common was showy poverty bush (*E. spectabilis*), which formed pure thickets under mulga (*Acacia aneura*), with harlequin fuchsia bush (*E. linearis*), frontage poverty bush (*E. malacoides* ms), Wiluna poverty bush (*E. enata* ms), Wilcox bush (*E. forrestii*), Batt's poverty bush (*E. battii*), burra (*E. fraseri*), native fuchsia (*E. latrobei*) and crowded-leaved poverty bush (*E. congesta* ms) growing nearby.

Eremophilas are not known to occur naturally in the high rainfall south-west corner of WA, and there are only a few known from the Kimberley. Eremophilas occupy a variety of habitats, from rocky hilltops and saline washes to sand dunes and hardpan flats. They can grow as solitary plants or in dense thickets—pure groves of the large, dark green leaved burra and red-flowered poverty bush (*E. ramiflora*) resemble

strange inland orange orchards.

Some species are confined to single ranges of hills, granite outcrops or salt lake margins. Rare poverty bush (*Eremophila mirabilis* ms), for instance, is known from just two breakaways near Menzies and north of Mullewa, with the Mullewa form perhaps representing a distinct subspecies.

Mysterious origins

Many *Eremophila* species hybridise. Some hybrid offspring are so distinctive that they were thought to be new species when first encountered. *Eremophila lachnocalyx* x *phyllopoda*, for instance, was given the manuscript name *E. retropila*. *E. accrescens* ms is almost certainly a hybrid between wedge-leaved poverty bush (*E. cuneifolia*) and stony poverty bush (*E. phyllopoda* ms). Slender flowered poverty bush (*E. graciliflora*) is only known from the type collection made from the Murchison River area by Augustus Oldfield prior to 1859. It is now suspected to be a hybrid between berrigan (*E. longifolia*) and Young's poverty bush (*E. youngii*).

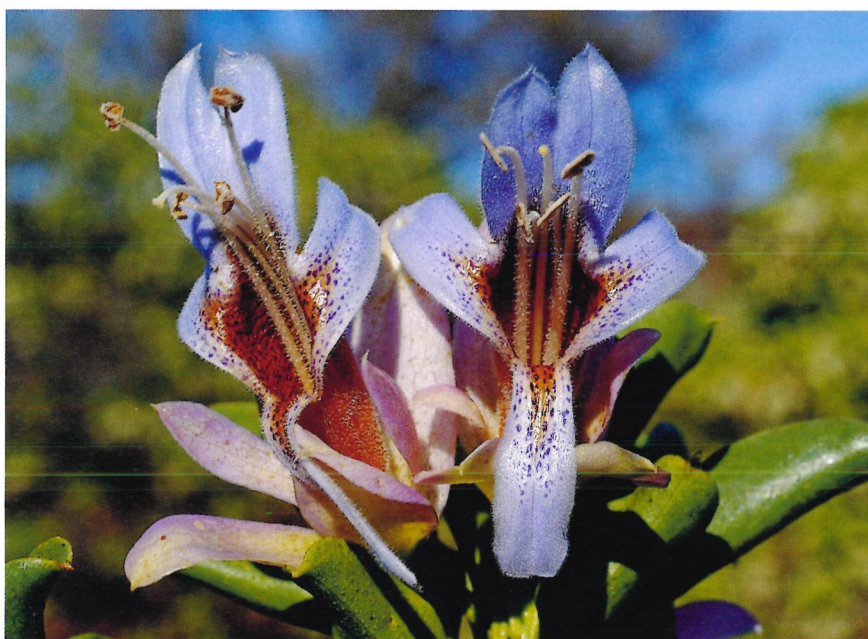
Eremophilas vary from prostrate ground covers, such as snake eremophila (*E. serpens*), to small or large shrubs and medium-sized trees. Perhaps the most well known tree species is pixie bush (*E. oldfieldii*), which is common in the northern WA Wheatbelt.



Flowers

All *Eremophila* flowers have an inner, often tubular, corolla (petals) of five fused segments and an outer calyx (sepals) of five, usually spreading, segments. There is often more than one flower in each leaf axil. Flowers may or may not be held on a stalk. Cumquat eremophila (*E. denticulata* subsp. *trisulcata* ms) has a long S-shaped flower stalk, while Veronica eremophila (*E. veronica* ms) has almost no stalk at all.

Red, purple, lilac and blue are the most common flower colours and include the red-flowered slender fuchsia bush (*E. decipiens*), purple-flowered round leaf poverty bush (*E. strongylophylla*), lilac-flowered desert fuchsia (*E. gilesii*) and blue-flowered sand dune poverty bush (*E. gibsonii*). There are also white-flowered species, such as broom poverty bush (*E. interstans*), and even green-flowered species such as Champion eremophila (*E. virens*) and wavy-leaved eremophila (*E. serrulata*). Some species also have flowers with spectacular combinations of colours. Rare poverty bush (*E. mirabilis* ms) has pink-and-white flowers with prominent purple blotches and showy poverty bush (*E. flaccida* ms) has blue, brown and mauve-pink flowers. The most beautiful are the ones with additional markings, like the spots on some forms of Wilcox bush or the purple, brown and cream combinations found in burra.



There are five basic flower shapes within the genus. Most common are the flowers with two petals above and three below, such as in small-leaved poverty bush (*E. exilifolia*). Some 132 WA species have this flower shape. In this group, the



Top left Some eremophilas are confined to rare habitats, with rare poverty bush (*E. mirabilis* ms) known from just two widely separated breakaways.

Centre left Perhaps one of the most commonly encountered and beautiful *Eremophila* species is burra (*E. fraseri*).

Left Some eremophilas are now common in cultivation. An example is the lipstick plant (*Eremophila maculata* subsp. *brevifolia*).

Right Red rods (*Eremophila calorhabdos*).

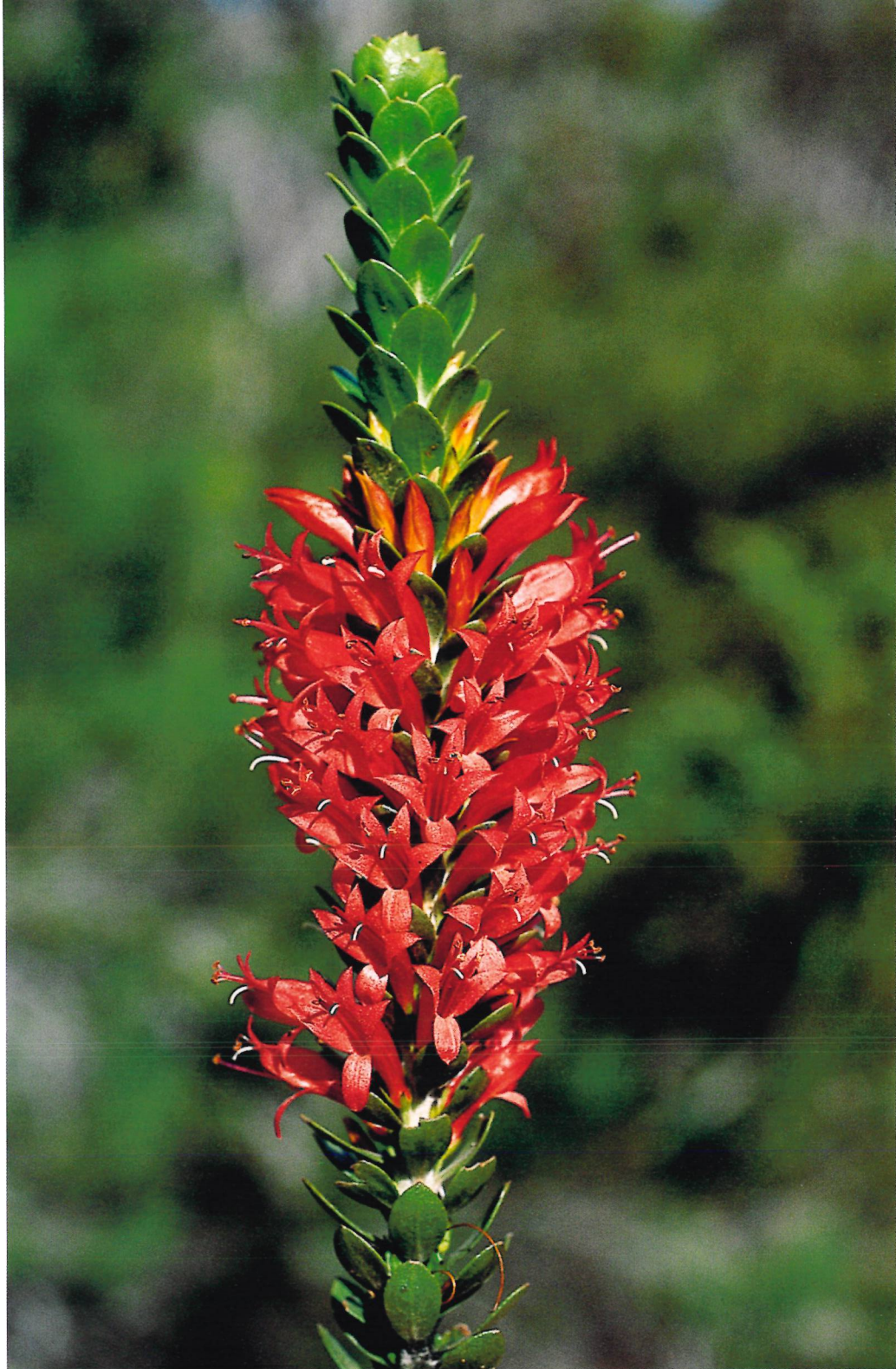
stamens are generally retained within the corolla but the style is usually slightly longer than the upper petals. Another 30 species from WA have flowers with four petals above and one prominently reflexed petal below and stamens that are always much longer than the corolla. An example is common emu bush. Species with this flower shape were at one time included in *Stenochilus*.

The other three flower shapes, which are essentially variations of the above two, are much rarer and, when combined, comprise just 36 WA species. They include bell-flowered poverty bush (*E. campanulata* ms), which has unusual bell-shaped flowers, native fuchsia, which has tubular flowers with the petals bent slightly back at the tip, and burra, which has very showy, brightly coloured flowers with the four upper petals and one large lower petal bent back away from the corolla tube.

Reproduction

Approximately 75 per cent of *Eremophila* species are pollinated by insects, with the rest pollinated by birds. The flowers of bird pollinated species contain rich sugary nectar at the base of a long flower tube (corolla). In their effort to extract the nectar, birds are dusted with pollen on their forehead and napes by the strategically located, and usually strongly protruding, stamens. Insects are the vectors responsible for pollinating *Eremophila* species that have much shorter floral tubes, shorter stamens and, in general, flower colours ranging from the blue to violet end of the spectrum.

Once fertilised, eremophilas produce a fleshy fruit enclosing 2-12 seeds. In nature, this fruit drops to the ground, dries out and remains dormant for many years until a disturbance such as fire or heavy rainfall stimulates germination. It is not therefore uncommon to find that many, or even most, plants in a population are around the same age, having germinated at the same time.



Growing eremophilas from seed is notoriously difficult, and often prone to failure. Most success has been from cuttings and many common species are now grown by nurseries using this method. Some intrepid growers have even managed to graft their favourite eremophila onto a stronger rootstock such as native juniper (*Myoporum insulare*). Once established, eremophilas are very drought tolerant and rarely require much watering. The flowers of some species produce nectar and are excellent for attracting birds.

Colour and plant form variations of common emu bush and lipstick plant (*E. maculata*) are often available from nurseries and make great additions to a native garden. Slender fuchsia bush (*E. decipiens*), Fitzgerald eremophila (*E. denticulata*), prostrate eremophila (*E. biserrata*), showy eremophila (*E. racemosa*) and Murchison River poverty bush (*E. laanii*) are also available.

Traditional use

Eremophila species have been used in Aboriginal tribal life in both cultural



and medicinal roles. Plant material has been used in ceremonial rites and extracts of plant parts have been used as liniments, medicines and antiseptics. The resin exuded from some species has also been used as sealants and adhesives. For example, berrigan (*E. longifolia*) was important to the Adnyamathanha people of the northern Flinders Ranges in South Australia, as reported by Rosemary Pedler in the Eremophila Study Group Newsletter, December 1994:

“A very common and widespread species, it was of considerable importance to them. The foliage was used to cover the dead before burial which did not take place immediately after death. The relatives would visit the dead person from time to time to observe what was happening to the covering leaves, and there was significance in the way in which the leaves lay. The body was buried at a depth of about an arm’s length after about a month and was again laid on and covered by the varti-varka foliage (*Eremophila longifolia*).

Also used for medicinal purposes, the bark of trunks was scraped off, reduced to ash and then mixed with emu oil. This preparation was then used for all manner of skin complaints with excellent results, according to several people in the group. This is still being used today.

I was also told by one of the men that the smoke from varti-varka was used in the initiation ceremony of young boys. This aspect is in the past as the last fully initiated Adnyamathanha man is very elderly now.”

During recent studies, many species were found to contain chemicals that may be of great pharmaceutical value for the treatment of colds, cancers and other ailments.



Top left Pixie bush (*E. oldfieldii*) is a common tree species of WA’s northern Wheatbelt.
Photo – Marie Lochman

Centre left Club-leaved eremophila (*Eremophila clavata*).

Left Crimson eremophila (*E. punicea*).

Right Round leaf poverty bush (*E. stronglyphylla*).

Below right *Veronica eremophila* (*E. veronica*) is an example of a species that grows in pure populations, forming a dominant understorey plant.

Bottom right More than 50 eremophila species can be found in the Wiluna area. One of the most common is showy poverty bush (*E. spectabilis*).



Rarities and delights

Although most *Eremophila* species are common and widespread, 15 are listed as declared rare flora (nine of these are critically endangered), and a further 52 species are on the Department of Environment and Conservation's (DEC's) Priority Flora list. Their presence on these lists is largely due to land clearing and other human influenced factors, rather than the species being naturally rare. In particular, *Eremophila* species that are restricted to the WA Wheatbelt have suffered badly from land clearing, grazing and salinity.

All declared rare species are protected by legislation but, due to their limited habitat (some are now known from just a few narrow road reserves or a couple of hills), are especially vulnerable to grazing, disease, old age, poor recruitment and accidental destruction. DEC has prepared interim recovery plans for these species and implemented measures to ensure their long-term conservation. Despite much of the Wheatbelt having now been cleared, several presumed extinct *Eremophila* species, including rough emu bush (*E. scaberula*) (see 'Endangered', *LANDSCOPE*, Summer 2003) and varnish-leaved poverty bush (*E. vernicosas*), have been rediscovered following searches of remnant bushland.

Other Wheatbelt species are still quite common. Drummond's eremophila (*E. drummondii*), named by Ferdinand von Mueller in 1868 from specimens collected by James Drummond, is encountered fairly often. This attractive species has blue to mauve flowers that appear in late winter and early spring. Western weewooka (*E. oppositifolia*), George's poverty bush (*E.*



georgei) and Lehmann's poverty bush (*E. lehmanniana*) are also common in the Wheatbelt.

Looking for eremophilas can be very rewarding, taking you to some of the most remote parts of WA where, in good seasons, salt lakes and rock pools fill with water, fields of annuals bloom en masse and eremophilas abound. So, when next travelling our outback areas, or even Wheatbelt areas closer to home, look out for our fabulous *Eremophila* species. You are bound to be fascinated by their remarkable adaptations, shapes and forms, not to mention their attractive flowers that, just a few weeks following rain, transform the landscape into a kaleidoscope of colour.



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endangered

by Andrew Brown



Wagin banksia

The genus *Banksia* contains 75 species. Three (*B. ilicifolia*, *B. cuneata* and *B. oligantha*) are placed in the subgenus *Isostylis*, and two are confined to Western Australia's Wheatbelt region and declared as rare flora.

Wagin banksia (*B. oligantha*), the rarer of the two Wheatbelt species, was first collected by Ken Wallace in 1984. Since then, searchers have located just three other populations, the most recent in March 2004. These occur over a range of 100 kilometres, growing in areas of remnant open low woodland in deep white to yellow-brown sand. Two populations are in decline, with just a single seedling recorded since monitoring began.

Bearing a superficial resemblance to parrotbush (*Dryandra sessilis*) when not in flower, Wagin banksia is a large shrub or small tree to four metres high. It has few main stems and oval-shaped leaves two to three centimetres long. Leaves have incurved margins, with two to four sharp points along each side. There are

heads of 20 to 30 flowers, which are cream with a red base. The scientific name refers to the fact that the inflorescence has relatively few flowers (compared with other members of the genus), a feature that separates this species from the closely related matchstick banksia (*B. cuneata*), along with the creamy yellow flowers, roughened basal bark and shiny green upper surface to its leaves.

A study of the reproductive biology of Wagin banksia carried out by Curtin University staff in 1996 showed that honeyeaters were the main pollinators, although insects also played a role in pollination.

Although fire kills adult plants, seeds are released from the fruits of Wagin banksia and germinate in the ashbed. The even-aged structure of some populations provides evidence that this has occurred in the past. Fire is, however, not essential for germination, and seedlings have occasionally been found in the absence of fire.

Wagin banksia is ranked as endangered in Western Australia due to its limited geographic range, severe fragmentation

and the continuing decline in the quality of its habitat. The species is also listed as endangered under the *Commonwealth Environment Protection and Biodiversity Conservation Act 1999*. The main threats, particularly to seedlings, are grazing by rabbits, drought, drift from chemical spray and weeds. Its limited habitat and poor recruitment are further concerns. Salinity may also be a future threat.

An interim recovery plan has been prepared for the species and is being implemented by the Katanning and Narrogin District Threatened Flora Recovery Teams. Recovery actions to date include rabbit control, fencing, and seed collection and storage in the Department of Environment and Conservation's Threatened Flora Seed Centre. Studies on the genetic divergence and diversity of the species have also been undertaken.

A one-year project supported by Natural Heritage Trust funding is investigating the influence of salinity and waterlogging, and aims to identify the tolerance of the species to hydrological changes.

Photo by Bert and Babs Wells/DEC

Magenta moments

by Rohan Swan

Lake Magenta Nature Reserve, one of the largest nature reserves in the Wheatbelt, is rich in plant species and an important habitat for native animals. Largely undisturbed by logging and land clearing, and part of the Department of Environment and Conservation's *Western Shield* wildlife recovery program, it is an ideal location to conduct research into the region's wildflowers and wildlife. For participants of the 'Magenta Magic' *LANDSCOPE* Expedition, this will be both a rewarding and enjoyable experience.



The 108,000-hectare Lake Magenta Nature Reserve lies in the south-eastern part of the WA Wheatbelt, and 40 kilometres south of Newdegate. The shallow, saline Lake Magenta, which generally only holds water during winter or after summer rains, covers 20 per cent of the reserve. To its north and south are a number of smaller lakes that make up a larger lake system. About a third of the reserve falls into the UNESCO Fitzgerald biosphere reserve buffer zone, making it a vital part of the overall biodiversity of the region.

Natural residents

Lake Magenta Nature Reserve has populations of three threatened plant species, plus an additional 24 species on the Department of Environment and Conservation's (DEC's) Priority Flora list. The vegetation is mainly mallee heath on sandy soils interspersed with areas of salmon gum woodlands. The reserve is connected—via large areas of unallocated Crown land—to the mallee shrublands to the east of the Wheatbelt.



The reserve provides important habitat for a number of native animals, including brushtail possums, chuditch, Mitchell's hopping-mice, heath mice, western mice, ash grey mice and red-tailed phascogales. Another 30 species of reptiles and frogs have also been recorded. Forty chuditch were released into the reserve as part of the *Western Shield* program in 1996. The associated fox baiting program significantly reduced the number of foxes in the area, allowing native animals to survive and thrive in the reserve. The chuditch population has now established, but at lower densities than hoped for. Some other medium-sized mammals such as quenda and woylies have also declined despite ongoing fox control and reintroduction efforts.

The richness in some species, and the lack of sustained recovery in others, has seen it and the nearby Dunn Rock Nature Reserve recently become the focus of a research program examining the reasons for limited wildlife recovery in the Wheatbelt. This is part of a much larger research program being undertaken by DEC scientists into the interactions between foxes, feral cats, feral dogs and native predators.

Threatened bird species found at Lake Magenta include Carnaby's black-cockatoos, malleefowl and western whipbirds. Malleefowl populations are being monitored by the Malleefowl Preservation Group. Spotted pardalotes, Gilbert's whistlers and wedge-tailed eagles are also often seen in the reserve.

The expedition

A *LANDSCOPE* Expedition to Lake Magenta and Dunn Rock nature reserves is planned for November 2006. Expedition members will visit the reserves each day for 10 days, where they will conduct biological surveys—identifying and recording animal species—to determine current population densities. This will help to determine which animals live in the reserves and allow scientists to estimate their numbers, as part of a wider project that looks at why some animals are not recovering, and monitors the presence of introduced predators, in particular foxes and cats.

Expeditioners will also search for threatened plant species with Anne Rick, a local botanist and member of DEC's Great Southern District rare flora recovery team. Anne will lead the botanical surveys into Lake Magenta and Dunn Rock nature reserves.



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Main Sunsets at Lake Magenta provide visitors with a glimpse of the area's many moods.

Inset Salmon gum woodlands.

Above left Torrential rains in January 2006 inundated large areas of the reserve and surrounding farms.

Left A western pygmy possum captured at Lake Magenta.

Photos – Brent Johnson



Above This ice formation was on a puddle near Lake Magenta on a chilly morning.

Above right Although it is seasonally dry, Lake Magenta reached record levels in 2006.

Right LANDSCOPE expeditioners will undertake hands-on wildlife monitoring. Photos – Brent Johnson

Below Freshwater snails near the lake edge. Photo – Michael James/DEC



As well as undertaking these daily collecting and research tasks, expeditioners will have an opportunity to work with scientists in the field. Accommodation will be under the stars in tents and swags. All the while, expeditioners will be conducting important and often groundbreaking research. This valuable contribution of time and funds makes the research possible, and adds to the overall knowledge of the biodiversity of WA's environment and its special areas.

LANDSCOPE Expeditions are non-profit, self-supported study and research projects offered by LANDSCOPE magazine in association with UWA Extension, a department of The University of Western Australia. The expeditions answer the need for research to protect the environment, while responding to the demand for first-class interpretation by scientists and specialists.

In 2006, there will also be LANDSCOPE Expeditions to Francois Peron National Park, in the Shark Bay World Heritage Area, and Cape Arid National Park, east of Esperance, to conduct similar research into the wildflowers and wildlife of each area.



For more information about this, and the other LANDSCOPE Expeditions planned in 2006 and early 2007, contact DEC's Kevin Kenneally or Rohan Swan on (08) 9334 0561 or by email (Kevin.Kenneally@dec.wa.gov.au or Rohan.Swan@dec.wa.gov.au).

Rohan Swan has spent much of 2006 acting in the position of LANDSCOPE Expeditions Coordinator. Before taking up this role, Rohan worked with the Nearer to Nature program at the Perth Hills National Parks Centre as its Program Coordinator.

Rohan would like to thank Keith Morris, Brent Johnson and Mitchell Davies of DEC for their assistance in the preparation of this article.





Western Australia is blessed with an enormous range of underwater habitats. The tropical waters around Rowley Shoals Marine Park and islands further north protect some of the world's most pristine coral reefs. Warm and cool waters mix in the Ningaloo and Jurien Bay marine parks and allow an amazing overlap of marine creatures from both climates. The temperate, plankton-rich waters of our south-west and southern oceans support an enormous range of colourful, vibrant cool water plants and animals. Marine parks are essential to protect these delicate ecosystems, and the plants and animals themselves have evolved many complex and interesting ways to survive.

Corals and their cryptic collaborators

story and photos by Ann Storrie

Corals flourish in tropical and temperate waters and occur in every habitat along WA's coast. Hard, reef-building corals in our warmer waters contain single-celled algae in their tissues called zooxanthellae. These are the first of the cryptic collaborators in the complex world of corals. The algae, which obtain energy from sunlight, leach nutrients that the coral polyps can utilise. This enables the polyps to grow relatively quickly, and layer upon layer of corals build up to form the massive coral reefs of the tropics. Hard corals in the temperate zones don't form reefs, but some grow very large and may dominate areas of rocky reefs.

Soft corals and sea fans grow in all habitats and are often the most colourful creatures on coral and rocky reefs. Unlike hard corals, these animals don't have a solid skeleton. Instead,

small, calcareous structures (sclerites) in their tissues support the colony (along with water pressure). Sea fans are often called gorgonians, as a horn-like material called gorgonin gives them more rigidity. These impressive corals can grow very large, often jutting out from sheer walls of coral or rock.

Corals belong to the animal group that also includes sea whips, sea pens, anemones, jellyfish and hydroids. All

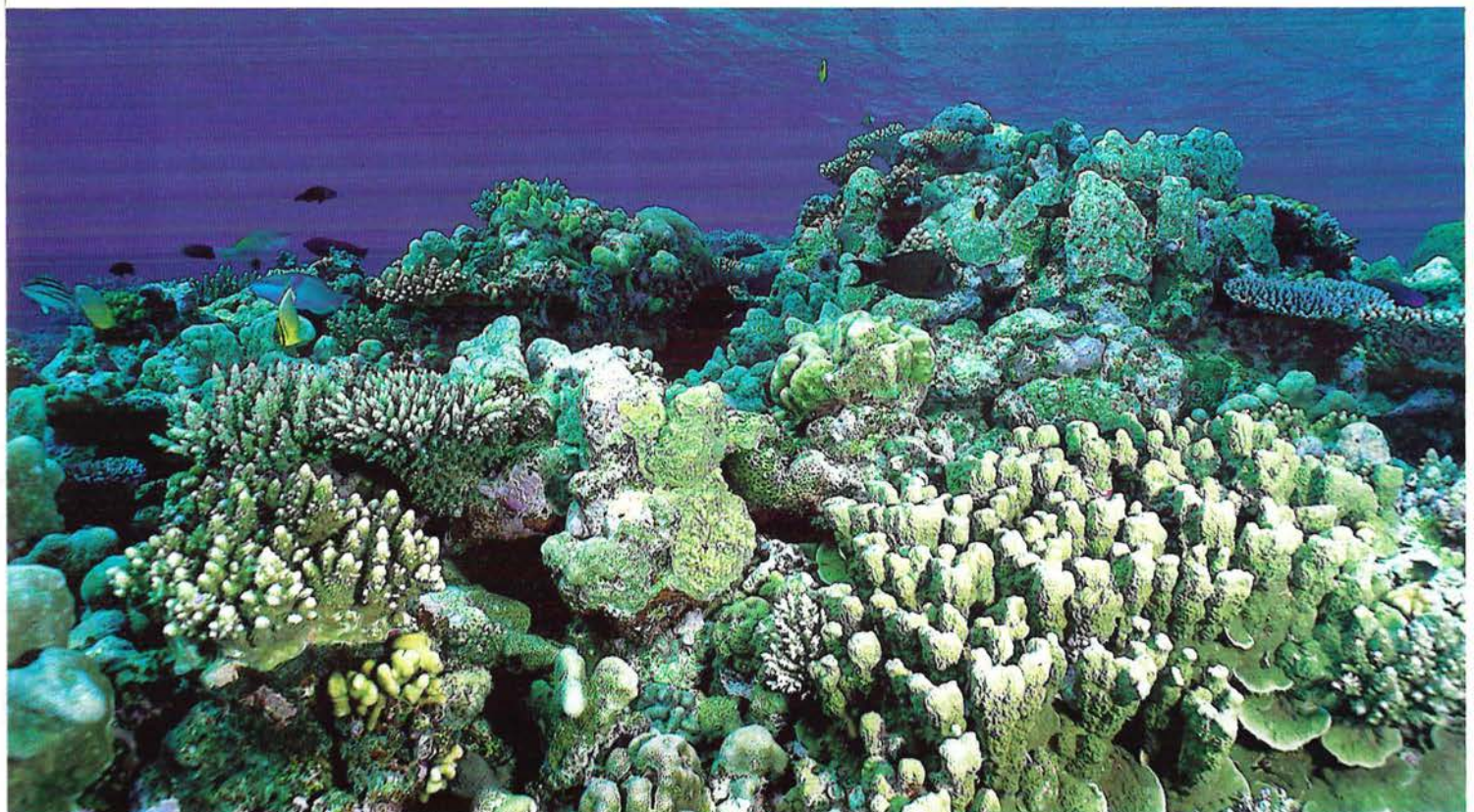
have a similar cup-shaped body with tentacles around the rim and a central opening that functions as a mouth and anus. The tentacles contain stinging cells, each of which contains a harpoon-like structure lying coiled like a spring. When touched, the harpoon shoots out of the cell and injects venom into the prey. Most hard and soft corals form colonies made up of hundreds or thousands of individual animals—

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Turret corals (*Tubastrea* and *Dendrophyllia*), non reef-building hard corals that often line cave roofs.

Right Christmas tree worm.

Below A 'garden' of hard corals.



coral polyps—all of which contain many stinging cells. If you were a tiny creature only a few millimetres long, and were immune to the stinging cell venom, you could therefore live in relative safety among a large colony of coral polyps.

Hard corals, crabs and Christmas tree worms

Many species of hard corals host large numbers of tenants. Colonies of Christmas tree worms (*Spirobranchus giganteus*), for example, inhabit large coral outcrops, especially the lumpy massive corals (*Porites* species) of the tropics. Anyone visiting Rowley Shoals Marine Park will be mesmerised by the fantastic, colourful array of worm tentacles protruding from the coral. Young worms settle on the coral and secrete a tube that kills the underlying polyps. The corals don't appear to be compromised by the worm's presence, for new coral growth quickly surrounds the tube. The worm continues to secrete additional tube material to keep pace with the coral's growth. The worm breathes, eats and excretes through the top of its tube and its feathery tentacles extend to trap plankton. The tentacles can be withdrawn in a split second if disturbed and a little cap, or operculum, seals the top of the tube for protection.

Several other species of worms, coral barnacles and molluscs bore into coral bombies. The worm snail (*Serpulorbis grandis*)—so called because divers often mistake it for a worm—cements its irregularly-coiled, tube-like shell to the hard surface. This mollusc has a beautifully mottled body. It secretes long, sticky strands of mucous to trap plankton, which are then pulled up by the snail and eaten, along with the plankton. Some animals, such as tiny coral hermit crabs and small blennies, take up residence in the empty tubes left when these animals die.

Clams and scallops also inhabit hard corals. A brightly coloured scallop, *Pedum spondyloideum*, lives encased in hard coral with its mantle visible. It has hair-like strands that are sensitive to touch and rows of red eyespots that perceive changes in light intensity, causing the valves to snap shut at the slightest movement or shadow. Coral



Top Coral crab.

Above False Tasmanian blenny.

clams also have sense organs on the edges of their colourful mantles. No two clams are exactly the same colour.

Cracks and crevices in, or branches of, hard corals provide homes for mobile animals, such as crinoids (feather stars), brittle stars, shrimps and crabs. Many *Pocillopora* corals with upright branches shelter a pair of little coral crabs, or trapeze crabs (*Trapezia wardi*), the male being the smaller of the two. This crab is unmistakable, with red spots on a white body.

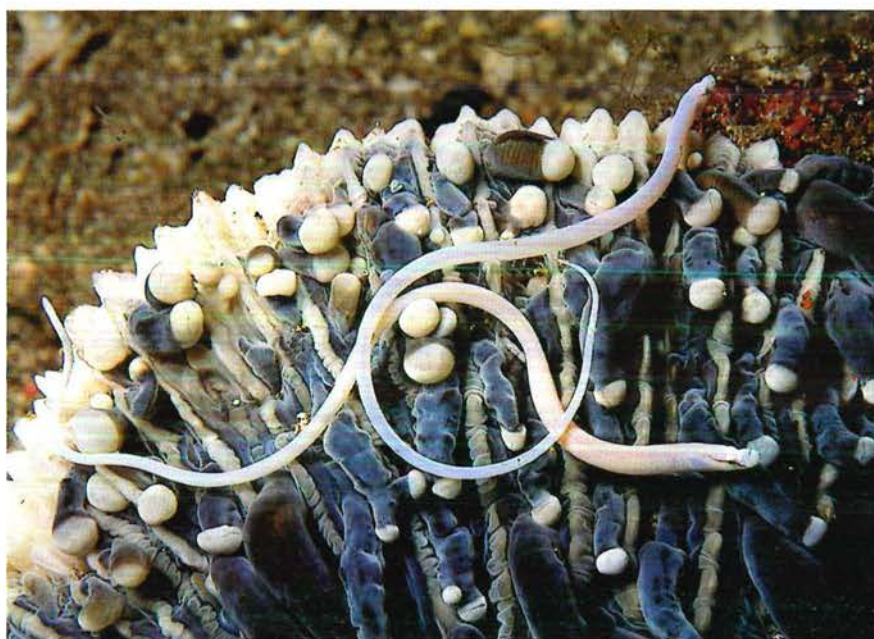
Many blennies and gobies—little fish with attitude—perch on hard coral outcrops to gain a good vantage point from which to pounce on small crustaceans and other prey. Some shelter in crevices, empty mollusc shells

or worm tubes in the coral. One group, the sabretooth blennies, are often seen poking their heads out of disused worm tubes. These blennies have two large, curved, canine teeth in the front of their lower jaws used for defence and sometimes to sever flesh from the fins of passing fish for food. Luckily, sabretooth blennies are only a few centimetres long!

Solitary corals, such as mushroom corals, are single coral polyps that grow relatively large (over 20 centimetres) and usually have an oval, or round disc-like



Above A shrimp (*Periclimenes holthuisi*) on bubble coral.



Left Mushroom coral pipefish are often mistaken for eels.

Below left Brittle stars take refuge in coral polyps during the day and extend their tentacles at night to feed.



skeleton. One such coral, *Heliopora actiniformis*, can host a number of tiny shrimps, and an unusual fish. At first glance, the long, white, slender, worm-like fish looks like an eel. It is actually the mushroom coral pipefish (*Siokunichthys nigrolineatus*). Several of these fish may be camouflaged among the coral's long tentacles. An unusual shrimp, *Periclimenes kororensis*, with a white spiny head and eyes that blend well with the white tips of the coral's tentacles, is also found in this coral. Watch out for its extremely long, transparent legs, which are often mistakenly chopped off in photographs. Many other *Periclimenes* shrimps are also found in this coral and are equally hard to see.

Bubble corals are hard corals with clusters of large, inflated, grape-like vesicles that are extended during the day. The vesicles contain symbiotic algae that take advantage of the light. At night, the vesicles deflate and the polyps and tentacles are extended to feed on plankton. Both the vesicles and

Right *Dendronephthya* soft corals are havens for many types of shrimps and crabs, such as the colourful candy crab.

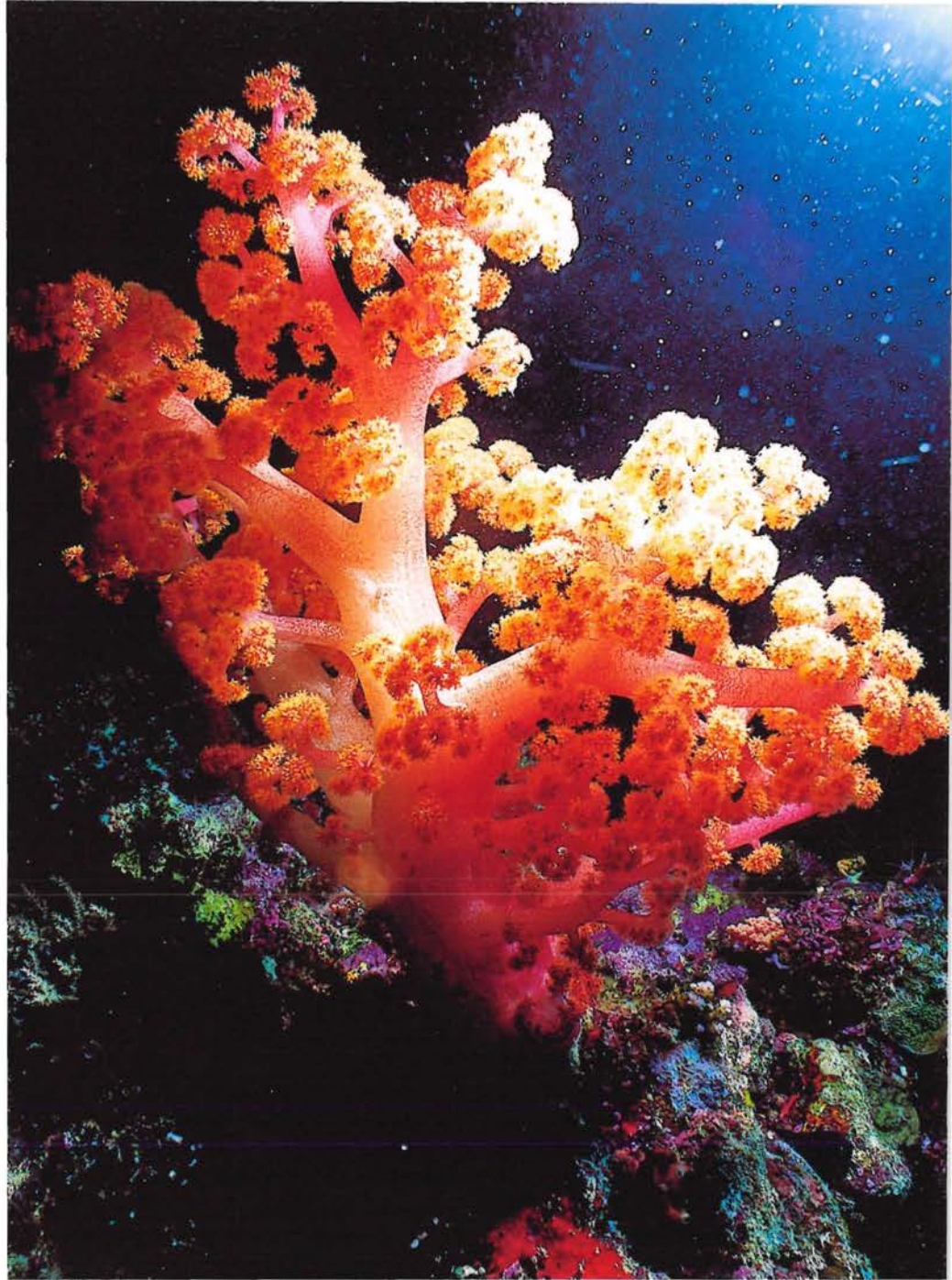
tentacles can deliver a nasty sting to divers, yet several commensal shrimps and crabs live on them. The orang-utan spider crab (*Archaeus japonicus*) has long, hairy legs upon which it can attach particles for camouflage. It particularly likes bubble corals, but is also found in several species of soft corals. The very cute, transparent little bubble anemone shrimp (*Vir philippinensis*) lives exclusively in bubble corals (*Plerogyra sinuosa*) throughout the Indo-Pacific. A relatively recent discovery was the invisible shrimp (*Pleurogyra singosa*), which has tiny, exquisite, pinpoint purple dots all over its legs and tail. Both of these shrimps share their bubble world with other *Periclimenes* shrimps, especially *P. holthuisi*, another almost-transparent shrimp with purple spots.

The vesicles of bubble coral attract acoel flatworms that are like small discs, often coloured green due to algae in the tissues. It is thought that the worms graze on minute crustaceans, such as copepods, and detritus that collect in the mucous on the surface of their vesicles. They add attractive patterns to the bubble coral.

Tubastrea and *Dendrophyllia* corals form clusters of tubular polyps that make a flamboyant show of yellow tentacles at night. Only their pink tubes are visible during the day, hanging under ledges or on cave walls. The two types of corals are very similar, only distinguishable by their internal skeletal structure. These corals may host acoel flatworms, a nudibranch, *Phestilla melanobranchia*, and wentletrap snails (*Epitonium billeanum*). Both the nudibranch and the snail feed on the polyps.

Soft coral shelters

Soft corals are also known as octocorals, as each polyp has eight feathery tentacles around its mouth. Octocorals include soft corals, sea fans, sea whips, blue corals, black corals, leather corals and sea pens. They are



as colourful as they are diverse, as are the creatures that live on them. Some of the most colourful are in the genus *Dendronephthya*, which has more than 250 described species. Also known as tree corals, they are usually profusely branched and their sclerites are often visible within the tissues. The sclerites are spindle shaped and give the coral its spiky look and feel, plus its brilliant colours of red, purple, orange, yellow, pink or white. They are a haven for small creatures.

The dendronephthya crab or candy crab (*Hoplophrys oatesii*), a small, superbly camouflaged crab, lives exclusively on this coral. Large, sharp spines on its body and legs look exactly like the polyps, and the colourful patterns on its translucent body perfectly mimic the

colour of the spicules. Tiny porcelain crabs also found on this coral are yet to be named. Less than 10 millimetres long, they are beautifully camouflaged with red to violet patterns on their white bodies. They move quickly, zooming around their host if disturbed. To photograph one often involves more luck than skill—the photographer may not even have known they were there!

Many spider crabs, coral crabs, shrimps, molluscs and echinoderms live on all species of soft corals. A beautiful, soft, white telesto coral that grows profusely on the piles of the Busselton Jetty (described in a book entitled *Beneath Busselton Jetty*) is home to decorator spider crabs that plant polyps on their bodies and legs. They are usually only seen at night when



you suddenly spot a clump of polyps 'walking' across the timber. The tiny telesto nudibranch (*Tritonia* sp.) is thought to feed exclusively on this coral. It has the ultimate camouflage with rows of feathery cerata, or protrusions over its body, that look similar to the coral polyps. The only flaw is that the number of 'tentacles' per cerata differs. The nudibranch has not yet learnt to count to eight!

Small cowries and allied cowries are amazing inhabitants of soft corals of the tropics. The colours and patterns of the shells are exquisite, and the mantle may be even closer in colour to the coral on which it lives. The mantle of the

mollusc is an outgrowth from the body wall that secretes and repairs the shell. It can completely cover the shell and may have a textured mantle that mimics the appearance of the coral polyps, adding to its incredible camouflage.

Sometimes, large numbers of brittle stars live on soft corals. Related to sea stars, brittle stars have five, very long, often fragile arms that can wrap around the branches of soft corals. Unlike most of their relatives, which hide under corals and rocks during the day, brittle stars rely on camouflage and a tight grip on the soft corals for protection. Brittle stars move around in search of prey at night. Basket stars may also wrap



themselves around soft corals, using the corals as a vantage point from which to extend their network of branched arms to trap passing plankton.

Sea fan cities and pygmies in polyps

Sea fans or gorgonians are gorgeous corals. Their breathtaking colours and sizes, in both tropical and temperate waters, never fail to attract divers, yet the myriad of small animal life within their branches goes largely unnoticed. Hundreds of species of fans can house tiny creatures from shrimps to sea-whip gobies to spindle cowries. Most fans grow in a flat plane, but are often very densely branched, with many branchlets fusing to form an intricate net-like structure. Finding tiny inhabitants among these enormous nets can be like looking for the proverbial needle in a haystack. Night is the best time to view these cryptic creatures, when the torch beam concentrates the search and the animals are actively looking for food.

Skeleton shrimps are among the smallest inhabitants of sea fans. They look like tiny strands of rubbish or



Above left The tiny telesto nudibranch is well camouflaged against telesto soft coral.

Above Pygmy seahorse attached to gorgonian coral.

Left A beautifully patterned worm snail sets a mucous net used to trap plankton.



Above Soft corals and sea fans at the Rowley Shoals Marine Park.

sticks caught among the branches. These shrimps are actually amphipods with large pincers or claws on their thoracic limbs. They are the stick insects of the ocean. Other small amphipods, such as ladybug amphipods (*Cyproidea* species), sometimes swarm over the surface of soft corals to feed on detritus among the polyps. They are approximately three millimetres long, but with striking orange to red spots and black stripes.

The gorgonian crab (*Xenocarcinus conicus*)—a long, triangular-bodied spider crab—blends in well with its environment, despite a distinctive white stripe down the centre of its carapace. Many other spider crabs and shrimps inhabit sea fans and are usually seen at night when they hunt for food.

Ovulids are related to cowries, but are in a family whose members feed on coral polyps. They are also known as allied cowries, egg cowries or spindle cowries. More than 200 species have been described. Spindle cowries are long and thin and lie flat along the branches of sea fans. Many have papillae ornamenting their mantles that mimic the polyps of their host, while the colours of the shell and mantle blend in perfectly. They are often the hardest animals to find among the gorgonian network.

Many fish live around and on the

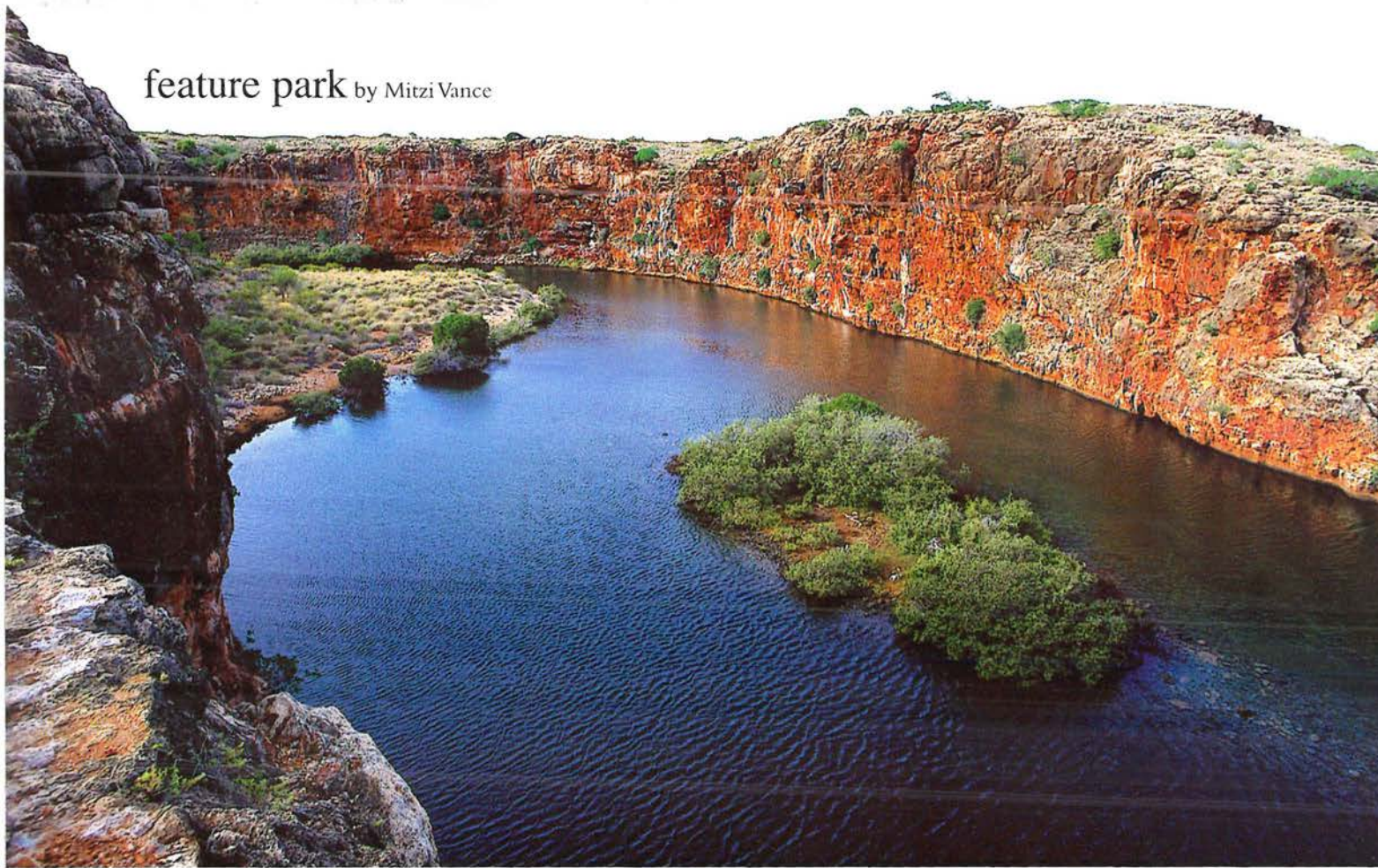
Right A brain coral at the Rowley Shoals.

sea fans. Juvenile fish, cardinalfish and damselfish swim among the network, while gobies and other small fish live on the branches. The amazing pygmy seahorses were only discovered in recent years. One species, *Hippocampus bargibanti*, grows to two centimetres and is usually found on *Muricella* gorgonians. They have two common colour variations—pink and yellow—depending on the colour of the sea fan they inhabit. Coloured nodules all over the bodies of these exquisite little fish look exactly like the withdrawn polyps of their host. They can live in areas of strong currents, tightly gripping the fan's branches while they feed on passing plankton. They occur in Indonesia, Papua New Guinea and northern Australia.

These amazing associations between host animals and their inhabitants occur everywhere you turn underwater. Understanding some of the complexity of life on our planet aids in appreciating the necessity to conserve our fragile environment.



Ann Storie, a freelance writer and photographer, has coauthored the full colour books *The Turquoise Coast*, *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.



Cape Range National Park

Cape Range National Park in the Pilbara region is known for its breathtaking scenery, startling contrasts and outstanding ecological values. The park is on the Register of the National Estate and, together with Ningaloo Reef, has been earmarked for possible World Heritage listing.

Above Yardie Creek Gorge, Cape Range National Park.

Opposite page

Top right Turquoise Bay, Cape Range National Park.

Photos – David Bettini

Encompassing diverse landscapes of high plateau shrubland, deep rocky gorges and flat coastal plains, the park offers habitats to an amazing array of wildlife, including extraordinary subterranean creatures found nowhere else in the world.

Range to reef

The park's rugged limestone range extends approximately 100 kilometres along the length of the peninsula, offering great opportunities for visitors to walk among deep gorges and across exposed scenic high country, such as Mandu Mandu Gorge (three kilometres, two hours) and the Badjirrajirra Trail (eight kilometres, five hours). From the foot of the range, a narrow coastal plain extends to sand dunes and the beaches, waters and coral reefs of the world-renowned Ningaloo Marine Park.

The limestone that forms Cape Range was laid down from marine sediments between 30 and 15 million years ago, when the whole area was covered by a warm, shallow sea. Over time, the seabed was thrust upwards

as the Earth's surface was faulted and folded. During some periods of extremely high rainfall, the range was deeply eroded into weathered surfaces and steep canyons.

Subterranean wildlife within the park includes species considered rare or likely to become extinct. The underground waterways within the park provide important habitats for these species and have been identified as nationally significant.

Euros, emus and perenties are abundant and the black-footed rock-wallaby is common on the cliffs of Yardie Creek. More than 200 bird species have been recorded in the area. The wildflowers are typical of the arid Pilbara region, but due to the area's relative isolation and geological history, the flora has some peculiarities. Some species, such as Sturt's desert pea (*Swainsona formosa*), have evolved distinctive forms, while others now isolated at Cape Range were once more widespread in northern Australia. Twelve plant species are found nowhere else but on the peninsula.



park facts

Where is it? The park's northern boundary is 39 km from Exmouth, travelling north and around the Cape. The southern boundary is 70 km north of Coral Bay (four-wheel-drive access only). Features on the eastern side can be reached via the Charles Knife and Shothole Canyon roads, south of Exmouth.

Travelling time 40 minutes from Exmouth, 3 hours along the coast from Coral Bay.

Total area 50,581 ha.

What to do Walking, beachcombing, camping, canoeing, picnicking, birdwatching, turtle watching and wildlife watching at Yardie Creek. Four-wheel-drive safaris are available from Exmouth.

Facilities Milyering Visitor Centre (drinks and souvenirs available at most times), Mangrove Bay bird hide. Picnic facilities at many sites. Camping areas are signposted (no campfires allowed) and fees apply. Water is available at one bore within the park and visitors are advised to bring their own drinking water. You can also stay at a wilderness camp within the park (swags and safari tents provided). Just outside the park, chalets, units, on-site vans and caravan sites are available at Yardie Homestead and at Lighthouse Caravan Park, 3 km from Tantabiddi boat ramp.

Must see sites The sheer walls of Mandu Mandu Gorge and the spectacular vistas of the gorge and ocean from Yardie Creek View.

Naming The range is on North-West Cape, so has been called Cape Range.

Campsites along the park's coast are adjacent to the magnificent Ningaloo Marine Park. The park access road is sealed, with two-wheel-drive access to camp and day-use sites. Four-wheel-drive is needed to cross Yardie Creek. Conditions change quickly with rain and access may become restricted. Campsites have limited facilities, without power or water. Fees apply and there are restrictions to the length of time you can camp in the park.

Milyering Visitor Centre is open

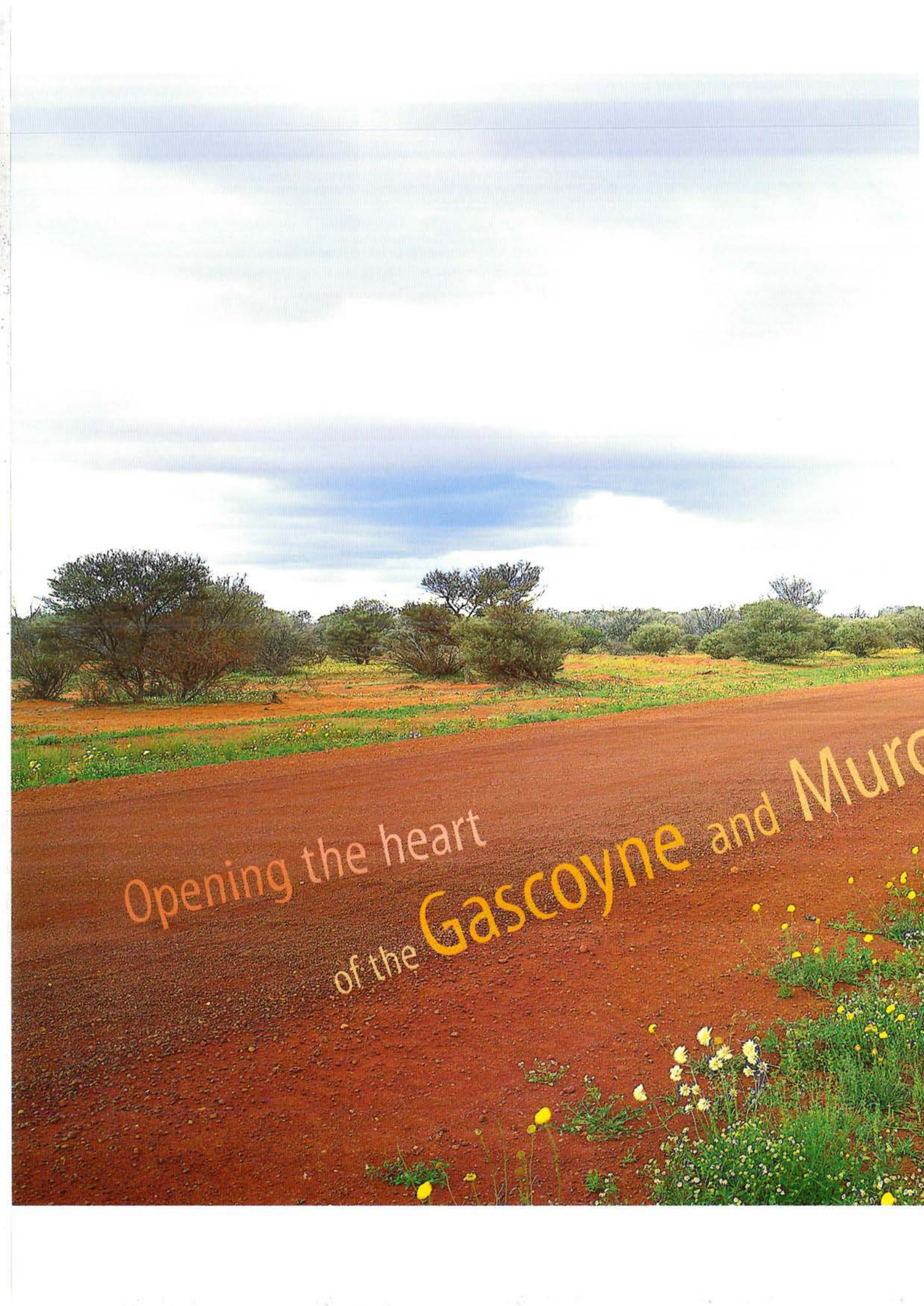
every day except Christmas Day. Displays, brochures and videos explain the natural communities of the park and adjacent marine park and a small library provides information for those with special interests.

Future plans

A draft management plan for the park was released for public comment earlier this year. It proposed strategies to ensure a range of high quality, sustainable recreation and tourism opportunities continue to be provided

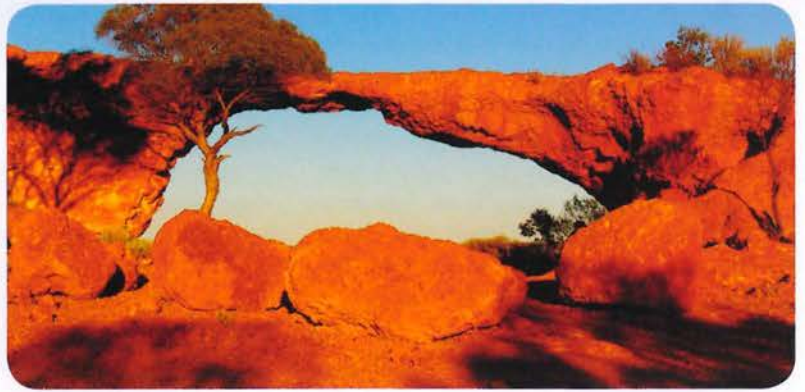
within the park, such as developing greater visitor opportunities away from the coast and nearer to the range, and improved day-use facilities.

A key part of Cape Range's future management is the involvement of traditional custodians, through the Yamatji Land and Sea Council, as the park contains many important Indigenous sites. Archaeological research has uncovered remnants from ancient marine-based communities, some of which are 25,000 years old.

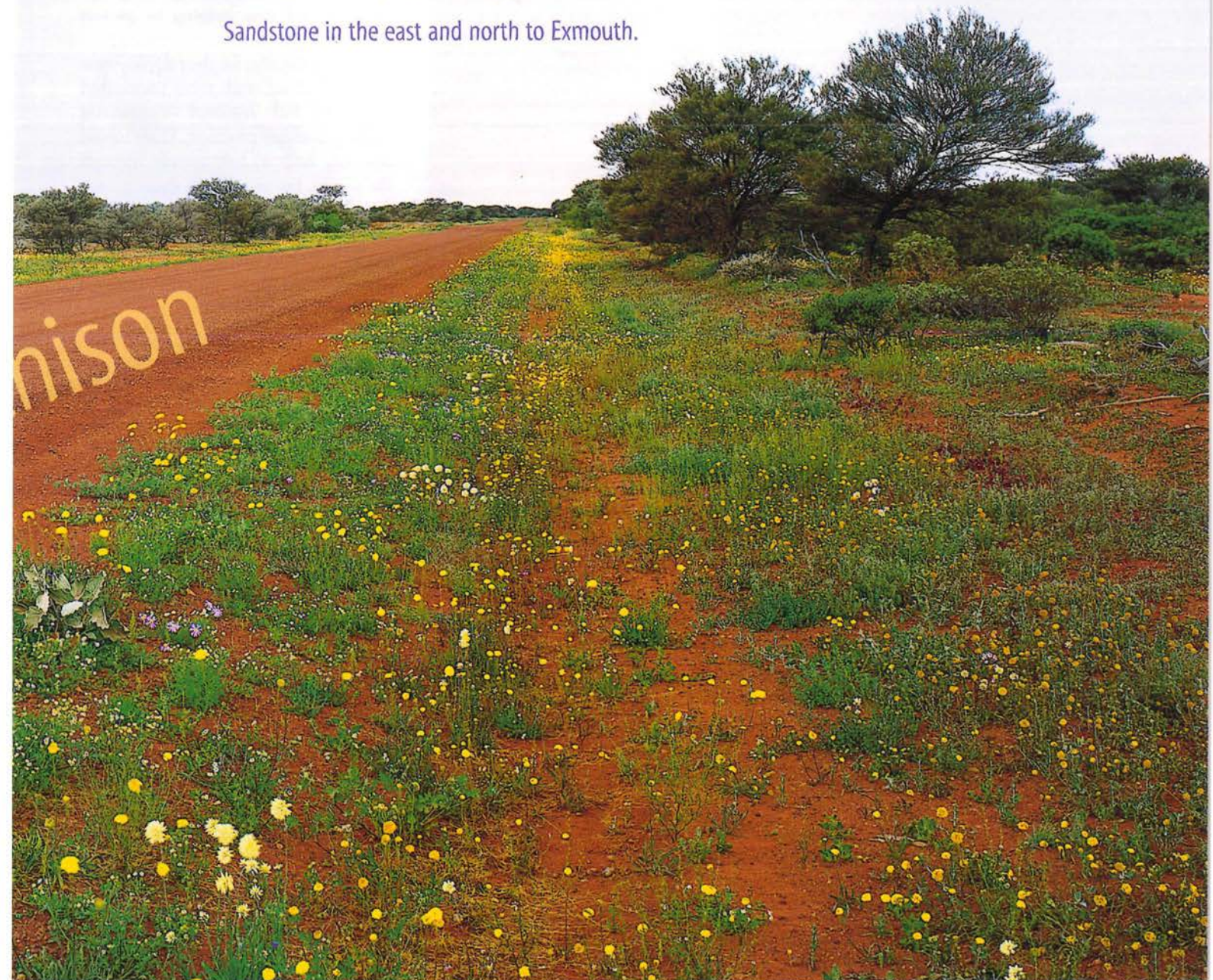


Opening the heart
of the Gascoyne and Murchison

More people are discovering the natural wonders and history of the Gascoyne and Murchison, thanks to the development of three self-drive trails. The Gascoyne Murchison



Outback Pathways traverse existing roads and are complemented by an extensive series of interpretive signage and a guidebook. The trails stretch from Geraldton in the west to Sandstone in the east and north to Exmouth.



by Samille Mitchell

Together, the three outback pathways—the Wool Wagon Pathway, the Miners Pathway and the Kingsford Smith Mail Run—traverse sweeping plains, stunning ranges, towering mounts, riverbeds, creeks and streams. They take visitors past ghost towns, heritage trails and areas of incredible natural beauty. But, more than all of this, the outback pathways open visitors' eyes to the wonders of the ancient landscape.

Instead of simply speeding by in a car, visitors are encouraged to stop and read the interpretive signs to discover

more about the area in which they are travelling. They may be driving over an ancient seabed, where fossilised sea shells imprisoned in the rocks provide clues to other ages. Or maybe they're following an old stock track, once frequented by Afghan teamsters and their camels, or by Aboriginal drovers with flocks of sheep. Perhaps they're at the desolate remains of a former gold rush centre, rusty machinery and aging artefacts the only clues of a once-bustling township. Or maybe they are at a site of Aboriginal significance—the subject of Dreamtime tales.

Project beginnings

The Gascoyne Murchison Outback Pathways project arose from the sweeping goals of the Gascoyne Murchison Strategy, which was aimed at improving the economic, environmental and social fabric of the region. It worked to improve opportunities for a dwindling population of Gascoyne and Murchison residents, many of whom were struggling to stay financially afloat due to the perils of drought and the difficulties of maintaining profitable station leases. Tourism was deemed a key to this aim. Tourism could encourage economic development and structural change in the region while at the same time supporting sustainable land use and thus helping to protect the environment.

And so the idea for the pathways was born. Self-drive trails were considered a way to link regional centres and existing tourism products. They would not only help to lure people through the region, but encourage them to stay longer. This, in turn, would encourage the development of further tourism product, bringing even more visitors and resulting in an upward spiral of economic growth.

Wool Wagon Pathway

The Wool Wagon Pathway begins in Geraldton and travels east to Yalgoo and north via the Murchison Settlement and Gascoyne Junction to Exmouth. It focuses on the pastoral industry and its pioneers, who settled the area more than a century ago.

After Geraldton, the first town one encounters on the Wool Wagon Pathway is Mullewa, one of the first townships to develop in the Murchison. This once-thriving settlement arose as

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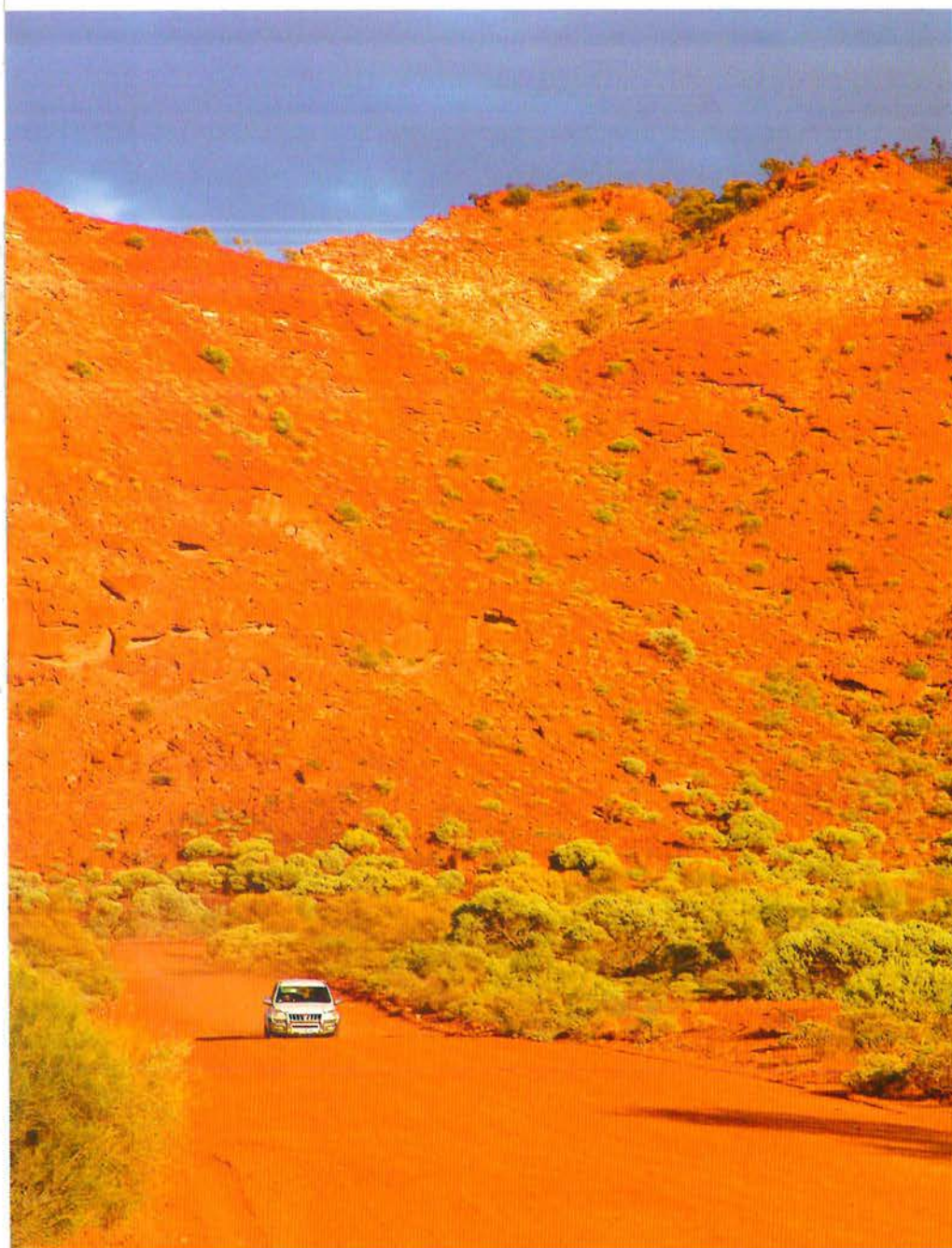
Main Carnarvon-Mullewa Road, near the Murchison Wool Wagon pathway.

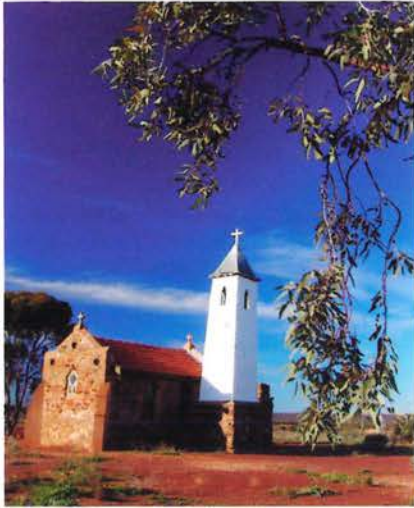
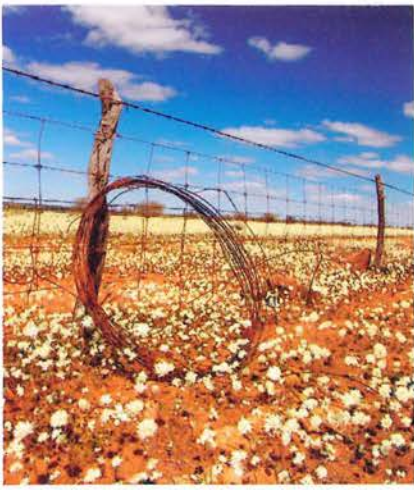
Photo – David Bettini

Inset London Bridge has long been a favoured picnic spot in Sandstone. Today it also features interpretive Outback Pathways signage.

Left A four-wheel-drive is dwarfed by a soaring cliff face in Kennedy Range National Park.

Photos – Samille Mitchell





Top Wildflowers adorn a Murchison roadside near Mullewa.

Above The Yalgoo Chapel is one of the many attractive buildings designed by Monsignor Hawes.

Photos – Samille Mitchell

a stop-off point for early pastoralists travelling from the inland Murchison to the port in Geraldton. These pastoralists would load their bales of wool and journey with donkey, horse, bullock or camel on dusty outback highways to Mullewa. Today, visitors to the region will find a much quieter rural township, renowned for its Indigenous culture and spectacular spring displays of wildflowers. Mullewa is also the former home of Reverend Monsignor Hawes, a remarkable man known for designing architectural gems across the Mid West in the early 1900s.

Continuing along the Wool Wagon Pathway, visitors will find the tiny settlement of Pindar. In its heyday, Pindar was the crossroads for the railway line—which travelled east to Cue and Meekatharra and west to Geraldton—and the trail extending north into the heart of the Murchison. Today, however, only a few heritage-listed buildings remain.



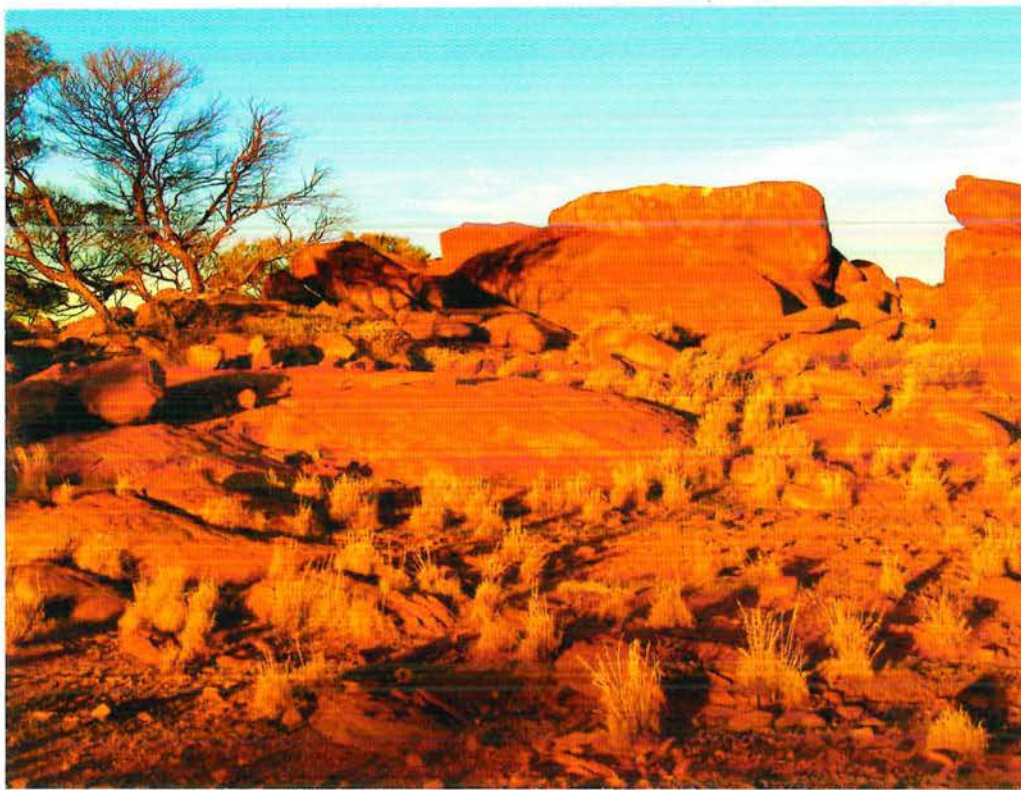
From Pindar, Outback Pathways travellers can head east to Yalgoo to the start of the Miners Pathway or north to the Murchison Settlement on the Wool Wagon Pathway. The Murchison Settlement is a tiny outback post renowned as the only shire in the country without a single township. But that is no wonder when you consider that just 150 people in 69 dwellings are spread throughout the 43,800-square-kilometre shire.

Continuing the journey north, travellers will pass two areas of natural beauty that are complemented by outback pathway interpretive signage. Errabiddy Bluff soars high above the surrounding plains. Its name is derived from the odd-looking rocks along its ridge: Errabiddy means 'mouth of bucked teeth' in the Indigenous language of the area. Bilung Pool is also of Aboriginal significance, and was an important meeting and camping

place for early Indigenous people. Its towering gums, small waterfall and pool make it a beautiful picnic spot today.

The next township on the Wool Wagon Pathway is Gascoyne Junction, well-known for its dinky-di Aussie pub. From here, travellers can join up with the Kingsford Smith Mail Run, heading east to Meekatharra or west to Carnarvon.

Pressing north along the Wool Wagon Pathway, travellers will find the magnificent Kennedy Range National Park, about 30 kilometres from Gascoyne Junction. Over the millennia, the natural forces of winds, rains and movement in the Earth's crust have combined to etch out valleys and push up a spectacular cliff face soaring up to 100 metres high. Today, the ancient landform stretches up to 25 kilometres wide and covers 75 kilometres in a north-south direction. Yet, 250 million years ago, the area was home to an



Left Peace Gorge in Meekatharra is a popular place to watch the sunset.

Centre left Yarding cattle at Bidgemia Station in the Gascoyne.

Below Meekatharra's wide main street greets travellers along the Outback Pathways.

Photos – Samille Mitchell

ancient seabed—one can still see life forms from another age imprisoned as fossils in the rocks here.

Many of the canyons of Kennedy Range are home to freshwater streams after rain, which pool to provide waterholes in the otherwise dry, inhospitable landscape. These pools must have been important water sources for the Indigenous people who inhabited the land from 20,000 years ago. It is believed that the Maia tribe inhabited land to the west of the range, while the Malgaru people inhabited land to the east. The range is home to about 100 sites of Aboriginal significance, including archaeological sites, ceremonial sites and sites of mythological importance. Indeed, the range plays an important part in the mythological history of the region. Indigenous people believe the Kennedy Range is inhabited and guarded by spirit beings such as the little people or big tall men and the rainbow serpent who occupies permanent springs and waterholes.





Above Rural scenes reflected at the old Big Bell townsite near Cue.

Photo – Samille Mitchell

Pressing still further north, through isolated station properties, travellers will eventually encounter Exmouth—gateway to the dazzling coral gardens of the Ningaloo Reef—on the coast.

Miners Pathway

The Miners Pathway covers the Murchison townships of Yalgoo, Mount Magnet, Cue, Meekatharra, Sandstone and Paynes Find in a figure-of-eight journey through the region. It explores the legacy of the remarkable gold rush period and the booms and busts these towns have since experienced. The starting point of Yalgoo is just one of many examples of the waxing and waning fortunes of Murchison townships. This now-sleepy outback post was once a thriving settlement, complete with dozens of shops and businesses, several pubs and hundreds of residents. Outback pathways travellers can gain an insight into these heady days of the past with many of the charming heritage buildings still standing in Yalgoo today.

The story is similar in Cue, Mount Magnet, Sandstone, Meekatharra and Paynes Find—each having boomed and then declined, yet still clung to existence and transformed with the times. Some are now experiencing another mineral boom. Other towns born in the gold rush era were not so lucky. Outback Pathways interpretive signage at places like Lennonville tell of formerly bustling townships—places where only crumbling stone walls and forgotten artefacts remain today.

Cue is particularly fascinating, boasting an excellent line-up of historic buildings and nearby ghost towns, such as Day Dawn and Big Bell. It's interesting to read the interpretive signs at these places and wonder about the trials and tribulations of the lives once lived here.

The Miners Pathway also traverses a geologically fascinating region. It boasts some of the oldest rocks in the world. In fact, recent advances in rock-dating technology have revealed that greenstone rocks found in the Murchison are from 2.7 billion to more than 3.0 billion years old. Some rocks at Mount Narryer and in the Jack Hills, north-west of Meekatharra, contain grains of the mineral zircon that are more than 4.3 billion years old. These are the oldest mineral grains to have ever been found and are helping scientists to understand how planet Earth formed.

It may seem strange but this ancient, seemingly inhospitable earth is also home to the most delicate-looking wildflowers. In fact, the entire Outback Pathways region, particularly in the Murchison, periodically bursts into colour. In late winter and spring the normally red and gold landscape erupts into a dazzling sea of colour as the annual wildflower show commences. This year is shaping up to be particularly spectacular, thanks to early winter rains.

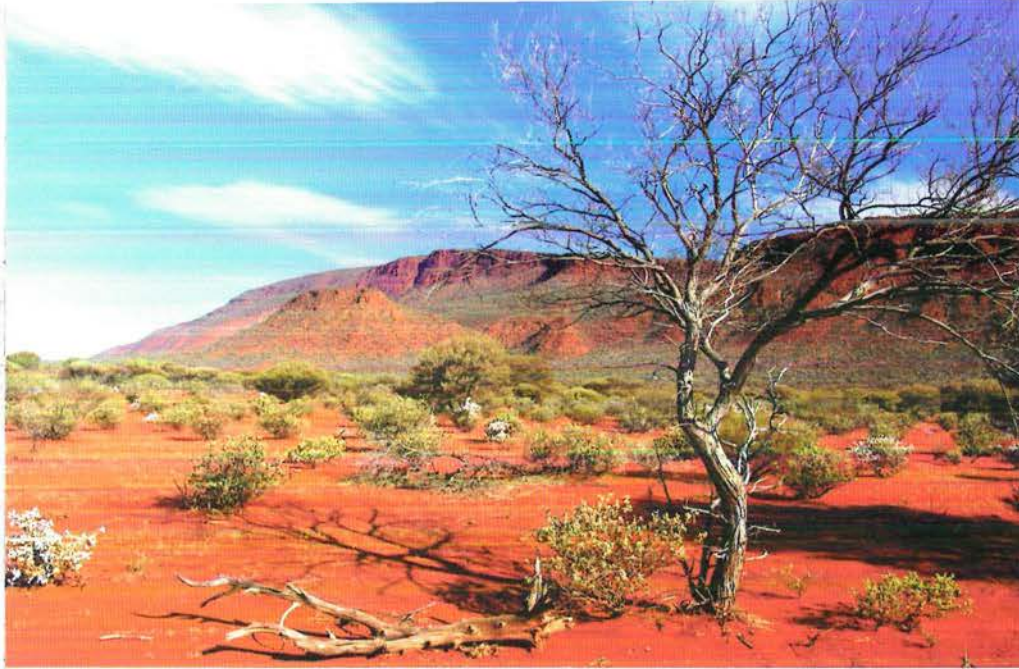
Kingsford Smith Mail Run

The Kingsford Smith Mail Run, from Carnarvon to Meekatharra, follows

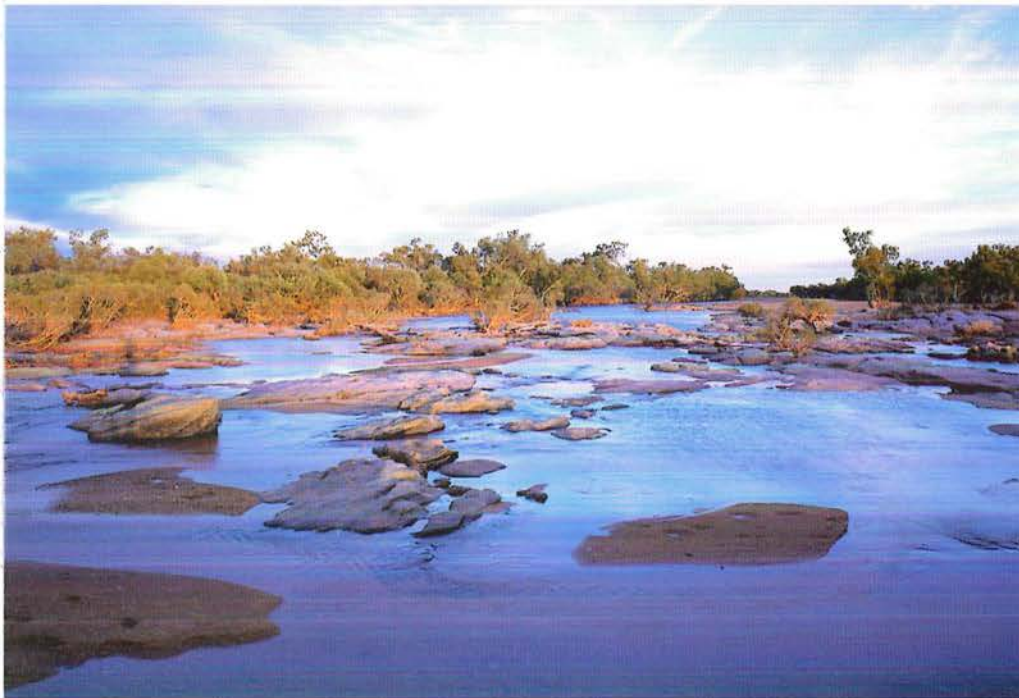
the tracks that Charles Kingsford Smith would have driven when he pioneered motor transport in the Gascoyne. Smithy, as he was known, arrived in 1924 fresh from a stint as a pilot for Australia's first commercial airline. He and his mate Keith Anderson bought a truck and set up a business as the Gascoyne Transport Company. One of the contracts he picked up was the mail run from Carnarvon to the Bangemall goldfields near Mount Augustus.

The trail begins on the coast in Carnarvon and heads east into an ancient inland landscape that was once home to an ocean. One interpretive sign along the trail tells of the weird and wonderful ocean creatures that once inhabited this now-dry landscape. If you fossick around here, you can even find fossils from this other age, imprisoned in the rocks.

The next town encountered is Gascoyne Junction—also the junction to the Wool Wagon Pathway. Nearby, you'll also find the mighty Gascoyne River. This river charges through the Gascoyne in times of flood and dries up almost totally during the dry summer months. Interpretive signage along the way tells of the important role this river and other water sources played in European and Aboriginal history, and its importance to local wildlife. It was named by early explorer George Grey on his treacherous journey of 1837.



Left The brooding beauty of Mount Augustus National Park.
Photo – Samille Mitchell



Below left Yinnetharra Crossing, Gascoyne River.
Photo – David Bettini

The Old Bangemall Inn on Cobra Station, 25 kilometres west of Mount Augustus, was the terminus for Smithy's mail run from Carnarvon. This oasis has provided food and accommodation for outback travellers since 1896 and is currently being revamped to improve its facilities. Bangemall Inn is an excellent base from which to experience the real Australian outback.

Continuing east, travellers will encounter the enormous hulk of Mount Augustus in the national park of the same name. This ancient landform soars 1105 metres above sea level and 715 metres above the surrounding plain. Though it is often referred to as a rock, Mount Augustus is, in fact, a sandstone and quartz massif with the rather unwieldy geological title of an

asymmetrical anticline. This refers to rock layers that were folded into an arch-like structure about 900 million years ago. Erosion of this anticline created the current form of Mount Augustus.

Mount Augustus is also known by the Aboriginal name, Burringurrah. Burringurrah was a boy who escaped the rigours of his tribal initiation, only to face the consequent wrath of his tribesmen, who speared him and clubbed him to death. The Wajarri people say the shape of the mount is the boy lying as he died on his belly with his left leg bent up, beside his body. The rock formations on the west of the rock show his wounds.

Mount Augustus and its surrounds are steeped in both Indigenous and European history. Aboriginal art adorns caves and rock walls at several points

around the base of Mount Augustus. However, the artworks are very ancient and are thought to be pre-Dreamtime, so their meaning has been lost to time.

Nearby, Outback Pathways travellers will also find the cool, shady waters of Cattle Pool. This gum-lined riverway is rich in birdlife. In fact, birdlife is a big drawcard to visitors at many of the waterholes across the Gascoyne and Murchison. At least 279 bird species are known from the Carnarvon Basin alone. Of these, 162 species breed in the area. Just walk along a tree-lined waterway and you'll be enchanted by the symphony of sound. Budgerigars, finches, native pigeons, galahs, parrots, and even pelicans and swans inhabit some of the pools.

Back on the road, travellers will pass the Aboriginal community of Burringurrah, designed to help Indigenous people remain on the land that has nurtured them for millennia. Nearby interpretive signs point to gnamma holes—natural holes in the rocks (often enlarged by Aboriginal people) that contain fresh water. In an otherwise dry landscape, these sources of water were very important to Indigenous people of earlier times.

Continuing on, travellers press deeper into the heart of Western Australia, before eventually arriving in Meekatharra—the launching point to the Miners Pathway and a whole other world of adventure.

Samille Mitchell is a freelance journalist and photographer specialising in travel and environment topics. She has recently written and photographed a 200-page guidebook on the Outback Pathways published by the Mid West Development Commission. The book is available from good bookshops, tourism information centres or you can order direct online from www.naturebase.net.



Critical action

Eight years ago the then Department of Conservation and Land Management (CALM) set out to help save 10 plant species on the brink of extinction.

Seedlings were propagated and planted in secure sites.

Has this strategy worked?

by Leonie Monks

So many of Western Australia's amazing wildflowers are rare or threatened. Some 376 of the State's 11,785 recognised species are considered rare, poorly known, at risk of extinction or presumed extinct. A variety of recovery actions can be implemented to protect our threatened flora. These may involve searching for new populations, collecting and storing seeds, restoring habitat and ameliorating threatening processes (such as competition from introduced weeds; grazing by feral animals, native animals and domestic stock; *Phytophthora*-caused dieback disease; increasing soil salinity, which is often coupled with rising water tables; changes in fire regimes; and accidental destruction).

For some threatened plants, however, the risk of extinction is now so high that it is not enough to look after the existing wild populations. Increasingly, flora translocations are being considered—in conjunction with other recovery actions—to help save some of our most threatened plants. In some cases, translocations are the 'last best hope' to stop our most critically endangered plants from going extinct.



Flora translocations are the transfer of plant material from one area to another for conservation purposes. This may mean planting more plants at a site where the species already occurs (or used to occur), or at new sites with appropriate habitat. In extreme cases, some species have suffered such dramatic declines in their natural habitat that translocation is urgent, but suitable habitat cannot be found. In such cases,

planting a seed orchard in a secure location is an option (see 'A safe haven for threatened plants', *LANDSCOPE*, Summer 2005–2006).

Undertaking a translocation isn't easy. It can take years of preparation and then, given the longevity of many Western Australian species, it can take many more years—or even decades—before it is known whether the plants have successfully established. So what does the process entail?

Striking new plants

First, a site needs to be found. It must have similar habitat to areas with existing populations of wild plants, but without the same kinds of threatening processes (there is no point planting at a site with threats, as the new population won't contribute to long-term conservation of the species). This means matching the soils and vegetation to the original site.

The next step is to propagate the plants. Seeds or propagation material (such as cuttings) can be collected from wild plants and grown immediately. In some cases, the seed material has already been collected and stored at low moisture content and low temperature (see 'Our Frozen Future', *LANDSCOPE*, Winter 2001) at the Department of Environment and Conservation's Threatened Flora Seed Centre. New plants are grown for the translocation by germinating seed in the Threatened Flora Seed Centre laboratory, or by striking new roots on leaf and stem material using plant hormones at the nursery. The new plants are grown in the nursery at the Botanic Gardens and Parks Authority, in conditions that ensure no weeds, pests or diseases are translocated along with the plants.

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Main Round-leaved honeysuckle (*Lambertia orbifolia*).

Photo – Andrew Davoll/Lochman Transparencies

Above Cunderdin daviesia.

Photo – Andrew Brown/DEC

Left DEC officer Renee Hartley plants Kambellup dryandra (*Dryandra ionthocarpa* subsp. *ionthocarpa*).

Photo – Leonie Monks/DEC



Planting takes place during the higher rainfall winter months, to guarantee the best start for the young plants. To learn as much as possible about the best techniques to use, and to ensure precious seed or plant material isn't wasted, all planting is done on an experimental basis. This may mean that, in some cases, only half the plants are fenced to protect them from herbivores such as rabbits and kangaroos, or only half the plants are watered over the first summer. Plants are monitored regularly for survival, growth, production of flowers and fruits and recruitment of second-generation plants to ensure we learn as much as possible about the likely success of the translocation.

How well has this strategy worked? Eight years ago the goal was to secure the long-term future of 10 critically endangered plant species using translocations (see 'Restoring diversity, restoring hope', *LANDSCOPE*, Spring 1997). Since then, CALM (which has since been incorporated into the Department of Environment and Conservation) has translocated 33 plant species, which has involved augmenting (adding plants to an existing population) six populations and starting 37 new populations in secure locations.

Some of these translocations haven't been successful. In some cases, drought has struck, kangaroos have eaten the seedlings, birds have damaged the watering systems or the seeds haven't germinated. In most cases we know what has not worked and why, and can therefore fix the problem before having another go. For example, 1500 blunt wattle (*Acacia aprica*) seeds were directly sown at a new site during the first translocation attempt. Only one of these seeds germinated—an incredible disappointment! The next year the seed was germinated in the laboratory, and grown in a nursery for six months before being planted at the site. Seven years later, 152 of the 181 seedlings planted are still alive—a survival rate of 84 per cent.

Round-leaved honeysuckle

Many translocations have done extremely well. They have survived, grown, flowered and then released thousands of seeds ready to start the next generation. In three cases, the second



Top Cunderdin daviesia habitat on a remnant road verge.

Above Cunderdin daviesia.
Photos – Andrew Brown/DEC

generation has already germinated—a promising sign that these new populations have the potential to be self-sustaining in the long term.

A good example is the round-leaved honeysuckle (*Lambertia orbifolia* subsp. *orbifolia*), which in 1998 was known from just two populations with a total of 169 individuals. These populations were threatened by *Phytophthora* dieback, aerial canker and accidental destruction during maintenance of their road verge habitat. Over four years, a total of 714 seedlings and cuttings were planted at a new site in a nearby nature reserve. Fifty four per cent of these plants still survive seven years later, having grown rapidly, flowered and produced viable seed. Pollinators, including the western spinebill, have been observed feeding from the flowers. Studies using molecular markers show these birds are moving pollen between many of these plants, resulting in significant cross

pollination. The most positive sign of all was the discovery in 2003 that seedlings had germinated naturally at the site. The presence of seedlings is the best indication that the new population will be able to persist in the long term without management intervention.

In addition to all this positive news, the use of some simple experiments has shown us that mulching and tree guards are not needed to successfully translocate this species. This will save hundreds of dollars, which can be better spent on future translocations or other recovery actions. Another experiment has revealed that fencing plants to protect them from grazing by kangaroos is absolutely essential to ensure plants can survive, grow and reproduce.



In another positive development, Department of Environment and Conservation Threatened Flora Officer Sarah Barrett discovered a new naturally occurring population of round-leaved honeysuckle and many more plants in one of the other wild populations. The land containing one of these populations was purchased by the State government and recently declared a

nature reserve. Translocation, combined with a range of recovery actions, has significantly increased the chance that round-leaved honeysuckle will continue to persist in the long term.

Spiral-fruited wattle

Spiral-fruited wattle (*Acacia cochlocarpa* subsp. *cochlocarpa*) is another success story. This subspecies was known from just 115 plants growing on a narrow road verge, about 250 kilometres north of Perth, threatened by road maintenance activities, spray drift from adjacent agricultural areas and competition from weeds. Over

four years, 779 seedlings were planted and 84 seeds were germinated directly in two disused gravel pits in a nature reserve (only about four kilometres up the road from the natural population) with the same soil type and similar associated plant species. To date, 557 of these plants are surviving—an almost sixfold increase in the number of plants in the wild.

Our experiments show that fencing to protect plants from grazing results in more than twice as many plants surviving as those left unprotected. This makes the cost of buying fencing a worthwhile investment. We have also found that six-month-old seedlings have a similar survival rate to seedlings grown in the nursery for 18 months, but grow at a faster rate and produce more seed per plant. Hence, it is better to plant younger seedlings, which are also less likely to be damaged when being moved to the site.

Watering the seedlings over the first summer was shown to result in greater growth, although it didn't increase survival. Greater growth means more seed can potentially be produced, thus improving the chance of a second generation.



Top left A volunteer mulches plants at a spiral-fruited wattle site.

Photo – Leonie Monks/DEC

Above left Spiral-fruited wattle habitat.

Photo – Gillian Stack/DEC

Above Spiral-fruited wattle flowers.

Photo – Bruce Maslin/DEC

Left Volunteers monitoring Three Springs davisia (*Daviesia bursarioides*).

Photo – Leonie Monks/DEC



Productive partnerships

Some translocation projects have allowed good partnerships to be forged between the Department of Environment and Conservation and community groups. The Cunderdin *daviesia* (*Daviesia cunderdin*) and tangled wattle (*Acacia volubilis*), for example, are both critically endangered and occur in small numbers near the Wheatbelt town of Cunderdin (about 150 kilometres east of Perth). Cunderdin *daviesia* is known from a single population of about 12 plants on a narrow road verge. Tangled wattle grows at the same location, but is also known from 10 other populations with a total of 89 known plants. In 2002, the Landcare Officers in Cunderdin, Amanda Godfrey and Faye Christison, became concerned about the Cunderdin *daviesia* and wanted to do something to help. As a result, a joint project was set up between the Cunderdin Landcare Group and the former agency CALM to look after Cunderdin *daviesia* and tangled wattle. The Cunderdin Landcare Group obtained a grant from the Threatened Species Network to help fund some of this work.

The Christisons owned a piece of remnant vegetation containing one of

the natural tangled wattle populations, so the plan was to translocate seedlings and cuttings of the two species there. In July 2004, 102 cuttings of Cunderdin *daviesia*, and 75 seedlings and cuttings of tangled wattle, were planted at the site. Because the first summer was long and dry, only 13 tangled wattles and 18 Cunderdin *daviesias* survived, but this was still a significant increase (in terms of percentages of the overall numbers of each species) in numbers of plants occurring in the wild. We have learnt more about how to carry out the next translocation and a productive partnership has developed between DEC and the Cunderdin Landcare Group.

Translocation is very labour and resource intensive, so it is very important to find out which techniques deliver the best outcomes. In the last eight years we have learnt a lot about how to achieve translocation success. For some projects, like the round-leaved honeysuckle, we are quietly confident that a new, viable population has been established. For other species, like the spiral-fruited wattle, the signs are encouraging, but it is still too early to say whether we have been successful.

Top Tangled wattle.

Photo – Andrew Brown/DEC

Above Tangled wattle flowers.

Photo – Bruce Maslin/DEC

Above left Amanda Godfrey, then the Landcare officer for Cunderdin, planting Cunderdin *daviesia*.

Photo – Leonie Monks/DEC

Below Flowers of the Cunderdin *daviesia*.

Photo – Andrew Brown/DEC

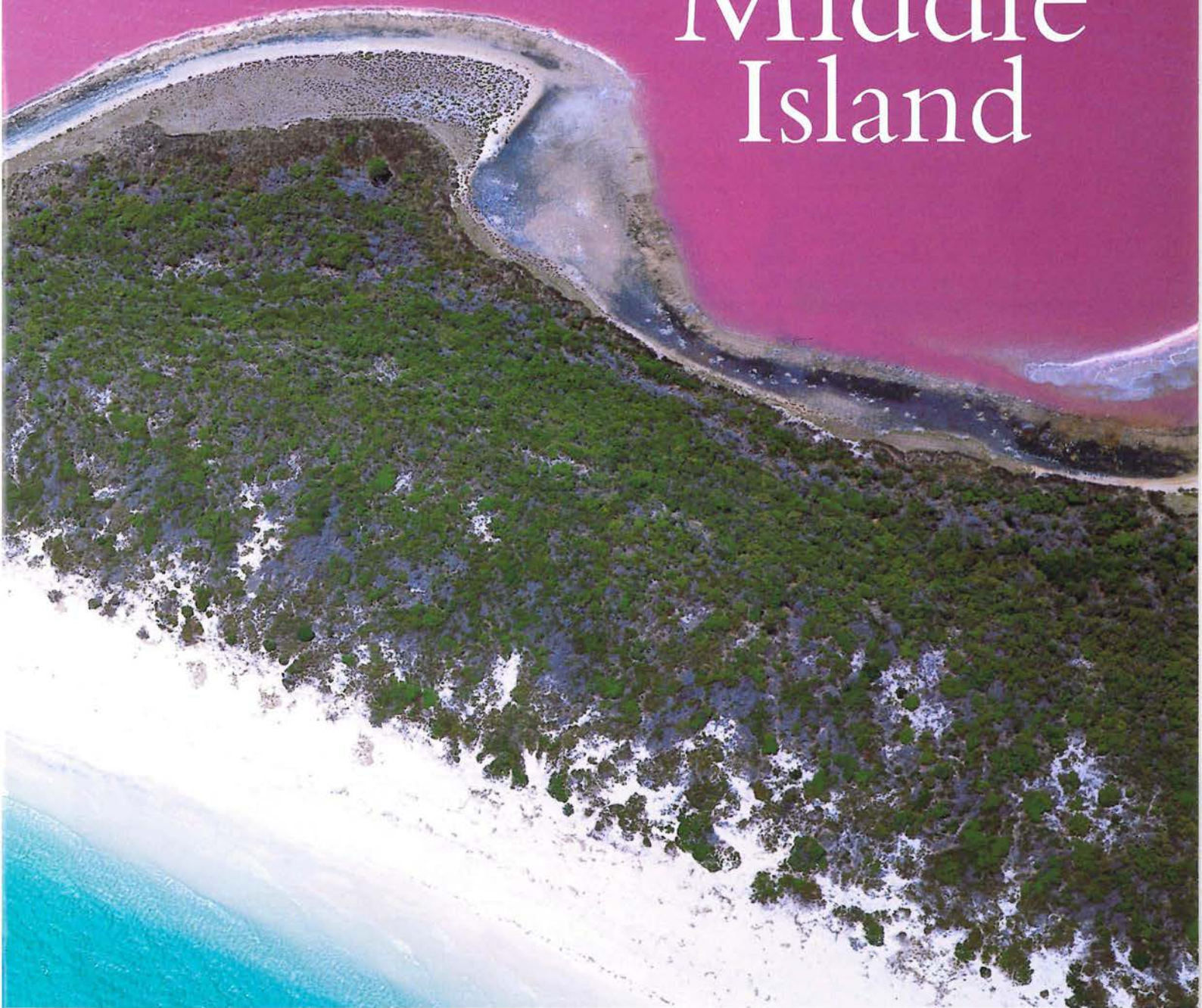
Overall, we know that translocations, monitored over the long term, and undertaken in conjunction with other recovery actions, are a powerful tool to aid in the fight to save our most critically endangered plants.



Leonie Monks is a Research Scientist in the Department of Environment and Conservation's Science Division, based at Kensington. She can be contacted on (08) 9334 0495 or via email (Leonie.Monks@dec.wa.gov.au).



A visit to Middle Island



Islands are places of romantic appeal—and Western Australia has hundreds of them, from the south coast to the Kimberley. Every island is different and each one has a story to tell. Department of Environment and Conservation officers Andrew Williams and Robert Powell have visited a number of islands to study butterflies, including fascinating Middle Island in the Recherche Archipelago.

by Andrew A E Williams and Robert Powell



Not so long ago, Western Australia's islands were actually part of the Australian mainland. During the last glacial maximum, some 18,000 years ago, the expanding polar ice-packs sucked up vast quantities of oceanic water. As a result, sea levels fell, and our islands became high points on an expanding coastal plain. Since then sea levels have risen, re-forming today's islands.

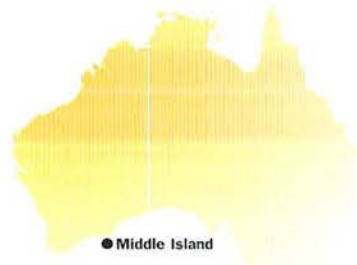
WA's islands vary in age. Some of those furthest from the mainland may have existed for 15,000 years, others for much less time. Rottnest Island, 18 kilometres off Perth, has apparently been separated from the mainland for 7000 years. Remarkably, Aboriginal oral history records Aboriginal ancestors as being able to walk from what is now Fremantle across Gage Roads to Rottnest.

Many islands have a distinctive appearance. Fires are usually less frequent on islands than on the adjacent mainland, but the pressure on plants from grazing animals is often higher. Such factors often result in island vegetation that is dramatically different from that of the nearby mainland.

From a conservation standpoint, islands may be immensely valuable as refuges for animals marooned as sea levels rose. Lancelin Island, for example, which lies less than a kilometre from the

mainland, is the only place where the Lancelin Island skink (*Ctenotus lancelini*) is now known to occur. Interestingly, the original population of this species now appears to have disappeared from the mainland. Some of our mammals that have become extinct on the mainland through the introduction of the fox and the cat still exist on some islands. Islands also provide places where many seabirds can nest, free from many mainland predators.

Biologically, WA's islands are fascinating places to study. Even though they have been isolated for a relatively short time, some already have animal forms that are distinct from their counterparts on the mainland. Two islands in the Recherche Archipelago have an endemic subspecies of dugite (*Pseudonaja affinis tanneri*) and the Houtman Abrolhos Islands have a distinct subspecies of spiny-tailed skink (*Egernia stokesii stokesii*).



Previous page

Main Aerial view of the northern shore of Lake Hillier on Middle Island.

Photo – David Bettini

Inset bottom Native hibiscus (*Alogyne hakeifolia*) after a fire in 1977.

Photo – Angas Hopkins/DEC

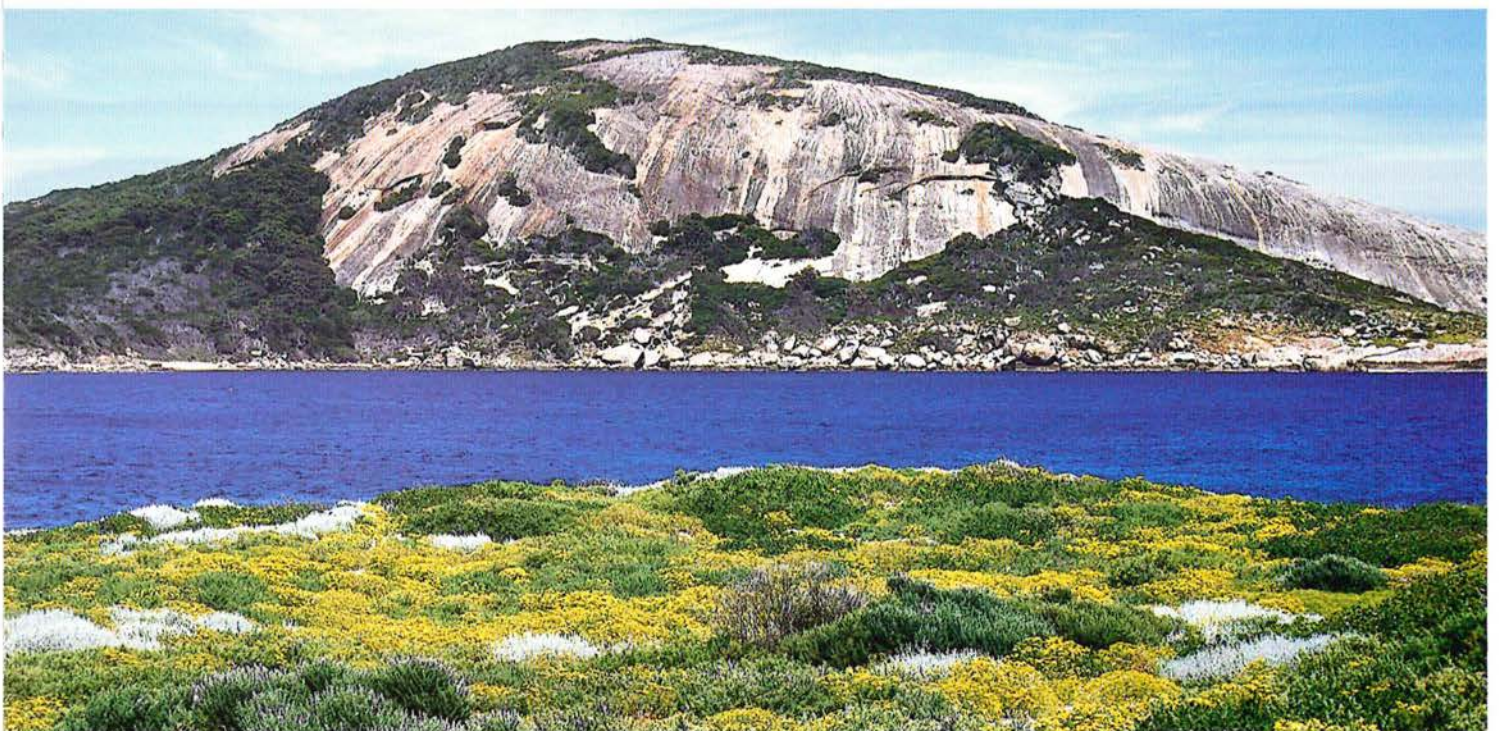
Inset right Fringed heath-blue (*Neolucia agricola*), a common resident butterfly.

Below Flinders Peak, Middle Island, viewed from nearby Goose Island.

Photos – Robert Powell/DEC

The Recherche Archipelago

The 100 or so islands of the Recherche Archipelago lie off the southern coast of Western Australia east of Esperance. Their earliest recorded history dates back to 1627, when Pieter Nuyts and Francois Thijssen visited the south coast of Australia in the Dutch ship *Gulden Zeepaard*. The next recorded visit, more than 150 years later, was in 1791, when Captain Vancouver arrived aboard the *Discovery*. The following year, Rear Admiral Bruny D'Entrecasteaux, in command of two ships, *La Recherche* and *L'Esperance*, visited the south coast, and named the islands 'L'Archipel de la Recherche'. D'Entrecasteaux did not, however, proceed through the archipelago, but chose rather to skirt





around it, following a safer, more southerly route.

In January 1802, Matthew Flinders arrived on board the *Investigator*. His party, which included noted botanist Robert Brown, was the first to set foot on Middle Island, the largest island in the archipelago. In 1803, having completed a circumnavigation of the continent, Flinders again visited Middle Island, where he buried two of his crew members, Charles Douglas and William Hillier. In 1818, Captain Phillip Parker King, on board the *Mermaid*, briefly visited Middle Island.

By 1825, reports of abundant seals had lured sealers to the south coast. By all accounts they were a rough lot, many being time-expired convicts, sent out by merchants from Sydney. Newspapers of the day (*Perth Gazette* and *Western Australian Journal*) reported on the activities of these lawless gangs, which had established themselves on the archipelago's largest islands. For a time the archipelago was virtually ruled by the notorious 'Black Anderson', a giant African-American from Long Island. About this time, Middle Island became a centre for whaling. Evidence of the stone houses and stone-lined wells built in those days is still visible today. When the whaling industry declined, Middle Island was abandoned and was not reoccupied until the end of the century, when salt was mined for a short time on Lake Hillier. Some years later, in June 1920, the SS *Penguin* was deliberately run aground in shallow water off Belinda Beach. The remains of its rusting hull can still be seen protruding from the water.



Top left Restored stone-lined well, originally built in whaling days.
Photo – Robert Powell/DEC

Top Lake Hillier.
Photo – David Bettini

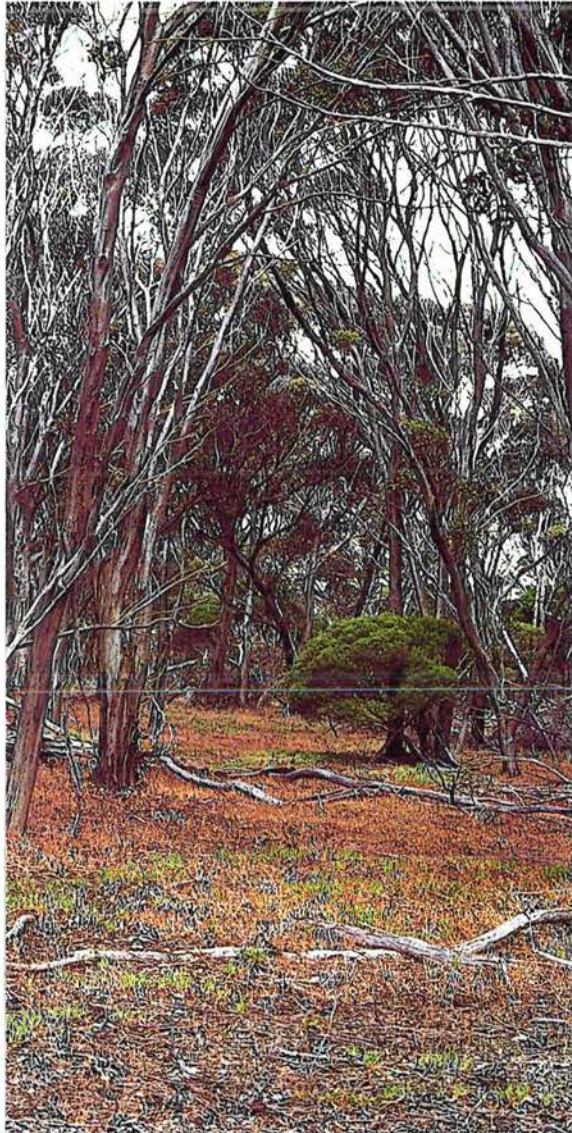
Above The SS *Penguin* was wrecked on Middle Island in 1920 while trying to shelter from a gale. It was engaged in survey work at the time.
Photo – Andrew Williams/DEC

In 1950 the Australian Geographical Society conducted a comprehensive biological survey of 20 of the archipelago's islands, including Middle Island. Today, the islands of the Recherche Archipelago are encompassed within the Recherche Archipelago Nature Reserve, and managed by the Department of Environment and Conservation (DEC).

Middle Island

Middle Island (1080 hectares) lies about 120 kilometres east of Esperance and 8.5 kilometres south of the mainland at Cape Arid. Its dominant feature, Flinders Peak, rises to 174 metres. Its coastline is very irregular, with numerous promontories and

coves. The only safe landing is Belinda Beach, on the northern side of the island, sheltered from the southerly swells. The island is composed largely of granite, though part of the central



area is overlain with limestone, and sand has accumulated in some valleys. The different soils give rise to a varied flora. Middle Island is the only island in the archipelago to have a lake. Lake Hillier, pink and hypersaline, is located behind a narrow, steep dune inland from Belinda Beach.

In November 2003, reserve management personnel from DEC's (then CALM's) Esperance office visited Middle Island to repair a boardwalk and erect new reserve signs. We joined the party to document the island's butterfly fauna. November was chosen as the best month for this purpose. We also took the opportunity to observe the island's vertebrate fauna and to study its vegetation.

Left Tall eucalypts in long-unburnt vegetation photographed on Middle Island in the 1970s.

Photo – Angas Hopkins/DEC

Below View across Lake Hillier. Eucalypts and moonahs (*Melaleuca lanceolata*) growing densely in the background are still far from their mature size, more than 26 years after the 1977 fire.

Photo – Robert Powell/DEC



Because Middle Island is part of the Recherche Archipelago Nature Reserve, strict conditions apply to visits to the island.

Vegetation

In 1972 a major wildfire burnt half of Middle Island and, the following year, staff from the WA Herbarium, the WA Wildlife Research Centre and other institutions collaborated to begin a study of its effects (an account of which is published in *SWANS*, Volume 11, No. 2, 1981). These studies established that, before the fire, Middle Island had not been burnt for 170 years. Unfortunately, a second wildfire, in 1977, burnt much of the remaining area, precluding further study of vegetation that had remained unburnt for such a long time.

On the mainland many tree and shrub species survive being burnt, and recover by resprouting from epicormic shoots along their branches, or from underground rootstocks. The fires on Middle Island, however, killed virtually all the trees and shrubs outright, and the subsequent regrowth was almost entirely from seedlings. Most of the area we explored was burnt in the fire of 1977. It was apparent that, 26 years later, the vegetation was far from fully developed. The eucalypts and moonahs (*Melaleuca lanceolata*) were still quite small and juvenile. We contemplated how very different it would have been had the fires not occurred: the old vegetation would have had a special beauty and given us a sense of timelessness. Moreover, we would have been able to get about much more easily. The old, tall vegetation, much more open at ground level than the dense tangle we encountered, would have allowed us access to Flinders Peak to look for hilltopping butterflies.

Vertebrate fauna

One mammal, 15 reptile species and a frog have been recorded from Middle Island. Our opportunistic observations showed that many species continue to flourish. Tamar wallabies (*Macropus eugenii*) were very common, particularly in the dense cover south of Lake Hillier. Southern heath monitors (*Varanus rosenbergi*), the island's main predators, were often foraging for invertebrates in leaf litter



Above Southern heath monitor.
 Photo – Robert Powell/DEC

Right The spotted-thighed frog occurs in southern WA, including two islands in the Recherche Archipelago. Here it takes advantage of summer rains to breed.
 Photo – David Pearson/DEC



around our campsite, and at times were bold enough to enter our tents! Ornate dragons (*Ctenophorus ornatus*) were active on exposed granite surfaces during the day. Several skink species, including Napoleon's skink (*Egernia napoleonis*) and *Bassiana trilineata*, were seen in shrubland and woodland habitats. At night, marbled geckos (*Phyllodactylus marmoratus*) and barking geckos (*Underwoodisaurus millii*) were spotted with the lights of our headtorches. A crowned snake (*Elapognathus coronata*) was found coiled under a sheet of exfoliating granite, and tadpoles, probably of the spotted-thighed frog (*Litoria cyclorhynchus*), inhabited a rock pool on a granite dome near our campsite. Several species of birds were seen, including the sooty oystercatcher, Pacific gull, white-bellied sea-eagle, silvereye and singing honeyeater.

Butterflies

Island butterflies can conveniently be divided into 'visitors' and 'permanent residents'. The visitors are species that

travel between the island and the mainland. They may breed on the island if the right plants grow there, but readily leave the island, and there are times when neither the butterflies nor their eggs, larvae or pupae are present. The permanent residents breed and also remain on the island. At any time of year either the adult butterflies or their eggs, larvae or pupae will be present. Most butterfly species fall neatly into one of those categories. Most visitors breed continuously and have several generations a year, whereas most permanent residents have just one generation a year.

Studying island butterflies tells us which species are mobile enough to

travel to islands, and which species are able to maintain a sedentary population on an island. Islands that lie different distances from the mainland can show us what distances the more mobile butterfly species will travel, and islands of different sizes show what size of habitat is necessary for the more sedentary species.

We recorded six butterfly species on Middle Island. Four of them—the Australian painted lady (*Vanessa kershawi*), yellow admiral (*Vanessa itea*), meadow argus (*Junonia villida*) and common grass-blue (*Zizina labradus*)—fall into the 'visitor' category.

The first three are powerful, fast-flying insects, known to be highly



Far left A golden-haired sedge-skipper (*Hesperilla chrysotricha*) on coast saw-sedge (*Gahnia trifida*) on which the larvae feed.

Left Fringed heath-blue butterfly.

Below left Australian painted lady (*Vanessa kershawi*), a highly mobile butterfly and a typical visitor from the mainland.

Bottom Andrew Williams setting butterfly specimens.

Photos – Robert Powell/DEC

mobile and migratory. They typically turn up on islands, even distant ones, where they breed on suitable plants. We recorded all three on islands of the Houtman Abrolhos group, 60–70 kilometres off the coast west of Geraldton. The last, the common grass-blue, does not fly so strongly, and probably relies more on favourable winds to travel to islands. During our survey on Mondrain Island, also in the Recherche Archipelago, 11 kilometres from the coast, we did not encounter this butterfly during the first three days, but found it in abundance on the fourth day, after the wind began to blow from the north-east, more the direction of the mainland.

The remaining two species—the fringed heath-blue (*Neolucia agricola*)

and the golden-haired sedge-skipper (*Hesperilla chrysotricha*)—are likely to be permanent residents.

The fringed heath-blue was common and widespread on Middle Island. It breeds on plants in the pea family (*Fabaceae*), in such genera as *Pultenaea* and *Eutaxia*. Specimens were found near flowering shrubs of *Pultenaea obcordata* and *Eutaxia obovata*, on which the larvae would undoubtedly feed.

Skipping danger

The golden-haired sedge-skipper was locally abundant along the eastern shoreline of Lake Hillier, where the plant on which the larvae feed, coast saw-sedge (*Gahnia trifida*), grows in a narrow belt. In the early mornings, males were seen flying among the

foliage, searching for newly-emerged unmated females. The larvae live in tubular shelters, which they make by producing silk and sewing three or four of the sedge's leaves together. One end of this tube is left open and the larva comes out occasionally to feed. Once it is mature it seals the entrance with a wad of silk and then pupates. The butterflies emerge in November, and are on the wing for only a week or two. Having mated, the females then lay their eggs on the sedge and the life-cycle begins again.

Wildfires on islands can threaten resident butterfly populations by destroying the foliage on which their larvae feed. The 1977 fire may well have burnt much or all of the coast saw-sedge at Lake Hillier. The sedge-skipper survived, however, probably because clumps of the sedge also occur on parts of the island not affected by this fire.




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Robert Powell is a keen naturalist who works at the Department of Environment and Conservation's Kensington office. He can be contacted on (08) 9334 0430 or by email (Robert.Powell@dec.wa.gov.au).

All enquiries about visiting Middle Island should be directed to the DEC Esperance District office by phoning (08) 9083 2100.

Manypeaks

rising from the ashes



Several important populations of threatened plants and animals—including Gilbert's potoroo, the most threatened mammal in Australia—live in isolated bushland areas along the South Coast region. When a scorching fire at Mount Manypeaks Nature Reserve killed many threatened noisy scrub-birds and western whipbirds—and burnt large areas of their habitat—the tragedy also provided scientists with the chance to find out more about the fire protection needs of the region's threatened plants and animals.

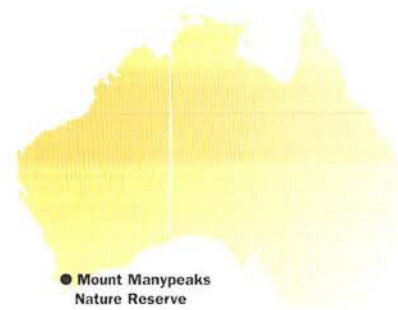
by Sarah Comer and
Allan Burbidge

In today's fragmented landscapes, conserving biodiversity presents many challenges. From the inherent complexities of managing isolated populations of plants and animals to managing processes and threats such as fire and introduced animals, land managers and scientists are constantly working to achieve real biodiversity outcomes, to ensure the long-term conservation of Western Australia's unique plants and animals.

This is an ongoing learning process. For example, for many years, noisy scrub-bird habitat had been managed on the basis of excluding fire from such areas, since scrub-birds prefer long-unburnt vegetation. The success of this policy was such that, in combination with a translocation program, it allowed the population size to exceed all expectations. In recent years, however, large wildfires on the south coast have forced managers and scientists to reconsider the strategy of total fire exclusion.

Special needs

Fire regimes that are inappropriate for a specific species may ultimately lead to its loss. Some animals require special food or shelter that is only found in long-unburnt vegetation, some rely on seeds produced by early post-fire colonising plants, and some require



● Mount Manypeaks Nature Reserve

structurally simple vegetation that is often seen in the years following a fire. Plants also have varied requirements, in both fire intervals and fire intensities, with many needing more than 10 years between fires to flower and set seed. Management of natural areas is thus, by necessity, a delicate balancing act to ensure different species with sometimes conflicting requirements are able to persist.

Staff from the Department of Environment and Conservation's South Coast region, Fire Management Services and Science Division have been working with recovery teams and community groups to provide the best outcomes for a suite of threatened plants and animals found in the Two Peoples Bay–Mount Manypeaks area. They include the Gilbert's potoroo, noisy scrub-bird, western ground parrot, western bristlebird, western whipbird and Australasian bittern. Threatened plants in the area include granite banksia (*Banksia verticillata*), mountain paper-

heath (*Sphenotoma drummondii*) and Manypeaks rush (*Chordifex abortivus*). Species that are uncommon, but not listed as threatened, include a trapdoor spider known only from moist habitats on the south coast.

The noisy scrub-bird has had the longest running recovery program of any of these species. The population of scrub-birds on Manypeaks was established following translocations in 1983 and 1985. By 1994, this area supported more scrub-birds than the source population, at Mount Gardner in Two Peoples Bay Nature Reserve. The strategy was to establish distinct subpopulations of this threatened bird, and thus minimise the risk of losing the entire population in a single wildfire.

The scrub-bird program also stimulated much more work in the Albany area, resulting in increased knowledge of other threatened species. To make decisions on managing habitat for these species, fire managers have had to come to grips with the special requirements of each species (see box on page 53) and needed to determine exactly where they occur. It is important to know when two or more of these species occur in close proximity, so that no species suffers because of management for the special requirements of another. Wildfire, however, can upset the best laid plans.

Unfriendly fire

In 2000, a wildfire burnt through most of the Angove Water Reserve and into Two Peoples Bay Nature Reserve, affecting about 6500 hectares of habitat used by several threatened species. Its impact on scrub-birds was not severe. The scrub-bird population had been surveyed just months before the fire.

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Main Mount Manypeaks three months after the fire. Kingias have flowered and sedges are resprouting, providing food for quokkas and other grazing animals. Photo – Sarah Comer

Left Quokkas have been seen regularly since the wildfire, having survived in small refuge areas. They are now benefiting from the resprouting and germinating vegetation. Photo – Babs and Bert Wells/DEC



Right The population of the western heath subspecies of the western whipbird was impacted severely by the fire.
Photo – Babs and Bert Wells/DEC



Below Staff from the WA Museum and DEC survey the southern slopes of Mount Manypeaks in the months after the fire.
Photo – Anne Cochrane

It was monitored again in 2001, and the recovery team estimated that less than 10 per cent of the total scrub-bird population had been lost in the wildfire. Quokkas, ringtail possums, bristlebirds and whipbirds had not recently been surveyed in the burnt area so it was impossible to determine the effect of fire on these species in any detail. While there was no impact on the only population of Gilbert's potoroo, the wildfire highlighted Mount Gardner's vulnerability to wildfire. It also highlighted the value of the noisy scrub-bird translocation program.

This fire provided the impetus for more extensive work on some of the other threatened birds and, in 2001, the Albany Management Zone was surveyed to provide a complete picture of population sizes of whipbirds and bristlebirds in the area.



Different species, different needs

Most, if not all, of the threatened vertebrates on the south coast are negatively impacted by extensive intense wildfires. Most of these species have limited dispersal abilities, so cannot escape such fires and are slow to recolonise afterwards. Although the western ground parrot is quite mobile, it suffers from extensive fires because its habitat is fragmented and restricted in area, so high-intensity fires can have a negative impact on local populations.

On the other hand, low-intensity fires are not much of a problem for the tree-dwelling ringtail possum, provided enough of the canopy is left intact to provide shelter sites and food. Such fires may even benefit possums, as they can promote the growth of young leaves on jarrah saplings, a particularly important food source for ringtail possums. However, even low-intensity fires trickling through the undergrowth can be bad news for semi-flightless noisy scrub-birds, which rely on a dense layer of leaf litter in which to find their food—litter invertebrates. In some places, fires like this are not a problem for western bristlebirds, as they can escape and move to a nearby unburnt area, provided it has similar vegetation structure. Some more common birds, such as robins, can even benefit from cool fires because they open up the vegetation structure and make it easier for these birds to use their 'perch and pounce' methods of finding food.

Like many other animals, quokkas suffer from intense fires. However, much of the area burnt during the recent fire on Manypeaks was at low intensity, and the mosaic of fire intensities left numerous refuge areas. Regeneration of vegetation following the fire has provided ideal conditions for quokkas, and the population has been expanding rapidly. The effects of fire on Gilbert's potoroos are much less clear. They have only survived at Two Peoples Bay in an area that has not been burnt for a very long time, suggesting that they are highly fire sensitive. However, even if the fungi that make up more than 90 per cent of the potoroo diet are more abundant following cool, patchy burns, the potoroo's requirement for dense shelter may not see this species benefit directly from fire. Much more research is needed to understand the complexity of the relationships between fungus-feeding mammals, their food supplies and fire.

Inappropriate fire can also be a problem for some invertebrates, such as the trapdoor spider (*Moggridgea* sp.) that was found on Manypeaks following the fire. These Gondwanan relictual spiders have shallow burrows around six millimetres deep in mossy creekbanks. These shallow burrows don't afford much protection against the intense heat of a wildfire, and individuals may be literally cooked in their burrows. Intense fire results in erosion and collapse of creekbanks through loss of vegetation, and the post-fire accumulation of litter and vigorous regeneration often makes these banks unsuitable for burrows.

The mountain paper-heath is an endangered species found on Mount Manypeaks, in Stirling Range National Park and in a small population near Walpole. It grows in shallow soils in steep rocky areas that afford it some protection from fire. Its seed is stored in the soil, and the plant is killed by fire. The juvenile period, or time to first flowering, is not known. The granite banksia is also restricted to relatively fire-free sites, often associated with granite outcrops. It is killed by fire, but extremely old populations may require fire to stimulate seedling recruitment. If threatened animals, or other fire-sensitive plants, occur in the vicinity, careful management of regeneration burns is required.

If these threatened species occur in the same area, management can be challenging, and has to be conducted at a very fine scale.



Above One of the noisy scrub-birds captured recently to translocate to Porongurup National Park.

Photo – Alan Danks



Left Basing water bombers in Albany has provided an opportunity to fight fires in otherwise inaccessible areas.

Below left Regenerating vegetation on Falls Gully on the northern slopes of Mount Manypeaks. It will be many years before it reaches maturity.

Photos – Sarah Comer



This improved our knowledge base, but still left the hard decisions. A discussion paper, written in 2003, put forward ideas on the fire management of the Two Peoples Bay–Manypeaks area. People with fire expertise and those with detailed knowledge of the area’s plants and animals subsequently participated in a workshop in Albany. The workshop examined the inherent problems of fire management in the area, and suggested some long-term solutions. After they had been endorsed and supported by recovery teams, the first of a number of prescription burns was planned for the area in 2004.

Mosaic for Manypeaks

The idea was to reduce the risk of large-scale wildfires by creating a mosaic of fire ages. At Mount Manypeaks, however, a single cell of around 4500 hectares had extensive areas containing very old fuel loads—and access was restricted to the perimeter of the cell due to the dense vegetation and lack

Right In some places the wildfire was very patchy, as on the ridge of Mount Manypeaks looking towards Bald Island. Photo – Sarah Comer

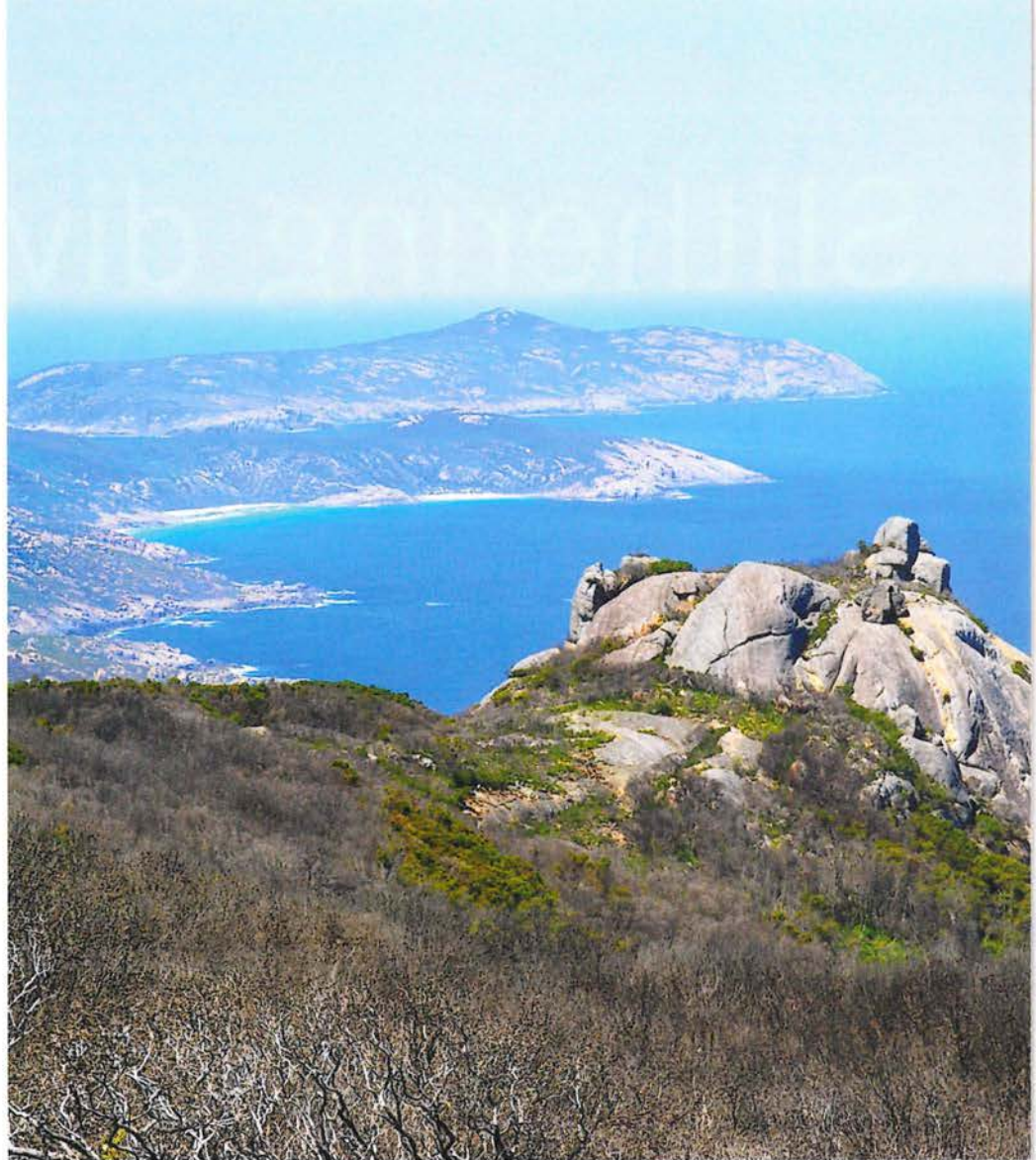
of internal tracks so—the use of fire in this area was highly risky, except under the most favourable conditions. To begin constructing a mosaic of fuel ages in the Manypeaks cell it was planned to aeri ally ignite very small areas under moist conditions. Before this plan could be executed, however, a lightning storm struck in December 2004.

A local fisherman reported a thin column of smoke on the southern slopes of Mount Manypeaks on 31 December. Crews—including water bombers, which had been based at Albany since 2004—were immediately mobilised to fight the fire but, despite their best efforts, the entire 4500-hectare block was burnt to some degree. This single area was home to more than half of the world’s noisy scrub-birds and more than 30 per cent of the western heath subspecies of the western whipbird.

Project Phoenix

Because of the unique opportunity to study post-fire recovery of Mount Manypeaks, ‘Project Phoenix’ was established. It began in early 2005 and will survey populations of threatened birds, study their recolonisation of the Manypeaks area and increase monitoring of other wildlife in the area. It will also increase fox baiting and implement cat control in the area; improve fire access and plan for future wildfire control at Manypeaks; and increase understanding of the impact of wildfire on noisy scrub-bird habitat.

In 2005, an enthusiastic team of volunteers and CALM staff (CALM has since been incorporated into the new Department of Environment and Conservation) conducted post-fire baseline surveys of noisy scrub-birds, western whipbirds and western bristlebirds. Populations of all three species had been severely impacted by the wildfire, in particular, those of noisy



scrub-birds and western whipbirds. In fact, almost all of the noisy scrub-birds in the 427 territories counted in the Manypeaks area in 2001—estimated to be about 1000 scrub-birds—had perished.

The loss—through this one event—of 4500 hectares of optimal scrub-bird habitat, in addition to approximately 4000 hectares of habitat burnt in other wildfires since 2001, means that only around 4500 hectares of optimal scrub-bird habitat now remain in the Albany area. Again, this demonstrated the value of the scrub-bird translocation program. It also reinforced the belief that the main objective is to ensure long-term persistence of all threatened species—a policy of fire exclusion might maximise numbers of individuals of a given species at some points in time, but is not necessarily the optimum strategy in the longer term, especially when it creates a situation where wildfire is almost impossible to manage, thereby putting the animals living in such areas at risk.

Challenges for the future include developing strategies that maintain suitable habitat for the assemblage of plants and animals—threatened and non-threatened—that occur in this and other areas with similar biological diversity. On Mount Manypeaks there is now an opportunity to establish a managed fire regime that minimises the risk of extensive fires affecting the entire mountain area. Increasing our understanding of fire behaviour—and the habitat requirements of these unique species—will help managers to use fire to help conserve this highly valuable conservation area.

Sarah Comer and Allan Burbidge are ecologists with the Department of Environment and Conservation. Sarah is based in the South Coast region at Albany and Allan in the Science Division at the Woodvale Research Centre. Both are members of threatened species recovery teams and have been involved with threatened species recovery for many years.



Slithering diversity: the remarkable snakes of Western Australia

What is it about snakes that so captures the imagination? Love or loathe them, their horizontal belly-bound life, limbless bodies and staring eyes convey an 'other-worldliness', especially to erect, lanky and blinking mammals such as us.

by David Pearson



Western Australia is blessed (yes, blessed!) with around 110 species of snakes (there are around 2600 species worldwide). New species are discovered occasionally in more remote regions, or through genetic techniques that can distinguish differences, despite similar external appearances. Snakes occur in just about every habitat you can imagine: from tall forests in the south-west to sandy coastal plains, and from rugged mountain ranges to arid spinifex deserts. Many species are also found in marine habitats, some preferring mangroves, and others inhabiting coral reefs or shallow inshore waters. Some sea-snakes even occupy deep oceanic waters.

Origin of snakes

The evolutionary history of snakes is still the source of some debate. As snakes have lots of small delicate bones,

they are not well preserved in fossil deposits, so the few fossils that have been located have generated considerable interest. Some palaeontologists maintain that snakes evolved from an aquatic ancestor, such as the plesiosaur of the dinosaur age. This is due primarily to the discovery of a snake-like species with small trailing legs in a marine fossil deposit (the aptly-named *Pachyrachis problematicus*). The more conventional view is that snakes evolved from a terrestrial burrowing lizard during the Cretaceous period around 100 million years ago.

The success of an elongate body form led to the evolution of many species of snakes. The older groups of snakes, such as the pythons and blind snakes, retain remnants of the hind limbs and the pelvis. In pythons, the hind limb remnants form small 'cloacal spurs' which male pythons use to tickle and tantalise females when they are mating. Interestingly, some snakes chose to colonise water and their body shapes evolved to suit an aquatic lifestyle, with a lateral flattening of the body and tail to aid in swimming, nasal flaps to stop

water entering the lungs during diving and an ability to accurately control buoyancy.

Australian snakes are derived from two geographic origins. Most have evolved from ancestors that occurred on the supercontinent Gondwana (an amalgamation of Australia, India, Antarctica, Africa and South America). These are the blind snakes (in the family Typhlopidae), pythons (Boidae) and front-fanged venomous species including sea-snakes (the Elapidae). Around 15 million years ago, as Australia drifted towards Asia, other snake species were able to cross the sea and colonise Australia by rafting or swimming between islands, especially snakes in the Family Colubridae (including the brown tree snake and several aquatic species).

Thin compromises

Adopting an elongate body shape posed a number of problems for snakes and they developed some elegant solutions to cope with the lack of body width. Most species have only one lung, the right lung, although often the trachea (or windpipe) is enlarged and also functions to exchange air. The lung is long and can extend up to two thirds of the length of the snake. Some snakes, such as pythons, retain a much smaller left lung. Unlike humans, snakes lack a diaphragm, so air is drawn in and out of the lung using movement of the rib-cage. Other body organs, such as the stomach and liver, are similarly elongate, while the heart must be able to pump blood to the extremities of the body, even when much of the body may be higher than the heart.

Reproductive organs have also been compromised. Testes are paired, but are small and flattened until the onset of breeding, when they swell with sperm. Female snakes have two ovaries, which continually form ova during their adult life. If they are not fertilised, then the ova can be reabsorbed, and the nutrients saved for other body functions.

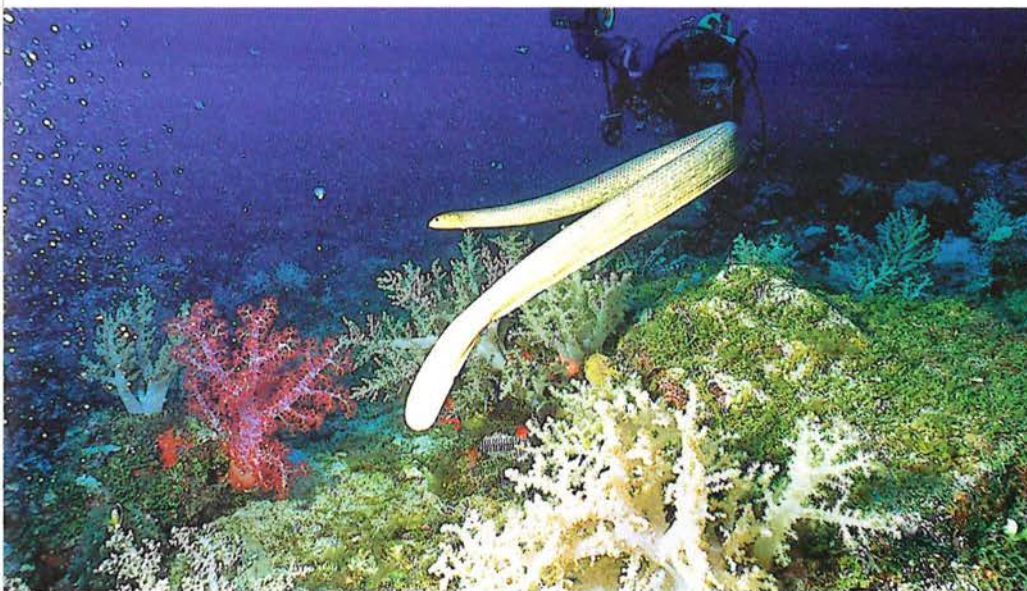
Long bodies require different support systems. Some snakes have in excess of 500 vertebrae. The vertebrae and ribs are linked by muscles, typically with each vertebra attached to several adjoining ones and, in turn, to ribs and skin. These complex overlapping

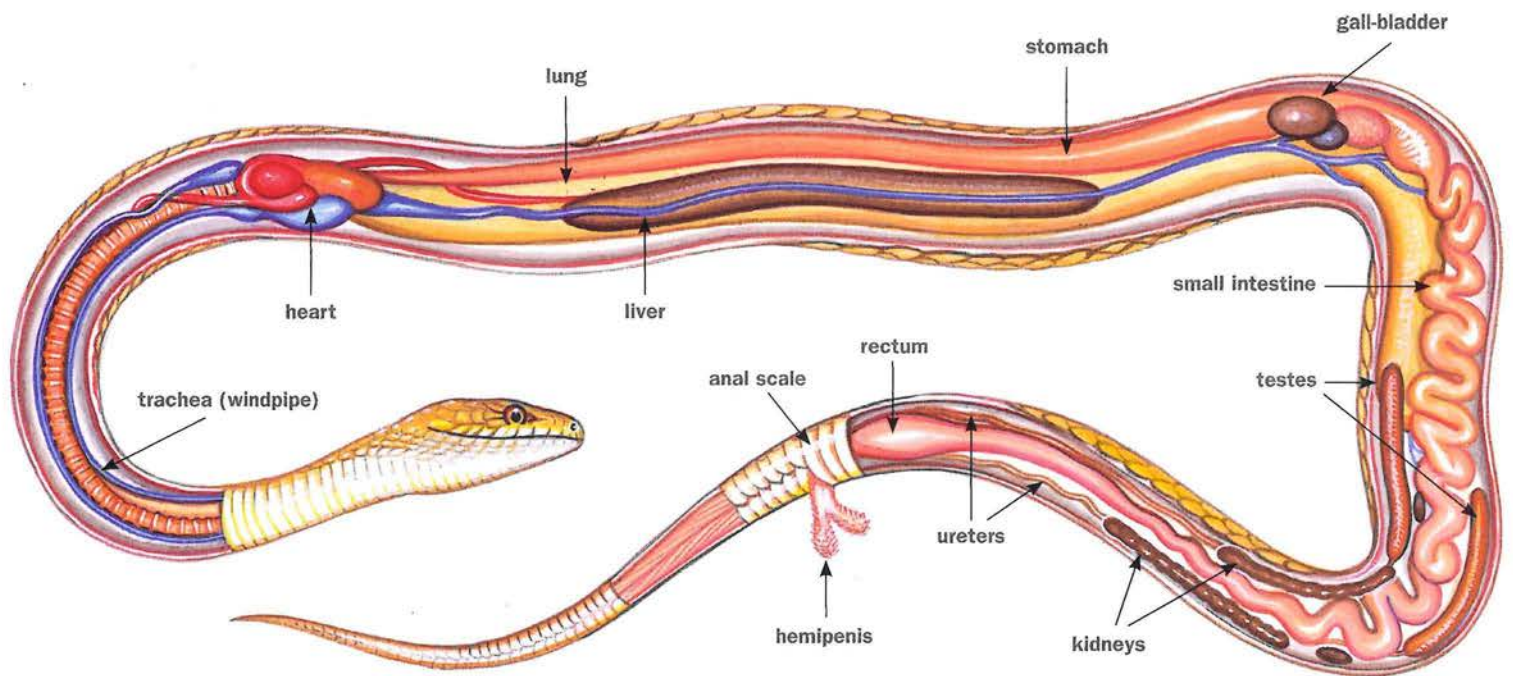


Previous page
Main Black-headed python.
Photo – Jiri Lochman

Left Carpet python scales.
Photo – Michael Pelusey

Below A paddle-like tail helps sea-snakes propel themselves through the water.
Photo – Ann Storrie





The internal structure of a male snake

muscles act like a set of ropes and pulleys, allowing snakes to move in their characteristic sinuous fashion.

Remarkable ecologies

The lack of limbs limits how snakes can handle their food. Think about it for a moment. Imagine having to manipulate and break up your food with your hands tied behind your back! Since they lack teeth to tear or rip food, the diet of snakes is constrained to what they can pass whole through their mouth. As a consequence, smaller snakes tend to eat smaller prey, but some species, especially the pythons, are able to consume huge prey relying on some amazing features in their jaws. Python jaws are very flexible and can open to a huge size; the lower jaw can be disarticulated to allow it to separate sideways. Large prey is scooped up, with the python using one upper jaw and then the other repeatedly to ratchet itself over the top of the prey.

Body coils are used to crush and expel air from the lungs of prey, to make the task of swallowing easier. The trachea is reinforced and can be extended so that snakes can continue to breathe while they are swallowing large items (it can take up to an hour for a python to swallow a wallaby!).

Above right A dugite with her eggs.
Photo – Babs and Bert Wells/DEC



Right A Pilbara olive python disarticulates its jaw to swallow a rock-wallaby.
Photo – David Pearson/DEC





Above Several male carpet pythons coil together around a female in an effort to mate with her.

Photo – David Pearson/DEC

Snakes have been so successful in Australia because of their abilities to cope with seasonal food shortages caused by droughts, fires and the low densities of prey. If food is limited, snakes will retreat to a shelter site such as a burrow, log or hollow limb to coil up and wait. The body's metabolism is slowed and various parts of the body not in use (such as the stomach and reproductive organs) are 'shut down', with their blood flow greatly reduced.

Most species of snakes, including those in the tropics, reduce their activity during the cooler months of winter. South-western carpet pythons, for instance, retreat to logs or tree hollows in May. There they remain relatively immobile and do not eat until September, only tempted to emerge to bask close to their shelter on warm days.

Serpentine reproduction

Snakes display a range of reproductive tactics. Females typically attract males using pheromone trails, which males follow using their strong sense of smell. In some species, males fight to gain access to females, often resulting in elaborate wrestling displays. In other species, males may coil together around the female in a mass of writhing

bodies. However, we have little or no information on the reproductive behaviour of most species.

Some species lay eggs. Pythons, for example, coil around their eggs and keep them at a stable temperature until they hatch. Other species, such as many of the elapid snakes and all sea-snakes, give birth to live young that are independent at birth.

Venom—just modified saliva!

The venom glands possessed by some groups of snakes are related to the salivary glands of other vertebrates. Venoms are a complex mixture of enzymes. They work on the body of prey in many different ways, including interfering with nerve-pulse transmission, which causes the heart and lungs to fail. Others damage blood vessels, leading to haemorrhaging, and others prevent blood from clotting. Venom has an important role in immobilising prey rapidly, so that the potential meal cannot inflict damage on the snake or get away.

A secondary use of venom is for protection. When people are bitten by snakes, it is almost always because the snake feels threatened and acts to defend itself. The best way to avoid being bitten is to leave snakes alone.

Never attempt to kill them and give them space so they can escape.

Frog hunter extraordinaire

Tiger snakes are frequent inhabitants of margins of swamps and waterways in the south-west, where they are able to obtain frogs, one of their preferred foods. They can hunt effectively during cooler times of the year and at low night-time temperatures, but consequently are often seen basking to warm up in the morning. Where tiger snakes occur away from swamps, they must rely on other prey. On Garden Island, near Rockingham, tiger snakes feed mainly on spiny-tailed geckos and introduced house mice and only reach a small size. In contrast, on nearby Carnac Island, adult tiger snakes are nourished on an abundant diet of seagull chicks and grow to substantial lengths in excess of one metre.

Camouflaged patience

Death adders are incredible masters of camouflage and are rarely seen unless crossing a road. They lie motionless in

Right A southern death adder lies in ambush position under leaf litter.

Below A sign at Greenough implores drivers to watch out for carpet pythons.
Photos – David Pearson/DEC



leaf litter or on the margin of a shrub waiting for a passing lizard or small mammal, sometimes for days at a time. At other times, they may be more proactive about obtaining their prey, and lift their unusually thin tail over their heads and wave it to and fro in a mesmerising display. Animals approach to investigate and are rapidly dispatched with a lightning-fast strike and a strongly neurotoxic venom injected by long fangs. Death adders are very slow-moving snakes and need a strong venom so that prey cannot move too far once injected. Four species of death adders occur in Western Australia, with the Pilbara death adder only recognised as a new species in 1998.

Lover of mice

The dugite is one of the most commonly encountered snakes in the Perth metropolitan area (and Rottnest Island), as well as many other urban and rural areas through south-western Australia. It is a species of brown snake unique to WA that has benefited in some areas from changes brought about by people. It is an active hunter of lizards

and small mammals, exploring burrows to ambush its prey. The abundance of house mice near people—and shelter provided by sheets of tin, other discarded building material, aviaries and sheds—have provided conditions which suit the lifestyle of dugites. They have a nervous disposition and will attempt to escape when encountered but, if cornered, will raise the body into a double s-shape, then hiss and strike. They are potentially dangerous and should be discouraged from living around homes by keeping lawns short, removing rubbish and controlling introduced rodents.

Threats to snakes

Human activities pose many threats to snakes. Clearing of habitat, the loss of prey (such as native mammals),

the presence of exotic animals and road deaths all impact to some degree on snake populations. Nonetheless, no snake species in WA has become extinct as a result of human activities, and only three (the Pilbara olive python, Rottnest dugite and pygmy dugite) are listed as threatened. Several species are known from only a handful of records, so further survey work is required to determine their conservation status.

You can help to conserve snakes by supporting the retention of native bush and its wildlife, preventing domestic pets from roaming in bushlands and driving carefully on country roads. Most snakes (and other wildlife) that are killed on roads are hit at night. Avoid driving at night in the country if you can—it is safer for both you and for snakes!



David Pearson is a Principal Research Scientist with the Department of Environment and Conservation's (DEC's) Science Division. His research interests include threatened reptiles and mammals and fire impacts on wildlife. He has recently written a full-colour, pocket-sized Bush Book on *Snakes of Western Australia* that is available from bookshops, DEC offices and other outlets for \$6.50.



urban antics

by John Hunter

Diggers and plungers

Is it ever going to rain?

Here I am in July, still enjoying the autumn-like froth and mist on Floreat Beach, mesmerised by a similar, but never the same, golden sunset over a calm Indian Ocean. Cloudless, endless, restless, who cares less... you wouldn't be dead for quids, would you?

In the distance, strange seabirds plunge from great heights and disappear underwater for some seconds... then, in a reverse splash, the swell gives birth to these creatures that pull vertically, shivering the brine from their plumage while climbing back towards a golden sky.

Australasian gannets (*Sula serrator*) are not usually observed so clearly from this urban beach at this time of year, as the weather is often inclement and they usually stay out a little further, possibly to lessen the risk of being storm-wrecked on land. Obviously, shoaling fish had tempted them further inshore on such a spring-like day.

The birds, while having similar fishing techniques to local terns, but far more spectacular, are quite different physically. They are very large, at around 90 centimetres long, and alternately flap and glide over the sea on barely moving slender wings, which may span up to two metres. Generally white in colour, with black primary, secondary and central tail feathers, a long neck and tail and somewhat penguin-like head, their wings in flight appear more mid-body than a tern.

Gannets migrate to the west coast. Most are usually the non-breeding birds that have travelled from their rookeries on a few islands off southern Victoria and Tasmania, but mainly from around New Zealand. Their usual dispersal at this time of year reaches to about the Tropic



of Capricorn on the west and east coasts of Australia, and from about 0.5 to 80 kilometres offshore. Here, they sleep at sea in complete silence, a huge contrast to the daily cackling crescendo from their dense breeding colonies. By October, they will have returned to the Southern Ocean, some staying and others heading for the rookeries by March.

About now, another wildlife phenomenon is underway on the headlands and islets of Rottnest Island, due west of our city suburbs.

Distinctly different from gannets, the entirely black-brown plumaged wedge-tailed shearwaters (*Puffinus pacificus*) have returned from their tropical climes of the north-west coast and Indian Ocean to their southern nesting colonies. From mid-August until late April, flocks

of mutton birds, as they are commonly known, return to the same nests at night under cover of darkness to dig or renovate burrows some one to two metres long and raise a single chick. The young are left alone in the depths of the burrows while the adult birds spend all day fishing at sea, surface feeding or sometimes diving up to 10 metres for small fish and squid, returning at night to the burrow to feed their young.

By April, the young shearwaters will weigh one-and-a-half times as much as the adults. From then on, the parent birds return less frequently, the fat chicks completing the last of their growth and their moult from downy to juvenile feathers, before leaving the colony to join the rest of the population at sea for the winter.

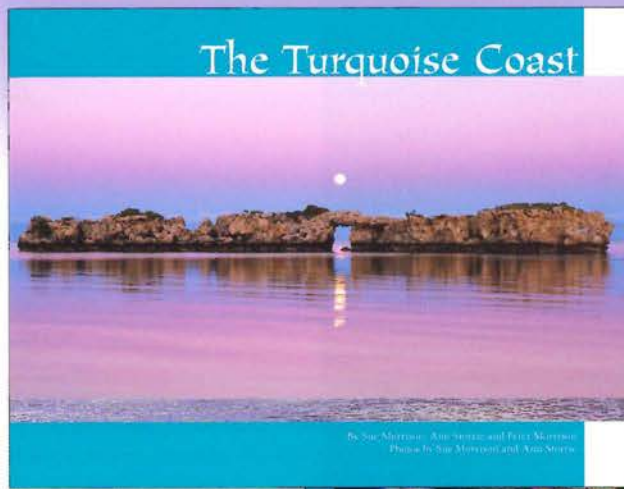
And so the cycle starts again.

DID YOU KNOW?

- Australasian gannets of the family *Sulidae* have a conical bill with serrate cutting edges and no nostrils. Like a living arrowhead and with air sacs under the skin to cushion impact, they plunge to scoop up pilchards and other shoaling fish.
- Wedge-tailed shearwaters of the family *Procellariidae* are typical of the petrels, with a long, slender, horny-plated bill, which is slightly hooked and tube nosed. They are occasionally found derelict on Perth metropolitan beaches.

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