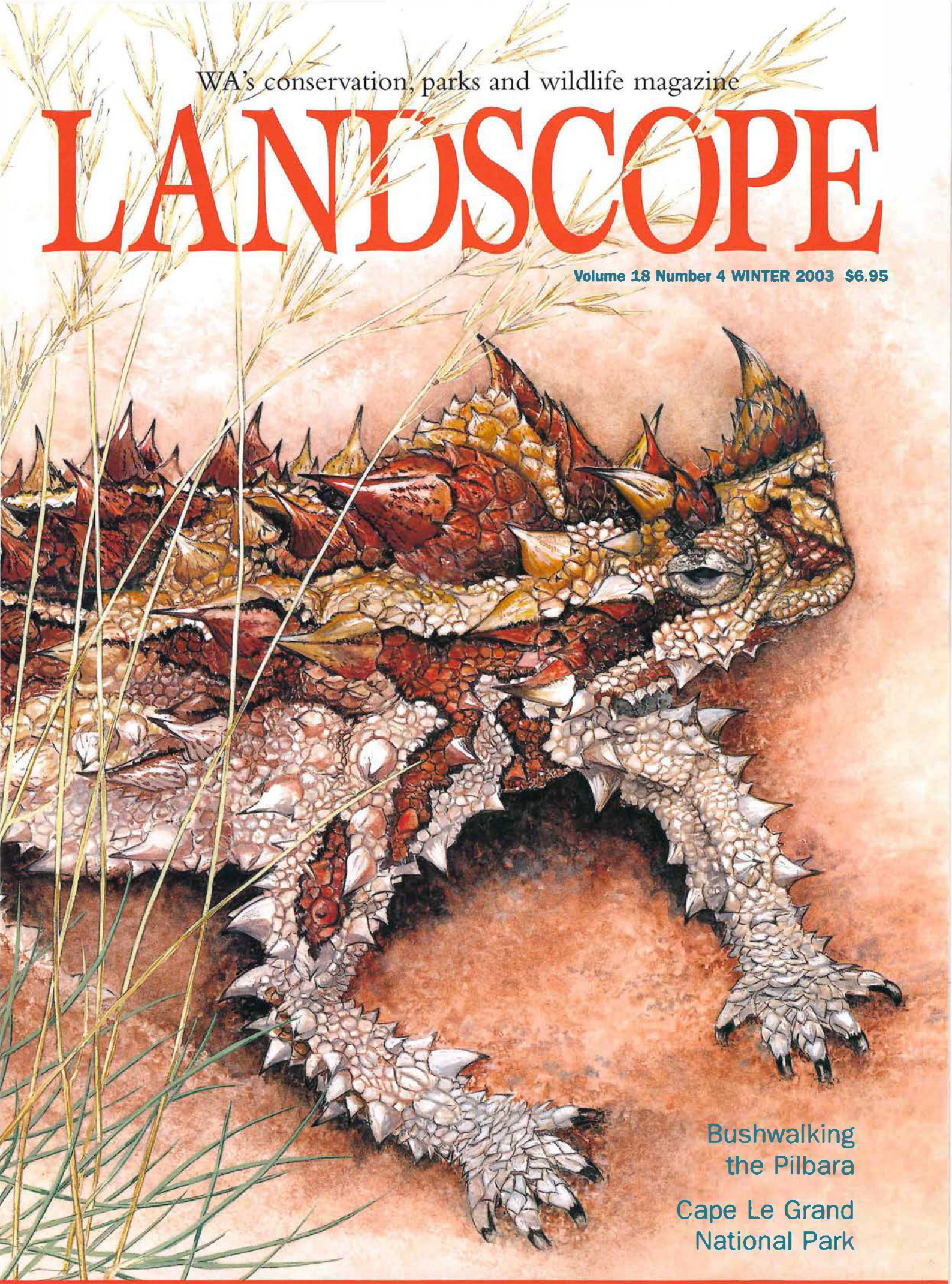
WA's conservation, parks and wildlife magazine

# LANDSCOPE

Volume 18 Number 4 WINTER 2003 $6.95



Bushwalking the Pilbara

Cape Le Grand National Park

The Recherche Archipelago **Mysterious marsupial moles** Albany pitcher plants

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Photo – David Bettini

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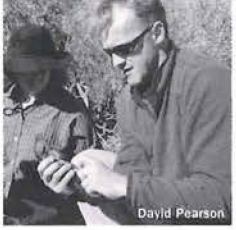
GOVERNMENT OF WESTERN AUSTRALIA

DEPARTMENT OF Conservation AND LAND MANAGEMENT


Judymae Napier


David Pearson

# contributors

**Judymae Napier** is the Information Officer for the Department of Conservation and Land Management's Pilbara Regional Office in Karratha. She is a mine of local knowledge and has an excellent understanding of the region's plants and animals. Judymae has visited most of the breathtaking sites of the Pilbara parks. She has unbounding enthusiasm and an undoubted affinity with the country.

**David Pearson** is a principal research scientist based at the Wildlife Research Centre in Woodvale. His research interests include rock-wallaby conservation, desert animals, Aboriginal ethno-ecology and the management of fire for conservation in desert lands. Right now, David is focusing on threatened reptiles, and particularly the carpet and Pilbara olive pythons.

**Greg Keighery** is a botanist and principal research scientist currently working on the biological survey of plant occurrence and distribution throughout Western Australia. He previously worked in the Kings Park and Botanic Gardens Authority on the biology of native plants. Greg's interest in garden history and bushwalking adds further to his appreciation and expertise in plants and wildflowers.

**Drew Haswell** is a projects manager for the Department of Conservation and Land Management and currently is the executive officer of the Tuart Response Group. Drew has held a variety of positions in the department such as regional strategic planner, policy advisor, regional and district manager and principal planner for fire management services, all of which have given him a broad appreciation of conservation and land management issues.

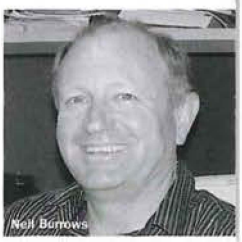
**Neil Burrows** is Director of the Department of Conservation and Land Management's Science Division. A fire research scientist, he specialises in the effects of fire on the environment and has a professional interest in the impact of predators on native wildlife and mammal conservation in arid zones. Neil cherishes those times when he is on biological surveys in remote desert areas of the State—getting down to grass roots.

## also contributing . . .

Kevin Bancroft, Joe Benshemesh (Monash University), Verna Costello, John Hunter, Brent Johnson, Gary Kendrick, Robyn Phillimore, Libby Sandiford, Carolyn Thomson-Dans, David Whitelaw, Alan Walker.


Greg Keighery


Drew Haswell


Neil Burrows

## editor's letter

Welcome. It is with both a sense of delight, and a little nervousness, that I invite you to explore the latest issue of *LANDSCOPE*.

My delight and nervousness are based on changes to the content and presentation we have initiated with this edition. We hope that you will find them an improvement on what, for many, was already a pretty good and worthwhile magazine on conservation, parks and wildlife in Western Australia.

While continuing to advocate for conservation and improved land management, and to provide you with stimulating and thought-provoking content in an easy-to-read style, we set out to create a fresher look for the magazine and to give you more reasons to subscribe and share *LANDSCOPE* with your family and friends.

From cover to cover, this is what we've done.

The cover continues to feature the stunning nature art of Philippa Nikulinsky and other botanical artists, but has been redesigned to give it more newsstand appeal and to make it easier for readers to quickly discover what stories are being featured in the magazine.

Inside, we've tried to make the magazine more accessible and navigable. The contents page has been changed from a single page to a two-page spread. This allows a clear distinction to be made between the feature articles – which now have more detailed story descriptions – and the regular departments (such as Endangered and the very popular Urban Antics).

We've expanded the magazine from 56 to 64 pages so that we can provide you with more content, from leading scientists, writers and photographers, on conservation and WA's remarkable native plants, animals, parks and other special places. Each issue of *LANDSCOPE* will now include at least one more major feature article than in the past.

Bush Telegraph has been replaced by new mini features scattered throughout the magazine (see Heath mouse eludes searchers on page 6 and Volunteers give wetlands a helping hand on page 48) and two new regular departments: a page of book reviews (Bookmarks, page 9) and a two-page feature on a national park (see Francois Peron National Park, page 18).

In the design of the magazine, we are making bolder use of the extraordinary photography that we have access to, and you will find more detailed maps included with feature articles. We've also changed the typeface throughout the magazine to make it easier to read.

This contributors' page is also a new feature and provides you with more background information on who is authoring the feature articles.

And finally, we have retained the current cover price (which was last increased in January 1997) and we will maintain that for as long as we can.

Enjoy the read. I look forward to your feedback on the magazine, and we'll see you again in spring.

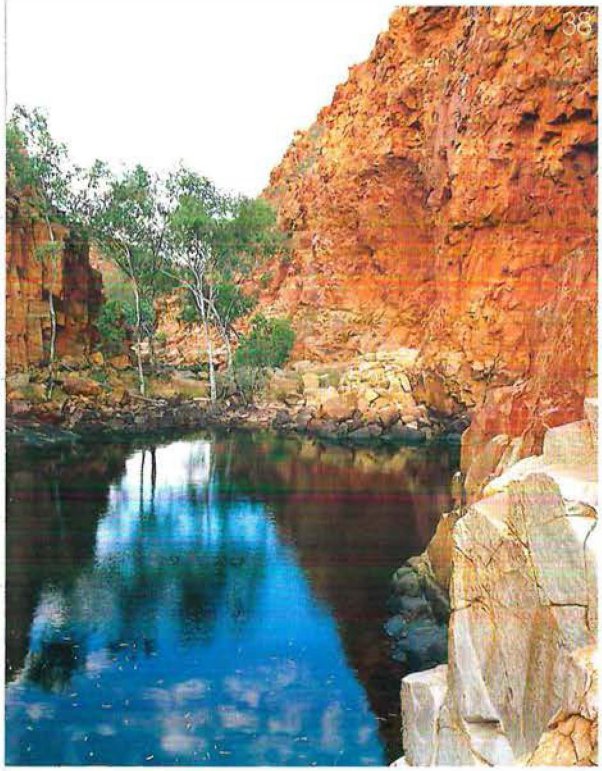
Ron Kawalilak
Executive Editor

# Features



**Cover illustration by Philippa Nikulinski**
The thorny devil's ferocious appearance belies its nature—this lizard feeds only on ants. It is common throughout the Shark Bay area and in Francois Peron National Park.

**Back cover photo Marie Lochman**
**Rudall River National Park**
Spinifex and sand are synonymous with the Pilbara region of Western Australia.

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# contents



## Regulars



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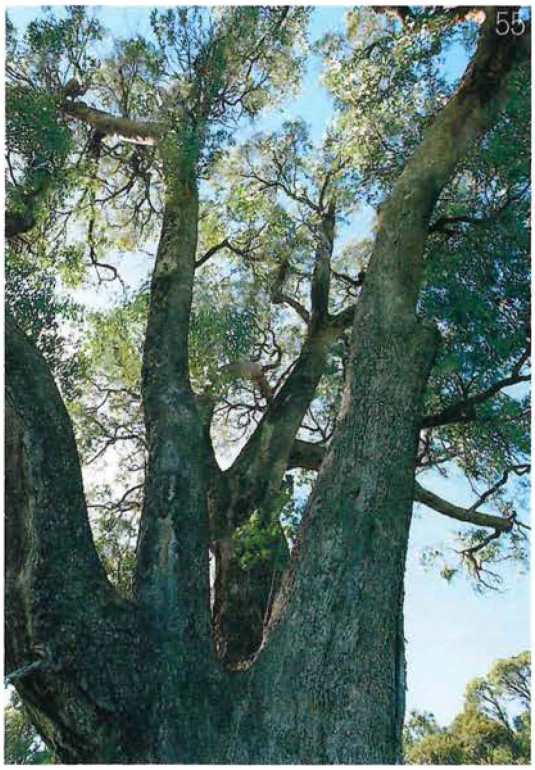
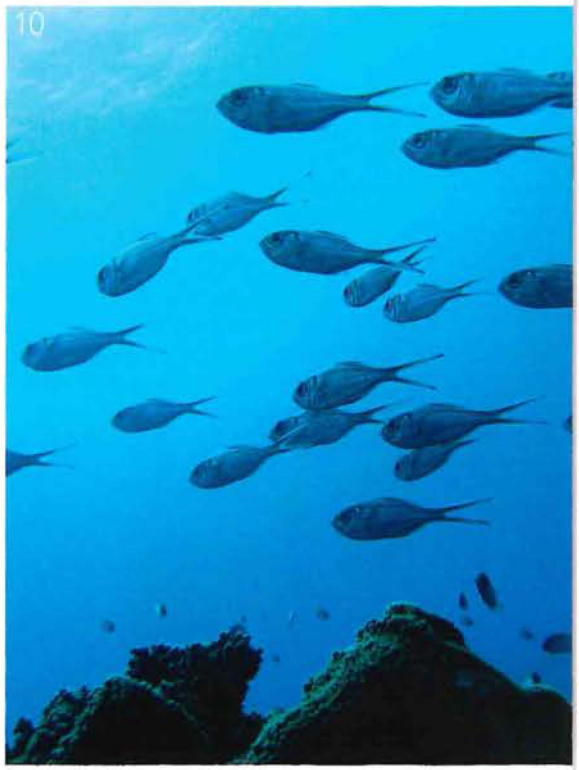




# Heath mouse eludes searchers

by Brent Johnson and Verna Costello

A project is under way in Western Australia to find a population of the threatened heath mouse or dayang (*Pseudomys shortridgei*) in order to study its biology and ecological requirements, and ultimately to explore ways to improve its conservation status.

In an effort to fill these knowledge gaps, the Department of Conservation and Land Management launched the new project, which saw wildlife researchers, postgraduate students and volunteers spending two weeks in November 2002 and again in March this year searching for the heath mouse in and near Fitzgerald River National Park. While traps were laid at sites where heath mice had been caught during the 1980s and 1990s, none was caught during the later trapping exercises.

During the mid-1990s, captures in these areas were highly encouraging, and as recently as early 2002, heath mice occasionally turned up in the department's Western Shield traplines in the eastern part of the park. The next step will be to search at Lake Magenta, where trapping for Western Shield has also turned up heath mice from time to time.

Lake Magenta was also the site of an investigation into trapping records and habitat types to help predict where heath mice might occur, and a few mice were, indeed, found where predicted. Departmental researchers and a postgraduate student from Murdoch University will again investigate this and other possible sites.

The heath mouse is quite stout and weighs up to 90 grams (much smaller than the similar bush rat which reaches 200 grams). It usually has light brownish-grey fur, flecked with black. The blunt-nosed face has bulging eyes and dark, hairy ears. The tail is shorter than the combined head and body. It has darker fur above, with paler fur beneath.

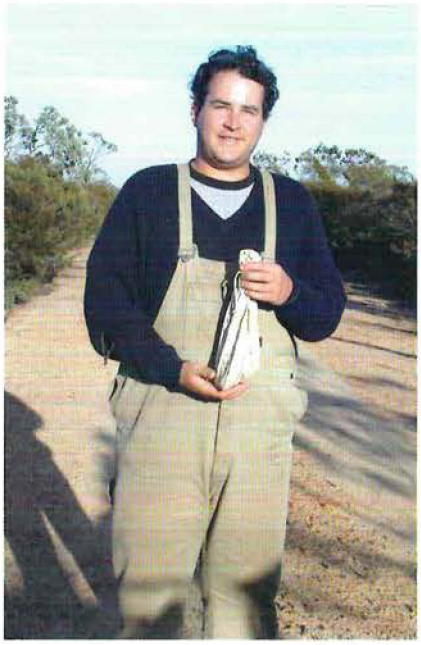
Female heath mice reach sexual maturity at about one year old, and are thought to produce their young in spring. In captivity, they have been known to survive for several years. Studies on this species in eastern Australia have shown that grass and seeds form most of its diet. Very little else is known, but they are believed to use nests and shallow burrows.

The heath mouse was believed to be extinct in Western Australia for more than 50 years before it was caught during a survey of the Ravensthorpe Range in 1983. These specimens were originally misidentified as bush rats. Only the discovery of fresh bone material and subsequent trapping of heath mice during a search for the threatened dibbler in Fitzgerald River National

**Left facing page** Heath mouse.
*Photo – Jiri Lochman*

**Above** Middle Mt Barren and Thumb Peak, in Fitzgerald River National Park.
*Photo – Marie Lochman*

**Right** Radio tracking at Fitzgerald River National Park.
*Photo – Brent Johnson*



Park in 1987 confirmed their existence. At the time, the species had last been recorded alive in WA in 1931. It is now known from only five locations in the southern Wheatbelt and south coastal areas of the State, and from only two conservation areas in south-western Victoria. Limited genetic analysis has been undertaken and it appears that in both States they are the same species. However, the limited studies undertaken here and in Victoria suggest that eastern states heath mice and those in Western Australia occur in different habitats, and each has different ecological requirements. This is not surprising given the distance between their populations and the length of time they have been apart.

The heath mouse is listed as vulnerable under Commonwealth legislation. In WA, it is listed as 'fauna that is rare or likely to become extinct' and is the only threatened rodent in this State with no conservation program.

Fire is used as a management tool on several of the conservation reserves where the heath mouse persists, and mining interests are becoming an increasing presence in adjoining areas. Information is needed on these potentially limiting factors, as well as the possible effects of introduced predators and dieback. Nevertheless, Department of Conservation and Land Management researchers are confident that, with the assistance of Murdoch University and the support of mining companies and other landholders, this study will greatly improve our knowledge and understanding of one of Australia's rarest rodents.

**Above left** Heath mouse.
*Photo – Jiri Lochman*

**Above** Murdoch postgraduate student Damien Cancilla happily holds a bag containing a heath mouse in Lake Magenta Nature Reserve.

**Left** A recently burnt site near Bandalup Hill will allow researchers to investigate the effects of fire on heath mice.
*Photos – Brent Johnson*

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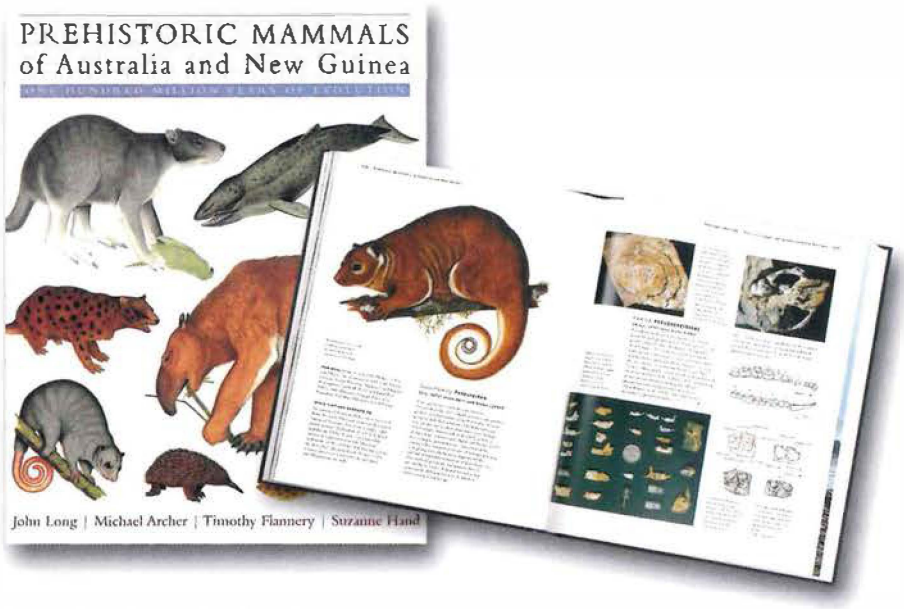
Verna Costello is a contributing editor and photo-journalist with the Department of Conservation and Land Management. She can be contacted by email at (vernac@calm.wa.gov.au).

# bookmarks by Verna Costello

## Prehistoric Mammals of Australia and New Guinea

**by John Long, Michael Archer, Tim Flannery and Sue Hand.**
**244 pages, full colour, published by University of New South Wales**
**ISBN 0-86840-435-7 RRP $69.95**




Ancestral koalas, meat-eating kangaroos, rhinoceros-sized diprotodons, bizarre 'thingodontans', marsupial lions, primitive bats, toothed baleen whales and a host of other ancient creatures are to be found in this new book.

The evolution of mammals is a complex, fascinating story beginning at least 225 million years ago, about the same time that the dinosaurs appeared on Earth. Although the book is often complex and technical, it is still readily accessible to lay readers. It provides fascinating information about the age, diet and habitat of these extinct mammals; how fossils are formed and dated; and how mammals evolved and are classified. There are 60 superb colour reconstructions by artist and palaeontologist Anne Musser, and 160 colour photographs.

## Beneath Busselton Jetty

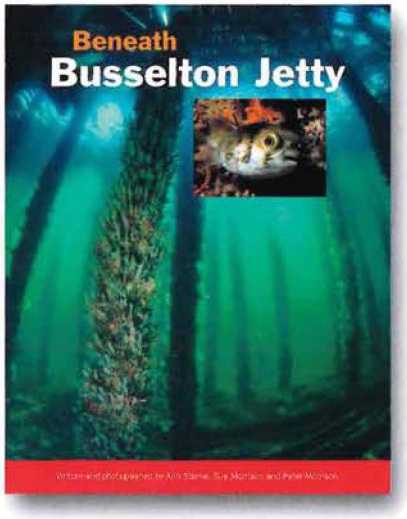
**by Ann Storrie, Sue Morrison and Peter Morrison**
**145 pages, full colour, published by Department of Conservation and Land Management**
**ISBN 0-7307-5531-2 RRP $21.95**

At more than 1.8 kilometres, the Busselton Jetty is believed to be the longest wooden jetty in the southern hemisphere, but it is 'what lies beneath' that entices divers and others interested in the marine environment to flock to this huge artificial reef.

Both its size and its age (around 140 years) have enabled the colonisation of the Busselton Jetty by an astonishing diversity of marine life that includes colourful corals, sponges, sea stars, shellfish, fish and other forms of marine life.

This marine life—ranging from the beautiful to the bizarre—is detailed in the book and generously portrayed in the authors' excellent photographs.

This is definitely a book to improve one's knowledge of marine life or simply to enjoy dipping into. Better still, it is a guide for those who want to explore the splendour that lies beneath the Busselton Jetty.



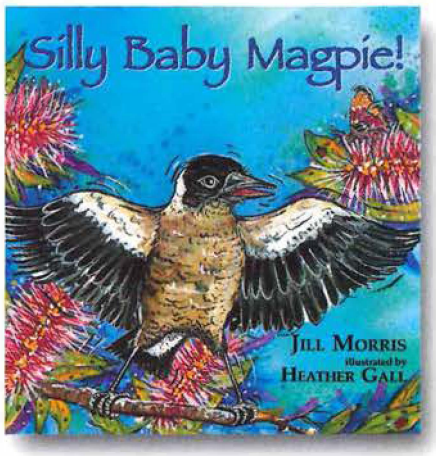

## Silly Baby Magpie!

**by Jill Morris**
**Illustrator Heather Gall**
**32 pages, full colour, published by Greater Glider Productions**
**ISBN 0-947304-59-2 RRP $14.30**

Suitable for three to eight-year-old children, this exquisitely illustrated book is fun to read aloud, and is easily adapted for performance by children. Music, representing the individual birdsongs of the Australian magpie, pied currawong, pied butcher bird and willy wagtail, is set out at the end of the main story. Numbered drawings on the final page name the animals shown in the coloured illustrations throughout the book.

The story charts in rhyme the baby magpie's progress from bursting out of its eggshell to adulthood. Magpies are a pleasure to watch with their babies, as readers of this book will find out.

For further information phone the publishers on (07) 5494 3000 or visit their website (www.greaterglider.com.au).



# Researching the Recherche

Exciting marine research has begun in one of Western Australia's most beautiful and little known areas of underwater wilderness.

by Carolyn Thomson-Dans, Gary Kendrick and Kevin Bancroft

The magnificent Archipelago of the Recherche stretches for more than 200 kilometres along the State's southern coastline, offshore from Esperance, and contains more than 100 islands and 1,500 islets.

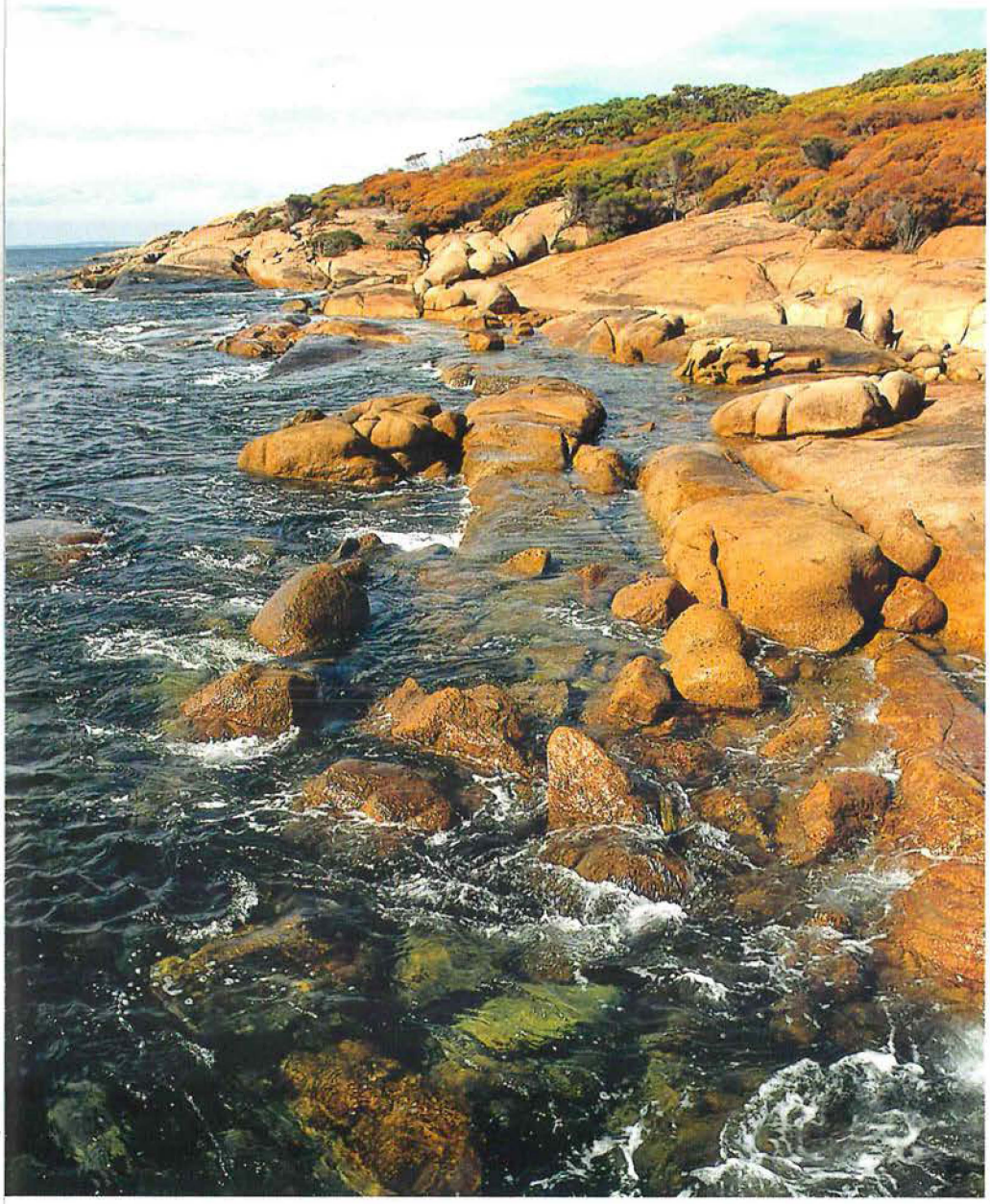
The islands represent the high points of an ancient land surface that is now flooded by the ocean. Most of the islands are exposed to high or moderate wave action from all directions and there are few safe anchorages or landings. In form and character, the islands—which are mostly inaccessible—resemble the granitic headlands of the mainland coast. In the most exposed areas, smooth, steep-sided, rocky slopes plunge into the sea. More sheltered bays have boulders and tide pools. Between some of the headlands there are beaches backed by low dunes or granite slopes. The depth of the sea floor within the archipelago averages about 40 metres, although the outer islands rise from depths of 70 metres or more.


## Use of the area

In 1627, Pieter Nuyts on the Dutch vessel *Gulden Zeepard* ('Golden Seahorse') passed through the archipelago, but did not land in the area. The next arrival was Captain George Vancouver, on the *Discovery*, who ventured through the still-nameless archipelago in October 1791. In 1792, *L'Esperance* and *La Recherche*, two French vessels under the command of Rear Admiral Bruny D'Entrecasteaux, were forced to seek shelter on the Esperance coast from a storm, conferring the name of one of their vessels on the spectacular island group. In 1802, Matthew Flinders, aboard the *HMS Investigator*, became the first to explore and chart the region. During the nineteenth century, sealers from the penal settlement at Van Diemans Land arrived, followed by American and French whalers.

Today, the lower rock slopes of the islands are important commercial fishing areas for greenlip and brownlip abalones. Gummy sharks, whiskery sharks and dusky sharks (bronze whalers) are extensively fished by net and long line in these waters. The waters of the archipelago also support a large proportion of the fishery for the southern rock lobster. A small trawl fishery for saucer scallops also operates seasonally within the area, and there is a regionally important, developing fishery for pilchard.

Woody Island is the only readily accessible island close to Esperance in the archipelago. It is also the only one on which overnight accommodation is available.



*Previous page*
**Main** New Island (centre) and Ram Island (top) offshore from Cape Le Grand National Park.
*Photo – David Bettini*
**Insets (left)** Information collected during a major study of the Recherche Archipelago will aid the planning of a marine conservation reserve.
**(right)** Sea slug on an encrusting sponge.
*Photos – Justin McDonald*

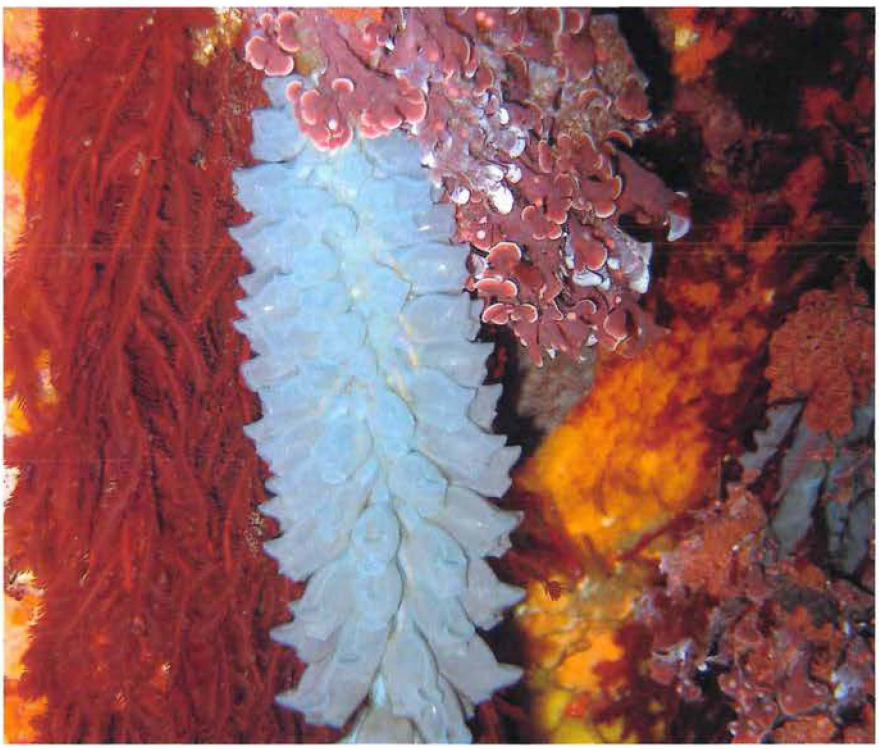
**Left** Woody Island is one of few islands in the archipelago that receives regular visitors.
*Photo – Jiri Lochman*

The coastal waters, islands and marine life provide a drawcard for boating, diving and fishing. Awesome, but gentle, southern right whales visit the bays and sheltered inlets, between July and November, to calve. They can be viewed from vantage points on land or by boat. Divers can experience crystal clear waters, diverse underwater life, cathedral-like caves, reefs and shipwrecks, including that of the *Sanko Harvest*, which ran aground on Harvest Reef 12 nautical miles off Esperance, on 14 February 1991. The region is an angler's paradise, with snapper, salmon, herring and other popular species readily caught from beaches, jetties or boats. But, given increased pressures for development in this lovely spot, how much longer can it stay that way?

## Conservation values

All of the islands in the archipelago are nature reserves. Many of the islands and emergent rocks in the archipelago are used as haul-out sites and breeding areas by Australian sea lions and New Zealand fur seals. The breeding colonies include the largest in the State for both species. There are also important nesting areas for the little penguin and the Recherche Cape Barren goose on several of the islands.

In depths below 20 metres, there are spectacular growths of attached invertebrates, especially sponges. Fish communities in the area are very diverse and even residential species like blue groper and queen snapper, which are extremely vulnerable to fishing pressure, are abundant.



**Top** Lake Hiller on Middle Island.
*Photo – David Bettini*

**Above** Underwater animals such as sea squirts and plants densely coat rock surfaces.
*Photo – Justin McDonald*

In June 1994, the Marine Parks and Reserves Selection Working Group in their report *A Representative Marine Reserve System for Western Australia* examined the values of the archipelago, but was hampered by lack of information. More than 30 years before, members of the Australian Geographic Society Expedition had published the only studies on the marine plants and animals that inhabited the archipelago. Even so, the report concluded that 'reservation of the entire area as a multiple-use marine reserve is warranted'. The Marine Parks and Reserves Authority, the vesting body for marine conservation reserves, subsequently identified the Recherche Archipelago as being of high priority for reservation. New research projects aim to reverse the dearth of information.

## New research

In 1999, the Department of Conservation and Land Management's Marine Conservation Branch successfully

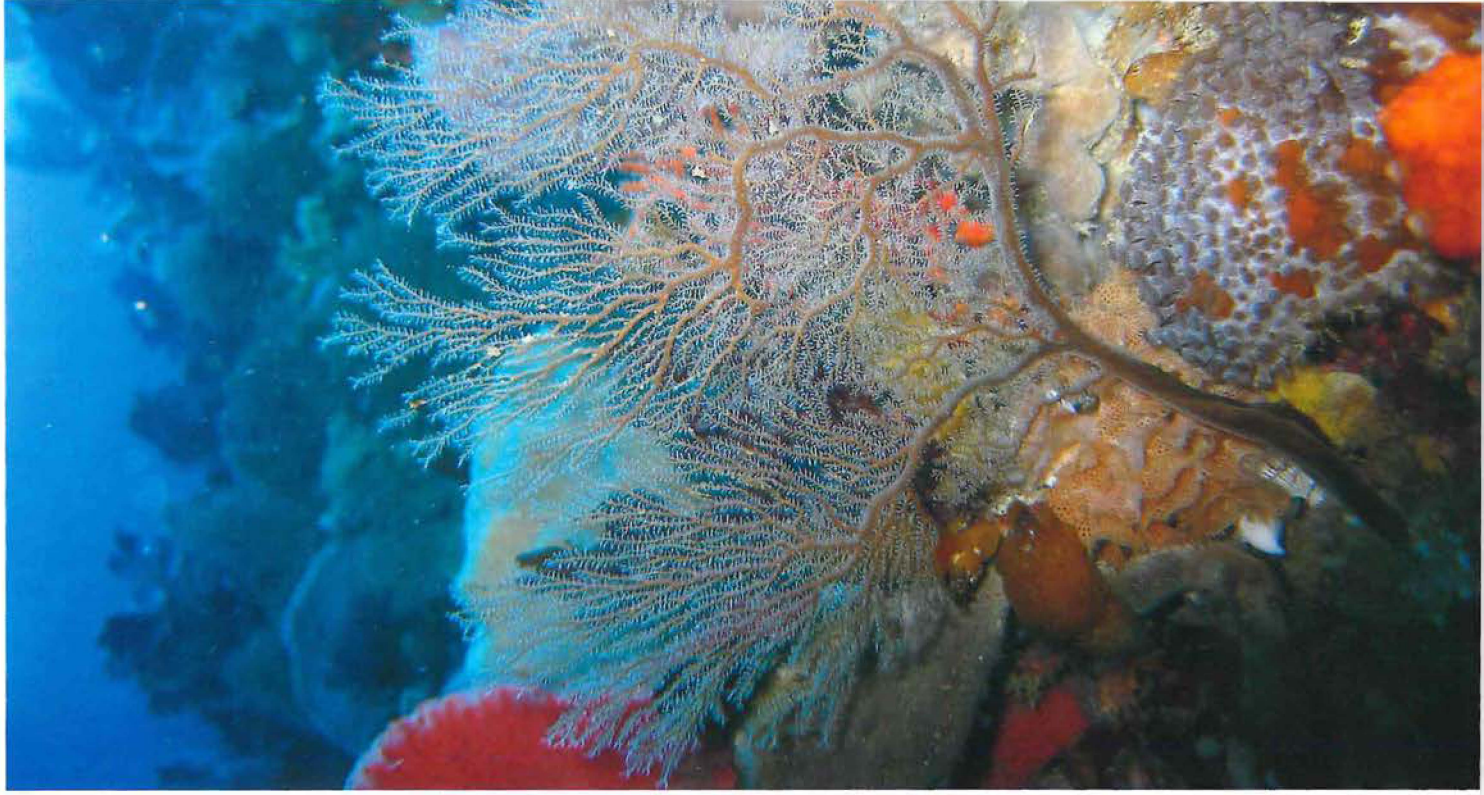
applied for funding through the Marine Protected Areas Program of the Natural Heritage Trust (NHT). The project involved mapping major marine habitats and the marine wildlife distributions of the area, as well as developing a preliminary understanding of the physical oceanography of the region. This project has involved staff from the department's Marine Conservation Branch and its Esperance District Office as well as scientists from The University of Western Australia (UWA) and was directed at obtaining some of the information needed for the planning of a marine conservation reserve in the area.

**Top left** Leafy seadragons inhabit the Recherche Archipelago. These fish are protected as their removal might lead to the species disappearing from an area.
*Photo – Peter & Margy Nicholas/Lochman Transparencies*

**Above** The lower rock slopes of the islands are important commercial fishing areas for greenlip abalone.
*Photo – Eva Boogaard/Lochman Transparencies*

**Centre left** Translucent red sea squirts growing on the tube of a tubeworm.

**Left** Giant western blue groper have disappeared from most heavily-fished parts of our coast, but are still seen in the Recherche Archipelago.
*Photos – Gerhard Saueracker/Lochman Transparencies*



**Top** Submerged granite walls are covered by invertebrates such as this fan-shaped hydroid.
*Photo – Justin McDonald*

**Above** The aptly-named harlequin fish.
*Photo – Gary Kendrick*

Last year, a consortium consisting of scientists from UWA, with assistance from local commercial fishermen, tourism operators and community groups, began a detailed three-year study of the benthic (sea floor) communities of the archipelago. The project is funded by the Fisheries Research and Development Corporation and UWA, and will build on the NHT-funded work done by the department, by examining the factors influencing the distributions of benthic marine communities in this area.

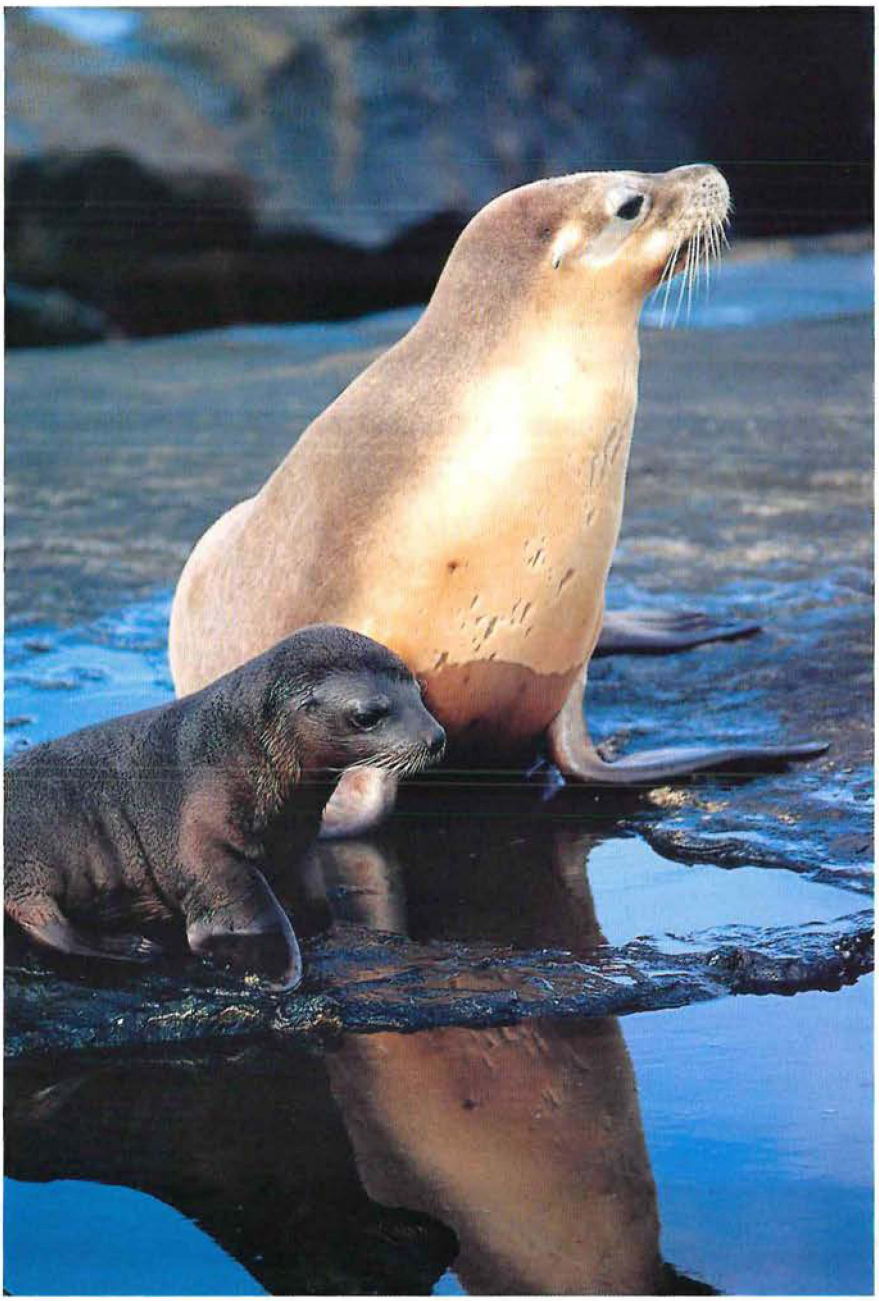
In October 2002, a team of 11 researchers spent four weeks surveying the distribution and abundance of habitats, seaweeds, invertebrates and fish on subtidal granite reefs in inshore and offshore islands in the western part of the archipelago.

This data forms the biodiversity component of the Fisheries Research and Development Corporation-funded fish-habitat mapping exercise presently under way in the archipelago. It is also supported strongly by the local community through the Recherche Advisory Group, an Esperance community driven coordinating organisation, the local commercial and recreational fishing groups, and cash grants from the Esperance Port Authority, Black Swan Nickel, Portman Mining and MG Kailis. The Department of Conservation and Land Management also assisted this project in many ways: including the provision of support and accommodation from its Esperance District Office, and financial and scientific support for their survey undertakings have been provided by the department's Marine Conservation Branch and the NHT.

The team consisted of Dr Gary Kendrick (coordination and seaweeds), Nisse Goldberg (seaweeds), John Heine (seaweeds), Dr Justin McDonald (leader invertebrates), Dave Abdo (invertebrates), Simon Grove (invertebrates), Dr Euan Harvey (coordination and fish), Dave Gull (fish), Nicole Harman (fish), Andy Bickers (sidescan sonar and towed video) and Katrina Baxter (GIS and spatial design). Visiting the islands further offshore necessitated using a much larger vessel, a local dive charter called the *Southern Image*. The assistance given by its crew and divemaster made the task all that much easier.

Over the time of the survey, ocean conditions ranged from warm and calm to 50-knot gales, adding to the unique experience the researchers had already had from the diversity and beauty of the underwater landscapes they visited.

The team studied the distribution and abundance of seaweeds, and



attached invertebrates, such as sponges, sea squirts, bryozoans, hydroids and fish on sheltered and exposed locations on groups of inshore and offshore islands. They sampled at 5–10 metres, 15–20 metres and greater than 20-metre depths at all locations. Their inshore locations were Black, Woody and Thomas islands and the offshore islands were Long, Remark and Frederick.

Once this survey was completed, a study of the differences in distribution and abundance of seaweeds, attached invertebrates and fish were further investigated, on sloping granite and vertical drop-offs at 15 to 20 metres in depth, at Mondrain and Figure of Eight islands.

## High-tech heaven

During the course of the survey the research team utilised amazing high-technology research techniques to identify and map sea floor habitats. They used hydroacoustics (the use of sound in water) by which a depth sounder measures the time it takes for a pulse of sound to reflect off the bottom and back to the boat. This technique can be used to determine both the depth and the type of habitat present on the sea floor. A sidescan sonar—with two fan-shaped beams generated by transducers—mounted on a 'tow fish' behind the boat can be used to build up a geo-referenced image if you continue to go back and forth. This is excellent for mapping habitat transitions around coastlines and islands. It is so sophisticated that it can pick up individual boulders and seagrass plants to a five-centimetre resolution. One of the interesting habitats recorded were vast beds of rhodolith—a type of calcareous alga that looks like pebbles.

However, the researchers still needed some way of ground truthing

**Above left** Rugged conditions make many islands in the Recherche Archipelago fairly inaccessible.

**Left** Many of the islands are important breeding areas for Australian sea lions.
*Photos – Jiri Lochman*

**Right** Kelp (*Ecklonia radiata*) attaches its stem to the reef by means of a 'holdfast'. *Photo – Clay Bryce/Lochman Transparencies*

these data, and this was achieved using video. Two types of underwater video systems were used, both of which can be deployed either by a diver or remotely. For towed video cameras, the researchers developed software that overlayed Global Positioning System (GPS) and depth data onto videotape.

Dr Euan Harvey sampled fish using stereo videography that he has been pioneering over the past six years. This method is non-destructive and very appropriate for surveying and monitoring in marine parks. The fish became more abundant and larger the further they went offshore, with some blue gropers they encountered being 1.5 metres in length. It was also evident that the fish populations varied with the depth and that there were different combinations of fish living on the more exposed side of the islands, compared with on the more sheltered sides.

## Early results

It seems that—in terms of finding new species—the survey has already struck gold. They have collected video of six species of fish that they are unable to identify using currently published material. Most of these are small wrasses living among the kelps. It also seems that there are five or six new species of algae. More amazingly, of the 300 to 400 species of sponges that were collected, around 40 to 50 per cent are likely to be species new to science.

The research team still has many months of work ahead of them, analysing the collections and videotapes. An extended survey in April and May 2003 incorporated more fine-scale collection work by divers.

## The future

The Western Australian Museum recently held an International Marine Biological Workshop in Esperance. Over a two-week period, more than 20 local and international scientists undertook intensive ecological, biological and taxonomic research in the nearshore waters of the archipelago, further adding to the rapidly increasing knowledge base for the area.

The Cooperative Research Centre for Coastal Zone, Estuary and Waterways Management (Coastal CRC) has been successful in attracting $3 million in supplementary funding from the Commonwealth Government. The seabed and estuarine habitat project will be developed by the Coastal CRC in collaboration with Curtin University, UWA, Defence Science and Technology Organisation, the Department of Conservation and Land Management, SonarData, Reson, Fugro Survey and the Georeality Group. The project will develop a toolkit of state-of-the-art techniques for mapping, identifying and classifying seabed habitats, data interpretation and visualisation techniques, and an education and training program. The Recherche Archipelago is one of the Coastal CRC project's key study areas.

The results that flow from the current and proposed marine research activities in the Archipelago of the Recherche will substantially boost our knowledge and, ultimately, the conservation of this unique and beautiful area of Australia.

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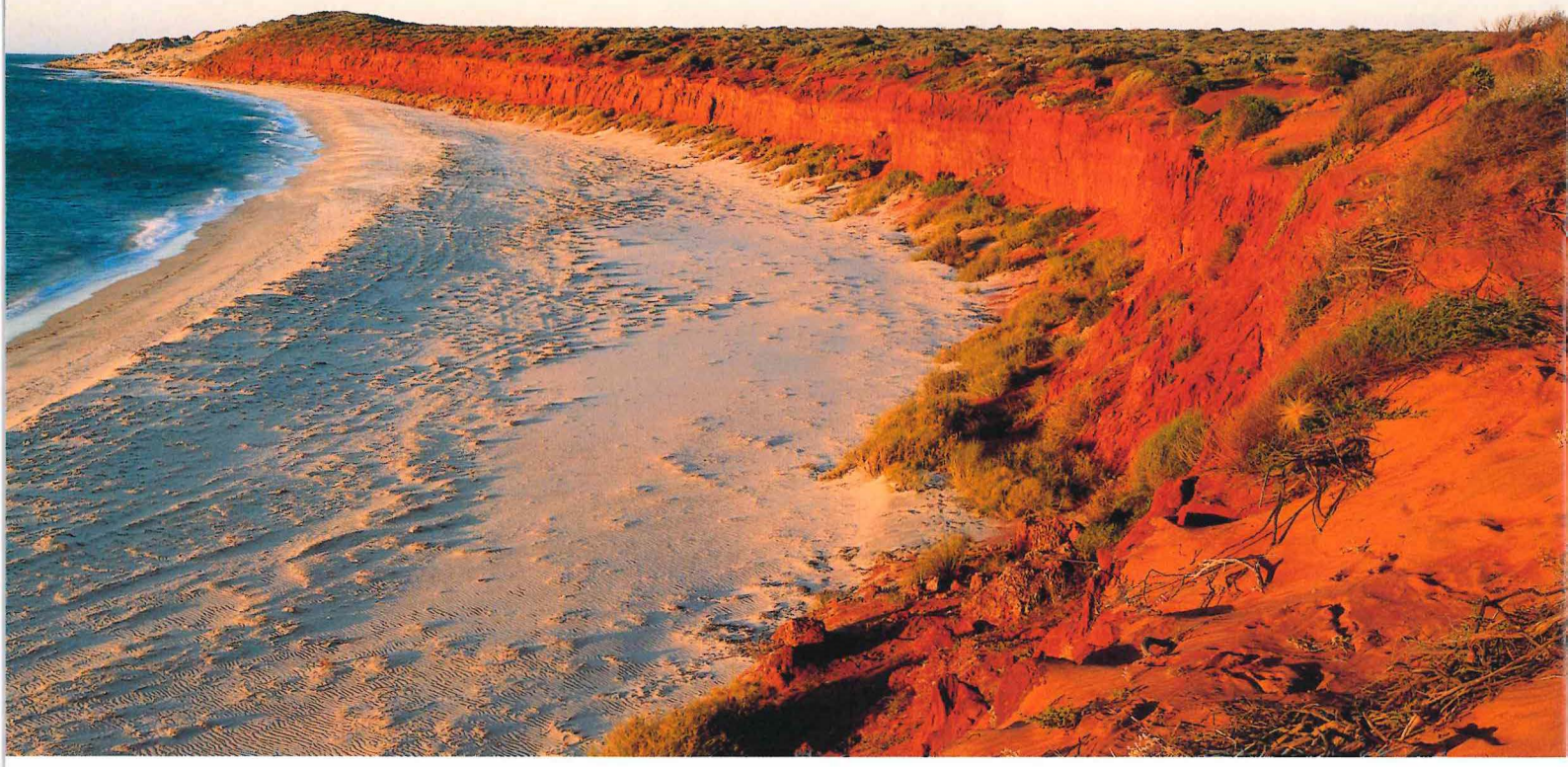
Kevin Bancroft is a marine ecologist with the Department of Conservation and Land Management's Marine Conservation Branch, based in Fremantle. He can be contacted on (08) 9336 0102 or by email (kevinb@calm.wa.gov.au).



# Francois Peron National Park

The rolling red sand dunes and dense acacia shrublands of Francois Peron National Park provide four-wheel-drive visitors with a wilderness experience.

**Above** The Cape Peron cliffs at sunset.
**Above right from top** Woylies have been reintroduced to the Peron Peninsula, in the Francois Peron National Park.
*Photos – Jiri Lochman*
An Aboriginal mia in the Francois Peron Visitor Centre.
**Far right** Bottlenose dolphins.
*Photo – Jiri Lochman*

Declared on 8 January 1993, Francois Peron National Park had its tenth anniversary this year. The park lies 10 kilometres from Denham, in the Shark Bay World Heritage Area, and is adjacent to the Shark Bay Marine Park. It covers some 52,500 hectares of the Peron Peninsula.

## Taste of pastoral life

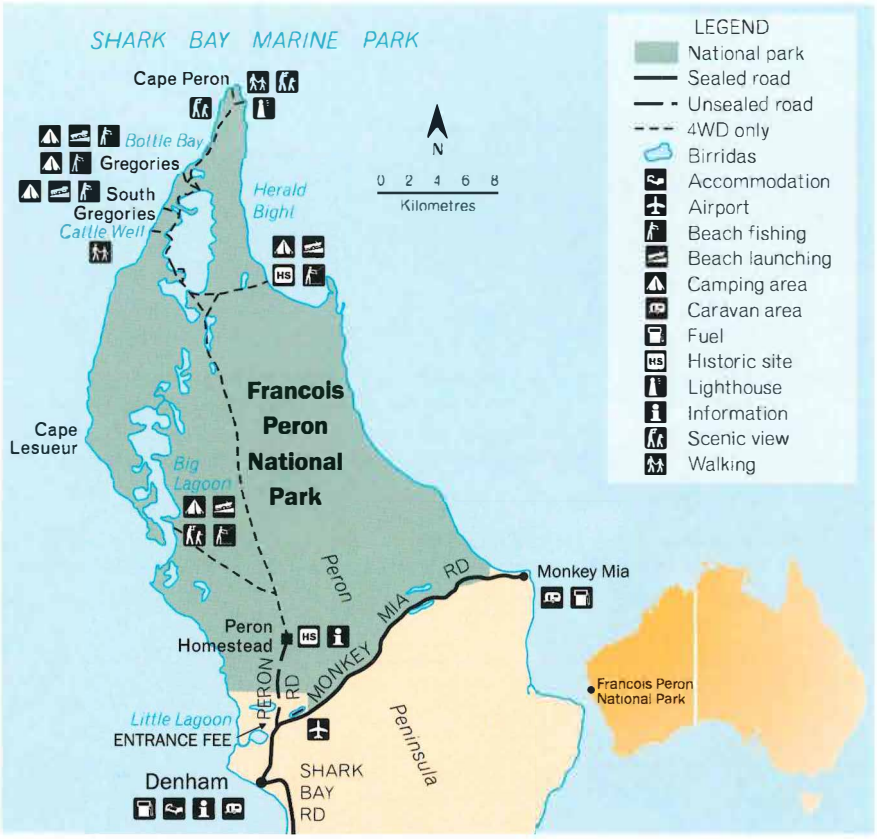
Francois Peron National Park was once a pastoral station, and you can visit the old homestead to experience how life was on a remote sheep station. The road to the old homestead is accessible to two-wheel-drives for much of the year, but you should check road conditions with the Department of Conservation and Land Management office in Denham before your visit.

The old overseer's quarters at the homestead has been converted into a visitor centre. A large wall mural at the visitor centre depicts local indigenous people, French maritime explorers, early pastoralists and fishers through to the conservation managers of today. Two sections of the display show how Project Eden, a plan to restore much of the native fauna to the Peron Peninsula, is changing Francois Peron National Park. One depicts the area before it became a national park, when old bottles, goats and other feral animals were prevalent. The other shows the native animals that are being reintroduced.

Now used to pump water into a recreational spa, the hot artesian bore was once essential to the survival of the former Peron Station. The homestead artesian bore was drilled between September 1922 and July 1923 and the water was pumped from the reservoir tank by three windmills to nine watering points for livestock. Today, as well as being able to enjoy a dip in the hot water, visitors can often see the emus and other birds that flock to drink in the overflow from the 'hot tub'. A nearby grassed area boasts barbecues and tables and is a great place for a picnic.

## Venturing into the wilderness

While you can reach the homestead by two-wheel-drive vehicles for much of the year, you need a four-wheel-




drive (low clearance four-wheel-drives are unsuitable) to visit the park's scenic coastline, with its dramatic contrasts of red cliffs, blue water and white beaches. From the cliffs of Cape Peron, visitors may see bottlenose dolphins playing, dugongs feeding, green and loggerhead turtles surfacing for air and large manta rays gliding past just beneath the surface. The park and the rest of the peninsula is interspersed with gypsum claypans known as birridas. Most birridas were landlocked saline lakes when sea levels were much higher, and gypsum was deposited on the lake floors. In some places, such as at Big Lagoon, the sea has invaded the claypans to form a shallow inland bay. The area was used by pearlers in the late 1880s and old pearlshells can be found on many of the area's beaches.

Bush camping, four-wheel-driving, walking, beach fishing and swimming are popular in the park. There are bush camping areas with few facilities (toilets and gas barbecues) at Gregories, Bottle Bay, Herald Bight and Big Lagoon.

The best time to visit the park is between April and October, when winds are generally lightest and the temperature is in the mid-20s (degrees Celcius). Temperatures can be extremely hot in the summer months.

## Restoring Eden

While several threatened mammals survive on Shark Bay's offshore islands, a large number of species have disappeared from arid parts of Australia. This is largely because of predation by introduced foxes and cats and competition from introduced grazing animals such as rabbits, goats and sheep. The Department of Conservation and Land Management's Project Eden is attempting to bring back threatened wildlife to Francois Peron National Park and other parts of Peron Peninsula.

As well as widespread baiting to remove feral cats, foxes, goats and rabbits from a 1050-square-kilometre area of the Shark Bay World Heritage Area, a 3.4-kilometre fence has been built to keep the ferals out. Foxes have virtually been eradicated and around 50–70 per cent of feral cats have been removed.

Bilbies and malleefowl are thriving since their release, and malleefowl chicks are commonly seen in summer. Despite Shark Bay being on the arid edge of their historical range, woylies are still holding on, five years after their first release. Unfortunately, the banded hare-wallaby and mala have suffered predation from remaining cats. However, Project Eden continues to be at the forefront of ecological reconstruction research and is continuing to develop new techniques that may soon allow other species such as the red-tailed phascogale, golden bandicoot, western barred bandicoot, sticknest rat, and chuditch to be returned to the national park. Project Eden is set to make the Shark Bay World Heritage Area one of the wildlife wonders of the world.

## park facts

**Where is it?** 10 kilometres from Denham, 340 kilometres from Carnarvon and 410 kilometres from Geraldton. Entry fees apply.

**Total area** 52,529 hectares.

**What to do** Walking, picnicking, taking a dip in Peron's artesian bore or 'hot tub', four-wheel-driving, fishing, bush camping.

**Walks** The Pastoral Lifestyle Walktrail, a 45-minute trail from the Peron homestead, takes visitors through the homestead and outbuildings of the former pastoral station.

**Must see sites** Cape Peron, Big Lagoon.

**Naming** The park was named after eminent French zoologist François Péron, who visited Shark Bay in June 1801 and March 1803 aboard the *Géographe*, describing many plants and animals for the first time.

**Nearest Conservation and Land Management Office** Knight Terrace, Denham. Telephone (08) 9948 1208.

# endangered

by Andrew Brown

## Pine featherflower

Verticordias, or featherflowers as they are commonly known, are among the most attractive of our native plant species. Currently, 101 species are known and these can be found scattered throughout the south-west of Western Australia. Some even occur in the arid interior.

Although many are common and widespread, some are confined to very specialised habitats and several of these are currently listed as threatened. One of the rarest of these is *Verticordia staminosa*, a species that is confined to a few granite outcrops in the Wheatbelt.

*Verticordia staminosa* has two subspecies and one of these is further divided into two varieties. All are currently declared as rare flora, with two of them (*Verticordia staminosa* subsp. *staminosa* and *Verticordia staminosa* subsp. *cylindracea* var. *erecta*) ranked as critically endangered. The first of these is confined to a single granite outcrop near Wongan Hills and is commonly known as Wongan featherflower. The second is found on two closely spaced granite outcrops near Newdegate and has the common name pine featherflower due to its erect habit and superficial similarity to a small pine tree.

Pine featherflower is a small, many-branched shrub with very narrow, more or less stalkless leaves to one-and-a-half centimetres long. Its solitary yellow flowers have protruding stamens six to seven millimetres long that are bright red with yellow tips. Below these are very feathery, yellow sepals five to six millimetres long and two bright red persistent bracts.

Pine featherflower differs from Wongan featherflower and the closely related granite featherflower (*Verticordia staminosa* subsp. *cylindracea* var. *cylindracea)* in its erect habit, growing up to one metre high. Interestingly, pine featherflower grows with granite featherflower at one location and the two do not appear to hybridise.

Some mature plants of pine featherflower have been killed when grazed by sheep. However, the main threat appears to be drought, with little winter rainfall in the Newdegate area over the past few years. Many plants look stressed and few seedlings have been observed.

Pine featherflower was declared as rare flora in October 1996 and ranked critically endangered in September 2000.

A recovery plan has been prepared for pine featherflower, and the Katanning District Threatened Flora Recovery Team is coordinating recovery actions that address threats to its survival in the wild. A two-sided A4 poster has also been prepared and distributed. A copy will shortly be placed on the department's website (www.naturebase.net).

If you want to know more about pine featherflower, detailed information can be found in the comprehensively written and beautifully illustrated book by Elizabeth George entitled *Verticordia—The turner of hearts.*

**Photos by Andrew Brown**

# Fire for life

Fire science has advanced as a result of research, including studies on fire behaviour and its effects on natural ecosystems, over the last four decades. How has this knowledge changed the way fire is managed in Western Australian bushland?

by Neil Burrows



The subdued natural landscapes of the south-west of Western Australia belie a diversity of wildflowers (many of them found nowhere else) so remarkable that the region is recognised as one of the world's 25 hotspots of biodiversity, and the only one in Australia.

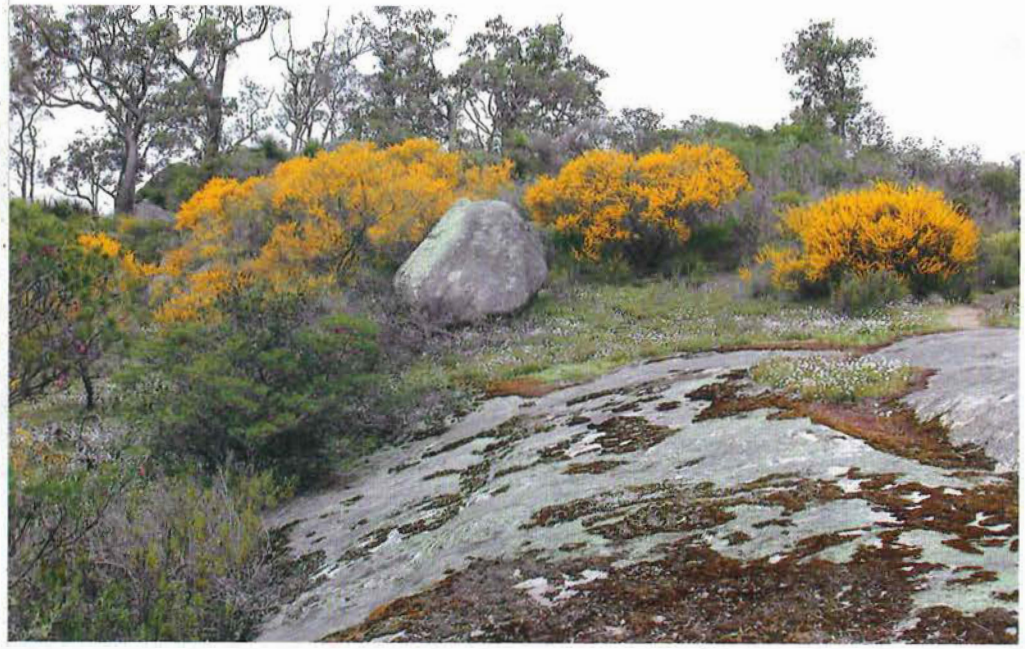
Flammable vegetation and hot dry summers have ensured that fire is a natural environmental factor, which, together with climate, landform and soils, has helped to forge this mega-biodiversity over thousands of years. Before European settlement, fires were started by lightning, but more frequently by Nyoongar Aboriginal people, who used fire with confidence, purpose and skill, as a tool with which to manage and manipulate the landscape, so that it provided the physical and spiritual necessities of life.

## Living with fire

Native plants, animals and ecosystems have evolved in this fire-prone environment. Many plant species reproduce or regenerate after fire (some cannot reproduce without a fire). Many plant communities need particular fire regimes to maintain their floristic and structural diversity. Fires, in a particular sequence or scale, are needed to provide diversity of habitat for many animals. However, the way in which species and ecosystems respond to fire varies. Some are quite resilient, returning to their pre-fire condition relatively quickly, while others can take decades to recover. No fire regime, or history of fire interval, season, intensity, patchiness and scale, is optimal for all species. Fire diversity can promote biodiversity, but some fire regimes can threaten biodiversity, especially in fragmented habitats or where introduced pests and diseases are present.

**Left** Most orchids, including this helmet orchid (*Corybus recurvus*), flower within 12 months of a fire. Research is needed to understand better the effects of fire on orchids.
*Photo – Neil Burrows*

Before European settlement, burning by Nyoongar people most likely maintained a patchwork-quilt of vegetation at different stages of post-fire development—from recently-burnt patches to long-unburnt patches. This fire mosaic contained the spread and intensity of wildfires. Large and intense wildfires were not in the best interests of Aboriginal people, and were probably rare. In many parts of Australia, where Aboriginal fire management has ceased and attempts have been made to exclude fire, the fire regime often becomes feral. Feral fire regimes are characterised by infrequent, large and intense wildfires, ignited by lightning or arsonists, that cause substantial environmental, social and economic damage.



*Previous page*
**Main** Regeneration of *Paraserianthes lophantha* from soil-stored seed after a fire.
*Photo – Jiri Lochman*
**Insets (top)** A honey possum (*Tarsipes rostratus*) using an old bird nest. The species depends on flowers for its food so prefers mature vegetation.
*Photo – Babs and Bert Wells/CALM*
**(below right)** An intense lightning-caused wildfire began near Mt Cooke, about 75 kilometres south of Perth, in January 2003.
*Photo – Kristian Pollock*

**Above (far left)** Intense wildfires cause severe damage to forest ecosystems, which take many decades to fully recover, and **(left)** can cause devastation to granite outcrops.

**Left** Even granite outcrops, such as this one, provide little protection from intense wildfires burning under hot, dry and windy conditions.
*Photos – Neil Burrows*

**Above** A hairy jugflower (*Adenanthos barbiger*) resprouts and flowers three months after an intense wildfire. About 75 per cent of forest species resprout after fire. *Photo – Jiri Lochman*

Today, in our fragmented, urbanised and settled landscapes, wildfires can threaten people, property and conservation values. The rapidly expanding rural-urban interface is most vulnerable, but wildfires also threaten rural towns, farms and other infrastructure. The job of managing fire in regional areas, including containing bushfires, falls largely to volunteer brigades and to fire crews from the Department of Conservation and Land Management, the Forest Products Commission and the Fire and Emergency Services Authority.

On lands managed by the department, the aim is to manage fire to conserve biodiversity, and to ensure an acceptable level of protection to human life and property. Fire management is complex and potentially dangerous, and requires the skilful combination of art and science. Fire science has advanced as a result of ongoing research, including studies on fire behaviour and its ecological effects on natural ecosystems, undertaken by a range of organisations and individuals over the last four decades. Although our knowledge is incomplete, fire management must be underpinned by fire science.

A fire symposium, attended by some 350 fire scientists, academics, fire managers, volunteer conservationists, volunteer fire fighters and interested community members, was held in Perth in April 2002. The scientific proceedings of this symposium have been published as a book containing 20 chapters written by expert fire managers and scientists. This synthesis of the latest fire science and technology is helping the department to develop and adapt its fire management further. A revised fire management policy and framework is being developed, based, in part, on 12 key scientific principles (see box on page 26).

## Setting objectives

Setting clear, workable and measurable fire management objectives for the conservation of biodiversity is of key strategic importance. It will assist with developing fire management plans and standards, with determining strategies and tactics and with assessing the acceptability or otherwise of the environmental impacts of fire as they are understood from research and monitoring.

To what extent should perceived wildfire threats to human life and property override biodiversity conservation objectives? One approach being taken by the department is to develop fire regimes that aim to conserve biodiversity, then to carry out a systematic wildfire risk analysis to determine the threat posed by these regimes to life and property. Fire management can then be modified where the threat is unacceptable.

Not all biodiversity can be conserved all of the time. However, to ensure the best possible outcomes, managers set objectives at three different scales: bioregional, landscape and fire management unit scales.

## Bioregional scale

The Australian environment has been divided into 80 broad biogeographic regions, which provide a framework for the development of a national reserve system and other natural resource management decisions. A bioregion is a large geographic area with similar climate, geology, landforms, broad vegetation types, wildlife and land use. There are seven bioregions in the south-west of Western Australia, ranging in size from about 15,000 square kilometres to 90,000 square kilometres.

Bioregion fire management objectives include the need to conserve the biodiversity of the bioregion while providing a sufficient level of protection to fire-sensitive ecosystems and to societal values. A key strategy to achieve this is to maintain a mosaic of interlocking patches that represent a diversity of fire regimes with varying intervals between fires and on varying scales. Where a wildfire risk analysis—to determine the threat to fire-sensitive species and communities, and to life and property—has shown an unacceptable risk of wildfire damage, measures to reduce the risk at this scale could include enhanced detection and suppression capacity; community education and awareness; and regional planning to minimise the exposure and vulnerability of life and property.

Climate models predict increasing aridity for the south-west, due to Greenhouse-induced climate change. At the bioregional scale, this will most likely extend the fire season and change the ways in which ecosystems respond to fire. Decreased rainfall will probably result in previously non-flammable, damp ecosystems becoming dry and flammable; slower rates of post-fire recovery; and reduced rates of fuel accumulation. There may also be a need to decrease the frequency of fires, due to the decrease in productivity. Current understanding of the ways in which ecosystems respond to fire may not be applicable under a changed climate, so the effects of climate change on fire response will need to be carefully monitored.

## Landscape scale

Within a bioregion, there are likely to be many different landscapes. Several attributes—including weather, soil types, assemblages of local plants and animals, and disturbance regimes—tend to be similar across the area.

**Above left** Holly-leaved banksia (*Banksia ilicifolia*) resprouts and flowers within two to three years of a fire.

**Left** Within four weeks of fire, drumsticks (*Kingia australis*) has numerous flowers.
*Photos – Neil Burrows*

Landscape-scale fire management objectives include maintaining biodiversity; maintaining diverse ecosystem structures, post-fire states and habitats; and protecting relatively fire-sensitive ecosystems and niches from frequent fires and from large and intense wildfires.

Management strategies to achieve these objectives could include maintaining an interlocking mosaic of recently-burnt and long-unburnt patches of vegetation, and patches burnt in different seasons. Managers also need to reduce the likelihood of large-scale, intense and damaging wildfires by incorporating fuel reduction, fire detection and suppression strategies into the overall mosaic. Wildfires that do occur can be incorporated into the mosaic, but their size and frequency need to be limited.

Vital attributes of key plants and animals can be used to estimate the range of desirable fire frequencies within a landscape. For instance, certain plants, known as obligate seeders, only regenerate from seed that is usually stored in the soil or in woody capsules on the plant. For many of these species, fire is necessary to stimulate and promote seed germination and development. If a fire occurs before these plants are mature enough to produce adequate seed reserves, these species are likely to decline. Conversely, if the bush in which such species occur goes for too long without a fire, some plants will be equally disadvantaged. It is also vital for managers to consider habitat requirements of key animal species, especially threatened species and those that have special habitat requirements such as long-unburnt vegetation.

To ensure that scientists are able to monitor the effects of fire, protectable, manageable and representative 'no planned burn' and 'regularly burned' scientific reference areas should be retained, where possible, as part of the mosaic.

## The fire management unit scale

A fire management unit is an area within a landscape. It could be a (sub) catchment or a mapped management boundary, such as a forest block, and it could contain a representation of landforms, ecosystems and vegetation complexes common to the landscape unit. Fire management units can be sinks or sources of recolonisation and can vary in size from a few hundred hectares to a few thousand hectares.

Various plants and animals will come and go, depending on the interval since the last fire and the structural development of the vegetation. Maintaining diverse fire regimes that vary in season, frequency, intensity and patchiness will provide a range of habitats and opportunities for organisms, given that no single fire regime is optimal. A key objective at this scale is to protect fire-sensitive ecosystems and habitats, such as riverside vegetation, some swamps, wetlands and rock outcrops, from frequent fires or large and intense wildfires. Occasional summer or autumn fires may be needed to regenerate these ecosystems and habitats.

**Top** Larger macropods, such as the western brush wallaby, thrive in recently burnt, open vegetation.
*Photo – Jiri Lochman*

**Above** The noisy scrub-bird prefers long-unburnt vegetation. It has poor dispersal ability so is favoured by small, patchy fires rather than large, intense fires.
*Photo – Babs and Bert Wells/CALM*

Strategies to achieve these objectives include varying the fire regime applied to a fire management unit over time: that is, varying the season, frequency and interval of fire based on vital attributes and life histories of key fire-sensitive species. The implementation of mostly patchy burns will create a mosaic within a mosaic, further adding to diversity of habitat at the landscape scale. Burn patchiness and protection of fire-sensitive habitats is best achieved by

**Top** Some species such as red swamp banksia (*Banksia occidentalis*) are readily killed by fire so occur in less flammable areas . Fire triggers the release of seed from protective woody capsules.

**Above** Fire promotes the development of numerous red swamp banksia seedlings, which take about four years to mature. *Photos Neil Burrows*

## Key scientific principles of fire management

**Principle 1** Fire is an environmental factor that has influenced, and will continue to influence, the nature of south-west landscapes and biodiversity.

**Principle 2** Species and communities vary in their response to, and reliance on, fire. Knowledge of the life histories of organisms or communities and their relationship to fire should underpin the use of fire in natural ecosystems.

**Principle 3** Following fire, environmental factors such as landforms, topography and life histories of various species, and random climatic events, often drive ecosystems towards a new transient state with respect to species composition and structure. This may prevent scientists from identifying which changes are specifically attributable to fire.

**Principle 4** Fire management is required for two primary reasons, which are not necessarily mutually exclusive: a) to conserve biodiversity and b) to reduce the occurrence of large, intense wildfires. Fire management should consider both ecological and protection objectives in order to optimise outcomes.

**Principle 5** The damage potential, suppression difficulty and biological impact (killing power) of a fire and the rate of recovery following fire are in direct proportion to the fire's intensity and size.

**Principle 6** Fire diversity promotes biodiversity. An interlocking mosaic of patches of vegetation—representing a range of biologically-derived fire frequencies, intervals, seasons, intensities and scales—need to be incorporated into ecologically-based fire regimes if they are to optimise the conservation of biodiversity at the landscape scale.

**Principle 7** Avoid applying the same fire regime over large areas for long periods of time, and avoid extreme regimes, such as very frequent or very infrequent fire intervals, over large areas.

**Principle 8** The scale of the fire-induced mosaic should a) enable dispersal of young native animals b) optimise boundary habitat and c) optimise connectivity, or the ability of animals to move through the landscape.

**Principle 9** All available knowledge, including life histories, attributes of native plants and animals and knowledge of Nyoongar fire regimes should be used to develop ecologically-based fire regimes for a landscape unit or a vegetation complex.

**Principle 10** Fire history, vegetation complexes and landscape units should be used to develop known and ideal mix of time since last fire.

**Principle 11** Wildfire can damage and destroy both conservation and societal values, so a systematic and structured approach must be used to identify and manage the consequences of such an event.

**Principle 12** Fire management should adapt to changing community expectations and new knowledge gained through research, monitoring and experience.

low intensity fire set under moist conditions in spring, when variation in moisture content across the landscape will result in patchy burn patterns. Of course, there is a risk associated with this because the vegetation could re-ignite as it dries out over summer. Alternatively, there is some evidence that Nyoongar people burnt parts of the landscape very frequently in summer and autumn, which, over time, resulted in a level of patchiness. Occasional intense fires under dry summer or autumn conditions will stimulate regeneration across the landscape. However, because intense fires under dry conditions are less patchy and burn more habitat elements such as hollow logs and dead trees, such fires should not be too frequent. Relatively fire-sensitive ecosystems are best protected by burning the more flammable and fire-resilient ecosystems in which they are embedded.

Based on our knowledge of the fire ecology of south-west ecosystems, we can apply a 'seven way test' to fire management, to check whether it is environmentally and socially friendly:

- Does fire management restrict the size, intensity, frequency and impact of wildfires?
- Does the fire regime maintain a fire-induced mosaic at an appropriate scale and provide a range of post-fire states?
- Does the fire regime include seasonal diversity?
- Does the fire interval allow seed banks to replenish?
- Does the fire regime include a sufficient fire-free interval to allow all habitat types to mature?
- Does the fire regime protect 'fire sensitive' ecosystems or allow them to regenerate?
- Does the fire management provide an acceptable level of protection to life and property?

If the answer to each of these questions is 'yes', we are well down the path to maintaining the south-west's mega-biodiversity, while at the same time being able to live with fire.

Neil Burrows is Director of the Department of Conservation and Land Management's Science Division . He can be contacted on (08) 9334 0463.

# Mysterious sand swimmers

The remarkable marsupial moles of Australia's sandy deserts survive and reproduce under exceptional circumstances, and by means of special adaptations and behaviour. Due to their cryptic underground lifestyle and small size (they fit snugly in the palm of your hand and weigh around 60 grams) they are among the most challenging Australian mammals to locate and study.

by David Pearson
and Joe Benshemesh

Living your entire life burrowing below sand is a daunting enough prospect, but imagine if the sand above your head is searing hot and lies in the middle of some of the driest country in the world. The sandy deserts of Australia are home to the remarkable marsupial moles that can survive and reproduce under such exceptional circumstances.

Until recently, it was considered that the underground habits of marsupial moles would protect them from falling prey to feral cats and foxes. However, researcher Rachel Paltridge, in her studies on feral predators in the Tanami Desert in the Northern Territory, found that the remains of moles were present in 10 per cent of fox droppings and three per cent of feral cat droppings that she examined. This work has focused attention on the conservation status of marsupial moles, and resulted in some innovative techniques to survey for moles and to study the mysteries of their ecology.

Two species of marsupial moles are recognised. The kakarratul, or northern marsupial mole (*Notoryctes caurinus*), is confined to Western Australia, and occurs in an arc from Warburton through the Gibson and Great Victoria deserts to the north-west coast in the Eighty Mile Beach area. The more widespread itjaritjari, or southern marsupial mole (*Notoryctes typhlops*), occurs throughout the Great Victoria Desert in both Western Australia and South Australia, as well as the southern Northern Territory and north-western South Australia. The two species are difficult to distinguish in the hand, differing in skull characteristics and minor external features. Both are considered to be nationally threatened due to their apparent rarity and growing concerns that populations may be in decline due to foxes, cats and numerous landscape changes over the past century.


## Tiny earth movers

Marsupial moles have some of the most bizarre physical features of any mammal, a consequence of evolutionary processes and ancestors that were able increasingly to adapt to a below-ground lifestyle. They do not excavate conventional burrow systems, but rather tunnel and backfill as they go, so that there is little sign of their passage. In a sense, these bizarre little animals seem to move a little elbow room with them as they push and dig by means of the nose and front legs, while the back legs push sand behind the body.

Marsupial moles lack functional eyes. The flattened head has a large area of exposed, leathery skin around the nostrils that forms a hard shield. The chest and shoulders have well-developed bony support, which, along with the nasal shield, absorbs the brunt of constant ramming through the soil. The ears have a simple opening, which is partly hidden under the fur, and most of the body is covered in silky cream to orange fur. The tail is small, marked with rings and terminates in a horny knob.

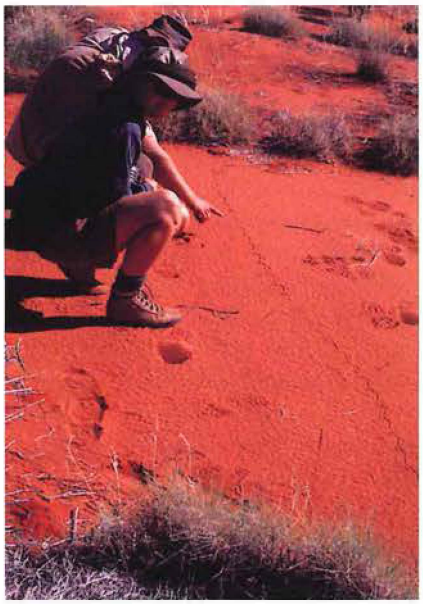
To enable propulsion through the sand, the marsupial mole's forelimbs have undergone considerable changes and have become efficient 'shovels'. Over evolutionary time, the forelimbs have rotated and extensive musculature has developed to enable moles to strongly force sand back past the body. Two digits on each forelimb have massive claws, reminiscent of the blades of earth-moving machinery, which cut away at the sand and shovel it backwards as the mole advances. Other claws on the hands are much reduced in size. Despite being awkward-looking and relatively slow-moving on the surface, moles are able to disappear speedily into the sand and then dig rapidly away, eluding efforts to dig them up.

## Marsupial mole dreaming

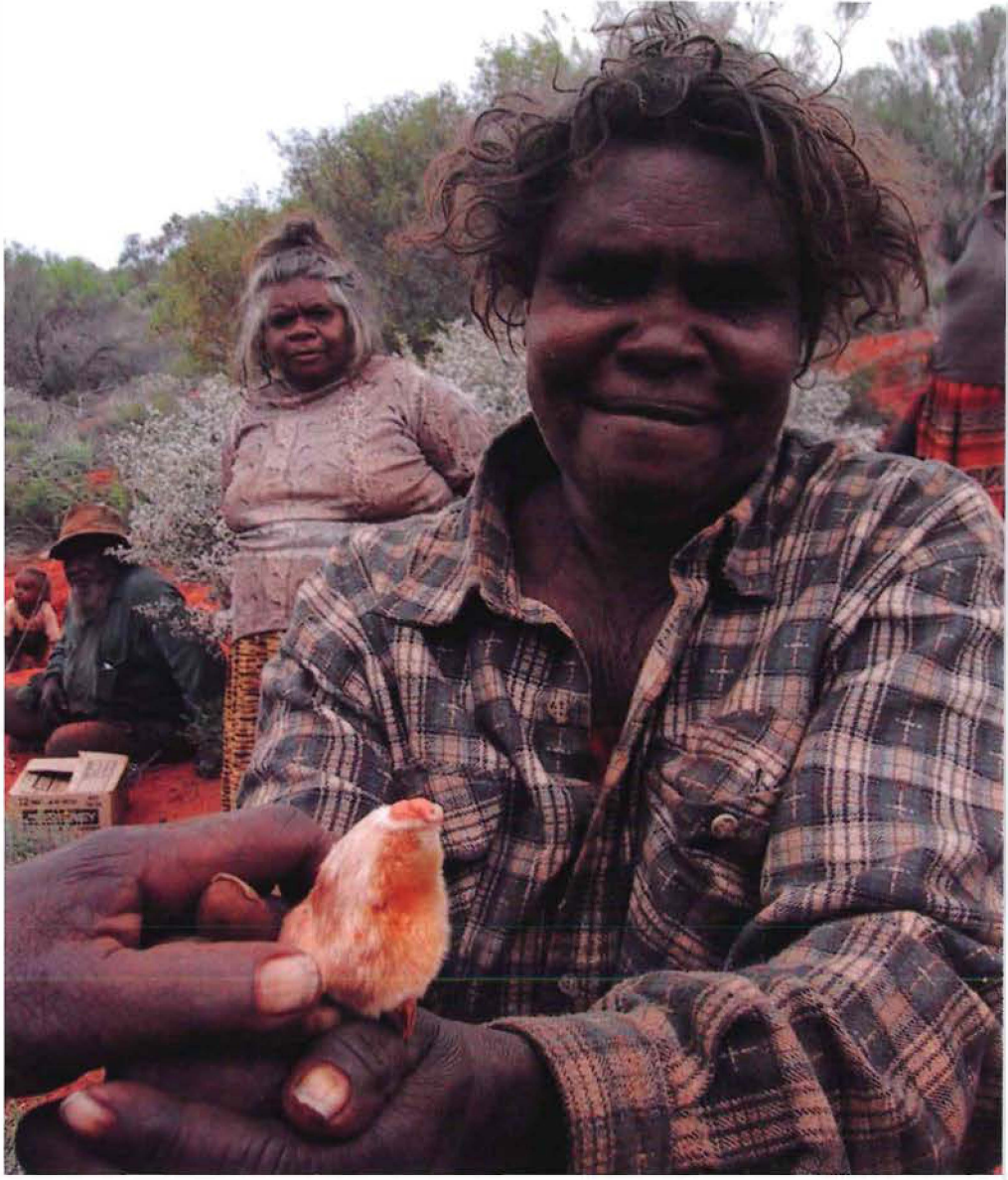
Desert Aboriginal people have long known about marsupial moles, because of their habit of occasionally surfacing and moving above ground. These surface forays leave distinctive tracks, typically starting with a circular hole only a few centimetres deep (where the animal has been unable to backfill), and ending in a neat pile of sand about 10 centimetres across. In between these is a sinuous belly drag bordered by

*Previous page*
**Main** Marsupial mole.
*Photo – D Roff/Nature focus*
**Inset** Marsupial mole tracks.
*Photo – Joe Benshemesh*

**Left** The northern marsupial mole.
*Photo – Andrew Burbidge*



**Above** Distinctive track left by a marsupial mole shuffling along the surface.



**Right** Traditional owner Mary Pan, from Anangu-Pitjantjatjara lands, holding one of the few itjaritjari people have ever seen. Traditional owners have played an integral role in recent itjaritjari research, working hard and enthusiastically as part of the successful research team.
*Photos – Joe Benshemesh*

paddle-like impressions of feet and a small continuous groove left by the tail. Marsupial moles were not important food for Aboriginal people, presumably because of their small size and low encounter rates. However, they are important in Aboriginal mythology and their blindness and tunnelling habit feature in several Tjukurrpa (Dreaming) stories about their exploits.

In an attempt to clarify their distribution and abundance in desert areas of WA, the Department of Conservation and Land Management carried out a study with the assistance of Jan Turner, an anthropologist with the Ngaanyatjarra Council. Observations of moles by Aboriginal people were collected throughout the Great Victoria and Gibson deserts, greatly extending their known distribution. Aboriginal people saw moles most often in winter and after rain, which appeared to force moles to the surface due to waterlogging. Ngaanyatjarra people refer to marsupial moles as itjarri itjarri or itjarrutju, and they feel affection and sympathy for the 'old blind ones'.

A *LANDSCOPE* Expedition to Queen Victoria Spring Nature Reserve in 1996 located a dead mole in the most serendipitous fashion. After initially stepping over what looked like a dingo dropping, closer examination revealed a large pair of claws on the foreleg. This find extended the range of marsupial moles more than 450 kilometres further south than previously known, to the southernmost part of the Great Victoria Desert in WA.

## Anatomy

The initial discovery of the marsupial mole generated much excitement in the scientific community and intense debate about the mole's relationship to other mammals. Much of what is known about the anatomy of the moles is based on dissection of Museum specimens, many collected in the late 1880s and early 1900s. Despite the lack of sophisticated equipment, Stirling (1888 and 1891), Wilson (1894), Gadow (1892) and Sweet (1904) were able to document and publish many of the remarkable features of the species. Even so, the existence of a pouch (marsupium) was not initially noticed and they were grouped with the monotremes (such as the echidna and platypus).

Over subsequent years, marsupial moles were shuffled from one mammalian group to another, eventually being placed in their own family (Notoryctidae; derived from the Greek words *notos* meaning 'south wind' and *oryktes* meaning 'one who digs' thus 'southern digger') with links to the polyprotodont marsupials (such as bandicoots). Recent work by Mark Westerman, using modern genetic techniques, found that marsupial moles were so different from other marsupial families that they warranted their own Order, indicating that moles have been evolving independently of other marsupials for a long period. Marsupial moles have external features and habits similar to the golden mole of Africa, but have evolved from entirely different ancestors, providing a fabulous example of convergent evolution.

**Above** Typical Great Victoria Desert sand-dune country inhabited by marsupial moles. *Photo – David Pearson*

**Left** A line of mounds where the marsupial mole has nearly surfaced numerous times. *Photo – Joe Benshemesh*

## Ecology

Very little is known about the ecology of marsupial moles, in part because they are so difficult to keep in captivity. The longest captive record is just 10 weeks, but most die within a month. The reason for this is unclear, but stress and our poor understanding of these animals' requirements are probably involved. Until recently, our knowledge of their ecology has been limited to what can be gleaned from Museum specimens and a range of observers, including Aboriginal people, who have encountered the animals. For example, we know from specimens that the female reproductive system is similar to that of other marsupials, and that females may have up to two young at a time (they only have two teats), even though young have only been recorded twice. We also know that the testes of the male are situated between the skin and the abdominal wall—a most unusual position for a marsupial. Presumably, this is another adaptation for their underground lifestyle, where there is no cooling advantage in having an external scrotum, but which may offer some protective benefits as well as reducing drag. But nothing else is known about the reproduction. There are so many puzzling questions, such as how moles find each other to mate in all that sand.

Museum specimens have also provided almost all of the available information on the diet of marsupial moles. Most of the diet consists of ants (particularly their eggs), termites and beetles, with occasional traces of spiders, grasshoppers and seeds. In captivity, moles have eaten the larvae of a variety of beetles, moths and other invertebrates, centipedes, spiders and even geckoes.

A kakarratul (northern marsupial mole) recently caught by Aboriginal people near Punmu community was sent to Philip Withers and Graham Thompson, physiologists at The University of Western Australia. They found that the body temperature of the mole was low (averaging around 30.8° C) relative to other marsupials and also ranged widely while in captivity (22 to 31°C). Its ability to tolerate a low and fluctuating body temperature may allow the mole to reduce its energy consumption (since fewer resources are spent keeping the body temperature elevated). This has been interpreted as either an adaptation to avoid overheating in the moist microhabitat of the soil or perhaps to cope with relatively scarce resources in the soil profile.

During the last three years, Joe Benshemesh has been working with Aboriginal people and Earthwatch volunteers in the Anangu-Pitjantjatjara lands of South Australia to try to learn about the ecology of itjaritjari in the field. Using a blend of traditional techniques such as tracking, high-tech surveillance equipment and good old shovelling, this work has been remarkably successful. New methods have been developed to reveal the backfilled tunnels of the animals, and this has provided much-needed techniques for survey and for piecing together the subterranean life of marsupial moles.

The results have been surprising. For example, in the same areas in which we would walk tens of kilometres to find a single marsupial mole track on the surface, we have found the equivalent of tens of kilometres of their backfilled tunnels per hectare underground. This is partly due to the fact that their underground signs may last for years compared with only days for surface tracks, but it's also a reflection of these animals' fossorial habits and that they surface only rarely. Indeed, exactly why marsupial moles surface at all is a puzzle, given the vulnerability of these blind and slow-moving animals to a host of potential predators. Understanding the threat posed by introduced predators, such as foxes, is particularly important and depends on why, and how often, itjaritjari surface. Traditional tracking skills have been invaluable in finding signs of moles on the surface and in interpreting the behaviour of the individuals that made them.

These techniques rely on signs the moles leave behind and provide a boon for answering many questions about their distribution, habitat preferences

**Right** Walalkara Indigenous Protected Area Ranger Robin Kankanpakantja listens to the sound of a marsupial mole burrowing through the sand.
*Photo – Joe Benshemesh*

**Below right** Southern marsupial mole eating a gecko.
*Photo – Mike Gillam*

and general ecology. But without being able to observe individuals in their natural environment, it is difficult to deduce much about their behaviour or to estimate population sizes. A means of observing animals going about their daily lives is therefore essential, and we have been developing ways of detecting and 'observing' itjaritjari using geophones (vibration detectors used in seismic and surveillance work).

Fortunately, itjaritjari make very distinctive tunnelling sounds and, with a grid of geophones, it is possible to count the number of individuals underneath the surface, and track the animals as they go about their normal activities underground. Although we have listened to the geophone grids for many hours and detected some itjaritjari, only a computer is able to listen long enough to collect systematic information and plot the animal's locations. To do this, George Jung (Geoscience, Monash University) has developed a sophisticated system that will be trialed in the field this year. While we may have to wait a while for an itjaritjari to wander into our study area, we are confident that when this happens a wealth of information on the habits and ranging behaviour of these strange little animals will be obtained.

The successes in the Anangu-Pitjantjatjara lands have been largely due to the collaborative spirit of the work, and finding a site at which the animals still occur in reasonable numbers. But we don't know how representative this is of the vast areas in which the two species of marsupial moles are thought to occur. There is an urgent need for surveys throughout this range, and any sightings should be carefully reported.

## Mole patrol

A 'Mole Patrol' kit encourages people travelling through desert areas to watch out for moles and their distinctive tracks and to report any sightings (see 'Bush Telegraph', *LANDSCOPE*, Summer 2002–3). The information packs, which contain photos of the moles and their distinctive tracks, are mailed to observers in the hope that further sightings can be made of this elusive inhabitant of the desert. If you would like further information, please contact the Mole Patrol on (08) 8952 1541 or by email (tsnnt@ozemail.com.au).

So next time you are out in the desert, especially if it's wet, watch out for the shuffling tracks of the marsupial mole. You just might be lucky enough to see one of the most bizarre and interesting Australian mammals.

David Pearson is a Principal Research Scientist in the Science Division of the Department of Conservation and Land Management. He is based at the Wildlife Research Centre, Woodvale, and can be contacted on (08) 9405 5112 or by email (davidp@calm.wa.gov.au).

Joe Benshemesh is a research associate at Monash University and is based in Alice Springs. His research is supported by Anangu-Pitjantjatjara Land Management and by grants from the Natural Heritage Trust, Department of Environment and Heritage SA, Earthwatch Institute, Nature Foundation SA, and Rio Tinto Aboriginal Foundation. He can be contacted on (08) 8951 8205 or by email (benshemesh@bigpond.com).

# Cape Le Grand National Park

## European heritage

Behind the names of Mount Le Grand, Thistle Cove, Lucky Bay, Rossiter Bay, Frenchmans Peak and Mississippi Hill, all in Cape Le Grand National Park, are tales of exploration, of whaling and of discovery.

by Libby Sandiford

Wild coastal scenery, rugged granite peaks and sweeping heathlands characterise Cape Le Grand National Park, a park of around 32,000 hectares about 30 kilometres south-east of Esperance.

The French were among the first Europeans to explore this coast, arriving in December 1792. An expedition, under the command of Admiral Bruny D'Entrecasteaux, had sailed east along the western south coast of what was known as 'New Holland'. Despite a brief to explore the land for its water supply and agricultural potential, and to report on its local inhabitants, the sailors did not venture ashore until they reached what is now Esperance, where they spent a few days.


However, the French were far from impressed by what they saw. The expedition's naturalist, Labillardiere, noted that:

> 'the interior country was interspersed with sandy downs which had the appearance of great sterility'.

The colours and forms of the sandplain heaths promised no agricultural prospects to European eyes accustomed to bright greens. But the wildflowers delighted the naturalist, and among Labillardiere's discoveries was creeping banksia (*Banksia repens*), whose ground hugging flowers rely on pollination by mammals such as the honey possum.

The French names of many features are a legacy from this period of exploration. Labillardiere described the events that led to the naming of the southern cape:

> '*L'Espérance* was driving towards the land so rapidly that she was on the point of being stranded when Citizen Le Grand ... went to the masthead in the very midst of the tempest and almost immediately came down, explaining with enthusiasm that the ship was out of danger! He then pointed out the anchoring place ... This discovery saved both the ships [*L'Espérance* and *La Recherche*] ... We gave [the cape] ... the name of Citizen Le Grand'.

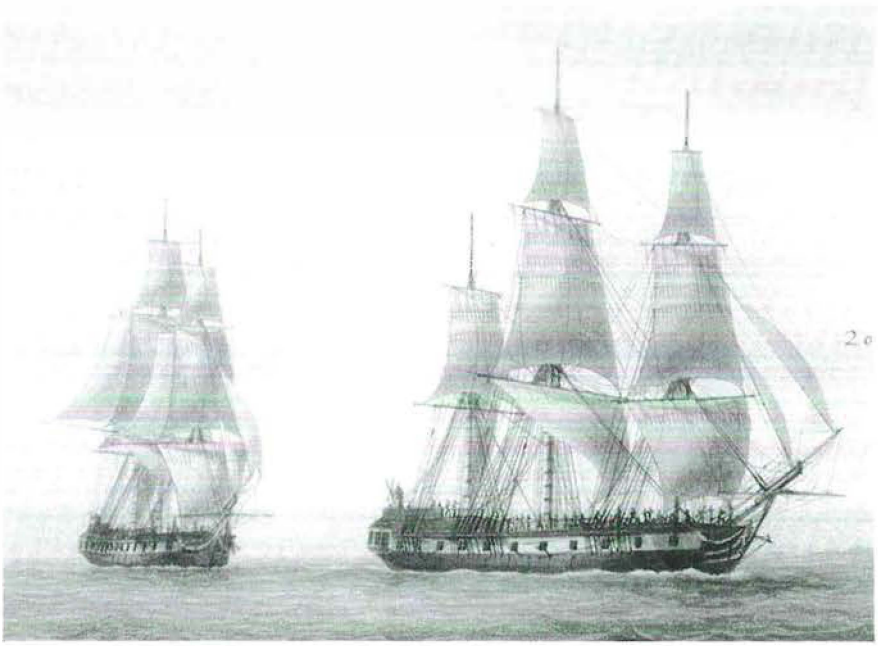
## Flinders

The next mariner of note to arrive was Englishman Captain Matthew Flinders in 1802. He was determined to travel through the islands, which D'Entrecasteaux had named the Archipelago of the Recherche, but skirted in 1792. However, he encountered a fairly severe summer storm. With, according to Flinders:

> 'no prospect of shelter under any of the islands, I found myself under the necessity of adopting a hazardous measure ... we steered directly before the wind for the main coast, where the appearance of some beaches behind other islands, gave a hope of finding anchorage. At seven in the evening we entered a small sandy bay, and finding it sheltered everywhere except from south west ... the anchor was dropped. The critical circumstance under which this place was discovered induced me to give it the name of Lucky Bay.'

Like D'Entrecasteaux, Flinders was unimpressed with the appearance of the land, though astonished at the variety of wildflowers:

> 'The vegetation indeed consisted of an abundant variety of shrubs and small plants and yielded a delightful harvest to the botanists, but to the herdsman and cultivator promised nothing, not a blade of grass, nor a square yard of soil from which the seed delivered to it could be expected back, was perceivable to the eye in its course over these arid plains.'



*Previous page*
**Main** Thistle Cove in Cape Le Grand National Park.
*Photo – Col Roberts/Lochman Transparencies*
**Insets from top** Illustrations of Captain Matthew Flinders and Admiral Bruny D'Entrecasteaux.

**Above left** Captain Matthew Flinders,
*Image – Mitchell Library, State Library of NSW*

**Left** Detail of *La Recherche* and *L' Espérance*, taken from a painting by Frédéric Roux, now in the Musée de La Marine, Paris.

However, Flinders thought Thistle Cove 'a small but useful find' and named it after Mr Thistle, the crew member who discovered it. With both wood and water here, Flinders thought it superior to Lucky Bay.

During the visit, Flinder's gardener Peter Good became one of the first Europeans to scale Frenchmans Peak. He wrote that:

> 'on ascending near the summit and arriving at the entrance we had supposed a cavern—we were astonished to find it a natural arch—entirely through the mountain ... on the summit we could count the country set on fire in 9 different places by the natives ... but what we saw is barren, no luxuriant vegetation to be seen'.

The fires were used by Aboriginal people to flush out animals and promote new growth to attract game.

Good also described their attempts to sample the local bush tucker, in this case the fruit of the zamia:

> 'In this day's excursion we met with a species of cycad with plenty of green fruit—on cutting it open and tasting, the seeds were very palatable and full of juice. As water was scarce we ate heartily then made a fire and roasted them and ate it in that form—but very soon after [were] taken with a pain in the stomach, a headache and repeated retching which continued all day'.

The seeds of this plant were a staple food of the Aboriginal people, but they first removed the toxins and carcinogens by a complex and lengthy method involving leaching, burial and roasting.

## Sealers and whalers

The next wave of visitors was the sealers, many of whom were fur hunters from Van Dieman's Land (Tasmania). The skins of New Zealand fur seals were particularly valuable,

**Above** Lucky Bay, Cape Le Grand National Park.
*Photo – Jiri Lochman*

**Below left** This small unnamed bay between Lucky Bay and Thistle Cove can be seen whilst walking the Cape Le Grand Coastal Trail.
*Photo – Marie Lochman*

**Below** Other crew members became extremely ill, after sampling the seeds of the zamia (*Macrozamia reidlei*).
*Photo – Jiri Lochman*

fetching 15 shillings at King George Sound and more than two pounds in London. However, by the 1840s, Western Australia's first industry had collapsed with the decimation of the seal populations. Today, though, both Australian sea lions and New Zealand fur seals are occasionally seen resting on the shores of these bays.

Like sealers, whalers were among the first non-Aboriginal people to benefit from the 'discovery' of this coastline. As the name implies, the preferred target, in the days of open-boat whaling with hand harpoons, was the southern right whale. This is because it was slow swimming, floated when dead and yielded large amounts of valuable products, particularly oil for illumination and lubrication, and baleen (horny plates that hang from the whale's upper jaw, used to filter food). Fortunately, these whales have now increased in numbers from near extinction in the late 1800s and, in winter and spring, right whales are frequently sighted along this coastline when females come close to shore to give birth. A v-shaped blow, the lack of a dorsal fin and squarish flippers distinguish the right whale from others. These mammals also have horny light-coloured growths called callosities around their heads, and the pattern of these is unique to each animal.

## Eyre overland

In 1841, while attempting to become the first European to cross from South Australia to Albany by land, Edward John Eyre and his Aboriginal guide Wylie approached Cape Le Grand from the east. Exhausted and suffering from the rigours of crossing the Nullarbor, they were heading for Thistle Cove where Flinders had previously recorded fresh water and where Eyre hoped to find food:

> 'we commenced our journey without breakfast. Being near Thistle Cove, where I intended to halt some time ... I was

**Above** Looking over granite tors and Thistle Lake to Frenchmans Peak.
*Photo – Brett Dennis/Lochman Transparencies*

**Left** Southern right whale.
*Photo – Steve Sadler*

**Right** Hellfire Bay.
*Photo – Steve Sadler*

**Below right** Rossiter Bay.
*Photo – Dennis Sarson/Lochman Transparencies*

> anxious to husband our little stock of flour in the hope that at the little fresh water lake described by Flinders ... we should find abundance of flag reed for our support'.

This reed was a native bulrush (*Typha angustifolia*), which Eyre thought:

> '[an] excellent and nutritious food ... of agreeable flavour and wholesome and satisfying to the appetite'.

On reaching Rossiters Bay, Eyre recorded that:

> 'upon looking towards the sea I thought I had discovered a boat sailing in the bay. Having hastily made a fire ... we fired shots, shouted, waved handkerchiefs and made every signal we could to attract attention, but in vain ... we stood silently and sullenly gazing after the boats as they gradually receded from our view. Whilst ... brooding over our disappointment we were surprised to see both boats suddenly lower their sails ... Poor Wylie's joy knew no bounds and he leapt and skippered about with delight ... I was no less pleased ... [soon] we were domiciled on board the hospitable *Mississippi*—a change of circumstance so great, so sudden, so unexpected that it seemed more like a dream than reality.'

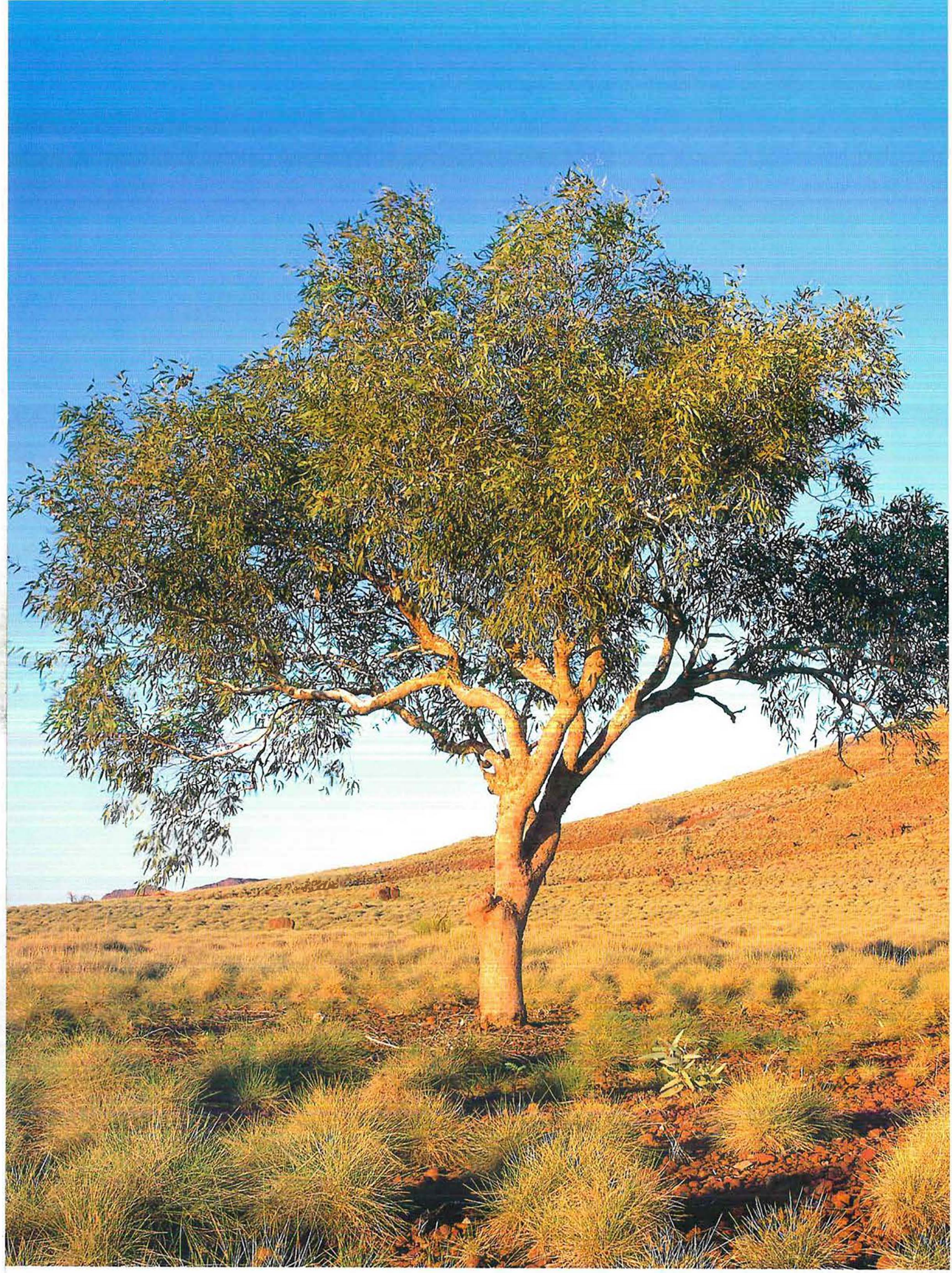
The Captain of the *Mississippi*, a whaling boat, was Mr Rossiter, after whom Eyre named the bay. Nearby Mississippi Hill, visible from Lucky Bay, was named after the ship. The *Mississippi* had arrived a few weeks earlier for the whale season. One chase was made while Eyre was on board, but was abandoned when they realised the whale was a humpback. Eyre noted that the whaling life was 'one of regularity but considerable hardship'. Once they had recuperated and had been provided with stores, Eyre and Wylie continued their journey and reached Albany a month later. Like those before him, Eyre considered the whole south coast 'arid and barren in the extreme', which no doubt delayed further interest in this coastline. However, he noted the Cape Le Grand area:

> 'Altogether seemed a favourable place and had we not met with the vessel it would have held out to us the prospect of obtaining an abundant supply of food for ourselves'.

A party led by explorer and prominent colonist John Forrest also passed through the area in 1870, in search of good country for pasture. During this expedition, Frenchmans Peak was named by his brother, surveyor Alexander Forrest, because its shape was said to resemble a man wearing a Frenchman's cap. The Aboriginal name for the peak is Mandoorbureup.

Today, the wild coastal scenery, wide beaches set in sheltered bays, rugged granite peaks and sweeping heathlands continue to attract visitors to Cape Le Grand National Park. However, they are also encouraged to reflect on the park's early history. A two-kilometre return heritage trail enables visitors to retrace the footsteps of these early explorers.

Libby Sandiford worked on the South Coast Heritage Trails Project for the Department of Conservation and Land Management in 1987-88. She lives in Albany, where she is a consultant botanist, and can be contacted on (08) 9844 4860.



# Spinifex in your socks

## *Bushwalking the Pilbara*

The Pilbara countryside is an artist's palette, but no amount of mixing will reproduce exactly the blue skies, red dirt and yellow spinifex, or the views that go all the way to the horizon. A soon-to-be-released book, *Bushwalks in the Pilbara*, will guide visitors through its scenic grandeur.

by Judymae Napier and David Whitelaw

The Pilbara region covers more than 563,951 square kilometres of Western Australia's north-west, from the 'beach to the border'. An area nearly two-and-a-half times that of the State of Victoria, it is grand in both size and variety. Pristine islands, shell beaches, hidden deserts and ancient seabeds are all part of this unique landscape. A closer look reveals WA's highest peaks, deepest gorges and oldest rock formations. In a playground of this magnitude, there is no waiting in line. There are endless opportunities for those who don't mind going out and getting dirty to embark upon a journey of discovery in this final frontier.

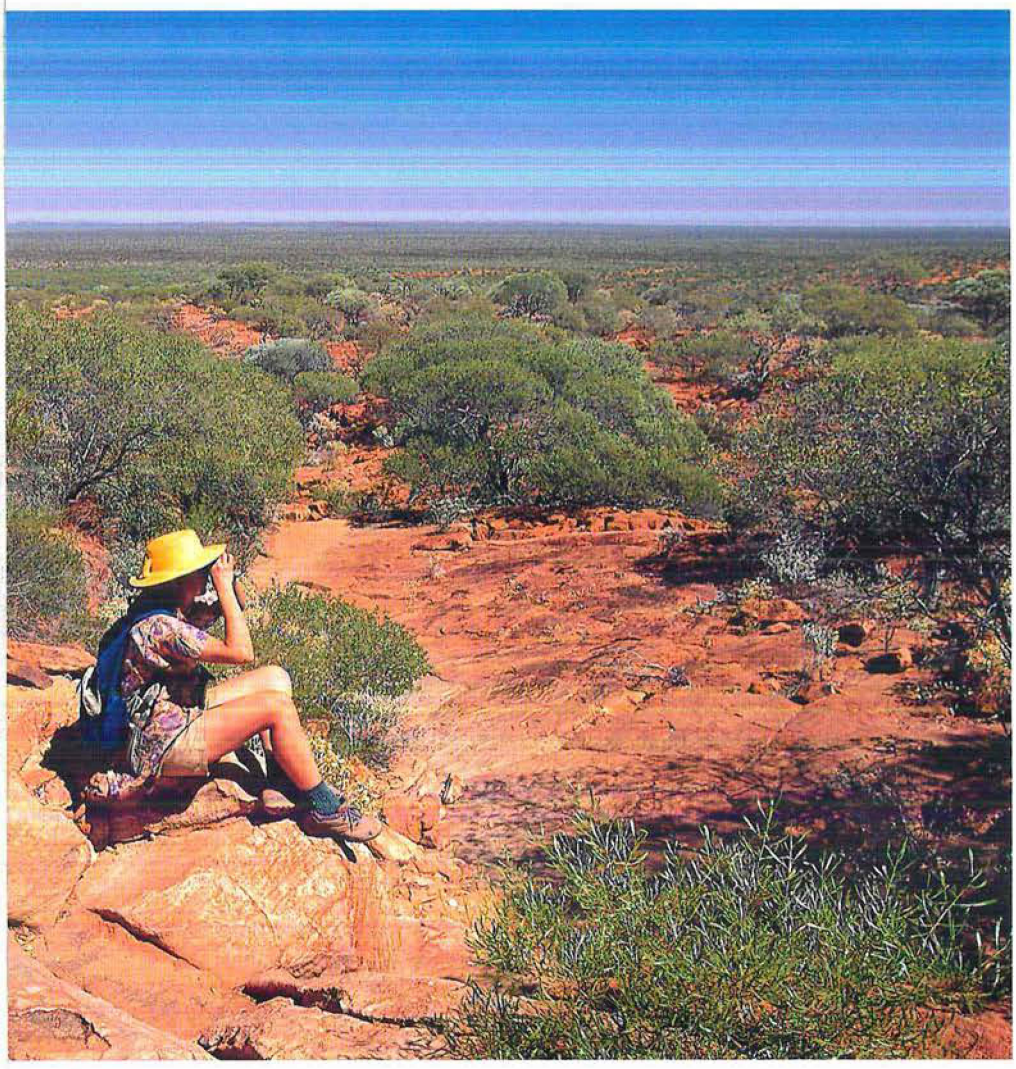
Distances from Perth to the Pilbara region and between its parks are great, and this can limit the amount of time visitors have available to spend in each park. With this in mind, there is a variety of trails that will help you experience the best of each park—some of the best walking and, in some places, scrambling in the Pilbara. While many of the trails are suited to a range of experience and fitness levels, the more adventurous walks pose significant risks and must not be undertaken lightly.

## Take the high road

There are several walktrails for those who like to be on top of things. The Badjirrajirra Trail is a loop that traverses the top of Cape Range National Park, negotiates the rugged limestone, passes spectacular canyons and offers breathtaking views east to Exmouth Gulf and west to the narrow coastal plain, sand dunes and beaches that form part of the world-class Ningaloo Marine Park. The trail begins and ends at the Thomas Carter Lookout, which—at 311 metres above sea level—is one of the highest points on the cape. Thomas Carter was a natural historian and collector of bird specimens who lived for a while at nearby Point Cloates. He is most famous for collecting the type specimen of the spinifexbird (*Eremiornis carteri*).

Limestone sinkholes are a predominant feature of this cratered landscape, providing a window into the cave network that worms its way beneath the ranges. To avoid a fall, stay on the formed trail, which takes you up and down the ranges, and passes through dry creek beds carved by torrential rain and flooding. The climate is much drier now, but summer rainfall continues the weathering process, undercutting hard layers and eventually causing large blocks of material to break off and tumble to the bottom of the gorges. There is no permanent water in the Cape Range gorges and medium to long-range walks through the area are recommended for the cooler months of the year.

Dodging camels is not something you'll have to do along the Chichester Range Camel Trail, but spare a thought for the animals and people that made and negotiated these tracks. The camel trail in Millstream-Chichester National Park was the transport route used by camel and bullock teams to carry goods from the port at Cossack to the inland Pilbara and to export the wool clip back out. They would carry up to nine tonnes of supplies. The Chichester Range escarpment was so steep that a blacksmith's shop was set up permanently at the foot of the range near Python Pool. Here, the smithy repaired wheels and brakes that had come apart on the 'big hill'.



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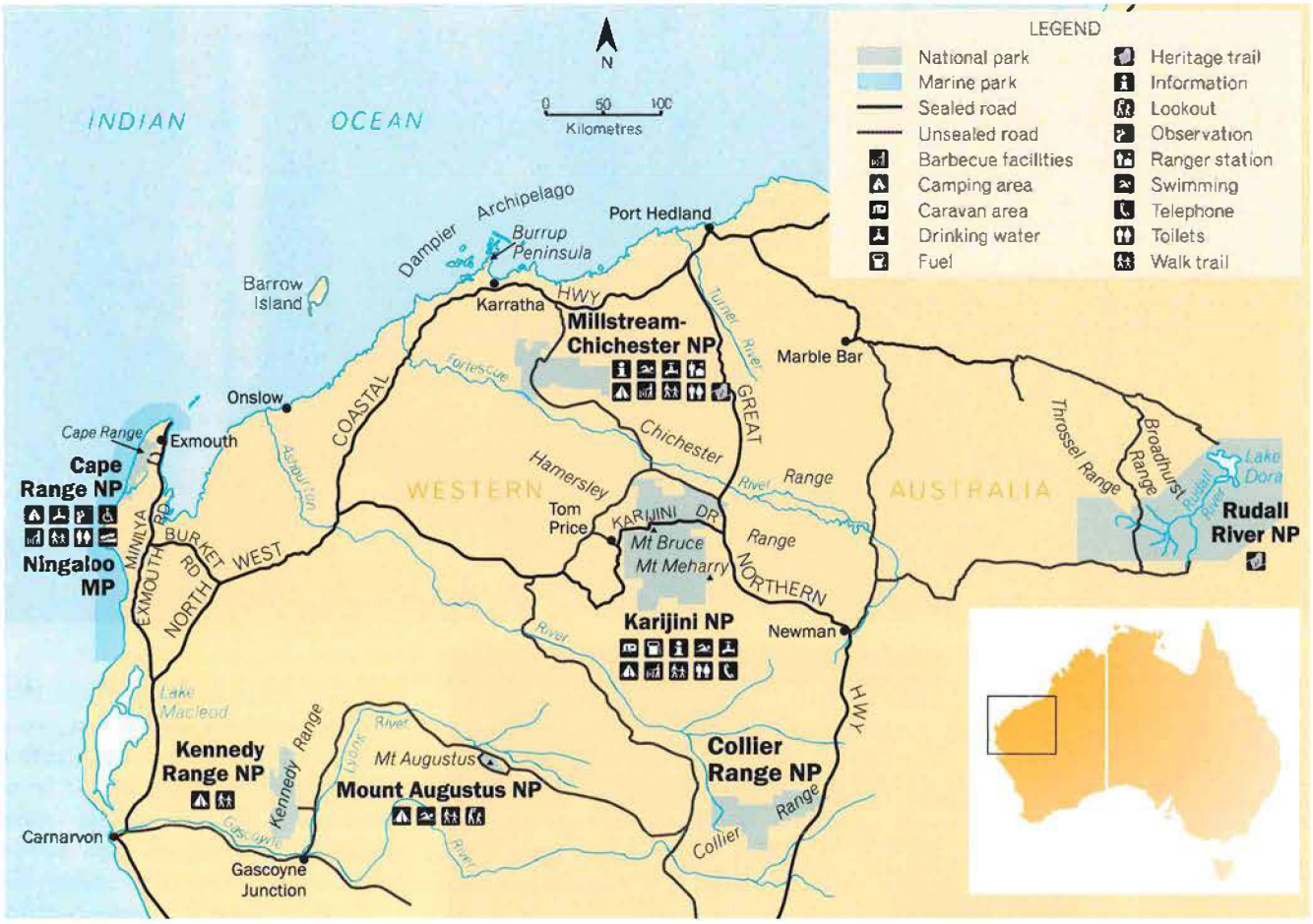
**Main** The Chichester Range.
*Photo – David Bettini*
**Inset** Roadside wildflowers, including pincushions, mulla-mullas and daisies.
*Photo – Bill Bachman*

**Left** Mount Augustus National Park, looking east across mulga plains from Edney's Lookout track.
*Photo – Bill Bachman*




Trails at Mount Augustus National Park will have you roaming up, down, around and over as you explore one of this State's most intriguing natural and cultural features. At twice the size and almost three times the size of Ayers Rock (Uluru), Mount Augustus rises abruptly from its flat surroundings. It has many fine examples of Aboriginal art that are many thousands of years old. At dawn and dusk, the colours of Mount Augustus change almost by the minute—from deep indigo to bright pink, orange or red, and occasionally green. You have to see it to believe it! (See 'Mount Augustus National Park', *LANDSCOPE*, Winter 1995.)

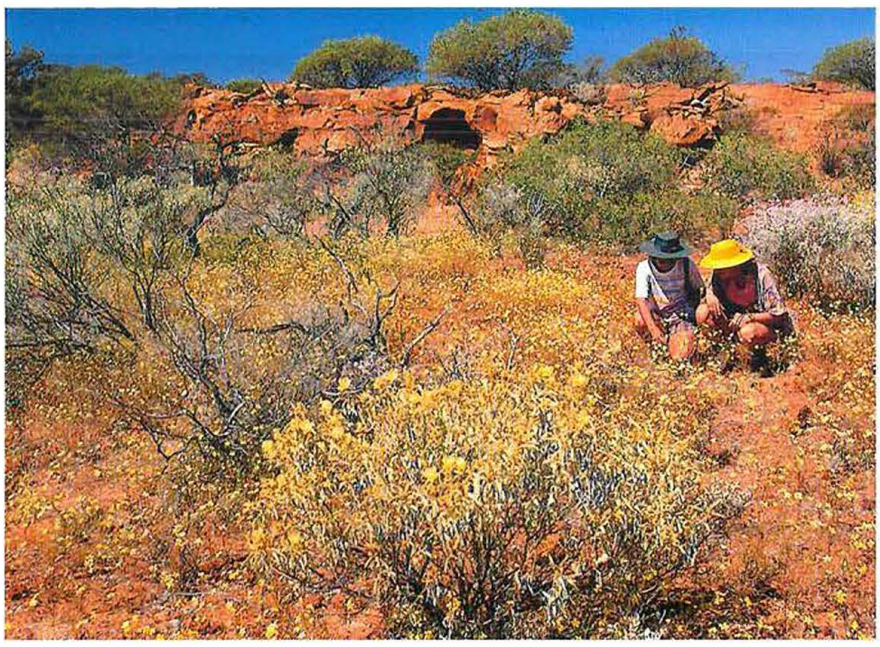
WA's two highest mountains—Mount Meharry and Mount Bruce—are found in the Pilbara region, and both are in Karijini National Park. The park also protects a section of the Hamersley Range, which is the most extensive elevated area of land in Western Australia.

Mount Meharry is the tallest peak, at 1,245 metres, and Mount Bruce is the second highest, at 1,235 metres. You can four-wheel-drive to the summit of Mount Meharry, but the Mount Bruce walktrail requires you to walk all the way. Mount Bruce, known as Punurunnha to the local Aboriginal people, signifies the boundary of different language groups and features in many local legends. The visitor's book at the summit also tells a few tales. "I feel like an eagle up here ... it's fantastic" to "I'm on top of the world". Most of a day is required to do the walk, enjoy the views and explore the airy summit ridge. Visitors who can't get all the way to the top can still enjoy some great walking, views and interpretation closer to the car park.

**Right** Hancock Gorge in Karijini National Park.
*Photo – Jiri Lochman*

## The low road

If Mount Bruce feels like you're on top of the world, Hancock Gorge would have to be a journey to the bottom. While the gorge is not completely enclosed, with the height of the cliffs and its sheer narrowness, it might as well be. Rocks have been worn smooth by the turbulent waters of flash floods, a reminder that the gorges are no place to be when there's rain about. Rocks and gravel flood over the gorge rim, scouring their way



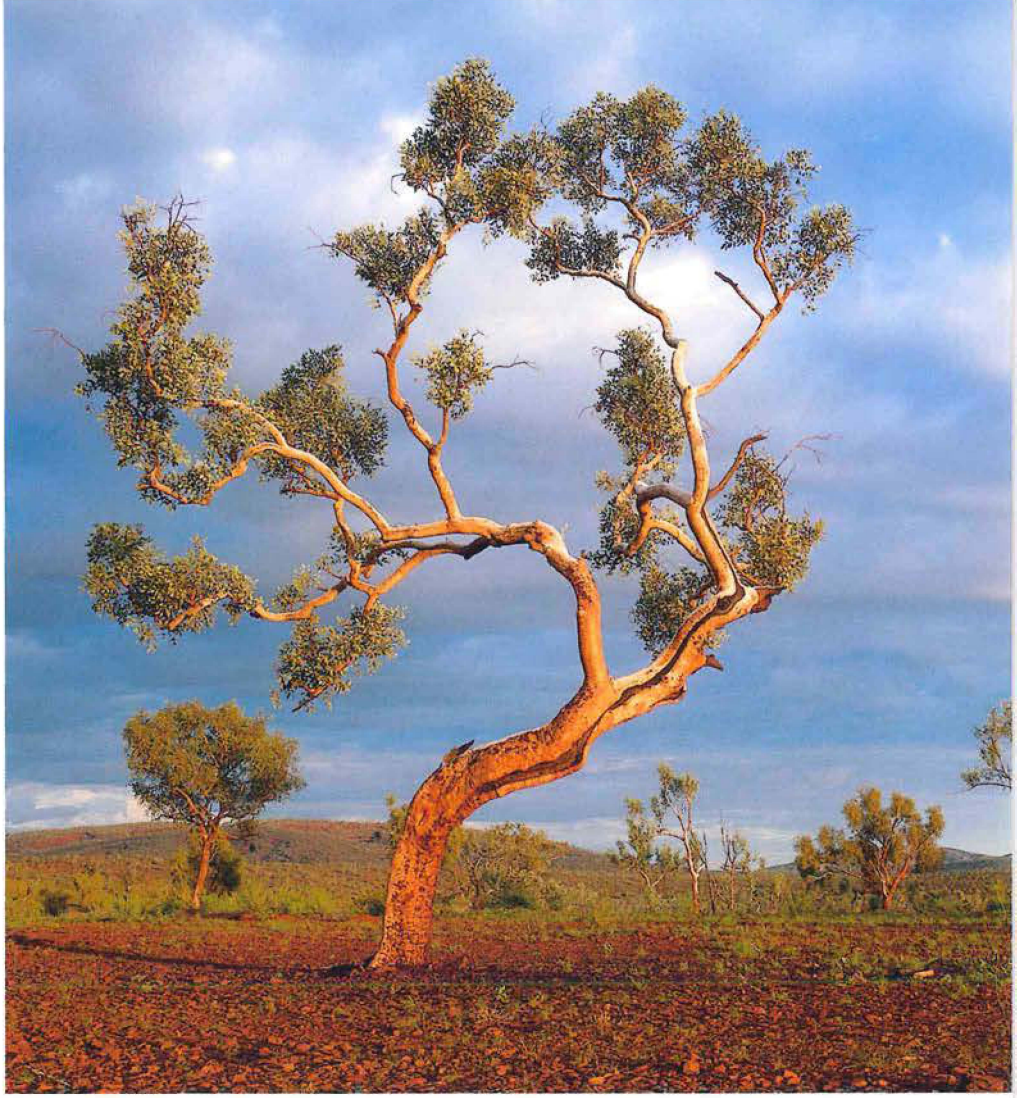
down to Junction Pool, where they combine with the debris and water from three other gorges before continuing downwards to the river floodplain. This trail includes some demanding climbing on high, narrow ledges, and is not for the faint-hearted.

At Dales Gorge, in Karijini National Park, you can follow a trail that takes you along the rim of the gorge before negotiating the steep slope down to Fortescue Falls, one of the park's spectacular all-year-round waterfalls. The many trees seen along the gorge rim and surrounding landscape include river gums (*Eucalyptus camaldulensis*) up to five metres high and weeping northern paperbarks (*Melaleuca argentea*). Descending into the gorges, you pass native fig trees (*Ficus platypoda*) and cypress pines (*Callitris glaucophylla*) known to have survived for 380 years inside this dynamic gorge environment. Further along the Dales

**Top** Late afternoon reflections in Dales Gorge near Circular Pool in Karijini National Park.
*Photo – Brett Dennis/Lochman Transparencies*

**Centre left** Fortescue Falls in Karijini National Park.
*Photo – Jiri Lochman*

**Left** Mixed wildflowers including *Goodenia* sp., along Edney's Lookout track, at Mount Augustus.
*Photo – Bill Bachman*



**Right** Snappy gums in Karijini National Park.
*Photo – David Bettini*

**Below right** The Homestead Visitor Centre, in Millstream–Chichester National Park.
*Photo – Dennis Sarson/Lochman Transparencies*

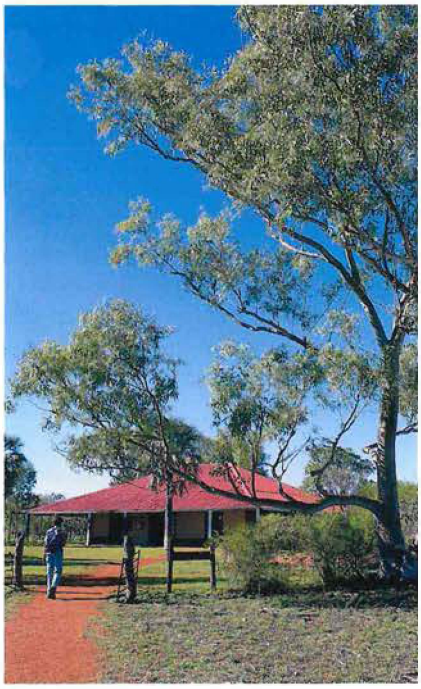
Gorge trail you reach the aptly-named Circular Pool—a rock amphitheatre, spring-fed by crystal clear water tumbling down the fern-lined walls. A dip here makes all the effort worthwhile. Brightly coloured dragonflies flit over the surface of the water, their voracious appetites supplemented by smaller insects buzzing around the pools. Only the stunning colours found in the rocks and pebbles along the gorge floor are able to compete with those provided by the unique insects found in this ancient environment.

In the Pilbara, there is much to remind you of the hardships people faced when they came to live in a region so foreign to many of them. The area surrounding Millstream was once a thriving pastoral station, family home and tavern, nestled between the Hamersley Range and the Chichester Range in the floodplain of the Fortescue River. The walktrail around the homestead lets you explore Millstream as it was in the early 1940s. Information plaques show the way, and take the perspective of a 12-year-old boy, keen to share his favourite places and good times with you. The homestead environment is an oasis of permanent pools and lush tropical palms that have been preserved to give visitors an experience of the amazing contrasts that only water can bring to the dry outback country. The Millstream homestead is now the park's visitor centre, providing interpretive information and insight into the lives of local Aboriginal people and European settlers since before the last century.

The local Martu Aboriginal people know Rudall River as Karlamilyi. Located where the Great Sandy Desert and Little Sandy Desert meet, it is one of the world's most remote national parks and is also Western Australia's largest. Rugged beauty, desert dunes, salt lakes and mountain ranges await its visitors. Be prepared, however, as the outback can be an unforgiving place for adventurers who are ill-equipped or not self-sufficient. (See 'Rudall River National Park', *LANDSCOPE*, Autumn 1997 and 'Land of the Lost', *LANDSCOPE*, Summer 1996-97.)

## Meet you at the coast

If you enjoy exhibitions, the Burrup Peninsula is for you. On show is an open-air gallery of mystical artwork—engraved over thousands of years—that shows a richness of traditional culture. Many sites also house shell debris and stone artefacts, standing stones and patches of rock abraded from seed grinding. Temperatures among the rock piles can become quite high, so choose your time carefully. Don't forget to take a breath and capture the mood of this ancient rock art site and enjoy the experience that our unique Aboriginal heritage provides us.



For an experience of the more natural kind, a walk along the northern rim of Yardie Creek, in Cape Range National Park, offers great views of the gorge and Indian Ocean to the west. Look out for the stilt mangroves nestled along the creek's edge, the grey foliage and mauve flowers of the Yardie

**Left** North West Ferry on Yardie Creek in Cape Range National Park.
*Photo – Bill Belson/Lochman Transparencies*

**Top** Osprey feeding on buffalo bream.
*Photo – Chris Surman/Lochman Transparencies*

**Above** Black-footed rock-wallaby.
*Photo – Jiri Lochman*

Creek morning glory (*Ipomoea yardiensis*) and rock figs (*Ficus brachypoda*) protruding from limestone cracks alongside the walktrail. As you make your way along the gorge, look carefully down and along the wall on the other side. The black-footed rock-wallaby (*Petrogale lateralis*) lives along the rock face of the gorge. A number of birds also nest along the limestone cliff faces, while white-breasted sea eagles (*Haliaeetus leucogaster*) and ospreys (*Pandion haliaetus*) soar overhead. The rugged limestone landscape of Cape Range provides a stark backdrop to the turquoise waters surrounding Ningaloo Reef, but, in many ways, highlights the spectrum of scenery offered to visitors to the Pilbara region.

## A time to visit

Most visitors to the Pilbara region arrive during autumn and spring. Winter days are pleasantly warm and clear, although nights can be cold and sometimes frosty. In the peak summer months, the refreshing cool waters of the gorges and rock pools—which in winter can be too cold for swimming—compensate somewhat for the extreme heat. Summer has its own advantages, with longer evenings and less bustle from other tourists in the parks. However, be aware that the weather can change dramatically, because the Pilbara has a tropical, semi-desert climate that is prone to cyclones and rain-bearing thunderstorms. This is all part of the excitement that makes sure we keep one eye on the weather when venturing 'out back'.

Getting around the Pilbara is all part of the discovery, with opportunities to fly, drive, take a guided tour or get off the beaten track. The destinations on offer can provide you with so many choices that there is always more to see and do, even after you've visited the rugged coastline, seen the mountain ranges and escaped to the desert sand dunes.

The selection of walktrails we have covered gives only a glimpse of the discoveries you can make. The Department of Conservation and Land Management will soon release a book on walktrails in all of the Pilbara region's national parks. *Bushwalks in the Pilbara* will invite those with an adventurous spirit to come and experience the Pilbara outdoors for themselves.

Judymae Napier has worked in the Pilbara region for 23 years, initially as a horticulturist with the Forests Department, and now as the Information Officer for the Department of Conservation and Land Management. She lives in Karratha and can be contacted on (08) 9143 1488 or by email (judymaen@calm.wa.gov.au).

David Whitelaw is the Parks and Visitor Services Leader for the Pilbara region. He has been with the Department of Conservation and Land Management for seven years, working from the Karratha office for the past two years. He can be contacted on (08) 9143 1488 or by email (davidw@calm.wa.gov.au).

*Bushwalks in the Pilbara*, a new book to be published by the Department of Conservation and Land Management, will be available later this year at a cost of $16.45.

# Volunteers give wetlands a helping hand

by Robyn Phillimore



Volunteers have long played an important role in helping to protect some of WA's special places—from major national parks to local bushland areas. One such group has contributed countless hours to the upkeep of the Brixton Street wetlands.

A large number of wetlands within the Perth metropolitan area have been destroyed or significantly altered by clearing or landfill. In fact, 97 per cent of the Swan Coastal Plain has been cleared for agriculture or housing. As a result, many of the plant communities associated with these wetlands have become rare or even extinct. Nevertheless, some plant communities still occur in a small, 19-hectare remnant near Brixton Street in the Perth suburb of Kenwick.

The Brixton Street wetlands lie 20 kilometres south-east of Perth near the base of the Darling Scarp. This small remnant forms part of the Greater Brixton Street Bushland, which contains around 127 hectares of vegetation. The reserve occurs on the winter-wet flats of the Guildford clays.

Brixton Street wetlands support a very rich flora, with more than 300 different species of plants. This is equivalent to more than 20 per cent of Perth's flora in only 0.005 per cent of the area. The wetlands also contain some rare plant communities known as threatened ecological communities, some of which were featured in the article, 'Threatened plant communities of the Swan Coastal Plain' (see *LANDSCOPE*, Spring 1996). They include rich herblands that cover the winter-wet claypans; herb-rich shrublands on clay flats; and marri woodlands on the higher ground where the soil is well drained. The wetlands also provide habitat for numerous birds, mammals, frogs and reptiles.

## Saving the wetlands

In 1992, The Friends of Brixton Street Wetlands was formed. They persistently lobbied government agencies to recognise the significance of the wetlands. As a result, the wetlands were saved from the effects of development. The group consisted of members from the Waterbird Conservation Group, the Wildflower Society and concerned members of the community. Later, a management committee, represented by the Friends, the Wildflower Society, the Department of Conservation and Land Management and the City of Gosnells, was formed to take on the active management of the wetlands, and continues to meet about twice a year to discuss management issues.

The Friends have put countless volunteer hours into managing the wetlands and providing information to the public. Working with the department's Swan Coastal District, the group has erected fences and signs, planted seedlings, removed rubbish and begun a program of weed control, all of which was made possible through numerous grants (such as National Heritage Trust grants) obtained by the group. The Friends group also coordinates regular guided walks and 'working bees' in the wetlands, and conducts displays in shopping centres, schools and libraries.

The Department of Conservation and Land Management is committed to ensuring that the conservation values of the Brixton Street wetlands are maintained. In recent times, staff from the department's Swan Coastal District and the Western Australian Threatened Species and Communities Unit (WATSCU) have assisted in managing the wetland by providing land planning advice and some operational measures such as fencing and firebreaks. Recently, staff from the district, in conjunction with the Friends group, built a lookout so that the public could view the numerous species of plants and animals that inhabit the site without impacting on the bushland. A Fire Management Strategy for the site was also developed

*Previous page*
**Top** The delicate flowers of early Nancy (*Wurmbea dioica*).
*Photo – Greg Keighery*
**Centre** Volunteers examine the weed watsonia in the Brixton Street wetlands.
*Photo – Kate Brown*
**Bottom** The viewing platform.
*Photo – Jiri Lochman*
**Inset** The striking blue tinsel lily (*Calectasia grandiflora*).
*Photo – Marie Lochman*

**Above** The threatened plant Keighery's eleocharis (*Eleocharis keigheryi*) grows in the wetland.

**Left** Looking across Brixton Street wetlands.
*Photos – Greg Keighery*


**Above** Brixton Street Observation Area. The incline at top left leads to the observation platform, which was built by staff from the department's Swan Coastal District, in conjunction with the Friends of Brixton Street Wetlands.
*Photo – Marie Lochman*

**Right** Small isolated populations of the weed *Sparaxis* were removed by hand.
*Photo – Robyn Phillimore*

by WATSCU, in consultation with all relevant stakeholders. This plan aims to help maintain the high conservation values of the site through controlling fire frequency and using fire-control methods that promote the best regeneration of the bushland. The department also prepares Interim Recovery Plans for threatened ecological communities to help guide their future management. These plans outline the most urgent actions needed to reduce threats to communities. Funding has been provided by sources such as the Natural Heritage Trust (NHT) and Wetland Conservation Funds.

## Weeds

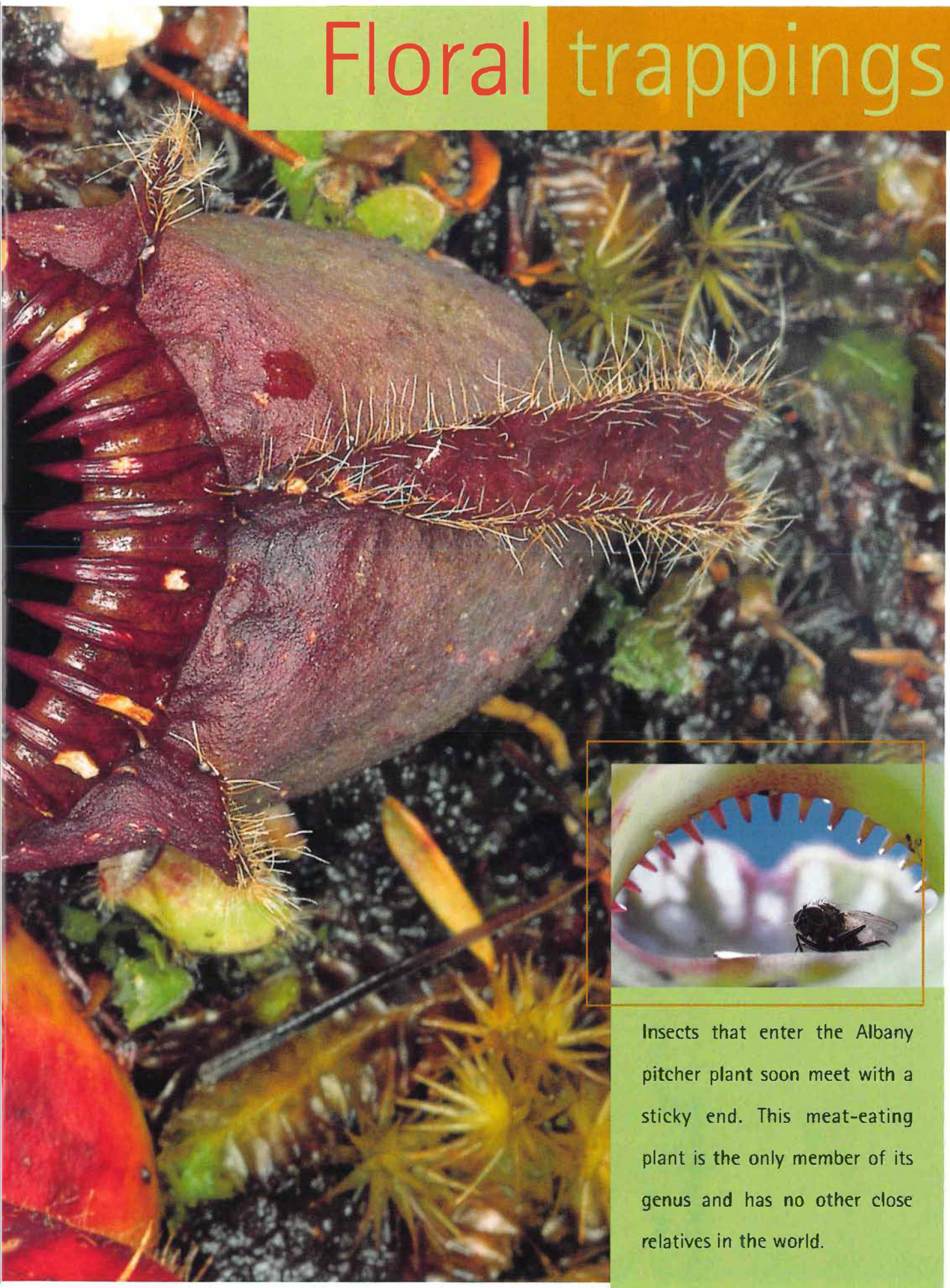
Another major threat to the native flora and to the plant communities of the Brixton Street wetlands is invasion and competition from bulbous weeds, such as *Sparaxis*, *Watsonia* and *Freesia*. Options for controlling these weeds, which grow closely among native plants in a wetland situation, are limited. The Environmental Weeds Action Network, in conjunction with the Friends and the department, undertook a three-year, NHT-funded program to conduct research on methods of controlling some of these weeds, set up a bush regeneration demonstration site, and make management recommendations for weed control. Under this project, dense infestations of weeds were sprayed with chemicals and small isolated populations of weeds in undisturbed areas were removed by hand.

The Brixton Street wetlands are not yet vested in the Conservation Commission, so management of the wetlands remains the responsibility of all the area's stakeholders. However, the department will continue to facilitate meetings with the stakeholders and assist the Friends group wherever possible.

The Friends of Brixton Street Wetlands are to be congratulated for their tireless work and commitment to the area. Their work is a great example of community support for the environment and of the positive changes that volunteers are able to make.

Robyn Phillimore is a project officer for the Department of Conservation and Land Management's WA Threatened Species and Communities Unit at Woodvale. She can be contacted on (08) 9405 5165 or by email (robynp@calm.wa.gov.au).

# Floral trappings





Insects that enter the Albany pitcher plant soon meet with a sticky end. This meat-eating plant is the only member of its genus and has no other close relatives in the world.

by Greg Keighery

The Albany or Western Australian pitcher plant (*Cephalotus follicularis*) is one of more than 500 species of flowering plants that attract, catch, trap and digest insect prey. These plants occur in a wide variety of, often-unrelated, flowering plant families throughout the world. Many use sticky hairs (sundews) or suction traps (bladderworts). Others—though this adaptation is less rare—have developed complex, yet passive, traps known as pitchers.

All 'meat-eating' plants grow in soils with low organic content and trap insects to supplement an inadequate supply of nitrogen. All of these plants have leaves containing chlorophyll (the green pigment that plants use to convert sunlight, water and carbon dioxide into food and oxygen) and are capable of photosynthesis. Hence, they can grow and thrive when provided with an adequate nitrogen supply, without needing animal prey.

## Family history

Pitchers have developed in three unrelated groups of flowering plants: the American pitcher plants (Sarraceniaceae), the tropical pitcher plants (Nepenthaceae) and the Western Australian pitcher plant (Cephalotaceae). Despite this, the pitchers of each group look remarkably similar, since they all operate in essentially the same manner.

The Albany pitcher plant is not at all closely related to other pitcher plants. It is related to the stonecrops (Crassulaceae) and more distantly to the hydrangeas (Saxifragaceae). However, it is distinctly different from both of these groups and is therefore placed in its own family, the Cephalotaceae.

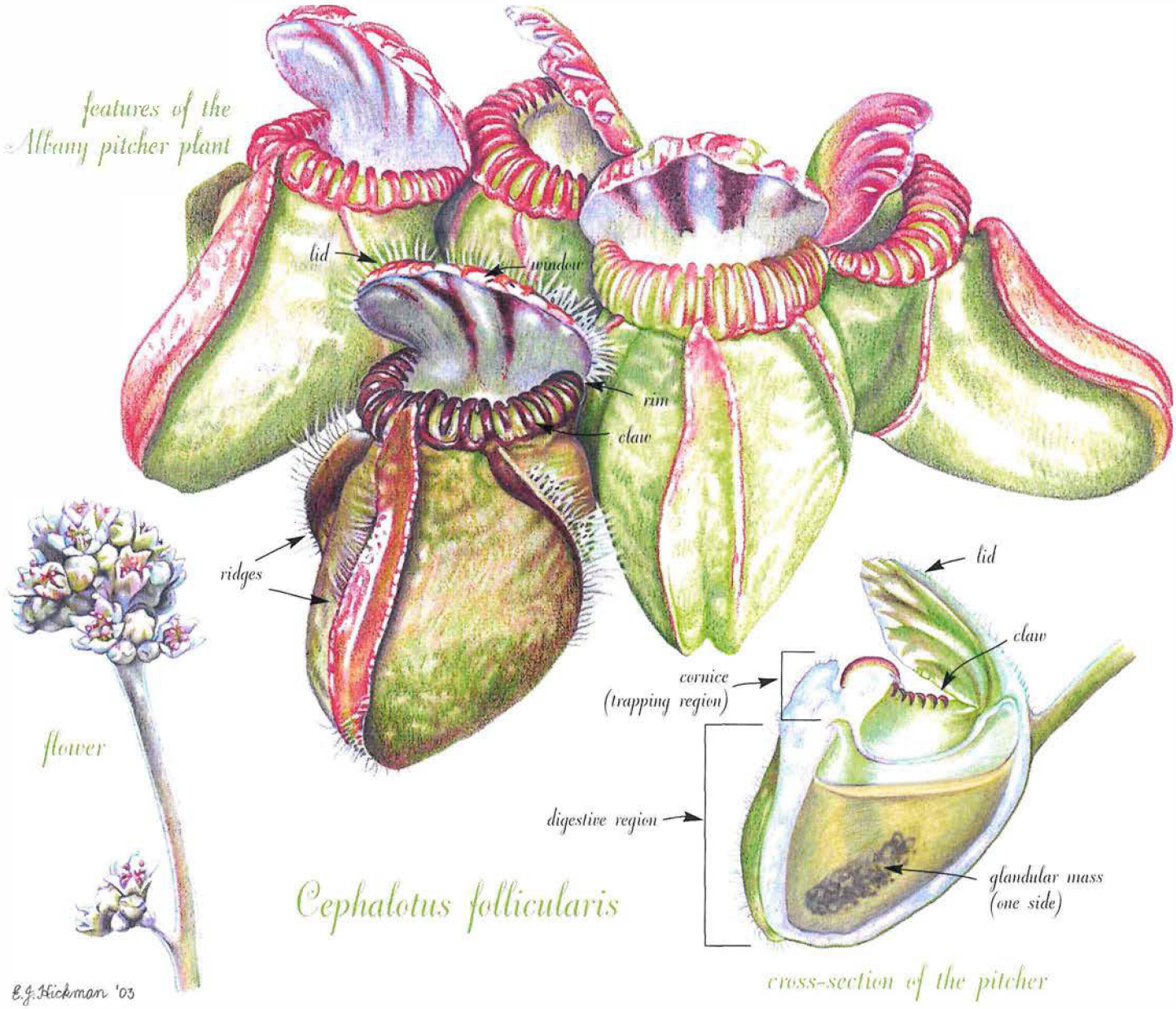
The south-west of Western Australia is world renowned for the diversity of its flowering plants, but this diversity is largely at the species (and to a lesser extent the genus) level. Our flora is closely related to that of eastern Australia and there are only a few small families confined to our State (see box on page 54).

The Albany pitcher plant was described by the great French botanist Labillardiere, in his publication on the botany of the voyage when he accompanied the D'Entrecasteaux expedition to Australia in 1791 to 1793. This voyage took six years because of the French Revolution and war with England and he did not return to France until in 1796. The expedition that Labillardiere accompanied only landed at Esperance, so it was believed that pitcher plants grew at Cape Le Grand (see pages 32–37). However, after numerous searches, three publications and 173 years had elapsed, it was finally determined that the species had been described from a collection made at Albany in 1803 by Leschenault de la Tour, a botanist on Baudin's expedition.

*Previous page*
**Main** This close up of a mature Albany pitcher plant (*Cephalotus follicularis*) pitcher shows its shiny digestive fluid.
*Photo – Marie Lochman*
**Inset** A fly enticed by the odour of decaying insects within a pitcher is poised just above the slippery trapping region.
*Photo – Babs and Bert Wells/CALM*

**Above** An Albany pitcher plant with normal leaves at rear and pitchers in the foreground.
*Photo – Greg Keighery*

**Left** Albany pitcher plant showing mature open pitchers and a developing, still-closed pitcher on the soil surface.
*Photo – Jiri Lochman*




Because of its unusual habits, the Albany pitcher plant is one of the most closely studied of all our native plants. More than 30 scientific papers have been published on aspects of its morphology (the form and structure), physiology (the parts and their function) and its botanical relationships. Despite this, many aspects of this unique Western Australian plant are still poorly known in the community at large.

## Habit and structure

Pitcher plants are perennial herbs with a short, fleshy rootstock bearing rosettes of leaves. There are two types of leaves on the one plant. The foliage (or normal) leaves are green, oval in shape and between 10 to 15 centimetres in length. In cultivated specimens, these leaves are produced in autumn and winter and the pitchers—which are modified leaves—are produced in winter and spring. In the wild, however, growth occurs between late October and March. Plants vary from having a single pitcher to more than 200 pitchers and unmodified leaves. Some plants that have been monitored are known to have lived for at least 12 years. Most pitchers are produced in summer, when insect activity is at its peak. Pitchers die throughout the year and are replaced annually, but may live for more than two years. They do not, however, increase in size once open.

At full size, the pitchers measure three to five centimetres long and about two to three centimetres wide (unlike other pitchers, the leaf stalk is not at the base) and are shaped like a loose purse or slipper. Since the pitchers lie on the surface, they are supported by three thickened ridges, to ensure sufficient rigidity. Pitchers in full sun are a deep red colour and are smaller than those in shade. The mouth of the pitcher has a thickened rim bearing approximately 24 stiff 'claws' that project inwards and downwards. This opening is surmounted by a lid, which lowers evaporation of the contents of the pitcher and prevents rain from diluting the contents. The lid has a series of transparent 'windows' (lines of tissue devoid of chlorophyll). Numerous nectaries, which secrete a sugary solution, are found between and below the claws, on the outside of the pitcher and inside the lid.

## Attracting and digesting

Inside the pitcher, when it is cut in half lengthwise, two distinct zones can be seen: the trapping region (cornice) and the digestive region. The cornice is a thick collar of spongy tissue forming an internal ridge. A covering of downward-pointing hairs gives it a slippery, glistening surface. Below the cornice is a brief transitional zone, before the start of the digestive region.

## Insectivorous plants of the world

| Family and genus | Number of species | Geographical distribution |
|---|---|---|
| **Droseraceae** | | |
| *Drosera* (sundews) | approx. 90 | cosmopolitan |
| *Dionea* (Venus fly trap) | 1 | North America |
| *Drosophyllum* | 1 | Portugal |
| *Aldrovanda* | 1 | Europe, SE Asia, Australia |
| **Roridulaceae** | | |
| *Roridula* | 2 | South Africa |
| **Byblidaceae** | | |
| *Byblis* | 5 | Australia |
| **Sarraceniaceae** (American pitcher plants) | | |
| *Sarracenia* | 10 | North America |
| *Heliamphora* | 6 | South America |
| *Darlingtonia* | 1 | North America |
| **Nepenthaceae** (pitcher plants) | | |
| *Nepenthes* | 40 – 70 | Madagascar, SE Asia to Queensland |
| **Cephalotaceae** | | |
| *Cephalotus* | 1 | south-western Australia |
| **Lentibulariaceae** | | |
| *Pinguicula* (butterworts) | 46 | northern hemisphere |
| *Utricularia* (bladderworts) | 200 | cosmopolitan |
| *Genlisea* | 15 | Africa, South America |

The digestive region is smooth, purplish in colour and contains two types of digestive glands. Large spherical glands are distributed around the inside of the pitcher, above the glandular mass, where small digestive glands are grouped on a purplish, kidney-shaped, glandular mass on each side of the pitcher. Below this gland is the fluid in which the prey drowns and is digested.

Insects are attracted to the pitchers by odour from the nectaries and decaying prey, the coloured markings on the rim and lid, and the light coming through the 'windows' on the lid. Crawling insects, such as ants, attempting to reach the nectaries inside the pitcher slip on the surface of the cornice and fall into the liquid. Flying insects are able to reach the nectaries

**Above left** Madagascar pitcher plant (*Nepenthes madagascariensis*), in the family Nepenthaceae.
*Photo – Jiri Lochman*

**Above** Sundew (*Drosera indica*) in the family Droseraceae with a dragonfly caught fast.
*Photo – Dennis Sarson/Lochman Transparencies*

**Far left** Family Lentibulariaceae. Bladderwort (*Utricularia fulva*).
*Photo – Jiri Lochman*

**Left** Northern byblis (*Byblis liniflora*).
*Photo – Marie Lochman*

**Right** Albany pitcher plant (*Cephalotus follicularis*) in the family Cephalotaceae. *Photo – Jiri Lochman*

(or the fluid), but, when they attempt to escape by flying through the 'windows', they hit the lid and eventually fall into the liquid, where they drown and are digested.

## Weird wetland

The water within the pitchers is secreted by the plant and is almost as pure as distilled water upon opening. This mini wetland ecosystem (such wetlands are also found in tree hollows and other pitcher plants) supports its own unique fauna—in only 20 millilitres of water! This ecosystem was studied by Sally Clarke (from the University of Western Australia Zoology Department) in 1985. Sally found more than 166 species of plants and animals within the pitchers, including various species of bacteria, fungi, algae, protozoa (flagellates, ciliates, amoeba and microflagellates), nematodes, roundworms, rotifers, arthropods (micro-crustacea, midge and fly larvae), water bears and water mites. The life forms within this ecosystem largely arrive via air currents, and are sustained by consuming the bacteria that aid the decomposition of the prey.

The much larger tropical and American pitchers—containing nine to 30 millilitres of fluid—host a series of mosquito, midge and fly larvae (up to 38 species in American pitchers), which predate on other inhabitants. Some of these species are only found as larvae in these pitchers. Sally thought that the small size of our pitchers precluded large predatory species. However, David Yeates of the Western Australian Department of Agriculture has since shown that the larvae of a small flightless fly (*Badsis ambulans*) may specialise in consuming decaying insect remains in our pitcher plant. Interestingly, the adult female fly is flightless and looks like a meat ant, the most common insect prey of the pitcher. So there is probably more to learn about this weird wetland.

## Distribution and habitat

Pitcher plants are found in and around moist acid peaty swamps, usually those with an ample and regular supply of fresh water. They are frequently found perched on the rootstock of the tea tree (*Homalospermum firmum*) that characteristically grows in these swamps, or they may grow directly on the soil surface.

In the wild, pitcher plants grow between Cape Riche, along the swampy coastal plain south of the karri forest to the Scott Plains and West Bay near Augusta, with an isolated population near Yallingup on the Leeuwin-Naturaliste ridge. There are old, but still unconfirmed, reports of pitcher plants in the Locke Estate Nature Reserve (near Vasse, west of Busselton), at the base of the Whicher Range and near Capel on the Swan Coastal Plain. However, detailed searches have not been able to confirm any of these reports.

Unfortunately, pitcher plants are apparently retreating from the western portions of their range. Recent searches have not relocated the populations from the Scott Plains, West Bay and the Leeuwin-Naturaliste ridge. We do not know if this is due to drought or the result of clearing interfering with the natural hydrology or due to changed fire patterns, including a lack of fire. Pitcher plants can resprout from their

## Western Australia's own plant families

There are six other families of plants that are confined to Western Australia, but, unlike the pitcher plant, these are almost unknown outside the scientific community. Most are relatively small and contain only one or a few species.

### Eremosynaceae

The solitary species in this family, *Eremosyne pectinata*, is a small annual herb that occurs abundantly after summer fires on sandy soils between Margaret River and Mount Manypeaks. It was once considered a possible relative of the pitcher plant, as they were both previously placed in the Saxifragaceae (a largely northern hemisphere family). *Eremosyne* is still considered a close relative of this family and is the only relative present in Western Australia.

### Emblingiaceae

The only member of this family, the slipper flower (*Emblingia calceoliflora*) is a prostrate perennial short-lived soft-wooded shrub that is also abundant after fires on limestone soils from Eneabba to North West Cape. Flowers are borne singly in the upper leaves and are pale yellow (south of Kalbarri) or pale orange (Shark Bay northwards). This plant, with its unusual slipper-shaped flowers is considered to be related to the Leschenaultia family (Goodeniaceae).

There are also a series of families that have been recently segregated from the jointed sedges (Restionaceae) on the basis of anatomy, chemistry, pollen morphology and fruit type. These are the **Anarthriaceae** (which contains seven species in *Anarthria*, largely from wetlands ranging from Perth to Cape Arid), **Ecdeiocoleaceae** (two species in two genera, *Ecdeiocolea* and *Georgeantha*, from sandplains north of Perth), **Hopkinsiaceae** (two species in *Hopkinsia* from sandplains between Eneabba and Lake King) and **Lyginiaceae** (three species in *Lyginia*, from sandy soils from Kalbarri to Cape Arid).

**From top right** Albany pitcher plant (*Cephalotus follicularis*).
*Photo – Babs and Bert Wells/CALM*
*Emblingia* (Emblingiaceae), *Eremosyne* (Eremosynaceae), *Eedeiocolea monostachya* (Ecdeiocoleae), *Georgeantha* (Ecdeiocoleaceae).
*Photos – Greg Keighery*

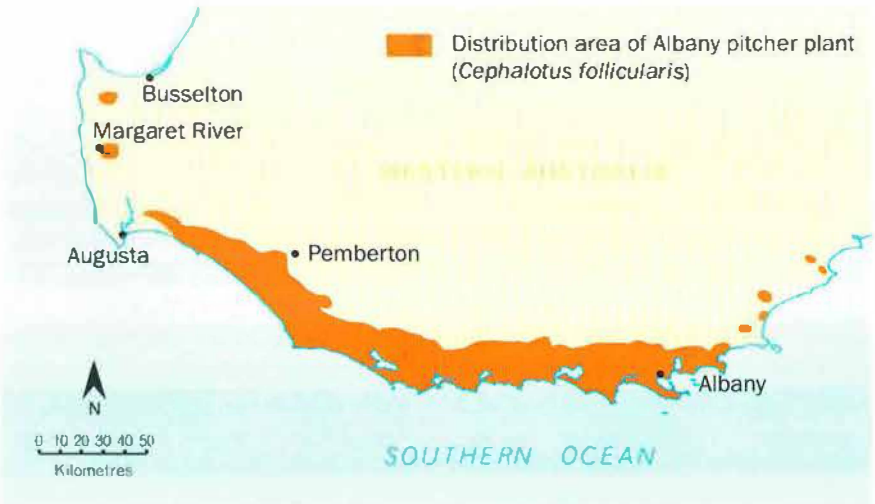
root base after fire, but are killed by hot summer and autumn fires that burn out the rootstocks or peat soils. They appear to flower and seed after less severe fires and regenerate from seed after sporadic hot summer fires. It is likely that a combination of all these factors is responsible for the decline of this unique species.

Pitcher plants produce a slender, leafless, inflorescence stalk, 40 to 80 centimetres tall, which bear numerous small, sweetly-scented, white flowers. These lack petals, but have six prominent sepals instead. Flowering occurs from January to March, when the swamps are at their driest. Held well above the traps, the flowers are pollinated by a variety of flying insects including small flies, bees and wasps. Flowering appears to be enhanced by fire and the inflorescences are also more visible after fire.

## Cultivation

Because of its unusual, carnivorous habits the Albany pitcher plant is widely grown in specialist collections—usually in pots in peat—throughout the world. Plants are readily grown from leaf cuttings or seeds. When grown in full sun, the pitchers develop a deep red colour that is very attractive, or are mottled reddish-green in partial shade.

Unfortunately, pitcher plants are still illegally dug up from the wild, despite being easily cultivated. This activity usually results in the death of any mature plants that are removed.




Greg Keighery is a principal research scientist at the Department's Wildlife Research Centre at Woodvale. He can be contacted on (08) 9405 5100 or by email (gregk@calm.wa.gov.au).

# The tenuous tuart

by Drew Haswell and Alan Walker

Since the mid-1990s there has been growing community concern about the noticeable decline in the health of tuart trees south of Mandurah. The State Government's Tuart Response Group (formed in November 2001) is working with local communities to plan and implement the conservation and management of tuart trees and ecosystems, and to investigate the causes of tuart's decline.

Tuart (*Eucalyptus gomphocephala*) is found only on the Swan Coastal Plain, growing from Jurien Bay in the north to the Sabina River, east of Busselton, in the south of Western Australia, and is generally confined to limestone soils close to the coast. It is estimated that before Europeans arrived there were more than 111,600 hectares of tuart woodland. Most of these were later cleared for agriculture and urban development.

In recent years, reductions in the health and vitality of some remaining tuart woodlands at Yalgorup, south of Mandurah, has highlighted the need for a comprehensive conservation and management strategy for all tuart ecosystems. Likely threatening processes include climate variability, changed hydrology, altered fire regimes and repeated attack by insect wood borers. Little is known about the tuart's requirements for nutrients, or the role of soil-borne fungi.

## Early descriptions

Tuart specimans were first collected from Geographe Bay and by the French explorer Leschenault in May 1801, and the name later published in 1828. Descriptions of tuart woodlands were undertaken soon after European settlement of WA's south-west. In 1831, Lieutenant William Preston described the Vasse estuary area:

> 'The country passed over this morning was beautiful, resembling a fine Park in England, with excellent timber, five or six to the acre.'

Later that year, John Bussell wrote:

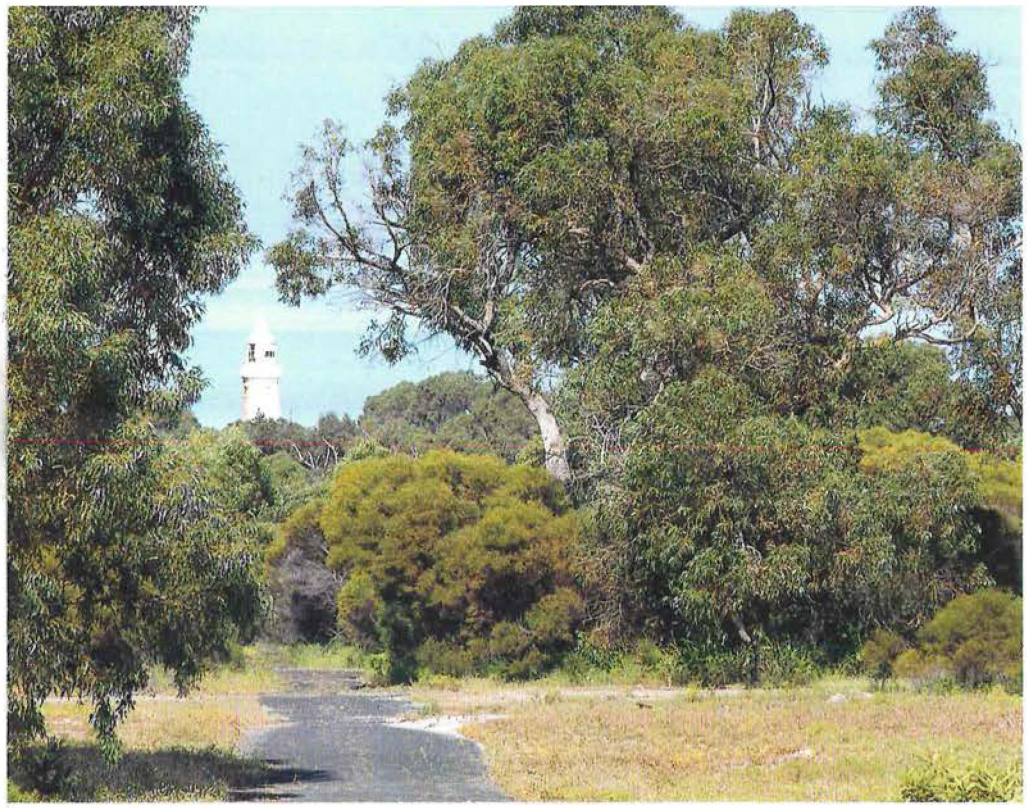
> 'A farmer could hardly grudge the fine spreading trees of red and white gum and peppermint the small portion of the ground they occupied, with an understorey typically of bright scarlet and yellow flower, daisy, buttercup and a purple marigold'.

In 1836, Lieutenant H W Bunbury described the Lake Preston Capel River area as:

> 'Open country with a good deal of grass growing on a light soil under very large white gums called ..."tooarts".'

Sixty years later, in 1896, pioneer forester John Ednie-Brown wrote of the Ludlow area as:

> 'Limestone country with tuarts dotted in a parklike fashion, and occasional brakes of peppermint (*Agonis flexuosa*) ... and a rich carpet of annual grasses.'



*Previous page*
Large mature tuart tree at Manning Lake, Perth.
*Photo – Jiri Lochman*

**Left** Tuart grove within Woodman Point Regional Park south of Fremantle.
*Photo – Sallyanne Cousans*

## Scales of mapping

**State scale** In 1964, the Director of the Kings Park and Botanic Garden, Dr J S Beard and others, initiated a project called the Vegetation Survey of Western Australia that was later published as a map series between 1979 and 1981. All vegetation in the State was classified according to dominant ecological structural units. The study defined the original pre-1750 extent and identified six broad dominant types for tuart on the Swan Coastal Plain from Moore River to Busselton.

**Regional scale** In 1983 the then Department of Conservation and Environment mapped vegetation communities of the Swan Coastal Plain as part of the review of conservation reserves within the Darling System 6 area. Geology, landform and soil values, climate zones and plant descriptions were used to determine the communities. Tuart woodlands were defined as part of this project.

**Local scale** In 1996 the Department of Environmental Protection and others used survey plots to assess the occurrence of local tuart populations. As expected, tuart occurs in a variety of floristic populations across its range including wetlands and uplands. Only in the southern tuart and peppermint woodlands of the Spearwood Dunes, and the tuart and/or peppermint woodlands of the Quindalup Dunes is tuart a defining species.

Noted botanists Greg and Bronwen Keighery have written that the most likely original vegetation in the Ludlow area was:

> '... a tall open forest to tall open woodland. In the southern area ... it appeared that tuart grew over scattered trees of *Agonis flexuosa* and *Banksia grandis* over low mixed shrubland over sedges, grasses and herbs. Towards the north, shrubs and *Banksia attenuata* became more common on the northern sandy rises.'

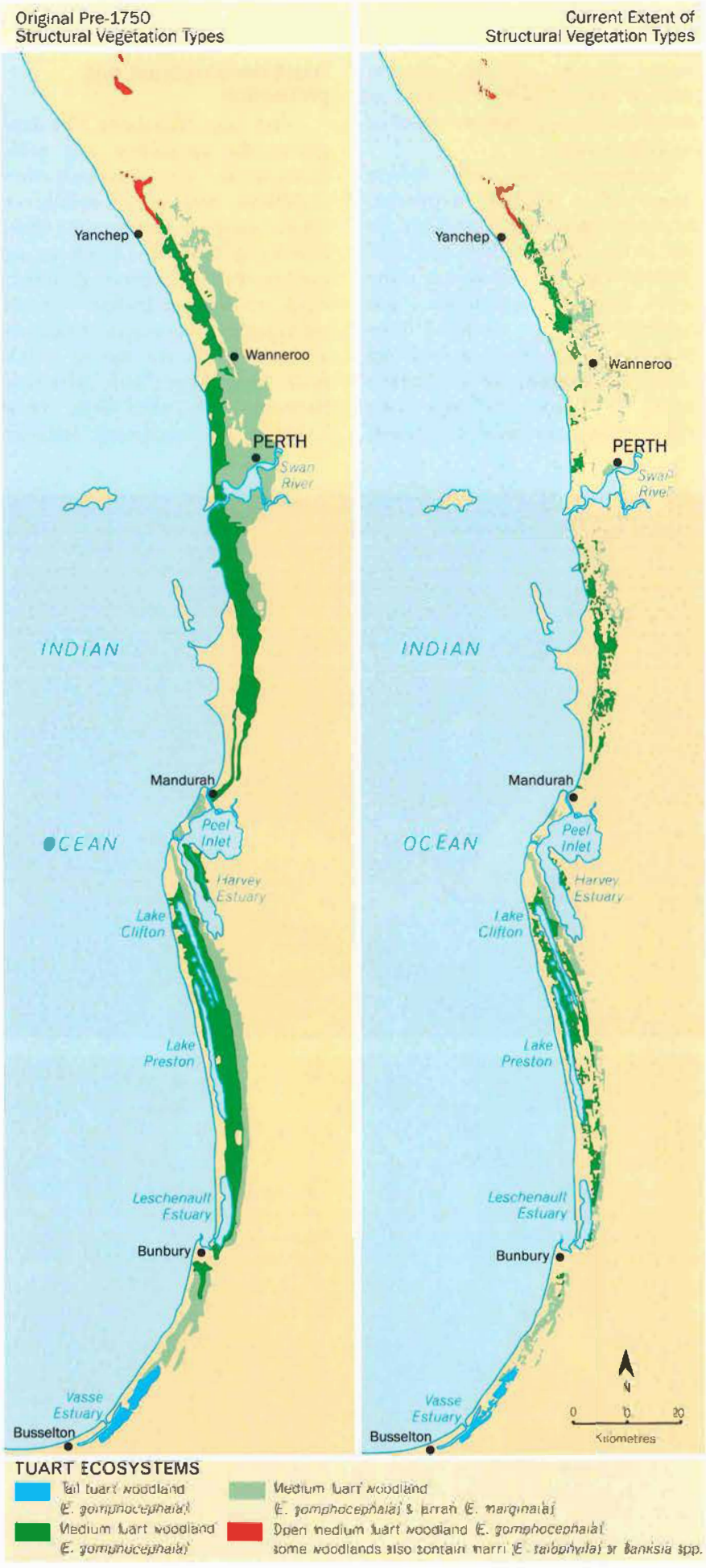
## Tuart communities

Tuart is mostly confined to two coastal sand dune formations, the Quindalup Dunes and the Spearwood Dunes found to the north and south of Perth, although there are outlying populations near the Moore, Swan, Canning, Murray, Serpentine and Harvey rivers. There is also an interesting historical report, by Surveyor-General Vernon Fyfe, of tuart having once occurred on the Arrowsmith River, near Three Springs. Fyfe's report is supported by a specimen collected and lodged in the Melbourne Herbarium (circa 1840) by the botanist Augustus Oldfield, that was obtained near the Arrowsmith River.

The distribution of tuart and the vegetation in which it grows have been considered in a series of studies at a State scale (dominant ecosystems), regional scale (vegetation communities), and local scale (floristic populations)—see box on page 56.

Tuart has wide environmental tolerance and occurs in a variety of situations across its range, including fresh, brackish and naturally saline wetlands and upland limestone ridges. The occurrence of tuart in plant communities on the Swan Coastal Plain demonstrates a high reliance on soil type and rainfall.

There are 414 native flowering plants recorded within tuart woodlands, including 38 species of orchids. The wildlife of tuart woodlands is not well documented. Present research has recorded 158 species, including 92 bird species, 43 reptile species and seven species of frogs. In particular, 16 of the 35 Swan Coastal Plain's mammal species live in tuart woodlands, with the western



ringtail possum and the common brushtail possum well represented in the tall tuart-peppermint woodlands of the Ludlow area.

Invertebrates, the most diverse component of terrestrial ecosystems, are poorly known for tuart. They are vital to the ecology of the areas they inhabit, being the chief food of many birds, reptiles, amphibians and mammals. They also perform other essential functions such as recycling nutrients, pollinating plants and keeping nature in balance by supporting important predators and their parasites.

## Tuart conservation and protection

Most tuart woodlands have been cleared for agriculture and urban development. The remaining tuart woodlands now occur equally on Crown and private lands, some of the latter being included in LandCare and Land for Wildlife programs. Prominent stands are found at Ludlow, Yanchep and Yalgorup national parks. Significant tuart woodlands are also located in Bold Park, Kings Park, Neerabup National Park, the Trigg Dune bushlands, the Leschenault Peninsula Conservation Park and The Maidens (south of Busselton). Tuart also occurs in Bush Forever sites at Yanchep, Woodman Point Regional Park and Lakes Cooloongup and Walyungup. Smaller remnants of tuart are scattered across its natural range.

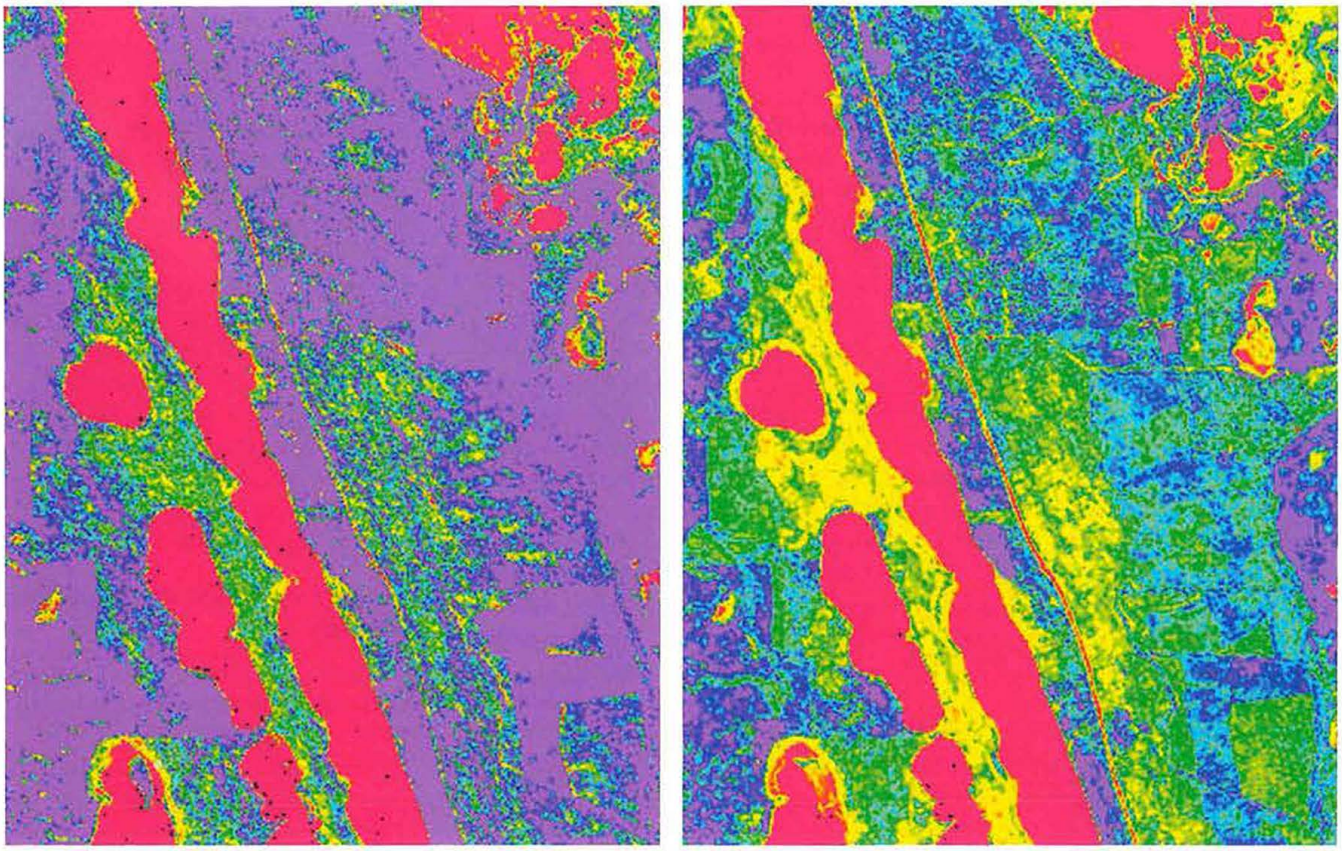
The conservation and management of tuart ecosystems is provided at three levels. The first and primary means is the existing system of secured reserves on the Swan Coastal Plain. Tuart's reserve status was last assessed in the early 1980s, as part of Conservation Reserves for Western Australia Sytem Six. The adequacy of tuart reservation requires further refinement in line with nationally agreed criteria for developing a comprehensive, adequate and representative reserve system.

The second level ensures that activities that may disturb tuart ecosystems outside reserves are carefully considered and, where possible, complementary to the objectives for tuart conservation and management within reserves. This level relies on effective statutory processes for controlling clearing and retaining native vegetation on lands intended for development. Sound tuart management and effective partnerships on freehold lands are also important at this level.

Because tuart woodlands are now remnants of their original (pre-1750) extent, a third level of conservation and management is necessary to protect plant and animal species, ecosystems and communities that have gone beyond the reach of the above two levels of protection, or where their survival is likely to be threatened. Management strategies aim to protect threatened plants, animals, ecosystems and communities, and control the impact of threatening processes.

**Above left** The western ringtail possum is an important mammal species of tuart woodlands.
*Photo – Geoff Taylor/Lochman Transparencies*

**Left** Dying tuart, Peppermint Road, in Yalgorup National Park.
*Photo – David Mitchell*



**Above** The above LandSat TM images show vegetation changes between August 1999 (above left) and November 2000 (above right). These figures have undergone preliminary analysis to contrast categories of tuart crown decline. The speckled red areas are dead tuart crowns (note that full colour equates to open water). The yellow represents bare branches and sparse crowns. Blue shows receding crowns and green represents full crowns. The areas of purple are those for which no interpretation is available.
*Source – Li Shu*

**Right** Tree borer feeding on a eucalypt flower.
*Photo – Jiri Lochman*

Since the mid-1990s, there has been a noticeable decline in the health and vitality of tuart trees, associated with chronic insect infestation, in the Yalgorup area. The reason(s) for the decline are not totally clear as there are a number of contributing and inter-related factors involved. Potential influences include the ongoing reduction in winter rainfall, changed hydrological and salinity factors near wetlands, soil type and nutrient supply, altered fire regimes, changes in the ecological balance between insect wood borers and their predators and parasites, competition with understorey species, land clearing and roadworks. It is likely that the insect attack is a secondary phenomenon that becomes significant once the trees have been weakened by other factors. Satellite remote sensing tools are being developed to monitor changes in the extent and the health of tuart trees.

## What's being done

Government and community-based action is now under way to investigate the causes behind this decline in tuart health, and to devise a strategy and action plan for conserving and managing the tuart woodlands. As an initial step, the Minister for the Environment and Heritage established the Tuart Response Group in November 2001. The main work of the group is to use its combined resources and knowledge to investigate the hierarchy of causes behind the observed decline in tuart, to devise a tuart conservation and management strategy and action plan, and to compile educational material for individual landowners and the community to help combat the decline of tuart trees.

In August 2002, the Tuart Response Group released the *Status report for tuart conservation and protection*. It provides the latest information on tuart woodland communities, conservation within and outside reserves, tuart research and future management directions. That status report was developed to guide community input during the preparation of the Government's tuart strategy and action plan later this year. In October 2002, the group conducted seven stakeholder and community workshops between Lancelin and Busselton. These identified a range of tuart conservation and management concerns and issues, and will also assist the preparation of the strategy and action plan.

A Tuart Science Workshop was held

by the group in July 2002, to evaluate future research needs. Its purpose was to involve Government agencies, the scientific community and industry in the development of research priorities and actions for the sustainable management of tuart woodlands.

The group successfully collaborated with universities and industry in obtaining Australian Research Council funding for tuart research from July 2003. The three-year research program includes tuart vegetation system health modeling, eco-hydrology, investigation into pests and diseases, and the role of understorey competition in tuart health and regeneration. A tuart research business plan is now being prepared.

## The Tuart Atlas

A key action undertaken by the Tuart Response Group has been to develop an 'atlas' to provide a more accurate assessment of tuart occurrence and the condition of its associated understorey.

The 'atlas' mapping process shows that there are now around 29,500 hectares of tuart woodlands on the Swan Coastal Plain. This compares with 38,829 hectares that were previously mapped in 1979. Mapping of tuart in 1979 was done at a scale of 1:250,000. The latest 1:10,000 fine scale mapping used high resolution aerial photography and more up-to-date computer mapping technology. The earlier mapping was part of a project that classified Western Australia's entire vegetation, whereas the new mapping focused only on tuart woodlands in the coastal strip between Lancelin and Busselton.

While some tuart may have been cleared since it was mapped in 1979, the 'atlas' shows that areas previously mapped as tuart are, in fact, other woodlands of the coastal plain. This occurred because the State-scale mapping, by definition, regionalised the patches that have been identified through the finer-scale atlas mapping. At the same time, the 'atlas' has revealed new tuart patches that had not been identified by the previous mapping. This includes some interesting occurrences on the Quindalup Dunes south of Bunbury, and at Woodman Point. While it means that tuart's extent is less than previously thought, the priority now is to work with the community to develop strategies and actions that ensure remaining tuart woodlands are properly conserved and managed.

The Tuart Atlas will contribute to recommendations for additional tuart conservation reserves, and identify special protection and management links between tuart in reserves and tuart on freehold land.

## Conservation and management strategy

Currently, there is no specific document identified as the State's tuart conservation and management strategy. Tuart woodlands are managed in parks, forests and reserves by the Department of Conservation and Land Management. Tuart is also managed in other significant reserves by the Botanic Gardens and Parks Authority and by local authorities. Some tuart woodlands on private land are included in LandCare and Land for Wildlife programs.

**Below** Dead and dying tuarts at Lake Preston, in Yalgorup National Park, one of the worst affected areas.
*Photo – David Mitchell*

**Above** Tuart woodland from White Hill in Yalgorup National Park. The trees are kept low by salt winds.
*Photo – Robert Powell*

**Right** The short-billed black-cockatoo is a key bird species of tuart woodlands.
*Photo – Jiri Lochman*

One of the newer means of conserving tuart is through the growing system of regional parks around Perth, Bunbury and Mandurah. Regional parks such as Yellagonga, Beeliar, Woodman Point and Rockingham Lakes, and the proposed regional parks at Peel and Bunbury, will assist in the protection of important tuart woodlands in urban areas.

The call for a comprehensive conservation strategy for tuart trees, ecosystems and associated communities requires the development of integrated and cooperative conservation and management approaches, to complement programs in existing reserves. The Government's strategy and action plan will enable the community to be more aware of tuart (see 'Cherish the Tuart', *LANDSCOPE*, Autumn 2003), and more involved and supportive of its conservation and management. The plan will promote partnerships with community groups having differing interests in tuart woodlands, and ensure tuart ecosystems are identified and adequately represented and managed for conservation within and outside reserves. It will also ensure that significant stands and specimens of tuart trees outside conservation reserves are retained and appropriately managed. It will introduce research-based support to minimise the impact of processes that threaten the health of tuart trees and ensure that accumulated knowledge leads to improved tuart management.

Hopefully, this important work will lay the groundwork for conserving the tenuous but magnificent tuart for future generations of not just people, but the other plants and animals that are associated with tuart woodlands of the Swan Coastal Plain.

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To view the *Status report for tuart conservation and protection*, the *Tuart communications and public involvement plan* and other tuart programs, visit the NatureBase website (www.naturebase.net).

# urban antics by John Hunter

## Seal of Approval

The swirling effervescence bubbled around my face and blurred my vision, then... pop! A very large face resembling the neighbour's Labrador dog, with enormous black eyes and long stiff whiskers, stared down into my very soul.

It's one thing to go looking for a wild animal, but when it comes unexpectedly looking for you it's potentially a dangerous situation. When you think you can smell the steamy breath and see the grubby canines, you're not sure whether to scream, or rush out to buy a new pair of Speedos.

And so it was when the young bull sea lion decided to check me out in the surf at City Beach last year. He would have been on the way from his birthplace at breeding islands near Jurien Bay to seasonal resting grounds just off the Perth metropolitan coastline. Here, the animals loaf in small groups on a few islands and other rock outcrops while the females and their new pups stay at home to suckle and fish the environs of the rookeries.

The Australian sea lion (*Neophoca cinerea*) is one of the rarest sea lions in the world, and the only one found solely in Australia, from just east of Kangaroo Island in South Australia to the Houtman Abrolhos Islands near Geraldton in Western Australia.

Of the order Pinnipedia, seals and sea lions are those marine mammals that have streamlined bodies, forelimbs modified as flippers, webbed hind limbs, and a tail reduced to a stump. The order comprises true seals, eared seals (fur seals and sea lions) and walruses. Eared seals of the family Otariidae spend a greater proportion of time on land resting, breeding, giving birth and moulting. They have ear lobes, longer flippers, a more flexible neck and hind limbs that can be turned forward for terrestrial quadrupedal locomotion (walking on all fours).

Only about 1000 sea lions are found off our west coast and, while they are generally sedentary dwellers, the seasonal travellers that rest on and around Carnac, Little and Seal islands close to Perth do visit our city area from time to time. The animals have been seen in the Swan River opposite the central business district, Matilda Bay, Maylands and on the Canning River at Bull Creek. Arguably, apart from watching dolphins and whales, there is nothing more connecting to nature than the observation of our local suburban sea lions.

There is concern, though, about the constant habit of visitors who generally disturb the wildlife when they land on Carnac Island Nature Reserve, which is not far from the mouth of the Swan River. People have been seen off-loading their children and picnic baskets to within a few metres of beached sea lions with resultant lunges, bites and many near misses. Recently, a large bull was seen to 'torpedo' in on a family swimming right in front of the resting herd. As he stood up, a confused mother inadvertently held up a frantic, kicking child. Fortunately, the big fellow swam off, but we've seen what serious injury these wild animals have done to intruders on their breeding islands.

If you go to Carnac Island please observe the rule of getting no closer than five to ten metres from the sea lions. Besides, you can see far more from the deck of a boat *and* still go for a swim, leaving the sea lions a safe haven.

**DID YOU KNOW?**

Sea lions are carnivores and use their powerful swimming and sharp teeth to catch fish, squid, octopus, cuttlefish, small sharks and rock lobsters.

They breed every 18 months, being the only species of seal or sea lion in the world with this unusual breeding cycle.

For more information see *Discovering Penguin Island and Shoalwater Islands Marine Park* published by the Department of Conservation and Land Management.

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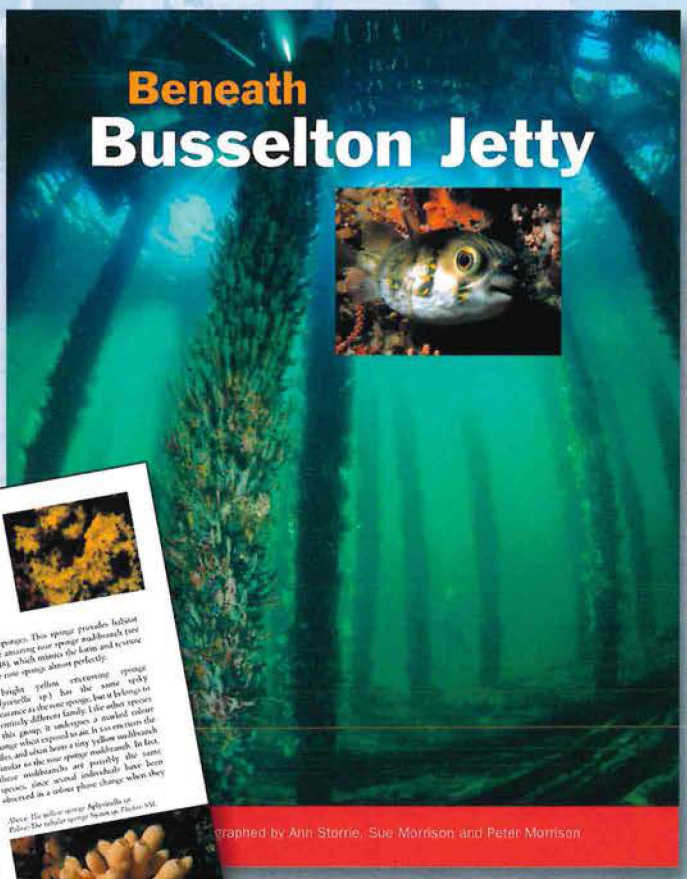


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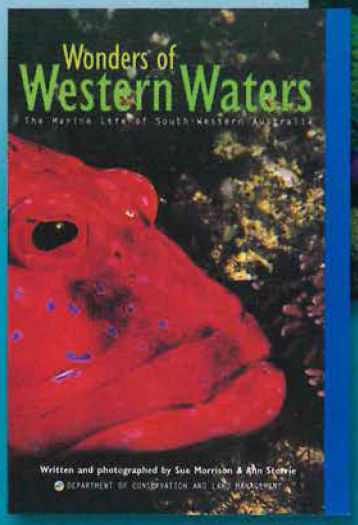


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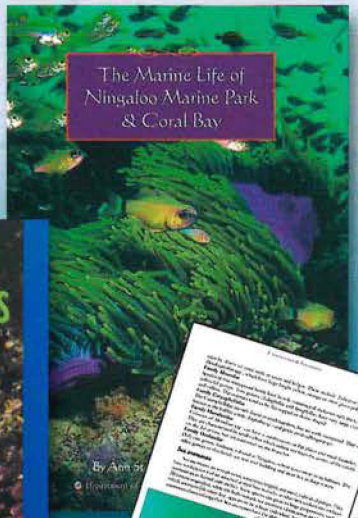


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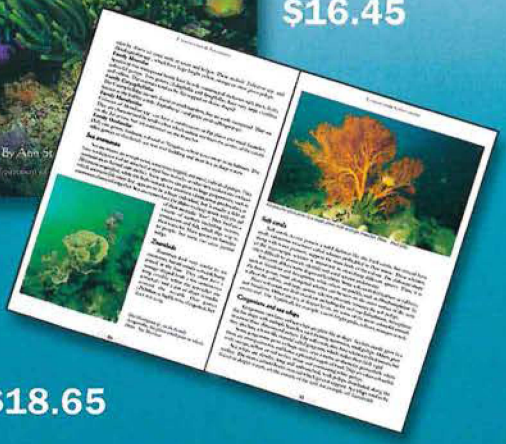

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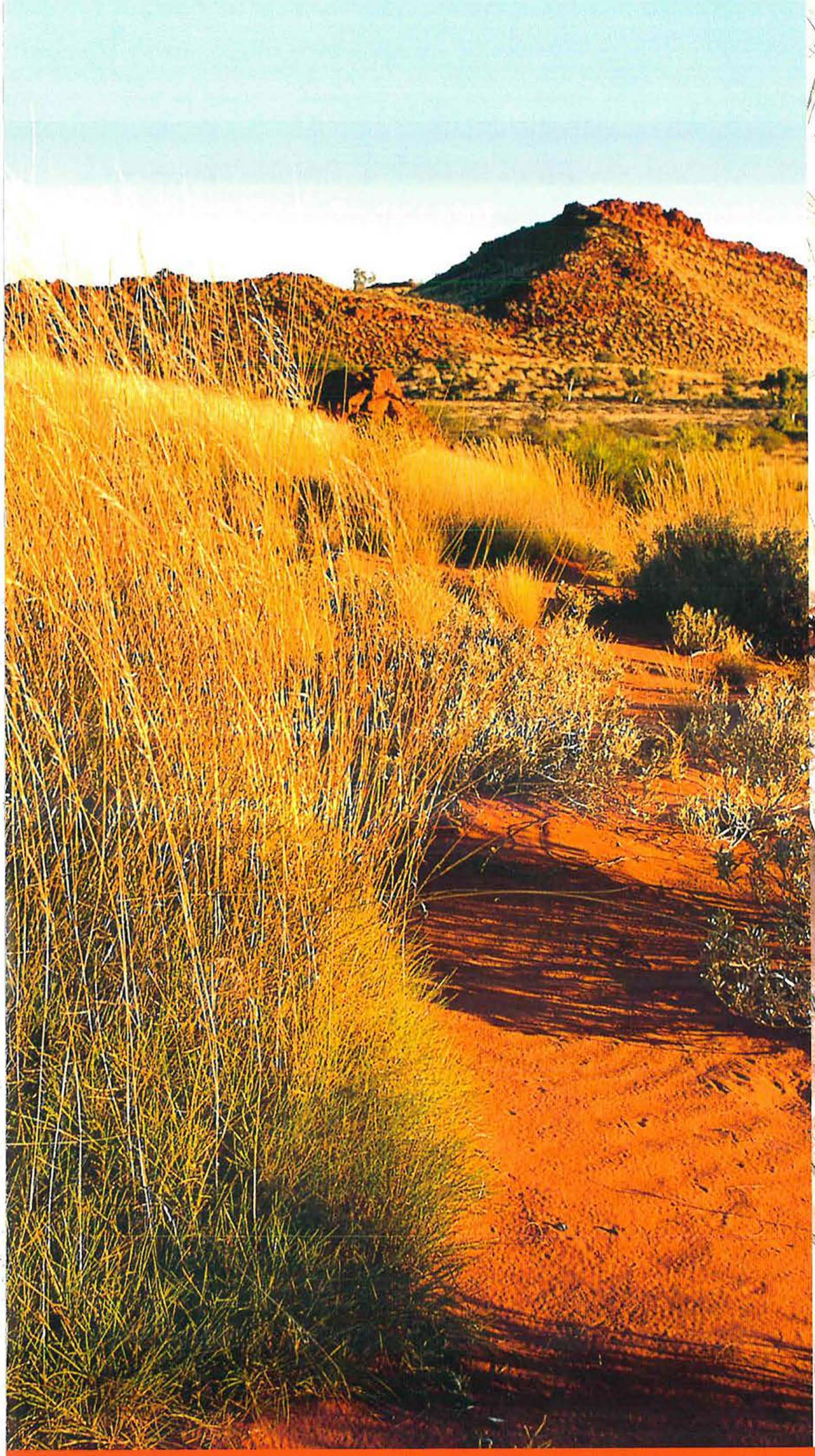

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