$6.95

AUTUMN 2001

LANDSCOPE

WA'S CONSERVATION, FORESTS AND WILDLIFE MAGAZINE

The great Australian ant

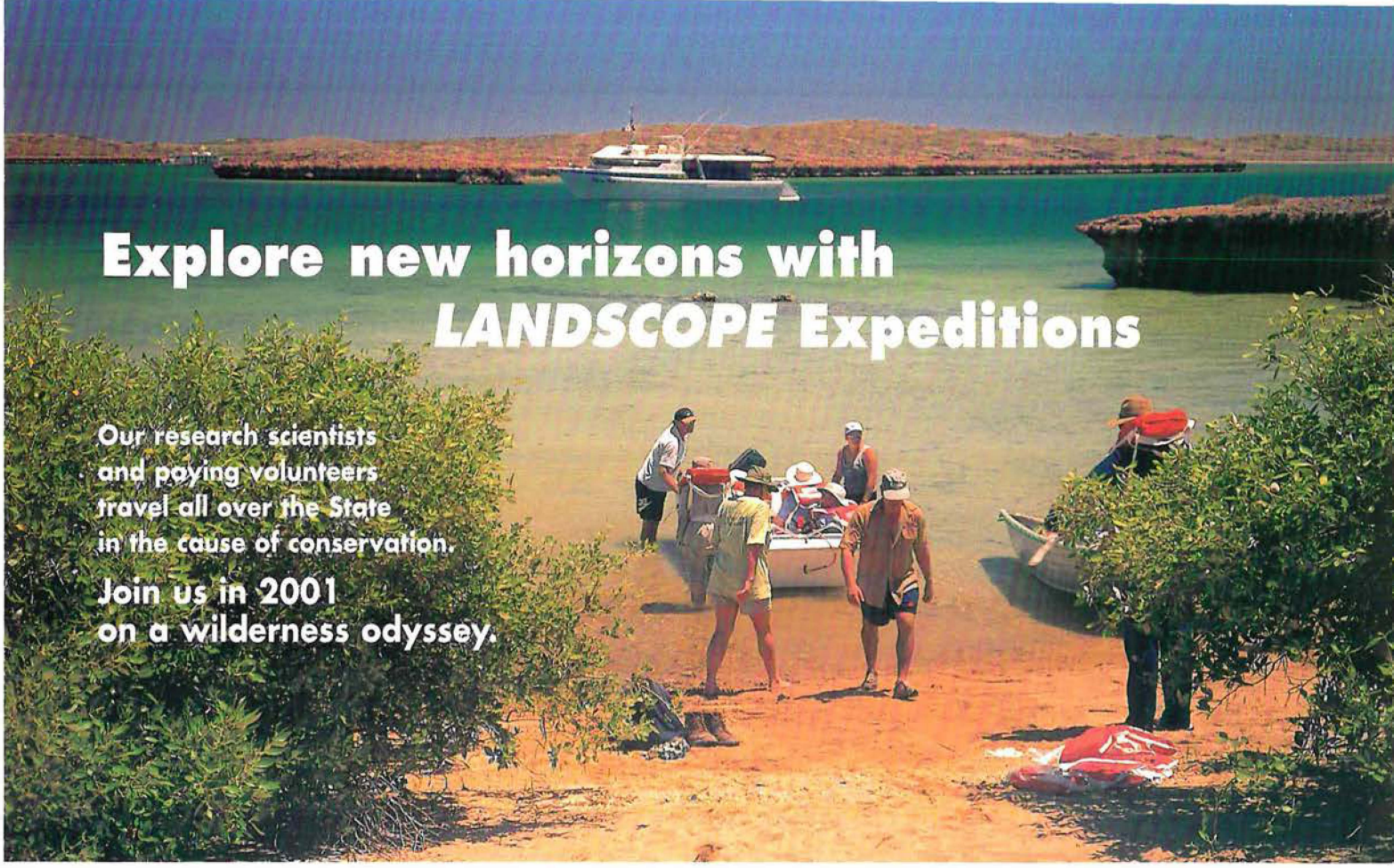
Ants and our ecosystems

Awash with colour

A *LANDSCOPE* Expedition with a difference

Parks of the Plateau

Four new conservation areas in the far north



ROCK POOLS AND RUGGED RANGES—
WILDLIFE OF THE NULLAGINE RIVER AND RIPON HILLS
May 21 – 30, 2001

Help survey a wide variety of fauna, including possums, rock wallabies, quolls and a range of small mammals adapted to the ancient Pilbara landscape. Travel east of Marble Bar to remote and beautiful country on the Nullagine River for some close encounters with wildlife.

LANDSCAPE OF THE HEART—
A JOURNEY TO THE CARNARVON RANGE
August 1 – 11, 2001

Visit a land of contrasts, from red bluffs and rock pools to sand dunes and salt lakes. Collect information on the plants and birds of the area as you learn about desert and wildlife ecology in the remote and beautiful Carnarvon Range in the Little Sandy Desert of Western Australia.

NIGHT AND DAY UNDER AN OUTBACK SKY—
AN ASTRONOMICAL ADVENTURE
August 18 – 25, 2001

Far away from the city lights, help astronomers from Perth Observatory evaluate Mount Singleton as a site for astronomical viewing. Learn about the night sky and the latest astronomical theories and see the Murchison at the height of the wildflower season.

BUCKSHOT AND BREAKAWAYS—
PLANTS AND ANIMALS OF THE GIBSON DESERT
September 3 – 14, 2001

The Desert Dreaming vision is to prepare the way for the eventual reintroduction of native species to their natural desert habitat. Experience the grandeur and remoteness of an Australian desert as you work with plants and animals few people ever see.

BEYOND THE DREAMING—PROJECT EDEN
September 20 – 28, 2001

Be a part of Project Eden—make the Peron Peninsula the largest area in Australia where endangered animals roam freely. Voyage to Salutation Island; enjoy close encounters with native mammals and reptiles; assist in the reintroduction of endangered species; and track their deadly enemies—feral cats.

MONTEBELLOS MAGIC—SAILING THE PILBARA COAST
October 6 – 14, 2001

After 40 years of limited access, the Montebello Islands are now being appreciated as a tourism destination. Join scientists on a visit to these historic islands, site of atomic testing in the 1950s but now being actively managed by CALM for their conservation values. Voyage from Dampier to Exmouth as we explore these and other islands along the Pilbara coast.

SEABIRDS OF THE HOUTMAN ABROLHOS
December 11 – 15, 2001

Voyage to the Abrolhos Islands in the Indian Ocean off Geraldton, renowned for their colonies of breeding seabirds. Observe and record the myriad seabirds with Kevin Coate, one of Australia's best known field ornithologists and winner of WA Tourism's FACET Golden Guide Award. Learn about shipwrecks, snorkel in the crystal waters and, in the evenings, hear tales of the islands' 'angry ghosts'.

Send for your *LANDSCOPE* Expeditions 2001 brochure now.
Call (08) 9380 2433,
fax (08) 9380 1066,
email: extension@uwa.edu.au
or write to:

LANDSCOPE Expeditions
UWA Extension
The University of Western Australia
35 Stirling Highway
CRAWLEY
WESTERN AUSTRALIA 6009

DEPARTMENT OF
Conservation
AND LAND MANAGEMENT
Conserving the nature of WA

Winner of the 1998 Alex Harris Medal for excellence in science and environment reporting.

LANDSCOPE

VOLUME SIXTEEN, NUMBER 3, AUTUMN 2001

Armed with sketch pad, pencils, pens and paints, an intrepid group of artists set off on a brand new LANDSCOPE *expedition. See 'Awash with Colour' on page 28.*

Most of us only know of the exotic pest ants that invade our kitchens. But what of the great Australian ants? See page 23.

Ningaloo Marine Park and Cape Range National Park lie side by side in our north-west corner. Read about how they are managed on page 17.

Four more conservation reserves now offer greater protection to areas in and around the Mitchell Plateau. See 'Parks of the Plateau' on page 48.

Scientists continue to develop ways to locate, track and trap animals for research. See 'Tools of the Trade' on page 41.

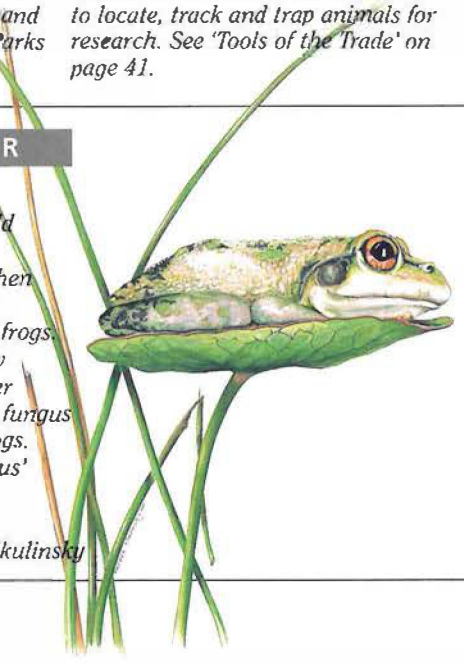
FEATURES

REGULARS

COVER

For many years, the decline of frogs in various parts of the world has puzzled conservationists. A breakthrough came in 1996 when scientists isolated a new kind of fungus that infects and may kill frogs. Western Australian research now under way is beginning to answer some initial questions about the fungus and its impact on our unique frogs. See 'In Pursuit of the Frog Fungus' on page 10.

Cover illustration by Philippa Nikulinsky



Executive Editor: Ron Kawalilak
Editors: David Gough and Carolyn Thomson-Dans
Bush Telegraph Editor: Verna Costello
Advertising copy and editorial assistance: Caris Bailey
Scientific/technical advice: Andrew Burbidge, Chris Simpson, Paul Jones and staff of CALMScience Division
Design and production: Tiffany Aberin, Maria Duthie, Gooitzen van der Meer
Illustration: Gooitzen van der Meer
Cartography: Promaco Geodraft
Marketing: Estelle de San Miguel ☎ (08) 9334 0296 Fax: (08) 9334 0498
Subscription enquiries: ☎ (08) 9334 0481 or (08) 9334 0437
Colour Separation by Colourbox Digital
Printed in Western Australia by Lamb Print

Please do not send unsolicited material to *LANDSCOPE*, but feel free to telephone the Editor.

Visit NatureBase at http://www.naturebase.net

Published by the Department of Conservation and Land Management, Dick Perry Avenue, Kensington, Western Australia

DEPARTMENT OF Conservation AND LAND MANAGEMENT
Conserving the nature of WA

LOOKING BEYOND THE OBVIOUS

The success of LANDSCOPE in the 16 years of its existence has been largely due to the calibre of our contributing writers, photographers and artists. Their talent, knowledge and enthusiasm has provided us with an abundance of fascinating and beautiful stories - more than 450 to date. In that tradition, the contributors to this issue of your conservation journal take us from slippery indicators of ecosystem health, to minute and tireless workers found throughout Western Australia, to scientific innovation, to spectacular land and marine conservation reserves in our remote north, and more.

By any standard, Philippa Nikulinsky is one of Australia's premier natural history artists and illustrators. Best known for her botanical work, her ability to capture Western Australia's wildlife with her drawings and paintings is equally delightful and inspiring. Check out her cover illustration of a motorbike frog and the photograph on page 12, and ask yourself whether it is the artist's or the camera's eye that has captured this animal best. It is good that we have both.

The decline of frog populations in various parts of the world has been a worrying indicator about the health of our ecosystems. Is the cause environmental contamination, global warming, or something else? In 'In Pursuit of the Frog Fungus', Ken Aplin and Peter Kirkpatrick of the WA Museum's Alcoa Frog Watch program examine the possible role of a new kind of fungus that infects and potentially kills frogs.

There may be between 700 and 800 different ant species in Western Australia (and as many as 20 different species of ant in your backyard) and they too are necessary to the health of many native ecosystems. In 'The Great Australian Ant', Brian Heterick explores the fascinating array of forms, behaviour and adaptions found in these helpful agents of land management.

For LANDSCOPE regular Tony Friend, Principal Research Scientist with CALMScience, the fight to save our native fauna demands a combination of technical skill, creativity, physical fitness and, occasionally, a sense of humor. In 'Tools of the Trade', Tony writes about the range of technologies that have been adapted to biodiversity conservation work in WA.

No issue of LANDSCOPE would be complete without an in depth look at some of spectacular and special areas in the State. In 'Parks of the Plateau', CALM's Kimberley Regional Manager Chris Done takes us to four new conservation reserves in and around the Mitchell Plateau that give greater protection to this scenic, biologically important and remote part of the Kimberley. And in 'Range to Reef', CALM's Exmouth District Manager Doug Meyers looks at the challenges we face in conserving the environmental heritage of Ningaloo Marine Park and adjoining Cape Range National Park more than a decade after the first formal management plan for the area was put in place.

Enjoy the autumn and we'll see you in winter.

Ra Kwelch

Executive Editor

BRISTLEBIRD MAGIC SHOW

You need to trick them into doing what you want them to do. They're difficult to catch, and you need patience getting them into the padded cells! They're western bristlebirds—one of WA's most threatened native birds.

Catching them for a translocation from Albany to Walpole was a mammoth effort involving CALM staff and volunteers from Perth, Albany and Walpole. Special effects were used to tantalise the birds into nets.

"It's like a magic show. You have to trick them into entering," CALM Regional Nature Conservation Program leader Alan Danks said.

"Once you've attracted them with carefully selected calls, you use a specially constructed mist net to trap them. To begin with, we missed more than we caught, but the technique is improving!"

There are two populations of western bristlebird, one near Albany in the Two Peoples Bay to Mount Manypeaks area and the other at Fitzgerald River National Park. The species inhabits dense near-coastal heaths, eats insects and seeds and is one of a suite of heath and scrub birds on the south coast.

It is endangered because of clearing and too-frequent fire, as the bird inhabits long-unburnt areas of old vegetation. Because it is a poor flyer it cannot cover long distances to find new territory.

CALM senior research scientist Allan Burbidge is leading the recovery effort for the western bristlebird.

"We decided that translocation was the wisest way of ensuring a safe future for them. The program is funded by Environment Australia and CALM, and supported by the considerable efforts of volunteers," Allan said.

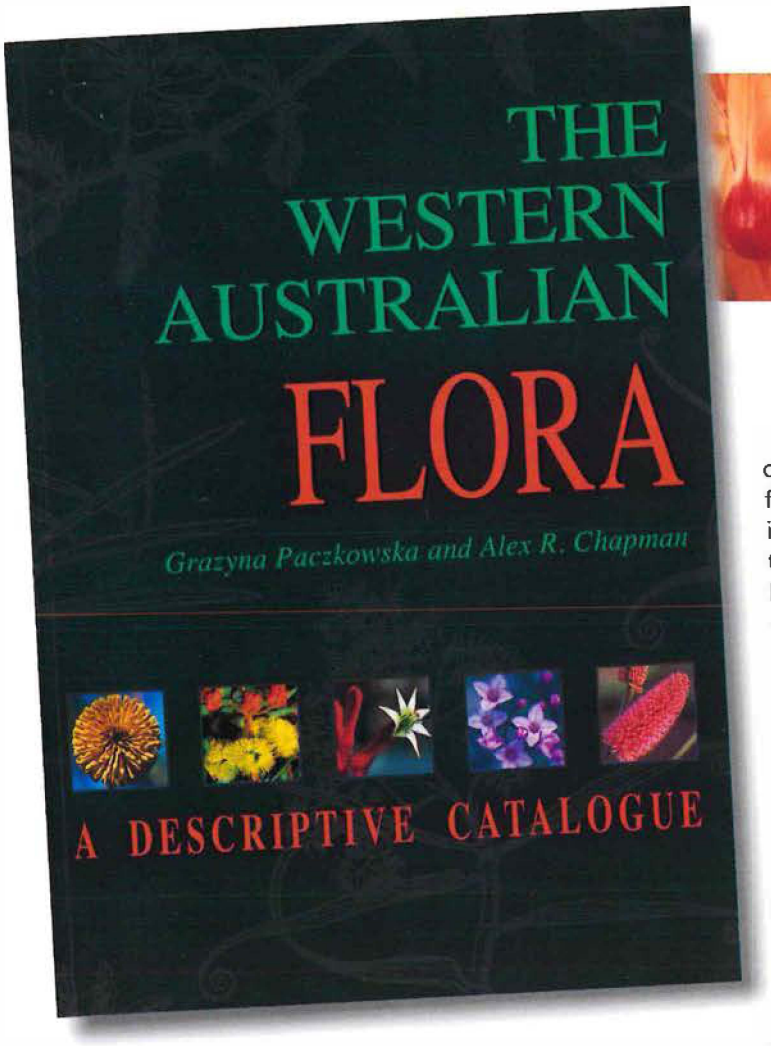
Last year, Allan's team moved eight birds from Two Peoples Bay Nature Reserve to Nuyts Wilderness in the Walpole-Nornalup National Park. This year, another seven were released there.

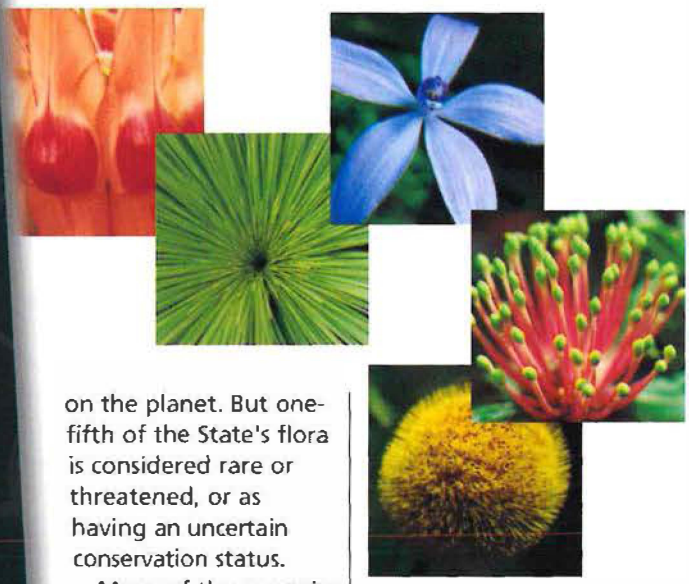
"We know at least half of them have persisted from last year because we've heard their distinctive calls. This is an excellent result. We're hoping they will breed and establish a new colony," he said.

CALM staff and volunteers drove to Walpole, then walked along bush tracks for an hour before releasing the birds from padded boxes, used to protect the birds from injury and stress.

Close-up of bristlebird. Photo – Neil Hamilton

NEW FLORA BOOK RELEASED





A seven-year project to catalogue the State's flowering plants has culminated in the release of *The Western Australian Flora: A Descriptive Catalogue*. The last book of its kind was published in 1970.

Every plant species known to exist in Western Australia is described in the new catalogue, which lists habit, height, flowering time and colour, habitat and distribution of 11,922 ferns and flowering plants recorded from the State's deserts, tropics, sandplains and native forests. It lists introduced as well as native species.

Authors Grazyna Paczkowska, a botanical consultant, and Alex Chapman, a botanist and research scientist at the WA Herbarium, used the State's botanical library, housed at the Herbarium together with its 500,000 preserved flora specimens, to produce the book. Material used ranged from the most recent collections to those dating back to 1801 when pioneer botanist Robert Brown collected plant specimens near Albany.

Almost half of Australia's flora grows in WA, and in the south-western corner nearly 80 per cent of plant species grow nowhere else on the planet. But one-fifth of the State's flora is considered rare or threatened, or as having an uncertain conservation status.

Many of these species are well recognised by conservation scientists but are yet to be formally named. For unnamed species, reliable phrase names or manuscript names are used in the book, and a synonym index is also provided so that recent classification changes can be tracked.

This means the catalogue will be a key tool for botanists, conservationists, researchers and the scientific community, as well as keen amateurs interested in growing and studying our native flora.

The Western Australian Flora: A Descriptive Catalogue is published jointly by the Wildflower Society of WA, CALM's WA Herbarium and the Botanic Gardens and Parks Authority.

Since 1993, the WA flora catalogue project has received $161,000 from the Lotteries Commission's Gordon Reid Foundation for Conservation, one of the largest amounts donated by the foundation to a single project. The Wildflower Society provided extra funding for the book's design and publication.

Staff at CALM's WA Herbarium have gone on to integrate the book's descriptive data with its authoritative plant name and specimen databases to produce a comprehensive online information system. FloraBase, which is located on CALM's NatureBase website, also includes maps and images. It can be found at www.naturebase.net/science/florabase.html

The Western Australian Flora: A Descriptive Catalogue is available from CALM's Kensington office, WA Naturally or the Wildflower Society and retails at $49.00.

WATTLE SYMPOSIUM: SOWING SEEDS FOR SOLUTIONS

Dalwallinu will host an international symposium to explore the economic and environmental potential of an enormous but under-used resource—the common Australian wattle (*Acacia* species).

Wattles are the largest group of plants in Australia. They dominate 60 to 70 per cent of the country and are particularly common in arid and semi-arid areas. The largest concentration of species occurs in the Wheatbelt region of Western Australia, with Dalwallinu located at the centre of this great diversity.

The symposium, which recently won the BankWest Conference Development Regional Award, is being organised by the Department of Conservation and Land Management's senior research scientist, Bruce Maslin, with help from the Heartlands Tourism Association and the Dalwallinu Shire and Tourism Group.

The symposium aims to explore the economic and environmental potential of acacias in helping to solve the serious landscape problems that currently confront many rural communities. It should also focus interest on Dalwallinu, which is currently attempting to develop tourism opportunities based on acacias.

Australia's fast-growing acacias are widely cultivated overseas, and in some countries, especially the Asian region, are important sources of timber and pulp. They are also used abroad for fuel wood, salinity control, for food and as a source of tannin to make leather. Within Australia, however, this enormous natural resource is largely under-used.

Many rural areas in southern Australia are currently experiencing serious land degradation, caused primarily by past clearing for agriculture. The most serious issue is increasing salinity over much of the landscape, due to rising water tables. Acacias have an important role to play in reversing this cycle of land deterioration. They have fast growth rates, great diversity in form, grow on a wide range of soil types, enrich the soil by fixing atmospheric nitrogen and are easy to cultivate.

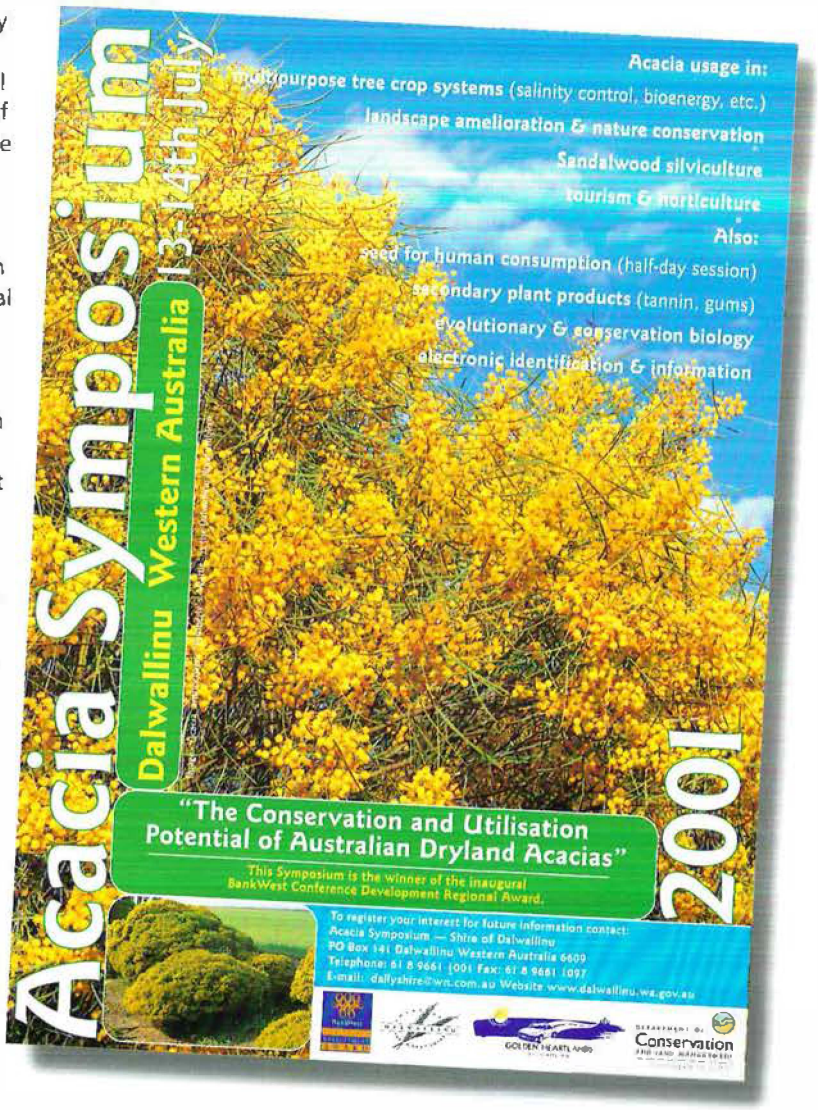
The symposium will cover a wide range of subjects, including the use of acacias in salinity control and landscape amelioration through wide-scale commercial plantations.

Other subjects will include the use of acacia seed as human food, use of acacias as a sandalwood host plant, the horticultural and tourism potential of the genus, aspects of its evolutionary and conservation biology and electronic identification and information dissemination.

The symposium will bring together scientists and other professionals to explore a wide range of issues and possibilities involving acacias. The intention is to build on what has already been done, within Australia and abroad, and what can be done in the future. It will be the first time such a broad-based evaluation will have been made of this group of plants and how they might contribute to social, environmental and economic problems facing many rural communities.

The symposium, titled "The conservation and utilisation potential of Australian dryland acacias", is scheduled for 13–14 July, 2001, and will follow an International Legume Conference in Canberra during the preceding week.

The symposium will be the culmination of a five day botanical field trip to the northern Wheatbelt and adjacent arid zone that will focus on many contemporary landscape and nature conservation issues, including salinity, species diversity, remnant vegetation, landcare and effective utilisation of the flora.



BETTER OPTIONS FOR FOUR-WHEEL-DRIVES

Four-wheel-drivers have been given greater involvement in managing CALM's tracks and better access to CALM-managed land.

A Memorandum of Understanding between CALM and Track Care WA, the umbrella organisation for the State's recreational four-wheel-drive associations, was signed at the Four-Wheel-Drive and Adventure Show in South Perth late last November.

The Memorandum of Understanding sets out guidelines on the behaviour of four-wheel-drivers in State forests, national parks and other CALM-managed land.

Four-wheel-drivers will receive information about responsible ways to use the bush, flora, fauna and tracks, and information about closures, openings, logging and proposed burns.

In the past, many of these tracks weren't designed for wide recreational use, so there were management problems when four-wheel-drivers began to use them.

"We'll continue to monitor any disturbance to wildlife, physical damage to tracks, noise and dust pollution, the aesthetics, littering, fire risk, health and hygiene, and the need for facilities," CALM's Director of Parks, Recreation Planning and Tourism Jim Sharp said.

Photo – Marie Lochman

CONSERVATION COMMISSION UP AND RUNNING

A new direction for the management of Western Australia's conservation estate began last November with the creation of the Conservation Commission of Western Australia.

The new Commission will meet public demand for a separate, independent body to oversee the management of State forests. The Commission will be the vesting body for all conservation lands including national parks, nature reserves, conservation parks, multiple-use State forests and timber reserves.

Responsibility for native forest and plantation commercial activities has been transferred from the Department of Conservation and Land Management (CALM) to the new Forest Products Commission.

The Conservation Commission has its own staff, including an auditing section that will monitor CALM's implementation of management plans as well as the harvesting activities of the Forest Products Commission.

Allied to the new direction is a strong commitment to build on the public participation processes and to facilitate more public involvement in conservation.

The new Commission's members are:

- Campbell Ansell (Chair), Company Director;
- Tom Day (Deputy Chair), chair of the former National Parks and Nature Conservation Authority (NPNCA), who will provide continuity between the former and new authorities;
- Pat Barblett, founder and chair of Forum Advocating Cultural and Eco Tourism and member of the former NPNCA;
- Dr Jennifer Davis, Head of the School of Environmental Science at Murdoch University;
- Glen Kelly, Project Officer with the Aboriginal Lands Trust;
- Barbara Morrell, Farmer in the Shire of Kent, member of the State Salinity Council and member of several community landcare and catchment management groups;
- Graeme Rundle, Secretary, WA National Parks and Reserves Association and member of the Conservation Council of WA; member of the former NPNCA;
- Rodney Safstrom, Environmental Consultant and the Chair of Greening Australia; and
- Dr Joanna Young, consultant on forest pathology and forest management.

CALM will be responsible for the integrated management of conservation lands and waters, including State forests and timber reserves, fire control and hazard reduction burning.

The Department's key functions include preparing management plans for consideration by the Conservation Commission, as well as providing scientific advice and drafting policy in relation to sustainable management, including sustainable levels of forest resources production.

The Conservation Commission can engage researchers when developing policy and, in particular, it will promote and facilitate the involvement of the community.

MILLENNIUM SEEDBANK

Western Australia has been invited to be part of the Royal Botanic Gardens, Kew, UK Millennium Seed Bank Project (MSBP).

The MSBP International Program is a 10-year global conservation program conceived, developed and managed by the Seed Conservation Department at the Royal Botanic Gardens, Kew.

The project aims to collect and conserve 10 per cent of the world's seed-bearing plants, mainly from the world's drylands, by 2010. This represents some 24,000 species. It also aims to develop research, training and capacity building relationships worldwide in order to support and advance seed conservation.

Over the past few years, some 93 per cent of the entire United Kingdom native seed-bearing flora has been collected and conserved in long-term storage.

The British Government's Millennium Commission has provided $83 million towards the project. More than $800,000 will be allocated to the Department of Conservation and Land Management (CALM) and the Botanic Gardens & Parks Authority (BGPA) to fund the Western Australian component over the next 10 years.

Seed samples will be collected and placed in long-term secure storage. The seed will be regularly tested to ascertain its viability. If viability drops, seed will be recollected. The stored seeds will be available to use for re-establishing plant species that become extinct in the wild.

Over the next 10 years, CALM's Threatened Flora Seed Centre at the WA Herbarium will collect seeds from 1,000 of WA's least-known species. Seed will be held in long-term storage in both WA and the United Kingdom.

The project will also entail studies within WA involving CALM and the Botanic Gardens & Parks Authority, as well as collaborative research between WA and the Seed Conservation Department of the Royal Botanic Gardens, Kew. The studies will improve the knowledge of germination, storage and how seeds maintain dormancy.

WA is well-placed to play an active role in this important project. CALM's Threatened Flora Seed Centre at the WA Herbarium plays a pivotal role in the State's flora conservation efforts.

CALM and BGPA's collaboration in the Millennium Seed Project will build on WA's expertise in conserving flora in the wild, particularly threatened species, and enhance conservation initiatives such as CALM's Western Everlasting Project and the BGPA's collaborative endangered plant rescue program.

Western Everlasting, initiated two years ago, is a broad-ranging program that aims to reduce the impact of threats such as dieback disease and weeds, and establish new populations of threatened species in suitable habitat.

Using seed banks is a relatively new and under-used tool to combat the loss of global plant diversity. While the emphasis and priority will continue to be maintaining native species in the wild, seed banks are an important 'insurance policy'.

The loss of biodiversity is of enormous concern, particularly in areas such as WA, where as many as 450 native plant species are at risk because of encroaching salinity in the species-rich Wheatbelt region. About 20 per cent of WA's flora may be susceptible to dieback and also in danger of extinction.

Millennium Seed Bank Centre Manager Anne Cochrane shows Regelia megacephala *seeds collected from Cairn Hill, north of Moora, to Principal Research Scientist David Coates and Principal Research Scientist Margaret Byrne.*
Photo – Verna Costello

WORLD INTEREST IN AUSSIE BUSHCRAFT

Some measure of the success of CALM's website NatureBase can be found by following Tim Hibbert's search for information about the WA bush and how to experience it safely.

Tim, a resident of Hong Kong, discovered CALM's Outback Safety and Bushcraft Course by exploring NatureBase and contacting CALM's Information Centre WA Naturally.

A safety officer with Cathay Pacific, Tim successfully completed CALM's basic Outback Safety Course in March, 2000.

Next, Tim completed an Urban,Wilderness, Emergency and Medical course in Colorado USA, then joined the Peruvian Airforce at its jungle survival school in the Amazon. This was followed by Earth Skills in Utah, training with the Federal Aviation Authority in Oklahoma, and Sea Survival and Underwater Escape in Connecticut.

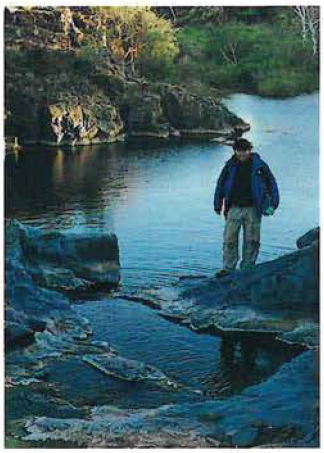
Tim then returned to WA to join the Rudall River Desert Workshop and Advanced Survival Course, both run by Bob Cooper in the Great Sandy Desert Bioregion. These courses, Tim says, enabled him to safely experience and enjoy one of the most remote areas in the world.

Bob Cooper has successfully managed CALM's Outback Safety and Bushcraft Course for more than 10 years, with more than 1,300 participants completing the course.

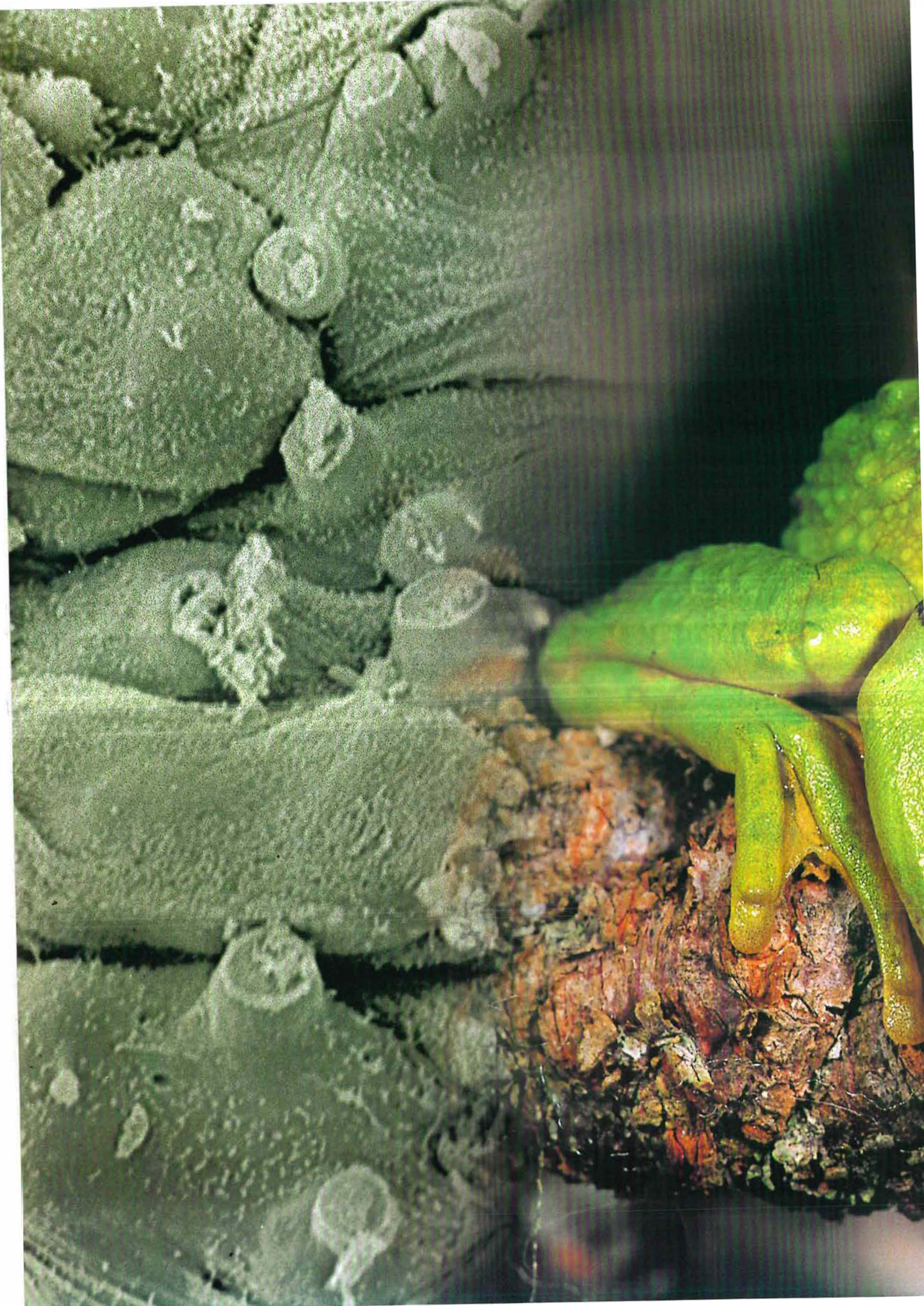
In recent years, he has conducted survival courses with the Texas Parks and Wildlife Department, forging a strong bond between survival experts in Texas and Western Australia.

National Geographic magazine's researchers joined one of the courses, producing a video for its Explorer television series on American CNBC.

Bob was recently approached by the British Broadcasting Corporation (BBC) Natural History Unit with a similar request for a series on extreme climates. There are no prizes for guessing how the BBC discovered the course. That's right, through browsing NatureBase—naturally!



Tim Hibbert at Daylight Pool in the Great Sandy Desert. Photo – June Ellis



For many years, the decline of frogs in various parts of the world has puzzled conservationists. A breakthrough came in 1996 when scientists isolated a new kind of fungus that infects and potentially kills frogs. Western Australian research now under way is beginning to answer some initial questions about the fungus and its impact on our unique frogs.

In pursuit of the frog fungus

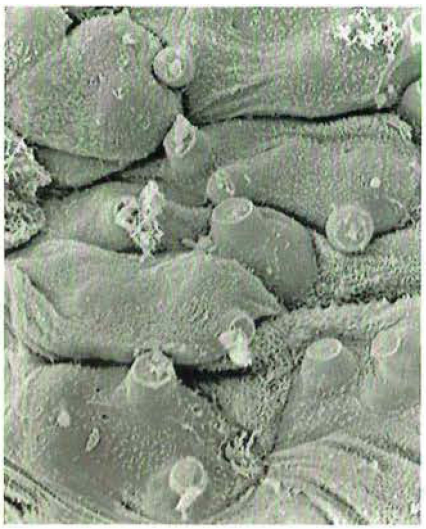
by Ken Aplin and Peter Kirkpatrick

Frog fungus? Never heard of it? To be honest, neither had we before August 1998. And neither had the rest of the world prior to 1996. But work over the past two years in Western Australia has already led to a significant increase in our understanding of this newly identified and potentially harmful disease of amphibians.

Frog fungus (*Batrachochytrium dendrobatidis*) is a microscopic fungus that lives on frogs, or more correctly, as a parasite within the skin of frogs and other amphibians. It belongs to an ancient group of funguses called the Chytridiales (or 'chytrids' for short—pronounced ki-trids). These tiny organisms usually exist as free-living single-cell organisms, most often in water-bodies or in soil. Although some are parasitic on algae and aquatic invertebrates, the frog fungus is the only member of the group known to live and feed on a vertebrate host.

DISCOVERY OF THE FUNGUS

Although the frog fungus is now known from nearly every continent, it was completely unknown to science until 1996. It was finally identified as a new 'pathogen' (agent of disease) by two teams of scientists working



Previous page
Motorbike frog (*Litoria moorei*).
Photo – Jiri Lochman

Left: A close-up of frog skin, heavily infected with frog fungus. The circular bodies are 'discharge tubes' through which new spores are released into the environment.
Photo – Lee Berger

Below: The motorbike frog, seen here in another colour variation, is a common victim of the frog fungus.
Photo – Babs & Bert Wells/CALM

independently, one at James Cook University in Townsville, Queensland, and the other at the National Zoological Park in Washington DC, USA. Both groups of researchers were investigating the mysterious deaths of large numbers of frogs living in apparently uncontaminated, healthy environments. In Queensland, this was happening in pristine rainforests in the World Heritage Wet Tropics Area. In America, it was happening in zoos with well-maintained and precious captive frog populations.

The breakthrough came only after several years of intensive research in each laboratory. Both teams followed many different leads, but eventually narrowed their search down to a mystery organism that appeared to be confined to the outermost layer of the skin. After comparing notes and with the help of mycologist Dr Joyce Longcore, this organism was identified as a chytrid fungus. The next step was to isolate the fungus from sick frogs and use it to experimentally infect healthy frogs. These test animals soon became infected with the fungus and developed the same clinical symptoms including lethargy and muscle spasms, leading to death. The tests established the link between the skin parasite and the disease symptoms, at least under laboratory conditions. Dr Longcore subsequently gave the fungus its near

Right: Western banjo frog is susceptible to the frog fungus, but shows no evidence of widespread decline.
Photo – Babs & Bert Wells/CALM

Below right: Adult moaning frogs rarely enter water and infection rates are lower than in many other species.
Photo – Brad Maryan

unpronounceable name, which means 'frog chytrid of dendrobatid frogs', dendrobatids being the family of poison arrow frogs, common victims of the fungus in American zoos!

In the five years since its discovery, the frog fungus has been recorded from many parts of the world. The current list, maintained on a website by Associate Professor Rick Speare of James Cook University, includes more than 90 different amphibian species from North, Central and South America, Europe, Africa, New Zealand and Australia.

Although the frog fungus was unknown until 1996, earlier records can be detected by studying historical specimens stored in various museum collections around the world. By this means, infections have already been recorded as far back as 1978 in eastern Australia and to the early 1970s in several parts of North America.

SUPPORTERS AND SCEPTICS

The discovery of the frog fungus was heralded by many researchers as a major breakthrough in the search for a common factor linking frog declines in various parts of the world. However, other researchers remained sceptical about its significance. Some expressed doubts that any wildlife disease could have such pronounced and widespread impacts, unless the affected populations were already compromised by some other stress-inducing factor such as environmental contamination or changes in global climate. Other researchers were dubious about whether the laboratory results accurately reflected conditions in the field—a common criticism of laboratory tests of this kind.

Nor could researchers agree on the reason for the differences in timing of chytrid disease outbreaks in different areas. Was the frog fungus spreading around the world, wreaking havoc on amphibian faunas with little or no resistance to the disease? Or was it a naturally widespread organism, which only emerged as a problem 'disease' when the relationship between host and parasite altered, perhaps because of environmental change or lowered immunity? Many examples of both kinds of 'emergent infectious diseases' can be cited from human history: for example, the spread of influenza into the New World in the sixteenth century and modern outbreaks of cholera following natural disasters and disruption of water supplies.

Like many scientific breakthroughs, the discovery of the frog fungus has raised many more questions than it has answered!

FUNGUS FOUND IN WA

The first evidence of the frog fungus in WA came in 1998 from a recently dead motorbike frog (*Litoria moorei*) picked up on The University of Western Australia (UWA) campus in Nedlands by a concerned zoology student. Diagnosis was performed by Lee Berger, formerly of the James Cook team, but by then based at the CSIRO Animal Health Laboratory in Geelong, Victoria.

The worrying news spread quickly. Ken Aplin appealed for help in locating sick or recently dead frogs, both through the news media and direct to several thousand dedicated members of the Western Australian Museum's Alcoa

Frog Watch. Within days, specimens were coming in from throughout the metropolitan area and beyond.

An initial sample of 70 or so sick and dead specimens was sent interstate for processing and diagnosis. The results were not good news—positive infections at various localities around Perth and as far away as Witchcliffe (near Margaret River), Manjimup and Albany. Moreover, fungal infections were recorded in at least four species of frogs. A thousand and one questions ran through our minds. Was the fungus recently introduced? Or had it always been here? Would some species be more susceptible than others and, if so, which ones?

LOCAL STUDIES

In 1999, we began a detailed study of the frog fungus in WA. This was made possible by funding from the Department of Conservation and Land Management (CALM) and the World Wide Fund for Nature Australia Frogs Program, and with training in diagnostic methods by Lee Berger and Rick Speare. Curtin University provided laboratory facilities. Additional work was undertaken by Zoe Car, an Honours student in Zoology at UWA.

Our combined studies aimed to answer five basic questions. Firstly, how widespread was the zone of infection? Secondly, how long had chytrids been present in WA? Thirdly, was there any seasonal or geographic pattern in infection rates? Fourthly, which species were being infected? And lastly, which of the infected species were showing clinical symptoms of ill-health including death? These questions were designed to provide a solid foundation for future management of the frog fungus disease in WA.

To address the first four questions, large numbers of specimens from the Museum's collection would need to be examined, preferably covering a large geographic area, a wide range of time periods and a diverse range of species. However, Museum specimens alone would not provide an answer to the last question. For this, many more sick and dead frogs would be needed to compare with the 'healthy' samples typically collected and deposited in museums. Throughout the study, repeated calls for help were issued, with good response, especially from many Alcoa Frog Watch members who took special care to monitor the health of their garden frog populations. Many specimens also came in from regional CALM offices.

After two years, we had examined more than 4,000 specimens, covering a 50-year period and representing 28 different species. Most of this material came from the south-western corner of the State—thus providing the most detailed study of a regional zone of frog fungus infection anywhere in the world.

ANSWERING QUESTIONS

Our studies answered many of our original questions. We now know that a broad zone of infection is present across the south-west corner of the State, from just north of Geraldton, south to Augusta and east to Esperance, extending inland nearly as far as Southern Cross. This doesn't mean that every frog population in the south-west is necessarily infected at any one time. However, it does mean that no site in this region can be thought of as a 'fungus free zone' in any long-term sense.

We also know that there is at least one isolated infection point on the Gibb River Road in the eastern Kimberley. This is disturbing, as there was previously no evidence of the frog fungus from anywhere in north-western Australia, although infections are known from northern Queensland.

Initial historical studies by Zoe Car produced some stunning evidence of frog fungus infections in the Albany region back as early as 1985! This led her to speculate that the fungus might in fact be native to the south-west region. However, subsequent testing of more than 1,000 samples from the period 1950–1984 failed to find any earlier cases. Rather, our more detailed study appears to track the fungus spreading outwards from an initial outbreak in the Albany region, reaching

Perth in 1989, Esperance by 1992 and Geraldton by 1998. These results clearly favour the notion of an introduction and rapid spread of the fungus, but this picture could change with further testing.

We found evidence of chytrid infection in every south-western frog species that we sampled intensively, a total of 17 in all. Quite possibly, the fungus can infect all frogs, although all may not develop any other symptoms or suffer any disease. Not surprisingly, infection rates in different frog species reflect their contrasting lifestyles. As a rule, frogs that spend more time in or near water, such as the motorbike frog, had infection rates three or four times higher than those, like the moaning frog (*Heleioporus eyrei*), that spend most of their life on land.

Four species of frogs dominated the 'sick and dead' sample brought in by members of the public. These were the two local tree frogs (the motorbike frog and slender tree trog, *Litoria adelaidensis*), the moaning frog and the banjo frog (*Limnodynastes dorsalis*). In each species, the chytrid infection rate was at least three times higher in this sample than in the corresponding 'apparently healthy and active' samples. This is strong evidence that fungal infection does indeed lead to ill-health and death of at least these species of frogs under natural conditions.

Given this conclusion, it was disturbing to find no evidence in our data that infection rates had fallen since 1985, hence no sign that local frogs were becoming more resistant to infection. Similarly, the fact that we found such high rates of infection in the 'sick and dead' sample also made it unlikely that local frogs had developed any strong resistance to clinical disease over this period.

On a more positive note, the intensity of fungal outbreaks appeared to differ from year to year, possibly with more 'good' years than 'bad' years so far. Taking only samples collected around Perth, we compared seasonal patterns for each year over the past decade. The graphs show a consistent seasonal trend in infection rates, beginning with values of one to five per cent during the dry, hot months of summer and autumn, climbing to around 10 per cent through winter, and peaking at between 20 and 50 per cent in spring and early summer, before rapidly dropping back to the summer low. Between years, the spring to early summer 'peak' has varied substantially in severity. During the 1991–92 and 1998–99 periods, every second frog around Perth was probably infected! (Significantly, some Alcoa Frog Watch members reported a 50 per cent mortality among their garden frog populations through winter to spring 1999.) However, between these periods, infection levels were considerably lower and there may have been lower rates of sickness and death among local frogs.

An unexpected result of our study was that infection rates did not seem to be influenced by environmental quality. Rates of infection were just as high in relatively undisturbed bushland habitats, away from strong human influence, as they were at some of the most disturbed and contaminated localities in the Perth metropolitan area.

PAST AND FUTURE

The really big unknowns are whether or not the frog fungus has caused any lasting declines in Western

Right: Slender tree frog (*Litoria adelaidensis*).
Photo – Babs & Bert Wells/CALM

Right: The orange-bellied frog has shown no evidence of decline, but is perhaps 'vulnerable' to disease due to its small geographic range.
Photo – Grant Wardell-Johnson/CALM

Below right: Kids netting for tadpoles—an age-old pleasure. Hopefully, future generations will continue to enjoy the experience of living together with frogs.
Photo – Ken Aplin

Australian frogs so far, and whether or not it is likely to in the future. As far as we know, WA has so far avoided the worst impacts of the frog fungus. Along the eastern seaboard of Australia, about eight frog species have become extinct over the past two decades and others are now highly threatened. Almost all of these are from high altitude areas. In the south-west region, we can be fairly confident that no frog species has become extinct or suffered a catastrophic decline over the past 15 years—perhaps the lack of high country in the south-west has somehow limited the impact of the disease? However, we cannot be so sure about other parts of the State, especially the infrequently visited Kimberley region. And have there been more subtle changes, even in the south-west?

Over the past decade, CALM staff and UWA researchers have accurately monitored populations of the white-bellied and orange-bellied frogs (*Geocrinia alba* and *G. vitellina*), both of which are restricted to small natural ranges in the Margaret River area (see 'Frogs: Value in Variety', *LANDSCOPE*, Spring 1994). The white-bellied frog is declining and is listed as 'critically endangered'. The orange-bellied frog is not, and is listed as 'vulnerable', even though there is evidence that the species was infected during 1996. This may be evidence that some species are more resistant to the fungus than others, but the picture is not clear.

Unfortunately, our work has shown that at least some groups of south-western frogs are highly susceptible to frog fungus disease. To what extent are these species under threat? The short answer is that we don't know. In many areas, populations of frogs have indeed fallen dramatically over the past one or two decades, but at present we are unable to say whether this has been caused by frog fungus disease or by one or more other factors, such as habitat degradation or our growing dependence on potentially harmful environmental chemicals. We believe in being cautious and vigilant. Our studies of the frog fungus will continue.

WHAT YOU CAN DO

After reading this article, you may want to know how you can help our frogs. To begin with, you can learn about frogs and help to raise awareness of disease and other threats to frogs. You can also help to identify major outbreaks and 'epidemic' years by collecting sick and dead frogs (contact the Museum to find out how). Another way to help is to become involved in frog conservation through assisting with landcare work. And we can all make a small but important contribution by looking after our own backyard, helping to make the suburban environment more frog-friendly overall (see 'Frogs in the Garden', *LANDSCOPE*, Winter 1993). By working together, we can help to make the State a better place for frogs.

Ken Aplin is Coordinator of the Western Australian Museum's Alcoa Frog Watch program. He can be contacted on (08) 9427 2826 or by email (frogwatch@museum.wa.gov.au).

Peter Kirkpatrick is a Curtin University Environmental Science graduate who spent 1999 working at the Western Australian Museum on the frog fungus. He is currently enrolled in Veterinary Science at Murdoch University but continues his frog disease work part time with the Museum. He can be contacted by email (frogwatch@museum.wa.gov.au).

RANGE TO REEF

Until the late 1980s, most visitors to Ningaloo Reef went there to fish. When the Ningaloo Marine Park was established in 1987, managers needed to encourage more passive and educational enjoyment of the park's spectacular reefs and marine life. Other challenges were to establish sanctuary zones, protect the park's unique habitat and sensitive marine animals like turtles and whale sharks, and manage the adjacent coast. More than a decade after its establishment, Doug Myers looks at the report card for Ningaloo.

by Doug Myers

Ningaloo Marine Park protects the largest fringing coral reef in Australia and one of the few large reef areas in the world found so close to a continental land mass; about 100 metres offshore at its nearest point and less than seven kilometres at its furthest. Living among or near the colourful corals is a remarkable diversity of tropical marine plants and animals, from dainty clownfish to massive whale sharks.

The State waters of Ningaloo were declared a marine park by the Western Australian Government in April 1987. After much public consultation, a management plan for the park was released in November 1989. The park's Commonwealth waters were declared by the Federal Government in May 1987, bringing the park's total area to approximately 4,300 square kilometres. A joint management arrangement between the State and Federal Governments enables the Department of Conservation and Land Management (CALM) and Fisheries WA to manage the Commonwealth waters of the park on a day-to-day basis.

The Commonwealth, via its agency Environment Australia, also provides the State Government with financial and technical assistance for the park's overall management. Environment Australia is currently preparing a new plan of management for the park's Commonwealth waters, to complement what is proposed for State-controlled waters.

DECADE OF MANAGEMENT

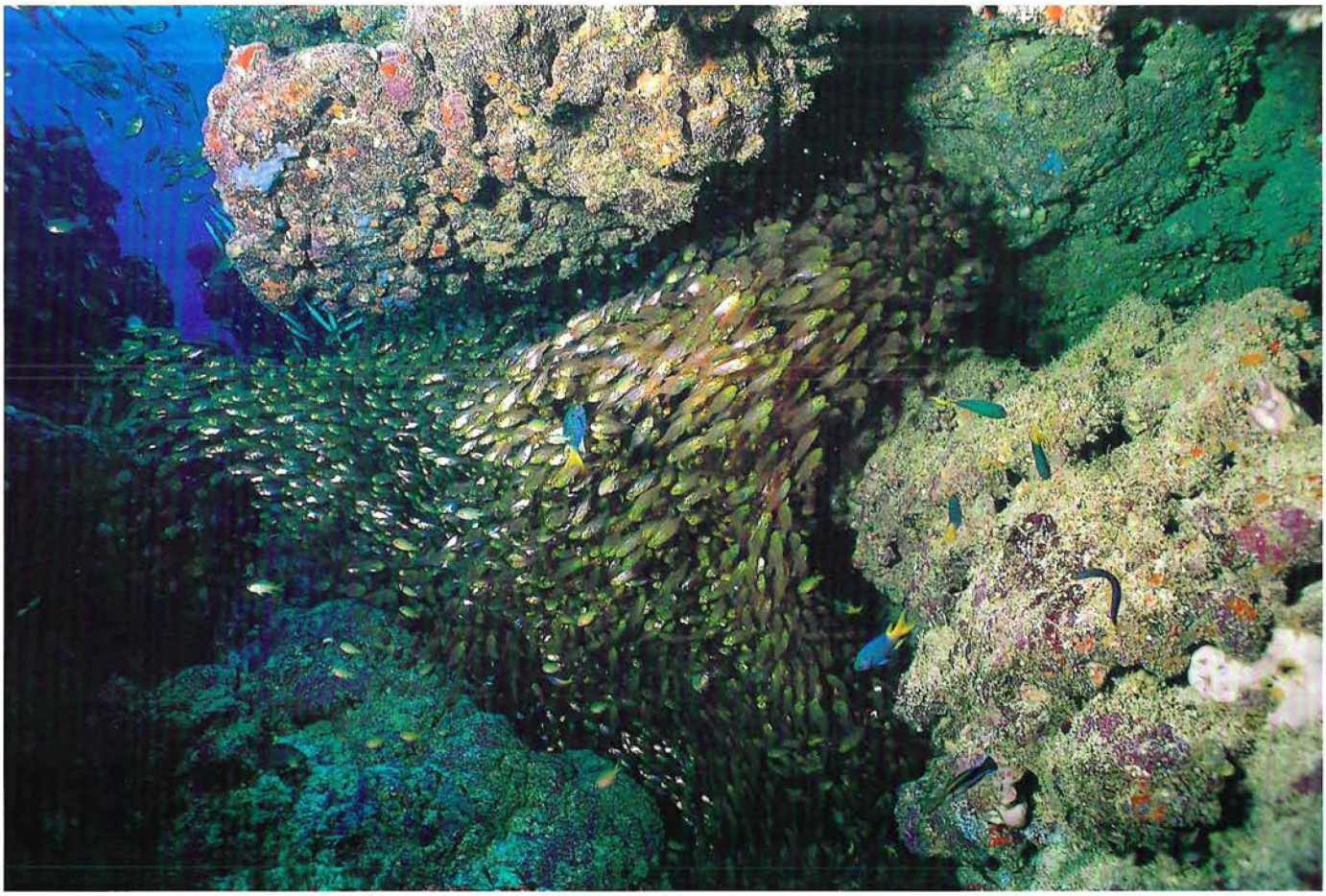
Since the park was established, visitors have gradually become less focused on fishing and more likely to visit the area to snorkel, go boating and view the plethora of marine animals. This change in attitudes has helped managers to encourage a conservation ethic among park users.

Previous page
Main: A large staghorn coral at Ningaloo Marine Park shows the proximity of the reef to the shore.
Photo – Brett Dennis/Lochman Transparencies
Inset: Loggerhead turtle.
Photo – Peter & Margy Nicholas/Lochman Transparencies.

Below: Ningaloo Reef offers superb diving.
Photo – Ann Storrie

The 10-year management plan for Ningaloo Marine Park is now being reviewed and CALM recently undertook an evaluation of the management of the park over the past decade. The evaluation provides an insight into some problems and issues that emerged over the past 10 years. This information is now being used to develop a 'new' management plan for the coming decade.

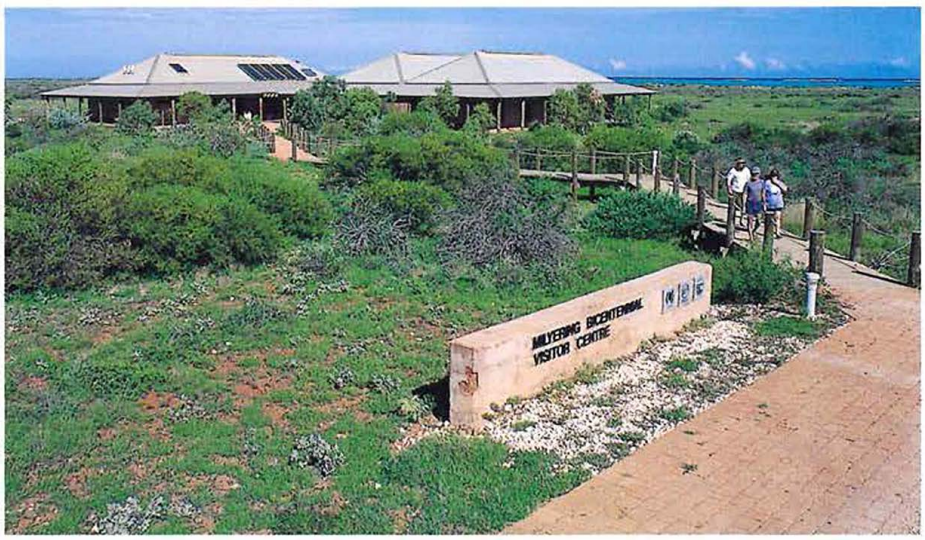
Most objectives in the current management plan for Ningaloo Marine Park have been achieved over the past 10 years. The park's zoning system has been implemented via legislation and



Right: Passive and educational enjoyment of the reef is now a major recreational activity at Ningaloo Marine Park.
Photo – Colin Kerr

Below right: Ningaloo is one of the world's few major reef systems that you can snorkel to from shore.
Photo – Bill Belson/Lochman Transparencies

Bottom right: The Milyering Visitor Centre in Cape Range National Park also provides visitors with information on Ningaloo Marine Park.
Photo – Dennis Sarson/Lochman Transparencies



signs have been erected to advise users of zone boundaries. Other significant achievements include implementing special regulations for recreational fishing.

Extensive education programs, especially those carried out soon after the management plan was launched, have achieved substantial public appreciation of the marine park's varied attributes and a high level of compliance with park regulations and policies.

Significant objectives not achieved over the past decade were associated with management of pastoral lands alongside Ningaloo Marine Park. Coastal environments adjoining the marine park have suffered from indiscriminate four-wheel-driving and largely uncontrolled camping. Future management of recreational activities in these areas is currently being addressed by CALM and the Ningaloo Reef Outback Coast Association (an association of owners or managers of pastoral leases abutting the park).

RANGE TO REEF

Cape Range National Park adjoins Ningaloo Marine Park, and the two parks can therefore be managed as a single unit. Most visitors to the North West Cape spend much of their time enjoying the long stretches of beach, at the interface between the two parks. The beaches are potentially far more susceptible to environmental degradation than less popular areas and require more intensive management. The parks are able to share infrastructure and visitor facilities. This strategy minimises administration and clerical support, and avoids duplication of resources.

Developments in Cape Range National Park are located to complement marine park attractions. The Milyering Visitor Centre, within Cape Range National Park, provides interpretation facilities for the two parks (including the Commonwealth waters of the marine park) from 'range to reef'. Some of the financial assistance provided by Environment Australia is used to employ additional staff during peak holiday periods. Environment

Australia also provides funds for ongoing maintenance of infrastructure and public displays at Milyering. In other words, the marine park benefits from the fact that a superb facility could be built on national park land right next to it, while Cape Range National Park gets spin-off benefits from Commonwealth funding available to the marine park.

Volunteer campground hosts located at peak times in all large camp sites in Cape Range National Park provide park visitors with 'on the spot' information on the coral coast parks. The hosts are mostly retired people. They provide invaluable support for CALM staff, who are coping with ever increasing numbers of visitors.

ADJACENT LANDS

The State and Commonwealth governments have agreed that the coastal part of Department of Defence lands, just south of Cape Range National Park, will be jointly managed by CALM and the Defence Estates Organisation (DEO). This land, locally known as 'the bombing range', was recently given the title of the Bundera Coastal Protection Area. Bundera Sinkhole, a large karst feature with significant geological values and habitat for rare subterranean fauna, lies within the protection area. A joint draft management plan for this land is currently being prepared by DEO and CALM, as well as a recovery plan for Bundera Sinkhole, which is a threatened ecological community.

A management plan for Jurabi and Bundegi coastal parks and the Muiron Islands, north of Cape Range National Park, was recently launched by the State Minister for the Environment. The coastal parks are Class C reserves for the purpose of recreation and coastal protection and abut Ningaloo Marine Park. They are jointly vested in the Shire of Exmouth and the Executive Director of CALM. The Muiron Islands are a Class C reserve for the purpose of recreation and protection of flora and fauna. This reserve is jointly vested in the Shire of Exmouth and the Conservation Commission of WA. It is proposed that day-to-day management of all three reserves be overseen by a management committee with equal representation from the Shire of Exmouth and the local CALM office.

MARINE RESEARCH

The creation of Ningaloo Marine Park helped attract significant scientific

Above: The exceptional beauty of the Ningaloo coast attracts visitors from all over the world.
Photo – Bill Bachman

Left: A small marine snail, *Drupella cornus*, consumes living coral.
Photo – Ann Storrie

Below: Fire coral overwhelms the skeletons of corals destroyed by drupella at Ningaloo Reef.
Photo – Geoff Taylor/Lochman Transparencies

Right: Measuring and tagging green turtles at Ningaloo Marine Park.
Photo – Eva Boogaard/Lochman Transparencies

Below: A golden ghost crab (*Ocypode convexa*) devours a loggerhead turtle hatchling.

Below right: A green turtle returns to the ocean after laying its eggs.
Photos – Jiri Lochman

interest in the area. More than 250 research projects have been undertaken in the marine park over a 12-year period.

CALM has established permanent habitat monitoring sites throughout Ningaloo Marine Park to detect natural (such as cyclones or infestations of the marine snail *Drupella*) or unnatural changes in the marine environment at an early stage. This information can then be used to initiate management strategies to address the causes of such change. A resurvey of 17 sites near Coral Bay has also been undertaken to assess the recovery of the reef killed by a coral spawn slick in 1989.

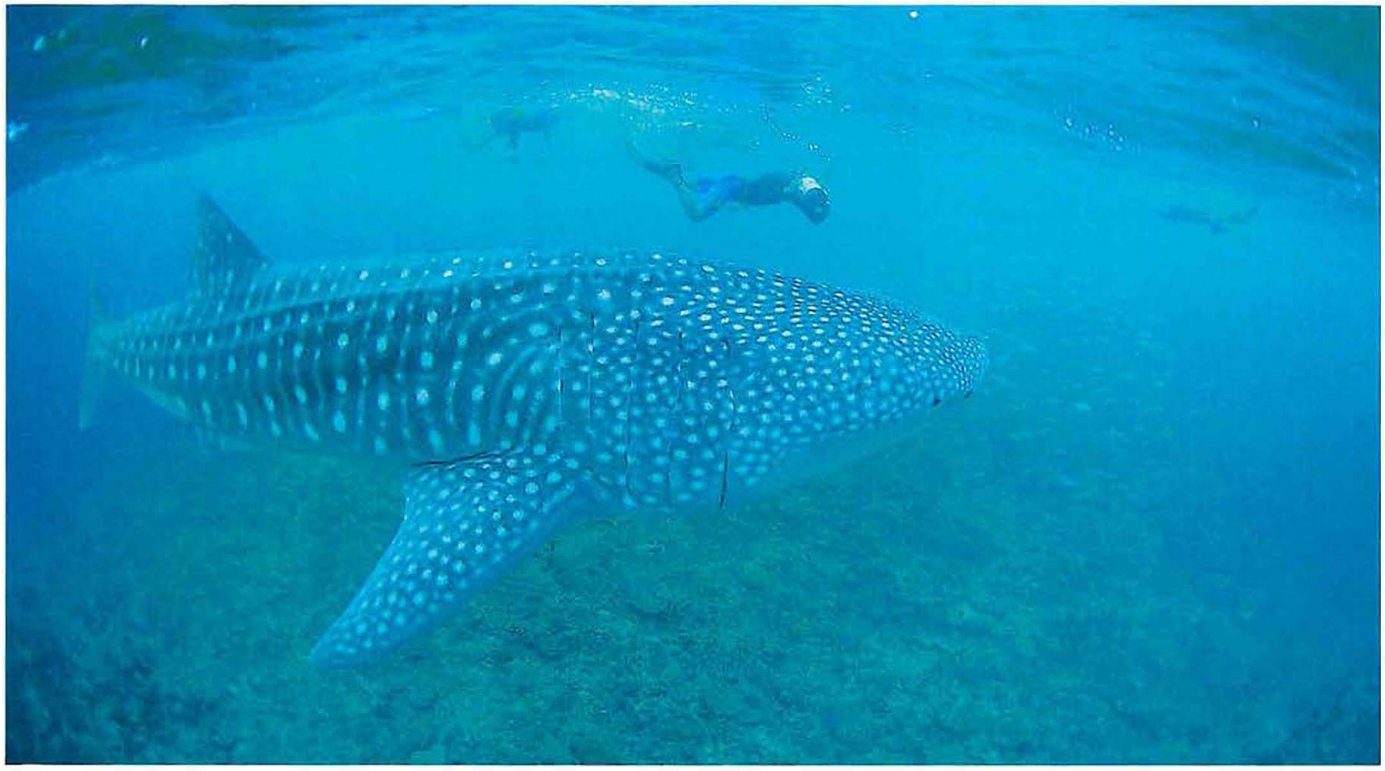
Other current research projects include a comparison of fish populations and marine habitats within sanctuary zones and those within multiple-use zones of the marine park. A review of the oceanography of Ningaloo Marine Park is currently being undertaken by CALM in association with the Australian Institute of Marine Science and CSIRO.

PROTECTING TURTLES

The northern beaches of North West Cape are significant nesting areas for sea turtles, mostly green turtles (*Chelonia mydas*). They come ashore each year in varying numbers. Large numbers of loggerhead turtles (*Caretta caretta*) also nest at the Muiron Islands. During the turtle-nesting season, CALM staff and volunteers tag turtles and monitor nesting activity and human interaction with turtles at North West Cape.

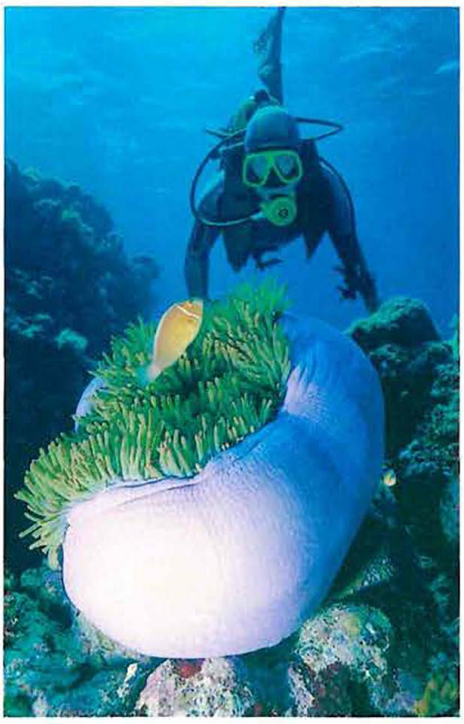
Further south in Ningaloo Marine Park, loggerhead turtles breed along the beaches near the small holiday settlement of Coral Bay, especially along the north-facing beaches of Bateman Bay. A range of threats—both natural and unnatural—to adult turtles and hatchlings exists at these sites. Human activity disturbs the females coming ashore to nest, introduced foxes dig up and eat the eggs, hatchlings become trapped in deep tyre ruts left by four-wheel-drive vehicles using the beach and ghost crabs kill the hatchlings as they head for the sea.

A community-run volunteer project is reducing some of the dangers faced by turtle hatchlings in the Coral Bay area. The project is led by Peter Mack, assisted by funding from the Coastwest/Coastcare program and supported by local CALM staff. Volunteers identify new nest sites early each morning, before the wind has blown away the turtle tracks. Careful probing into the sand determines the precise location of the nests. Each nest is numbered and its date and position recorded. The nests are protected with wire cages to reduce fox predation of eggs and to protect the baby turtles once they have hatched. The hatchlings are then released under more



controlled conditions, to avoid some of the threats to their survival.

Turtle watching has become a significant attraction for people visiting Ningaloo Marine Park, especially during summer, when there is much nesting and hatching activity. CALM distributes a considerable amount of educational material on appropriate methods of observing nesting turtles. Special light-reflecting interpretive signs have been erected at popular nesting sites.



WHALE SHARKS

Human interaction with whale sharks (*Rhincodon typhus*), the world's largest fish, has become a major attraction for people visiting Ningaloo Marine Park. These awe-inspiring creatures appear each year at Ningaloo, usually between March and June. They are evidently attracted to the area by food pulses associated with several seasonal oceanographic events, including water movements related to the Leeuwin Current. The filter-feeding sharks' diet includes tropical krill, planktonic copepods and small fish.

Commercial whale shark tour operators in Ningaloo Marine Park are licensed by CALM and required, under their licence conditions, to record the number of paying passengers and the number of whale shark interactions. These data are analysed and total numbers of visitors and shark sightings are continually added to an ongoing database. The licence conditions incorporate a 'code of conduct' developed by whale shark tour operators and CALM staff.

Research on whale sharks within Ningaloo Marine Park includes a satellite tagging program conducted by Dr John Stevens of CSIRO Marine Research (Hobart), in conjunction with Murdoch University graduate Brad Norman. Brad is also studying aspects of the biology and ecotourism industry of whale sharks in north-western Australia.

THE FUTURE

Ten years on, one of Australia's most remarkable marine areas remains a healthy ecosystem, and establishment of the marine park has gained wide public acceptance within Western Australia. The attractions of Ningaloo Marine Park and its pristine nature are becoming well known throughout the rest of Australia and, indeed, the world. Increasingly, the coral coast parks are attracting international tourists throughout the summer months, historically a time of very low visitation.

Above: A code of conduct for interaction between people and whale sharks is helping to ensure the world's largest fish keeps coming back to Ningaloo.
Photo – Ann Storrie

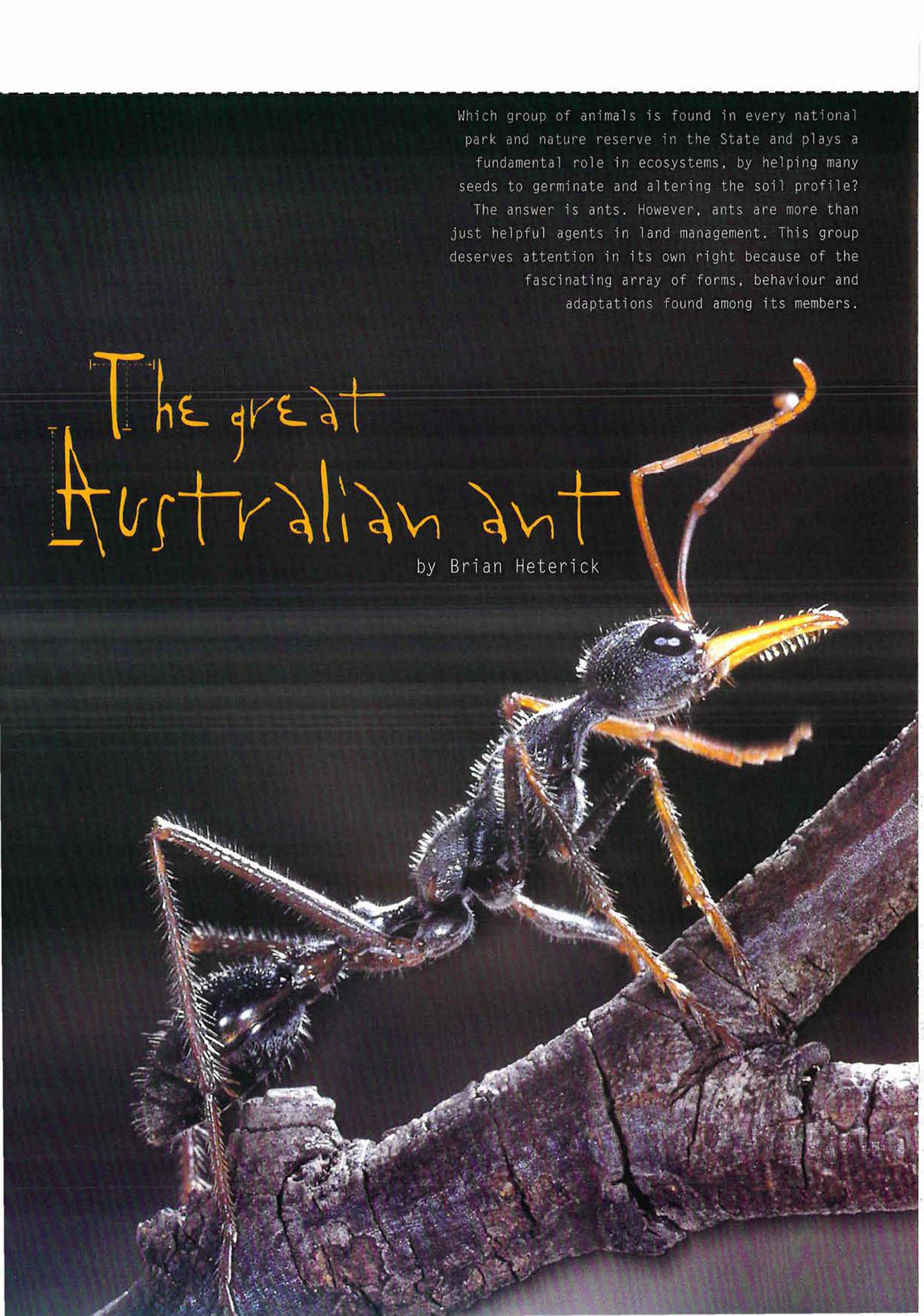
Left: An anemonefish gains protection from predators in the tentacles of a sea anemone.
Photo – Peter & Margy Nicholas/Lochman Transparencies

Doug Myers is the Manager of CALM's Exmouth District. He can be contacted on (08) 9949 1676.

Which group of animals is found in every national park and nature reserve in the State and plays a fundamental role in ecosystems, by helping many seeds to germinate and altering the soil profile? The answer is ants. However, ants are more than just helpful agents in land management. This group deserves attention in its own right because of the fascinating array of forms, behaviour and adaptations found among its members.

The great Australian ant

by Brian Heterick



Ants, like bees and wasps, belong to the insect Order Hymenoptera, with all ants being placed in the Family Formicidae. Also, as with bees and wasps, the Australian ant fauna is huge, and contains many endemic forms found nowhere else. Western Australia boasts an enviable portion of this diverse ant fauna. The western third of our continent may be home to between 700 and 800 ant species, out of an Australian total of perhaps 4,000. All 10 of the Australian ant subfamilies have Western Australian representatives, though several of these, like the Nothomyrmeciinae, are known from only one or a handful of specimens.

Indeed, *Nothomyrmecia macrops*, the only surviving member of the ancient ant superfamily Nothomyrmeciinae, has been termed 'the fossil ant'. Two specimens of this rare ant were collected in 1931 'somewhere' east of Esperance, but it was not rediscovered until 1975 in South Australia's Eyre Peninsula, near the small settlement of Poochera.

THE IMPORTANCE OF ANTS

Ants are necessary to the health of many native Australian ecosystems. For instance, ants perform a vital function in dispersing seeds. Forty per cent of the seeds dispersed by ants are from *Acacia* and *Eucalyptus* species, and the Proteaceae (the banksia family), Fabaceae (pea plants) and Casuarinaceae (sheoaks) are dominant families in banksia woodland whose seeds are also spread by ants. The ants take the seeds back to the nest, eat the oily appendages and leave the embryos intact, enabling them to germinate.

Ants also cycle litter in the soil. Decomposition of litter is aided by the dispersal of fungi and bacteria by ants. In this way, ants help to modify the physical and chemical properties of soil.

AMAZING ANTS

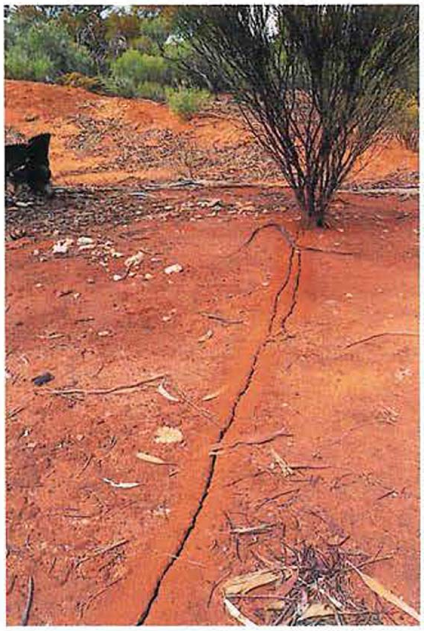
Ants display an amazing variety of forms and lifestyles. Some ants, like the tropical green tree ants (*Oecophylla smaragdina*), which use their larvae as living shuttles to weave together the leaves of their nest, or the desert-dwelling 'honeypot' ants (in the genera *Camponotus* and *Melophorus*) are well known. Less well known is the little spinifex ant (*Ochetellus flavipes*) of the Pilbara and Kimberley regions, which tends plant-sucking bugs (Order Hemiptera) under coverings of plant resin and soil.

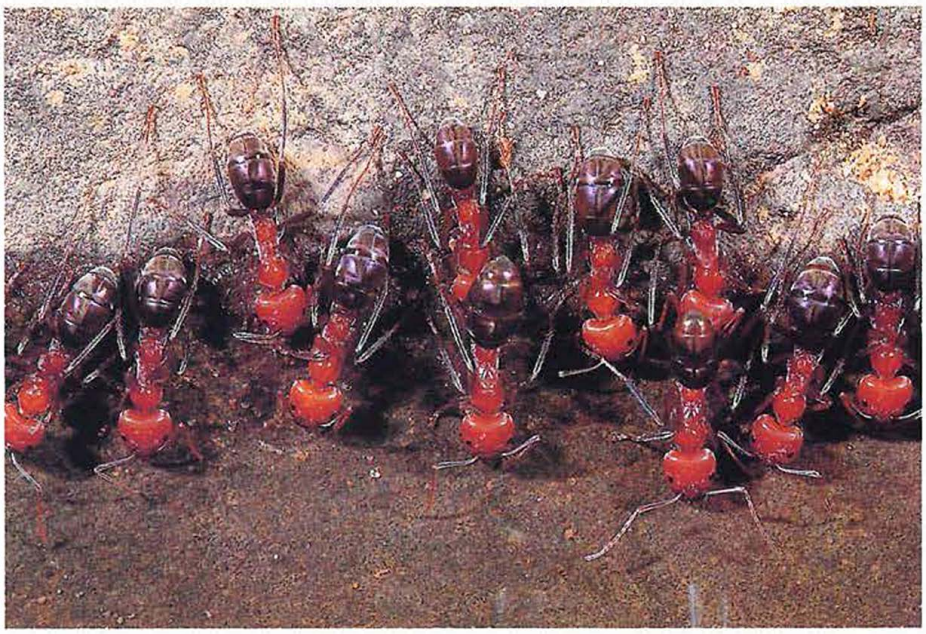
In the south-western forests, tiny nocturnal hunters (members of the Myrmicine tribe Dacetini) stalk their springtail prey. These ants have jaws like spring-traps, which snap shut when sensitive hairs on or around them are touched. The traumatised prey is then stung and immobilised. *Odontomachus* has superficially similar dentition to some of the dacetine ants, but belongs to the Subfamily Ponerinae and is much larger, with a powerful sting. Its

Previous page
A bulldog ant.
Photo – Babs & Bert Wells/CALM

Above: Green tree ants build a nest from leaves, using silk produced from the silk gland of the larva.
Photo – Hans & Judy Beste/Lochman Transparencies

Left: A bulldog ant returns to its nest with a spider that it has captured. These ants are skilful predators.
Photo – Jiri Lochman





jaws snap shut in as little as a third of a millisecond, one of the fastest response times in the animal kingdom!

The ubiquitous meat ants (*Iridomyrmex purpureus* species group) are well known to, and sometimes detested by, country residents of Western Australia, while the unique bulldog ants (Subfamily Myrmeciinae) have stings that can be life threatening to people who are sensitive to ant, bee and wasp venoms. Rather more comical are the enormous-eyed 'robot' ants (*Opisthopsis* spp.), which move in grotesque little jerks.

ANT DIVERSITY

These and many other ant species are dominant life forms in most terrestrial ecosystems of Western Australia. Our ant biodiversity can be astonishing. On mining tenements in heathland at Eneabba, 300 kilometres north of Perth, just over 100 ant species have been found in a few hectares of heathland. A similar number has been recorded from the trunks of four species of eucalypt in the Darling Range. Nearly 60 species have been identified on the Mt Eliza escarpment in Kings Park, almost in the heart of Perth.

Ant diversity is reduced in developed areas, although as many as 20 species of ant may still reside in reasonably large backyards of the newer Perth suburbs. In such areas, however, exotic ant species or those that can adapt to disturbance are more plentiful than 'bush' ants. In fact, because our ant fauna as a whole is sensitive to disturbance, as well as to climatic variability, ants are very useful bioindicators in terrestrial ecosystems. They are also abundant as a group, easy to capture (especially in pitfall traps) and reasonably easy to identify to at least 'morpho-species' level without a great deal of technical training.

A number of Australian researchers are now using a classification of ant communities pioneered by John Greenslade (ex CSIRO, Division of Soils) and Alan Andersen (CSIRO, Darwin) to examine the effects of overgrazing, rehabilitation of mine sites, burning regimes and similar environmental activities. Ants are placed in functional groups according to their competitive interactions, postulated habitat requirements and evolutionary history. Nine ant groups are currently recognised. They are

Above: Channels excavated by ants.
Photo – Dennis Sarson/Lochman Transparencies

Above right: Ants (*Iridomyrmex* sp.) drinking.
Photo – Jiri Lochman

Right: Meat ants may carry small pebbles to their nest. They can build huge mounds which are very large in relation to the ant's body.
Photo – Babs & Bert Wells/CALM

dominant Dolichoderinae (the huge genus *Iridomyrmex* that dominates native ant communities, and several smaller closely related genera); subordinate Camponotini (containing the sugar ants, *Camponotus* spp., as well as *Calomyrmex*, *Polyrhachis* and *Opisthopsis*); hot climate specialists (*Melophorus*, *Meranoplus*, some *Monomorium* and the spinifex ant); cold climate specialists (*Dolichoderus*, some *Monomorium*, *Stigmacros* and several smaller genera); tropical climate specialists (such as the green tree ant and red fire ant, *Solenopsis geminata*); cryptic species (a number of small, litter-loving ant genera); opportunists (the little black house ant, *Ochetellus glaber*, *Paratrechina*, *Rhytidoponera* and some other genera); generalised Myrmicinae (*Crematogaster*, various small *Monomorium* species and the large genus *Pheidole*); and specialist predators (the bulldog ants, the Dacetini, and about half-a-dozen small genera).

Researchers have noted some important patterns when they place their ant data into functional groups. For example, urban areas have few, if any, specialist predators. This is mainly due to the absence of specific prey species or prey in sufficient abundance to support colonies of large insects such as bulldog ants. Householders also target the latter species for extermination! Litter-dwelling cryptic species are also usually absent, or present only in small numbers, since lawns and other plant monocultures provide few suitable habitats for them. In large disturbed areas, such as new mine sites or overgrazed paddocks, pioneering dominant dolichoderines (especially meat ants) and opportunist species are favoured, and their numbers are often far higher than those of ants in other categories. Over time, with the return of most of the original vegetation of the area, their numbers can be expected to diminish, while those of ants in the other categories rise. On the other hand, unsuccessful rehabilitation results in disproportionate numbers of dominant dolichoderines and opportunist species.

LODGERS IN ANTS' NESTS

Ants' nests also provide homes for an astounding variety of invertebrates, including spiders, mites, millipedes, springtails, representatives of 10 or more insect orders, and some vertebrates. The most important invertebrates from the ants' point of view are plant-sucking bugs, which may be 'farmed' for their honeydew (actually sugary faeces). Queens of the genus *Acropyga* even carry honeydew-producing mealybugs with them on their nuptial flights! Many of the other invertebrates are harmless scavengers, but some prey on the ants or their brood.

Vertebrates found in ants' nests in Western Australia include certain lizards, snakes (particularly blind snakes in the Family Typhlopidae) and native rodents. Around Perth, the small Gould's hooded snake (*Rhinoplocephalus gouldii*) can be found in the nests of stick-nest ants (*Iridomyrmex conifer*). In the Pilbara,

Above left: Ants obtaining honeydew from a plant-hopping bug. Ants will protect these creatures from predators and parasites.
Photo – Ann Storrie

Left: A legless lizard (*Delma australis*) emerges from an ants' nest in Fitzgerald River National Park.
Photo – Babs & Bert Wells/CALM

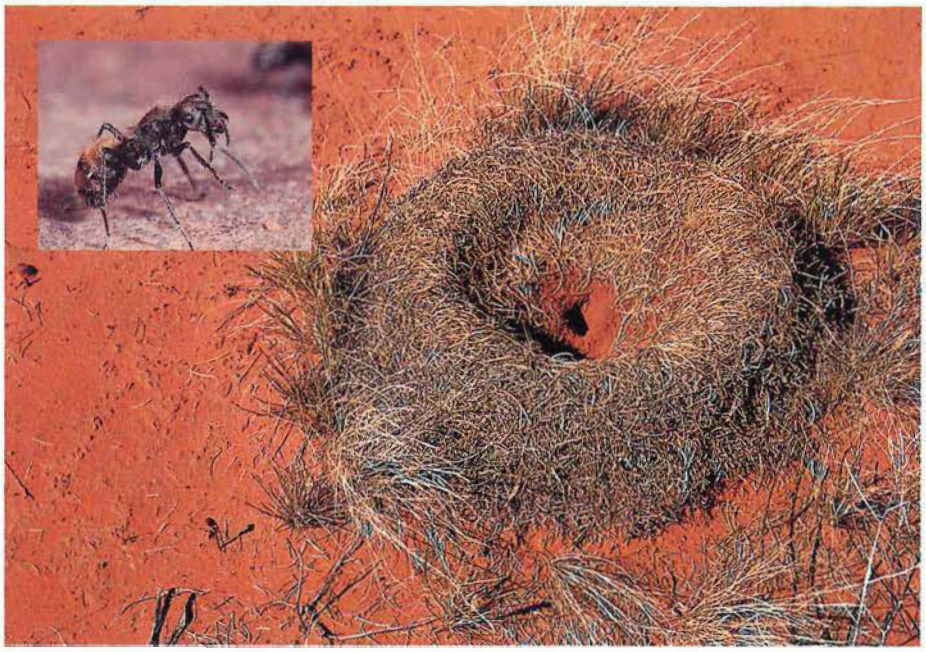
native mice often shelter from predators in the nests of large ants, such as those of the mulga ant (*Polyrhachis macropus*).

URBAN 'TRAMPS'

Despite the presence of such a diverse suite of ant species in relatively undisturbed areas, ants seen by the public in large cities like Perth are, unfortunately, mostly exotics. Most of these so-called 'tramp ant' species were introduced to Western Australia around World War II or just afterwards. Since then, they have made steady progress in dominating ant communities in and around the larger towns and cities. These ants have large colonies with many queens, and can live in very temporary habitats. Moreover, the typical urban ground cover of bitumen, brick, cardboard, concrete, lawn, sheet metal and wood shavings is sufficiently commodious for Singapore ants (*Monomorium destructor*), Argentine ants (*Linepithema humile*), coastal brown ants (*Pheidole megacephala*) and similar exotic pests to make their homes. At the same time, it does not provide pleasant living quarters for native ant species.

Recent research by staff and students of the Department of Environmental Biology at Curtin University suggests that the picture, at least in Perth, is becoming quite grim. Using studies done in the mid-1980s as a comparison, researchers are finding that the Argentine and coastal brown ants, in particular, appear to be eliminating other ants from the metropolitan area at a rapid rate. Undoubtedly, their success is being furthered by urban development and urban infill that results in increasingly sterile conditions for native invertebrate species.

Just as we have accepted that changes in outlook and practice have been necessary to ensure the preservation of our indigenous vertebrate fauna, so changes in outlook and practice will be needed if we want to retain our delightful, diverse and ecologically important native ant fauna in cities and towns. Otherwise we will be hosting only the annoying and damaging ant pests introduced in a less enlightened age.



Top: Mulga ant (*Polyrhachis macropus*) nests are raised above the desert floor as a defense against flooding.
Photo – Jiri Lochman
Inset: A closely-related ant in the same genus as the nest builder.
Photo – Bill Bachman

Above: Bulldog ants investigate an intruder to their nest.
Photo – Ann Storrie

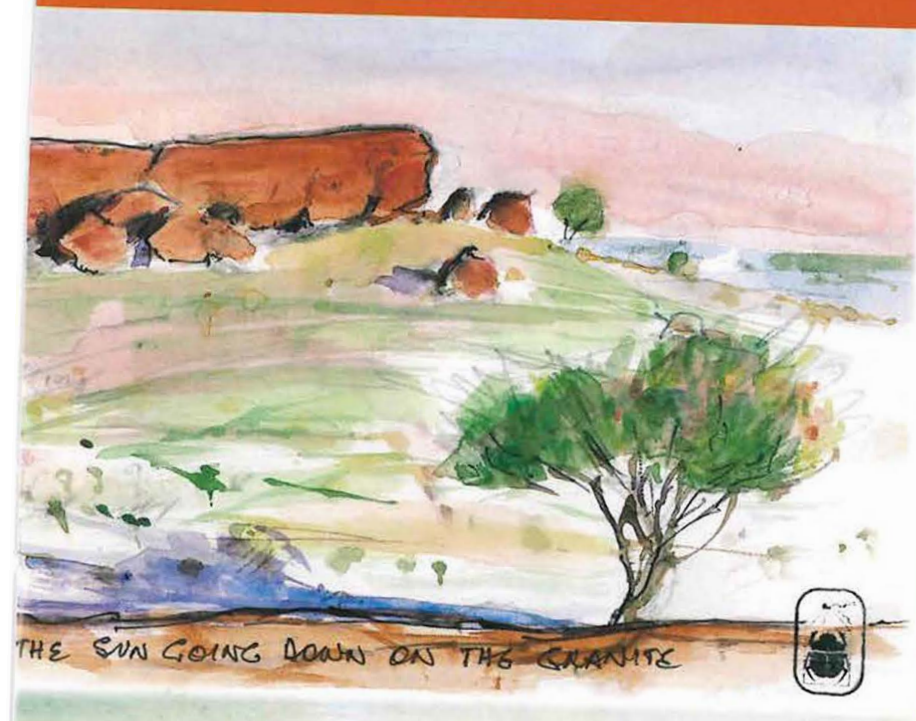
Brian Heterick is a part-time research assistant in the Department of Environmental Biology at Curtin University of Technology. He can be contacted by phone on (08) 9266 3598, or email (rheteric@ALPHA2.curtin.edu.au).

SUNDOWN @ LIZARD ROCK - WOGALNO STN

WE HAD CANAPES & CHAMPAGNE, WATCHING

Awash with colour

A *LANDSCOPE* Expedition with a difference



With raw sienna, cerulean blue, rose madder, cadmium red and olive green to colour our palettes, we set off to record the landscapes of the Murchison and Gascoyne on our journey to the largest rock in the world, Mount Augustus.

STAN DILKES LAYING SOME PAINT OUTSIDE THE SHEARERS COOKHOUSE DAIRY CREEK AUGUST 2000

81 Year old Stan has the energy of a man a third of his age. Wherever we stopped, he bounded out of the bus to do a sketch. He was a Catalina pilot during WWII and now lives in Margaret River. I consider it one of life's bonuses to have met him and hope to catch up with him again

by Sue Patrick

Our journey was a *LANDSCOPE* Expedition that would, for the first time, combine painting with botanical collecting. Brian Hoey, artist and author, would guide us in drawing, painting and photography. Botanical activities would provide an additional scientific and artistic focus on this expedition. Collecting would be led by Sue Patrick and Anne Cochrane, botanists at CALM's Western Australian Herbarium. The resulting visual diary would record the expedition from an artist's point of view.

Visual diaries have been used for centuries by travellers to record their experiences, and were an integral part of early scientific journeys of exploration. They encourage travellers to heighten awareness of their surroundings, to hone their observation skills and create a record that is both personal and historical. It is also a lot of fun and very satisfying.

Although our itinerary was designed to take us through some of the State's best wildflower country, there would be few carpets of everlastings to capture in our diaries this year. The winter of 2000 had been dry throughout much of our intended route. Instead, we would focus on more robust visual feasts—geological, botanical and historical—during 10 days of travel through this fascinating country.

On the botanical front, we knew that about 80 poorly-collected plant species occurred in the Murchison and Gascoyne regions. Many grew in isolated areas that we would not visit, but we hoped to find and record some of them and learn more about their conservation status. Other opportunistic collecting would increase our knowledge of the area, in which the plants were not well known.

We left Perth on a crisp winter's morning in early August, heading for Wogarno Station via the Benedictine monastery township of New Norcia. The diverse group—from Perth, Margaret River, Melbourne, Sydney and Canberra—travelling in the bus quickly became acquainted. The botanists tagged along behind in the support vehicle.

Previous page
Three pages from Brian Hoey's visual diary (*from top*): sundown at Lizard Rock, Wogano Station; far horizons, on the way to Mount Augustus; and Stanley Dilkes laying paint outside the cookhouse, Dairy Creek Station, shearers quarters in background. *Inset:* Wildflowers on the way to Mt Augustus.
Photo – Michael Holt

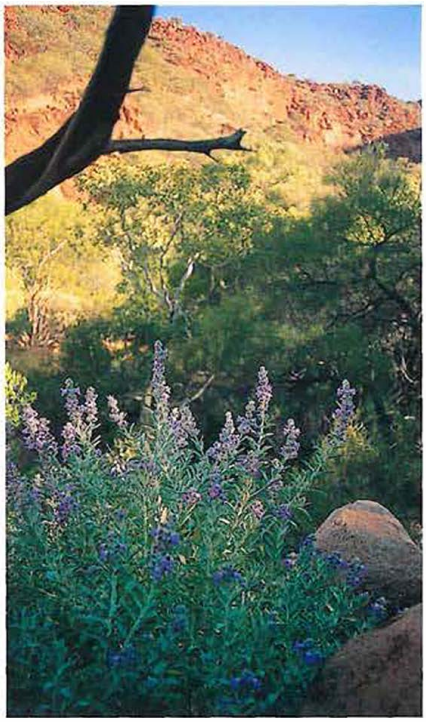
Left: The bus framed by river red gums at Flintstone carpark, Mount Augustus National Park.
Painting – Brian Hoey

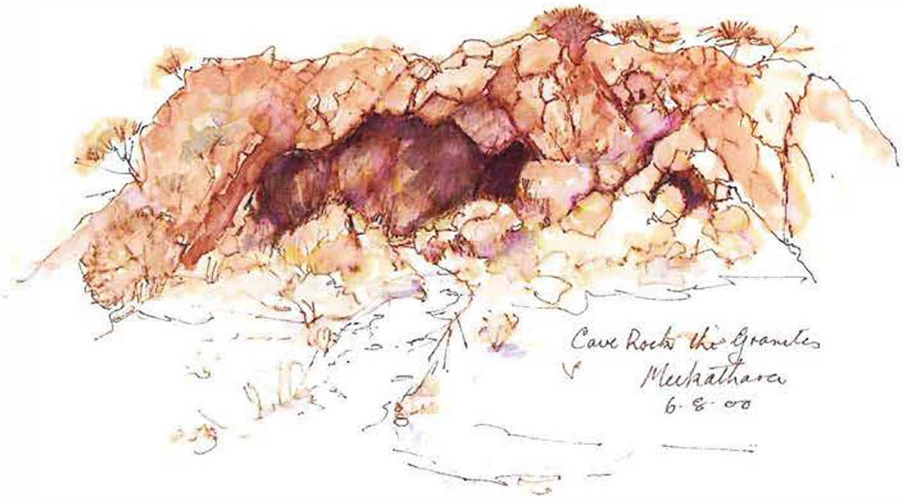
As we headed north into the Eremaean Botanical Province and with a lot of ground to cover, the bus rarely stopped on this first day of travel. The paddocks of the Wheatbelt gave way to acacia shrublands and we spotted first Mount Gibson and then Mount Singleton rising from the undulating plain. North of Paynes Find we entered mulga (*Acacia aneura*) country, where the small grey-leaved trees dominated the local vegetation.

Wogarno Station, south of Mount Magnet, was a welcome sight. The lack of recent rain was obvious, with few flowers to be seen. Between the mulgas were the withered remains of annuals that had germinated after early rains, then died. However, country hospitality was in full bloom. We were treated to champagne as we watched our first outback sunset at Lizard Rock, where rock and sky glowed with rich, changing colours. Then it was back to the homestead for a splendid country dinner and a good night's sleep in the shearers' quarters. Next morning we left, hoping our hosts at Wogarno would get more rain. Little did we know how soon our wishes would be realised!

North to Cue, where gold was discovered in 1892. We glimpsed some fine buildings, including the Masonic Lodge, said to be the largest corrugated iron structure in the southern

Left: Breakaway on Curbur Station.
Painting – Malcolm Calder





hemisphere. Heading west, our goal was Walga Rock on Austin Downs Station, a monolith of red granite with water-stained sides and dark weathering. Its Aboriginal rock paintings impressed us. Snakes, emu and kangaroo track motifs, hand and boomerang stencils and a controversial white painting of a sailing ship ranged along the walls of a high, weathered cave.

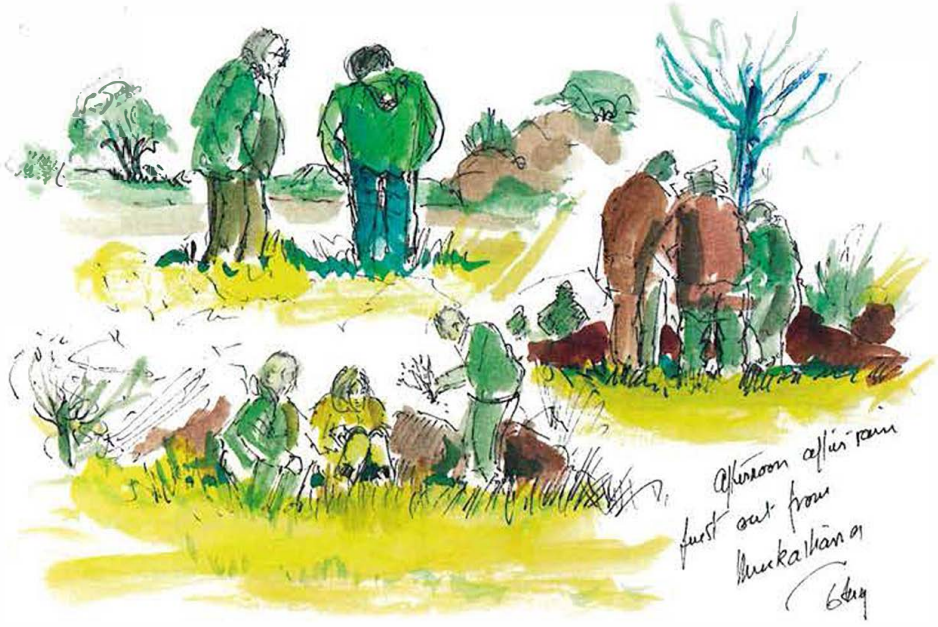
Later, a patch of desert peas, crimson and black, were the only plants of this species that we would see during the entire journey. Further north, the botanists travelling at the rear to search for plants noticed an enormous line of fast-moving clouds in the south-west. Would the approaching front hamper our journey northwards? At the Royal Mail Hotel in Meekatharra we discovered the answer.

MEEKATHARRA

Meekatharra is thought to be an Aboriginal word meaning 'place of little water'—but not for us. Early next morning the first raindrops fell, and by breakfast time it was raining steadily. Brian was concerned about the conditions for driving. To the north were unsealed roads, crossing the Hope, Murchison and Gascoyne Rivers. Would the rivers rise? Telephone calls were not reassuring. The hotel could provide accommodation for another night. Reluctantly, we decided to postpone our first view of Mount Augustus for at least another day.

We put the wait to good use. A poorly known plant was found here in 1986. Braving the rain, we headed for an area of granites and breakaways and there it was—red drummondita (*Drummondita miniata*). Growing from bare reddish rock on breakaway edges, old gnarled shrubs bore tubular orange flowers with yellow and mauve fluffy stamens. Some of us counted the population, others painted. The landscape, clothed sparsely in small shrubs and surrounded by grey mulga shrubland, featured reddish conical hills, caves, cliffs and tumbled boulders, tilted and eroded. Rain drove us away before lunch, but we continued our painting and botany in an impromptu workshop in the hotel dining room, until the cry went up: 'The rain has stopped, the sun is out,' and we went back to the gorge to finish our work.

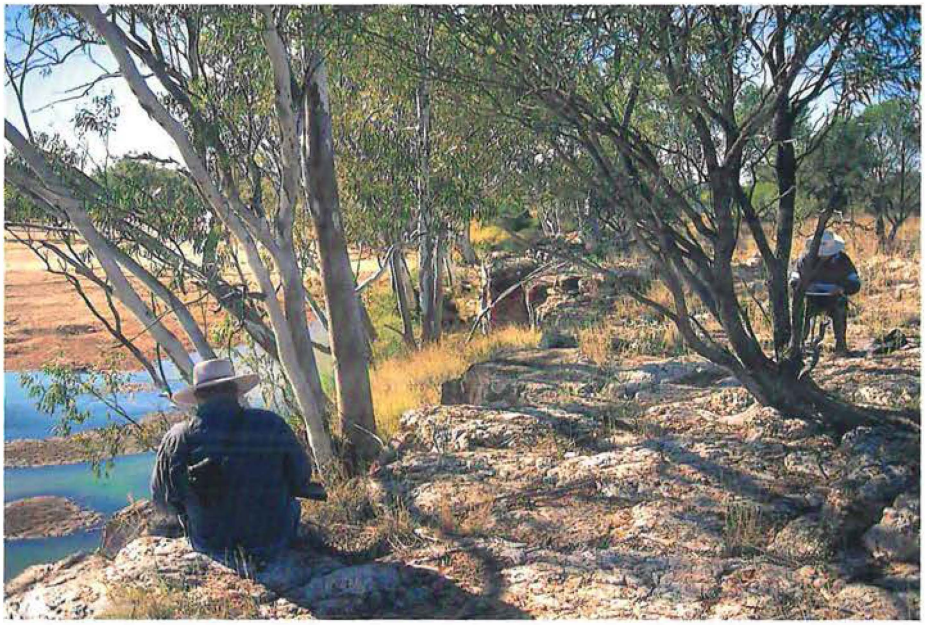
Away by 7.00 am next morning, we were eager to make up for lost time. The mid-morning stop was at Mount Gould, the site of the first police station in the Murchison. The restored building and mountain backdrop provided more inspiration for the artists. Evidence of local rains showed in small patches of pink, white and yellow annuals further along the way.

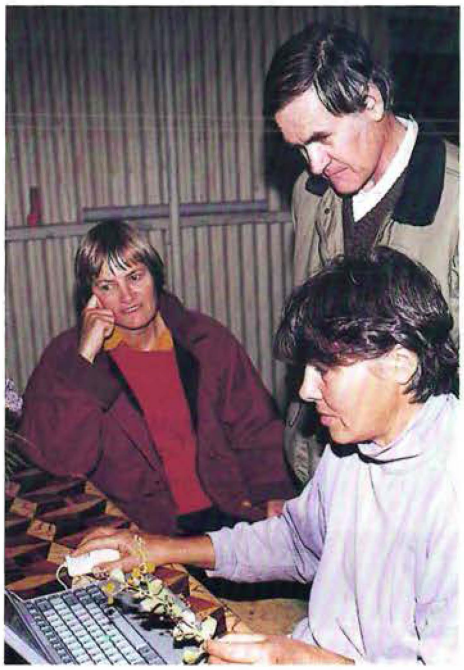


Above: Mount Augustus foxglove (*Pityrodia augustensis*) growing in a steep creekline on the lower slopes.
Photo – Michael Holt

Above right: Cave Rock at the Granites, Meekatharra.
Painting – Margaret Leavesley

Right: Observing and collecting plants after rain at Meekatharra.
Painting – Stanley Dilkes





Top: Expeditioners view Mount Augustus at sunset, from Emu Hill Lookout.
Photo – Sue Patrick

Above: Painting on the banks of the Geeranoo Creek, Dairy Creek Station.

Left: Anne Cochrane, Gwenyth Bray and Kevin Bray using WATTLE, a new electronic, interactive key for identifying acacia species.
Photos – Michael Bolt

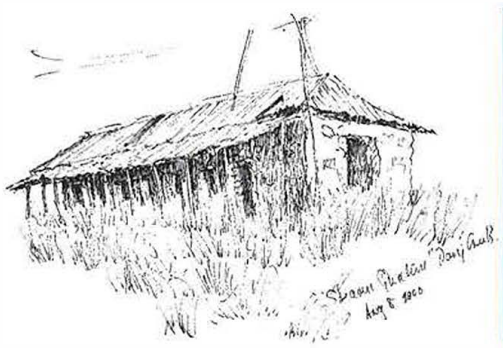
Top right: Green birdflower (*Crotalaria cunninghamii*).
Painting – Malcolm Calder

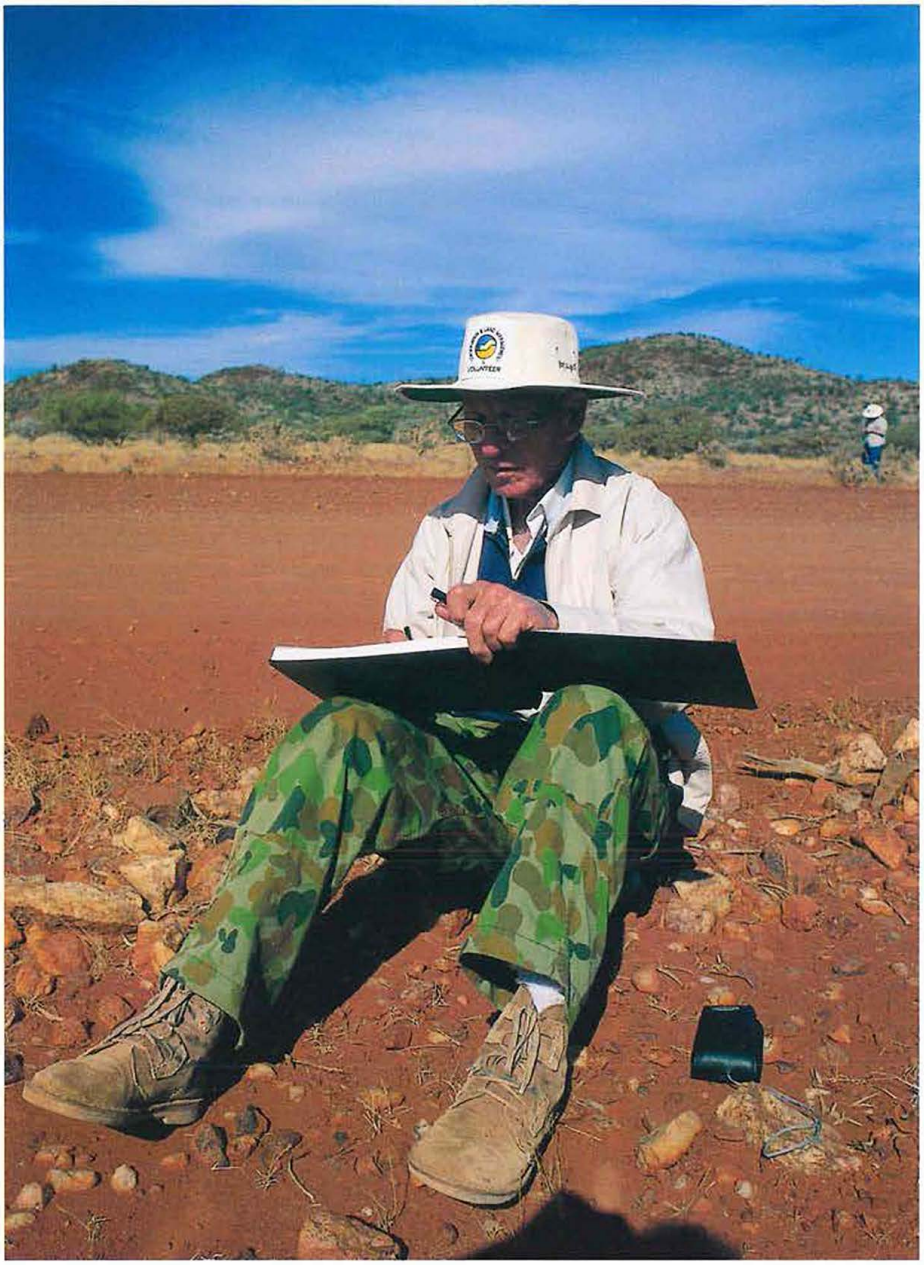
Above right: Plants of the Gasgoyne: fuschia bush (*Eremophila maculata*); turpentine bush (*E. fraseri*); cassia; and swainsona species.
Painting – Margaret Leavesley

MOUNT AUGUSTUS

Mount Augustus at last came into view—blue hazed by the time we reached the Mount Augustus Outback Tourist Resort, our destination for the night. The largest known isolated monocline, Mount Augustus is, in simpler terms, the world's biggest rock. This eight-kilometre-long segment of sandstone and conglomerate strata has been folded and uplifted, with ancient granite beneath. It is incredibly ancient—between 1,650 and 1,900 million years old.

In 1989, Mount Augustus and the land immediately around it were declared a national park. Pastoral stations surround the mountain—Mount Augustus Station to the north-east and Cobra Station to the south-west. Both stations surrendered portions of their





leases so that the park could be created (see 'Mount Augustus National Park', *LANDSCOPE*, Winter 1995).

At last, we stood below the mountain. Viewed from Emu Hill at sunset on the previous evening, its colours had changed from green and blue, through coppery pink and bronze to velvety purple. At dawn it had glowed red and now, in the early morning, its looming height provided an awesome spectacle. Rising more than 700 metres above the surrounding plain, its soaring rock faces, steep gorges and exposed summits support very different plant communities from those on the plains below.

We made an early start along the dusty road, aiming to search for several plants. Three small, short-lived species on our list had a fondness for wet places, so would we find them this year? On the south-west side, we found that the creek lines at the base of the rock were still wet. Partly shaded from the northerly sun by the mountain, and meandering beneath groves of river gums, they are fed by natural springs seeping from the drainage lines of the rock. We began our search.

In five localities we found the ephemeral raspwort (*Gonocarpus ephemerus*), collected only five times previously, and an undescribed sedge (*Schoenus* sp. Kalbarri) known from only one other locality and collected only twice before. Both were plentiful in herb swards on the damp soils, as was a small pink triggerplant (*Stylidium weeliwolli*). Known from two other localities, it grew here in four places. We admired the Mount Augustus foxglove (*Pityrodia augustensis*), a shrub with deep lilac flowers that is restricted to the mountain.

By late morning, we reluctantly left this fascinating flora and continued west to Cobra Station for lunch. The former Bangemall Hotel, built in 1896, is now used as the homestead, and provided subject material for some quick sketches after our excellent lunch. After admiring the flourishing gardens, we turned southwards towards Dairy Creek Station, where we were scheduled to stay for two nights.

Above: Stanley Dilkes sketching on the way to Mount Augustus.
Photo – Michael Holt

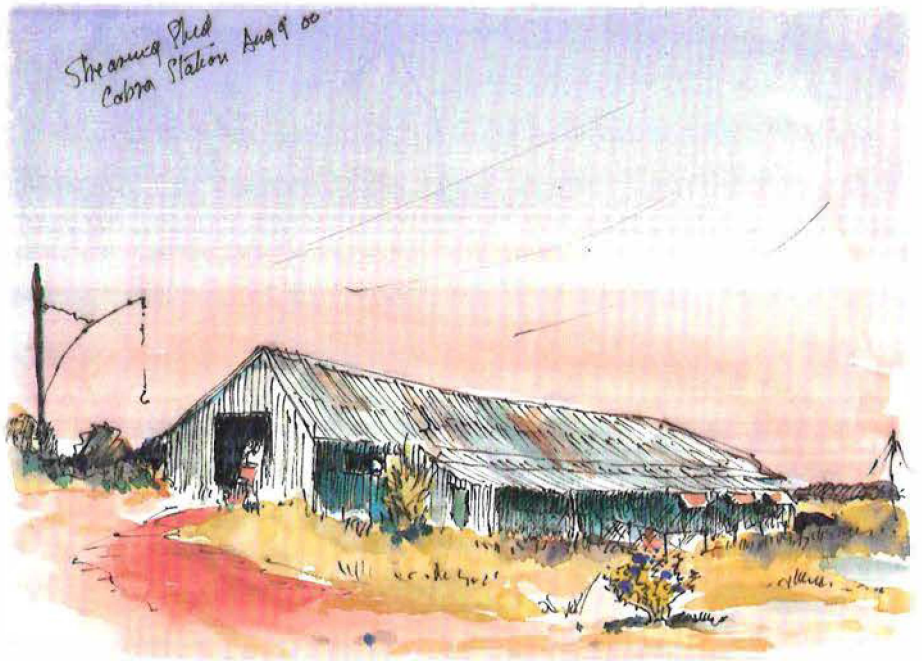
Above left: The shearers' quarters at Dairy Creek Station.
Drawing – Stanley Dilkes

DAIRY CREEK

The original homestead at Dairy Creek Station was built in 1890, but was replaced by another in 1904. The ruins of the old building, close to our accommodation in the shearers' quarters, became a focus for our paintings. The results were a wonderful example of different artistic styles and interpretations.

Wooded creeklines, stony flats, claypans and breakaways yielded much to interest the botanists. Two poorly collected, locally restricted species were found: a grevillea (*Grevillea subterlineata*) that grows on damp red clay flats at the foot of breakaways, and an acacia (*Acacia atopa*) found on upper slopes.

Journeying south, we made an important discovery. A rocky landscape of low red siltstone rises had some uncommon plants in its sparse shrubland. We found a white-flowered shrub, not realising that it had been collected only once before, and was a new population of *Hemigenia* sp. Glenburgh.



We also found more of the grevillea and a yellow mulla-mulla (*Ptilotus asterolasius* var. *luteolus*) a long way north-west of any previous collections.

In the early afternoon, a shady pool beneath large old river gums gave the artists, aided by Brian, more to record. Bilung Pool is formed where Bilung Creek plunges about six metres, creating a waterfall at the head of a gorge. Beneath paperbarks and minniritchie (*Acacia cyperophylla*), along the creekline, we found more plants, including a pink-flowered turpentine bush and sedges a few centimetres tall.

CURBUR

Standing on the shore of Breberle Lake, above breaking waves, it was hard to believe that in the early days no-one wanted much of the land that is now Curbur Station, because there was no permanent water. The lake had filled after cyclonic summer rain, increasing its size and causing a detour of the Carnarvon-Mullewa Road.

A story of a tragedy last century, related to the lack of water on Curbur (originally spelt Kurbur), is told by Frank Wittenoom in his memoirs. A shepherd was on the lease near water with a flock of sheep and rations to last a month. However, the water dried faster than expected and the shepherd had no means of letting his boss know. Most of the sheep died, and the shepherd, who was too loyal to leave them, was also found dead.

Plant searches were very rewarding during our two-day stay at Curbur. Twelve new populations of six poorly known plants were found, particularly on granite outcrops and siltstone ridges. Anne Cochrane, manager of CALM's

Above left: Members of the 'Awash in Colour—Painting a Path through the Murchison' *LANDSCOPE* Expedition, August 2000.
Photo – Michael Holt

Centre left: The shearing shed at Cobra Station.

Left: Bilung Pool, shaded beneath river red gums.
Paintings – Stanley Dilkes

Threatened Flora Seed Centre, collected seed from two new populations of Jamieson's featherflower (*Verticordia jamiesonii*), one of which was a previously unrecorded colour form with yellow flowers.

BACK ON THE BITUMEN

South of Curbur, after crossing the Greenough River, the country began to change. Higher rainfall resulted in several stops at patches of everlastings. Soon we encountered bright green wheatfields and the bitumen road, the first since Meekatharra, seven days before. The natural vegetation changed too, with more eucalypt woodland and acacia shrublands. At the Carnamah Hotel we celebrated and reminisced about the wonderful hospitality we had experienced during our journey.

During the expedition, each member of the group had spent time with the botanists, and their sharp eyes helped to increase the collections. Kevin and Gwenyth Bray found time for bird watching and sketching, while Malcolm Calder, a botanist, painted plants as well as landscapes. Stanley Dilkes, probably the most prolific artist in the group, produced lightning sketches at every stop, and illustrated his entry in the collective diary as well. Michael Holt, who had been on a previous expedition, took many photographs. Margaret Leavesley, another experienced expeditioner, compiled an extensive bird list and painted plants and places. Jacqui Wisdom had a keen interest in plants and plant recording, besides learning to paint. The mainstay of the expedition, Brian provided artistic guidance, kept the schedule and drove the bus. He was in his element, travelling the outback while sharing his passionate interests in heritage and community arts.

Below: Photographing flowers.
The last page in Margaret Leavesley's visual diary.
Painting – Margaret Leavesley

THOSE ELUSIVE PLANTS

Our journey achieved two aims: producing a series of visual diaries, and increasing botanical knowledge of the region we visited. We recorded 34 new populations of 15 poorly-known species. This work would not have otherwise been done. Sometimes it was not until the specimens were identified later that we realised the importance of our discoveries. We need to revisit some of the populations to find out more about them and survey other places, so the expedition will be repeated in 2002. Anybody interested?

Sue Patrick is a Senior Research Scientist with CALMScience based at CALM's WA Herbarium. She can be contacted by telephone on (08) 9334 0485 or email (suep@calm.wa.gov.au).

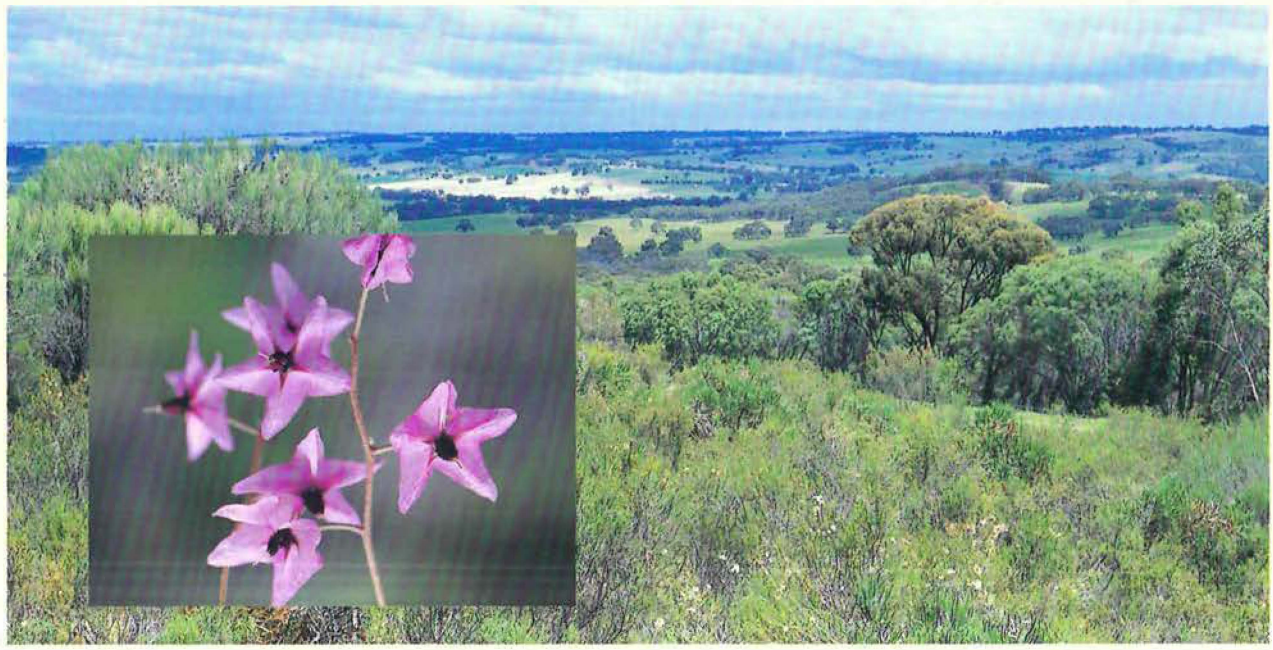
Sue Patrick will co-lead the following expeditions in 2001 and 2002:

Night and Day under an Outback Sky—An Astronomical Adventure
August 18 – 25, 2001
Astronomy and botany at Mount Singleton in the Murchison

Awash in Colour—Painting a Path through the Murchison
August 9 – 18, 2002

Botanical Treasures in an Everlasting Landscape
August 31 – September 7, 2002
A botanical survey at Muggon Pastoral Station in the Murchison

ENDANGERED!



GREEN HILL THOMASIA

Cecil Andrews, an early twentieth century botanist, is believed to have collected the first specimen of Green Hill thomasia. This record is listed only as 'within Western Australia', and was originally identified as *Thomasia stelligera*. Botanists later discovered that the collection was a new species —currently known as *Thomasia* sp. Green Hill.

Nearly 70 years later, in 1972, botanist Susan Paust located a population of Green Hill thomasia several kilometres south of New Norcia. However, this population has not been relocated and it is possible the area has now been cleared.

Another 23 years passed before the species was seen again. In 1995, consultant botanist Diana Papenfus, who was working for the Department of Conservation and Land Management (CALM), discovered two small subpopulations about 1.5 kilometres apart in remnant bushland owned by the Benedictine Community at New Norcia.

The monks are keen to conserve the rare thomasia, and recent population counts are a tribute to their management of the site. Plant numbers have increased from 66 plants in 1998 to about 100 in 1999. This clearly shows the importance of conservation of private bushland. It is also possible that the species may occur in other areas of uncleared bushland near New Norcia. A small poster has been produced describing and including photos of the species, and it is hoped it will result in the discovery of other populations.

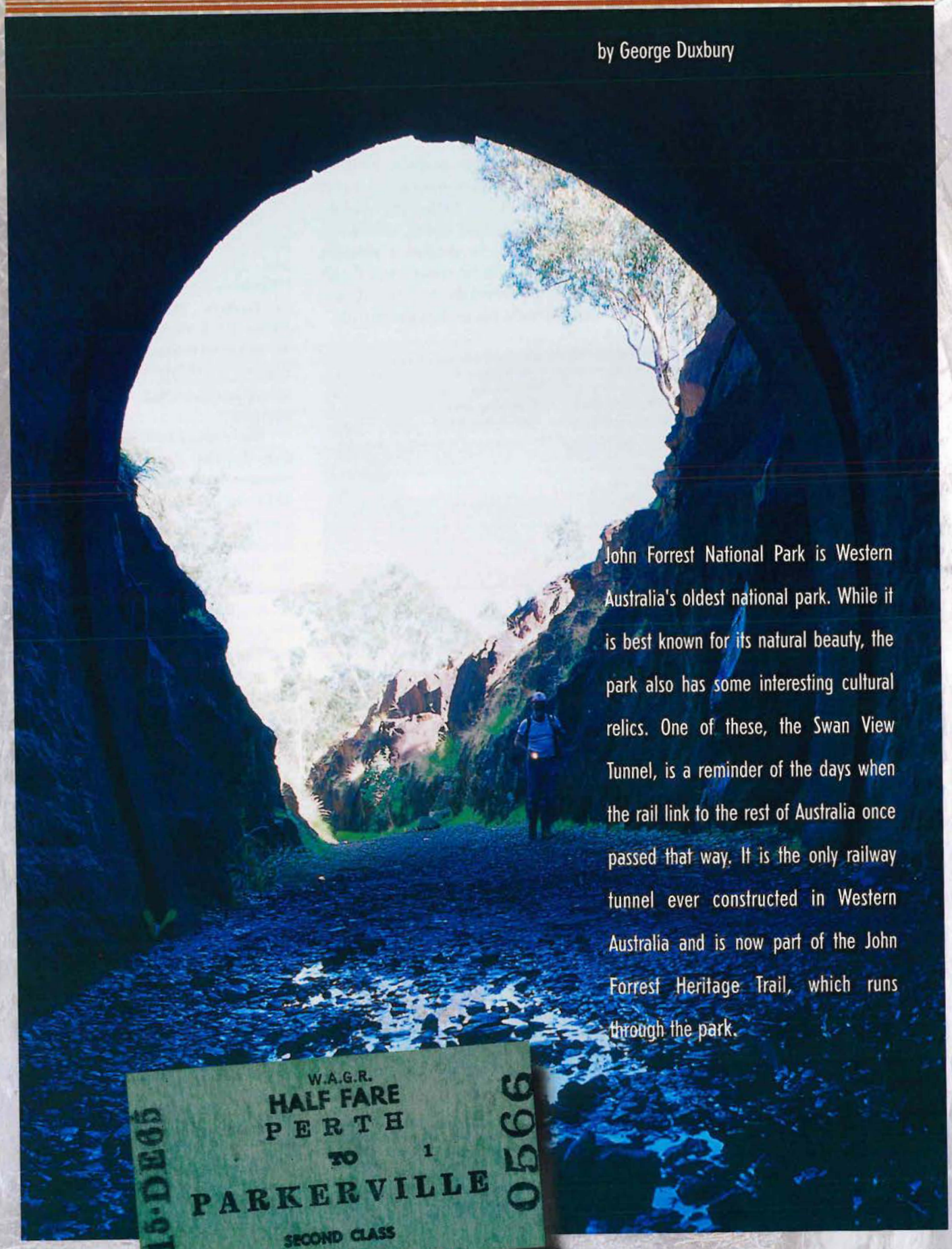
Flowering in September and October, Green Hill thomasia is a low multi-stemmed shrub growing up to 40 centimetres high. The leaves are flat and narrow, 10 to 13 millimetres long and five millimetres wide. Flowers are usually in groups of three. The seven-millimetre-long ribbed outer whorl of the flowers is mauve with a reddish-purple base, and is divided for less than half its length into five obtuse arching lobes. The rounded petals and anthers are dark purplish-black. The plant inhabits brown clayey sand over laterite in open wandoo woodland.

Due to its extreme rarity, Green Hill thomasia is listed as 'critically endangered' and CALM has developed an Interim Recovery Plan for the species. The plan lists recovery actions, including maintenance of boundary fences and firebreaks, weed control, further surveys and regular monitoring of the health of the population, that will ensure the long-term conservation of the species. CALM staff will continue to work closely with the landowners to help implement the plan, which will help guide the management of this highly restricted species.

Val English and Andrew Brown
Photos by Andrew Brown

RAIL AGAINST TIME

by George Duxbury



John Forrest National Park is Western Australia's oldest national park. While it is best known for its natural beauty, the park also has some interesting cultural relics. One of these, the Swan View Tunnel, is a reminder of the days when the rail link to the rest of Australia once passed that way. It is the only railway tunnel ever constructed in Western Australia and is now part of the John Forrest Heritage Trail, which runs through the park.

Straddling the Darling Range, John Forrest National Park is set in jarrah forest that is still largely in its natural state. In late winter and spring, wildflowers are profuse and colourful, displaying the wide variety of plants that inhabit the northern jarrah forest.

Having long attracted visitors, the park also has an interesting history. According to Aboriginal people, the rainbow serpent or Waugal crawled across the land, leaving streams and waterways in its wake, and thence created Jane Brook. The rocks in and along the streams are said to be the droppings of this wondrous creature. Surrounding the centrally located tearooms are rock gardens, built by sustenance workers during the Great Depression of the 1930s. The gardens lead down to Jane Brook, which has been dammed to created a pleasant pool. And a historic railway tunnel still survives intact from the days when all east-west rail traffic passed through the park.

CONSTRUCTION

The original railway line, built in 1884 and running from Midland to Mundaring, was so steep (up to 1:25) that trains had to have locomotives pushing from behind, as well as pulling from in front, to get them to the top. This caused a number of accidents and problems, and an easier route was chosen (at a grade of 1:44) to follow Jane Brook. It was incorrectly named the Mahogany Creek Deviation.

The man in charge of the project to build the new line and tunnel in 1893 was the great Charles Yelverton O'Connor—the then Engineer-in-Chief of Western Australia's Government Railways. C Y O'Connor later gained fame for designing Fremantle Harbour and the Eastern Goldfields Water Supply. The surveying was carried out by John Talbot Burnett.

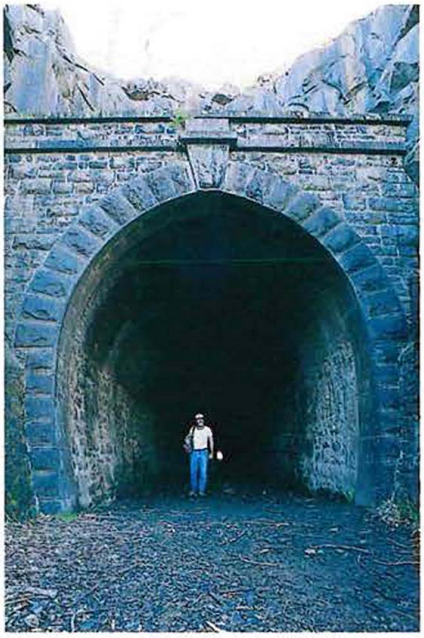
The contract to build the tunnel was won by the South Australian firm Smeaton and Hedges, and work began in 1894. In all, five bridges, six short cuttings and a tunnel had to be built to lay the new line. Four of the bridges and the tunnel were within John Forrest National Park. The work was hard. Workmen lived in tents near the tunnel. The rock was unstable ancient granite that had to be blasted and shored up on the embankments. The 340-metre-long tunnel had to be lined with masonry walls and an arched brick roof to stop rock falls.

The work was scheduled for completion within 12 months, but unexpected difficulties in constructing the tunnel (which had to be cut through solid rock), wet weather and other problems (including a short strike by horse drivers for an extra shilling on Sundays) helped to slow the project down. The tunnel was completed in 1895 at a cost of about £12,000.

Previous page
Main: The Swan View Tunnel, which was completed in 1895.
Photo – Ann Storrie
Inset: Ticket from the final train journey.

Above left: Wandoo country within John Forrest National Park.
Photo – Dennis Sarson/Lochman Transparencies

Left: Wildflowers in the park during spring.
Photo – Jiri Lochman



Top left: Tunnel arch.

Top right: The eastern end of the tunnel.

Above: Two of the six bridges within the park.
Photos – Ann Storrie

ACCIDENTS AND INCIDENTS

Being an engine driver at the turn of the century was very different from now. Shortly after the opening of the new line in 1896, engine crews began complaining about problems being experienced while passing through the tunnel. The locomotive cab was open and this, combined with poor ventilation within the tunnel, meant that drivers and firemen were engulfed in smoke and fumes from the locomotives as they slowly inched their way through the tunnel, pulling heavy loads. Train crews found the summer months best for passing through the tunnel, as the strong easterly winds—common to the area at that time of year—blew the smoke and steam past the cab in the opposite direction to their travel.

The first serious accident occurred in 1903, when a driver fell from the engine after being overcome by asphyxiating fumes. The fireman heard the bump, but in the darkness and belching smoke, paid no attention to the sound. It wasn't until the engine reached daylight at the other end, that the driver's absence was noticed. The fireman stopped the train and searched the tunnel. Fortunately, his unconscious partner had fallen clear of the wheels and sustained only minor injuries.

The worst accident took place on 4 November, 1942. A double-headed goods train, pulling a load of some 431 tonnes (just 14 tonnes short of its maximum allowable load), entered the tunnel at walking pace. The locomotive crews were quickly overcome by heat and fumes and rendered unconscious. The driver of one of the engines had managed to shut off power before he passed out, but the driver of the second engine was overcome before he could do likewise. He died on his engine in the tunnel. The train started to roll back, which caused the engine still on power to slip into reverse, and the train began powering backwards.

The guard had already alighted and applied the handbrakes (although not the vacuum brake, as he thought the driver would quickly regain control) on the wagons. However, the engine crews were in no condition to regain control and the train careered through Swan View Station at an estimated 70 to 80 kilometres per hour. The runaway train went into a runaway dead-end, which had been constructed in case of such an incident. The rear portion of the train piled up in a mass of wreckage. Fortunately, this had a cushioning effect and saved the three unconscious men from serious injury.

Following this accident, locomotive loads, levels and configurations were

changed, but tunnel ventilation still proved difficult to overcome, and it was decided to build a tunnel bypass on the northern side. This was completed in November 1945 at a cost of about £150,000 ($300,000) and the tunnel was then only used by trains moving downhill. The last work on the tunnel was done in 1956, when the track was lowered by 30 centimetres to allow passage of the bigger locomotives in use at the time, and to correct drainage problems.

THE LAST TRAIN

The Mahogany Creek line, from Midland to Northam, continued to be used until the Avon Valley dual gauge railway came into full operation. The line closed on 13 February, 1966. Although the trains are now long gone, the old railway alignment remains, clearly delineated by the embankments and bridges. Park visitors can follow the path of the old railway, which forms the basis of the John Forrest Heritage Trail, and walk through the tunnel.

But the old railway is far from the only attraction of John Forrest National Park. The scenic drive into the heart of the park affords panoramic views over Perth and the Swan Coastal Plain. Once they enter its forested hills and valleys, good walktrails throughout the park encourage visitors to wander through the bushland and admire the scenery of the scarp. Some of the large, exposed granite tors have been eroded over the centuries into fantastic shapes, adding to the diversity of the landscape. It shows that we don't have to go to the outback to enjoy the wonders of a beautiful place. In John Forrest National Park there is a place of beauty, close by.

Top: A major accident occurred in the park in November 1942, when locomotive crews passed out from heat and fumes in the poorly ventilated tunnel.
Photo – Trevor Marshall

Above left: Falls in John Forrest National Park.
Photo – Jiri Lochman

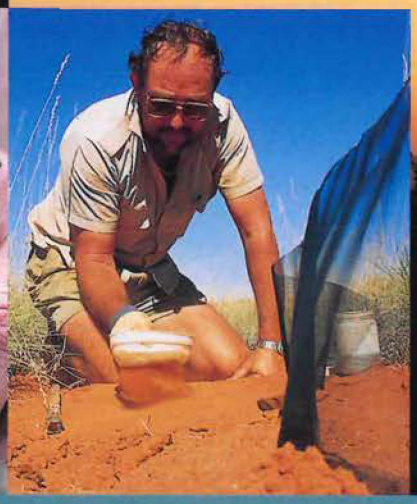
Above: Visitors can now walk through the tunnel along the John Forrest National Park Heritage Trail.
Photo – Wayne Storrie

TUNNEL FACTS

- The length of the tunnel is 340 metres.
- The maximum grade through the tunnel is 1:49.
- The tunnel runs through granite, with a maximum cover of 27.5 metres above the ceiling.
- The maximum height at the crown of the arch is 4.3 metres.
- The extreme width is 3.8 metres.
- The walls are lined with rock to the height of 2.4 metres.
- The entire arch is lined with 330,000 bricks, to stop pieces of granite falling from the roof onto the tracks.

Recently retired, George Duxbury was a national park ranger for 23 years, and Senior Ranger at John Forrest National Park for almost 12 years. He has a long-standing interest in the park's old railway system. George can be contacted on (08) 9298 8367.

Tools of the trade



How do we learn what we need to know about threatened animals? Department of Conservation and Land Management (CALM) wildlife researcher Tony Friend describes some 'tools of the trade'.

by Tony Friend

Techniques to study wild mammals are many and varied. Each species has its own characteristics that make it easier, or more difficult, to find, observe or catch. Western grey kangaroos are large, communal and feed in open country, so are easy to find, observe and count. Gilbert's potoroos, by contrast, are almost impossible to observe as they are very shy and remain in almost impenetrable cover, where they can find all of their needs. Opportunist foragers like brushtail possums, boodies and bush rats are easily lured into cage traps, as they are attracted to a wide range of smells that might be food. On the other hand, numbats feed only on termites. These insects occur widely throughout the woodland habitat, so termites or termite smells are a poor inducement to enter a trap.

In many cases, it is possible to study the animal directly, by watching or catching it. Indirect methods of study may be used if an animal is particularly secretive or rare. For example, some mammal species can be detected using 'hair tubes'. A tube, pipe or arch is placed in the animal's habitat in such a way that the mammals will move through it and leave their hairs on double-sided tape placed inside. Depending on the species, bait may be used to attract the quarry. Microscopic examination reveals which mammal species the hairs came from. Recent developments in molecular biology mean researchers can now sex animals or identify individuals from their hairs. These techniques have been vital in studying the critically endangered and extremely secretive northern hairy-nosed wombat in Queensland. Whereas live traps need to be checked daily, hair tubes can be left for weeks before being checked, a significant advantage in poorly accessible areas.

Indirect methods are often less time-consuming and therefore less costly than direct methods. Census and survey techniques include recording evidence of animals rather than the animals themselves. Distinctive scats (droppings), diggings or other evidence of feeding may be used to record the presence and sometimes the abundance of a particular animal. Surveys for diggings and scats are used in CALM's numbat reintroduction program to monitor the spread of the animals into their new habitat. Scat counts have been used to estimate numbers of kangaroos. Pellets are cleared from marked plots and their rate of accumulation is used, in comparison with data from known populations, to calculate abundance.

Previous page
Main: Radio-tracking nocturnal animals at Shark Bay.
Insets clockwise from top:
Brush-tailed phascogale wearing a radio-collar.
CALM researcher Bill Muir checks a pitfall trap for small creatures.
Photos – Jiri Lochman
Pygmy possums are often caught in pitfall traps. Here a female and her young were captured together.
Photo – Bill Bachman

Left: Pitfall traps catch many small reptiles such as this gekko *Heteronotia binoei*.
Photo – Neville Passmore

Below: A radio-collared female numbat emerges from her burrow in Dryandra Woodland.
Photo – Jiri Lochman

GOT YOU!

Capture-and-release methods are usually used for studies of population size and rate of change, because a wide range of information can be gathered by handling individuals. Population size is measured by comparing the ratio of previously marked to unmarked individuals caught in a given trapping period. The sex, size, weight and reproductive condition of the captured animals can provide detailed information on the health of the population. Hair follicles or small clippings of ear tissue may be taken to sample the individual's DNA. The DNA samples can be used to compare populations, to determine levels of inbreeding or to find new species. They also provide a host of other information useful in managing and conserving species. Blood can be sampled to determine the health of individuals and populations. Capture is also necessary if radio-tracking is to be used to learn more about the animals and their habitat.

How are mammals caught for study? Most Western Australian mammal researchers use two types of traps. Australian-made Elliott© traps are collapsible aluminium box traps. A treadle releases an inward-folding door to trap the unsuspecting small mammal. Twenty or 25 medium Elliott© traps pack into a carry-case for easy transport through the bush. Wire cage traps ('possum traps') are made by several local manufacturers and catch mammals from the size of a mouse to a quokka. Bait containing peanut butter is most commonly used, as it is an amazingly universal attractant. In fact, 'universal bait' containing this olfactory treat in one form or another features in mammal research all over the world. A concoction of peanut butter, oats and sardines is most commonly used in Western Australia. Some variation is necessary for targeted trapping—Gilbert's potoroos, like eastern Australian potoroo species, are attracted to bait containing pistachio essence, presumably reminiscent of the truffles that form their staple diet. Where chuditch and woylies coexist, the chuditch capture rate can be artificially low because a woylie is caught in almost every trap. A chuditch bait with a high fish meal content was designed to discourage woylies and attract more chuditch.

Some situations or study species require modifications to the standard traps or the development of new traps, and CALMScience technical officers have been at the forefront of this process. Wambengers are small enough

Right: Elizabeth Sinclair, a researcher who rediscovered Gilbert's potoroo, sets a quokka trap in Two Peoples Bay Nature Reserve.

Below right: A brush-tailed possum peers out of a modified Elliott© trap.
Photos – Jiri Lochman

Below: Radio-collars allow both dead and live animals to be located. By the use of forensic methods, the cause of death can generally be determined from the remains.
Photo – Tony Friend

to be caught in medium Elliott© traps but strong enough to pull the door open after hooking their claws around its edges. CALM Senior Technical Officer Brent Johnson designed a simple catch for these traps that prevents the trap being opened so easily. Black-flanked rock-wallabies bash themselves around in cage traps, often losing young. CALM Technical Officer Bob Bromilow designed a 'soft' trap with walls of rope netting suspended from but held away from the metal frame. In the two 10-hectare 'Return to Dryandra' breeding enclosures, several species of locally extinct marsupials have been released for breeding. Easily stressed mala share an enclosure with bilbies and marl (western barred bandicoots). Cage traps are ideal for catching bilbies and marl but mala knock themselves around in them. CALM Senior Technical Officer Neil Thomas modified the standard cage traps to exclude the larger mala but not the bilbies or marl.

Another common capture technique is pitfall trapping, which employs a smooth-sided pipe or bucket dug into the ground. For some unknown reason, perfectly healthy, wary animals seem unable to resist jumping down inside the unbaited pit. The smaller ones can't jump or climb out again and are retrieved during a daily check of the pit-trap. Some mammals, such as dunnarts, pygmy possums and honey possums, are more readily caught in pit-traps than in baited box or cage traps. Small reptiles such as geckos are also most easily caught this way. Capture rates can be increased by the use of a low fly wire fence, 20 to 30 metres long, that guides animals towards the pit or line of pits.

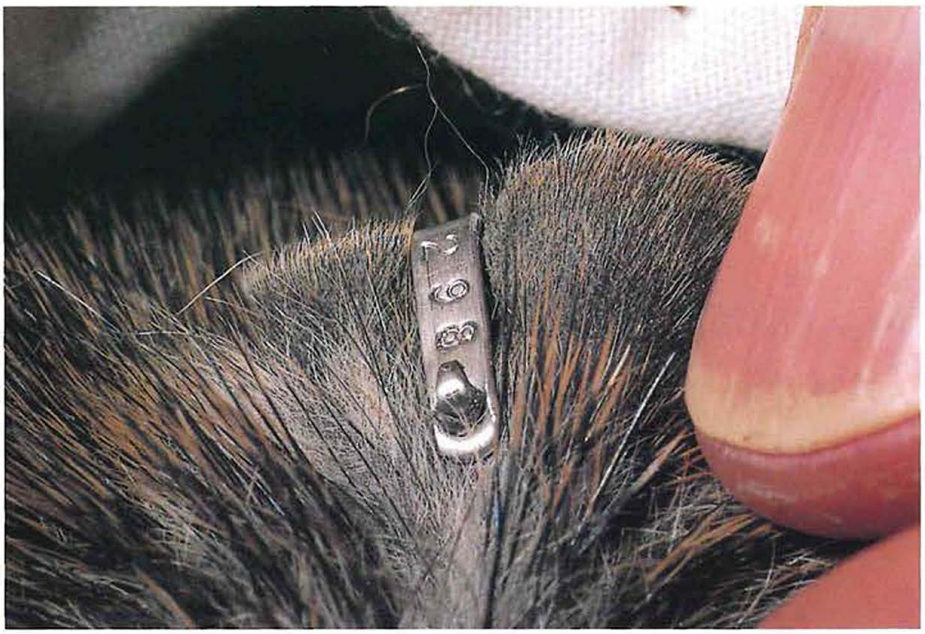
No such easy methods are available to catch numbats, contemptuous of baited traps as they are. The standard method is still to drive around until one is seen, whereupon someone jumps out of the vehicle and runs after it, keeping the animal in sight until it enters a log. Then, if the hollow is too deep to

Above left: A black-footed rock-wallaby is released from a Bromilow trap.
Photo – Jiri Lochman

Left: CALM volunteers record details of animals captured by pitfall trapping.
Photo – Neville Passmore

retrieve the numbat, a specially-designed trap with a canvas shroud that fits around the log is set over the entrance until the numbat decides to come out.

It is also rare for western ringtail possums to enter traps, whether set on the ground or in a tree. Capture also relies on sighting an animal then removing it from its perch. A dart-gun that fires an anaesthetic dart has been used to catch these arboreal marsupials. A laser sighting device removes some of the guesswork involved in delivering the dart at a safe low velocity, while compensating for its drop over distance. Shortly after being hit, the possum falls from the tree into a waiting blanket.



Above: A tiny ear-tag on a quenda allows its future reidentification for research purposes.
Photo – Ann Storrie

Right: Numbats are radio-tagged so they can be recaptured regularly to monitor their condition, growth and reproduction. This numbat was found with four-day-old joeys.
Photo – Tony Friend

WHO'S WHO IN THE MAMMAL WORLD

The importance of tagging captured animals with a unique mark cannot be understated. It enables researchers to estimate population size. The fate of an individual can be followed through successive trappings, revealing its growth rate, the development of its young, the rate at which it produces young and other details. In fact, anything that changes over time can be traced, including the movement of individuals between traps set at fixed points.

Methods of marking are varied, but the most appropriate minimise the effect on the animal while remaining readable for its lifetime. Tattooing and notching ears according to a numerical pattern are two long-standing methods. A newer technique employs an implant known as a Passive Integrated Transponder (PIT), developed for marking domestic stock and pets. A small glass capsule (10 x 1.5 millimetres) is injected under the skin from a sterile needle and remains there for life. A portable reader is used to scan each animal on capture. If an implant is present, the reader displays a unique 10-digit code. Using PIT technology removes doubt from animal identification, but the cost of around $9 per implant makes it too expensive for some studies.

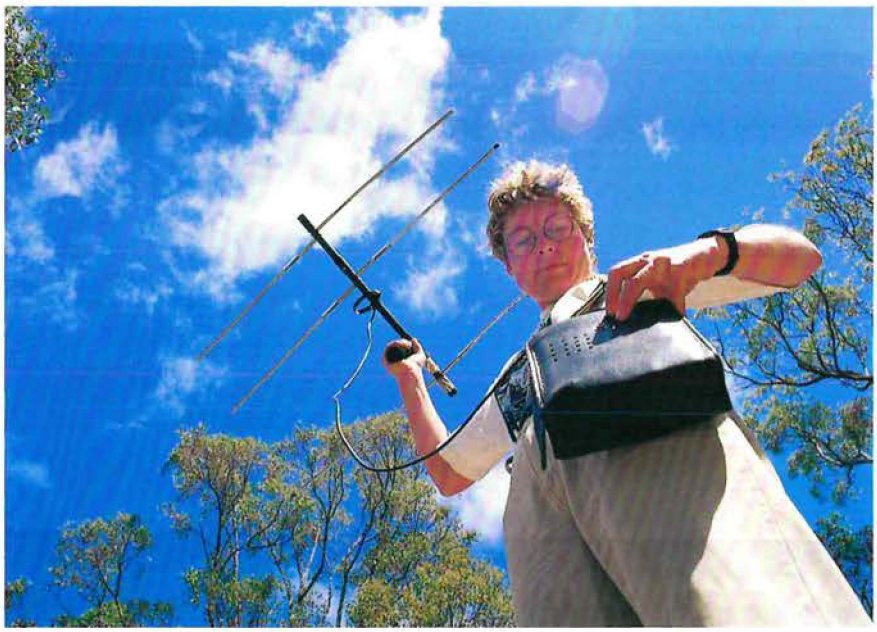
SPYING ON PRIVATE LIVES

The development of radio-tracking in the late 1950s provided a powerful tool to delve into the private lives of wild animals. A miniature transmitter is attached to a captured animal. The transmitter emits a signal for a set period of days, weeks or years, allowing the animal to be relocated by the researcher during that time.

Radio-tracking allows individual animals to be tracked remotely, so their behaviour is not affected by human presence. This allows nesting sites, movement patterns, habitat use and many other facets of the animal's biology and behaviour to be studied. Species that are hard to catch, like numbats, can be caught at intervals by locating them and removing them from their refuges. This method yields the same type of information as periodic capture through successive trapping sessions. Dispersal of young or translocated animals can be followed, as radio-tagged animals can be located from the air using a light aircraft equipped with receiving antennae.

Miniaturisation and the development of more efficient batteries mean that smaller radio-tags can now produce stronger signals for longer periods. A seven-gram numbat radio-collar with a battery life of six months can be detected from a kilometre away with an easily portable antenna and receiver. Tiny transmitters with shorter lives can even be attached to small bats without a detectable effect on their flight or foraging behaviour.

With the arrival of the microprocessor, quite sophisticated functions can now be programmed into radio-tags. 'Smart' transmitters can turn themselves off and on at



predetermined intervals so that they only use normal power levels when needed, greatly extending their life. Motion detectors built into tags vary the time between signal beeps if the animal is active. Combined with a clock circuit, the transmitter can be set to emit a different beep rate at a set time (say 12 hours) since last movement, indicating that the animal wearing the tag has died. Advances in technology mean it is now possible to determine the time of death of a radio-tagged animal.

A group in New Zealand is developing transmitters that communicate with each other, recording interactions between animals. One transmitter responds to another that is very close to it, and records the identity of the other animal along with the time of day. Thus, a continuous log of each radio-tagged animal can be created. This project primarily targets the common brushtail possum, introduced to New Zealand and now a serious economic and environmental pest. Knowledge of the possums' habits will greatly assist the development of biological control methods in that country.

BEAM ME UP SCOTTY

While conventional radio-tracking methods require the presence of researchers in the field, the ARGOS system satellite network, set up to record and relay the position of oceanographic buoys, has been used for more than 15 years to provide automatic position logging for animals. A transmitter fitted to an animal emits a signal that is detected by one of at least two satellites passing overhead between six and 28 times per day, depending on latitude (more frequent passes closer to the poles).

The position of the transmitter on the ground is calculated by measuring the change in frequency (Doppler shift) on two or more transmissions during one pass. The locations and other data that can be transmitted via the satellites are sent automatically by the Internet to the researcher. The locations are generally not as accurate as those achieved by conventional radio-tracking, and the transmitters are too bulky to use with mammals much smaller than a fox. The automatic data collection is a great benefit, however, and, though expensive, the cost compares with accommodation, vehicle, aircraft and salary costs needed to monitor conventional radio-tags. Satellite tags really come into their own when deployed on wide ranging or migratory species. They have been used with great success to track albatrosses, marine mammals, caribou and polar bears. A satellite transmitter has been fitted in a recent trial to a fox in the northern jarrah forest of Western Australia.

Above: The signals from even small radio-tags can be detected from kilometres away using an aircraft-mounted tracking system.
Photo – Tony Friend

Above right: Using a portable receiver and antenna, researchers can locate and follow radio-tagged animals in their habitat.
Photo – Jiri Lochman

Right: Measuring a King's skink attracted into a cage trap by 'universal bait'.
Photo – Ann Storrie

Right: Releasing a Gilbert's potoroo at Two Peoples Bay. Pistachio essence helps researchers lure these critically endangered truffle-eaters into traps.
Photo – Jiri Lochman

Below right: This GPS collar provided very accurate location and activity information for a moose in western Ontario for several months before the animal was killed and eaten by a pack of wolves.
Photo – Art Rodgers

GLOBAL POSITIONING SYSTEM

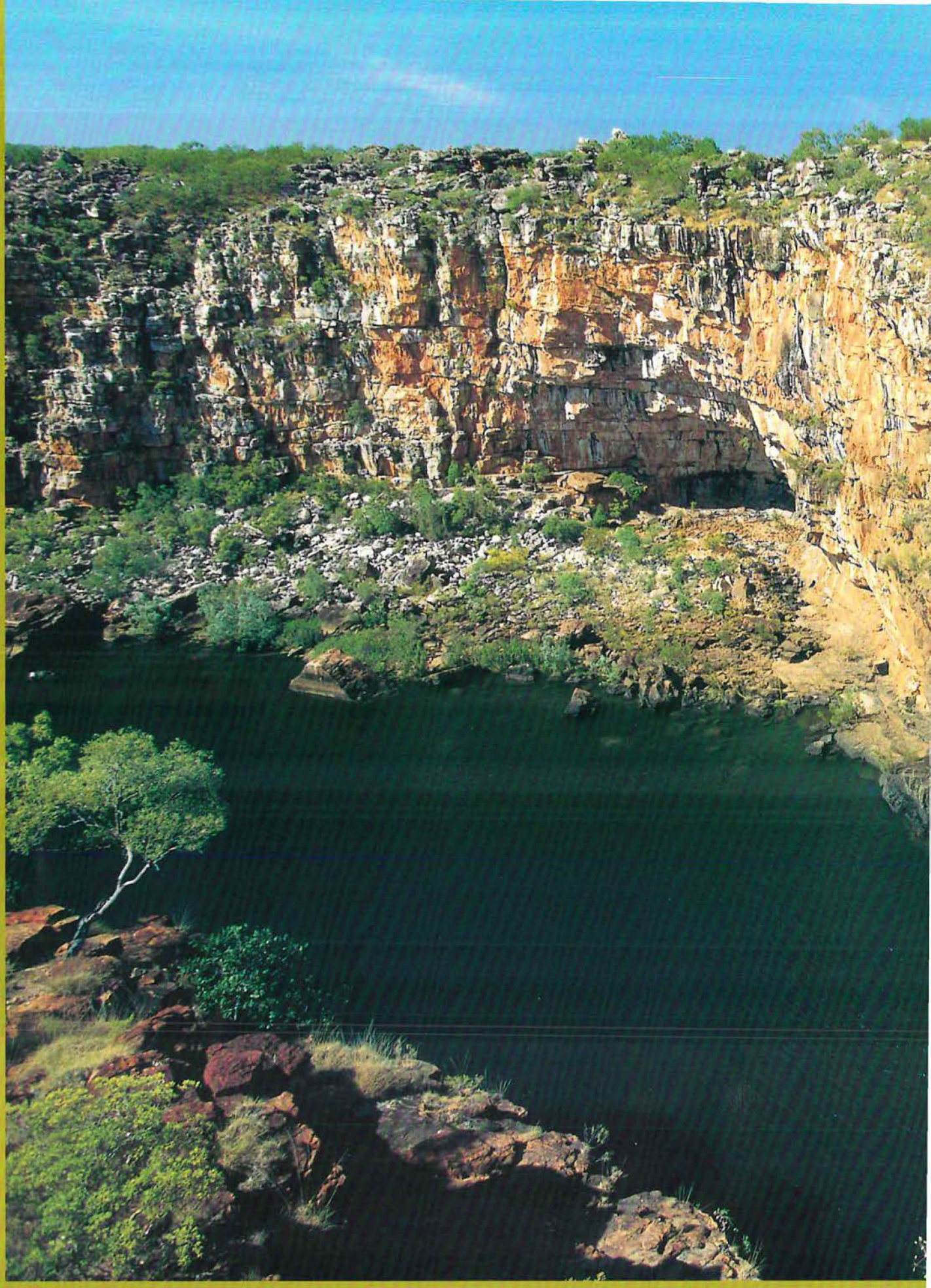
The Global Positioning System (GPS) satellite network enables ground-based receivers to calculate an accurate position anywhere on the globe. Since GPS receivers became available to the public 10 years ago, they have revolutionised all human navigation activities.

Wildlife research has also benefited from the ability to determine location accurately. During the reintroduction of numbats to Karroun Hill Nature Reserve, 450 kilometres north-east of Perth, between 1985 and 1993, the impact of the GPS was particularly apparent. At first, navigating the radio-tracking aircraft over the virtually trackless reserve relied on relating vegetation patterns on the ground to aerial photographs, marking numbat positions onto the photographs, then using them as maps to walk to the site. The first innovation was the use of a powerful transmitter, packed in foam padding, thrown out of the plane over the numbat location. Researchers could follow the powerful signal to the numbat location, then search for the weaker numbat transmitter. With the emergence of GPS, however, researchers merely pushed a button when over the site, saving the location, then used the GPS to walk to the numbat location. All important sites are fixed by GPS to aid mapping.

GPS technology has another interesting use in wildlife research. As the GPS 'engine' is now smaller than a matchbox, it is possible to incorporate one into a collar tag, programmed to take fixes at regular intervals. One manufacturer's product sends data back to base via the ARGOS satellite system, while a rival model can download months worth of data through a radio link to a receiver in an aircraft. Sixty GPS collars have been fitted to moose in two areas in western Ontario with different logging prescriptions. The study aims to evaluate the impact of the two prescriptions on moose movements and biology. These hi-tech collars are extremely expensive, weigh two kilos and run for 18 months. The smallest animal on which the GPS collar has been placed is a lynx in Canada. There is limited use for these devices in Western Australia unless much smaller units can be developed.

As fast as new technology is available, it is being used in wildlife research and management. The fight to save our fauna requires all the support it can get.

Tony Friend is a Principal Research Scientist with CALMScience, based at CALM's Albany Research Centre. He can be contacted on (08) 9842 4523 or by email (tonyf@calm.wa.gov.au).



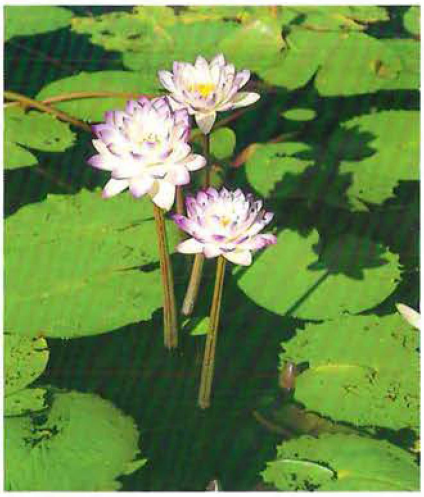
Parks of the Plateau

Four new conservation reserves in and around the Mitchell Plateau give greater protection to this scenic, biologically important and remote part of the Kimberley.

by Chris Done

The Kimberley Plateau is a vast area of more than 100,000 square kilometres of comparatively flat, high country in the extreme north Kimberley. The flatness, however, can only be appreciated from a distance. Up close, the area is extremely rugged, with tablelands and mesas rising to nearly 800 metres above sea level in the central part and dipping gently towards the sea in the north and west. Steep escarpments up to 300 metres high and deep gorges carved over eons by large rivers dominate landscapes on a local scale.

The rocks here were formed when large braided river systems deposited sediments (some of them in a shallow marine environment) in the Kimberley Basin, forming thick beds of sandstone interlayered with beds of conglomerate, mudstone, shale and dolerite (a magnesium-rich form of limestone). Some of these sedimentary beds are in formations up to 5,000 metres thick and are nearly two billion years old. The source of the incredible quantity of sediments that make up these beds was a huge range of mountains (similar to today's Andes) on the southern margin of the Kimberley. At the time, the Kimberley was not part of Australia, but attached to another continent to the north.



Previous page
The Mitchell Falls cascade over four main steps into a deep pool.
Photo – Steve Sadler

Left: The waterlily (*Nymphaea violacea*) is common in billabongs and swamps on the plateau.
Photo – Kevin Kenneally/CALM

Below: An outcrop of light-coloured sandstone contrasts with the lush wet season growth in the Mitchell River National Park.
Photo – Pamella Butt

Astonishingly, the sedimentary beds are still horizontal and easily recognised over much of the area, despite the massive forces that have been acting on them since their formation. Volcanic intrusions 1,800 million years ago introduced thick sills of igneous dolomite and basalt between the sedimentary layers, leaving older sedimentary rocks sitting on ever so slightly younger (in a geological context) volcanic layers.

The Mitchell Plateau is a remnant portion of the much larger Kimberley Plateau. Fifty to 70 million years ago the region had a tropical climate (as it does now) and the very high rainfall caused deep weathering, leaching away the magnesium, calcium and some other elements and concentrating iron and aluminium.

In more recent times (about 17,000 years ago), sea levels rose as much as 180 metres, as ice from the last ice age melted. This drowned the coastline and established a new coast, sometimes up to about 200 kilometres inland from its former position. River valleys and

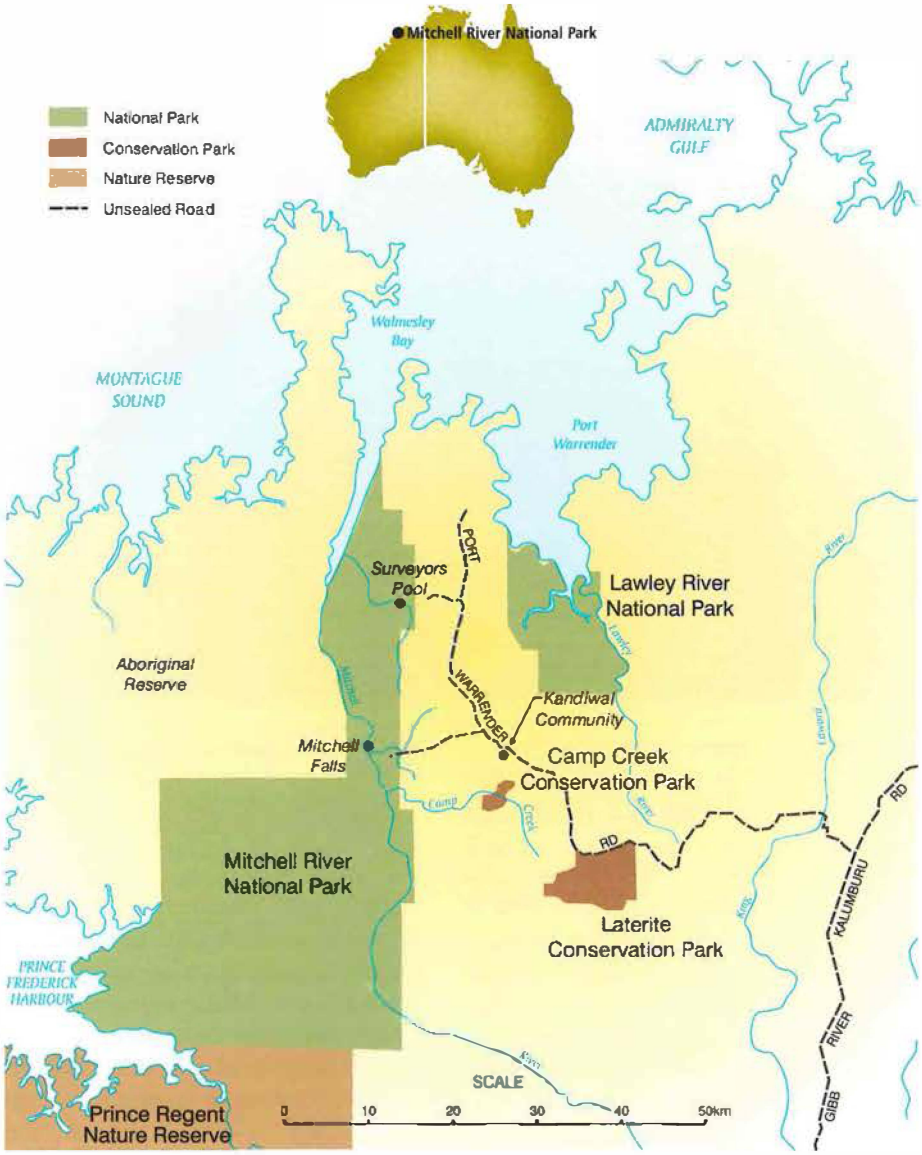
canyons became gorges flooded by the sea, and hills and mountains became islands and headlands.

A relatively humid tropical climate, the stable geological and biogeographic history as well as the area's isolation from other high rainfall tropics favoured the development of a diverse, rich biota over eons. This biological richness (almost all of which is intact today) along with the area's scenic grandeur and cultural importance gave the impetus for the creation of these significant new reserves.

HISTORY OF USE

Aboriginal people have inhabited the Kimberley for more than 40,000 years. The Wunambal people describe the creation of the landscape as central to their law and they have actively managed the land for cultural and sustenance needs over millennia. The remaining biological richness of the land can largely be attributed to their management and cultural activities. A major management tool was their expert use of fire and, after they moved to Kalumburu and other centres in the 1950s, the area was subject to inappropriate large-scale burning regimes. After moving, local Aboriginal people continued to visit their traditional lands and in the last few years have re-established a community on the Mitchell Plateau.

From as early as 1819, when botanist Alan Cunningham (who accompanied Lt. Philip Parker King on his surveys of the Kimberley coast aboard the cutter *Mermaid*) went ashore at Crystal Head and the Lawley River, the area has been of interest to scientists. Such early reports indicated an area of immense biological interest and this interest intensified after access was improved from 1965 onwards, allowing further investigations to be carried out. In November 1976, a major biological survey was undertaken of the Mitchell Plateau, the adjacent lands in the Mitchell and Lawley River drainage systems and the shores of Port Warrender. The survey was organised by the WA Museum, with officers from the then Department of Fisheries and Wildlife, the then National Parks Authority and the Field Museum of Natural History (Chicago) also participating.



Mineral exploration during the 1960s led to the discovery of low-grade bauxite deposits. They were sufficient, however, for mining companies to take out special permits to enable them to mine the area should economic conditions become favourable. Exploration also opened up this spectacular area to a few determined tourists with four-wheel-drive vehicles. The area's reputation had spread by 1978, when I first visited and was captivated by its unique vegetation, relatively pristine condition and spectacular scenery. Further biological studies sponsored by the mining company were carried out from the mid-1970s, and the richness of the area began to be more widely appreciated.

By the mid-1980s, it was obvious that steps needed to be taken to protect the area's fragile ecology from ever increasing visitor pressure, large-scale wildfires and feral animals. No government department had formal responsibility for the area, so an informal alliance of concerned officers from the then departments of Tourism, Forests, and Youth, Sport and Recreation was set up. The group was known as the Kimberley Natural Resources Management Group. With funding from the mining company, it produced a brochure to guide people within the Mitchell Plateau (but not designed to attract people to the area) and ensure they behaved responsibly. The group also put up signs to help visitors negotiate the confusion of mining tracks that existed at the time. The group had some discussion with the Wunambal people, who provided input into the naming of some of the features.

These measures were useful but, without resources to follow them up, the area remained largely unmanaged for some years. Community concern for the area was growing, however, and the local Land Conservation District Committee arranged some litter clean up and feral animal control over a

Left: Dense pandanus and paperbark vegetation along a creek line makes for difficult access through this area.
Photo – Jiri Lochman

Below far left: Stands of the cycad (*Cycas lane-poolei*) occur on deeper soils.
Photo – Kevin Kenneally/CALM

Below left: A patch of rainforest surrounding a dry creek bed.
Photo – Marie Lochman

number of years, while the Shire of Wyndham-East Kimberley upgraded the directional signs. More recently, the State Government and the mining company (the Mitchell Plateau Joint Venture) entered into an agreement to station a CALM ranger on the plateau to assist the growing number of visitors. Commercial tour operators had by this time set up camps on the plateau and offered scenic helicopter flights over the area.

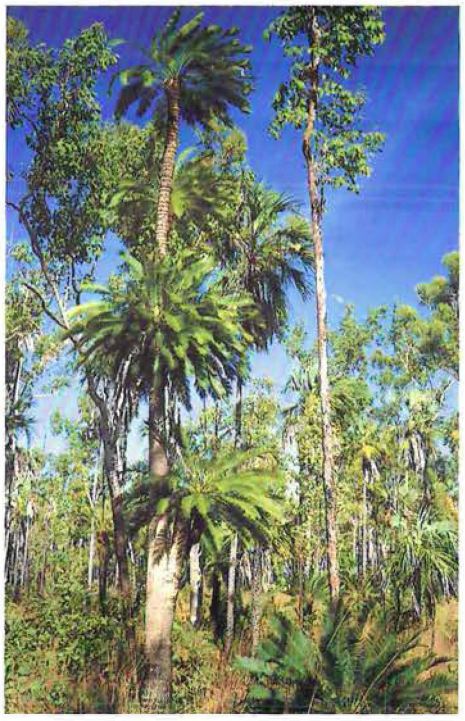
NEW RESERVES

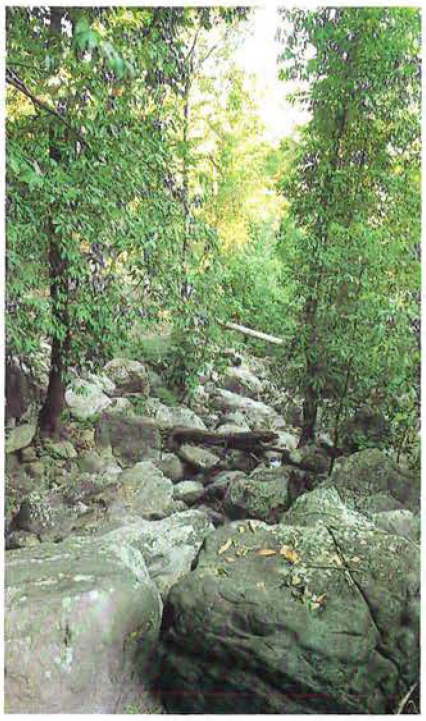
In 1980, the Environmental Protection Authority's 'Red Book' for System 7 (the Kimberley) recommended the creation of conservation reserves on the Mitchell Plateau. In 1991, CALM's publication *Nature Conservation Reserves in the Kimberley* reassessed and refined the proposals. The National Parks and Nature Conservation Authority accepted that the proposals should be pursued on an opportunistic basis. However, little progress was made in expanding the conservation reserve system in the area, mainly because the mineral potential of the region had not been fully assessed and it was recognised that Aboriginal interests needed further consideration.

Finally, in August 2000, The Western Australian Government announced the creation of four new north Kimberley parks, to protect and conserve the region's important ecosystems, cultural features and landforms from ever increasing pressures. CALM was given responsibility for actively managing the areas. The new reserves are as follows.

Laterite Conservation Park, covering 12,191 hectares of the Mitchell Plateau, was reserved to protect a representative area of the distinctive Mitchell Plateau vegetation. Mitchell River fan palms (*Livistona eastonii*) occur only on the plateau and in nearby areas. In association with woollybutt (*Eucalyptus miniata*), Darwin stringybark (*E. tetrodonta*), Melville Island bloodwood (*Corymbia nesophylla*) and round-leaved bloodwood (*C. latifolia*), the palms dominate the plateau vegetation. In fact, this is the only locality in the State where palms are such a dominant feature. Also conserved in this area are ancient cycad plants. The conservation park was reserved with the cooperation of the Mitchell Plateau Joint Venture (which also held the Mitchell River Pastoral Lease), which relinquished portions of their pastoral lease and mineral tenement.

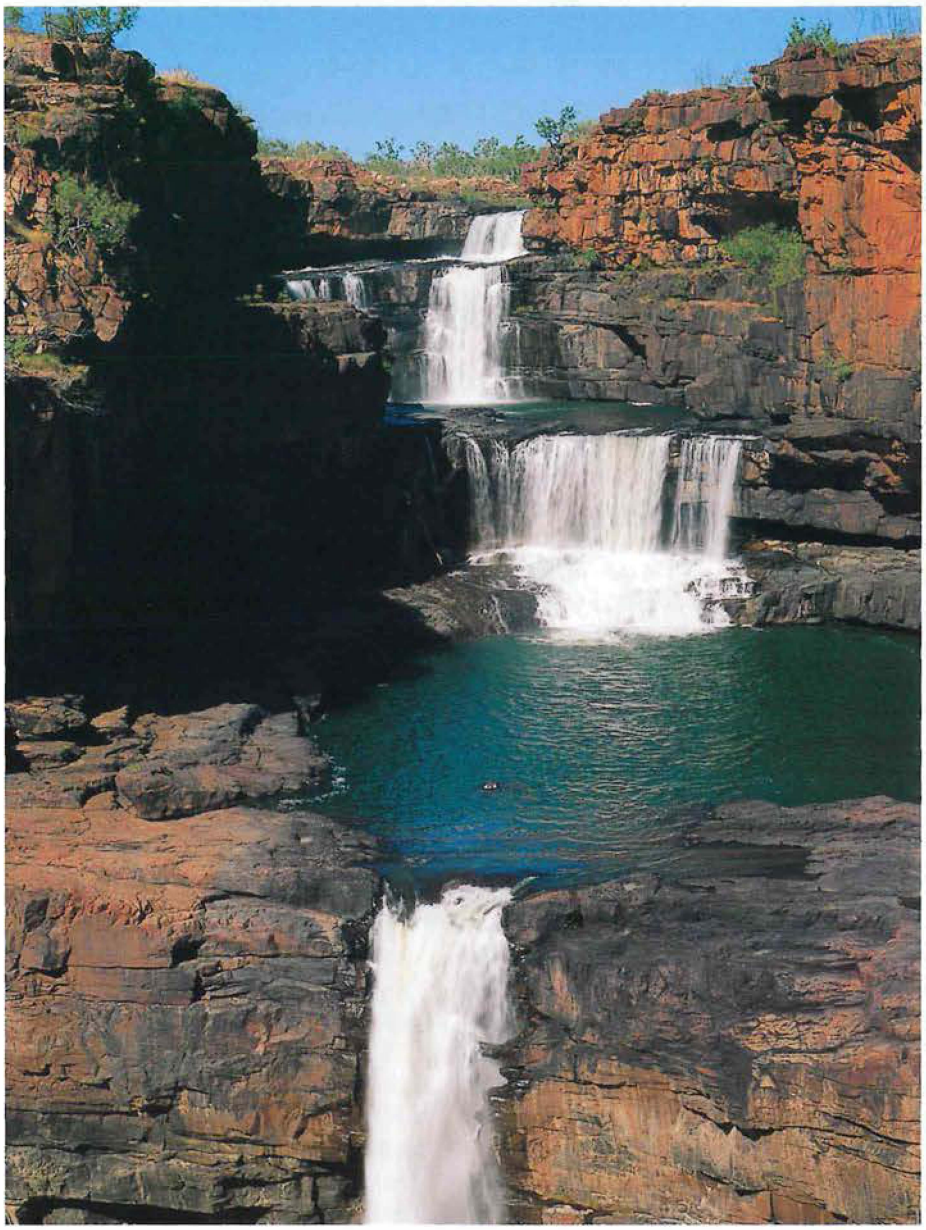
Mitchell River National Park covers 115,325 hectares. Mitchell Falls and Surveyors Pool are the park's two main scenic attractions. At Mitchell Falls, the Mitchell River cascades over a series of falls and pools over blocky layers of sandstone, each successively more spectacular, and finally plunges into a deep gorge. Surveyors Pool is surrounded by white bluffs of King Leopold Sandstone. Riverine and rainforest vegetation, mangroves and extensive sandstone formations represent some of the variety of habitat. The new park adjoins the Prince Regent Nature Reserve to the south





Right: The Mitchell Falls is highly significant to the traditional Aboriginal owners. It features strongly in their creation stories.

Below right: The monjon is confined to the rugged north-west Kimberley and some adjacent islands, including the new conservation reserves.
Photos – Jiri Lochman



and extensive Aboriginal lands to the west.

Lawley River National Park, covering 17,572 hectares takes in the Lawley River catchment and extends to the River's mangrove-lined mouth in Admiralty Gulf. It encompasses a wide variety of habitats and supports a diverse range of plant and animal species.

Camp Creek Conservation Park, a small reserve of just 1,267 hectares, protects some significant rainforest patches, some of which are subject to long-term monitoring programs.

Thirty-nine species of mammal have been recorded from the Mitchell Plateau area (the largest number known from any area of similar extent in Western Australia), including the monjon (*Petrogale burbidgei*) and scaly-tailed possum (*Wyulda squamicaudata*). The newly-created reserves around the Mitchell Plateau have all been subject to previous land tenure such as pastoral lease. The reservations will coexist with native title rights.

MANAGEMENT

The new parks adjoin Aboriginal reserve. Complementary management objectives for both tenures will go a long way to ensuring that the unique biological values, perhaps the least impacted of all mainland Australian regions, are maintained. Cultural values will also be protected.

The involvement of the native title claimants is considered by CALM to be vital in the management process. A management plan being produced by the Wunambal people is a welcome initiative and will complement recreation management concepts jointly developed with them by CALM over the past 18 months or so.

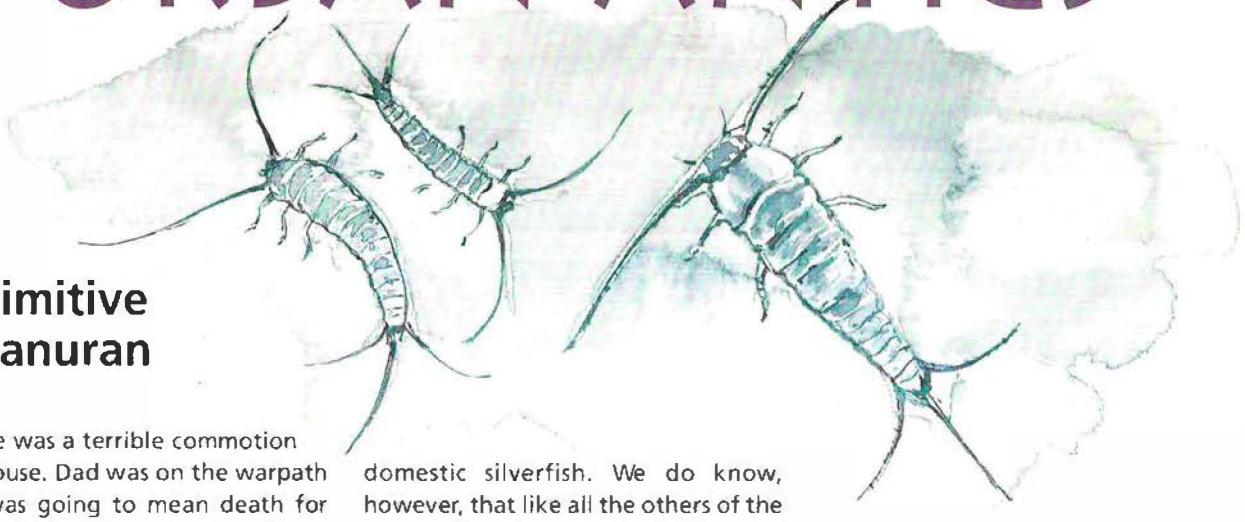
CALM looks forward to effective cooperative management with Aboriginal claimants of the new reserves.

Inappropriate fire regimes and the presence in the area of feral cattle and other exotic animals have been impacting adversely on the region's biota over recent decades and are two of the major management imperatives. It is hoped that traditional knowledge can be incorporated into modern fire management techniques so that the adverse impacts of fire can be minimised. Feral cats are as much a problem here as they are in other areas of the State, despite its remoteness.

Managing the area so that visitors can see and appreciate its values without affecting them is a major challenge and working in partnership with the Aboriginal people from the area will greatly enhance this process.

Chris Done is the Regional Manager for CALM in the Kimberley. He can be contacted on (08) 9168 4200 or by email (chrisd@calm.wa.gov.au).

URBAN ANTICS



A primitive thysanuran

There was a terrible commotion in the house. Dad was on the warpath and it was going to mean death for silverfish that had eaten grandma's face off in the hallway.

This sort of talk was frightening for a youngster, as far as I could work out we hadn't been fishing for weeks, grandma lived in Melbourne and my father didn't drink. And so to war we marched, up and down the passage, the old fly-spray pump going flat-strap.

In those days you didn't query adults, you simply waited to be told what was really happening, or high-tailed it to your room to quietly decipher the innuendo. Finally I had it —they were insects that had damaged our family photos.

Silverfish... who in their right mind started that misnomer?

Have you ever picked up a treasured photo, or your favourite 1949 copy of *Woman's Day* magazine from the bottom of a rarely used drawer? Chances are that silverfish have chewed, scraped, furrowed or eaten right through your adored image of the British royal family.

Silverfish are apterygote insects, primitive wingless insects that moult. They are of the Order Thysanura, whose members are small creatures with an elongated body, normal biting mouthparts, and three long, tail-like processes at the end of the abdomen.

While there are quite a few species of silverfish throughout the world, the one most familiar to us is *Lepisma sacharina*. This animal is an immigrant from Europe and is found in our homes and sheds, where it inhabits cool, dark and damp places.

Like so many common things, little is known of the life history of our domestic silverfish. We do know, however, that like all the others of the order, there is no metamorphosis or passing through the development stages of egg, larva, pupa and imago.

From the time it emerges from an egg, the tiny beast is a true reproduction of its parents, and as it grows it simply moults its 'skin' (which is actually an exoskeleton) to achieve a more roomy covering. After about six or seven moults the five to 15 millimetre long adult is sexually mature and carries on its life of continuous activity with no apparent resting periods.

Between September and March (typical high season for insects) silverfish reproduce. The male deposits a sperm capsule, and the female picks it up and transfers it to her genitalia (how really boring). A rather large egg (about the size of a small pinhead) for such a small animal is then laid anywhere near a food source, or simply on the lounge room carpet.

Silverfish live for about four years, and are nocturnal. They shun the light and, when disturbed, scurry with tremendous speed to hide in cracks and crevices. The animals possess strong toothed mandibles or jaws and their food includes the surface of bookcovers, photographs and wallpaper. The starchy dressing in these objects seems to provide the chief attraction. Dusty corners also seem to provide an attractive habitat and food source.

Although they are considered to be harmless, silverfish nevertheless cause consternation in any household. While we can clean and spray within the home to rid us of these freeloaders, one is thankful that they are mere specks on the carpet. The fact that they will readily devour their own cast off 'skins', or the dead bodies of other insects, and in captivity show unmistakable cannibalistic tendencies, serves us to give thanks they are not the size of the family dog.

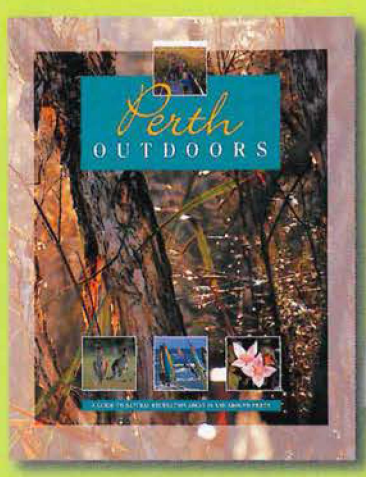
BY JOHN HUNTER

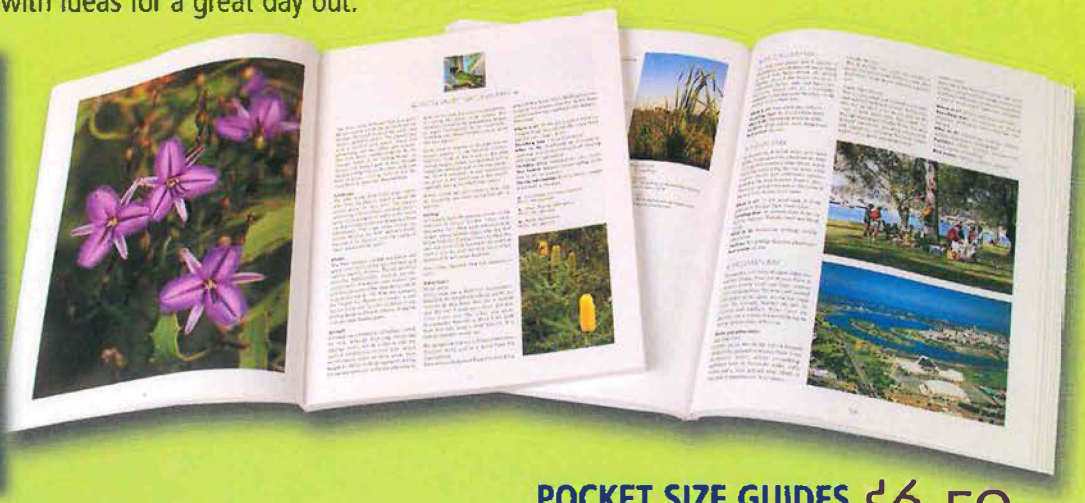
DID YOU KNOW?

- *Their common name is due to the rich silver lustre of their exoskeleton, which is covered by minute scales that become a residue of fine metallic dust when brushed from the animal. Under a microscope each scale is as beautiful as a finely sculptured scallop shell.*
- *Among the most primitive of living insects, silverfish are so soft and delicate they have never left a single trace of their existence as fossils in enduring prehistoric stone.*
- *There are also many native species of silverfish that live under bark and leaves on the ground and never venture near human dwellings. Others are tolerated inhabitants of ant and termite nests.*

Discovering Perth's outdoors

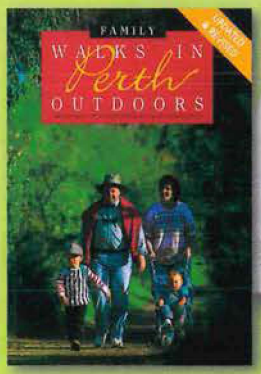
Perth and surrounding areas have a range of outdoor recreation sites that are perfect for visitors and locals alike. Here are publications packed with ideas for a great day out.





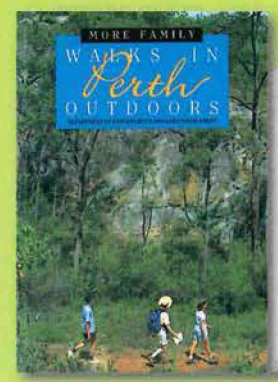
PERTH OUTDOORS $21.95

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



FAMILY WALKS IN PERTH OUTDOORS $16.45

Few capital cities have such a variety of natural areas right on their doorstep. This book sets out 50 walks to explore Perth's forests, woodlands, wetlands and coastal environments, ranging from a few hundred metres to 20 kilometres. Each walk is described stage-by-stage and illustrated with a mud map to keep you on track.



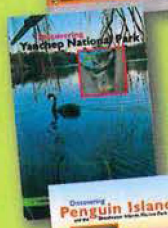
MORE FAMILY WALKS IN PERTH OUTDOORS $16.45

More Family Walks follows in the footsteps of the bestselling Family Walks. It contains maps and descriptions of another 52 walks, as well as features on some of the plants and animals you might see while out walking, and a list of common birds of the Perth area.

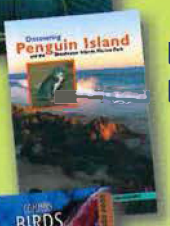
POCKET SIZE GUIDES $6.50 each

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

Discovering the Swan River



Discovering Yanchep National Park



Discovering Penguin Island

Birds in the backyard

Bugs in the backyard

Beachcombers guide

Available from good bookshops, newsagents and CALM offices, or by mail order from CALM at the address below (postal charges apply).
Locked Bag 29, Bentley Delivery Centre, Western Australia 6983
Tel: (08) 9334 0333, Fax: (08) 9334 0498 TTY (hearing impaired) facility available (08) 9334 0546

DEPARTMENT OF
Conservation
AND LAND MANAGEMENT
Conserving the nature of WA

Pipidinny Swamp, on the coastal plain north of Perth,
is home to a variety of frogs.

Photo – Jiri Lochman

ISSN 0815-4465

9 770815 446034

PRINT POST APPROVED PP665002/00004