WA's conservation, parks and wildlife magazine

LANDSCOPE

Volume 26 Number 2 SUMMER 2010–11 $6.95

Great Western Woodlands

Mulgaras return

Caves of Yanchep National Park

Endemic creatures **Montebello Islands** Biodiversity of the Western Desert

We hope you enjoy this issue of *LANDSCOPE* magazine.

Can you think of anyone who would love to read *LANDSCOPE* too?

Our special offer to subscribers

Buy a family member or friend a two-year gift subscription to *LANDSCOPE* magazine for $54 and we will give you a free one-year extension to your existing subscription.

That's three years (12 issues) of *LANDSCOPE* magazine for the price of two years (eight issues)!

Plus, with every gift subscription you purchase your gift recipient will go in the draw to win one of five *LANDSCOPE* binders (each binder holds eight issues).

It will make a perfect gift.

What your family member or friend will receive:

- Two years (eight issues) of *LANDSCOPE* magazine filled with fascinating articles and spectacular photographs delivered to their door each season.
- A gift card letting them know what they will receive and who it's from.
- PLUS: a chance to win one of five *LANDSCOPE* binders.

What you will receive:

- Free! One-year extension to your existing subscription.
- The thrill of knowing you have given a gift of true value and enjoyment.

Phone our customer service staff now on (08) 9219 8000. You'll find an order form in this issue.

Department of Environment and Conservation


Carl Gosper


Alison McGilvray

contributors

Carl Gosper is a research scientist who has been investigating the role of fire in plant conservation since 2007. Employed jointly by the Department of Environment and Conservation's (DEC's) Science Division and CSIRO Ecosystem Sciences, he has worked on projects such as how fire, fragmentation and weed invasion affect plant communities in the wheatbelt, and how woodland communities change with time since fire in the Great Western Woodlands. Previous fields of research include the effects of plant invasions on bird communities and how birds influence the spread of fleshy-fruited invasive plants.

editor's letter

It's always good to hear from readers of *LANDSCOPE*. Recently a reader, while giving mostly complimentary feedback on the Winter 2010 issue, set us straight on a point of diction: "In the article on Dryandra forest you included a photograph of one of the old forestry houses, and the caption says this is a 'woodcutter's cottage'," he writes. "I fear this demonstrates a very inadequate understanding of the history of Dryandra. The houses at the Forests Department settlement were built for, and occupied by, foresters and forest workmen and their families. [Their] job was to oversee the protection and regeneration of the Dryandra forest." The reader goes on to point out that the word 'woodcutter' has never been used in the Australian bush, where forest enterprise has always been carried out by 'timber workers', 'firewood cutters', sandalwood pullers', or more colloquially, 'jarrah jerkers', 'bush gangs', or 'the forestry'.

So what is it about the word 'woodcutter' that doesn't work here? It's a quaint term, especially when juxtaposed with the word 'cottage', calling forth images of a character from a 19th century folk tale heading off into a Bavarian pine forest with a hatchet and shoulder bag, on a solitary pursuit with little consequence. While in Sydney recently, I had occasion to view photographs of forestry operations taken by celebrated photographer Max Dupain—the man responsible for the iconic Australian image *The Sunbaker*—in the south-west of WA in 1945. One image is of a steam train near Pemberton. The mighty locomotive engine, entering a small clearing, is dwarfed to toy size by the girth of the gigantic karri trees around it. So massive are the stems that the height of the trees can only be imagined, their crowns understood to be well outside the frame. In another, two shirtless men work a cross-cut saw through the trunk of a tree with a circumference greater than could be encircled by four of them with outstretched arms. Felling one tree looked to be a full day's work. The term 'woodcutter' clearly doesn't fit this scale of effort.

WA's forests have a long and surprisingly diverse history of supporting economic and social development in the state. For example, it's not widely known that the Great Western Woodlands— a huge and biologically rich expanse of bush stretching from the eastern wheatbelt deep into the goldfields—was a vital source of timber for fuel and mine pit props from the time of the gold rushes of the late 1890s. By the mid 1900s a vast network of railway lines spread outwards from the mining centres, taking the so-called 'woodlines' into the far reaches of the semi-arid region, and much of the species-rich eucalypt country standing there today is a result of prolific regeneration that followed the harvesting. While the woodlines ceased operating in the 1960s, the activity remains a small but significant part of the remarkable natural and cultural heritage of the Great Western Woodlands, which is now to be protected under a comprehensive integrated conservation strategy (see 'The Great Western Woodlands: protecting our biological richness', page 10). On behalf of *LANDSCOPE*, thanks to readers for helping us honour our past as we look to the future.

Madeleine Clews
Executive Editor

2010 International Year of Biodiversity

Alison McGilvray is a biodiversity officer with DEC and Rangelands Natural Resource Management in the Pilbara Region. She moved to Karratha in 2007 and has worked on pest plant and animal and threatened species projects in the Kimberley and Pilbara, including community weed control north of Broome with the Bardi Jawi Rangers. Prior to moving to the north-west, Alison worked with the Swan River Trust on foreshore assessments and at the Australian Wildlife Conservancy's Karakamia and Paruna sanctuaries. Alison enjoys the starry nights on Martu country and is inspired by the connection the traditional owners have with the land and its stories.

Brad Durrant is a research scientist with DEC's Science Division, based at the Wildlife Research Centre since 1999. He has primarily been involved with the department's regional biological surveys, working with ground-dwelling invertebrates. Recently, Brad has been involved with providing advice to stakeholders on environmental impact assessments involving short-range endemic invertebrates and subterranean fauna, as well as further developing assessment protocols for consultancies regarding these groups.

Alexander Watson is the national program manager for the non-government organisation *Leave No Trace*. In the summer months he also works as a whale and seabird lecturer and guide in Antarctica. From 2006 to 2009, he was the Great Western Woodlands campaign manager for The Wilderness Society, where he worked to bring together key stakeholders to develop a regional plan for managing this extraordinary landscape. Alexander is a passionate conservation scientist who wishes to use his ecology background to protect natural biodiversity and, where possible, empower traditional owners.


Brad Durrant


Alexander Watson

also contributing…

Anne Cochrane, Sarah Comer, Peter Collins, Jonathan Pridham, Cameron Tiller, Neil Hamilton, Mike Onus, Karla Forrest, Melinda Moir, Samille Mitchell, Joanna Moore, Caroline Haynes, Peter Kendrick, Christie Mahony, David Gough, Ian Herford, Colin Yates, Suzanne Prober, Neil Thomas, Brian Macmahon, Nicky Marlow, John Hunter and Brent Johnson.

Cover illustration by Philippa Nikulinsky
Scorpions were one of five fauna groups highlighted in a guidance statement released by the Western Australian Environmental Protection Authority in 2009 as warranting investigation as potential short-range endemics (SREs). SREs are animals with very limited distributions and several animal groups have been identified as having a high number of SRE species, primarily terrestrial invertebrates—animals without backbones that live on land. Pictured here is a scorpion of the genus *Urodacus*, which is found throughout Western Australia.
Illustration reference photo by Babs and Bert Wells/DEC.

Back cover photo by Brad Durrant/DEC
Short-range endemism is affected by a range of factors including physical barriers such as mountain ranges or gorges, such as the one pictured here in Karijini National Park.

Features

Volume 26 Number 2 SUMMER 2010-11

contents

Regulars

Publishing credits

Executive editor Madeleine Clews.

Editors Joanna Moore, Samille Mitchell.

Scientific/technical advice Kevin Thiele, Paul Jones, Keith Morris, Michael Rule.

Design and production Tiffany Taylor, Lauren Tyrrell, Peter Nicolas, Gooitzen van der Meer.

Illustration Gooitzen van der Meer.

Cartography Promaco Geodraft.

Marketing Estelle de San Miguel.
Phone (08) 9334 0296 or *fax* (08) 9334 0432.

Subscription enquiries
Phone (08) 9219 8000.

Prepress and printing GEON, Western Australia.

ISSN 0815-4465

Please do not send unsolicited material, but feel free to contact the editors.

Published by the Department of Environment and Conservation (DEC), 17 Dick Perry Avenue, Kensington, Western Australia.

Visit DEC online at www.dec.wa.gov.au to search the *LANDSCOPE* catalogue.

Department of
Environment and Conservation

Fighting back: mulgaras return

Long-term, sustained feral cat control at Lorna Glen is leading to an increase in mulgaras on the former pastoral station.

by Neil Hamilton, Mike Onus and Karla Forrest

Above Mulgaras were once widespread across Australia's arid regions.

Above right Mulgaras are effective hunters, feeding mostly on insects.
Photos – Jiri Lochman

Left A brush-tailed mulgara track at Lorna Glen former pastoral station.
Photo – Neil Hamilton/DEC

The brush-tailed mulgara (*Dasycercus blythi*) is fighting back after a combination of factors decimated numbers across arid regions of Australia. The mulgara, a small carnivorous marsupial weighing about 130 grams, has been at risk due to altered fire regimes, habitat loss and predation by feral cats (*Felis catus*), foxes (*Vulpes vulpes*) and wild dogs (*Canis lupus familaris*).

Once widespread through Australia's central desert regions, mulgaras are now present in fragmented distribution in the extreme western parts of Queensland and throughout the Northern Territory and Western Australia. However, a recent survey has shown a population explosion at Lorna Glen, a former pastoral station about 160 kilometres north-east of Wiluna.

The hunter becomes the hunted

Mulgaras are an extraordinary yet little-known species. They are keen hunters, making use of their powerful jaws and good forward vision to catch and kill their prey. A fearsome predator to small vertebrates and insects, the mulgara swiftly subdues its prey with several quick bites to the head before peeling back the skin, crushing the skull and consuming both the body and brain.

Despite its hunting prowess, the mulgara has fallen victim to its own formidable foe, the feral cat. The introduction of feral cats into WA has caused a multitude of problems for native fauna including the brush-tailed mulgara, which is listed as a 'priority' species in WA.

Control of feral cats and foxes is considered critical to the revival of extant species such as the brush-tailed mulgara. Various baiting strategies have been trialled across WA with increasing success (see 'Controlling introduced predators in the rangelands: the conclusion', *LANDSCOPE*, Winter 2010). Baiting at Lorna Glen since 2003 has resulted in a sustained reduction in cat numbers. It is thought that this decrease has contributed, at least in part, to a recovery of mulgaras on the former pastoral lease.

Promising signs

During a recent study of feral cat abundance, researchers from the Department of Environment and

Conservation (DEC) were pleasantly surprised to find an abundance of mulgara tracks and burrows in cat monitoring plots. The unprecedented number of tracks was found in different vegetation types from thick spinifex to open shrubland.

In addition, several animals were trapped and a number photographed from remote cameras (see 'Camera traps: paparazzi in the bush' on page 27). This comes as a welcome change because the capture of mulgaras has been sporadic in WA in the past 25 years. Mulgara numbers are difficult to monitor due to natural population fluctuations, but DEC staff are nonetheless optimistic about the results of the survey. The numbers are the most they have ever recorded.

More species fighting back

In addition to the increase in mulgara activity at Lorna Glen, ground and low-dwelling bird sightings have increased noticeably over the past several years. Species such as the bush stone curlew (*Burhinus grallarius*), red-capped robin (*Petroica goodenovii*), hooded robin (*Malanodryas cucullata*), painted finch (*Emblema pictum*), chestnut-breasted quail thrush (*Cinclosoma castaneothora*), chestnut quail thrush (*C. cinnamomeum*), splendid fairy-wren (*Malurus splendens*), white-winged fairy-wren (*M. leucopterus*) and spotted nightjar (*Eurostopodus argus*) have all become more common in the area. The western bower bird (*Chlamydera guttata*), previously in very low numbers at Lorna Glen, is also becoming more abundant. In addition, perentie monitors (*Varanus giganteus*) are becoming more noticeable.

The recent increase in bird and mammal sightings suggests that the long-term feral cat control at Lorna Glen has assisted in the recovery of extant species previously present in very low numbers. This trend in species recovery has also been observed elsewhere, even on tropical islands, where DEC staff have undertaken feral cat control. Recently, increased numbers of white-breasted waterhen (*Amaurornis phoenicurus*) and white terns (*Gygis alba*) have been observed on the Cocos (Keeling) Islands where long-term cat control has been conducted.

The mulgara population explosion at Lorna Glen has been met with optimism by DEC staff, who will continue to closely monitor numbers. The continuation of baiting programs will play a vital role in securing the future of Australia's native fauna including the brush-tailed mulgara.

Top Sightings of birds such as the white-winged fairy-wren have increased at Lorna Glen former pastoral station.
Photo – Stuart Miller/Lochman Transparencies

Above A brush-tailed mulgara at Lorna Glen, where their numbers have significantly increased.
Photo – Neil Hamilton/DEC

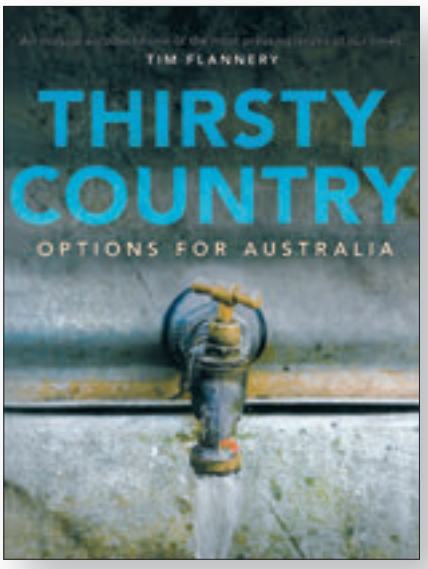
Below left Perentie monitor.
Photo – Jiri Lochman

Neil Hamilton is a senior technical officer with the Department of Environment and Conservation's (DEC's) Science Division, based at Woodvale. He has worked on feral cat research under the fauna conservation program for the past nine years. He can be contacted by email (neil.hamilton@dec.wa.gov.au).

Mike Onus is a senior technical officer with DEC's Science Division, based at Woodvale, working on feral cat and fox research for the past 25 years. He can be contacted by email (mike.onus@dec.wa.gov.au).

Karla Forrest is a final year Communication and Cultural Studies student at Curtin University majoring in Professional Writing and Publishing. She can be contacted on (08) 9355 5005 or by email (karlaforrest@hotmail.com).

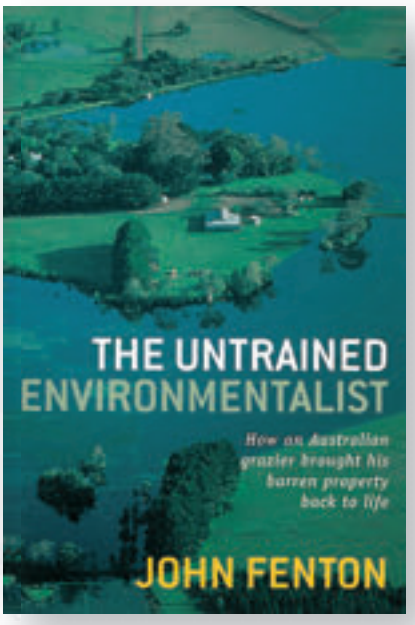
bookmarks by Karla Forrest



Thirsty Country: Options for Australia

Author: Åsa Wahlquist
Publisher: Allen and Unwin
www.allenandunwin.com
216 pages, paperback, colour maps and graphs
ISBN: 978-1-74175-484-1
RRP: $27.95

In *Thirsty Country*, Åsa Wahlquist provides a comprehensive look at the water issues facing Australia today. A thought-provoking read, the book outlines the history of Australia's water shortages as well as the climatic and geological influences on water. A variety of reputable sources provides the basis for Wahlquist's assertion that good water management is linked with a wider social understanding of water, climate and geology. Wahlquist suggests things we can do to improve water conservation at both a household and national level. The book also includes a colour section with detailed maps and graphs which help explain climate and rainfall patterns. A valuable read relevant to all Australians.



The Untrained Environmentalist

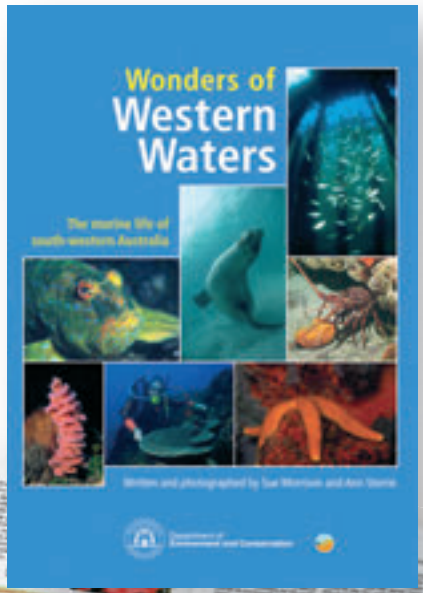
Author: John Fenton
Publisher: Allen and Unwin
www.allenandunwin.com
250 pages, paperback, colour photographs
ISBN: 978-1-74237-019-4
RRP: $35

A fascinating tale of one farmer's dedication to righting past wrongs, *The Untrained Environmentalist* is a pleasure to read. Author John Fenton's family property of Lanark near Hamilton in Victoria was a dustbowl before he and wife Cicely began planting trees. In their many years, they planted some 100,000 trees, completely transforming the property into a thriving and sustainable farm. Fenton takes readers on an autobiographical journey to explain why and how he worked so hard to reclaim his barren property.

Wonders of Western Waters: The marine life of south-western Australia

Authors/photographers: Sue Morrison and Ann Storrie
Publisher: Department of Environment and Conservation
www.dec.wa.gov.au
147 pages, paperback, full colour
ISBN: 978-0-7309-6894-8
RRP: $19.95

This reference book is perfect for those interested in the diverse and wondrous marine life of Western Australia's south-west waters. The book includes species found in coastal waters from Jurien Bay Marine Park, south to the Recherche Archipelago near Esperance, and is especially useful for divers wanting to identify particular species of interest. This reprint is a revision of the original 1999 edition, with new photos and updated information. The stunning photography along with easy-to-read descriptions makes it a convenient and visually appealing handbook.



The Great Western Woodlands

Protecting our biological richness

The Great Western Woodlands is the largest remaining area of intact Mediterranean-climate woodland on Earth—an internationally significant region of great biological richness. A strategy has been developed to ensure the long-term conservation of its unique natural and cultural values, establishing a vision for the region and principles which will guide its future management.

by Ian Herford and Alexander Watson

If you were to head east from Perth, over the escarpment hills of the Darling Range, you would eventually enter the great sweep of cleared country known as the Western Australian wheatbelt. Driving further east, a simple fence marks a line between the wheatbelt and the beginning of a remarkable place—the Great Western Woodlands.

Between Kalgoorlie, Esperance and the Nullarbor Plain lies a huge expanse of natural bush. This rich tapestry of woodlands, mallee and shrublands connects Australia's south-west corner to its inland deserts. At almost 16 million hectares, it is more than twice the size of Tasmania and larger than England. Despite being biologically distinct, the region has never had a unique name, usually simply being referred to as part of the 'Goldfields' region. The name 'Great Western Woodlands' was selected because it best reflects the region's position in the west of the continent and status as containing the largest remaining area of temperate woodland in Australia. The boundaries of this distinct bioregion, established by researchers from the Australian National University, separate the eucalypt woodlands from the mulga (*Acacia aneura*) country to the north, the treeless Nullarbor Plain to the east, the moist coastal heath to the south-east, and agricultural land to the west and south.

In modern Australia, this landscape is of great significance. The Great Western Woodlands is one of the very few large, intact landscapes remaining in temperate Australia. Temperate woodlands once covered large areas of southern Australia, and the vast majority of these woodlands have been removed—those that remain are fragmented and heavily used. The same story can be told in Asia, Europe, Africa, North and South America. As a consequence, the Great Western Woodlands now stands as a globally unique example of extensive, healthy woodland ecosystems.

A biodiversity hot spot

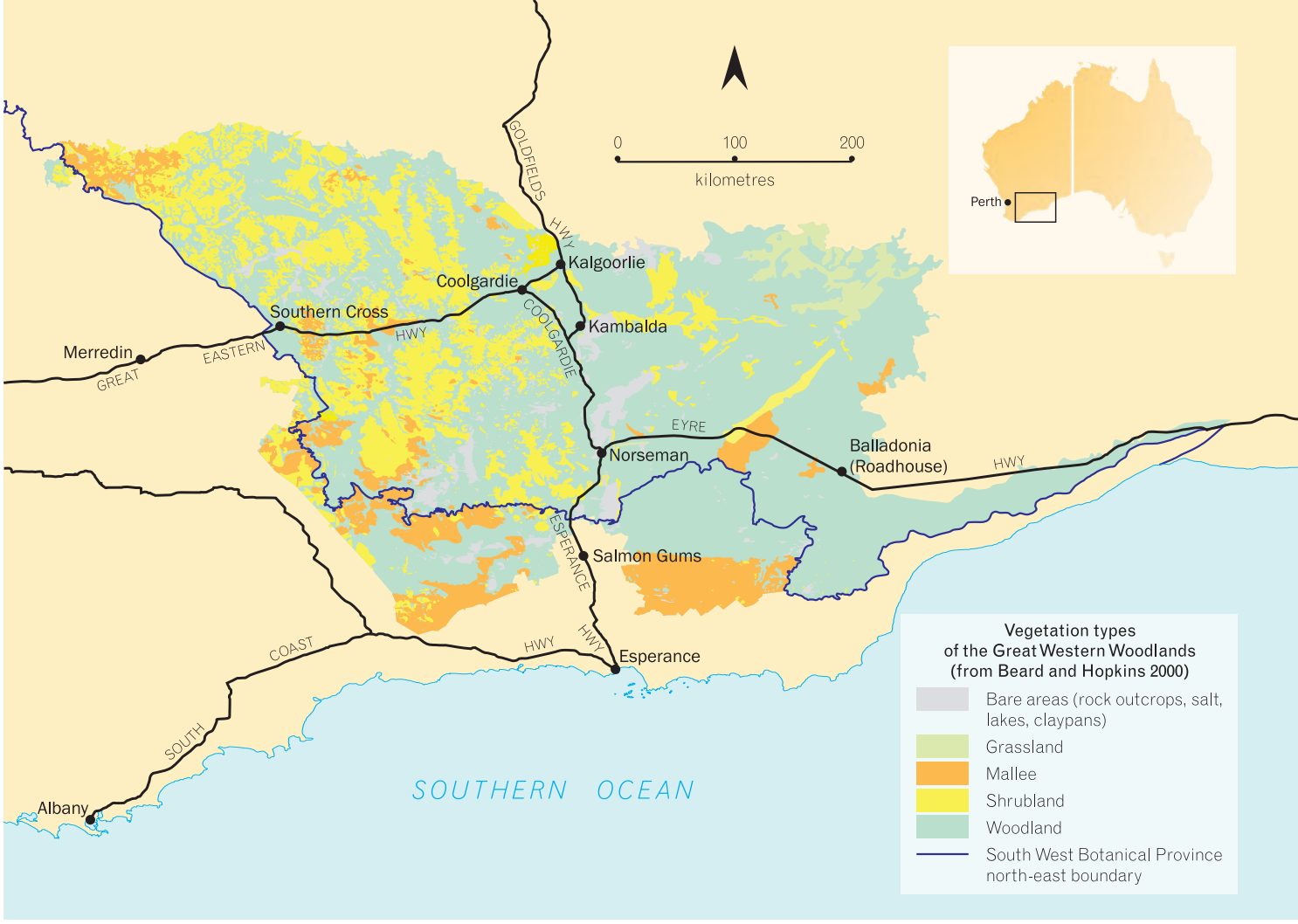
The diversity of the Great Western Woodlands has three key features. First, there are extraordinarily high numbers of species. Second, the taxonomic composition and structure of ecological communities vary greatly over short distances across the landscape. Third, the ecological processes which allow such richness and biomass to persist under such semi-arid and infertile conditions are remarkable.

The Great Western Woodlands is a global biodiversity hot spot on par with Western Australia's spectacularly diverse

Previous page
Main Salmon gum woodland in the Great Western Woodlands.
Photo – Marie Lochman
Inset Western bearded dragon (*Pogona minor*).
Photo – Jiri Lochman

Above left Pincushion hakea (*Hakea laurina*).

Left Open woodland. Large trees such as these are extremely uncommon in semi-arid areas of the world.
Photos – Amanda Keesing



south-west heathlands and forests. More than 3,200 plant species have been recorded to date, representing more than one-fifth of Australia's estimated 15,000 flowering plant species, and more than twice the number of species that occur in the whole of the United Kingdom (1,500 species). It is estimated that almost half of these species are endemic to south-western Australia.

The biological and structural diversity of plant communities across the Great Western Woodlands is known to provide different foraging, nesting or roosting habitat for an array of animals, even though relatively few comprehensive surveys have been undertaken. Forty-nine species of mammal, 138 reptile species, 14 frog species and 215 species of bird have been found in the region. Species recorded in the region include the elusive scarlet-chested parrot (*Neophema splendida*) and the Lake Cronin snake (*Paroplocephalus atriceps*), which is found nowhere else (see 'One of a kind' on next the page).

Why so many species?

The woodlands' landscape has not experienced mountain building, glacial events, or ocean submergence for some 250 million years, so these lands have a uniquely continuous biological heritage that includes the development of the first flowering plants, the coming and going of dinosaurs, and the appearance of humans. The interplay between the age of the lands, the complexity of the soils, the climate, and isolation from eastern Australia, have all combined to allow the woodlands' exceptional diversity of species to evolve.

One of the main reasons why the Great Western Woodlands is biologically significant is that it spans two climatic and botanical zones. The region is the interzone between Australia's moist, cooler south-west corner and its desert interior, which not only means that it has elements of both these climatic zones, but that enormous speciation occurs. For example, some scientists, including the Director of the Royal Botanic Gardens in Kew, Stephen Hopper, believe that variable rainfall has had a major effect on the speciation and current distribution of Australia's south-western flora. This area has experienced intense, long-term climatic pulses between wet and dry conditions over the past two million years, leaving the region with a very rich locally adapted flora.

Right The scarlet-chested parrot is one of the 215 species of bird found in surveys so far in the Great Western Woodlands. *Photo – Len Stewart/Lochman Transparencies*

At risk

For decades, the incredible diversity and beauty of the Great Western Woodlands was known

Left Lake Cronin snake.
Photo – Dave Robinson

Below left Burnt mallee.
Photo – Amanda Keesing

One of a kind

The Lake Cronin snake (*Paroplocephalus atriceps*) grows to half a metre in length, has a distinctive broad, black head and is venomous, its bite producing severe symptoms. This snake is known only from a small number of localities within the Great Western Woodlands and is believed to be endemic to the Lake Cronin area. Its very limited distribution suggests that it may have evolved to suit a specific range of conditions found only in this locality. With such a restricted range, the species is potentially vulnerable to influences such as habitat disturbance, introduced predators and the impacts of climate change, although little specific research has been conducted. The Lake Cronin snake is listed as a 'priority three' species by the Department of Environment and Conservation, meaning that further survey and evaluation of its conservation status are required before consideration can be given to its formal declaration as 'threatened fauna' under the Wildlife Conservation Act.

only to a few. That is now slowly changing as increasing knowledge of the biodiversity and importance of the region is gained. With this knowledge, however, has come the understanding that, despite its size, the Great Western Woodlands is at risk. Foremost is the threat from frequent, large bushfires that often burn for days and occur almost every year. Over time, these frequent large bushfires have the potential to alter and degrade woodland ecosystems and their associated fauna and flora.

Like much of Australia, introduced animals including foxes (*Vulpes vulpes*) are also wreaking havoc among the small mammal, reptile and bird populations that occur in the region. Thirty fauna species in the woodlands are now recognised as being in danger of extinction. Introduced weeds are another increasing problem. Weeds threaten native plant diversity and also promote the spread of fire. Pressure for minerals and other resources also has an impact on the region's biodiversity.

The environmental non-government organisation, The Wilderness Society, recognised the region was in need of conservation management and employed scientists to write a peer-reviewed report to raise the profile and identify the key values of the Great Western Woodlands. This report—*The Extraordinary Nature of the Great Western Woodlands*—was produced with support from other organisations including GondwanaLink, The Nature Conservancy, the Pew Environment Group and the Wind-Over-Water Foundation and contains contributions by more than 20 scientists. Since the release of the report, a collaboration of environmental non-government organisations has continued to work with a wide range of stakeholders to achieve better recognition and conservation of the values of the Great Western Woodlands.

Staying ahead of the game

It is a fact of conservation management that it is preferable to prevent an area from deteriorating than to attempt to 'patch it up' afterwards. Recognising that there was an opportunity to maintain the Great Western Woodlands in its relatively intact state, the WA government made a commitment to better protect and manage the area and to ensure the long-term conservation of its unique natural and cultural values.

The first step has been to develop a conservation strategy for the Great Western Woodlands. The woodlands is a multi-purpose area, so the strategy needs to take into account the full range of economic, social and cultural activities and values. The government undertook to work with Indigenous communities, the scientific community, conservation groups and industry to develop the conservation strategy.

To provide advice during this process, the Minister for Environment appointed a stakeholder reference group including representation of a broad range of interests: mining, exploration, prospecting, conservation, Aboriginal affairs, local government, pastoralism, timber harvesting and tourism. Over a series of three meetings, members discussed and workshopped a range of challenges affecting the Great Western Woodlands and developed agreed approaches to prevent any long-term deterioration of the natural and cultural values of the area.

The strategy, which was released by the Minister for Environment, Hon Donna Faragher MLC, on 3 November 2010, is a 10-year plan that aims to address key threats to the values of the Great Western Woodlands including those posed by weeds, feral animals and damaging unplanned bushfires. The government has allocated $3.8 million to enable the highest priority on-ground works identified in the conservation strategy to be completed.

Millennia of occupation

The Great Western Woodlands is steeped in history and cultural significance. Aboriginal people are believed to have lived in the area for at least 22,000 years and their close relationship with this land continues today. Aboriginal people are the original managers of the area and, according to traditional rules and customs, have responsibility for its management today and into the future. These rules and customs focus on principles of respect and preservation for long-term sustainable use. They are incorporated in the regulation of traditional use of the land's varied resources.

There are significant sites and other physical evidence of this living association throughout the Great Western Woodlands. Some of these places and artefacts—such as 'water trees'—are vulnerable to the effects of land management activities. Water trees were created when groups moving through an area jammed a rock into the fork of a sapling to create a bowl at the base of the multiple stems. As the tree grew, larger rocks were substituted until a sizable water dish was formed to provide vital pools of water in a dry landscape. These, along with trees used for spears and other implements, can be destroyed by a single fire.

Maintenance of traditional ties is vitally important to the people of the area and they have expressed a strong desire to be involved in the ongoing management and protection of the Great Western Woodlands. Joint management arrangements between the government and Aboriginal people will be pursued. Not only will this ensure that traditional knowledge helps frame management approaches,

Above right An example of a 'water tree', created by Aboriginal people.
Photo – courtesy Betty Logan and the Dimer family

Above far right Members of the stakeholder reference group discuss strategic conservation issues.
Photo – Ian Herford/DEC

Right A typical scene during the gold rush. Coolgardie goldfields, 1895.
Photo – courtesy Battye Library

but job opportunities will emerge as on-ground actions are implemented.

A new wave of settlers

The search for new pastoral lands first brought Europeans to the Great Western Woodlands. As early as the 1860s, the area's potential for pastoralism was assessed and today about 17 per cent of the Great Western Woodlands is covered by pastoral leases. But it was the discovery of the area's vast mineral wealth that was to excite the blood of a new wave of settlers.

Prospectors came to the Great Western Woodlands in the 1890s, particularly searching for gold. The discovery of gold in the Coolgardie area in 1892 attracted more people to the area and led to the discovery of the Golden Mile in Kalgoorlie the following year and to the ensuing gold rush. People arrived from all over the world to make their fortunes, with many having to walk to the goldfields from the coast. Conditions on the early goldfields were extremely harsh, with most people living in canvas and hessian huts. Supplies were limited and miners were forced to pay high prices for water and other essentials. Disease was common and many died.

A total of 1,400 tonnes of gold has been extracted from the rich 'greenstone' ores, more than from any other single source in Australia. The mining sector is the major employer in the goldfields and provides the economic base for its residents, with nickel and other resources being extracted in addition to gold. With a workforce in the Goldfields-Esperance Region of more than 4,500 in 2006, the industry here accounted for more than 11 per cent of the WA mining workforce.

Woodlines

There is also a wealth of history associated with the early days of the mining industry in the goldfields. The history of mineral extraction and processing in the Great Western Woodlands is closely intertwined with the exploitation of local timber resources. From the 1890s, woodland timbers were cut to supply fuel to roast ore during the gold extraction process and for pit props for mines. Firewood was also essential for pumps and winders, production of fresh water in condensers, pump stations along the water pipeline, electricity generation and domestic use.

Transported on an extensive narrow-gauge rail network known as the 'woodlines', which radiated from Kalgoorlie, more than 30 million tonnes of hardwood timber were harvested between the 1890s and the 1960s. It is estimated that one-fifth of the Great Western Woodlands was impacted. Immigrants, mainly from

Above left Tourists panning for gold.
Photo – Dennis Sarson/Lochman Transparencies

Left A woodline track today, regrown since earlier clearing.
Photo – Amanda Keesing

Above Victoria Rock.
Photo – Dennis Sarson/Lochman Transparencies

Above right Salmon gum woodland.
Photo – Jiri Lochman

Survivor in an arid land

One of the most prominent trees of the Great Western Woodlands is the salmon gum (*Eucalyptus salmonophloia*). These majestic salmon-pink trees, which grow to more than 25 metres in height and more than two metres in diameter, stand out in the flat landscape. Trees of this height are common throughout the world in places with higher rainfall, but not in arid areas. In the Great Western Woodlands, they manage to attain this significant size in country which receives as little as 150 millimetres of average annual rainfall. Scientists are still not exactly sure how salmon gums manage to grow so tall in such dry and variable conditions. It is likely that the trees are able to make use of both rainfall and groundwater, but further research is required to solve the puzzle.

Europe, came to the goldfields to cut and haul timber and lived in extremely harsh conditions at the limits of the rail network, known as the 'head of the line'. The many historical sites associated with the woodlines deserve to be protected as an important part of the Great Western Woodlands' heritage. Although most of the three million hectares which were cut-over have regrown, the ecological impacts of the woodline cutting are still evident in some areas.

Spreading the word

Mosaics of woodlands and flowering heaths, rock formations and a diverse range of flora and fauna exclusive to the Great Western Woodlands combine to provide a seemingly untouched escape for travellers and locals alike. The Great Western Woodlands is an important recreational destination for residents of the area. Activities such as four-wheel driving, prospecting, bush camping and yabbying in pastoral dams are popular with local people.

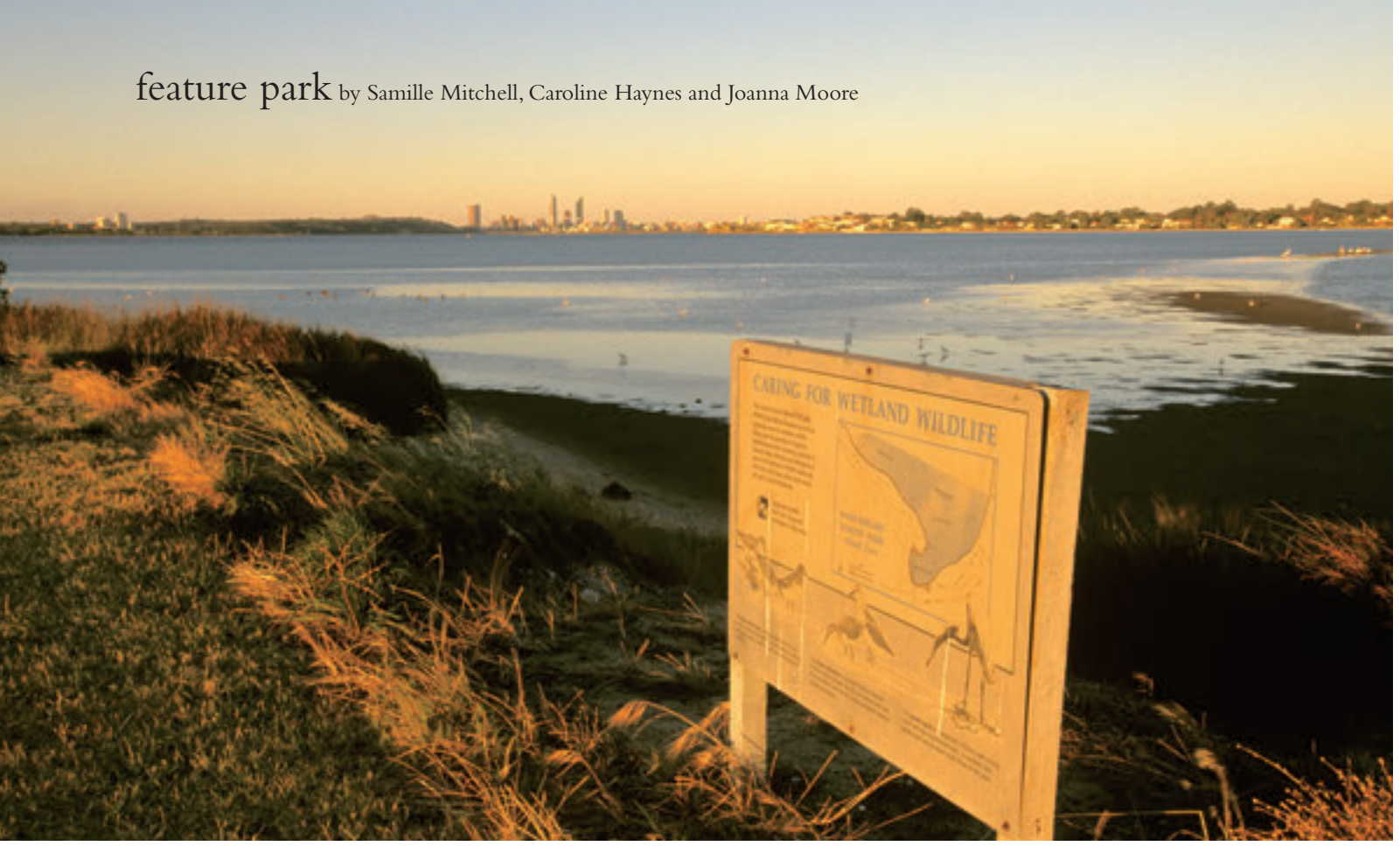
Popular drive trails such as the Holland Track, Granite Woodlands Discovery Trail and Golden Quest Discovery Trail, all of which traverse the Great Western Woodlands, help promote the area and draw increasing numbers of tourists. Some recreation sites have been developed at places of interest, with low-key management.

Despite its obvious potential as a tourism destination, the Great Western Woodlands is currently not well known nationally or even within WA. To a large extent, the wonders of the area are still a well-kept secret shared by those lucky enough to live within it and the adventurous few who visit.

The release of the conservation strategy for this internationally significant area, along with greater promotion, will introduce the delights of this treasure trove of biodiversity and cultural values to many more tourists. This will be a bonus for the individuals who visit, and also for the economy of the region.

Ian Herford is the Department of Environment and Conservation's project coordinator for the Great Western Woodlands. Based in the department's Albany office for most of the past 21 years, Ian has coordinated planning processes for management of the conservation estate as well as at a strategic level across broader areas. He can be contacted by email (ian.herford@dec.wa.gov.au).

Dr Alexander Watson is the national program manager for the non-government organisation *Leave No Trace*. He has more than 10 years' experience working with Western Australia's forest and woodland biodiversity, including being the lead author of the report *The Extraordinary Nature of the Great Western Woodlands*. He can be contacted by email (watson.alexander@gmail.com).



Swan Estuary Marine Park

The sparkling waters of the Swan River are an iconic Perth attraction. People walk and cycle the many paths that line its banks, picnic upon its shores, canoe, kayak, sail and boat on its waters. But what of the plants and animals that rely on it, not merely for admiration and recreation, but for survival?

Above Alfred Cove, one of the three sites that make up Swan Estuary Marine Park.
Photo – Marie Lochman

Swan Estuary Marine Park protects three different areas within the Swan River. It is made up of 190 hectares at Alfred Cove, adjacent to Attadale and Applecross, a 40-hectare parcel at Pelican Point in Crawley and 95 hectares at Milyu, adjacent to the Como foreshore and Kwinana Freeway.

Traditionally, Nyoongar people who camped along the Swan River were drawn to areas which combined freshwater, terrestrial and estuarine environments. Pelican Point was a popular camping, fishing and hunting site for the Mooro tribe at the time of colonial settlement. Remains of traditional fish traps have also been found at Milyu.

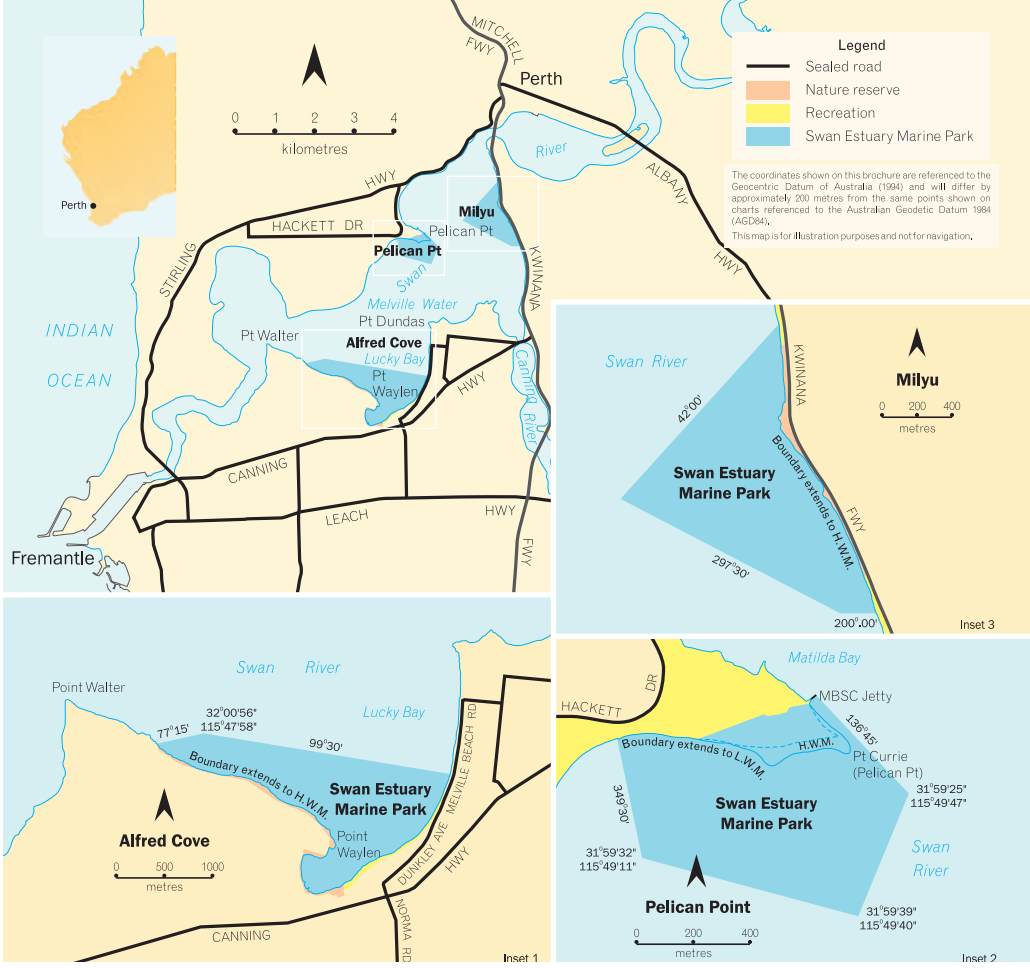
Natural attractions

Milyu is the Aboriginal name for samphire—a small native plant that once dominated this shoreline. Today, only small pockets of samphire remain because of the introduction of foreign grasses and other plants as well as degradation from past land uses and development. Samphires have evolved over thousands of years to survive harsh and ever changing environmental conditions. Milyu and Alfred Cove now support the only two significant areas of essential samphire flat habitat within the Swan River Estuary.

Along with samphires, many endemic plant species have been lost from these areas, damaging their ecological integrity. Ongoing restoration programs in the nature reserves are ensuring gradual rehabilitation and will help provide improved habitat for birds and the other species that frequent these areas.

In particular, the areas provide a haven for migratory birds. These feathered visitors travel from as far afield as Siberia and Mongolia to reach the Swan River's shores. Up to 10,000 migratory wading birds visit each summer. Of these birds, 33 species of wader are protected under international treaties. Most birds are seen from August to the following March.

Life below the water's surface is also biologically important. The river is home to numerous seagrass species,



Top Large egret (*Egretta alba*).
Photo – Jiri Lochman

Above Wetland area near Applecross.
Photo – Marie Lochman

Below right Purple-tipped tube anemone.
Photo – John Butler/Lochman Transarencies

anemones, tubeworms, nudibranchs, octopus, crabs, prawns, catfish, mussels, seahorses and bottlenose dolphins (*Tursiops aduneus*).

Exploring the park

Alfred Cove is the largest and most important of the three areas that make up the marine park and has vantage points for viewing more than 140 species of bird. The southern end of Troy Park provides a boardwalk and accessible viewing of a multitude of bird life including black swans (*Cygnus atratus*), pelicans (*Pelecanus conspicillatus*), many species of duck and the majestic osprey (*Pandion haliaetus*) which nest here. Many more species also frequent the shallow, well-vegetated river basin in this area and roost on the sandbars. An interpretive trail at this site may be followed to learn more about the area and its inhabitants. Enjoy wandering along the foreshore but remember to minimise disturbance to nesting birds by leaving your dog at home and treading lightly.

Seagrass beds adjacent to the mudflats support many of the animals which the waders depend on for food, and they are an important nursery area for fish and prawns. Alfred Cove is also a hunting ground for ibises, egrets and other rarer waterbirds such as spoonbills. Due to the stunning vistas and proliferation of birdlife in the reserve, photography is a popular pastime with visitors to the area.

You can also see the birds and take in views of the mudflats from Australia II Drive at Pelican Point and from the beach or foreshore path at Milyu, also a popular cycling route. Windsurfers can head to the popular launch point of Melville Beach Road on the foreshore at Applecross.

Swan Estuary Marine Park is zoned for general use, which means that people are allowed to fish anywhere in the marine park as long as they comply with Department of Fisheries rules and regulations such as bag limits.

There are many ways to get involved with ensuring the continued health of Swan Estuary Marine Park, its adjacent nature reserves and their wide diversity of inhabitants. Birds Australia conducts a twilight birdwatching walk and other activities weekly, while community members, government agencies, university students and other volunteers are involved in rehabilitation works along each section of the reserve foreshore.

For more information on these programs, to get involved or for any information on the area contact Department of Environment and Conservation Marine Ranger Caroline Haynes on 0412 893 801.

park facts

Where is it? Swan Estuary Marine Park is made up of 190 hectares at Alfred Cove, adjacent to Attadale and Applecross, 40 hectares at Pelican Point in Crawley and 95 hectares at Milyu, adjacent to the Como foreshore and Kwinana Freeway.

Total area: 325 hectares.

What to do: Birdwatching, fishing, windsurfing, kayaking, photography, volunteering.

Park fees: No entry fees apply.

Relevant DEC office: Hillarys Office, 2/45 Northside Drive, Hillarys Boat Habour, phone (08) 9405 0780.

by Brent Johnson

New island home

Few would guess that islands once used to test atomic bombs would become refuges for threatened species. Populations of mammals and birds recently translocated to Hermite Island, in the Montebello Islands group in the state's north-west, are so far thriving in their new homes.

At precisely 8am on 3 October 1952, a momentous flash and closely following roar shattered the tranquility of a little-known island group 120 kilometres off the Pilbara coast in northern Western Australia. After one second, the mushroom cloud had reached 500 metres into the sky and after about four minutes had billowed past 3,000 metres. Following the massive impact of the supersonic pressure wave, large amounts of sand, water and solid fragments of warship fell across much of the nearest island. To most observers, this was a unique and awe-inspiring event:

"At the end of the countdown, there was a blinding electric blue light, of such an intensity I had not seen before or ever since. I pressed my hands hard to my eyes, then, realised my hands were covering my eyes. This terrific light power, or rays, were actually passing through the tarpaulin, through the towel, and through my head and body, for what seemed ten to twelve seconds, it may have been longer. After that, the pressure wave [hit], which gave a feeling such as when one is deep underwater. This was then followed by a sort of vacuum suction wave, to give a feeling of one's whole body billowing out like a balloon."

Anonymous observer

The first British atomic bomb test, codenamed 'Hurricane', had just been conducted on Australian soil. Great Britain was now a nuclear power as it strived for equal footing on the world stage with the USA and Russia.

Blasted to fame

This virtually unknown island group was now front-page news and the name Montebello would become well known to that cold war generation following two more tests, codenamed 'Mosaic' in May and June 1956.

While the Hurricane test had involved the atomic weapon being placed below the waterline in HMS *Plym*, an aging British Navy frigate, the Mosaic devices were mounted on towers situated on Trimouille and Alpha islands, within the Montebello Islands group. The later explosion officially yielded 60 kilotons (an explosive force equal to that of 60,000 tonnes of TNT), with some estimates of up to 98 kilotons, and created a 15,000-metre-high mushroom cloud. It was the largest atomic test in Australia and was about five times bigger than the devastating atomic bomb dropped on Hiroshima in 1945.

After these tests, the Montebello Islands remained a prohibited area and the frenetic military activity and tumultuous events faded into history, allowing the area to slowly recover with little human intrusion. In 1992, the Commonwealth Government decided to hand control back to the WA authorities as radiation hazard assessments had given assurances that residual radiation levels had fallen and most of the islands were safe for human visitation. It was considered the ground zero areas should have ongoing limited access.

The intervening years had seen the islands visited mainly by commercial and recreational fishing boats and pearl

Previous page
Main The ruin of the British atomic testing observatory stands sentinel over the islands.
Photo – Judy Dunlop/DEC

Above left The Hurricane test of 1952 was the first of three atomic detonations at the Montebellos.
Photo – courtesy British Government archives

Left Montebello Islands.
Photo – David Bettini

farm operators. The area's isolation, lack of facilities and landing restrictions confined most visitors to boat-bound activities. Cyclonic activity also is a seasonal consideration for visitors. In recent times, cruising yachts and charter vessels have become a more familiar sight in the numerous calm anchorages.

There has also been a dramatic increase in interest and activity in gas and oil exploration throughout the surrounding area. The islands lie within the Northwest Shelf oil and gas production zone and are now surrounded by industry infrastructure that supports this highly valuable industry.

Subsequently, the numerous islands and islets that comprise the group have become Montebello Islands Conservation Park and the surrounding waters a marine park (see 'Montebello and Barrow Islands Marine Conservation Reserves', *LANDSCOPE*, Winter 2004). The islands are vested with the Conservation Commission of Western Australia, and the marine reserves with the Marine Parks and Reserves Authority. All are managed by the Department of Environment and Conservation (DEC). The terrestrial and marine reserve areas are managed in a complementary way, involving close cooperation between agencies, including DEC and the Department of Fisheries.

Above Intertidal mudflats can link some islands at low tide.
Photo – Judy Dunlop/DEC

Right Alpha Island was the site of the largest atomic test conducted on Australian soil.
Photo – Brent Johnson/DEC

Conservation beginnings

Long before the atomic testing, the original mammal fauna of the islands had suffered local extinction or severe declines due to the introduction of feral cats (*Felis catus*) and black rats (*Rattus rattus*). In 1912, the Montague expedition to describe the natural history of the islands had predicted such extinctions when they detected the presence of cats on the islands. Black rats have been implicated in declines of breeding sea and land birds on islands throughout the world. It is thought both these destructive species arrived with the pearling vessels that visited the islands in the late 19th and early 20th century. Amazingly, they appeared to survive the atomic testing later on.

Those native animals that survived the nuclear weapons testing and introduction of exotic mammals included 21 terrestrial reptile species and more than 50 bird species. Despite anecdotal evidence that they suffered considerable population loss from radiation contamination, green (*Chelonia mydas*) and hawksbill (*Eretmochelys imbricata*) turtles also commonly nest on the northern islands.

The then Department of Conservation and Land Management (CALM), one of DEC's predecessor departments, commenced the *Montebello Renewal* project in 1994, part of the statewide *Western Shield* fauna recovery program. The project for the Montebello Islands group was aimed at removing the threats to native fauna and ultimately returning some of the original species to the islands.

The first step was to eradicate the introduced black rats from every island. This involved coordinating materials, staff, helicopters and boats on a considerable scale. CALM *Montebello Renewal* project leader Dr Andrew Burbidge was responsible for this enormous planning and logistical task and, by 2001, the islands were declared rat free (see 'Montebello Renewal', *LANDSCOPE*, Summer 1996–97). During this period it was discovered that feral cats had persisted only on Hermite Island, the largest in the group. The last feral cat was removed from this island in 1999 following an intensive eradication program undertaken by DEC's Science Division.

Prior to the completion of these tasks, two native species had already been introduced to the Montebellos. Both Trimouille and North West islands had been cleared of rats in the first eradication work in 1996. Two years later, 30 mala, or rufous hare-wallabies (*Lagorchestes hirsutus*), were flown 1,500 kilometres from the Tanami Desert and released onto Trimouille Island and soon after, in 1999, djoongari, or Shark Bay mice (*Pseudomys fieldi*), were released onto North West Island. Subsequent monitoring of these two species has confirmed both colonies are thriving in their new environment and, in doing so, are providing excellent insurance for the ongoing wellbeing of these two threatened mammal species. It is expected these colonies may also provide source populations for more translocations.

Gorgon—the great Barrow airlift

The start of the Gorgon gas project on nearby Barrow Island, the biggest industrial development in Australia's history, was highly publicised (see 'Giant steps: industry and conservation make history through Gorgon', *LANDSCOPE*, Winter 2010). Well before approval was given for the project, negotiations were under way for the preparation of a Threatened Species Translocation and Reintroduction Program that would form part of the environmental conditions for final approval. Included in this were proposals to return the golden bandicoot (*Isoodon auratus*) and spectacled hare-wallaby (*Lagorchestes conspicillatus*) to Hermite Island in the Montebello group, along with two bird species that had also become locally extinct.

Top left This spinifexbird was fitted with an identification band prior to release on Hermite Island.

Centre left The use of helicopters was critical to the success of the translocations.

Left DEC officers Sean Garretson and Brent Johnson begin an early morning search for the released mammals.
Photos – Judy Dunlop/DEC

Hermite Island is just 20 kilometres from Barrow Island. The islands are within the same biogeographical region and have very similar habitat. The two birds—the spinifexbird (*Eremiornis carteri*) and black and white fairy-wren (*Malurus leucopterus leucopterus*)—along with golden bandicoots and spectacled hare-wallabies, are all abundant on Barrow Island and removal of the relatively small numbers required to start the translocation would have little detrimental impact on those populations.

At 1,020 hectares, Hermite Island is the largest island in the Montebello group and all four species were known to exist there before the arrival of cats and black rats. The island has a highly convoluted coastline, rugged terrain and no vehicle access. There is no fresh water, it has a low rainfall with occasional downpours from episodic cyclones and is very hot for much of the year. Much of the vegetation is low-lying spinifex with clumps of taller *Acacia*. Introduced buffel grass (*Cenchrus ciliaris*) is also present in areas disturbed by the British military in the 1950s. Good quality mangrove stands exist in some intertidal zones.

Accommodation and storage facilities were established on Hermite in the early 1990s for departmental staff working on the islands, although cyclones and corrosion have caused serious deterioration in recent times. Following refurbishment, these facilities were ideally suited to become the headquarters for the translocation program and ongoing management of the area.

Following the rapid mobilisation of qualified staff and equipment, fauna translocation teams proceeded to their assigned locations and tasks in late January 2010. The team on Barrow Island worked tirelessly during the four-week period capturing, selecting and processing mammal species found on the soon-to-be-cleared gas plant site. Golden bandicoots and spectacled hare-wallabies were transported by helicopter to Hermite Island at regular intervals throughout this period. By the end of this phase, some 161 bandicoots and 111 hare-wallabies had arrived safely at Hermite.

Then, each evening, the DEC fauna team on Hermite Island carried the new arrivals out to selected areas

Above right DEC researcher Brent Johnson prepares to release a spectacled hare-wallaby on Hermite Island.
Photo – Judy Dunlop/DEC

Right Spectacled hare-wallabies quickly found food and refuge upon release.
Photo – Adrian Wayne/DEC

Below Golden bandicoots have rapidly increased in number and colonised areas some distance from release sites.
Photo – Judy Dunlop/DEC

Above Dawn breaks over new beginnings at the Montebello Islands.
Photo – Brent Johnson/DEC

Below right Hermite Island.
Photo – Judy Dunlop/DEC

and, following another check on their wellbeing, released them into their new habitat. There were no deaths or injuries recorded during the transportation and release phase and all the mammals quickly started exploring their new surroundings.

The second phase, in May 2010, involved the capture and translocation of the two bird species. This was undertaken by DEC bird specialists and involved the capture and selection of suitable spinifexbirds and black and white fairy-wren individuals on Barrow Island followed by a short helicopter ride to Hermite. More than 30 individuals of each species were translocated in this first phase and follow-up monitoring will determine whether they establish populations on the Montebellos.

New life on Hermite

The released mammals were monitored throughout February and on subsequent visits, and, by a major monitoring session in May 2010, all radio-collars had been removed. Trapping of individuals showed significant weight gain by the two species, extremely high survivorship and strong breeding activity. Weight gains in particular have been remarkable. Many golden bandicoots doubled their body weight in the first three months. The population average weight of this species upon release was 240 grams and, by May 2010, had increased to 430 grams, an 80 per cent increase.

Members of the bandicoot family and several other native mammals are known to be excellent ecosystem engineers, creating soil disturbance and improving water nutrient recycling which is highly desirable for landscape productivity. The long-undisturbed topsoil of Hermite Island quickly showed signs of such activity, with tracks, droppings and diggings becoming apparent within weeks. Some animals explored considerable distances while others stayed within the vicinity of their release site. Both species have been recorded in all habitat types present on the island, except mangroves. All these indicators suggest that there is abundant food on the island and almost no competitors for resources. Likewise, predators are limited to native species such as goannas and raptors and these appear to have had little or no impact at this stage.

Renewal

While these translocations are still in their infancy, early evidence suggests that they will be successful. Should some catastrophe befall populations on Barrow Island, Hermite Island should provide additional secure populations of spectacled hare-wallabies, golden bandicoots and the two bird species.

The translocation also fulfills the responsibility to return native species to parts of their former range once all threats have been removed and the habitat allowed to sufficiently recover. It is hoped that the species' integral roles in landscape productivity and natural cycles will help in the complete restoration of the Hermite Island ecosystem.

The Montebello Islands have endured some of the greatest impacts of any place on Earth, and yet the cycle of recovery and renewal is no longer a vision but a reality.

Brent Johnson is a Department of Environment and Conservation (DEC) principal technical officer undertaking fauna conservation on the Montebello Islands. He can be contacted at DEC's Wildlife Research Centre in Woodvale on (08) 9405 5106 or by email (brent.johnson@dec.wa.gov.au).

The author would like to acknowledge Chevron Australia and Jayrow Helicopters as well as DEC officers Ann Biasol and Rob Connell and staff from DEC's Pilbara Region and Science Division who have greatly assisted with the project.

Camera traps

paparazzi in the bush

During the 100 years that people have been using camera traps to photograph animals in their natural environments the devices have changed dramatically. These days the technology is well advanced and capable of contributing significantly to conservation efforts.

by Neil Thomas, Brian Macmahon and Nicky Marlow

When you think of a trap you generally think of something that physically restrains an animal allowing you to directly handle it. Camera traps, on the other hand, do not restrain the animal but take a remote candid photograph of the subject. The animal itself triggers the camera by either pulling on a baited wire, moving a trip wire, treading on a trigger plate, or setting off a photo-electric sensor.

Not so flashy beginnings

Wildlife photographers have been using camera traps since the early 1900s to photograph everything from birds to large carnivores. The early camera traps were bulky and unreliable, and could only take a single photograph per trigger event. As a result, they were only used by very dedicated wildlife photographers. There was also concern about the welfare of the photographed animals as the light source was magnesium flash powder which not only resulted in very bright light but produced a pyrotechnic explosion likened to a 'small cannon report'. However, one of the earliest pioneers of camera traps highlighted the future conservation value of the camera when he said:

> "Every camera hunter must admit that the immediate and lasting pleasure is better afforded in ranking a running deer from stem to stern, at twenty yards, with his 5 x 7 bore camera than driving an ounce ball [bullet] through its heart at 100 yards."
>
> George Shiras III, 1906

It was not until the mid-1950s that the first camera traps were used by the scientific community and, although these were successful in recording information about their subject matter, they were still unreliable, often cumbersome, and required regular servicing (such as changing film). They were generally purpose-built by the researchers and, in many cases, could still only take one photograph per trigger event.

As camera technology improved with the development of fully automated cameras so did camera traps, particularly with the incorporation of infrared flashes and triggers. However, the improved camera traps still had major limitations—they were expensive, were prone to mechanical failure and required regular servicing as false triggers could consume all the film in a very short time. Despite these shortcomings, camera traps had proved to be a vital tool in monitoring elusive species, particularly large cat species such as tigers (*Panthera tigris*), where the animals' unique coat patterns could be used to identify individuals.

With the development of digital technology there was a rapid expansion in the use of camera traps, principally in the USA. This was not in wildlife research but by weekend hunters using the cameras to establish where trophy game may be found, before the start of the hunting season. As a result, there was a proliferation of web forums on how to modify and build your own digital camera traps and it was not long before there were commercially available digital camera traps, often referred to as game or trophy cameras.

Previous page
Top Camera traps photograph animals such as woylies.
Bottom A camera trap in the field.
Photos – Neil Thomas/DEC

Above A bilby in its natural habitat.
Photo – Jiri Lochman

Left A camera trap set up outside a bilby burrow.
Photo – Neil Thomas/DEC

Right Camera traps provided new information on animals in Dryandra Woodland.
Photo – Marie Lochman

Below Checking images on a camera trap.
Photo – Sallyanne Cousans

Below right A feral cat recorded by a camera trap.
Photo – Neil Thomas/DEC

Cats through the lens

Early in 2003, a senior technical officer at the then Department of Conservation and Land Management's (later the Department of Environment and Conservation's—DEC's) Wildlife Research Centre, John Angus, started investigating the feasibility of using commercially available digital camera traps to photograph feral cats (*Felis catus*). Feral cats are notoriously difficult to physically trap and nearly impossible to re-trap. Camera traps were seen as a possible technique to obtain multiple 'captures' of feral cats, which could be used to identify individual cats according to their markings and thus map their movements.

However, John found that many of the commercially available camera traps had poor resolution and a slow trigger time (the time between detecting the animal and taking the photograph), which in some cases resulted in the animal leaving the field of view before the photograph was taken. To overcome these problems, he started building his own cameras, modifying standard digital cameras by incorporating a control board that remotely triggered the camera when a passive infrared sensor detected movement of an animal. These proved to be very effective in photographing not only feral cats but other feral and native species.

Capturing bilbies at Dryandra

Research staff at DEC's Wildlife Research Centre then decided to investigate the use of camera traps to monitor one of the more elusive native marsupials, the bilby or dalgyte (*Macrotis lagotis*). This work was done at Dryandra Woodland, a re-introduction site for bilbies. Bilbies are difficult to monitor using traditional techniques. They do not readily go into standard cage traps and other accepted monitoring techniques, such as track counts, were not practical at Dryandra Woodland due to the lack of suitable sand. Late in 2005, camera traps were deployed at a number of bilby burrows throughout Dryandra resulting in numerous photographs of bilbies and other native fauna. Despite the bilbies being a nocturnal species, the cameras showed they were active up to half an hour after sunrise.

This initial work at Dryandra highlighted how effective camera traps could be in monitoring elusive animals, as well as highlighting some of the problems associated with using them. One of the major problems was the flash. Despite the native fauna being apparently oblivious to the white flash, feral species were startled. If feral species were to be monitored using camera traps this needed to be resolved. Fortunately, commercially available camera traps had by then improved markedly, with improved trigger times, higher resolution and infrared flash technology incorporated. A small downside of the infrared flash and filter is that the resulting photograph has a slight crimson colouration.

Above Brushtail possum.
Photo – Jiri Lochman

Above left A fox recorded taking a bait at night.
Photo – Neil Thomas/DEC

Below left Camera trap set-up.

Below Quenda.
Photos – Sallyanne Cousans

Woylie decline in focus

In 2006, DEC started a major study, the Mesopredator Project, to investigate the recent decline in woylie (*Bettongia penicillata*) numbers in the south-west of Western Australia (see 'Down but not out: solving the mystery of the woylie population crash', *LANDSCOPE*, Winter 2008). Although the reasons for the decline were unknown, there were a number of potential causes including increased predation from native predators, such as carpet pythons (*Morelia spilota imbricata*) and wedge-tailed eagles (*Aquila audax*), or feral cat predation, disease, and the current baiting regime becoming less effective in controlling foxes (*Vulpes vulpes*). Camera traps were seen as a vital tool in investigating whether the 1080 meat baits used to control foxes were still effective.

A significant number of cameras was needed to adequately monitor the baiting effectiveness. A team of researchers deployed up to 50 camera traps in the field every few months to photograph what was happening to the baits. Some 13,500 photographs later, there was evidence that not only were foxes taking the baits, but a myriad of native fauna were also taking them, including quenda (*Isoodon obesulus*), woylies, bobtail lizards (*Tiliqua rugosus*), goannas (*Varanus* spp.) and meat ants. However, the main culprit was the brushtail possum (*Trichosurus vulpecula*), which took up to 50 per cent of the available baits on the first night they were deployed. Brushtail possums and other native fauna have developed a high tolerance to the 1080 poison used in fox baits. On average, an adult possum found in Dryandra Woodland would have to consume nearly 65 fox baits in a short timeframe to get a lethal dose, whereas a fox only needs to eat one 1080 bait. This tolerance to the poison 1080 occurs in many native animal species in south-west WA as the animals have co-evolved with poison bush (*Gastrolobium* spp.), which naturally contains this poison.

Despite possums taking many of the baits, other work showed the baiting program was still very effective in controlling foxes. There were still baits available and there were many photographs of foxes taking them. Of more concern to the woylies was the number of feral cats photographed and, despite many of them photographed investigating baits (and even one cat playing with a bait), no feral cat was photographed taking a bait. The photographs showed a variety of coat

colours and markings so that some feral cats could be individually identified and their movements followed as they moved throughout the reserve.

Cameras and conservation

Digital camera traps are a relatively new conservation tool and, as they have become more readily available, sophisticated and affordable, they are becoming a mainstream tool in conservation work. In recent times, there has been a rapid uptake in their use in ecological work, where they are seen as a reliable method of monitoring rare and cryptic species such as bilbies. They are also seen as a very simple tool for undertaking inventories of species that may be found in an area.

Recently, commercially available camera traps have improved remarkably—for example, movable infrared filters now result in clear daytime photographs and black and white night photographs. They can now be deployed into the field for several months at a time, taking hundreds to thousands of photographs, with the main limitations being the size of the memory card and the need for a power supply. The power issue can be solved with some camera traps now having solar panels.

Camera traps do have limitations. One of these is that, unless the target species has unique markings, it is not possible to identify individual animals from the photographs, and this means no reliable estimates of numbers of animals found in an area can be made. Also, small animals can move around some camera traps without detection, particularly if the camera trap is not set up correctly. Heat, wind, poorly mounted or positioned cameras, and even shadow movement can cause the camera trap to take numerous spurious photographs. So, although seen as an addition to the conservation arsenal, camera traps do not replace the wildlife ecologist going out into the field and undertaking the fundamental research of trapping and physically examining and marking individual animals.

Above Tammar wallaby.

Below left A bilby photographed by a camera trap at night.
Photos – Neil Thomas/DEC

Bottom left Preparing a camera trap set-up.
Photo – Andy Williams/DEC

Another early pioneer of the camera trap best explained the delight in using the cameras (despite their initial shortcomings), when he said:

> "If there be any sport in which the joys of anticipation are more prolonged, the pleasures of realization [sic] more enduring, than that of camera trapping ... I have yet to find it!"
>
> Frank M Chapman, 1927

As camera trap technology improves and more work is undertaken in analytical methods, there will be more and varied use of camera traps with just as much anticipation in the resulting photographs as found by the earliest pioneers of the camera trap. There will be no escaping the bush paparazzi!

Neil Thomas is a research scientist with the Department of Environment and Conservation's (DEC's) Science Division based at the Wildlife Research Centre in Woodvale. Neil has more than 25 years' experience undertaking threatened native fauna and feral species research throughout Western Australia. He can be contacted by email (neil.thomas@dec.wa.gov.au).

Brian Macmahon was seconded from DEC to the Invasive Animals Cooperative Reserch Centre for the Mesopredator Project. He is based in Narrogin and has been working in the district for some 20 years, gaining extensive experience in reserve management, fauna monitoring and feral species control techniques. He can be contacted by email (brian.macmahon@dec.wa.gov.au).

Nicky Marlow is a senior research scientist at DEC's Science Division also based at the Wildlife Research Centre in Woodvale. Nicky has more than 25 years' experience working throughout WA on fox control methodologies and threatened fauna research. She can be contacted by email (nicky.marlow@dec.wa.gov.au).

The authors would like to thank the Invasive Animals Cooperative Research Centre for providing funding for the Mesopredator Project, Lions Dryandra Woodland Village caretakers John Lawson and Lisa Richards and DEC's Narrogin District for their support and assistance with the project.

Biodiversity of the Western Desert:

looking after country with the Martu traditional owners

by Alison McGilvray and Peter Kendrick

It was only 50 years ago that the Western Desert's traditional owners, the Martu, had their first encounter with European people. Now they are using western scientific methods to manage their traditional lands.

The Martu are the traditional occupants of Western Australia's remote Western Desert region. Martu is the collective name for 12 language groups of desert people whose land covers about 20 million hectares—almost the size of Victoria. Most of the Western Desert is now held by the Martu and Birriliburu under native title determinations. It extends across the Little Sandy and Great Sandy deserts, the Gibson Desert and parts of the Gascoyne and Murchison regions. These deserts—which are lucky to receive an average of 250 millimetres of rain per year—have been home to the Martu for thousands of years. Martu people are integrally linked to the health of their country.

Now, with the support of two Indigenous organisations, the Department of Environment and Conservation (DEC), CSIRO and Rangelands Natural Resource Management (NRM) Coordinating Group, Martu people are taking part in a number of land management projects that improve knowledge of the biodiversity of the Western Desert, while also providing local employment, empowerment and health benefits.

Martu country

Australia's deserts were much larger about 16,000 to 18,000 years ago, during the last glacial maximum. Rainfall was reduced, and strong winds transported sand, salts and fine sediments across the land. As Australia and the world have moved into the present, more humid interglacial period, the inland deserts have contracted to their present extent. The vegetation on Western Desert dune systems stabilises the sand, reduces erosion and provides a rich and diverse habitat structure for animal species.

Despite its desert status, the Western Desert often abounds with life and has long provided sustenance for the Martu people. At least 10 threatened mammal and reptile species surviving in the Western Desert are listed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. These include the greater bilby (*Macrotis lagotis*), great desert skink (*Egernia kintorei*), northern and southern marsupial mole (*Notoryctes caurinus* and *N. typhlops*), mulgara (*Dasycercus blythii* and *D. cristicauda*) and the black-flanked rock wallaby (*Petrogale lateralis lateralis*). Most of these species are now extinct through the majority of their former range.

There are groves of desert oak trees and wide vistas of grassy sand plains set among vibrant iron-rich soils and brilliant skies. Some plant species have not been well recorded or collected and are poorly known to European scientists. However, the flora, together with animal species and desert places, has special significance to the Martu, who hold deep knowledge and understanding of country, and its plants and animals. This is held in the Dreaming stories of the desert peoples.

Wetlands also provide refuge habitat for aquatic flora and fauna and resting areas for migratory birds,

Previous page
Main Western Desert landscapes.
Photo – Alison McGilvray/DEC
Inset Birriliburu land management workers at Carnarvon Range.
Photo – Mark D'Lima

Above Great Sandy Desert.
Photo – Jiri Lochman

Left Marsupial mole.
Photo – Stan Breeden/Lochman Transparencies

Above Some of the Jigalong tracking team. *Photo – Joy McGilvray*

Below right Parnngurr ranger coordinator Richard Goonan shows Yanjimi Rowlands and Vincent Campbell the techniques for reading the turbidity (suspended particle matter) of a water sample from Georgia Bore.

Below left Sunrise at Punmu community. *Photos – Alison McGilvray/DEC*

enabling them to fly long distances to move across the continent. For example, the pools of the Durba Hills and Rudall River system which flows through Karlamilyi National Park are recognised as nationally important wetlands. Freshwater rockholes, springs and soaks support ferns, sedges, rock figs and aquatic invertebrates.

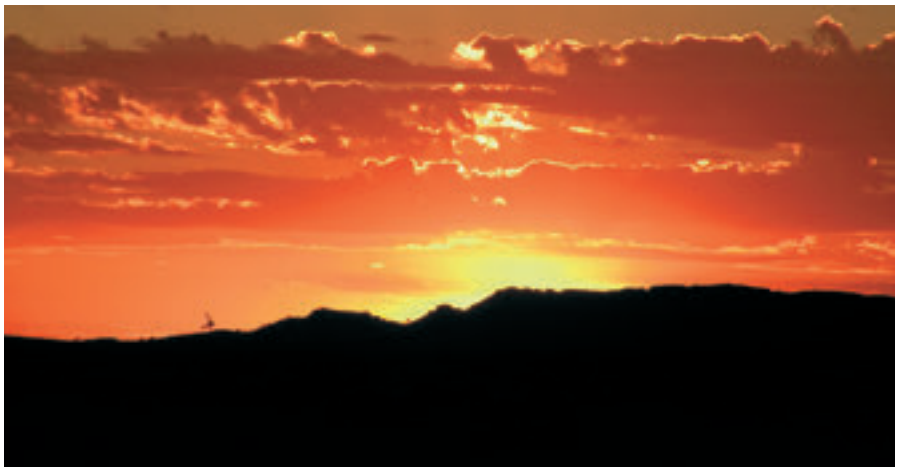
Looking after country

Recently, Martu people have become actively involved in managing country to protect and maintain biodiversity through partnerships between state and Commonwealth agencies and native title and Indigenous representative groups. DEC has worked with Martu people since the late 1980s on nature conservation programs, in particular with Martu from Jigalong on a recovery project for the threatened black-flanked rock wallaby in the southern part of Martu country.

In 2009, Rangelands NRM secured Commonwealth *Caring for our Country* funding for a two-year project entitled *Managing biodiversity on Martu lands in the Western Desert*. Project partners include Kanyirninpa Jukurrpa (KJ), Central Desert Native Title Services (Central Desert), DEC and CSIRO. KJ is a cultural and land management organisation which manages a wide range of activities, including documentation of cultural events and stories, filmmaking, ranger programs (funded by the federal *Working on Country* program) and other land management activities. The organisation represents people from the Martu native title area. Central Desert represents Martu from the Birriliburu native title determination to the south.

Both organisations have engaged and employed Martu people to undertake fauna and environmental surveys, and support fire and weed management. They facilitate inter-generational knowledge transfer between elders and young people and increase the capacity of Indigenous people to eventually develop viable enterprises and a local workforce.

DEC helps Martu and field staff with field data collection and the provision of training, technical advice and guidance on a range of land management topics, including maps and the analysis of field-collected data. CSIRO has developed a comprehensive series of cultural maps of the desert landscapes, including fire patterns and history, food resources and waterholes.



Left South Australian biologist Rick Southgate shows the gait of bilby tracks to field team leaders during a training session held at Lorna Glen former pastoral lease.
Photo – Alison McGilvray/DEC

Below left Animal tracks.
Photo – Hans and Judy Beste/Lochman Transparencies

Bottom left Martu elder Waka Taylor tells the story of a rock hole near Parnngurr community.
Photo – Alison McGilvray/DEC

Work has grown from a small sub-project in 2008, involving surveying the status of threatened fauna species in a few locations in the Little Sandy and Great Sandy deserts, to a comprehensive land management program based out of the communities of Parnngurr, Punmu, Jigalong and Wiluna. To date, KJ and Central Desert have employed more than 200 Martu field staff to track both native and introduced animals, undertake water quality monitoring and carry out weed mapping and visitor impact surveys. The information gathered is helping guide adaptive land management practices.

The project aims to manage biodiversity at a landscape scale and integrate traditional and contemporary natural resource management knowledge to help landowners and managers protect threatened fauna species, reduce feral animals, implement prescribed burning programs and control or eradicate weeds.

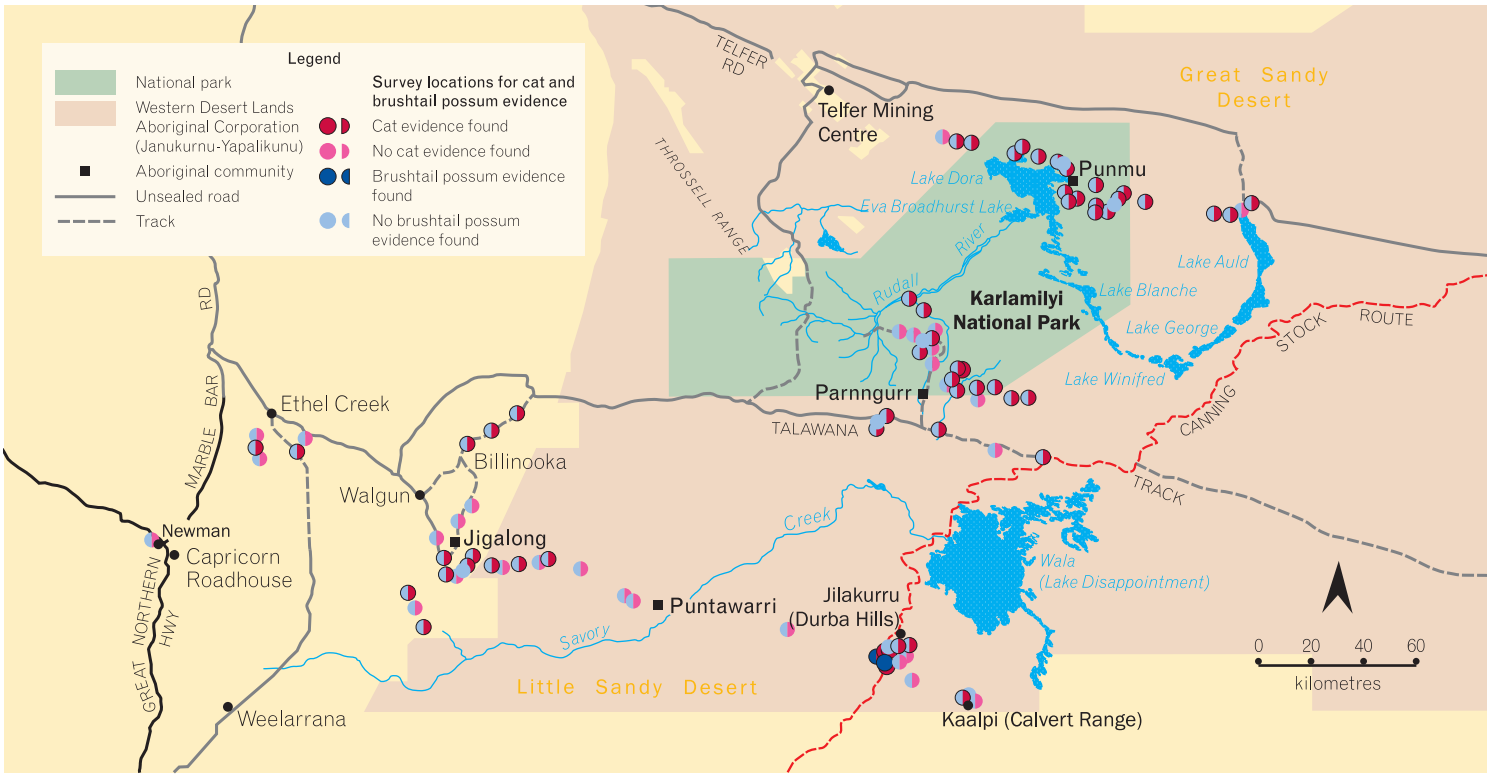
Fauna track monitoring

Project partners have implemented a random track-based plot survey method devised by rangeland ecologists to determine the distribution and abundance of animal species across sandy desert regions of Australia. These animals include threatened species such as the great desert skink and marsupial mole, game species such as the euro (*Macropus robustus*) and bustard (*Ardeotis australis*), and invasive species such as the cat (*Felis catus*), fox (*Vulpes vulpes*), donkey (*Equus asinus*) and camel (*Camelus dromedarius*).

The random plot survey method is a rapid technique which allows monitoring of populations over very large areas. The traditional tracking methods of Aboriginal people are fundamental to the accurate identification of signs which animals have made, in Martu terms, 'last night or yesterday', 'last week' or 'long time ago'. A two-hectare area is searched for a standard time period for the presence or absence of jamana (footprints), kuna (scats), pirti (burrows) and jawani (diggings).

Data are collected in the field using the freeware program 'Cybertracker'. The program is designed for field data capture, using on-screen icons, photographs and short wording. All data are geo-referenced and entered into a geographic information services program to show the distribution of species across the surveyed area.

These methods have uncovered some interesting finds. Up until now,



Above A sample of data collected in surveys: cat and brushtail possum evidence from April to June 2010.

Right Members of the ranger team Arthur Samson and Timmy Patterson on a reconnaissance flight over Jigalong country prior to aerial ignition.
Photo – Richard Boykett/DEC

distribution records for the brushtail possum (*Trichosurus vulpecula*) post European settlement have indicated that the species had disappeared from the Western Desert. However, using the plot survey method, brushtail possum signs have been discovered in several locations, though the evidence indicates that the desert possum numbers are very low. Possum claws were found in fox scats from an area near Well 29 on the Canning Stock Route in mid-2009, and tracks were discovered in a small cave at Durba Hills (known by the Martu as Jilakurru) in June 2010. In many areas where threatened native species were located, there were also abundant signs of introduced predators. This information may help to target areas for feral animal control programs in the future.

Burning traditions

Fire management is integral to both modern and traditional land management culture. It encourages the regeneration of vegetation and promotes habitat complexity, which is important to a range of animal species. Fire, introduced through prescribed burning, also reduces fuel loads and lowers the risk of a bushfire on a high fire risk day covering a large area, which simplifies habitat.

In the past, Martu people burnt country while seeking food or for other purposes as they travelled from one water source to the next. Now Martu travel in vehicles, but they continue to burn as they move along hunting tracks and between communities. These fires are usually very small: less than five hectares. However, while these transport routes are often burnt, country that was once accessed by people on foot is usually only burnt infrequently by bushfires that burn with high intensity and cover large areas.

Bushfires of high intensity that cover large areas can have devastating effects on plant and animal populations. They reduce the pockets of unburnt vegetation, important as refuges for some animals, and leave large areas exposed to wind erosion. Some weed species, such as buffel grass (*Cenchrus ciliaris*), are encouraged by fire, regenerating more rapidly than most native grasses and dominating plant communities.

In 2009, DEC initiated aerial burning with the Birriliburu native title holders in conjunction with Central Desert. Discussions were held with Martu and DEC to determine which areas were most suitable for burning, with consideration being given to areas of cultural significance, creek lines and waterholes.

This has been followed up with prescribed burns during 2010 south-east of Jigalong community and in the Carnarvon Range, resulting in about 12,000 hectares being burnt. On both occasions, aerial burning was complemented by on-ground burning by the traditional owners.

Water sources, camels and weeds

In 2010, environmental surveys were conducted with Martu people to determine the environmental condition of places which are visited often, compared to rarely visited areas. Surveys assessed water source condition and water quality, vegetation structure and condition, and the presence and distribution of weeds.

Water sources are precious and culturally significant places in desert landscapes. Rock holes, soaks, springs and other water sources are threatened by increasing camel populations. Camel herds increase at a rate of between 10 and 12 per cent each year, and it is estimated that there are at least one million camels in the arid centre of Australia (see 'Inland invaders: a million wild camels', *LANDSCOPE*, Spring 2010).

In 2006, an aerial survey conducted by DEC, the Department of Agriculture and Food and Newcrest Mining highlighted Karlamilyi National Park as a hot spot for camels, with densities reaching an average of about one animal per four square kilometres. The population size was then estimated at more than 21,000 over 78,500 square kilometres. Camels foul desert waterholes through excrement, and sometimes die in the water when they are unable to climb out of steep-sided rock holes. Camels, donkeys and cattle also trample riparian vegetation and muddy and churn up waters and pool sediments.

At the Western Desert Lands Aboriginal Corporation annual general meeting in 2009 (the Kalkan Kalkan meeting), Martu agreed on a broad strategy for managing camels and donkeys on their country. This included that in wirrilyi (far away) country, Martu will work with government to implement aerial control programs to help keep country strong. Following this decision, in November 2009 camel control was conducted along Savory Creek and the fringe of the pastoral and desert area. Aerial control of camels continued in November 2010, this time focusing on Karlamilyi National Park and the surrounding areas as part of the National Camel Project, funded through the *Caring for our Country* program. Martu will work with DEC to monitor the health of the river, waterholes and important vegetation following the camel control.

Buffel grass was introduced as a pastoral species to support cattle drives on the Canning Stock Route. It has infested ephemeral water courses and many areas around soaks and rock holes. Buffel grass out-competes native vegetation and reduces habitat condition and complexity. Martu field officers are helping to map buffel grass populations, providing a benchmark to measure its spread in the future, or the effectiveness of control.

Recovery of the warru

Extensive searches through the Western Desert in the mid-1980s found living black-flanked rock wallabies, or warru, only at the Calvert Range (Kaalpi). At that time, the population appeared to be thriving and little evidence of feral predators existed. However, when the population was revisited in the early 1990s, a different story emerged. Dingoe (*Canis lupus dingo*) and feral cats were common and rock wallabies were much less conspicuous than a few years earlier.

It was clear that action was needed to conserve the supposedly last population of rock wallabies in the Western Desert. Fox baiting began in 1992. Despite this, annual monitoring of the population did not show any sign of rock wallaby recovery.

In 2002, the department's Pilbara Region, together with Martu people from Jigalong, started a cat baiting program. Baits containing the 1080 toxin were dropped across Kaalpi and the surrounding sand plain during winter and distributed along vehicle tracks by hand. Although monitoring

Above left Herds of camels, some containing up to 50 individuals, are frequently sighted in the desert.

Left A Martu traditional owner burning desert.
Photos – Jiri Lochman

effort varied, it seems that rock wallaby numbers have greatly increased. In 2008, 20 individuals were trapped and tagged for the first time, and 13 animals which had been tagged in previous years were trapped. In comparison, in 1991, a single animal was trapped and, in 2001, no rock wallabies were trapped at all.

Continuing on from the success of the population recovery at Kaalpi, KJ and DEC are now planning to re-introduce black-flanked rock wallabies from Kaalpi to Jilakurru. Before this can occur, cat baiting must be carried out at the release site. Baiting will be targeted to minimise impacts on the Jilakurru dingo population.

Benefits for all

Biodiversity conservation programs under way in the Western Desert have involved strong collaboration and goodwill between government agencies and community organisations and great steps forward are being made. This work represents a significant partnership between state and Commonwealth governments, non-government organisations and the Indigenous community.

In addition to environmental outcomes, these programs deliver employment opportunities, health benefits, and empowerment for the Martu participants. Understanding of the desert environment has increased greatly through combining traditional knowledge with western scientific methods of data collection and processing. These data help to develop a constructive and adaptive management model that will protect and restore the desert flora and fauna, and guide their interactions with humans. The biodiversity values of the Western Desert now have a tremendous opportunity to be secure and protected for future generations, both for traditional custodians and for the greater community.

Above left Cath Rummery and Peter Kendrick, from DEC's Pilbara Region, record the body measurements and condition of a black-flanked rock wallaby from Kaalpi (Calvert Range).
Photo – Alison McGilvray/DEC

Above Members of the Jigalong ranger team Arthur Samson, Mark Jeffries and Timmy Patterson assist DEC's black-flanked rock wallaby monitoring program at Kaalpi.
Photo – Brett Lewis/DEC

Below Tracks of the munyanga, or 'mountain devil'.
Photo – Zan King

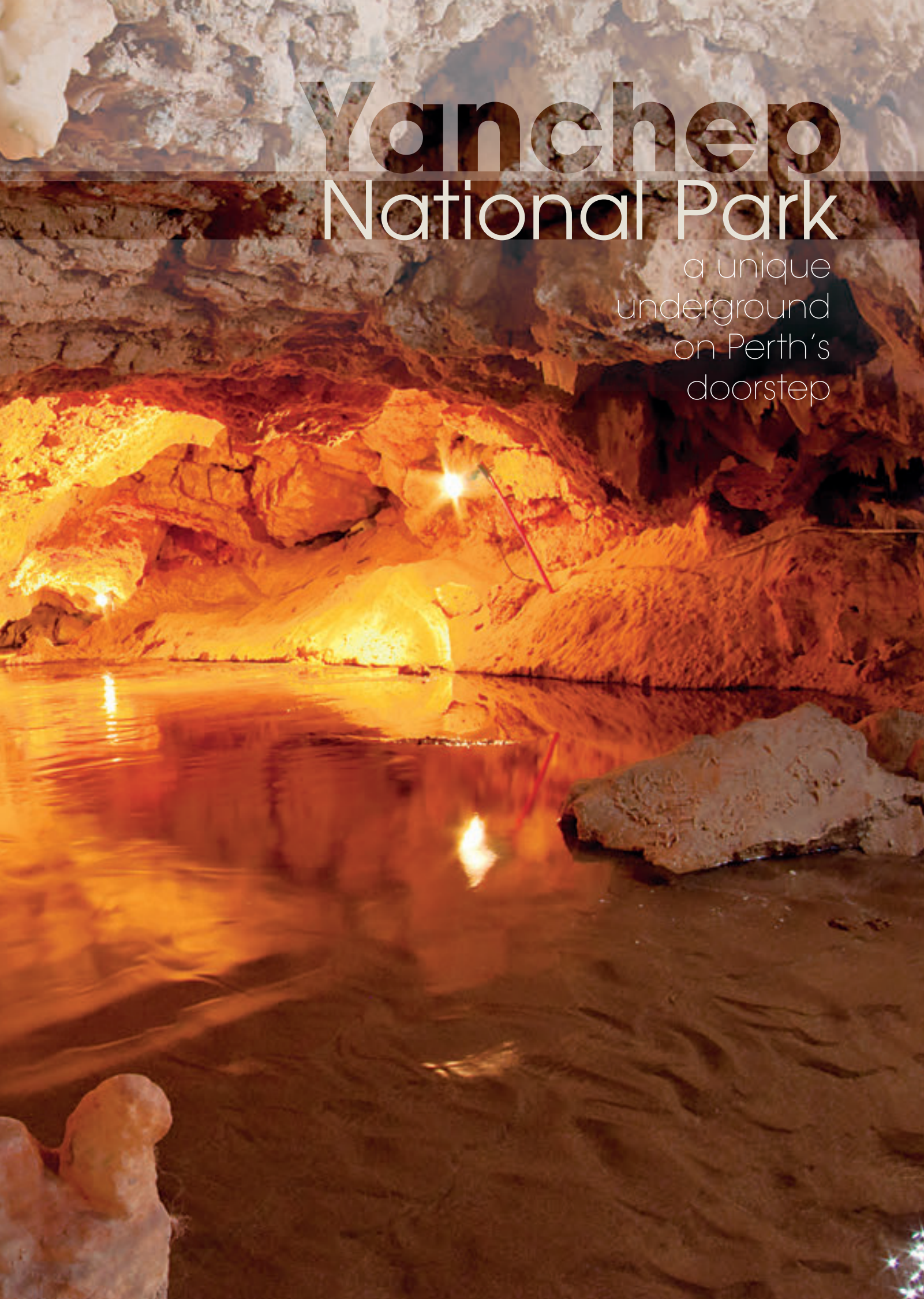
Alison McGilvray is a biodiversity officer with the Department of Environment and Conservation (DEC) and Rangelands Natural Resource Management (NRM) WA. She can be contacted at DEC's Karratha office on (08) 9182 2041 or by email (alison.mcgilvray@dec.wa.gov.au).

Peter Kendrick recently started as a DEC senior reserves officer on Barrow Island, after 21 years in the Pilbara Region as the department's regional ecologist and regional leader of nature conservation. He can be contacted on Barrow Island on (08) 6103 1578 or by email (peter.kendrick@dec.wa.gov.au).

The authors would like to acknowledge Rangelands NRM and Caring for our Country *for project funding, and Kanyirninpa Jukurrpa, Central Desert Native Title Services and the Martu people for their drive, passion and commitment to this project.*

One of Western Australia's most popular national parks is also the site of a complex network of caves. Some of these can be explored by visitors to the park, while others shelter critically endangered species and are the site of watering trials aimed at protecting the threatened ecological communities on which they depend.

by Christie Mahony and David Gough



Yanchep National Park

a unique underground on Perth's doorstep

Nestled in tuart and banksia woodland, alongside the shimmering waters of Loch McNess, Yanchep National Park is home to an abundance of wildlife. Water and bush birds from swans, cormorants, egrets and kingfishers, to parrots, wrens and honeyeaters abound. Endangered Carnaby's black cockatoos (*Calyptorhynchus latirostris*) are a spectacular sight, screeching across the morning and evening skies. Western grey kangaroos (*Macropus fuliginosus*) are commonly seen along the walk trails or grazing on the picnic lawns, ovals and golf course.

The park environment provides a unique setting to experience environmental and cultural activities

that are informative and promote awareness about our natural areas. Every day, there is a range of activities for visitors of all ages, as well as a seasonal program of activities aimed at school and community groups.

One of the most interesting features of the park is the network of nearly 600 documented limestone caves that weaves its way beneath the surface—making it one of the six major cave regions in the state. The caves at Yanchep were formed by underground streams, which flow westwards from the Gnangara Mound. Most of the caves in the park are relatively small in dimension and sit close to the surface. Several of the larger caves have been opened up for tourism during the past 70 years. These include Cabaret, Mambibby, Yanchep, Yonderup and Crystal caves, each as different as the next in its beauty and splendour.

History and tourism

Yanchep National Park is located within the north-coastal corridor of the Swan Coastal Plain and lies 50 kilometres north of Perth's CBD. The biologically rich area has been used by Nyoongar people for many generations because of its abundance of food and fresh water. Aboriginal artefacts found in the Wanneroo and Yanchep region date back between 6,500 and 1,700 years.

More recently, the 2,800-hectare park was recognised by Europeans for its ecological value when, in 1905, the government of the time reserved the area for the 'Protection and Preservation of Caves and Flora for a health and pleasure resort'. Initially the area was vested in the Caves Board as a class 'A' reserve. However, because of the

Previous page
Main Crystal Cave.

Above left Crystal Cave formations.
Photos – Peter Nicholas/DEC

Left Jewel City, Crystal Cave.
Photo – DEC

Below Cabaret Cave.
Photo – Peter Nicholas/DEC

Above Loch McNess.
Photo – Peter Nicholas/DEC

Right An endemic species of amphipod lives in underground pools at Yanchep.
Photo – DEC

remote location of the park and sandy track conditions, the board's attempts to develop the park were unsuccessful. The ensuing years saw management of the area change hands several times until, in 1931, the State Gardens Board assumed control of the park.

During the early 1930s, a large amount of money was donated to the park and used to employ sustenance workers to undertake extensive development projects. It was during this time that Yanchep National Park was supplied with power and water, internal roads were built and a single-wire telephone was connected. Crystal Cave was modified with the development of pathways and lighting, and thousands of tons of limestone were removed from Silver Stocking Cave (now known as Cabaret Cave) to open up a pavilion to be used for dining and dancing. Other caves in the park were also explored in order to open them up for tours.

Cabaret Cave

The first European to discover Cabaret Cave—initially known as Milligan's Cave, later renamed Ballroom Cave then Silver Stocking Cave—was Henry White in 1902. The cave consists of two chambers, which were developed as a supper room and ballroom, and was opened in 1932. A ball was held in the cave in honour of the Duke of Gloucester during his visit in 1934. It was also used extensively as a venue for dances, debutante balls and as a tourist cave until it was closed in the early 1970s due to floor erosion.

Cabaret Cave was repaired during 1983–84 and reopened with a reception to commemorate the 50th anniversary of the Duke of Gloucester's visit hosted by the City of Wanneroo. The guest of honour was the then State Governor Sir Gordon Reid. In 2006, the Department of Environment and Conservation (DEC) spent more than $260,000 on the Cabaret Cave precinct. The cave was closed for six months while a 52-bay coach and car park was constructed, an additional water supply and power were provided to run the ovens that had been installed in the second chamber of the cave, and lighting was installed. A new powder room and toilet facilities were built near the cave entry.

Cave tourism continues today with adventure caving on offer for people looking for something new and exciting. Groups are matched to a cave depending on the group size, experience and age of participants. The three main caves used for adventure caving are Yonderup, Yanchep and Mambibby, all of which have sections in which participants are required to climb and crawl through tight passages into open caverns with unique and wonderful cave flora and fauna. The caves on offer are unlit and relatively untouched; exploring with your hardhat and torch you can delight in breathtaking cave formations.

Caves under threat

Although caves are enjoyed the world over by tourists and recreational cavers, it's important not to overlook their ecological significance. Caves provide important habitat for unique species of flora and fauna, as well as being sites of archaeological and scientific importance.

Extensive research has been carried out within the Yanchep caves. Researchers from universities and caving groups have conducted surveys on the stygofauna existing throughout Yanchep National Park and the surrounding area. Studies have also focused on climatology and groundwater levels, which are also monitored by staff from the Department of Water.

The largest issue currently facing the park's cave systems is that of rapidly declining groundwater levels. This is believed to be related to a combination

Above Exploring Yonderup Cave.
Photo – Heather Beswick/DEC

Above left Monitoring water quality.

Below A tour group in Crystal Cave.
Photos – Peter Nicholas/DEC

of the large expanses of pine trees located to the east of the park, the increasing number of Perth residents relying on water supplies from the Gnangara Mound, and Perth's recent decline in annual rainfall. This decline in the watertable is having a drastic effect on stygofauna such as amphipods, which need water for their survival.

Crystal Cave

Crystal Cave is home to an endemic species of amphipod that lives in pools of underground water and relies on tuart tree rootlets for shelter and food. As the underground pools have been slowly drying up, these small creatures have become critically endangered. In an attempt to save this small species of crustacean and the threatened ecological communities associated with it, a joint project between the Water and Rivers Commission and one of DEC's predecessors, the Department of Conservation and Land Management, was established in 2000.

In consultation with a number of experts, a world-first caves re-watering trial has been established in which filtered groundwater is pumped back into Crystal Cave initially and then other nearby caves to re-establish the original underground pools of water and hence secure the future of the threatened ecological communities relying on these pools. This project is believed to be the first of its kind in the world and, while there have been a number of obstacles faced throughout the project, if successful it may offer some solutions to similar issues being faced in cave systems elsewhere.

Looking to the future

The caves of Yanchep National Park now provide an important educational tool whereby visitors can directly see the effects of a drying climate on our environment. During cave tours, visitors are encouraged to think about the way in which they use water and how they can conserve water around their home.

The drying of the Yanchep caves reiterates what an incredibly important commodity water is, and how a lack of it can have a dramatic effect on the world in which we live. By thinking about this in our everyday lives, there is hope that we will all have a brighter future.

Christie Mahony is an interpretation officer for the Department of Environment and Conservation's (DEC's) Frankland District. Before moving to Walpole, Christie was based at Yanchep National Park as volunteer coordinator, where she liaised closely with the Yanchep Caves Advisory Committee. She can be contacted on (08) 9840 0400 or by email (christie.mahony@dec.wa.gov.au).

David Gough is a DEC web projects manager and can be contacted by email (david.gough@dec.wa.gov.au).

Yanchep National Park attracts more than 240,000 local, interstate and international visitors each year. Visit the park visitor centre or call the park office on (08) 9405 0759 for more information.

endangered

by Melinda Moir

Eula's planthopper

Eula's planthopper (*Budginmaya eulae*), pronounced 'Bud-gin-may-a u-lay', is a unique and rare bug. It is unique in that worldwide it is the only member of its family (Flatidae) known to co-exist with ants in their nests in a form of mutualism.

Mutualism is an association between two organisms where both derive some benefit. Through their 'bodyguard' of ants, these bugs receive protection from predators. In turn, the bugs provide the ants with honeydew for food—which is the bug's excretion after feeding on plant sap.

All planthoppers are herbivorous and, although much of the biology of Eula's planthopper is unknown, it is reasonable to infer that the ants 'herd' the bugs from the nests at night to feed on nearby host plants (species of which are currently undetermined) and then back into the nests before dawn. Interestingly, Eula's planthopper lives with the ant species *Camponotus terebrans*, which is also the known host to a suite of other insects, including butterflies and leafhopper bugs (see 'The ant, the butterfly, the leafhopper and the bulldozer', *LANDSCOPE*, Autumn 2010).

Subterranean life with ants has transformed the appearance of Eula's planthopper into something that is markedly different from its closest relatives within the family Flatidae. Characteristically these bugs, known as common green planthoppers, are recognised as about one-centimetre-long green 'triangles' which jump or hop, and are often seen in gardens on the branches of plants. In contrast, Eula's planthopper has yellow-brown colouring, smaller eyes and wings (the hindwings are completely absent) and bigger antennae, plus many small sensory hairs covering the head and body.

Eula's planthopper was discovered in May 2007 and, despite intensive sampling in the vicinity, had not been seen previously, nor has it been collected since. Because of its rarity, it is currently listed as 'priority one' on the Department of Environment and Conservation's list of threatened species.

All the bugs were collected under a single rock within the same ant nest on Bandalup Hill, east of Ravensthorpe. This area is also home to a number of rare plants including *Kunzea similis* subsp. *mediterranea* and *Eucalyptus purpurata*. As the bug relies upon the presence of both the ant and a host plant species for its survival, it is possible that the host-specificity of Eula's planthopper is determining its restricted distribution. This would be the case if the required host plant is a threatened species such as *E. purpurata*.

The discovery of such a unique insect endemic to the south-west of Western Australia highlights the region's international importance as a biodiversity hot spot.

Photos by Melinda Moir

Ecological research explores the complexities of fire management in remnant vegetation in the Western Australian wheatbelt.

by Carl Gosper, Colin Yates and Suzanne Prober

To burn or not to burn

challenging decisions in fragmented landscapes

South-west Western Australia is regarded as one of the world's biodiversity hot spots due to the richness of flora and the degree of threat it faces. In common with other Mediterranean-climate regions, fire has been an important feature of south-west WA for millennia. Together with soils and landforms, it has played a key role in shaping the composition and structure of vegetation communities.

Since European settlement, however, native vegetation has been removed over large portions of this landscape, especially across the WA wheatbelt. One of the many consequences of this fragmentation of native vegetation has been a disruption to the ways fires occur.

Changed fire regimes

Recent analysis of satellite imagery shows that fires have become less frequent in vegetation remnants in the wheatbelt than in comparable continously vegetated landscapes. It has also shown that, within the wheatbelt, the smaller the patch of vegetation, the less frequent the fires.

What might the consequences of this be for biodiversity? It is known that in fire-prone landscapes generally, including south-west WA, many plant species germinate predominantly in the first few years following fire, while others have limited longevity and decline in vegetation that has experienced a long time since fire. On the other hand, some fauna species require habitat features that only develop in long-unburnt vegetation, and many plants require a minimum fire-free period to accumulate a large enough seed bank to replace themselves.

These differing responses to fire suggest that a single fire regime applied widely across space and time—as is the present trend for many wheatbelt reserves—is unlikely to support existing levels of biodiversity. They also suggest that varying fire frequency, intensity, season and extent within ecologically defined bounds may promote diversity (see 'Fire for life', *LANDSCOPE,* Special Fire Edition Volume 2 2005).

Managing fire in south-west WA's wheatbelt nature reserves to achieve conservation objectives—such as the maintenance of biodiversity and diverse ecosystem structures, states and habitats—must take into account the context of the reserves themselves. Introduction of fire in some circumstances could make remnant native vegetation more vulnerable to invasion by weeds, which are abundant in the surrounding agricultural landscape. As fire temporarily removes vegetation cover, it may consequently raise watertables and exacerbate the impacts of secondary salinity. Moreover, because many nature reserves are isolated and poorly connected, species that rely on dispersal from unburnt populations to recolonise areas after fire may be unable to do so.

This creates a conundrum for conservation managers. Various questions arise: should fire be excluded and suppressed in wheatbelt nature reserves because of the potential threat of weeds, particularly alien invasive grasses, even if excessively long periods without fire result in the loss of biodiversity? And, if fire is introduced, how long should it be before an area is burnt again?

Study region and ecosystems

A project jointly funded by the Department of Environment and Conservation's (DEC's) *Saving our Species* initiative and CSIRO Ecosystem Sciences is providing information for managers that will help them assess the risks and benefits of particular fire

Previous page
Main Fires generate new life.
Photo – Len Stewart/Lochman Transparencies

Above Verticordias are among the biodiverse flora species of the wheatbelt.
Photo – Jiri Lochman

Below left Banksia after burning.
Photo – Dennis Sarson/Lochman Transparencies

Above Mallee woodland after burning.
Photo – Carl Gosper/DEC

Above left Banksia fruits that have opened and released their seeds after fire.
Photo – Jiri Lochman

Below left *Hakea pandanicarpa.*
Photo – Marie Lochman

regimes in wheatbelt nature reserves. The research team has been studying how two plant communities that are widespread in the south-eastern wheatbelt—mallee and mallee-heath—respond to the length of time since fire and how fire affects weed invasion. The mallee community is dominated by species that sprout after fire, with the canopy comprised mainly of mallee (*Eucalyptus* spp.) over an understorey with a significant component of broombush (*Melaleuca hamata*). The mallee-heath community is dominated by obligate seeders (species that are killed by complete canopy scorch and must regenerate from seed after fire), with sparse emergent mallee tallerack (*E. pleurocarpa*).

The study area was centred on Lake Magenta and Dunn Rock nature reserves and adjoining unallocated Crown lands south of Newdegate. These comprise some of the largest areas of native vegetation remaining in the wheatbelt. The fire history of the area was described using remotely sensed satellite imagery (courtesy of DEC's Fire Management Services) and historical maps. The vegetation ages in the study sites ranged from two years since a fire to no fires having been recorded, which means that the last fire occurred before the 1960s.

Changes in vegetation with time since fire

Information on how vegetation communities change with the passage of time since the last fire is crucial when deciding on the appropriate intervals between fires for biodiversity conservation. Fires initiate vegetation redevelopment, but the path this redevelopment takes over long time periods is poorly known.

The results of this study indicated that species diversity in the mallee-heath community was highest immediately after fire and declined as the vegetation aged. What's more, the composition of species differed in the recently burnt vegetation (less than 10 years post-fire) compared with the less recently burnt vegetation.

The occurrence of a suite of species known as 'post-fire ephemerals' is likely to have contributed substantially to these results. These species—which include a variety of forbs (such as *Goodenia* spp.) and short-lived shrubs (such as *Gyrostemon* spp.)—typically occur as above-ground plants only in the immediate few years after fire, quickly maturing and setting seed, then dying and existing only as soil-stored seed until the next fire.

Structurally, the mallee-heath community stagnated when long-unburnt. By about 40 years after a fire, the height of each layer of vegetation and litter cover had peaked, and then either remained stable or decreased as the vegetation aged, while the amount of bare ground and standing dead vegetation increased. Mallee-heath thus appears susceptible to biodiversity and structural decline with unusually long intervals between fires.

In contrast, the mallee community showed little change in diversity and composition with time since fire: instead, variations in soil properties and regional patterns of species distribution appeared to have a larger bearing on species composition. What's more, the mallee community continued to increase in stature 50 years after the fire and beyond. It was not maintained

by fire and appeared resilient to long intervals without fire. Long intervals between fires are also likely to be significant in providing habitat features of importance to mallee fauna and in enhancing carbon accumulation.

Seed bank accumulation and mortality

An alternative way to determine appropriate periods between fires for plant communities is to sample fruit production and mortality in a range of species likely to be susceptible to variation in times between fires. A minimum acceptable interval between fires can be defined as the period since fire that is required for slowly maturing obligate seeding species to accumulate a seed bank of sufficient size for population replacement. A maximum acceptable interval between fires would be the period of time since fire when levels of mortality increase, or seed bank sizes decline such that the potential for population replacement or persistence after fire is reduced.

Fruit crop size and mortality were measured in a range of obligate seeder and sprouter species in which the seed is stored in the canopy, known as 'serotinous' species, from the families Proteaceae and Myrtaceae. Serotinous species were used because fruit crop size is readily measurable and because, unlike species with soil-stored seed banks, serotinous seed banks typically only survive as long as the parent plant survives and are exhausted after each fire.

Patterns of seed bank accumulation over time were broadly similar in both mallee and mallee-heath communities. Many serotinous obligate seeders had not accumulated a substantial seed bank until about 25 years after fire. The slowest maturing species, *Hakea pandanicarpa* subsp. *crassifolia*, did not accumulate a substantial seed bank until about 30 years after fire. This indicates that fire intervals of less than 20 years risk the loss or decline in abundance of a range of serotinous obligate seeding plants, and that intervals extending beyond 30 years are necessary for substantial seed bank accumulation in particularly slowly maturing species. In long-unburnt vegetation (more than about 50 years), several obligate seeding species exhibited a decline in total seed bank size relative to vegetation of an intermediate age.

Mortality rates were generally low, but several species showed a change in mortality rate with time since fire. Of these, each of the obligate seeders had increased mortality with greater intervals since the last fire. In the species with the greatest mortality, (*Hakea pandanicarpa* and *Petrophile glauca*), 80 to 90 per cent of individuals had died at some long-unburnt (more than 50 years) sites. Mortality rates among sprouters were generally lower, and showed a variety of relationships with time since fire.

Due to both higher adult plant mortality and a decline in the size of the seed bank on surviving individuals, declines in the abundance of several obligate seeding species after the occurrence of the next fire is likely at some long-unburnt mallee-heath sites. This suggests that some plant species require fire for population maintenance, and that fire should be viewed as important for biodiversity

Top left Long-unburnt mallee heath.

Left Wildflowers in the wheatbelt.
Photos – Carl Gosper/DEC

Below Bushfire in mallee heath.
Photo – Len Stewart/Lochman Transparencies

conservation in mallee-heath. The uncertainty of the actual age of these long-unburnt sites (known to be more than 50 years, but could be much older) means that defining specific upper bounds of periods between fires is not possible at this stage, only that an upper bound does appear to exist.

Weed invasion

Vegetation remnants are vulnerable to weed invasion due to the combination of changed disturbance regimes (such as fire, grazing and human visitation), altered environments at the edges of the patches of vegetation and high weed seed input from nearby weed populations. Fire potentially facilitates weed invasion by stimulating the germination of dormant weed seed, increasing resource availability and reducing competition. A field experiment in mallee vegetation examined weed abundance and growth in relation to fire, weed seed availability from post-fire seeding with bearded oat (*Avena barbata*) and the position of the mallee vegetation in relation to remnant edges (adjoining paddocks or within reserve interiors).

It was found that the location of vegetation in the landscape had a much greater impact on weed performance than fire: only at paddock edges did weeds grow well, and they did so irrespective of whether the site had been burnt or not. Bearded oat abundance was also related to seed availability, as there were always more plants where seed was added. The study found that higher weed growth at edges is likely to be underpinned by enhanced soil nutrient levels as a result of neighbouring agricultural activities. Soil at the edge of paddocks had higher levels of nitrogen, phosphorus, ammonium, potassium and organic carbon than reserve interiors, irrespective of fire.

The study also showed that fire did not exacerbate weed invasions in intact mallee, and consequently is a viable way of maintaining biodiversity in mallee remnant interiors. However, as weed growth was high at paddock edges with or without fire, it may be appropriate for land managers to take a precautionary approach and seek to avoid fire on paddock edges if resources are not available for post-fire weed control.

Management implications

Mallee and mallee-heath occur in a mosaic across a landscape subject to occasional extreme bushfires and with few topographic barriers to fire spread. While this shared exposure to fire may suggest that these communities may respond similarly to fire, this was not found to be the case. Mallee-heath needed fire to maintain diversity and structure, while mallee did not.

For both communities in the Newdegate area it was found that periods between fire of less than about 20 years will reduce the potential for population replacement of some serotinous obligate seeders. Maximum desirable intervals between fires exist for mallee-heath, and are greater than 50 years. As the average period between fires in small wheatbelt remnants is currently more than 100 years, active fire introduction may be appropriate to rejuvenate aging mallee-heath stands. Mallee showed a lower requirement for fire to maintain structure and diversity when long-unburnt. Consequently, active introduction of fire in mallee communities in remnants should be a much lower priority than for mallee-heath.

While fire management in remnant vegetation in the WA wheatbelt remains a complex task, this research should help land managers make better-informed decisions.

Above right Agricultural paddocks adjoining nature reserves are a source of weed seeds and soil nutrients.
Photo – Georg Wiehl/CSIRO

Below right New banksia growth after burning.
Photo – Jiri Lochman

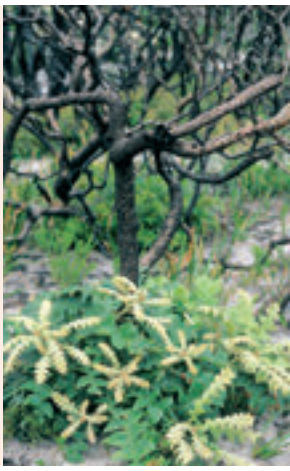
Below Sampling vegetation in burnt areas.
Photo – Georg Wiehl/CSIRO

Carl Gosper is a research scientist investigating the role of fire in plant conservation in fragmented landscapes employed jointly by the Department of Environment and Conservation's (DEC's) Science Division and CSIRO Ecosystem Sciences. He can be contacted by email (carl.gosper@dec.wa.gov.au).

Colin Yates is a principal research scientist with DEC's Science Division. He can be contacted by email (colin.yates@dec.wa.gov.au).

Suzanne Prober is a senior research scientist with CSIRO Ecosystem Sciences. She can be contacted by email (suzanne.prober@csiro.au).

The stratification of survey sites was partly based on the remote sensing data derived from research by Dr Li Shu in digital image processing and remote sensing at DEC's Fire Management Services, Regional Services Division. Georg Wiehl, Blair Parsons and Steve Zabar contributed greatly during fieldwork.




Spineless
impact assessments

From trapdoor spiders to millipedes, more and more animal groups are being discovered that have a high number of species with very limited distributions—a phenomenon referred to as short-range endemism. This concept is providing a focal point for improving environmental protection within environmental impact assessment processes in Western Australia.

by Brad Durrant

All forms of life have limitations on their distribution—environmental and biological factors that prevent them from colonising surrounding environments. The planet Earth represents the broadest example of endemism; no life that occurs on our planet is likely to occur anywhere else in the universe. At the other extreme, there is potential for small pockets in the landscape—such as mountain tops, permanent springs, gorges and islands—to harbour species not found anywhere else.

The concept of short-range endemism is not new and has been around for as long as people have been studying living organisms and their distributions. Recently, however, the idea has provided a focus for improving the capacity of the environmental impact assessment process to contribute to the conservation of biodiversity in Western Australia. The driving force behind this change has been the identification of a number of animal groups over the past 15 to 20 years that have a very high number of species with very limited distributions, and some groups that are made up almost entirely of short-range endemics (SREs).

These SRE groups are primarily terrestrial invertebrates—animals without backbones that live on land—and include arachnids (spiders, for example), insects, snails, myriapods (millipedes, for example) and worms. SREs do occur in other groups as well—freshwater and marine fauna, mammals, birds, reptiles and amphibians—but they are a minority with most species having regional, statewide or even Australia-wide distributions.

In 2002, Dr Mark Harvey of the Western Australian Museum produced a research paper discussing short-range endemism and terrestrial invertebrates, providing a basis for what may be regarded scientifically as a 'short range'. This helped to highlight the importance of this fauna and identified a major deficiency in the environmental impact assessment process at the time. Mark adopted a conservative figure of 10,000 square kilometres (100 kilometres by 100 kilometres) as an approximate threshold for what distribution may be regarded as a short range.

Degrees of endemism

Endemism comes in degrees: sometimes it is very distinct and sometimes it is difficult to discern. The variation in degrees of distinction between habitats can be related to the barriers surrounding an area, whether they constitute a physical barrier or because the surrounding environment is inhospitable. Islands represent a very common and very obvious environment that contributes to endemsim, made so by the fact they are surrounded by water, an environment that most land-based animals cannot survive in, even for short periods of time.

Physical barriers can also play a significant role in restricting movement, so environments such as gorges or mountain ranges can be very important for some species. Gorges are a very good example of restrictive habitats. While they can represent a physical barrier between themselves and the surrounding environment, as well as creating a division between areas, they may form specialised habitats in their own right. The structure of

Previous page
Main Trapdoor spider burrow.
Photo – Brad Durrant/DEC
Inset Trapdoor spider.
Photo – Ryan Ellis

Above Moggridgea trapdoor spider.
Photo – Jiri Lochman

Left Millipede.
Photo – Ryan Ellis

gorges provides a significant amount of protection for animals and their habitats. This protection is primarily in the form of reduced exposure to the elements, particularly sunlight and wind, but also protection from fire. This allows the soil to remain consistently moist, which enables more moisture-dependent vegetation to grow, resulting in a more sub-tropical or tropical habitat than an arid one.

Much of the endemism in WA has been driven by the climatic changes during the Tertiary period (65 million to 1.8 million years ago) when the rainforests that covered the country dried out and contracted, forcing the fauna that relied on these habitats to contract as well, adapt or become extinct. Many species were able to take refuge and establish viable populations. Some species moved underground into spaces and voids or into underground aquifers, evolving into pale, blind animals relying on extra-sensory features to move, feed and mate. Others contracted into protected positions in the landscape, also known as refugia. These refugia provide enough protection from disturbance and exposure to enable these species to survive but the isolation may not allow easy dispersal to other suitable habitats, or to other populations.

The Stirling Range near WA's south coast is a good example of an important landscape feature providing refuge for a number of known invertebrates. These include the Stirling Range moggridgea spider (*Moggridgea* sp.), the palisade spider (*Neohomogona stirlingii*), a giant earthworm *Megascolex* sp. and the Stirling Range rhytidid snail (*Rhytidid* sp.).

Biological factors

The size of an animal's distribution can be limited by a number of biological factors, the most obvious being the animal's ability to move. There will commonly be at least one stage of an animal's life cycle where dispersal is a primary goal, usually as a juvenile. Large animals (mammals, birds, reptiles and amphibians) have a greater ability to disperse because of their size and mobility, hence few species in these groups are regarded as SREs. Similarly, most flying insects are successful dispersers because of their ability to fly. Within the spider world, most of the modern spiders disperse easily as baby spiders (spiderlings) using a technique known as ballooning, where light gossamer silk is released from the spinnerets and the spider is carried away with the wind. The lower number of marine and freshwater SREs can be largely put down to the influence of water in providing a suitable medium for moving between areas.

Other factors that can place pressure on species include their growth rate (particularly the time taken to reach sexual maturity) and fecundity, or reproductive capacity (how many offspring are produced). A good example of the restrictions that these factors can place on a group can be found with the trapdoor spiders. The ability to produce large broods of spiderlings is a modern trait and presents a massive advantage to those species that are able to do so. Broods of hundreds of individuals are common in many web-building species. Conversely, the primitive trapdoors may only produce broods of up to a dozen, with this number likely to be reduced further due to predation and natural attrition before the brood even leaves the burrow.

Above Gorges are a good example of restrictive habitats. Kalamina Gorge, Karijini National Park.
Photo – Ann Storrie

Many trapdoor spiders are very long lived, with females of some species living as long as 25 to 30 years. While this may seem to represent an advantage over other organisms, as an individual female may produce several broods during her life, the time it takes for these long-lived species to reach sexual maturity can be about five to seven years. This means that before they can even begin reproducing, they need to survive several years, much longer than most invertebrates live their entire lives.

So the combination of large broods, short life spans (and the resultant quick maturity) and easy dispersal has provided modern spiders with a major advantage over the more ancestral trapdoor spiders. This advantage doesn't just extend to maintaining or expanding a distribution, but also to the ability to recover from disturbance. Recolonising areas and the reestablishment of a viable population is very difficult when small numbers of individuals are produced which then take years to mature to produce the next generation.

Environmental factors

Short-range endemism in the predominantly arid environment of WA is largely driven by moisture retention and protection from disturbance. Moisture retention can be affected by a variety of different factors, most notably soil type and structure, and protection from sun exposure. This is most evident in the arid zones when looking at the large rangelands. The least amount of exposure throughout the year is on the southern slopes of range systems and hills, which receive direct overhead sunlight during the summer months but are protected during winter because of the change in the angle of the sun. This is most noticeable with the heavier vegetation that tends to occur in these southern positions, compared to the sparse, lower vegetation found elsewhere.

One of the more prominent types of disturbance in WA—fire—can occur naturally or through human intervention, either accidentally or deliberately. Habitats such as gullies and gorges can provide protection from fire but other refugial habitats such as woodlands and springs are usually more exposed to fire. This means they are more prone to being devastated by hot, intense fires that can completely remove the protective qualities of the habitat, potentially rendering some species locally or totally extinct. However, it is also worth noting that fire is a natural and essential part of many habitats in Australia, and that less intense fires that create a mosaic of burnt and unburnt patches play an important role in maintaining and improving biodiversity values.

Pastoral and feral stock also impact on these isolated habitats. Gullies and gorges again afford some protection but heavier vegetation in woodlands and permanent water attracts livestock, removing much of the protective overhead vegetation and trampling and disturbing the soil, particularly around the base of trees where leaf litter provides most of the protection for many SREs.

Both these disturbances can be particularly devastating for trapdoor spiders, with fire removing the door to their burrow and most of the protective leaf litter and overhead vegetation, leaving no material to rebuild. And, if the spider manages to survive the heat generated from the fire in the first instance, the effect of the fire continues as it reduces the numbers of prey species. Similarly, grazing animals remove vegetation, move leaf litter away from the base of trees, kick and trample burrow doors and cave in burrows.

Environmental impact assessment

The environmental impact assessment process is used to assess the likely impacts of a development proposal on the environment and, if there is likely to be a significant impact, formulate conditions to be applied to the project to ensure the environment is protected. The *Wildlife Conservation*

Above Department of Environment and Conservation volunteers search for short-range endemic invertebrates in Karijini National Park.
Photo – Brad Durrant/DEC

Left Land snails.
Photo – Jiri Lochman

Above Moggridgea trapdoor spider habitat in the Stirling Range.
Photo – Marie Lochman

Below Pseudoscorpion.
Photo – Ryan Ellis

Act 1950, WA's flora and fauna species protection legislation, underpins the approach to the conservation of species within the environmental assessment process. Species listed under the Act remain the primary focus of environmental conditions for many environmental impact assessments.

Beyond listed species, the focus of most environmental impact assessments had been almost entirely on vertebrate animals, plants, threatened ecological communities and species that have been listed as threatened or 'priority' and in need of further study. Over the past several years, subterranean fauna have become an important consideration in many of these assessments and the past few years has seen SRE invertebrates become important as well.

In 2009, the Environmental Protection Authority (EPA) released a guidance statement for SRE fauna (Guidance Statement 20), which provides an overview of fauna groups warranting investigation as potential SREs, habitats to focus on, and an overview of sampling techniques and issues. Five groups have been highlighted: trapdoor spiders, millipedes, scorpions, pseudoscorpions and land snails. These groups were chosen for a few reasons: they all represent groups with high levels of short-range endemism, there are taxonomic experts available to identify them, largely at the WA Museum, and they are all reasonably easy to sample.

There are two primary functions of SRE investigations undertaken as part of impact assessments. Firstly, they are focused on providing data aimed at demonstrating with some confidence that none of the SRE species present in the project area will be made extinct as a result of the development, taking into account both direct and indirect impacts. This requires a clear demonstration that the species found within areas that will be affected by the development are also found outside in viable populations, or are highly likely to occur elsewhere. This can be difficult to demonstrate as surveying issues can produce patchy results, making the true distribution of the species difficult to ascertain. The fact that many species have not been collected before also adds to the difficulties.

The WA Museum plays an invaluable role in overcoming this taxonomic roadblock, providing most of the taxonomic expertise and housing specimens of thousands of WA animal species as WA's animal 'library'. The museum's role as a central depository is absolutely critical to the environmental impact assessment process, as only a centralised collection will allow for a proper assessment of a species' endemism and provide material for

Left Wetlands such as Carine Swamp in Perth may harbour short-range endemic species.
Photo – Marie Lochman

Below Slater.
Photo – Brad Durrant/DEC

taxonomic research. Molecular studies also play a valuable role in assessing species distributions but have limitations without the taxonomic perspective.

The other primary function of surveys is providing some context about habitat. Impact assessments can never take into account every living organism in any given area, but changes in vegetation type or structure can be an indication of other environmental changes—such as position or soil variations—which can point to important habitats, or possibly refugia. With this in mind, the use of SRE distribution information can provide a clearer understanding of whether a particular habitat is an important refuge, both for the species detected during the sampling, and for other species dependent on the habitat that may not have been collected.

Another important issue that has been emerging from recent environmental impact assessments relates to known rare and threatened invertebrate fauna. There are a number of species of terrestrial invertebrates that are currently listed as threatened in WA. Many of these fall in the potential SRE invertebrate groups mentioned; in particular, certain trapdoor spiders, land snails and millipedes are listed as either threatened or 'priority' species. However, some don't fit these groups, such as a number of flying insects that are listed as threatened, including bees and moths.

Anthopogenic endemism

Human-induced restriction in species' range through habitat loss and fragmentation (also referred to as 'anthopogenic endemism') is a major issue in heavily populated areas and agricultural regions. Many of the invertebrates that appear on the list of threatened fauna are there because they occur in the Perth metropolitan area or the wheatbelt and their distributions have been massively impacted by land clearing and habitat destruction. Threatened fauna are treated differently from other groups in environmental impact assessments. If a threatened taxon is likely to occur in the project area, a targeted survey is required and, if found, a comprehensive survey is carried out to determine the extent of the impact on the species.

One recent example of this is the shield back trapdoor spider (*Idiosoma nigrum*) which has been the focus of a number of mining proposals in the midwest because of its propensity to inhabit the gullies and southern slopes of some of the iron ore-rich ranges. Several companies have carried out comprehensive surveys of their tenement areas involving counting of burrows, which are fairly distinctive. This has provided a massive increase in available data for this species and allowed the EPA to make decisions on the significance of proposal impacts with greater confidence.

The use of SRE invertebrates in impact assessments has provided a more comprehensive approach to determining the true impact of a development on the local environment. It has increased the chances of identifying important refugia whose significance may not have been obvious through the exclusive use of larger animals or plants. The process of using SREs in assessments is still evolving, as the knowledge gaps that are commonplace when working with invertebrates continue to present problems. The large number of SRE surveys currently being undertaken is providing much needed data that will, over time, feed back into and further enhance the information available to confidently assess proposals, particularly with regard to the identification of animals and sampling protocols.

However, much of the ecological and environmental context for these species is not gathered as part of the impact assessment process and will continue to be a significant gap in our knowledge. This is particularly evident with threatened fauna, where very little is known about the behavioural and ecological factors that are integral in providing that protection. Much of the current approach to assessing impacts on threatened invertebrate species involves the use of basic knowledge of broad taxonomic groups, general assumptions and anecdotal evidence to protect animal species that are known. However, there are likely to be many invertebrates—both SREs and threatened—on which human activities and development will continue to put immense pressure. If there was ever a time when further research on these animals was desperately needed, it is now.

Brad Durrant is a research scientist with the Department of Environment and Conservation's Science Division, based at the Wildlife Research Centre since 1999. He can be contacted on (08) 9405 5148 or by email (brad.durrant@dec.wa.gov.au).

Michaelmas Island

King George Sound

Although close to Albany on the south coast of Western Australia, this 90-hectare island set in the crystal clear waters of King George Sound is relatively unexplored. Staff from the Department of Environment and Conservation recently made a visit to the island to improve understanding of its biodiversity values.

by Anne Cochrane, Sarah Comer, Peter Collins, Jonathan Pridham and Cameron Tiller

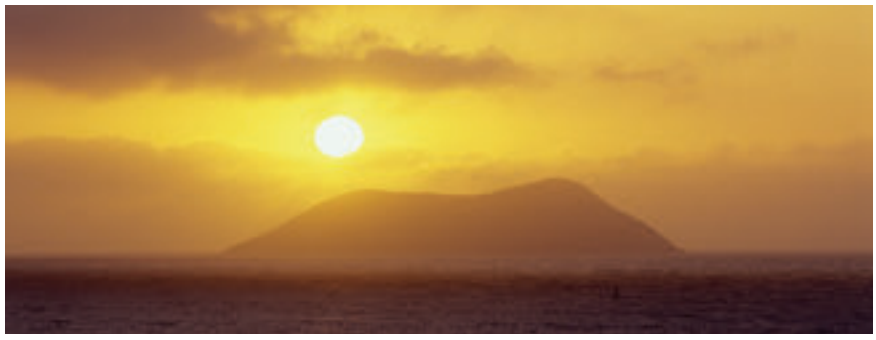
Michaelmas Island lies 10 kilometres east-south-east of Albany and 2.2 kilometres offshore. The island was named by George Vancouver on 29 September 1791, Michaelmas Day. This long, narrow strip of land is 1.4 kilometres long by half a kilometre wide, with steep rocky slopes rising from the sea to guard its shores. Geologically, the island consists mainly of granite-gneiss, with extensive capping of aeolianite limestone, particularly on its northern side. There are no broad beaches for landing a boat and access is only possible in calm weather.

The island is thought to be an important breeding site for seabirds such as the little penguin (*Eudyptula minor*) and fleshy-footed shearwater (*Puffinus carneipes*). For this reason, the island was declared a nature reserve in 1983 and is now managed by the Department of Environment and Conservation (DEC). Access to the island is difficult and consequently public visitation is low, thereby ensuring minimal disturbance to breeding seabirds.

Exploring the island

On a calm sunny April day, we motored across Kind George Sound to the island. Fleshy-footed shearwaters were seen in profusion between Gull Rock and Michaelmas, and we also saw a pod of common dolphins (*Delphinus delphis*). We landed in a small protected cove on the north-eastern side of the island. The sea surrounding the island was clear and refreshing (determined by a swim at the end of the warm day).

After a scramble up the limestone-encrusted slope, we entered a treed plateau that stretched the length of the island. A walk along this ridge line revealed thick woodland dominated by the ridge-fruited mallee (*Eucalyptus angulosa*). Deep leaf litter carpeted the ground, yet surprisingly little invertebrate life was discovered, despite this spongy layer being quite moist.



Previous page
Main Rugged foreshore and clear waters of Michaelmas Island.
Photo – Sarah Comer/DEC
Insert top right Silvereye.
Photo – Dave Watts/Lochman Transparencies
Insert centre Michaelmas Island.
Photo – Rob Olver

Top Michaelmas Island.
Photo – Bill Belson/Lochman Transparencies

Above Bush rat.
Photo – Jiri Lochman

Right Singing honeyeater.
Photo – Rob Drummond/Lochman Transparencies

There was no evidence of recent fire and the vegetation appeared long unburnt. We knew of no written record of fire on the island and the considerable lichen coverings and deep leaf litter attested to the absence of fire for some time, as did the notable size of hakea plants in the middle of the island. A northern running gully at the western end of the island supported large trees of Bald Island marlock (*Eucalyptus cornuta*).

Views and dives abound

At its western end, the island rises to a granite dome, 152 metres above sea level. From here the views back to the mainland and to adjacent Breaksea Island are glorious. From Mount Manypeaks in the east to Bald Head in the west, the shores of this section of the south coast are dotted with magnificent bays, beaches and headlands. The waters off the eastern and northern parts of Michaelmas Island provide good diving sites and the ex-whale chaser *Cheynes III* was scuttled off the western end of the island in 1982 to provide a dive wreck.

Above right King's skink.
Photo – Jiri Lochman

Right A variety of fungi grows on branches of trees.

Below Thick bushland and granite formations of Michaelmas Island.
Photos – Sarah Comer/DEC

Although relatively unscathed by human disturbance, the evidence of rabbits (*Oryctolagus cuniculus*) was obvious, with diggings and scats seen across the island. A number of weed species were also noted, including scarlet pimpernel (*Anagallis arvenis*) and bridal creeper (*Asparagus asparagoides*), although the incidence of invasive plant species generally appeared minimal.

Adding to the inventory

In 1975, DEC research scientist Ian Abbott recorded some 80 plant species, although he took specimens from only 24, two of these non-native. One of our aims on this visit was to collect more specimens to provide a comprehensive flora list for this rarely visited island. We collected 30 more native species, one of conservation significance (the fern *Asplenium aethiopicum*) and sighted another 14 plant species that Ian had already collected on his visit 25 years ago. The difference in season of visit may account for the lower numbers of plant species found, with Ian's spring visit more likely to uncover ephemeral annual species.

On the fauna side, a number of small skinks was seen although most proved too fast to capture in the thick leaf litter, the only exception being the skink *Ctenotus labillardieri*. King's skinks (*Egernia kingii*) have been recorded on the island previously, though we saw no signs of these large reptiles. We also saw no signs of seabird burrows, although these have mostly been recorded in the southern parts of the island. A number of skulls of the bush rat (*Rattus fuscipes*) were found, along with a millipede from the genus *Atelomastix* and some land snails from the genus *Bothriembryon*. Birds recorded included the grey fantail (*Rhipidura fuliginosa*), golden whistler (*Pachycephala pectoralis*), singing honeyeater (*Lichenostomus virescens*), silvereye (*Zosterops lateralis*) and inland thornbill (*Acanthiza apicalis*). An eagle's nest was sighted high in a Bald Island marlock.

Improving our understanding of the biodiversity values of small islands such as Michaelmas is necessary to assist managers with the long-term conservation of these special places. The survey team plans a longer follow-up visit to the island to collect invertebrates and other leaf litter residents, map weeds and establish survey plots in the long-unburnt vegetation.

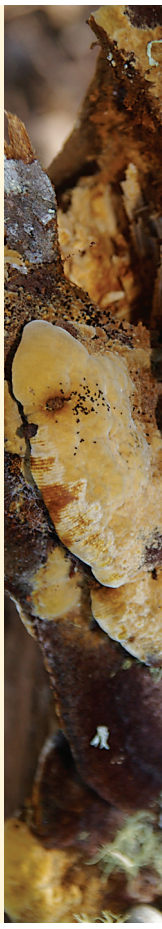
Anne Cochrane is a senior research scientist working with the Department of Environment and Conservation (DEC) in Albany. She manages the Threatened Flora Seed Centre and can be contacted on (08) 9842 4500 or by email (anne.cochrane@dec.wa.gov.au).

Sarah Comer is DEC's south coast regional ecologist, based in Albany. She can be contacted on (08) 9842 4513 or by email (sarah.comer@dec.wa.gov.au).

Peter Collins is DEC's south coast regional fauna conservation officer, based in Albany. He can be contacted on (08) 9842 4531 or by email (peter.collins@dec.wa.gov.au).

Jonathan Pridham is DEC's south coast regional wildlife officer, based in Albany. He can be contacted on (08) 9842 4549 or by email (jonathan.pridham@dec.wa.gov.au).

Cameron Tiller is an adaptive management conservation officer with DEC, based in Albany. He can be contacted on (08) 9842 4533 or by email (cameron.tiller@dec.wa.gov.au).



urban antics

by John Hunter

Dry as...

Apart from being bombed by golf-ball-sized hail and nearly flooded out of my home last March, the rest of the year in Perth has resulted in a lack of recurring rain ... it's as dry as a dead dingo, you might say.

Surface water reservoirs are extremely low, water bills are high and watering habits are as antiquated as a rusty Saxon sword.

Should we be worried? Nah ... not really, contrary to what some of the experts say, there is still plenty of water for Perth's domestic population, it's just that we have to manage better that which is readily available, and use it more efficiently. If we're serious, grey water treatment should be high on the state agenda. Watering by hand once a week, even in summer, will keep lawn green and alive, will reduce the number of mowing times and will enable you to appreciate the BMWs and fashion plate joggers as they cruise suburbia.

Let's face it, we are sandgropers, we are tough little diggers and we will do what is really necessary, that is, plant appropriate species, water by hand in the great outdoors and enjoy the exercise. You can even install a sub-irrigation drip-system which is most efficient in saving water and delivers direct to the root systems of plants in amounts only according to their needs. For the most, fixed sprinkler use is wasteful because of evaporation, surface tension run-off, wind interference and often malfunctioning spray heads.

These days, there are some really interesting native gardens and road verge creations happening even in the suburbs of the bourgeoisie where once-proud European cottage gardens flourished. With a little effort and flair, householders are responding to the need for 'waterwise' gardens with positive results.

While not every native plant is suitable for the home garden, recent advances have been made in selecting plants, forms and cultivars that are suitable for ornamental horticulture.

As a result, there is now a very wide range of native plants, most of which will attract birds, butterflies and other wildlife to your property.

It is necessary to know, however, that prior to planting, our local sandy soils must be improved with organic matter. Good compost will dramatically increase the moisture, nutrient and microfauna capacity of soil, all needed for healthy plant growth. Bare soil encourages weeds, wastes water and puts heat stress on plants; so use surface mulch with a mixture of large irregular-shaped particles of bark, wood, sticks and grass matter—and this will further feed the soil as the mulch breaks down. Erosion and temperature fluctuation are also overcome. Over time, more mulch can always be added. But remember to keep it away from plant stems so that collar rot and other diseases are not attracted.

By organising plant types that flower at different times of the year, not only will you be entertained by the usual magpies, mudlarks, willie wagtails and butcher birds, you will be able to see possibly six or seven species of visiting honeyeaters, from wattle birds to miners, spinebills and chats.

Go on, give it a go, you just might like the result.

DID YOU KNOW?

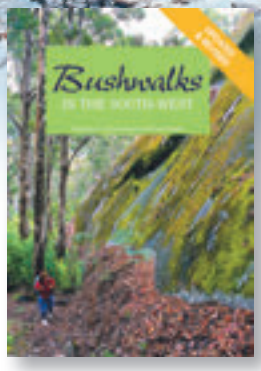
- Through its website (www.watercorporation.com.au), the Water Corporation puts out a good series of downloadable brochures on creating 'waterwise' gardens.
- To find your local Waterwise Garden Centre that can help with plant selection and water needs, go to the above website or phone the Waterwise Helpline on 13 10 39.
- We have to fit how we live with ways that will not interfere with our water in the future, if we are to sustain human life.

Take a journey through the state's south

with a range of books from WA Naturally Publications

The best of the South West *LANDSCOPE* special edition $9.95

Discover the best of the south-west in this collection of *LANDSCOPE* articles focusing on natural icons throughout the region.



Bushwalks in the South-West $16.95

A guide to 49 walks through this beautiful area, plus maps.

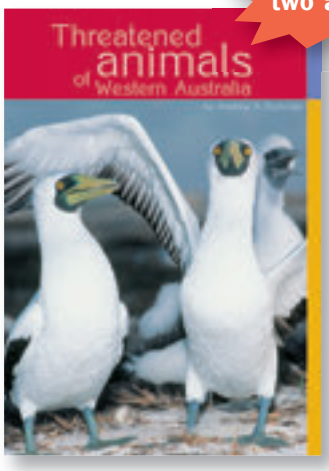
Common Wildflowers of the South-West Forests $6.50

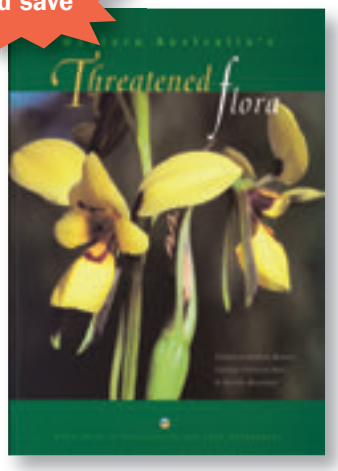
A Bush Book guide to the region's glorious seasonal wildflowers.

Wildflowers of the Stirling Range $6.50

A Bush Book guide to the wildflowers that adorn the beautiful Stirling Range National Park.

Buy the set of two and save





Special offer

Threatened animals of WA and WA's Threatened flora

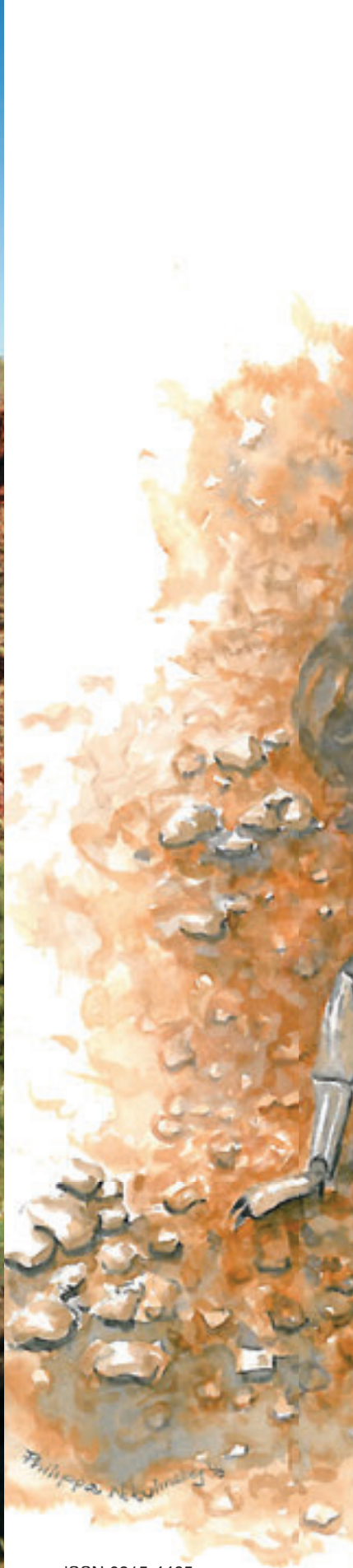
Buy the set of two books for $55 (RRP $32.95 each) and receive a free copy of Kangaroo paws and catspaws valued at $24.95.

A special offer only for *LANDSCOPE* subscribers, valued at more than $90.

WA Naturally Publications

These publications and many more are available from good bookshops, newsagents, tourist information centres and Department of Environment and Conservation (DEC) offices and by mail order (postal charges apply) addressed to Locked Bag 29, Bentley Delivery Centre, WA, 6983. You can also phone: (08) 9219 8000, fax: (08) 9334 0498 or order online through DEC's website (www.dec.wa.gov.au/shop).

Department of
Environment and Conservation



ISSN 0815-4465

9 770815 446027

Print Post Approved pp665002/00004