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LANDSCOPE

Volume 28 Number 4
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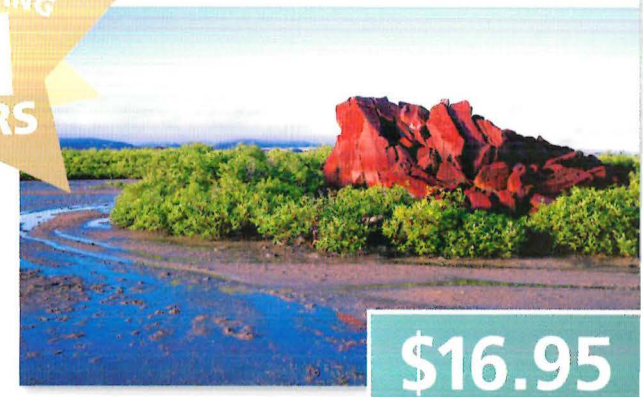

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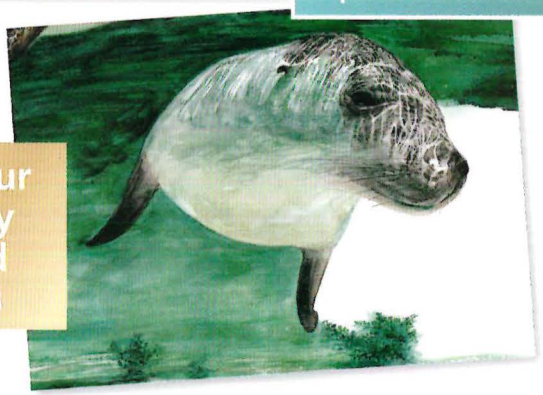

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Madeleine Clews


Amy Prendergast

contributors

Madeleine Clews has been the Department of Environment and Conservation's (DEC's) manager of corporate communications since 2009. She was born and raised in Saskatchewan, Canada, where she completed a BA (Hons) in English. While undertaking graduate studies in Old Norse at Oxford University in the mid-1980s she met a Western Australian who coaxed her to the antipodes. Marriage, a career in journalism and two children followed. After seven years with ABC radio in various locations around the state, Madeleine worked in media relations and corporate publishing for a number of government departments, and was inspired in the 1990s to complete a post-graduate diploma in science at The University of Western Australia (UWA). She is passionate about any pursuit that combines science and the arts in seeking greater understanding.

editor's letter

There is something about rats. Most people shudder at the very mention of them. It's because of the way they congregate where people are, freeloading and, if unchecked, breeding into plague numbers: invading buildings, infesting and contaminating food stores, spreading disease. Rats have become a symbol for squalor and decay and the general failure of human systems. The discovery by American psychologist Jaak Panksepp that rats laugh when tickled and may express joy[1] merely adds to the revulsion. We think of rats and we feel fear, mistrust, possible guilt at the way we use them for experimentation, and maybe a little grudging admiration at their opportunism and tenacity.

We are talking about the European rat (*Rattus rattus*) here of course, and the threat it poses as a species is not limited to human communities. Throughout the history of seafaring, stowaway black rats have been invading foreign shores and taking over, wreaking havoc on local fauna and ecosystems. Eradicating introduced rats is often one of the first steps in a conservation effort. But on Sunday Island, off the Kimberley coast, researchers carrying out survey work to determine the level of rat invasion were in for a surprise ('The mysterious case of the black rat on Sunday Island', page 42). I won't spoil the suspense by revealing any more, but suffice to say, in this case the story did not play out as expected, and had something of an unforeseen happy ending.

The Sunday Island work is part of a wider scientific effort in the Kimberley, where four years of surveying has identified a high degree of biodiversity in the offshore islands ('Treasures revealed: Kimberley islands diversity', page 16). So what? Islands can be ecological arks, often supporting vestige populations of species that have become threatened or extinct on the mainland. But they are also fragile and vulnerable, and may be priceless inventories of knowledge. American biologist and Biodiversity Chair of the Heinz Center for Science, Economics and the Environment Tom Lovejoy told an international environment summit last year that "biodiversity is an enormous living library of pre-tested solutions to all kinds of environmental and biological problems ... many problems we face have already been solved and the answers are sitting out there waiting for us to learn about them".

At the same summit, presenters made frequent reference to the recently coined term 'Anthropocene' to describe the current geological age, referring to the unprecedented impact on global ecosystems by the activity of one species—human beings. And where there are humans, there will be rats.

Food for thought.

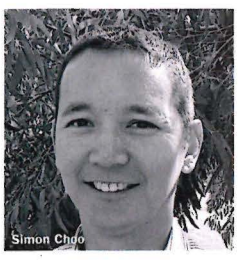
Madeleine Clews
Executive Editor

[1] 'Beyond a joke: from animal laughter to human joy?'. *Science* 308, 62 (2005)

Amy Prendergast has a passion for wildlife and a deep love and appreciation of Australia's unique and diverse fauna. She feels fortunate to live in Western Australia, which features a global biodiversity hot spot, and boasts numerous endemic species. Amy studies herpetology at UWA and feels honoured to share her knowledge and passion about these amazing animals with *LANDSCOPE* readers. Currently completing her final year majoring in Zoology, Conservation Biology, and English and Cultural Studies, Amy seeks to continue studies contributing to conserving Australia's amazing biodiversity.

Simon Choo has worked in interdisciplinary and intercultural fields for more than 15 years. Trained and practised as an anthropologist and lawyer, with undergraduate degrees in anthropology and law from UWA and a PhD in interdisciplinary cross-cultural research from the Australian National University, Simon has worked across the community, private, academic and government sectors, including a number of years as a lawyer with Yamatji Land and Sea Council. This work has spanned Australia, Malaysia, Singapore, East Timor, Papua New Guinea, Indonesia and Pakistan, and has focused on Aboriginal heritage, native title and international development assistance. He is DEC's native title and heritage coordinator.

Abby Thomas is the fauna technical officer for DEC's Species and Communities Branch, where her main responsibility is to maintain the threatened and priority fauna database. Since starting with the department last year she has joined the Roadside Conservation Committee crew on field trips, headed to Cape Arid National Park to aid in monitoring as part of DEC's *Western Shield* program, worked on nominating fauna for threatened species listings, worked on standard operation procedures, created species distribution maps and generally helped in increasing the department's knowledge of our unique threatened and priority fauna. Abby aspires to eventually work as a field scientist within DEC's Science Division.


Simon Choo

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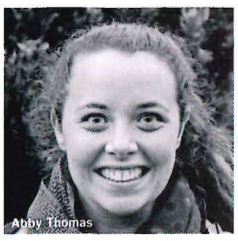
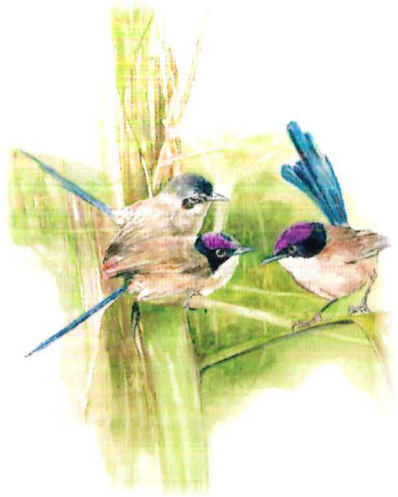

Abby Thomas

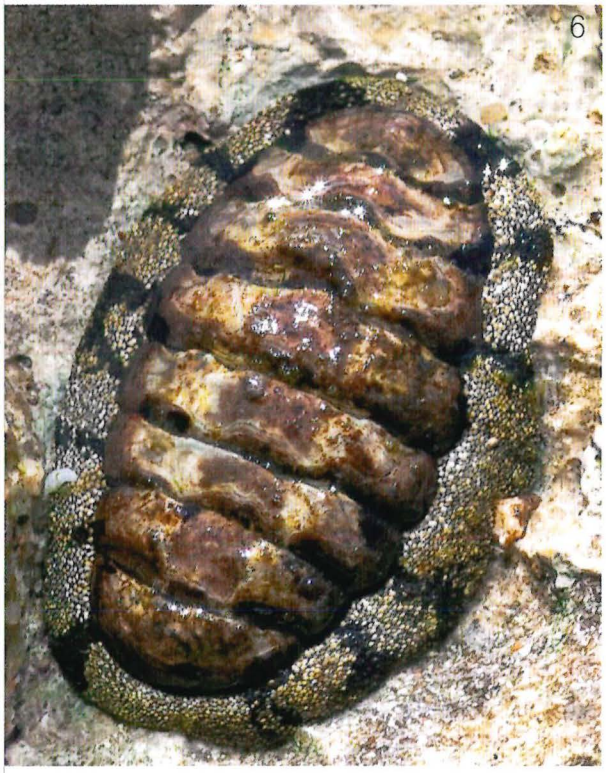


Cover illustration by Gooitzen van der Meer
The purple-crowned fairy-wren (*Malurus coronatus*) occurs nowhere else but northern Australia, alongside waterways from the Kimberley to western Queensland. The male is characterised by its striking purple crown which occurs during breeding season. Both male and females have brown backs and wings and bluish tails.

Illustration reference photos by Australian Wildlife Conservancy (main) and David Bettini (bird on the right).

Back cover photo by David Bettini
Dimond Gorge, Mornington Sanctuary, Kimberley.

Features



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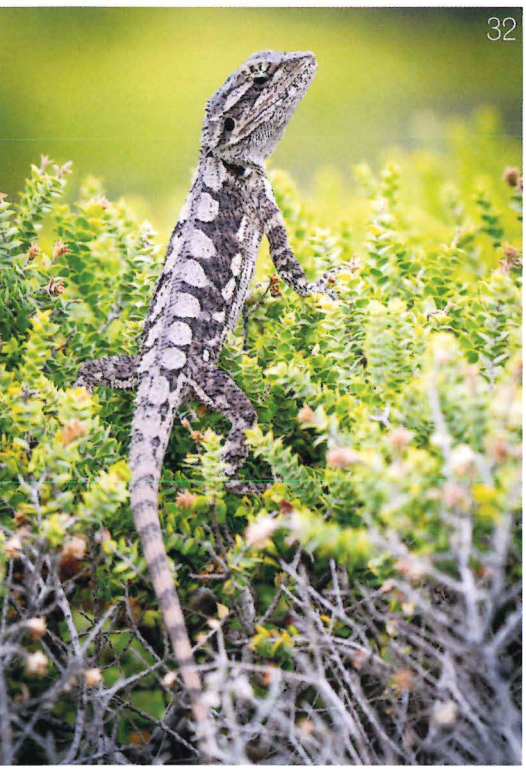
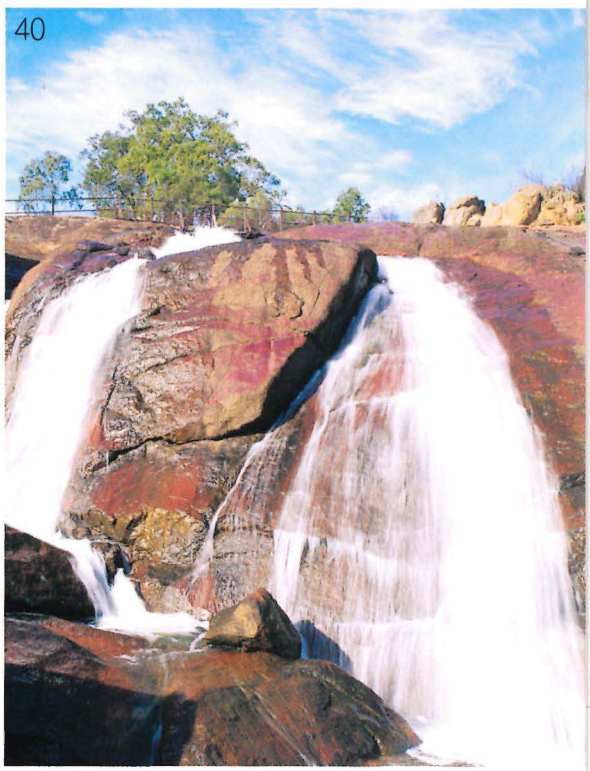




Platforms and boulders: intertidal habitats of Ngari Capes Marine Park

Early morning beachgoers along the scenic Leeuwin-Naturaliste coast in Western Australia's south-west are typically surfers out to catch a few waves before heading to work. However, during November 2012, the surfers were joined by Department of Environment and Conservation (DEC) marine scientists wielding sampling quadrats and notebooks who were taking advantage of particularly low tides at daybreak to undertake preliminary surveys of intertidal reef habitats and communities in the recently created Ngari Capes Marine Park. This work will complement a three-year research project on intertidal reef communities of the Marmion and Shoalwater Islands marine parks near metropolitan Perth (see 'Life on the edge', *LANDSCOPE*, Autumn 2012). While these communities were studied by University of Western Australia scientists in 1999 as part of an assessment of the marine conservation values of the Capes region, few such surveys have been carried out since.

A diverse shoreline

Intertidal habitats of Ngari Capes Marine Park differ from those of the Perth area because of the complex geology of the Capes region which is dominated by the Leeuwin-Naturaliste ridge, a massive granitic formation that comprises Australia's south-western corner. Many popular features of the Capes coast including Sugarloaf Rock and Canal Rocks and the promontory of Cape Leeuwin are formed from this rock. This geologically ancient granite is partially overlain by Tamala limestone which has accreted more recently from coastal sands and which has subsequently eroded into quite different shapes such as coastal cliffs and the spectacular caves of Leeuwin-Naturaliste National Park. The limestone and granite are often adjacent along the Capes coastline and form entirely different features where they meet the sea.

Surveys of the intertidal reef areas of Ngari Capes Marine Park have uncovered an interesting array of creatures and habitats.

by Alan Kendrick and Michael Rule

Above main Red triton shell (*Charonia lampas*). *Photo – Michael Rule/DEC*

Inset Waratah anemone (*Actinia tenebrosa*). *Photo – Ann Storrie*

Limestone platform reefs

Shoreline limestone platform reefs are most prominent between Yallingup and Prevelly in Ngari Capes Marine Park. These reefs are typically larger than those of the Marmion and Shoalwater Islands marine parks and can extend more than 50 metres across. Even relatively brief surveys reveal that many of the most prominent invertebrates inhabiting these reefs differ from those on limestone platform reefs closer to Perth. Intertidal reefs at the Capes, for example, support fewer sea stars and urchins than reefs near Perth, and some species such as the red triton shell (*Charonia lampas*) and the lighthouse shell (*Campanile symbolicum*) are more common in the Capes region. Interestingly, similar species are often common at one location or the other but not both. For example, the western turban shell (*Turbo pulcher*) is prevalent in the Capes region, while the closely related *T. torquatus* is more prevalent on reefs of the Marmion and Shoalwater Islands marine parks.

Other species inhabiting shoreline limestone intertidal reefs are common to both the Perth and Capes regions. These include the pontifical cone (*Conus doreensis*) and the western creeper (*Rhinoclavis bituberculata*), both of which burrow into sandy hollows on the reef. Numerous limpet and chiton species also occur in both regions, while the colourful opistobranch *Hydatina physis* is a common resident of some reefs in the Capes region and Rottnest Island.

Granite boulders

The granite shores of Ngari Capes Marine Park create intertidal habitats that do not exist in marine parks of the Perth area. In exposed locations, the granite shorelines often comprise smooth and steep dome-like rocks that are continuously battered by the

Above Limestone cliffs at Cape Hamelin.
Photo – Brett Dennis/Lochman Transparencies

Left Bubble shell (*Hydatina physis*).
Photo – Michael Rule/DEC

Below Smooth top shell (*Austrochochlea rudis*).
Photo – Ann Storrie

powerful swells that characterise the Capes region. Only a few hardy species inhabit these intertidal zones, such as limpets and barnacles, which are not easily dislodged. More sheltered granite shores, however, often form intertidal fields of small, smooth boulders that are very different to limestone platform reefs and create complex and sheltered habitats that suit many invertebrate species. While littorinid snails, limpets and tangles of tube-building worms adhere to the sides of these rocks, many more species live beneath them. Here can be found a variety of polychaete worms, anemones, echinoderms and shells, such as the large elephant snail (*Scutus antipodes*). Even small fish can be found in the shallow pools among these rocks. If you wish to observe intertidal animals in such habitats take care not to leave them exposed for long and always carefully return rocks to their original position.

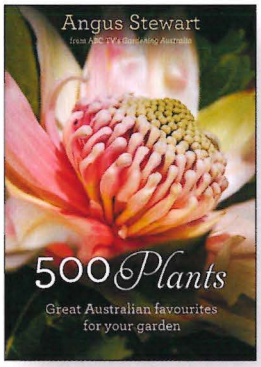
Building knowledge

DEC's intertidal reef surveys in Ngari Capes Marine Park and other marine parks and reserves build our knowledge of WA's marine biodiversity and contributes to the development of the department's long-term marine monitoring program. More broadly, undertaking similar surveys at different marine parks and reserves also creates an opportunity to examine how the marine environment differs across WA's large and diverse coastline.

Alan Kendrick is a senior research scientist with the Department of Environment and Conservation (DEC). Alan can be contacted on (08) 9219 9793 or by email (alan.kendrick@dec.wa.gov.au).

Michael Rule is a DEC research scientist. He can be contacted on (08) 9219 9800 or by email (michael.rule@dec.wa.gov.au).

bookmarks by Catherine Jack



500 Plants

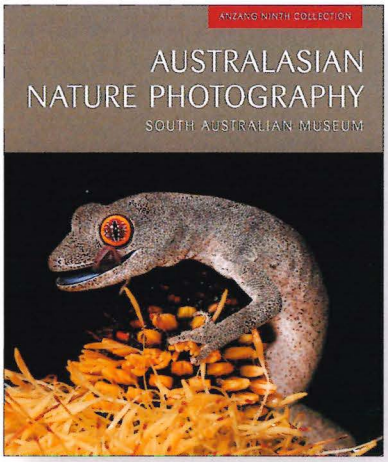
Author: Angus Stewart
Publisher: Allen & Unwin
www.allenandunwin.com
304 pages, soft cover, colour photographs
ISBN: 978 17 4331 150 9
RRP: $35

This offering from Gardening Australia's Angus Stewart does not disappoint. Like a little backyard bible of natives, *500 Plants* is the result of years of experience with the various soils and climates that challenge gardeners around Australia.

While historically many people have viewed the Australian bush as drab, straggly and grey, this book is a celebration of the new and improved cultivars of native plants that have helped nurture a more positive view of our natives.

The book presents an alphabetical catalogue of plants, with up to two colour photographs of the plant and information on its needs and care, and attention to plants in every Australian climate and major soil type. Stewart also lists his top 10 plants in various areas, with this reader being particularly taken by the lists for sandy soils, pot plants and perfumed plants.

This book would be a welcome gift for any gardener or a great resource for someone starting out.



Australasian Nature Photography ANZANG Ninth Collection

Author: South Australian Museum
Publisher: CSIRO Publishing
www.publish.csiro.au
112 pages, soft cover, colour photographs
ISBN: 978 06 4310 826 4
RRP: $39.95

This book displays a selection of the entries in the 2012 ANZANG Nature Photographer of the Year awards which highlight the bioregion of Australia, New Zealand, Antarctica and New Guinea—countries linked by their co-existence as Gondwanaland more than 50 million years ago.

The shots excite the senses with macro detail, while anecdotes describe how each photograph was taken. The images capture breathtaking instants in time, including the moment a baby seal leaves the warmth of its mother to survive being born onto minus 25 degree Celsius ice.

The beautiful detail and mood achieved in the images will delight viewers of all ages.

Adventures in Wild and Wonderful Places

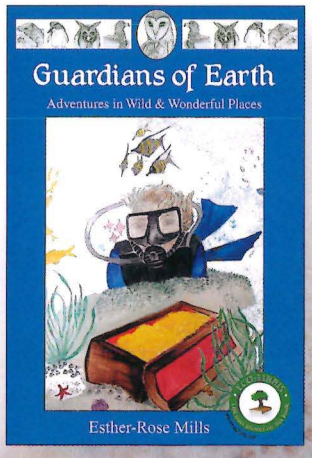
Author: Esther-Rose Mills
Publisher: Mind Body Spirit Press
www.mbspress.com
32 pages, soft cover, some colour illustrations
ISBN: 978 19 2188 330 9
RRP: $14.95

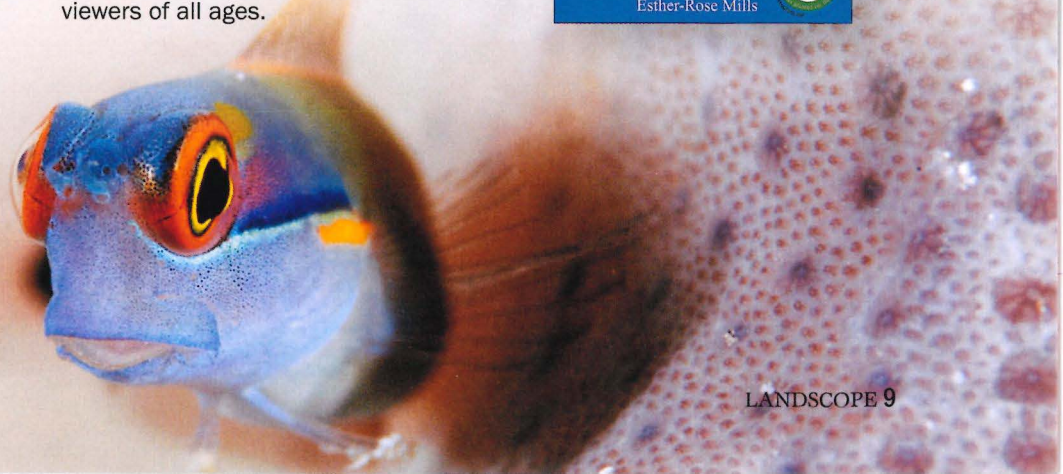
Nannup author and illustrator Esther-Rose Mills has released the first installment in her *Guardians of Earth* series—the children's book *Adventures in Wild and Wonderful Places*.

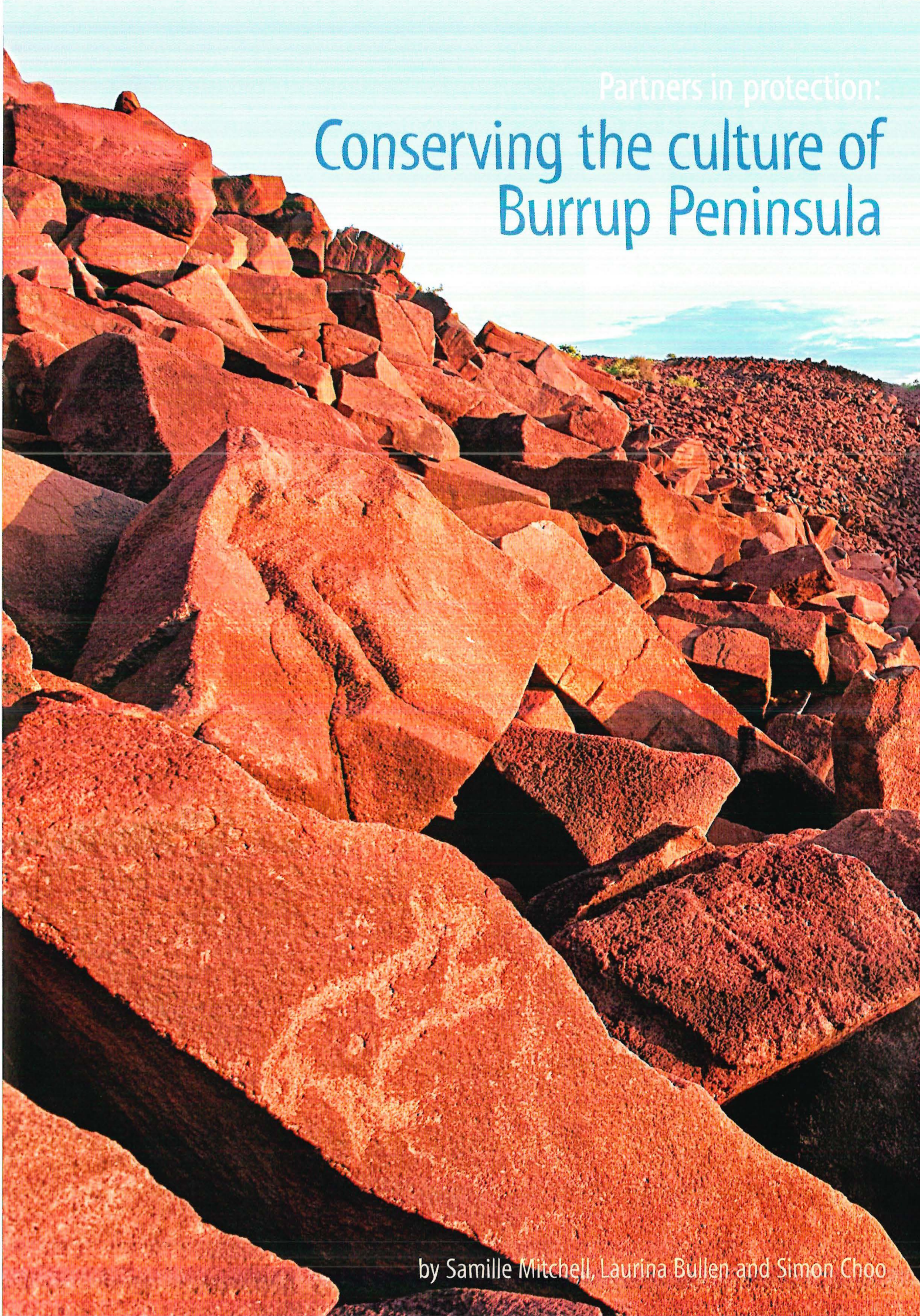
The stories are based on the author's life with her ranger husband in Western Australia's Fitzgerald River National Park and the benefits of having such diversity in their backyard.

Viewed through the eyes of their children, the book takes the reader through adventures in nature as the kids meet the backyard 'locals', including carpet pythons, wedge-tailed eagles and penguins.

This book is an excellent educational resource for primary school-aged kids and is interspersed with illustrations of the animals and children.





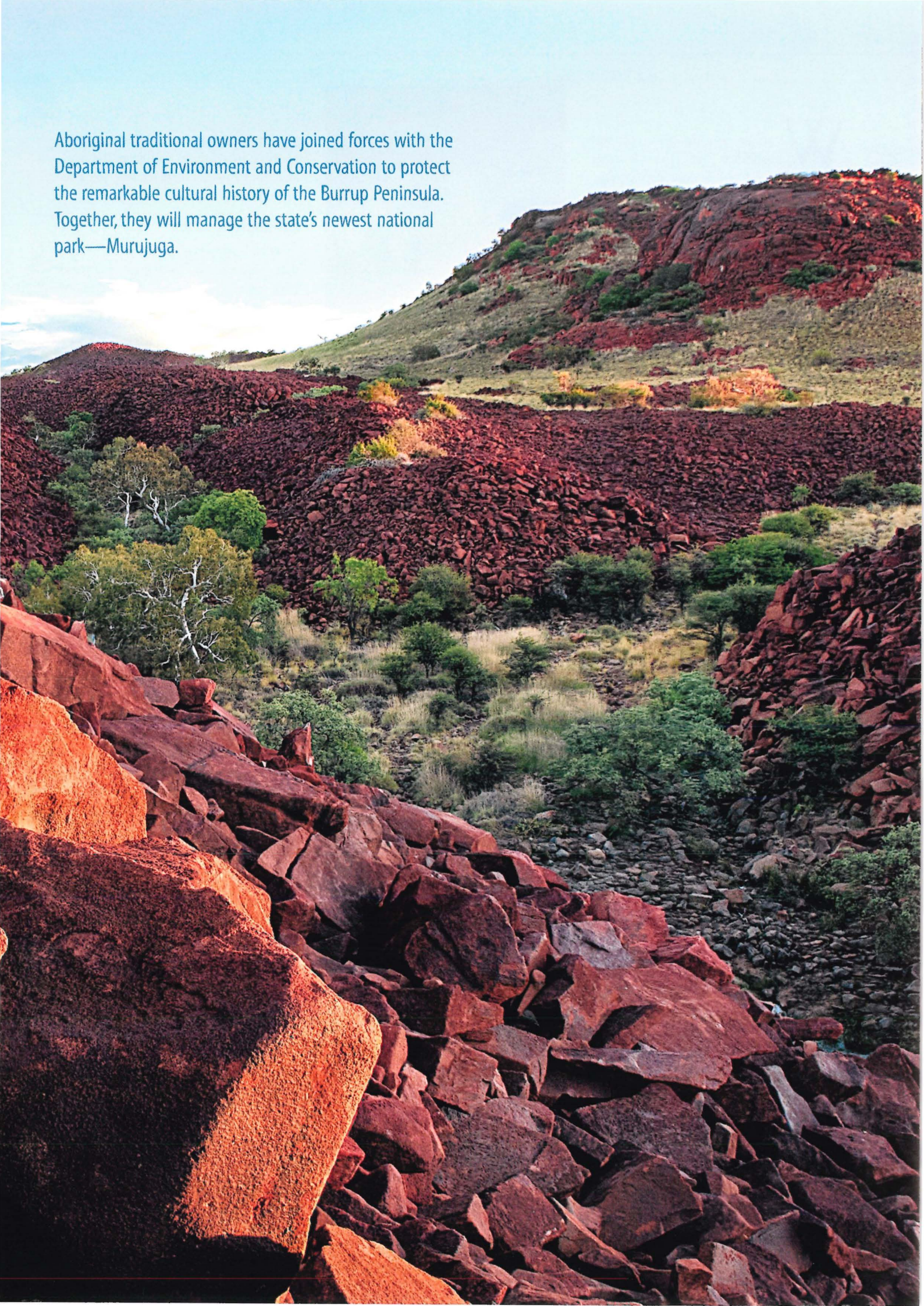


Partners in protection:

Conserving the culture of Burrup Peninsula

by Samille Mitchell, Laurina Bullen and Simon Choo

Aboriginal traditional owners have joined forces with the Department of Environment and Conservation to protect the remarkable cultural history of the Burrup Peninsula. Together, they will manage the state's newest national park—Murujuga.



Wander among the rust-red boulders of the Burrup Peninsula and you'll note images that seem to materialise from the rocks. They are faint at first sight—emu footprints in one place, extinct Tasmanian tigers in another. But as your eyes recognise what you are looking for, you'll spot yet another image, and another.

These images are the cultural signature of Aboriginal people who have lived here for many thousands of years. Some estimate up to a million rock engravings, called 'petroglyphs', adorn the rocks here and on the nearby Dampier Archipelago, making it the world's biggest gallery of Aboriginal art.

While dating the images is tricky, they are believed to have been carved anywhere between 6,000 and 30,000 years ago. Indeed, there is archaeological evidence that Aboriginal people have lived here for the past 9,000 years, with more recent evidence suggesting they may have lived here up to 60,000 years ago.

But what of the engravings' meaning? What secrets can they reveal of the area's past? Aboriginal people of the area, collectively known as the Ngarda-ngarli, believe the images are the work of creation spirits known as marrga. During the Dreamtime, these

spirits formulated the rules for social conduct and left the engravings as a visual reminder of how Aboriginal lore should be followed. Such sites were possibly also associated with rituals, ceremonies and initiation rites. The stones are the bible of local Aboriginal lore and have meanings beyond the descriptive interpretations of modern archaeologists.

Given the immense significance of such sacred sites, Aboriginal lore dictates an obligation to protect them, a responsibility passed on through the generations.

The inherent need to protect the country is at the heart of the recent creation of the 4,913-hectare Murujuga National Park—Western Australia's 100th national park and the first to be owned by Aboriginal traditional owners and truly managed in joint partnership between the state and Aboriginal custodians (see 'Partners in management' on the next page).

An ancient land

The towering piles of boulders that characterise Murujuga National Park give a striking visual sense of the land's age. The raw, stark form of the rocks set against a seemingly desolate landscape appear as ancient jagged monuments of the Pilbara Craton, where the 3,600-million-year-old landscape was formed during Earth's earliest days, the Archaean period.

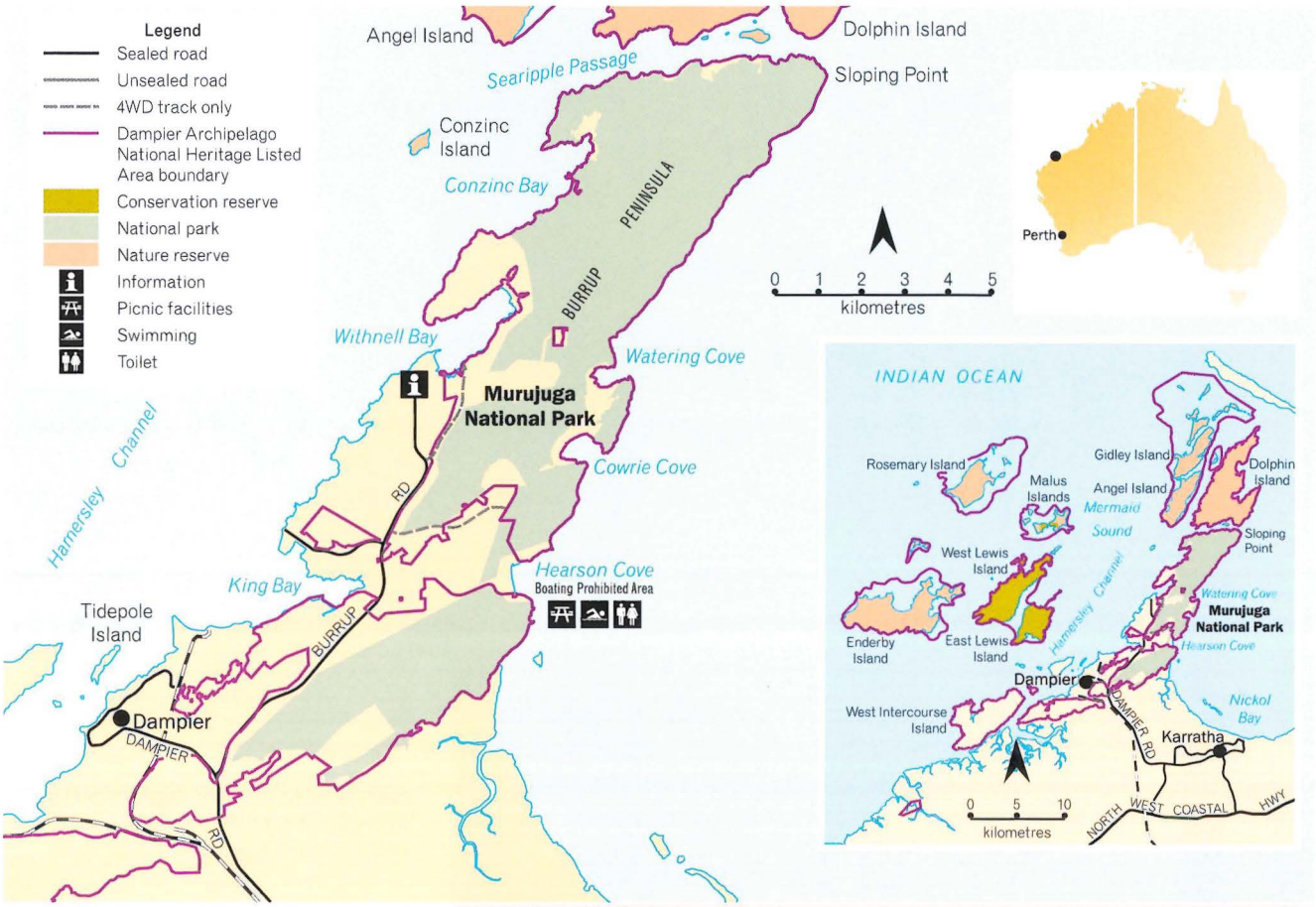
The Ngarda-ngarli people of the area believe the rocks here mark the path of a large number of waramurrungkas, or flying foxes, that emerged from the sea during the Dreamtime and travelled southwards along the Burrup Peninsula, across the salt flats and coastal plains and over the range of hills near Mount Leopold. A line of dark rocks on the hills marks the spots where the flying foxes crossed the range. From there the waramurrungkas travelled up the course of the Fortescue River to Millstream.

Rocks at the highest point of the southern peninsula are the metamorphosed bodies of the ancestral flying foxes that were turned into stone there by a vengeful spirit. An exposed dolerite rock outcrop running down the face of the hill south of Karratha forms part of the mythical path of the waramurrungkas as they passed from the Burrup Peninsula to the Fortescue River.

Previous page
Main Ancient Aboriginal art adorns towering piles of boulders in Murujuga National Park.

Above A fish figure carved in stone.

Left The land exudes a feeling of timelessness.
Photos – Sallyanne Cousans



Turn to chaos

The ancient land sustained the Yaburara people, who inhabited Nickol Bay, the Burrup Peninsula and the islands of the Dampier Archipelago. The Ngarluma people lived to the east of the Yaburara and the Mardudhunera lived to the south-west. Today, many of these people refer to themselves generally as Ngarda-ngarli.

The people's long association with the area is evident in shell middens, stone artefact scatters, quarries, ceremonial and mythological sites, graves, and, of course, the famed petroglyphs. Some 2,000 localities on the Burrup Peninsula are registered in the Department for Aboriginal Affairs' site register, but several times more than this are thought to exist.

Buccaneer William Dampier was the first recorded European to visit the Burrup Peninsula, when he visited briefly in 1699. This apparently uneventful first contact heralded the end of the long stable history of the Burrup Peninsula and the Yaburara people. It was with the next recorded interactions with Dampier's countrymen in the 1860s that the situation turned violent and chaotic.

Partners in management

Recent changes in state legislation have paved the way for Aboriginal people to have a more formal say in the way protected areas are managed (see 'Connecting with country', *LANDSCOPE*, Autumn 2013). In the case of Murujuga National Park, these changes mean the Aboriginal freehold land has been leased back to the state to be jointly managed as a national park, with formal protection under the *Conservation and Land Management Act 1984*.

The Murujuga Aboriginal Corporation (MAC) and the Department of Environment and Conservation (DEC) will jointly manage the national park under the guidance of the Murujuga Park Council (MPC). Day-to-day management of the park will be conducted by DEC and Aboriginal rangers employed by MAC, with shared responsibility between DEC and MAC. Park planning and strategic management will be the responsibility of MPC that comprises representatives of MAC, DEC and the Department for Aboriginal Affairs.

The MAC-initiated Murujuga Ranger Program has recently completed its first year of development and training in land and sea management. The program employs seven male and seven female Aboriginal rangers and is building their capacity to become long-term managers and custodians of the area. The program operates on the advice of a 'circle of elders'. The circle enables the correct cultural knowledge to be handed down to future generations, and also ensures rangers' cultural safety at work, as well as the cultural safety of visitors to the area.

Such arrangements nurture the Ngarda-ngarli's deep connection with their lands and provide a forum for their culture to be shared with others. This is of particular importance to the Ngarda-ngarli, considering much of their traditional country has been taken up with pastoral, mining or government interests.

Goals for the park include protecting the area's cultural heritage, safeguarding its environment, creating employment opportunities for Ngarda-ngarli people, enhancing visitors' cultural and general safety, raising awareness of the area's history and providing opportunities to see and appreciate the remarkable landscape.

Above North-west Aboriginal stockmen played an important role in the region's pastoral history.
Photo – Jiri Lochman

Left Woodside's North West Shelf Project at Burrup Peninsula.
Photo – Marie Lochman

The Yaburara people, already a small group, declined in number following European settlement of the area, most probably due to introduced diseases and some displacement from traditional lands. The remaining people were decimated by a series of violent clashes in 1868, including what has become known as the 'Flying Foam Massacre' in February of that year. The conflict was initiated after a young Aboriginal woman was captured by a police officer and the Yaburara men made subsequent attempts to free her. This resulted in the killing of a police constable and two other men. A series of reprisal raids conducted by local police and 19 especially sworn-in constables followed. The records from the time are vague and inconsistent but it is clear this campaign resulted in the near genocide of the Yaburara people. Although it is more accurately recorded as a series of events, and though it occured at various locations rather than a single site, 'Flying Foam Massacre' has a single meaning and memory. The Ngarda-ngarli feel strongly about seeking to have an area at King Bay recognised for the events that took place there.

Industry arrives

Apart from intermittent activity sparked by gold and other mineral discoveries, the establishment and expansion of the pastoral industry dominated the history of the west Pilbara for the next 100 years. Aboriginal people played a key role in the industry, providing cheap labour, knowledge of the country and the ability to work in the demanding environment.

In spite of the well-documented exploitation of Aboriginal people in the pastoral industry, the 'station days' are still fondly remembered by many older Ngarda-ngarli. These positive memories are built on the fact that, during this time, they were able to maintain their physical and spiritual interaction with their country traditions, language and culture, and avoid many of the social and health problems related to poverty, unemployment and discontent that characterise the more urban lifestyle of many Aboriginal people today.

While pastoralism remains in the region today, it is now mining that dominates industry. The Pilbara is the economic powerhouse of the state, with iron ore mining bringing immense riches to the country and posing challenges for environmental and cultural protection.

Into the future

Given the area's remarkable history and its world significance for ancient Aboriginal art, it is perhaps surprising

Right Nickol Bay, Murujuga National Park.
Photo – David Bettini

Below right Hearson Cove, adjacent to Murujuga National Park, is a popular day-use site.
Photo – Samille Mitchell/DEC

that it is not more widely visited. But the increasing knowledge of the area's treasures is bound to result in more visitors. The joint management of Murujuga National Park is designed to guide this visitation in a culturally safe way that enhances the experience for visitors, while also protecting the area's culture and environment.

Among management aims is a desire to enhance visitor awareness and understanding of the cultural heritage of the area, and protect particularly sensitive or vulnerable rock art areas. An area known as Deep Gorge near Hearson Cove has been earmarked for possible interpretive trails and facilities.

To inform such interpretation and better document the importance of the land to its traditional owners, a management plan for the area points to the need to protect the less tangible side of cultural heritage. Most current research into cultural heritage has been into use and occupation rather than the knowledge and deeper associations between people and land. The Ngarda-ngarli are keen to better document this knowledge and share it with visitors.

The Murujuga Park Council (MPC) is now investigating which areas can be safely opened to the public. The southern portion of the park will be the first main focus, while MPC consideration will be given to construction of management infrastructure and a visitor centre at a culturally appropriate location. The Murujuga Ranger Program (MRP) will present these plans to the 'circle of elders' who provide cultural advice to the rangers (see 'Partners in management'on page 13).

Vehicle access is also to be better managed, with plans to guide vehicles to interesting areas, while leaving particularly culturally sensitive or environmentally vulnerable areas less accessible.

The plan also recognises visitors' enormous interest in Aboriginal culture and lifestyle, and consequent opportunity for the Ngarda-ngarli to develop tourism enterprises. Guided walks, activities, vehicle-based tours, camping and nature study tours, including reference to Ngarda-ngarli languages, stories and songs, are just some examples of activities which can be run by the Ngarda-ngarli, with help from DEC. The development of such ventures will provide both Aboriginal and non-Aboriginal people the opportunity to learn more about this remarkable area and its history.

With such plans in place, together DEC, MAC and MRP will be honouring the cultural obligation to protect this very special piece of country.

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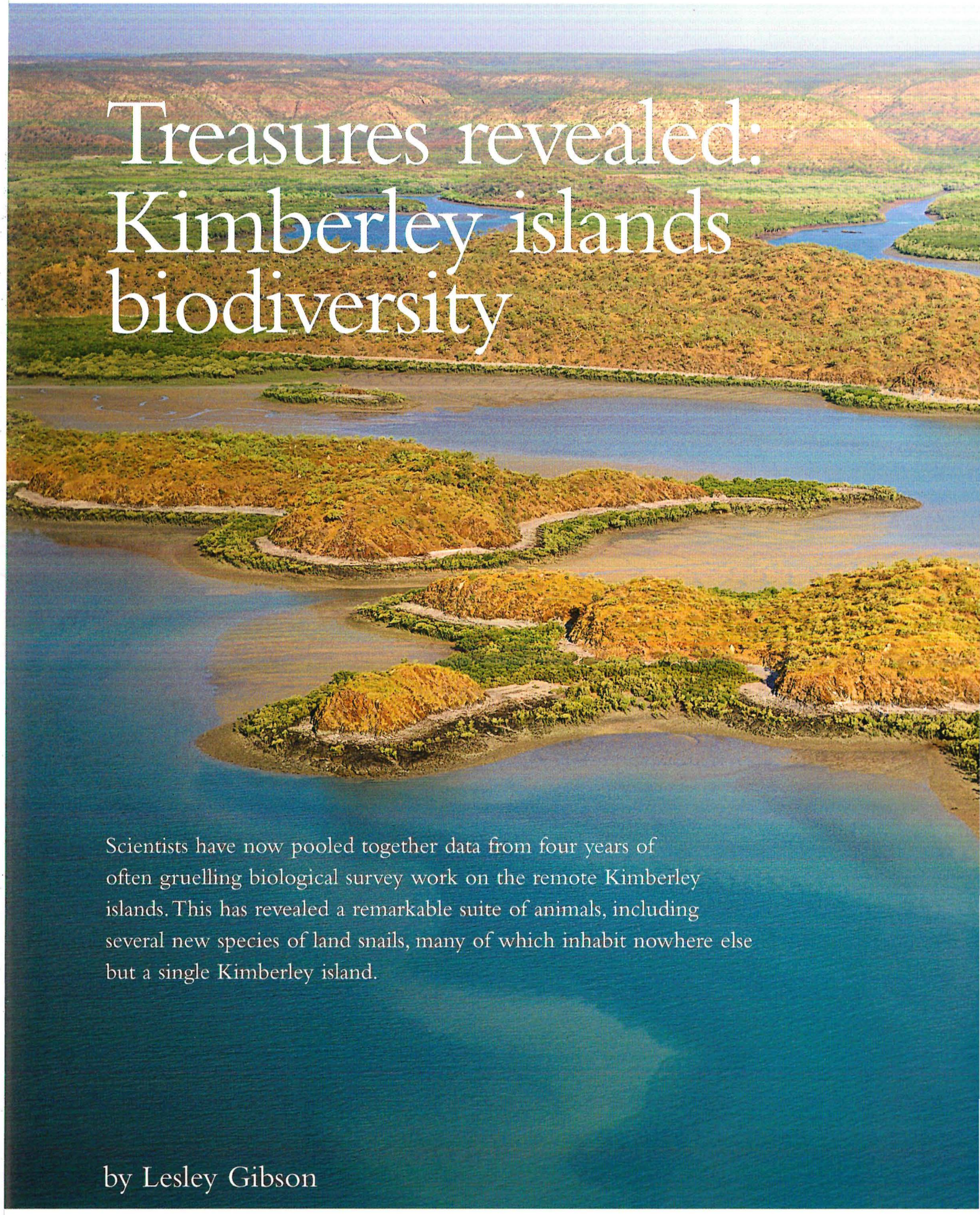
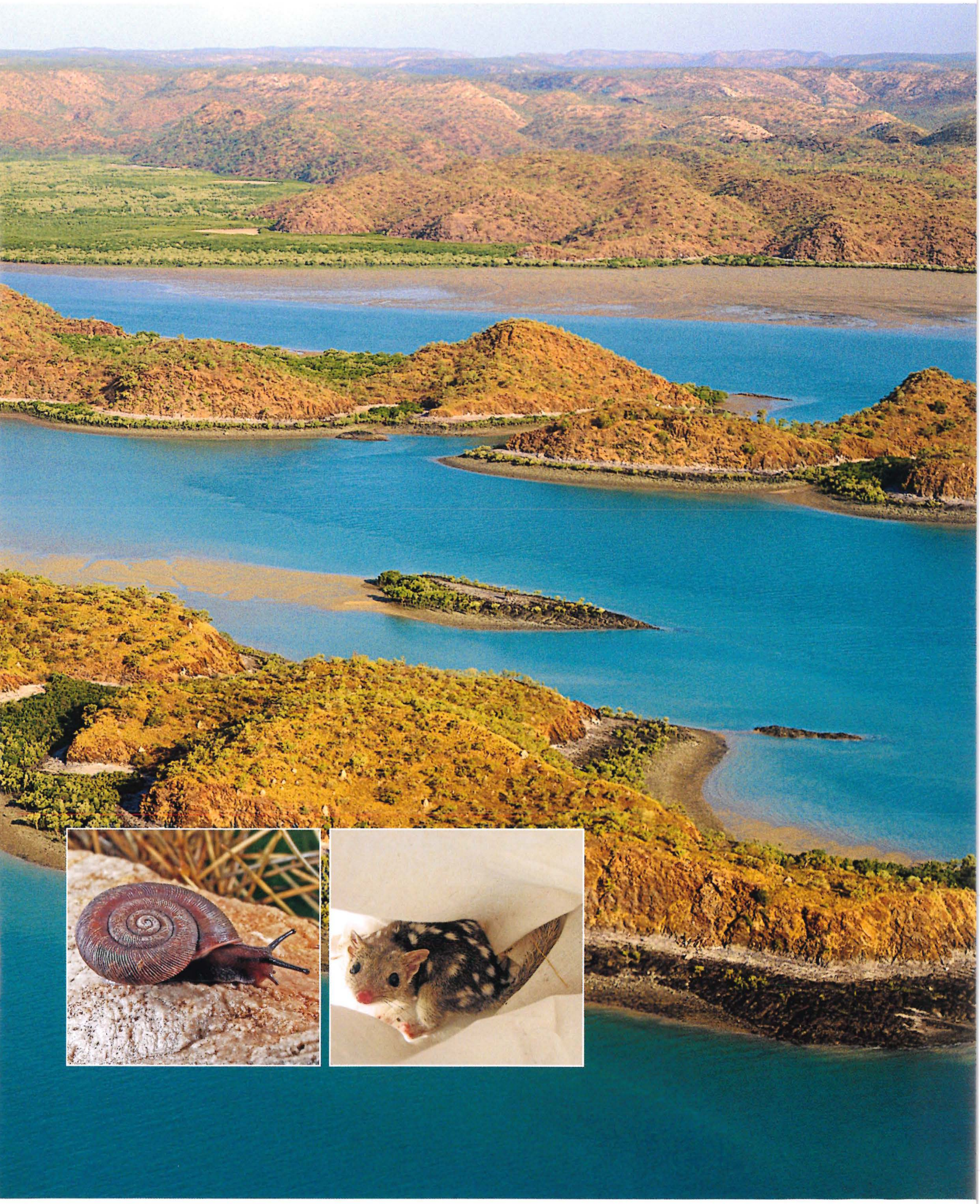
Material for this article was gleaned from the Murujuga National Park Management Plan 2013, *available from the DEC website (www.dec.wa.gov.au).*

Treasures revealed: Kimberley islands biodiversity



Scientists have now pooled together data from four years of often gruelling biological survey work on the remote Kimberley islands. This has revealed a remarkable suite of animals, including several new species of land snails, many of which inhabit nowhere else but a single Kimberley island.

by Lesley Gibson



Tropical islands bring to mind thoughts of white sandy beaches, crystal clear blue water and, for some, cocktails by the pool. But along with providing sun, sand and surf, islands also play a significant role in the conservation of plants and animals. Not only do they act as refuges for species that have suffered major contractions of their distributions on the mainland, but some islands are also important for the endemic and threatened species which inhabit them. Some islands also provide secure breeding sites for seabirds and turtles. Unfortunately, islands are also susceptible to dramatic changes to their ecosystems when exposed to environmental disturbances such as grazing by feral herbivores, fire, and invasion by non-native species. Globally, extinction rates are much greater on islands, with well over half of bird, mammal, reptile and plant extinctions being island species. It is vitally important to protect islands from undesirable disturbances.

Thousands of islands

Just under a third of all Australia's islands are situated along the remote Kimberley coast of north-western Australia. In excess of 2,500 islands along this visually stunning coastline were formed as a result of rising sea levels up to 10,000 years ago. These near-pristine islands have been relatively isolated from many of the threats affecting the adjacent mainland, including changed fire regimes and feral animals. The Kimberley islands also represent part of the traditional lands of Aboriginal people in the region and are of great significance to them. Many of the islands have been subject to native title determinations or are under native title claim. We know these islands have high conservation values but for most of them we have only limited biological knowledge. There is an urgent need to gain a better understanding of their biodiversity.

A biological survey

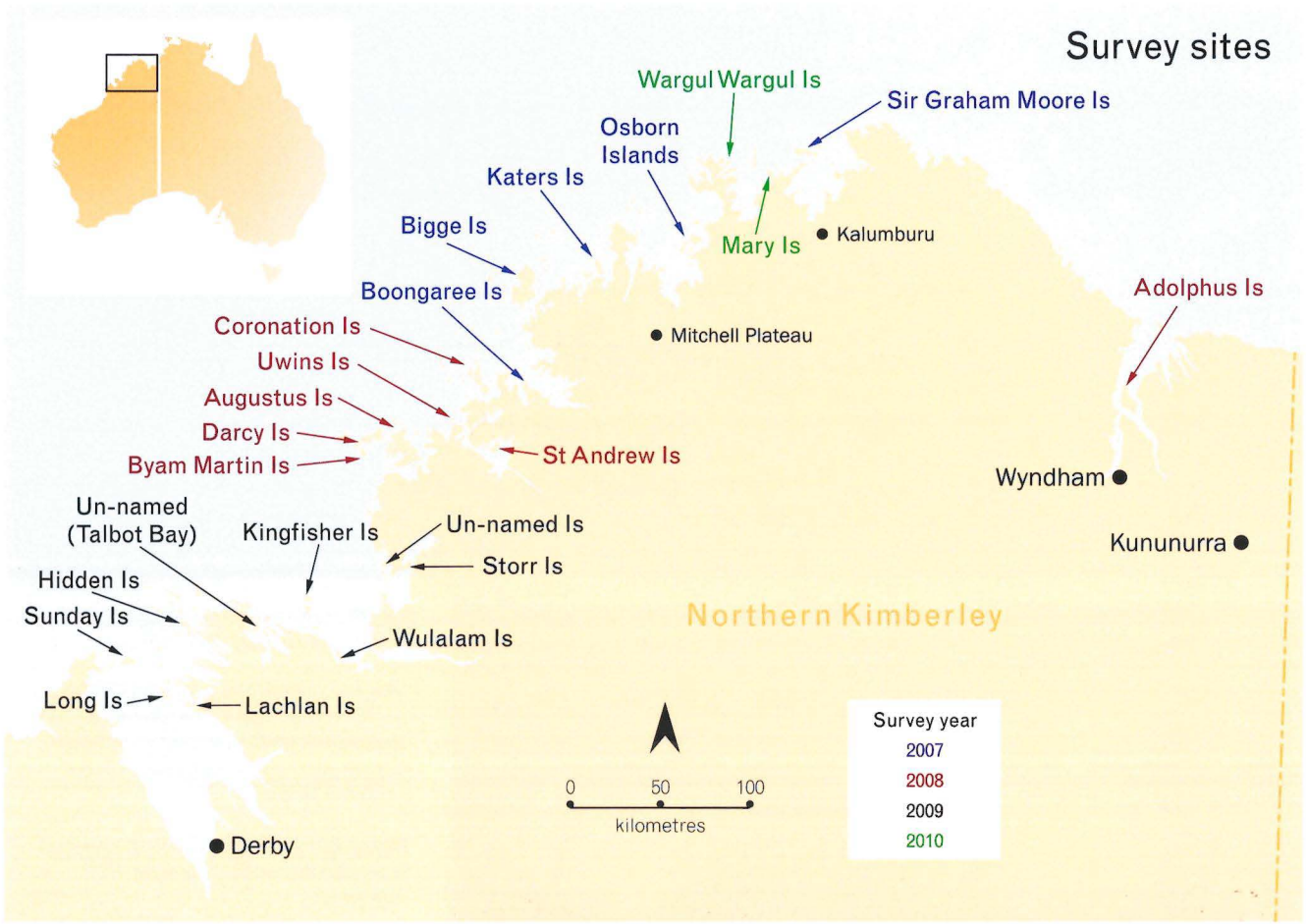
In late 2006, scientists from the Department of Environment and Conservation (DEC) and the Western Australian Museum, in partnership with Balanggarra, Uunguu, Dambimangari, Mayala and Bardi-Jawi traditional owners (coordinated by the Kimberley Land Council), embarked on a biological survey of the Kimberley islands (see 'Treasures of a sunken coastline', *LANDSCOPE*, Winter 2008). This logistically challenging survey aimed to expand knowledge of six ecologically and biogeographically different components of biodiversity across the variety of islands. The information gained was to provide the knowledge base for decisions on conservation, recreation and sustainable development. The survey focused on species groups believed to be most at risk from threats to biodiversity on the Kimberley mainland, and included mammals, reptiles, frogs, land snails, birds and plants.

During four dry season (winter) and three wet season (summer) surveys from 2007 to 2010, field teams documented the occurrence of plant and animal species they encountered from 24 islands ranging in size from 300 to 19,000 hectares. Since the completion of field work, scientists have been busy identifying species, compiling and analysing the data and presenting the results in scientific papers and spoken presentations.

Previous page
Main The island-studded Kimberley coastline at Strickland Bay.
Photo – Col Roberts/Lochman Transparencies
Inset left The snail species *Retroterra discoidea* is endemic to the Kimberley islands.
Photo – Vince Kessner
Inset right Northern quoll.
Photo – Lesley Gibson/DEC

Above Golden bandicoot (*Isoodon auratus*).
Photo – Mark Cowan/DEC

Left The survey helicopter approaches Hidden Island.
Photo – Lesley Gibson/DEC



Right Traditional owner Jahni Isaac and zoologist Duncan Sutherland set a funnel trap line for reptiles on Long Island.
Photo – David Pearson/DEC

Now near completion, the papers are being made publicly accessible on the Western Australian Museum website at www.museum.wa.gov.au/research/records-supplements/supplements/supplement-81 as they are finalised. Traditional owners, with assistance from the Kimberley Land Council and consultant anthropologists, also contributed a paper that describes Aboriginal connections, values and knowledge of the Kimberley islands. This paper emphasises the importance of research partnerships with traditional owners in the Kimberley region, and describes a research agreement that provided for managed access to cultural sites, participation in the field work alongside scientists, data sharing, and input into the final publications.

Biodiversity values

Field work on the Kimberley islands is physically demanding. This is due in part to the hot and humid tropical climate, but also to the rugged terrain which makes these islands very difficult to traverse on foot. Nevertheless, all the hard work paid off, with species lists more than doubled for most of the islands where historical information existed, and a significant amount of new information gathered for those islands not previously surveyed.

Based on current estimates, 74 per cent of mammal, 59 per cent of reptile, 70 per cent of frog, 69 per cent of bird and 56 per cent of plant species of the Northern Kimberley bioregion are collectively now known to occur on the islands surveyed. While lower species diversity on the islands was expected, surprisingly some species that are widespread on the adjacent mainland were not recorded on the islands. For example, small insectivorous mammals such as dunnarts and planigales were not detected on the islands. Large mammals, such as the antilopine wallaroo (*Macropus antilopinus*) and euro (*M. robustus*), and reptiles, such as the larger goannas and

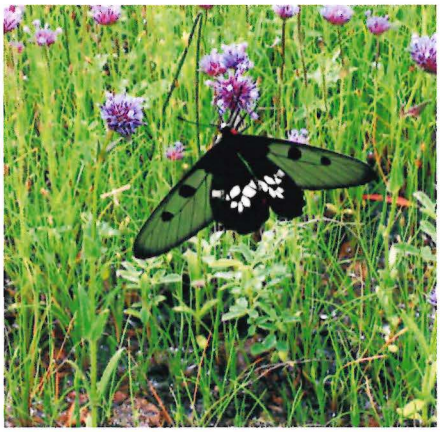
Above Traps were set on Long Island.
Photo – David Pearson/DEC

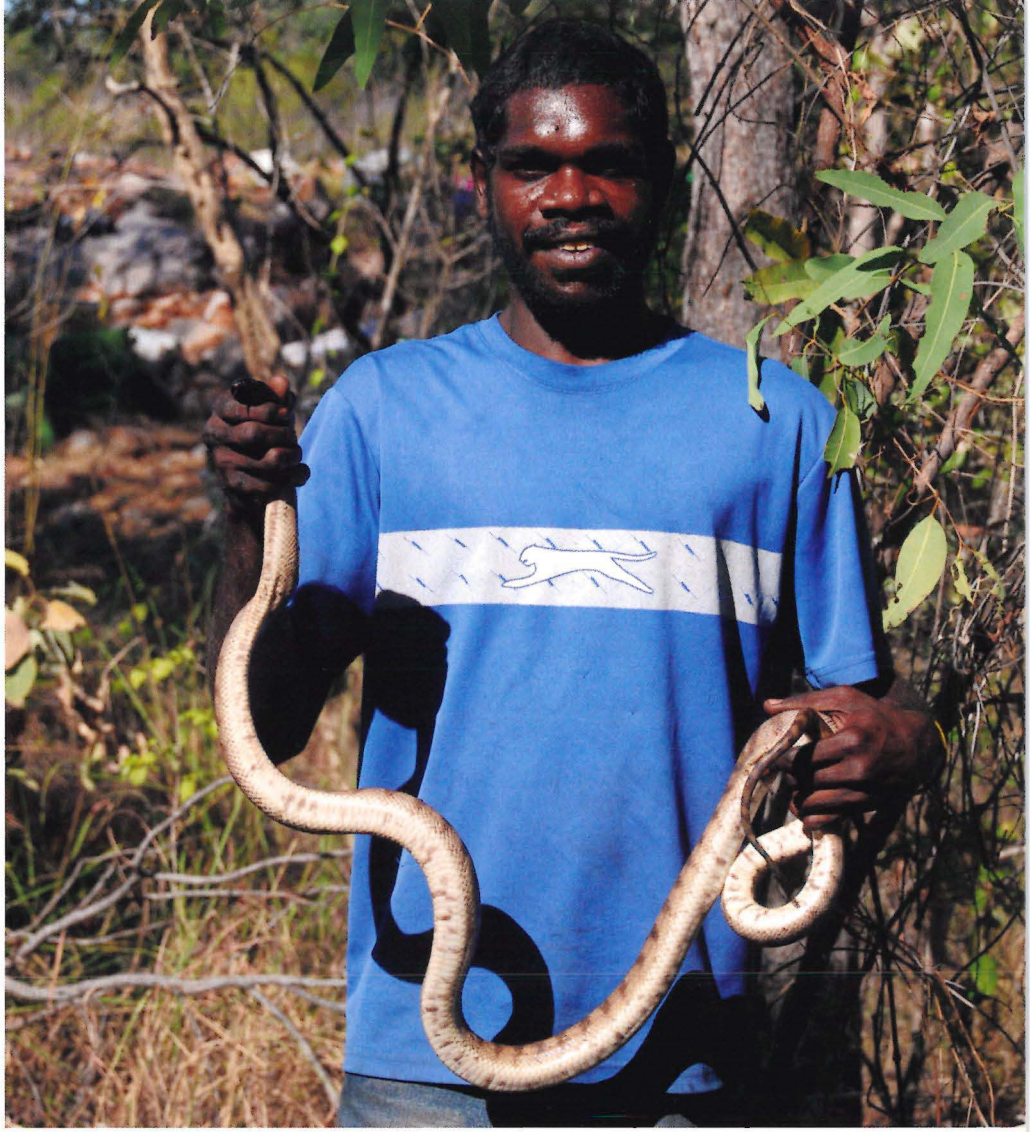
Left An olive python captured during surveys on Saint Andrew Island by zoologist Mark Cowan and traditional owners Jeanine Numendumah and Sonnette Ozies.

Below left A northern quoll is released back into the wild by botanist Tricia Handasyde.
Photos – Lesley Gibson/DEC

snakes, were also apparently absent or rare on the islands. However, the limited resources on islands, such as food, water and habitat, are likely to prevent the persistence of such large animals. There was one exception, the olive python (*Liasis olivaceus*), which was relatively common on the islands. This very large snake (up to four metres long) is a capable swimmer, easily able to swim between some of the closer islands and the mainland. A crew member from one of the expedition vessels was surprised when an olive python boarded his boat anchored 700 metres from the shore. Another unexpected finding was the large number of frog species found on the islands, as permanent freshwater is scarce on all but a handful.

Previously unknown island populations of many vertebrates were discovered. This included two new populations for each of three threatened species—the northern quoll (*Dasyurus hallucatus*), golden bandicoot (*Isoodon auratus*) and golden-backed tree-rat (*Mesembriomys macrurus*). At least three new reptile species were discovered (see 'A little gecko tells a big





Top left A swallowtail butterly and wildflowers (*Spermacoe* sp.) on Boongaree Island.
Photo - Lesley Gibson/DEC

Above Traditional owner Craig Rastus holding a recently caught black-headed python (*Aspidites melanocephalus*) on Storr Island.
Photo - Mike Lyons/DEC

Above left Sticky kurrajong (*Brachychiton viscidulus*) on Wulalam Island.
Photo - Tricia Handasyde/DEC

story', *LANDSCOPE*, Spring 2011). An astonishing result was the number of new land snail species discovered on the islands, with 74 distinct new species now described (see 'Diversity hot spot revealed: land snails of the Kimberley', *LANDSCOPE*, Spring 2010).

A significant number of species endemic to the Northern Kimberley mainland were also detected on the islands. This included all five endemic mammals, almost all of the frogs and reptiles, and more than half of the birds. A total of 10 vertebrate species, all reptiles, were restricted to islands with no known mainland distributions. However, among the land snails, an amazing 73 of the 89 camaenid land snails discovered (Camaenidae being the dominant family in the Kimberley) are only known from the islands, and 62 of those were endemic to a single island.

Biodiversity patterns

In a major survey like this, the compilation of comprehensive species lists for each island is one important outcome. However, to take it one step further, an examination of biogeographic patterns—that is, where species occur, with whom, and why—is what helps set conservation priorities. A strong positive relationship between the number of species detected on an island (or its species richness) and its area was apparent; as a generality, the larger the island, the more species occur there. In fact, the species-area relationship is considered to be one of the few 'laws' in ecology. Bigger islands tend to have a greater number of habitats, and more of each one, and so can support a wider range of species.

The most rugged islands of the high rainfall zone (more than 1,000 millimetres on average per year) of the north-west Kimberley typically had the greatest numbers of endemic species, a pattern also observed on the adjacent mainland. Since rainfall determines soil moisture, vegetation growth and productivity, the importance of this climatic variable is not surprising. In turn, spatially complex and rugged boulder country results in diverse habitats that are largely protected from fire and damage due to cyclones.

The number of habitat types in a given area not only influences the number of species, it also affects the suite of species that are likely to occur there. For example, species that prefer monsoonal rainforest are more likely to persist on high rainfall islands, since the extent of rainforest on islands was positively correlated to rainfall. The high rainfall and dissected rocky islands contained species associated with those habitat types on the mainland, whereas drier islands with more subdued topography supported widespread species with more general

Above More than 2,500 islands line the Kimberley coast.
Photo – David Bettini

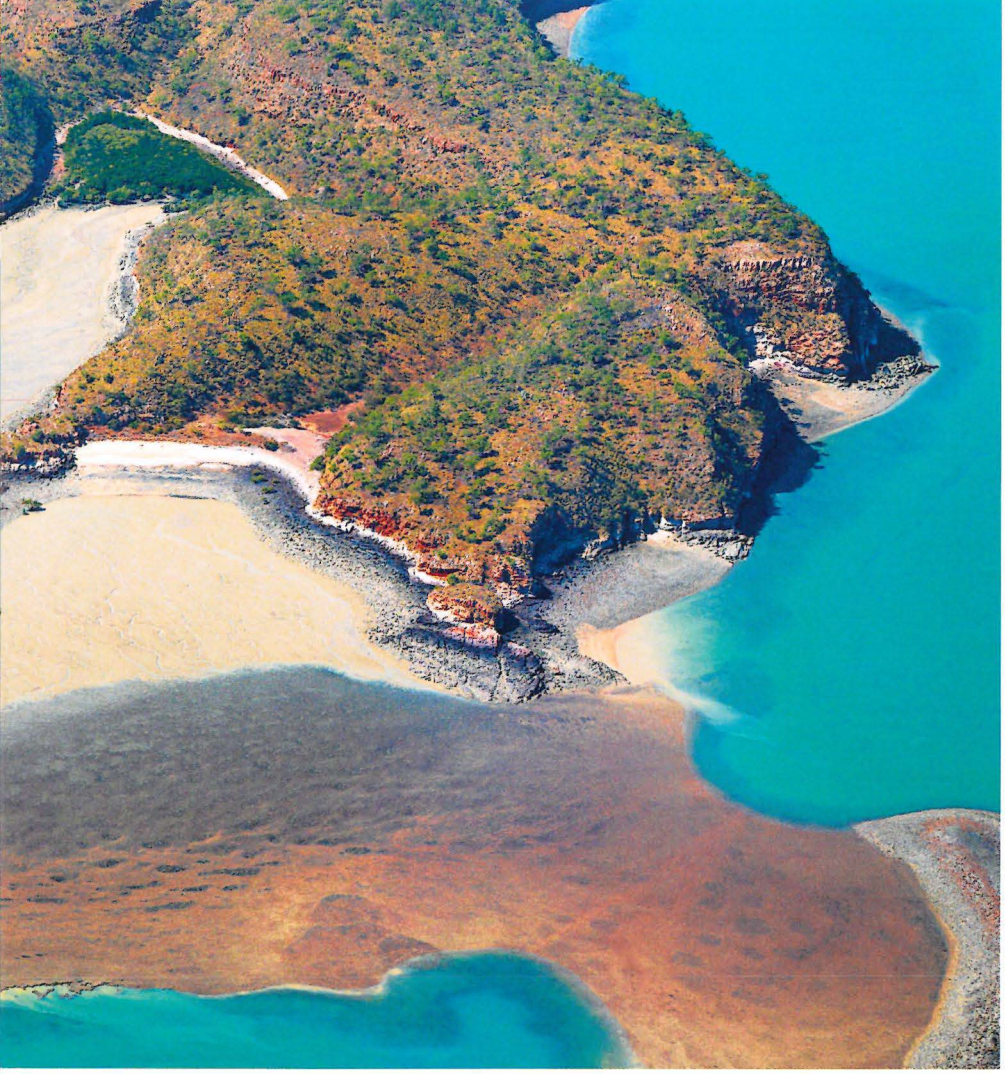
Left Senior research scientist Lesley Gibson on Darcy Island.
Photo – Tricia Handasyde/DEC

habitat requirements and distributions extending into semi-arid and arid zones.

Pesky species

Fortunately, there was little evidence of introduced animals on the 24 islands sampled. Despite historical records of the European rat (*Rattus rattus*) on Sunday Island, the species was not detected during the Kimberley island survey (see 'The mysterious case of the black rat on Sunday Island', on page 42). However, records of feral pigs on Sir Graham Moore Island were confirmed during the dry season survey in 2008. Few weeds were recorded, with no more than three species on most of the islands surveyed. The most significant weed on the islands was the stinking passionflower vine (*Passiflora foetida*) which was ubiquitous, and particularly abundant along drainage lines, rainforest margins and beach swale thickets.

However, the relative lack of introduced species on the islands gives no reason to be complacent. The rugged beauty of the Kimberley islands, and this section of coastline in general, attracts many visitors each year, who arrive by boat or helicopter. With increasing human activity, the risk of species being introduced to the islands also rises. Many pest species can 'hitch' a ride to islands with people; examples are the cane toad (*Rhinella marinus*), the Asian house gecko (*Hemidactylus frenatus*) and introduced rats and mice. Visitors to islands can also inadvertently introduce weeds via seeds hidden in clothing or equipment. Once pest species invade islands, they can be notoriously difficult and expensive to eradicate. Cane toads are a major threat to the biodiversity of some Kimberley islands. As many islands are close to the mainland, and several are



Above Yellow-spotted monitor (*Varanus panoptes*) on Adolphus Island. *Photo – Tricia Handasyde/DEC*

located in river mouths, the risk of toads rafting or swimming to islands is high.

Cane toads have colonised many islands off the Queensland and Northern Territory coastlines, with severe consequences to the fauna. Several species known to be susceptible to poisoning by ingestion of cane toads were recorded on the Kimberley islands, including the carnivorous northern quoll, six species of goanna, the blue-tongue skink (*Tiliqua scincoides*) and several species of snake including the death adder (*Acanthophis praelongus*). Strategies to prevent cane toads reaching islands are crucial, as are regular surveillance to detect them if they sneak ashore, and eradication programs.

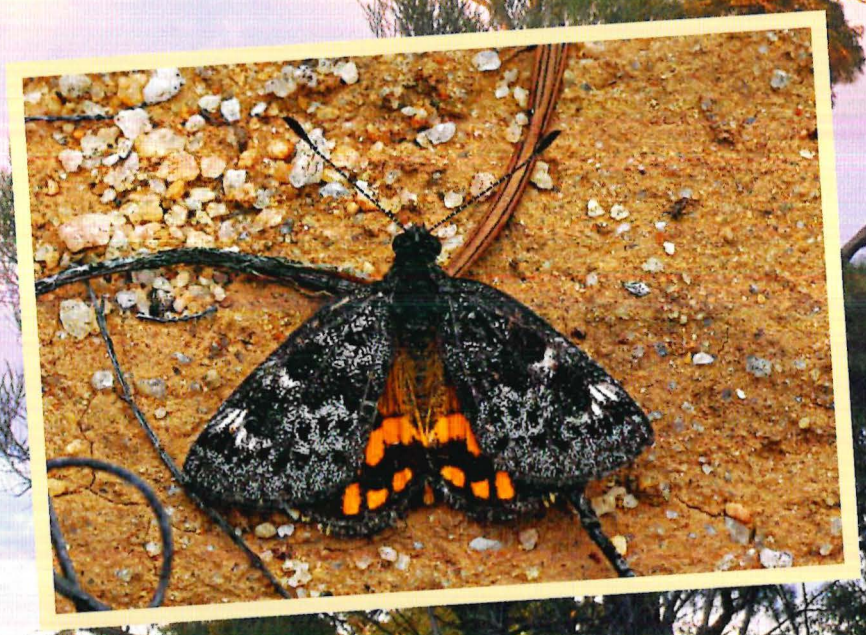
What does it all mean for the islands?

In terms of their value for conservation, the largest islands in the highest rainfall section of the northern Kimberley coast are particularly important due to their high species diversity, including numerous regional endemics. However, while low rainfall islands generally contain fewer species, they often have unique communities and some are important refuges for threatened mammals such as the northern quoll and golden-backed tree-rat. Probably the most compelling conservation message comes from the remarkable patterns observed in the land snails. They display incredibly high levels of island endemism such that almost every island conserves one or two unique species. Together the islands capture the incredible diversity of these delicate survivors from a time when the north Kimberley was much wetter than it is today.

The Kimberley Islands Biodiversity Survey has confirmed the immense value of these islands as conservation refuges. The islands are also important culturally and economically for a number of Aboriginal groups along the north Kimberley coast. Future management is likely to be dependent on mutually agreed strategies which protect both the biodiversity and the cultural treasures of these spectacular islands.

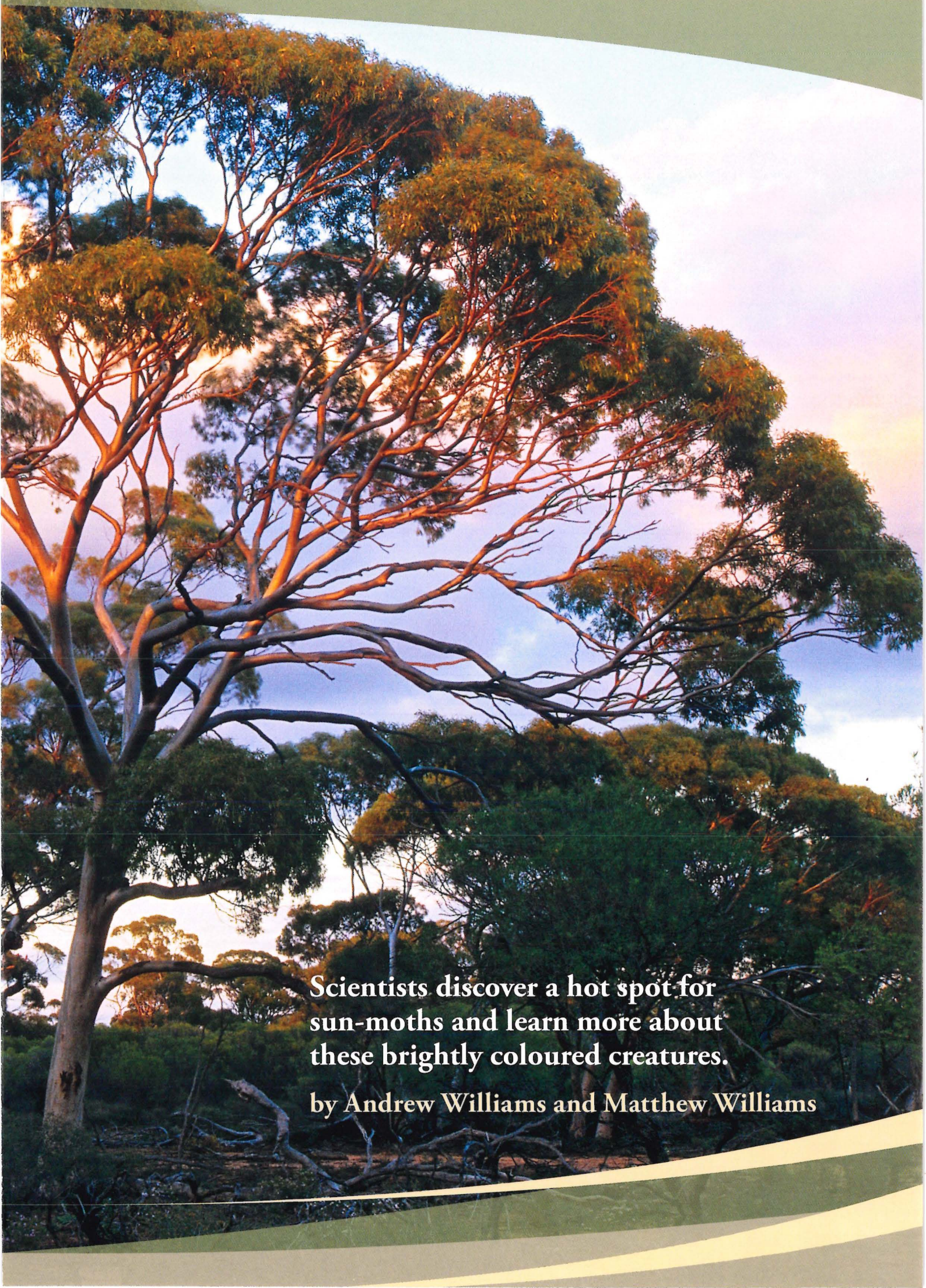
Lesley Gibson is a senior research scientist at the Department of Environment and Conservation (DEC) and is the Kimberley Islands Biodiversity Survey project coordinator. Lesley is based at DEC's Wildlife Research Centre in Woodvale. She can be contacted by email (lesley.gibson@dec.wa.gov.au).

The author would like to thank all those involved with the survey including colleagues from DEC, the Australian Museum, Western Australian Museum (WAM), Kimberley Land Council, Biota Environmental Sciences, traditional owners, Aboriginal rangers and base camp volunteers. She also thanks those involved in the WAM publications, especially managing editor Susan Yates. David Pearson, Mark Cowan and Rachel Meissner provided valuable comments on this article. The Kimberley Islands Biodiversity Survey was possible through a research agreement with the Kimberley Land Council for the Balanggarra, Bardi-Jawi, Wanjina-Wunggurr Dambimangari, Mayala and Wanjina-Wunggurr Uunguu native title groups.



Sun-moth haven in the Wheatbelt:

Wyalkatchem Nature Reserve



Scientists discover a hot spot for sun-moths and learn more about these brightly coloured creatures.

by Andrew Williams and Matthew Williams

Sun-moths belong to a moth family, the Castniidae, which occurred on the ancient supercontinent of Gondwana. Today the distribution of these brightly coloured day-flying moths mirrors that of the marsupials—they occur only in South and Central America and Australia. In South America they are called 'giant butterfly moths', whereas the Australian species are called 'sun-moths'.

In Australia there are about 45 species of sun-moth. Of these, at least 20 occur in south-western Western Australia. Most are endemic to the region with a large proportion yet to be formally named. Over the past three years the Department of Environment and Conservation (DEC) has begun surveys to determine the distribution, relative abundance and habitat preferences for some of the species which occur in the south-west. Nature reserves, national parks and flora conservation areas have been specifically targeted for inspection. In the central Western Australian Wheatbelt, Wyalkatchem Nature Reserve has been identified as a significant sun-moth hot spot.

What is a sun-moth?

As their name implies, sun-moths tend to fly only in bright sunny conditions. In flight they resemble butterflies, particularly as their hind wings are usually brightly coloured in yellow, orange or red. Like butterflies, sun-moths also have distinctly clubbed antennae. But when at rest sun-moths can always be distinguished from butterflies because they settle with their forewings folded back beside and over the body. This is a very characteristic moth posture; butterflies, on the other hand, rest with their wings held in an upright position above the body.

The biology of most of the Australian species has not yet been documented, but their pattern of development is fundamentally the same. The larvae (caterpillars) feed on monocotyledons with deep rhizome root systems. Native grasses, sedges and mat-rushes belong to this group and are commonly used by the sun-moths. Female sun-moths mate soon after they emerge from the pupa, and then start laying their eggs. They do this by means of a long retractable ovipositor, depositing an egg at a time in the soil at or near the base of their larval host plant. After hatching, the larva chews its way into the lower stem and then tunnels downwards into the leaf base or root rhizome. Here it remains underground, feeding on the plant's developing leaf shoots before they reach the surface. Plants which harbour sun-moth larvae will often exhibit patchy stem and leaf die-off, a telltale indication of larval presence.

Previous page
Main Salmon gum occurs in some areas that sun-moths inhabit.
Photo – Marie Lochman
Inset A Perth sun-moth (*Synemon* sp.'Perth').
Photo – Andrew Williams/DEC

Below Butterflies such as the Australian painted lady, below, can be distinguished from sun-moths by the way they hold their wings upright, as opposed to downturned like the claret sun-moth, pictured below right.
Photos – Jean Hort, Andrew Williams/DEC

Above A ruby sun-moth showing its characteristic dark red hind-wing which is broadly bordered in black.
Photo – Andrew Williams/DEC

Seeking sun-moths

Each sun-moth species has very specific food-plants on which its larvae can feed. Knowing the identity and being able to recognise these plants in the field is particularly helpful when planning surveys to look for sun-moths. Details of food-plant distributions can be accessed on DEC's *FloraBase* website, and using these data enables researchers to focus on areas of potential sun-moth habitat.

Other crucial information to know is what time of year different sun-moths are likely to fly. Each sun-moth species has its own distinct flight period. Most species fly in spring or early summer, but there are some which only come out in mid to late summer, or early autumn. For this reason, repeat surveys of the same reserves have to be carried out at regular intervals during the year to ensure that these specialised species are not overlooked.

Sun-moths which appear in the hot dry summer months fly at times when flowering plants are few and far between. Nectar is generally not available, so over time the mouthparts of these specialised species have become greatly reduced. They do not feed but rely on nutrients accumulated during the larval stage for energy. The life span of individual adults may be very short, in some cases only three or four days. Their sole imperative is to mate, and for the females to then locate suitable plants alongside which to lay their eggs. Frequently these rare summer sun-moths are only observable for about 10 to 14 days. Living in seasonally arid and hostile environments means that they must be adaptable. There is evidence that the juvenile stages may regulate their rate of development, enabling adults to emerge in greater numbers in years when weather conditions are most favourable.

Survey techniques

When surveying for sun-moths in the south-west, several factors must always be considered. Daily weather conditions often dictate when surveys can be carried out, as sun-moths always prefer to fly in warm to hot sunny conditions. The optimal time to see them is between 10am and 3pm. Experience has shown that surveying on overcast days is unprofitable. Male sun-moths are also territorial and, like some butterflies, they will seek out and occupy prominent ridges, hilltops or even areas of bare ground. Such places are always examined during surveys.

Sun-moths are also known to spend time in the vicinity of their larval food-plants, so areas in which these plants grow are specifically examined. It is not uncommon to see male sun-moths searching these food-plants for freshly emerged un-mated females. In addition to walking transects in nature reserves to find adult sun-moths, a surveyor may also locate juvenile sun-moths by scrutinising the food-plants for signs of larval activity.

Wyalkatchem—a sun-moth haven

Initial DEC surveys to document sun-moth distribution in south-western WA were undertaken in an area south-west of a line running from Geraldton to Esperance, an area mostly covered by the Wheatbelt. Although mostly cleared for agriculture, scattered remnants of the original vegetation remain. Many of these patches of remnant bushland are now preserved

Left Salmon gum and wandoo woodland in Wyalkatchem Nature Reserve. The claret sun-moth's food-plant *Lomandra effusa* grows in this patch of woodland. Claret sun-moths can readily be seen here in February.
Photo – Andrew Williams/DEC

Below left A western red sun-moth resting on its food-plant.
Photo – Eleanor Williams

Bottom left Sunny sun-moths showing the distinctive white spot on the forewing.
Photo – Andrew Williams/DEC

for nature conservation in the form of nature reserves, national parks or local wildflower conservation areas. Even reserves vested for other purposes, such as timber or water supply, may have nature conservation value if their native vegetation is well preserved. Although often relatively small, nature reserves in the Wheatbelt frequently had great sun-moth diversity. As a general rule, sites with a combination of woodland, species-rich heathland and sedgeland featured the most sun-moths. One such area in the central Wheatbelt is Wyalkatchem Nature Reserve. This area has the right habitat attributes and supports an astonishing six different sun-moth species. In eastern Australia, localities seldom support more than a single species of sun-moth.

Wyalkatchem Nature Reserve is located north-east of the Wyalkatchem townsite. With an area of about 256 hectares, it is bordered to the north, south and east by gently undulating cleared farmland typical of much of the central Wheatbelt. Wyalkatchem Golf Course abuts the south-western boundary. The nature reserve can be accessed along Goldfields Road which runs alongside most of the southern boundary, and the Koorda–Wyalkatchem Road which cuts through the northern edge of the reserve. The habitat on the nature reserve can be broadly separated into four units. To the west, salmon gum (*Eucalyptus salmonophloia*) and wandoo (*E. wandoo*) woodland predominates on the heavy clays, with mallee-dominated woodland at the northern end of the nature reserve. Much of the remainder of the nature reserve supports variable tamma (*Allocasuarina*

Right A mating pair of western red sun-moths showing the extensive red markings on the upper-side of the hind wings (female, left) and underside of the wings (male, right).
Photo – Andrew Williams/DEC

campestris) dominated shrubland over low mixed heath with tussocky cord-rush (*Ecdeiocolea monostachya*) and other sedges. In some parts of the nature reserve, tussocky cord-rush sedgeland exists on its own.

The spring fliers

Of the six sun-moths known from Wyalkatchem Nature Reserve, three fly in spring, one in early summer, and two in mid-summer. The three spring-flying species are the western red sun-moth (*Synemon catocaloides*), the ruby sun-moth (*S. nupta*) and the Perth sun-moth (*S.* 'Perth'). The unofficial name *Synemon* 'Perth' is used here as a convenient tag for a complex group of closely allied sun-moths which are presently under taxonomic revision by Australia's sun-moth authority, Ted Edwards, curator of Lepidoptera at the Australian National Insect Collection in Canberra.

The western red sun-moth is a large species with a wingspan of up to 50 millimetres. The upper surface of the forewing is dull grey with indistinct dark markings and sometimes whitish markings as well. By contrast the upper surface of the hind wing is bright red or orange-red with some blackish markings. The underside of both the fore and hind wings have contrasting orange-red and grey markings, and in flight this orange and red colouration is very conspicuous. However, when at rest, the wings are folded so that only the dull grey upper forewing surface is visible. This provides the moth with excellent camouflage. It is a relatively common species in the Wheatbelt, where it flies from October to early November. It is almost invariably found in habitat where its larval food-plant, the tussocky cord-rush, predominates.

The ruby sun-moth is slightly smaller than the western red sun-moth and flies at the same time of year. However, the ruby sun-moth is generally found in the vicinity of its larval food-plant—a medium-sized broad-leaf sedge. This sun-moth is superficially similar to the western red sun-moth, but the upper side of its forewings is darker grey with blackish and whitish markings. The upper side of the hind wing is dark red, but very broadly bordered with black. The underside of the wings is mostly black with some restricted dark red markings on the forewing and whitish spotting on the hind wing. In flight this sun-moth always appears very dark. When settled, the dull dark grey forewing pattern also gives this sun-moth effective camouflage.

The Perth sun-moth is a medium-sized sun-moth with mottled grey, black and white rounded forewings, and hind wings heavily spotted yellow or orange-yellow. At Wyalkatchem, this sun-moth flies in October and early November and is usually seen in open tamma-dominated shrubland.

The summer flyers

The three summer-flying species are the sunny sun-moth (*Synemon heliopis*), the claret sun-moth (*S. jcaria*) and the darkling sun-moth (*S.* 'BobHay'). The unofficial name *Synemon* 'BobHay' is, like *S.*'Perth', simply an interim identification tag while the species is officially described. The sunny sun-moth is relatively small with a wingspan of 35 millimetres. The upper surface of its forewing is dull grey-brown with a small bright white central spot. The upper side of the hind wing is also dull grey-brown but with extensive paler orange-brown makings. In flight, this sun-moth is inconspicuous. However, when it settles on upright sedges or twigs, the white spot on the forewing is always prominently displayed. In Wyalkatchem Nature Reserve, sunny sun-moths may be seen in mid to late November and

Above left Tamma-dominated shrubland over tussocky cord-rush sedgeland is widespread on Wyalkatchem Nature Reserve.

Above The claret sun-moth, which inhabits the salmon gum and wandoo woodland in Wyalkatchem Nature Reserve.

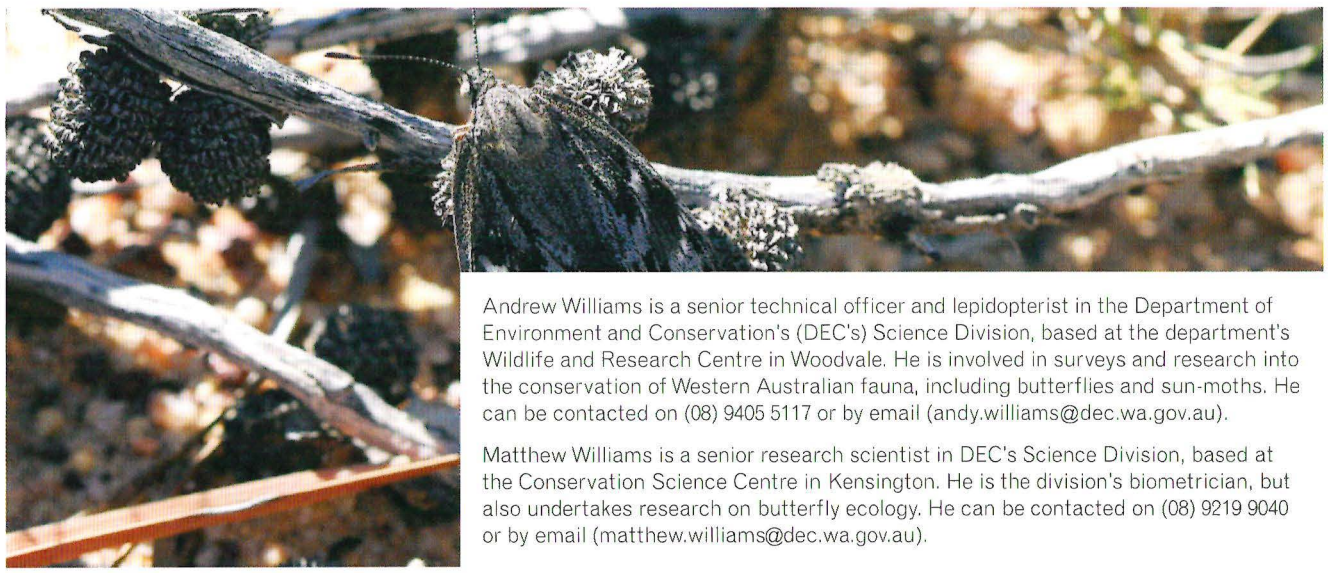
Below A ruby sun-moth at rest.
Photos – Andrew Williams/DEC

early December, usually in tamma shrubland where tussocky cord-rush predominates.

The claret sun-moth is a very small sun-moth, most individuals having a wingspan of only 30 millimetres. The sharply pointed forewings have a diffuse pattern of grey, brown and whitish markings, while the hind wings are bright orange, usually with a narrow black band and border. The underside is mostly pale orange. These small, fast-flying sun-moths invariably fly close to the ground in the vicinity of the food-plant, scented mat-rush (*Lomandra effusa*). At Wyalkatchem the species flies in February and may be seen in salmon gum and wandoo woodland where the larval food-plant is particularly common.

The darkling sun-moth is unusual, in that it does not have brightly coloured hind wings like most other sun-moths. The upper side of the forewing is dull grey with variable diffuse markings, while the hind wing is greyish-black with a slightly iridescent sheen in some lights. The underside is dark brownish -grey variably patterned with whitish spots. At Wyalkatchem this cryptic species flies only in February, where it is found in tamma shrubland over tussocky cord-rush sedgeland.

These preliminary sun-moth surveys have greatly increased our knowledge of the diversity, abundance and distribution of sun-moths in south-western Australia, and further highlighted the importance of remnant patches of bushland in the Wheatbelt for the conservation of our invertebrate fauna. Much is still to be learnt about the habits and life histories of these ancient sun-moths, but it is reassuring to know that they have survived the impact of past large-scale clearing of native vegetation. Having an understanding of where the various sun-moths occur will enable DEC to better manage these priceless endemic Western Australian species.



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endangered by Abby Thomas

Purple-crowned fairy-wren

Deep in the heart of the Kimberley, along several of the river systems, you may spot a tiny bird with a vibrant purple crown: the purple-crowned fairy-wren (*Malurus coronatus coronatus*). The bird, just 14 centimetres tall, is a riparian specialist, only residing in habitat within 20 metres of permanent rivers, billabongs or swamps.

The striking purple crown that distinguishes this species is only present on breeding males. Otherwise both genders are very similar in appearance: a warm brown colour above and white below with a long vertical blue tail.

These charismatic birds sing coordinated duets with their long-lasting breeding mates to ward off other fairy-wrens from their family group and territory. The family group of this species consists of the progeny from previous breeding seasons that stay around to help raise the next generation. This is known as cooperative breeding, and some helpers remain four or more years.

As early as 1908, collector JP Rogers noted that this species was rare in areas where it was previously abundant. The effects of cattle grazing on riparian understory led to the purple-crowned fairy-wren being first listed as 'threatened' in January 1978, under the Western Australian *Wildlife Conservation Act 1950*. However, re-assessment of all Australian bird species led to the purple-crowned fairy-wren being delisted in April 2002.

The purple-crowned fairy-wren was once again listed in November 2012, as a result of work by the Department of Environment and Conservation, Australian Wildlife Conservancy and external consultants. This survey work showed that the riparian habitat the birds occupy is contracting and deteriorating in quality due to trampling from livestock and feral herbivores, more frequent or intense fires, or floods and invasive weeds. This has caused severe declines in the number of areas the birds occupy throughout their range.

There are currently five main catchment areas where purple-crowned fairy-wrens are found in Western Australia and three additional catchment areas in the Northern Territory. Due to the purple-crowned fairy-wren's patchy distribution over a large area of riparian habitat, conservation managers and scientists recommend conservation actions to conserve riparian vegetation at a regional scale. This will be the most effective way to conserve this species for future generations. So, while the future of the purple-crowned fairy-wren is still uncertain, relisting the species was the first step in recognising that immediate conservation management is required to safeguard this charismatic little bird.

Photo by David Bettini

Australia's **real dragons**

For many, dragons are make-believe fantasy creatures—mythical beasts of the imagination found only within the pages of a fairytale or the inner mysterious mists of the human psyche. However, there are real-life dragons thriving in the deserts of Western Australia's arid interior.

by Amy Prendergast

The dragons that live in Western Australia have a superficial and miniaturised resemblance to the mythical dragons of fantasy. Dragons are the common name given to a group of lizards within the family Agamidae. About 73 species from approximately 14 genera of these dragons (agamids) occur across the continent, of which about 66 species occur in Western Australia. New species are still occasionally discovered and described.

WA is home to some of the most distinctive of Australian dragons such as the bearded dragons (*Pogona* spp.), netted dragons (*Ctenophorus* spp.), the frilled neck lizard (*Chlamydosaurus kingii*), and the thorny devil (*Moloch horridus*). This last species is a bizarre dragon and is certainly evocative of the dragons of fantasy. Its unique nature has warranted scientists to recognise it as evolutionarily distinct among the agamids and to classify it as the sole member in its genus, *Moloch*. While completely harmless to humans, and any other creature except ants, the dragon's extremely spiny body and pair of devil-like horns prompted the generic name *Moloch*, derived from a fearsome ancient near-eastern deity to whom children were sacrificed, and the specific name *horridus*, Latin for 'frightful'.

Previous page
Main Gilbert's ta-ta dragon (*Amphibolurus gilberti*).
Photo – David Bettini
Insets Frilled neck lizard scales.

Above right Western netted dragon.

Below Thorny devil.
Photos – Simon Cherriman

Characterising dragons

Dragons are a charismatic reptile group. They are characterised by rough, ridged-keeled scales producing a body surface like sandpaper; robust, richly patterned bodies; relatively powerful legs which they use to dig burrows for shelters and egg chambers; and often long-clawed toes which confer them great skill in scaling trees and boulders. They have large, well-defined heads with large eyes bordered by moveable eyelids, and often engage in complex social behaviours.

A unique characteristic of the agamid dragons is that their posterior teeth are fused to the outer rim of their jaws and cannot be replaced, a condition known as 'acrodont dentition'. Chameleons, the group to which agamids are most closely related in an evolutionary sense, are the only other lizard group that possess acrodont teeth. However, unlike chameleons, agamids (except for the thorny devil) also possess front (anterior) teeth typical of other lizards—known as pleurodont teeth—which are borne on the inner margin of the jaw and are replaced continuously throughout life.

Dragon species range in size from the pebble dragon (*Tympanocryptis cephalus*) and mallee military dragon (*Ctenophorus fordi*), with bodies less than five centimetres long, to the largest dragons such as the frilled neck lizard and water dragons (*Physignathus* spp.). These have body lengths of about 30 centimetres and tails stretching another 30 centimetres.

Australia's dragons are an impressive sight. Their bodies often sport spines, crests, and erectable frills and gular (throat) pouches, or prickly beards. These body ornamentations may serve in camouflage, defence, to startle predators, to impress or attract

Right The long-nosed ta-ta dragon earned its common name from the way it holds its limb as if waving goodbye.

Below right Spotted military dragon.
Photos – Janine Guenther

Bottom right Central netted dragon.
Photo – Jiri Lochman

mates, or to assert dominance against competitors during feuds over territory or mating rights.

In addition to their eye-catching appearance, dragon lizards display complex behavioural repertoires, using various postures, poses and movements—like head-bobbing or hand-waving—to communicate. Tail-lashing, push-ups and head-dipping are performed to display territorial claims, sexual or reproductive status, and dominance or subservience. One common Western Australian species, *Amphibolurus longirostris*, is so prolific in its hand-waving antics that it has earned the common name of the long-nosed ta-ta dragon ('ta-ta' being Australian slang for goodbye).

Dragons on the hunt

Boasting the keenest vision among Australian lizards, agamids exploit their visual acuity to detect both prey and predators, as well as for communication between individuals. This makes them proficient hunters. However, rather than being active predators, dragons are typically 'sit-and-wait' or ambush predators, lunging at prey when it comes within range and using their broad, sticky tongues and strong jaws to catch it. They feed primarily upon arthropods (insects and spiders), but various larger species and individuals may include small vertebrates or plant matter in their diet.

While most are opportunistic and take whatever insects are readily available, the thorny devil is a highly selective eater, with a diet composed exclusively of small black ants in the genus *Iridomyrmex*. A thorny devil is able to devour more than 1,000 ants in a single feeding bout, yet it consumes just one ant at a time, picking each one up individually with its tongue. The thorny devil is highly adapted to what

Above Long-nosed ta-ta dragon.
Photo – Simon Cherriman

Left A superb two-lined dragon's colouring helps it blend in with its surroundings.
Photo – Jiri Lochman

would otherwise be an unpalatable and indigestible diet. It has specialised tricuspid teeth that form a very efficient shearing apparatus, enabling it to puncture the hard, chitinous exoskeleton of its ant prey to access the nutritious inner tissue.

Masters of adaptation

While sharing the same basic body plan, various dragon species developed adaptations to suit their diverse ecological niches. Species occupy a range of habitats, and may be ground dwelling, arboreal (tree dwelling), semi-arboreal, or found primarily in rocky outcrops. The body of the arboreal superb two-lined dragon (*Diporiphora superba*) is extremely slender and green, providing excellent camouflage in trees. And, like many other arboreal species, it has an extraordinarily long tail, measuring more than four times its body length. This probably helps it balance as it clambers among shrubs. It is physiologically adapted to withstand high body temperatures with a record of up to 46 degrees Celsius. It copes with excessive heat through its long, thin body which gives it a high surface area to volume ratio, maximising heat loss. It can also keep cool by seeking respite in shady foliage.

Other species feature body characteristics which enable them to hide in burrows, rock crevices or cracks in the sun-baked earth to escape desiccation and predation. These include the ring-tailed dragon (*Ctenophorus caudicinctus*), which has a flattened body that enables it to live beneath rocks; and the painted dragon (*C. pictus*), saltpan ground-dragon (*C. salinarum*) and western netted dragon (*C. reticulatus*), which have robust limbs adapted to digging.

Dragons are numerous both in species and numbers in arid environments. They zip between the clumps of spinifex that dominate sandy and stony deserts, and perch like kings on top of termite mounds. Other species inhabit a wide diversity of environments, ranging from the rainforest of northern Queensland to along watercourses. One even lives in alpine regions of Tasmania. In Western Australia, only one species appears to have a high affinity for water—the long-snouted water dragon (*Lophognathus longirostris*). This species inhabits areas close to water, but may also range further afield. Common along the banks of the Murchison River, this dragon also often decides to set up residence among well-watered gardens in the area.

Fresh water is scarce over much of Australia and some dragons exhibit particular adaptations to this. The thorny devil has highly modified scales with a micro-honeycomb appearance. This sculptured skin surface enables the uptake of water in rain or dew. Little channels between

Above Saltpan ground-dragon.
Photo – Ann Storrie

Right An example of 'stilting' by an eyrean earless dragon (*Tympanocryptis tetraporophora*). Here only its hind feet and tail are touching the hot surface.
Photo – Gunther Schmida/Lochman Transparencies

the scales direct water to the corners of the thorny devil's mouth so it can drink just by having one foot in a puddle.

Temperature control

Dragons are generally active by day. The typical daily routine of a dragon starts with a morning sunbath—it selects a sunny spot, darkens its skin, and flattens and orients its body to maximise heat uptake. This basking enables the dragon to raise its body temperatures to a level where body functions are most efficient. Once warm enough, it starts the rest of its daily activities—foraging for food, finding mates and defending territories.

Sometimes, during the middle of the day when the sun is at its peak, temperatures become too extreme. In these cases, a dragon will retreat to cool shaded micro-habitats such as a burrow, beneath a boulder, underneath bark or within vegetation. For desert species where such refuges are scarce, dragons avoid overheating by blanching (becoming paler) and raising their bodies as high as possible above the scorching substrate, known as 'stilting'. In this position, only the tips of the toes and heels of the feet make contact with the hot earth and the dragon may rock back and forth between its toes and heels to cool them, or balance and lift a foot off the ground.

Dragons can change colour markedly in response to environmental conditions, to aid their thermoregulation (becoming darker to better absorb solar radiation and warm up, or lighter to reflect solar radiation and reduce overheating). Agamids are heliothermic, primarily deriving their body heat from the sun. They can precisely regulate their bodies at their optimal functioning temperature of about 35.5 to 38.2 degrees Celsius for most species.

Dragons also can brighten or fade in response to social situations to indicate mood, aggression or reproductive status. Body pattern and colouration may also vary depending upon sex, age and season, and can serve in camouflage or communication. Some species, such as the red-barred dragon (*Ctenophorus vadnappa*), broadcast ultraviolet signals that most other animals cannot see. This provides a specific channel for communicating to members of the same species without drawing the unwanted attention of predators.

Outwitting predators

Agamids adopt a variety of methods of defence to escape predators. While some rely on speed to flee from threats,

Above Ornate dragon sunning itself in camouflage.
Photo – Ann Storrie

Left Frilled neck lizard displaying a defensive posture.
Photo – Marie Lochman

others scare off would-be attackers by putting on displays rivalling those of the fearsome beasts of their namesakes, involving gaping, hissing, tail-lashing, and darkening and inflating their bodies. The frilled neck dragon is a well-known example—when faced with a threat, it hisses menacingly, gapes its mouth wide and spreads its frill. When extended the frill, which usually lies like a cape draped over its shoulders, makes the dragon appear to double in size. Should this fearsome display fail to terrify its attackers, a frilled neck dragon will rise up on its hind legs and rapidly run away. This two-legged escape technique enables it to attain high speeds and outpace a pursuing predator. Other long-legged dragon species can put on impressive bursts—sprinting long-nosed dragons (*Amphibolurus longirostris*) can travel at up to 22 kilometres an hour.

In contrast, the thorny devil moves very slowly with measured, deliberate steps, its body rocking back and forth. However, this species can afford to be sluggish—if a predator sees past its camouflage, its impressive spines are a clear warning that a thorny devil would not be pleasant to chew on. Moreover, the thorny devil features a distinctive hump on the back of its neck, which many believe creates the illusion of another head, and thus distracts predators from its comparably diminutive real head.

Creating the next generation of dragons

Australia's dragon lizards often exhibit strong sexual dimorphism. That is, males are often larger, brighter in colour and pattern, and bear more prominent ornamentation than females, likely a result of sexual selection. Along with their attractive physical appearance, males often attempt to woo

Right A bearded dragon (*Pogona minor*) buries its eggs in a sandy burrow.
Photo – Simon Cherriman

Below right Thorny devil.
Photo – Janine Guenther

Bottom right Canegrass dragon (*Diporiphora winneckei*) ambushing pollinating insects on mulla mulla (*Ptilotus* sp.) flowers.
Photo – Jiri Lochman

females, as well as ward off male rivals, by accompanying courtship displays with behavioural shows of 'fitness', including doing 'push-ups'.

Dragon lizards are oviparous—they lay eggs rather than give birth to live young. Clutch size varies with the body size of the mother. Most agamids lay clutches of four to 10 eggs, but small species such as the mallee military dragon (*Ctenophorus fordi*) lay only two eggs per clutch, while females of large species such as bearded dragons (*Pogona* spp.) can lay clutches with as many as 35 eggs. Most agamids, after laying a clutch in a burrow, provide no further parental care. Moreover, once the hatchlings emerge, adults may harass them, driving the juveniles into marginal habitat.

When defending territories, males will often change colour to signal strength, dominance and behavioural condition. During the breeding season (often spring) when competition is intense, males select perching sites and defend their territories atop vegetation, termite mounds, rocks and even fence posts. From up high, dominant males decked out in full regalia broadcast via colour and movement signals, stake their claims to prime sites and ward off rivals. While face-offs between competing males are largely ritualised displays of bluff, when they do escalate to physical sparring they can be ferocious, with serious damage inflicted. Along with dragon lizards' striking appearance, it is such behaviour that contributes to this group of reptiles earning the label assigned to fantasy creatures of myth and legend.

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John Forrest National Park

The state's oldest national park, named after Western Australia's first Premier Sir John Forrest, has a history rich in Aboriginal culture, colonial development, conservation and recreation.

Above Blue leschenaultia.
Photo – Jiri Lochman

Above right from top Swan View Tunnel and Jane Brook.
Photos – Marie Lochman

Far right New Holland honeyeater.
Photo – Jiri Lochman

John Forrest National Park was set aside for conservation in 1898 and proclaimed a national park in 1900. Originally called Greenmount National Park, it was later renamed Forrest National Park and then John Forrest National Park.

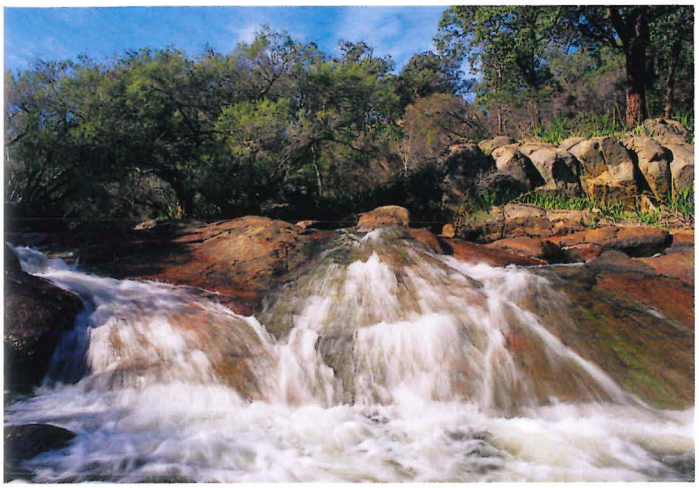
Being so close to the state's capital city, just 26 kilometres east of Perth, the area has had a close association with people throughout its 113-year history as a national park. It is a popular place to spend the day and take a bushwalk, view wildlife or enjoy scenery. Its elevated position on the Darling Scarp offers excellent views across the Swan Coastal Plain, taking in Perth and Fremantle.

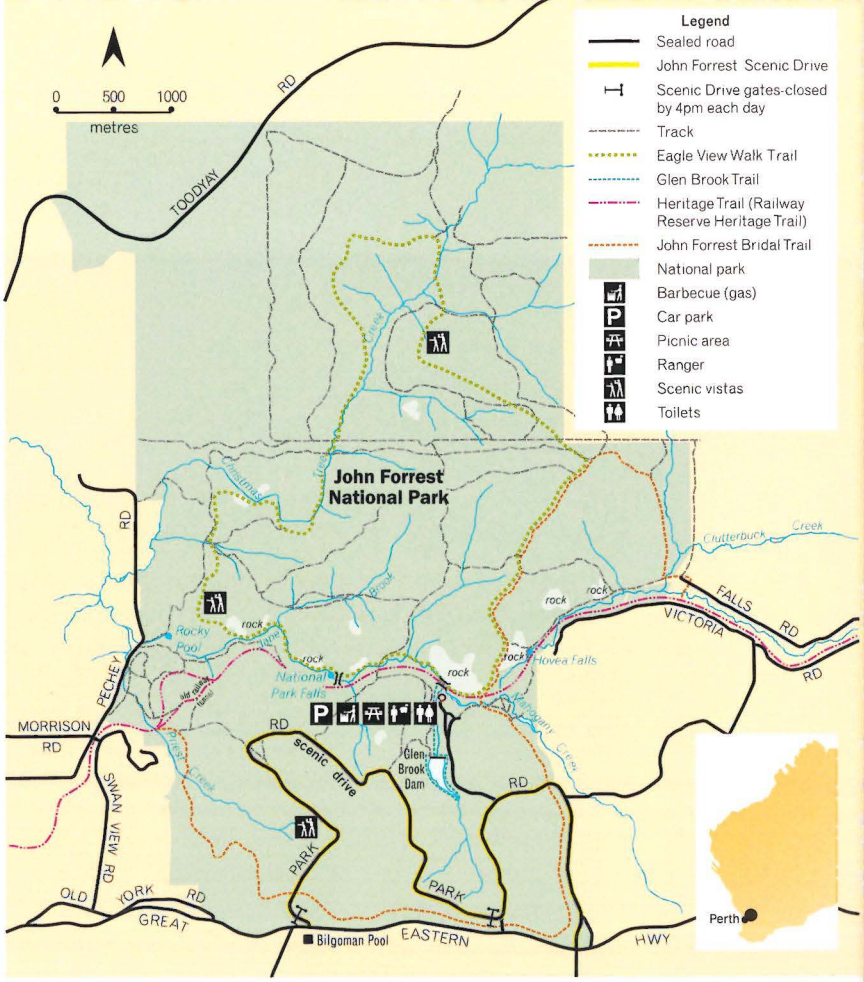
History

The Midland to Guildford area supported a significant Nyoongar population before European settlement. They hunted in the area where John Forrest National Park now occurs and used Jane Brook Valley as an ancient highway to cross the Darling Scarp to the more open country in the east. Jane Brook, one of the tributaries to the Swan River, also has a connection to the Dreamtime serpent, the Waugal, being one of the waterways created as the serpent traversed the landscape.

Following European settlement, the famous engineer CY O'Connor oversaw the construction of a new section of the railway line from Midland to Mundaring through the park. The work included the creation of the Swan View Tunnel in 1895. The railway tunnel now forms part of the John Forrest Heritage Trail, where people can walk or cycle through the tunnel's 340-metre length to gain a glimpse into the state's rail history.

With the construction of the rail line, John Forrest National Park became a popular place to visit, especially after work began to develop the park for recreational use. During the Great Depression in the 1930s, sustenance workers built gardens, rock walls and pathways. Jane Brook was dammed to create a swimming pool. Small picnic shelters were built in the style of mini cottages, some of which





remain today. Workers also constructed a small church, which became a park landmark before it was burnt down by vandals in the 1960s.

Wildlife and walk trails

The heart of the park contains barbecue and picnic facilities, gardens, a tavern and ranger's station. Aside from visitor and land management facilities, however, the park is largely undeveloped.

The valley floor is dominated by flooded gums, swamp peppermints and paperbarks, while the slopes support jarrah, marri, wandoo and powderbark trees. John Forrest National Park is also characterised by expanses of granite outcrops that support mosses, orchids and sundews.

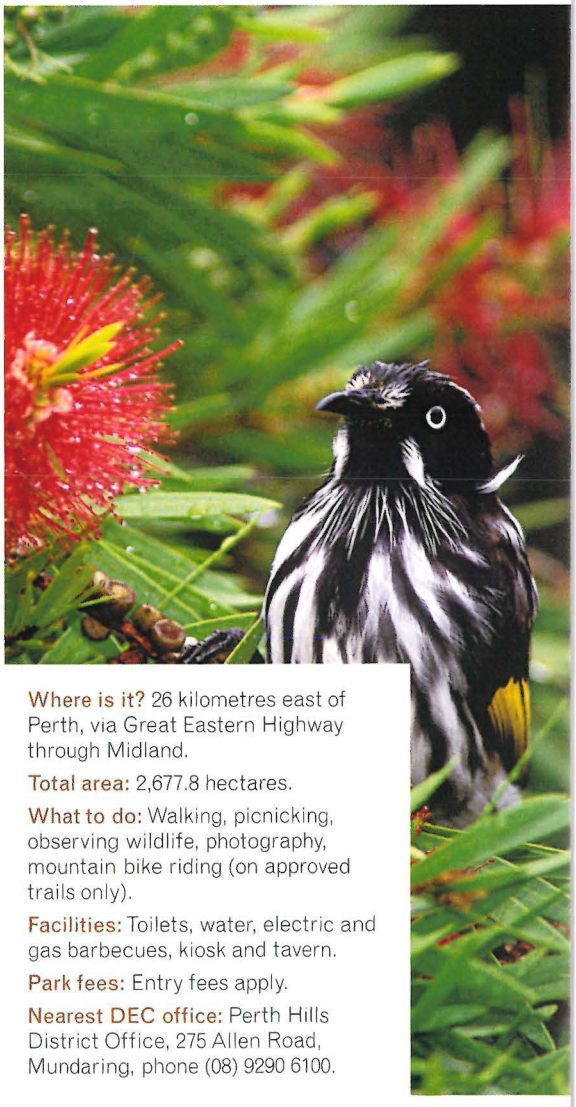
The park is home to a variety of animal life, including honey possums (*Tarsipes rostratus*), western pygmy possums (*Cercartetus concinnus*), mardos (*Antechinus flavipes*), western grey kangaroos (*Macropus fuliginosus*) and echidnas (*Tachyglossus aculeatus*). Bird species such as western spinebills, parrots, splendid fairy-wrens, rufous and golden whistlers and New Holland honeyeaters are also found here.

Wildflowers abound in John Forrest National Park. The first touch of spring brings rich violet hovea (*Hovea chorizemifolia*) flowers that contrast beautifully with green shrubbery. Blue leschenaultia (*Lechenaultia biloba*) and golden wattle (*Acacia pycnantha*) also pepper the landscape.

The waters of Jane Brook tumble through the park's centre in wintertime. Rocky Pool, on the western edge of the park, provides the perfect spot to sit and watch the waters of Jane Brook fall down a series of rapids into the pool.

There is a number of walk and cycle trails within the park. The 10.2-kilometre John Forrest Heritage Trail stretches from east to west across the park, following the old railway line. People have the option of travelling east or west from the starting point at the main picnic area. Going west, visitors will reach National Park Falls, one of two waterfalls in the park, where water rushes down a 20-metre rock face after winter rains. Heading east along the trail visitors will find Hovea Falls, which flows more sedately over a large granite sheet.

John Forrest National Park has long been a part of the lives of many Western Australians, from when Aboriginal people lived and hunted in the area, to colonial times and, more recently, as a key conservation and recreation space.



Where is it? 26 kilometres east of Perth, via Great Eastern Highway through Midland.

Total area: 2,677.8 hectares.

What to do: Walking, picnicking, observing wildlife, photography, mountain bike riding (on approved trails only).

Facilities: Toilets, water, electric and gas barbecues, kiosk and tavern.

Park fees: Entry fees apply.

Nearest DEC office: Perth Hills District Office, 275 Allen Road, Mundaring, phone (08) 9290 6100.

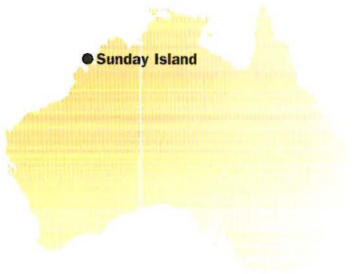
The mysterious case of the black rat on Sunday Island

As they plied the island-studded coastline of the Kimberley, early explorers and nagivators had long referred to problems with rats. Given the threat introduced black rats pose to fragile island ecosystems, the Department of Environment and Conservation set out to determine the level of threat on Sunday Island, or Iwany. Yet such a task produced unexpected results, and created something of a mystery.

by Russell Palmer, Damon Pyke, Paul Meek and Viki Cramer

The Sunday Island group—just off the eastern tip of the Dampier Peninsula in the Kimberley—marks the entrance to King Sound. This area of treacherous tides, swirling seas and seemingly desolate islands is the home of the saltwater Bardi Jawi people, who knew how to harvest the abundant resources of the surrounding ocean and passed on this knowledge over generations of teaching and storytelling.

Despite the area's remoteness, it wasn't long before other cultures began mixing with the Bardi Jawi, and exerting their influence on the area. Europeans first visited Bardi Jawi country when buccaneer and explorer William Dampier entered King Sound aboard the *Cygnet* in 1688. Later, the discovery of rich pearling grounds in the 1880s heralded the beginning of sustained contact between Bardi Jawi people, Europeans, Malays and Japanese. By 1899, a non-denominational mission was established by Sydney Hadley on Sunday Island, or Iwany (Island) to the Bardi Jawi people. The mission housed hundreds of Bardi Jawi people over the years of its existence and generated profitable exports of pearl and trochus shell.



But with ships came rats. Black rats (*Rattus rattus*) are a commensal species in that they benefit by living alongside human habitation. In close association with the spread of human settlement, this unwelcome neighbour has spread across the globe. Black rats have colonised more than 80 per cent of the world's island groups, spreading some of the worst diseases that affect humans and devastating native wildlife populations.

Invasive rats are now routinely eradicated from islands for conservation purposes. Black rats have been successfully eradicated from more than 30 islands in Western Australia and from over 200 worldwide. To continue this work, the Department of Environment and Conservation (DEC) needed to determine if black rats occurred on Sunday Island or surrounding islands and, if so, to put plans in place to reduce their menace.

Rat records

The historical literature certainly testifies to the presence of rats along the Kimberley coast. Visiting ships were infested by rats, a fact evident in the journals of the early navigators and mariners. During his four voyages charting Australia's northern coasts between 1817 and 1822, Captain Phillip Parker King experienced significant problems at the hands—or should we say teeth—of the rats living on the *Mermaid*. While they were in Admiralty Gulf in the Kimberley in 1819, rats gnawed holes in the ship's water casks, reducing the water stores to a fortnight's supply. King and his crew failed to find any local supplies of water and had to sail to Timor for resupply.

Not all seafarers of the north-west loathed rats on their vessels. Pearl luggers plying their trade along the Kimberley coast and in King Sound were also riddled with vermin, including rats. In his book *The White Divers of Broome*, John Bailey recorded that "a rat-free boat was thought to be a disaster because rats kept the cockroaches down. If a boat had no rats, the crew might moor the vessel at a certain creek where, on a quiet night, a few might be enticed aboard".

Previous page
Main Black rat.
Photo – Marie Lochman
Inset Nilagoon beach and exposed reef at low tide.

Left Setting a camera at Dean Island, or Inyjanoo, with Sunday Island in the background.
Photos – Damon Pyke

Above A mosaic-tailed rat takes shelter after release.
Photo – Paul Meek

Top right Traditional owner Reggie Thomas and ranger Chris Sampi check out a large male mosaic-tailed rat.

Centre right The survey team brings gear to the Sunday Island mission entrance, or Moori.

Right The Bardi Jawi Rangers at Middle Beach, One Arm Point or Ardyaloon.
Photos – Damon Pyke

The notorious waters of the Sunday Island group also claimed their fair share of these rat-infested vessels, with at least five being wrecked there between 1890 and 1935. The *Ritie* came to grief on Poolngin Island next to Sunday in 1923, potentially allowing black rats ashore.

On Sunday Island, rats apparently arrived soon after the mission was established. A search of the Western Australian Museum catalogues revealed that WH Bird, a teacher at the mission school, donated two young black rats to the museum in April 1909. In 1911, the commander of the survey vessel the HMS *Fantome*, JD Nares, gave the name 'Rat Island' to one of the islands near where Dampier anchored in 1688. Several years later, explorer and medical practitioner Herbert Basedow complained about the hordes of rats that overran the sheds where his equipment was stored at Derby wharf while they waited for the arrival of the *Rita*. The *Rita* was the mission cutter chartered to collect Dr Basedow for his 1916 'Northwest Expedition'. Only four days into this journey, they noticed numerous unwelcome associates aboard, the largest of which were rats, so the *Rita* was thoroughly overhauled and cleaned at low tide at the mission landing in a protected cove on the north-west side of Sunday Island. "We rested under the verandah of the Missionary's house for the night, but, weary as we were, there was not much sleep to be had on account of the numbers of black rats which ravaged the place in the night," he recorded.

But were all of these ravagers black rats, or was it a case of mistaken identity? The first biological survey team to visit the island in 1982, some 20 years after the mission closed, found two black rats at Nilagoon on the southern end of Sunday Island. However, they also trapped 10 native mosaic-tailed rats (*Melomys burtoni*) on Sunday and East Sunday islands. The field guides at the time stated that male mosaic-tailed rats, known to the Bardi Jawi as miijo, should weigh a maximum of 65 grams, but the mosaic-tailed rats on Sunday Island were giants, weighing up to 172 grams. At this size, black rats and mosaic-tailed rats are easily confused—they both have a tail longer than their head–body length (a key diagnostic measure for telling *Rattus* species apart). However, each species has a distinctive scale pattern on their tails that lets scientists easily differentiate between the two. Without close inspection, one species of rat is easily mistaken for the other. And not many of the early explorers and naturalists wanted to get that close to a rat.

The Nilagoon site, now the site of an outstation with roughly 10 buildings and sheds constructed in the early

Left Ranger Dwayne George and camera-trapping expert Paul Meek set up an infrared camera over a bait set to attract rodents.
Photo – Russell Palmer/DEC

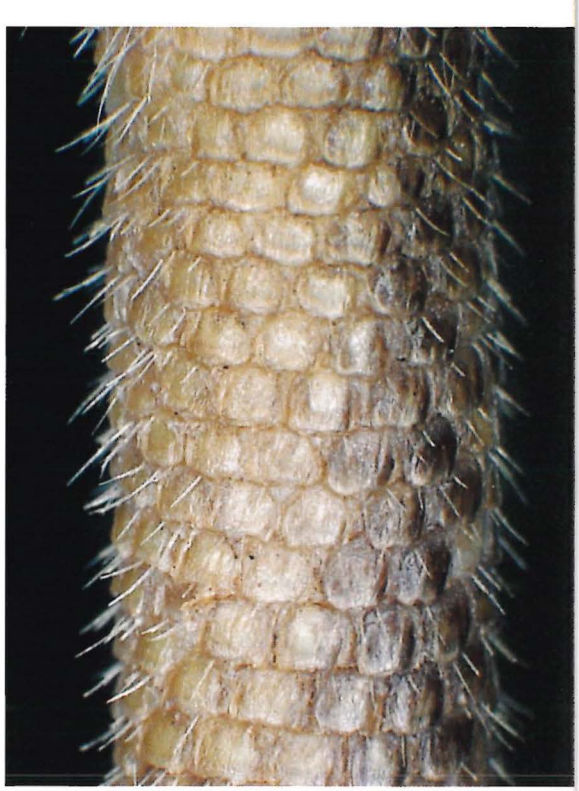
Below left Traditional owner Reggie Thomas and ranger Wesley Hunter take in the view from Goorlilbooloon, south of Nilagoon.
Photo – Damon Pyke

1990s, was surveyed again during the Kimberley Islands Biological Survey (see 'Treasures of a sunken coastline, *LANDSCOPE*, Winter 2008) in June 2009. Seven mosaic-tailed rats were captured in five nights of trapping, but no black rats were detected.

Mission black rat

With support from the federal government's *Caring for our Country* program, DEC has sought to eradicate exotic rodents from a number of islands in WA. However, before starting eradication measures on Sunday Island, DEC needed to conclusively establish whether black rats were still there. To do this, staff enlisted help from the Bardi Jawi Rangers (see 'Working together for dugong conservation', *LANDSCOPE*, Autumn 2010), who are responsible for supporting the management of land and sea across their native title area, including the Sunday Island group. This area includes approximately 1,100 square kilometres of land with 200 kilometres of coastline, and 2,000 square kilometres of sea. Rangers' work covers cultural and natural resource management, including weed control, biodiversity monitoring, vine thicket protection, turtle and dugong monitoring, fire management, coastal patrols, environmental education with schools and tourist cultural awareness talks.

With the approval of traditional owners, full support of the rangers, and the expertise of camera-trapping expert Paul Meek from the University of New England, DEC set about conducting a survey on Sunday Island in October 2012. Our team also included traditional owner Reggie Thomas, to provide advice on culturally important areas that should be avoided.



Above left A captured mosaic-tailed rat, with its head marked to identify repeat captures.
Photo – Paul Meek

Above The distinct pattern of a mosaic-tailed rat's tail.
Photo – Kirsty Quinlan/DEC

Although nobody has lived on Sunday Island since the late 1990s, we expected that our best chance of detecting black rats would still be where people had lived in the past—the mission, with its freshwater wells where wild bananas still flourish, and Nilagoon Outstation. We armed ourselves with cage traps, instead of the more convenient Elliott traps used on most mammal surveys, as black rats tend to avoid entering these enclosed aluminiun box traps. We also took more than 60 remote cameras, which enabled us to target a bigger area on the island. However, the cameras also presented a new challenge, as we would need to use diagnostic features other than the fine scale patterns on rat tails to positively separate the species.

We hoped that the rats would be hungrier in the late dry season, and therefore more readily attracted to baits in traps or placed in front of the cameras. Also, a substantial portion of the island had been accidentally burnt by fires in July, meaning any rats present on the island were likely to be concentrated in the unburnt patches, which were mostly near the coast, including the fringing mangroves and rugged rocky sandstone country. The downside to the fires was the lack of shade, meaning there were few places we could take respite from the blistering late dry season heat.

And the rats cometh

The team set up camp at Nilagoon Outstation, the site of the last confirmed black rat records 30 years earlier. The first night, as we sat wearily around the camp fire after a hot day of setting up camp and lines of cage traps, a few rats began to emerge from the buildings that surrounded us. Thinking that we would have little chance of catching the rats by hand, we decided to let the cage and remote-camera traps we had just set do their work. That large-sized rats with long tails were living in rafters of the buildings—where we expected the cosmopolitan black rat to live—did not appear to be good news for the island's biodiversity.

Like Dr Herbert Basedow almost 100 years before us, our next eight nights camped at the outstation were sometimes sleepless as the rats climbed up onto the tables and rummaged through any food that we forgot to put away in containers. They loved our boxes of cereal. Like many island creatures, the rats showed little fear of us, and the longer we stayed the cheekier they got. The upside of this growing nonchalance of the outstation's rats was that it enabled us to get close enough to inspect the vital diagnostic feature separating black rats and the native mosaic-tailed rats—the scale pattern on their tails. Once a rat was spotted in the beam of a head torch, it was often possible to reach out and hold the end of its tail for a brief moment to get a look at the scale pattern, rather than grab the animal and risk being bitten. And it was not just the rats that became increasingly relaxed in our presence; just as he was about to 'tail' a young rat one night, Paul Meek was startled to have a children's python (*Antarasia childreni*) literally snatch the rat out of his fingers, and proceed to swallow it.

We observed, trapped and captured images of only the mosaic-tailed rats at Nilagoon Outstation. The story was the same for our three cage trap

Above left The bynoe's gecko (*Heteronotia binoei*) is one of 19 species of terrestrial reptile known from Sunday Island.
Photo – Trevor Sampi

Above Mangrove golden whistlers (*Pachycephala melanura*) are highly conspicuous on Sunday Island, in appearance and sound.
Photo – Damon Pyke

and remote-camera trap lines radiating out from the outstation, located in mangroves, coastal dunes with beach spinifex and rugged King Leopold sandstone hills. At the old mission on the western side of the island, we set cage traps in the mangroves, around the wells and in the unburnt wild banana patch in the valley. (The missioners' building on the hill top was avoided due to asbestos.) Remote cameras were also used here and in some of the remaining buildings that were the homes of the Bardi Jawi people. Cameras were left in place for more than 30 days.

In spite of the presence of fresh water, shelter and ripening bananas, we detected only a handful of mosaic-tailed rats. We caught nothing at the mission landing where black rats were ejected from the *Rita* during Basedow's expedition. Cameras placed by boat on all the major sandy beaches on Sunday and East Sunday islands also failed to snap any pictures of black rats. Likewise, cameras placed on 14 other smaller islands throughout the Sunday group for 30 days, including Rat and Poolngin, failed to detect any black rats.

And the ecological winner is ...

Our work on Sunday Island has raised a number of intriguing historical and ecological questions about the presence of black rats on the island, and about their ecological interactions with the native mosaic-tailed rat. Undoubtedly, black rats were present on Sunday Island historically, but their ability to populate and flourish on the island is likely closely linked with the island's European history. Although rats may well have 'jumped ship' on the islands of King Sound during the visits of Dampier and the pearlers, it may not have been until the mission was established in 1899 that black rats, with their preference for human environments, could establish large populations. In the vegetable gardens and where goats and cattle were grazed around the mission, and in the mission buildings themselves, black rats would have been more successful than the similarly sized mosaic-tailed rat.

The hordes of rats that kept Dr Basedow sleepless some 20 years later were most probably black rats. During the time of the mission, we expect that black rats expanded into the 'richer' rat habitat found in the Nilagoon area in the south of the island. Once the mission closed in 1962, the continual disturbance that humans cause through agriculture and other activities ceased and, even though some of the buildings remained, the conditions that favour black rats over mosaic-tailed rats were removed. With the human presence advantage gone, black rats appear to have been out-competed by mosaic-tailed rats, and it seems that native rats also took a liking to living in the buildings. Sunday Island may not be totally free of black rats, but the island appears to be in hands of a superior native competitor.

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Slowing the extinction of insects

Insects are as important to healthy ecosystems as plants or vertebrate animals. A conservation project in the south-west is looking at ways to identify and manage risk to herbivorous insects as well as the plants they inhabit.

by Frances Leng and Melinda Moir

Australia's south-west region, one of the world's 34 recognised biodiversity hot spots, has a high rate of species endemism thanks to its geographic isolation. One threat to the unique diversity of the region is 'coextinction'; the process whereby a species goes extinct when the species it depends upon (a host) becomes extinct or there is a change in the host's population size. It is thought that as much as 40 per cent of the world's fauna are dependent species that are reliant upon one or more host species for survival. Lose the host and these dependent species are likely to go extinct as well. Loss of species through coextinction is contributing substantially to the current biodiversity crisis. Driving factors that can assist in the acceleration of coextinction rates include habitat loss, invasive species and climate change.

Invertebrates (such as insects, worms, snails and mites) are arguably the largest group to be threatened by coextinction. The importance of invertebrates as a component of biodiversity, and their role in ecosystem functioning, has been well documented. It has been conservatively estimated that invertebrates comprise more than 80 per cent of the world's biodiversity, in terms of number of species and biomass. Beetles alone could represent as much as a quarter of all species on Earth today. These overwhelming statistics are regarded as the major obstacle in effective invertebrate conservation. When so many species must be considered, how do we determine which invertebrate species are potentially threatened, why they are threatened and what to do about these threats?

In Australia it is estimated that there are about 300,000 species of invertebrates (excluding marine species), of which less than a third are described. What's more, of the nearly 100,000 species formally described, we still have little, or no, biological or ecological knowledge of them (with the exception of a few charismatic groups such as butterflies and dragonflies). This lack of knowledge on the distribution, habitat requirements, population size, life cycle and population biology has been termed the 'Wallacean Shortfall'. And such a shortfall makes it very difficult to formulate effective conservation plans for invertebrate fauna.

Previous page
Main The critically endangered *Banksia montana* in Stirling Range National Park is the only host plant for the *Banksia montana* mealybug.
Photo – Frances Leng
Inset *Banksia montana* mealybug.
Photo – Sonja Creese

Below Little is known about most insect species, except charismatic groups such as dragonflies.
Photo – Marie Lochman

Why worry about insects?

Insects play a fundamental role in maintaining healthy ecosystems. They are often the main food source for many other animals, such as insectivorous birds, spiders and skinks. Insects also form important mutualisms (beneficial partnerships between multiple species) with non-herbivores such as certain species of ant. However, the value of the roles of insects is difficult to discern. It is challenging to save a species when we have virtually no knowledge of it. The only certainty is that extinction is forever. And it is for this reason that the precautionary principle should be applied in efforts towards insect conservation.

The precautionary principle is the idea that a lack of full scientific certainty is not a reason to postpone action, if the postponement could cause extinction or other detrimental consequences. A world without insects

Above Ellen Peak in Stirling Range National Park.
Photo – Andrew Halsall

Right Insects often form mutually beneficial relationships with other species, such as these green tree ants tending aphids.
Photo – Jiri Lochman

would be ecologically devastating, with cascades of secondary extinctions and outbreaks of pest plants and animals. With so little information on insects available, and when the consequences of losing any single species on the ecosystem are unknown, it is far better to prevent these unidentified effects by applying the precautionary principle.

Despite difficulties associated with conserving insects, over the past decade there has been a steady gain in momentum in conservation projects in Australia. One such project focused on insect conservation is unfolding in the south-west of Western Australia. The project, funded by the National Climate Change Adaption Research Facility, aims to develop conservation strategies to identify which plant-dwelling insects are at greatest risk of coextinction induced by climate change, and to identify which management actions will be most cost-effective at reducing coextinction.

Saving south-west insects

The south-west is home to an estimated 8,000 plant species, most of which are endemic, with 1,909 identified as needing some form of conservation action. Translocations of more than 45 plant species have been occurring in this region during the past decade to save some of the most highly threatened plants from extinction. The main threats to plants here include dieback caused by the plant fungus *Phytophthora cinnamomi*, wildfire, habitat fragmentation and climate change.

While plant translocations have occurred in the south-west with the aim of preservation, very little work has occurred to save their associated dependent insects. It is estimated that this region contains between 14,200 and 27,500 insects species that are restricted in diet to just one host plant.

Left Vacuuming plants to remove predators before threatened insects are translocated.

Below left *Banksia montana* mealybug translocated onto its host plant.
Photos – Melinda Moir

However, the actual number of insects that are dependent upon all the plant species is unknown. What is known is that if these plants are threatened, then so too are the highly dependent insects reliant on them for survival.

A solution to conserve these threatened and highly dependent insects is to translocate them and their host plants. Ecologist-biologists Joern Fischer and David Lindenmayer described translocation in wildlife conservation as the "deliberate and mediated movement of wild individuals or populations from one part of their range to another", with the aims of increasing species' ranges, enhancing critical population numbers and establishing new populations, thereby decreasing species' extinction risks. Two main types of translocations occur frequently—introductions and reintroductions. Introductions (*ex situ*) establish species outside their recorded distribution, whereas reintroductions (*in situ*) establish species in an area where they once occurred historically, but where they have become locally extinct.

In what is believed to be a world first, the project has recently resulted in the translocation of three highly dependent insects onto rare or conservation-listed translocated plants in the south-west. To reduce the coextinction risk of these insect species, translocation trials are being conducted both *ex situ* and *in situ* in Stirling Range National Park. Two insects that have undergone *ex situ* translocations are the *Banksia brownii* plant-louse (*Trioza* sp. nov.) and *Banksia montana* mealybug (*Pseudococcus* sp. nov.). Vesk's plant-louse (*Acizzia veski*) has been translocated *in situ* onto two naturally occurring populations of its host plant, *Acacia veronica*, within Stirling Range National Park. These three insects have been the focus of

Above Sampling for *Banksia brownii* plant-louse in Stirling Range National Park.
Photo – Melinda Moir

the translocation trials because they occur on highly threatened plants and their diet is restricted to their one host plant species. The insects have been discovered only recently, with *Banksia brownii* plant-louse and *Banksia montana* mealybug yet to be formally named.

A mealybug and two plant-lice

The *Banksia montana* mealybug is extremely small—just one to three millimetres long. It has the typical oval shape characteristic of its family (Pseudococcidae) and is covered in a film of white fluff. It has only been found on several *B. montana* plants in the eastern mountains of the Stirling Range. The *Banksia brownii* plant-louse is also very small (about three millimetres long) with colouration varying from green to orange, with clear wings. It has been recorded from populations of *B. brownii* in the Stirling Range and three other natural populations occurring around Albany in the south. Both host plants of these two insects are listed as critically endangered nationally and have been the subject of translocation trials by the Department of Environment and Conservation (DEC) for the past decade.

The conservation status of *A. veronica* is 'priority 3', meaning it is in need of further study, while Vesk's plant-louse was recognised in 2012 as a co-threatened species and listed as vulnerable under the state government's *Wildlife Conservation Act 1950* (see 'Endangered', *LANDSCOPE*, Spring 2012).

On the move

These insects have restricted and predominantly localised dispersal. For example, the *Banksia montana* mealybug often remains on the host plant it emerged from. Therefore, its recolonisation to translocated threatened plants at alternative sites or *in situ* plant population sites greater than 10 kilometres away is highly unlikely without human intervention. Translocation of the three insects occurred last spring. Capturing insects for translocation occurred using 'hand collection', 'beating' and 'vacuuming' techniques (the latter with a weed-blower!). The insects were then transported in specially made containers. Once at the translocation site, the insects were caged on their respective host plants to help exclude predators and restrict the insects' movement in the hope of promoting successful attachment to their host plant.

The location where the *Banksia montana* mealybug and *Banksia brownii* plant-louse were translocated—an area on private property north of Albany—was reserved for conservation in 2003. The threatened plants were grown from seed or cuttings and transplanted as seedlings to a 2.8-square-kilometre area of remnant woodland. The *in situ* translocation sites for Vesk's plant-louse are located on the eastern side of the Stirling Range, more than 10 kilometres away from the natural population in the west of the park.

The host plants of the *Banksia montana* mealybug and *Banksia brownii* plant-louse at the *ex situ* translocation site are protected from threatening processes such as fire, grazing and

Above left *Bothriembryon glauerti* is a conservation-priority snail from the same mountains as the *Banksia montana* mealybug.
Photo – Sonja Creese

Above *Atelomastix tigrina* is a threatened invertebrate species from the same mountains as *Banksia montana* mealybug.
Photo – Frances Leng

Below Fieldworkers faced difficult weather conditions.
Photo – Karl Brennan

dieback disease. As the translocation site is located on private property, access to plants is controlled and DEC staff also safeguard the well-being of the plants with regular monitoring. Invertebrate predators and competition from herbivores was controlled by vacuuming the host plants before insects were translocated. However, based on samples collected from translocated plants in 2007, extremely low abundances of both predators and herbivores are expected.

It is highly unlikely that Vesk's plant-louse occurs on hosts other than *A. veronica*, and it therefore is unlikely the louse will switch hosts at the *in situ* sites. This is also true for *Banksia montana* mealybug and *Banksia brownii* plant-louse at the *ex situ* translocation site.

Gaining knowledge

It is hoped that successful translocation trials of these insects will contribute towards constructive plans for multi-species management for critically endangered insect taxa, in addition to *in situ* conservation. Such management plans will add value to existing translocations where more species could be conserved for very little extra resources. *In situ* conservation enables the preservation of natural genetic reservoirs, and *ex situ* translocation will hopefully safeguard these species. But whether successful or not, insect translocation trials will assist in closing the knowledge gap on the ecology of these rare insect species and the roles they play in ecological networks and food webs.

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A tree marked B

In the once-remote and inhospitable environs of Nambung National Park a giant tuart tree bearing the mark 'B' has puzzled generations of people intrigued by its history.

by John Hunter

Tuart trees (*Eucalyptus gomphocephala*) are found only in the coastal regions of Western Australia from about Cervantes to Busselton and are one of the toughest trees on the planet, known both for their survival in harsh terrain and their steel-like wood. One such eucalypt is a historically famous west coast landmark which, on survey maps, is simply referred to as 'Tree marked B'. Little more was known of its exact location and history. But detective work over the past 40 years has resulted in various ideas for the tree's origin being put forward and accepted until, each time, new evidence came to light forcing a rethink of its history. Adding to the puzzle was the fact that the river on which the tree occurred changed name three times, and landholders who may have been responsible for the carving each had the same initial—B. Just how long had the tree been blazed, interested people asked, who had marked it, and when did they leave their initial?

Opening new ground

In the early days of the colony of Perth, drovers, troopers, explorers and prospective landowners forged north in an effort to discover new agricultural land, or were simply carrying out their allotted work duties. Within some 150 kilometres, however, they encountered a most inhospitable and waterless terrain that seemed to go on forever, defeating many aspirations and, in a few cases, ending in disaster and death.

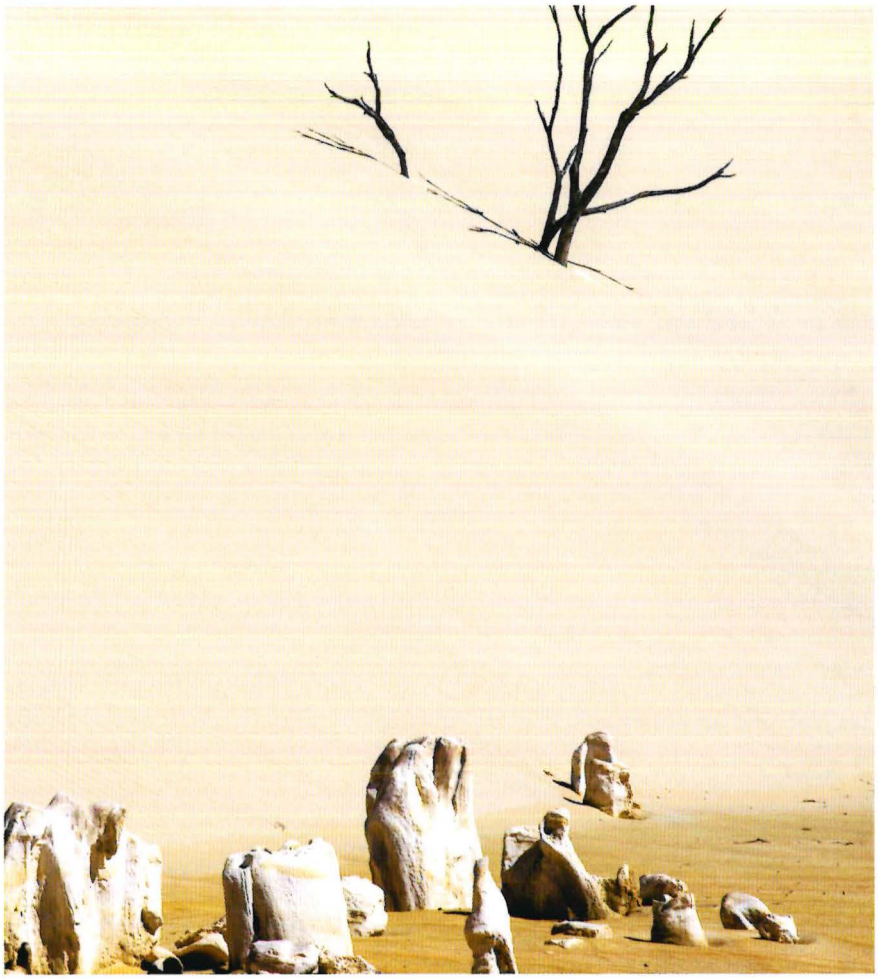
Today, the Mid West coast near the town of Cervantes incorporates Nambung National Park, abutted on the north and south by large tracts of flora-rich nature reserves. While Nambung is well known for its Pinnacles Desert, the surrounding area contains a rich biodiversity of caves, extensive heath lands, scattered banksias, stunted gums, tuart forest and, in spring, myriads of wildflowers. However, to the early colonists, this passage to the north of the state was a most unwelcoming place, especially during the warmer months.

In 1839, just 10 years after the settlement of Perth, British explorer Lieutenant George Grey and a party passed through the area after becoming shipwrecked and being forced to walk from near modern-day Kalbarri back to Fremantle. During this arduous walk of some 700 kilometres, the party lost Fredrick Cook Smith, an eighteen-year-old who had arrived from England expressly to join Grey's exploration party. Smith expired on the beach south of what is now Nambung National Park and, in his admiration of the lad's courage, Grey named a nearby creek the 'Frederick Smith River'.

A landmark found

Later, during the mid 1800s, some sections of fertile land in the area that is now national park were opened up for lease as agricultural grants and a stock route for cattle. And there began the 'Tree marked B' puzzle taken up and investigated about a century later.

In 1968 Nambung National Park was officially named and acquired its first full-time ranger, Alf Passfield. He soon became very interested in a point marked on the then Lands and Surveys Department plans of a section of the Nambung River in the park. The point was designated as 'Tree marked B' but, although Passfield and others tried for years to find that tree, it remained lost—probably destroyed



Previous page
Main Shifting dunes in Nambung National Park.

Above A dead tuart protrudes from a sand dune in Nambung National Park.
Photos – Janine Guenther

Above The Pinnacles of Nambung National Park.
Photo – Len Stewart/Lochman Transparencies

Left Tuart flower.
Photo – Janine Guenther

by bushfires they thought. Even so, the tree remained on every local pastoral map since 1921. What was its history? What was its fate?

The maps of government surveyor E Manning, who surveyed the area in 1921, clearly showed the tree's location relative to his survey pegs, but those wooden pegs were burnt by bushfire soon after placement.

Then, in May 1968 when private property inside the new park's boundaries was resurveyed, the burnt and rotted stumps of Manning's 47-year-old pegs were found. This enabled ranger Passfield to get out into the scrub and start searching again.

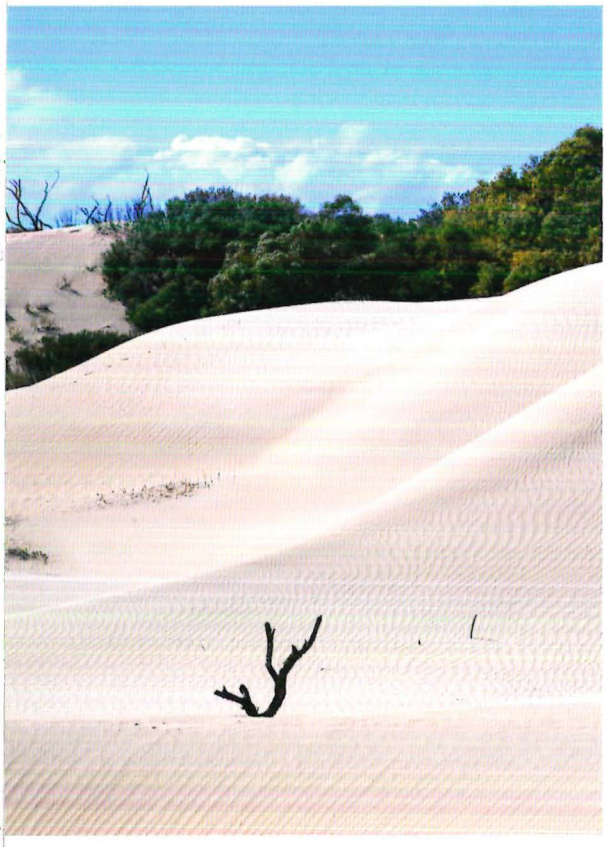
In November 1971, with his hand compass for direction and his pace for distance measurement, Passfield set out to re-plot Manning's survey lines. His reckoning eventually bought him face to trunk with what he thought was the biggest tuart tree in the whole park, right on the bank of the Nambung River where the elusive marker 'B' should be. Despite its potential as a marker, he could find no letter 'B' on the tree at all, the only unusual feature being a large termite nest up one side of the trunk. Was there anything under the nest?

Passfield was soon back with an axe and, as the nest fell, he could see that the bark of the tree was cut away in the shape of a large shield. After a few minutes of careful scraping he found a deeply carved letter 'B' in the wood, still in perfect condition. The rock-like nest had effectively hidden it from searchers and had given amazingly good protection to the carving for, while termites prefer to build their nests against a tuart, the wood itself is immune to their attack.

Detective work

The question still remained as to the 'B's origin. The Lands and Surveys Department could only find it as early as Manning's maps of 1921, although they found cancelled maps showing the tree was marked before 1913. Still no one knew when the tree was marked, or by whom.

Ian Elliott of the Lands and Surveys Department's Geographical Names



Above left The northern end of the Pinnacles Desert where the white sand dunes meet thick tuart forests.
Photo – Janine Guenther

Above The famous tuart tree bearing the carving 'B'.
Photo – Steve Taylor

Register then became interested in the riddle and after many hours of research in the department's records and the Western Australian State Archives, he uncovered a pastoral lease map of the area—the old cancelled 'Melbourne 4' District Public Plan of 1898 which showed a lease in the area taken out by a HA Bower. Although no marked tree was shown on the lease application, it may have been Bower who carved the tree with his initial to mark his western boundary, a common practice at the time. As seen on the application, at this time, the Nambung River was known as Namban River (thought to be a mispronunciation for the Nyoongar word nambung which means 'crooked' or 'winding').

A little more detective work back in the archives uncovered two previous applications made by LC Burges for renewal of a lease over the same land in the area. These applications in 1887 and 1873 both featured 'Tree marked B' on the Namban River as the sole reference point from which the boundaries of the lease were drawn. Then Elliott discovered a copy of 'Melbourne plan 8' drawn by surveyor EC Dean in 1868 naming Nambung River as Smith River (Grey's tribute to his deceased colleague) and, on its course, the tree now mapped as 'Tuart marked B'. The tree was also the primary reference for the surrounding lease belonging to LC Burges. And this was the first reference which revealed the tree's species type—confirmation of Alf Passfield's find. This earlier document now meant a change in the theory—perhaps it was Burges who carved the 'B' instead of Bower.

Lockier Clare Burges Esq. was from a wealthy and influential family and held leases over many areas along the western coastline of the Swan River Colony. He also often set out to explore new regions. He is probably the only man in Australia's history to be convicted of manslaughter, serve his sentence and later become a Justice of the Peace. In 1872 he was convicted of shooting an Aboriginal man who was escaping after capture for stealing one of Burges' saddles. His sentence of five years penal servitude was later reduced to one year and, in 1877, his appointment to Justice of the Peace was announced in the *Government Gazette*. With such a background, Burges may well have kept a diary, so the hunt was on again to find confirmation of the origins and age of that carving on what was now known as the 'Burges Tree'.

Meanwhile, back to Alf Passfield's time. After a year without the protection of the termites, the carving on the tuart was weathering rapidly.

But those tenacious builders were making a comeback and, by mid 1973, the shield was practically covered once more affording it protection against rain, sun and fire.

The search for Burges' diary continued until June 1973 when Ian Elliot again uncovered more information that turned the whole story back even further. An entry in the *Government Gazette* dated 20 May 1862 referred to a proposal for a road from Perth to Geraldton, and a portion of that read: "... crossing the Smith River near the east boundary of Mr R Brockman's lease 588, where a tuart tree is marked with the letter 'B' ...".

Above One of the larger tuarts of the river valley.
Photo – Jiri Lochman

A further check found that lease Number 588 was taken up by WL Brockman on 16 March 1855 and transferred to Robert Brockman on 3 November. The original lease application for 1,000 acres read: "Bounded on the east by a line extending 120 chains north and 197 chains south from the centre of a tuart tree marked 'B' and situated on the right bank of the Frederick Smith River, about 16 miles in a north-westerly direction from Dandaraga Spring and on the north and south by west lines of 315 and a half chains each and on the west by a north and south line of 317 chains. All bearings and boundaries true."

So the blaze was there even before Burges held the lease which suggests it was in fact WL Brockman who performed the handiwork in carving his initial. At last the mystery of this historic survey point and giant sentinal of the old Perth to Geraldton stock route had been solved.

Today in the wilderness area of Nambung National Park stands the fire-scarred tuart of some 200 years of age bearing the blaze and a somewhat indecipherable 'B'. The record has been put straight but, like all living things, the tree will not last forever.

Mystery in a moonscape

The mystery and intrigue of this semi-arid piece of Mid West coastline goes back even further than the 1600s when first observed from the passing Dutch and French sailing ships blown close to shore, and sometimes wrecked, by the vicious sea winds. The onshore desert dune systems with their pinnacle stone monuments would have appeared to the merchant mariners as a distant fortress and perhaps not a good place to just 'drop in'. Little did they realise that nomadic Aboriginal people had visited the area for thousands of years.

The Pinnacle Desert, however, harboured an even older secret—one of an extraterrestrial nature.

In 1964, Messrs RL Devitt and JH Turner were wandering through the area admiring the sand drifts and calcium spires when they noticed a strange boulder lying on the barren sandy surface among the pinnacles. Noting the boulder's foreign appearance to the surrounding geology, its flaky coating of 'iron-shale' and a patch of fusion crust at one end, the men were suspicious of its earthly origin. The object was rightly delivered to the Western Australian Museum and the task of identification began.

As thought by the finders, the boulder was verified as a deeply weathered 'olivine-bronzite chondrite'—in other words a meteoritic stone of bronzed iron and magnesium with a core of other minerals and iridescent glass particles. The crudely pear-shaped and slightly flattened object some 26 centimetres long by 20 centimetres wide tapering to 12 centimetres, weighed about nine kilograms, which gave some indication that the meteor would not have been transported by Aboriginal people who frequented the area.

Several questions then came to mind. How old was this visitor from out of space? Where was the crater that it made on landing? Why was the atmospheric explosion and resulting light trail not seen or reported?

One can only surmise the meteorite's weathered condition was exacerbated due to the marine atmosphere, making an estimate of the landing date impossible. It is thought to have landed anytime from recently to thousands of years ago.

But what of the crater meteorites normally leave? By examining the solidified spatter on the object's fusion crust, you can surmise that it was reaching its final deceleration where all cosmic velocity is lost and it simply had a 'soft' landing. Where else could that be better achieved than in the loose quartz of the desert dunes?

And what of the lack of sightings? That's simple—this object also had one of the most isolated and least inhabited parts of the globe on which to land.

It is ironic that, like the nearby 'Tree marked B', after the meteorite was collected and documented and a tablet of stone set to record the site in 1965, it was for all intents and purposes forgotten, until recent times. While looking for a lost tourist last year, ranger Paul Robb climbed a small butte in Nambung National Park dunes and, there on the rocky crest, out of sight and mind, were the details of the discovery from some 50 years ago on a man-made stone plaque.

One question remains—what else may be found in the shifting, whispering sands of the Pinnacles Desert?

John Hunter is a Department of Environment and Conservation public affairs officer and long-time contributor to *LANDSCOPE* magazine. He can be contacted on (08) 9389 4016 or by email (john.hunter@dec.wa.gov.au).

The author would like to thank Ian Elliott, and acknowledge the content of unsigned notes discovered in an old government desk many years ago.

Managing our dynamic marine environment and fisheries sustainably requires robust long-term monitoring data that marine scientists and managers can analyse for trends and patterns. Over time, a deeper understanding of marine ecosystems can be established and science-based management recommendations can be developed.

However, as global ocean temperatures rise and we experience more extreme climatic events, this task is becoming increasingly challenging for marine scientists and managers. Determining what is 'normal' is becoming ever more complex, as is anticipating the consequences for our fisheries and ecosystems. This makes devising adaptive management strategies for a changing marine environment critical.

In response to warming ocean conditions, marine species face three options: adapt to the new conditions and stay; move away in search of their preferred conditions; or die out. A new collaborative project called Redmap Australia is zeroing in on the movement option to ask the questions: are marine species shifting their ranges, are they just one-off visitors, or are they simply moving along the coast with seasonal variations?

Citizen scientists

Redmap Australia collects data by enlisting fishers, divers and beachcombers as 'citizen scientists'. The mission is simple—be on the lookout for unusual marine species at your favourite fishing and diving spots and log what you see on the Redmap Australia website (www.redmap.org.au). Anyone can take part in the project by uploading their photographs of out-of-the-ordinary species, together with details of when and where they spotted them. These reported encounters are then reviewed by a network of marine scientists around the country, to verify the species' identities and confirm the quality of the data collected. In Western Australia, these marine scientists are from the Department of Fisheries, Western Australian Museum, the Department of Environment and Conservation and Murdoch University.

Each report to the website is like a piece in a puzzle that, over time, will reveal which species may be experiencing the greatest changes in their distribution and the regions in which these changes are occurring. Verified photographic reports are posted on the Redmap Australia website, enabling fishers and divers around the country to share their information and see how the project develops. The information will benefit the community, scientists and industry.

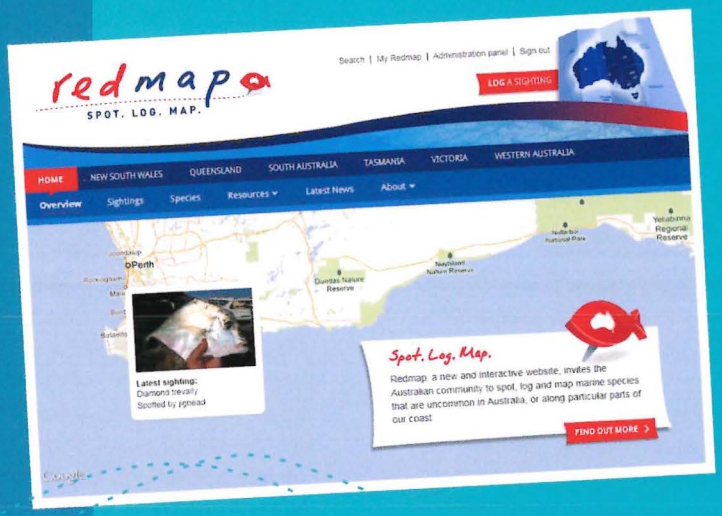
New knowledge

As part of a pilot Redmap project that started in Tasmania in 2009, there

Citizen scientists monitor marine change

by Mike Burgess

Something fishy is going on in Australia's oceans. And, with the aim of determining exactly what and how best to respond, the observation skills of an estimated three million people are being recruited to be involved in a new nationwide initiative called Redmap. Through this initiative—also known as the Range Extension Database and Mapping project—marine scientists have joined forces with divers and fishers to collect and share data that can help reveal whether fish and other marine species are shifting where they inhabit due to warming oceans.



Use your smartphone and QR reader to view Redmap on your phone.

Above main Fishers are helping monitor marine life.
Photo – Redmap
Inset Redmap website.

Right Chinaman cod.
Photo – Phillip Good/Redmap

have already been several dozen reports of new species, or reports that extended the documented range of known species in Tasmanian waters. WA fishers, divers and the wider community can also help gather this kind of information, and the sooner this occurs the more useful the information will be. An extreme event during the summer of 2010–11, dubbed the 'WA marine heatwave', provided a stark demonstration of the effects of ocean temperatures more than three degrees higher than normal over a wide area of WA's west coast. The immediate result saw extensive fish and shellfish kills along the Mid West coast, regional level coral bleaching and numerous reports of tropical fish species along the lower west and south coasts. Longer-term consequences are being investigated or are only now becoming apparent. For example, University of Western Australia (UWA) researchers have recently published a paper documenting how the range of a brown macroalgae (*Scytothalia dorycarpa*) has contracted by more than 100 kilometres on WA's west coast due to the marine heatwave. Other UWA researchers have also measured damage to seagrass beds in Shark Bay.

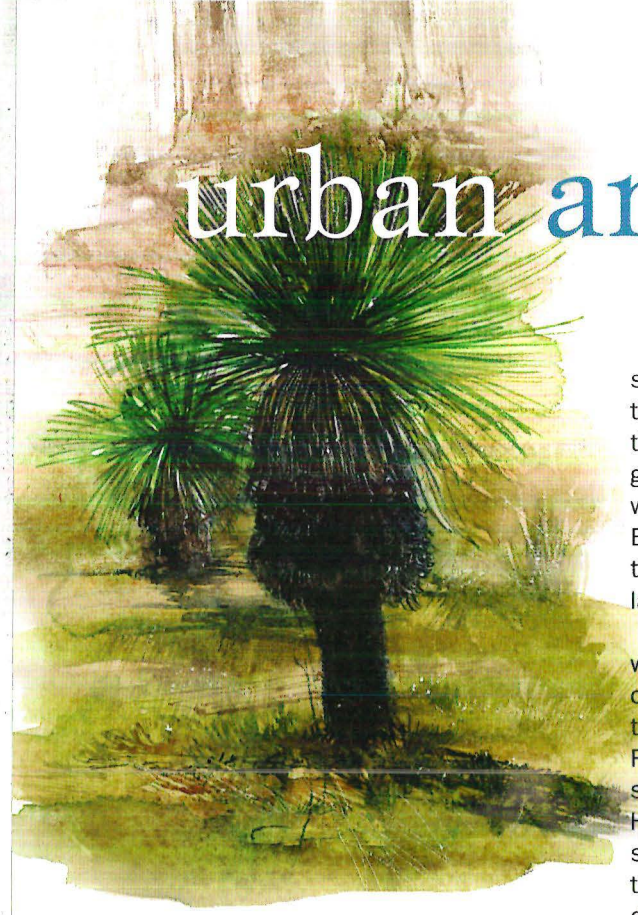
So next time you head out on or in the water, have your camera or mobile phone ready—you just don't know what you will spot. Register as a Redmap Australia member, sign up for the quarterly newsletter and, most importantly, log unusual marine species on the Redmap website.

Mike Burgess is the Western Australian Department of Fisheries community education coordinator and Redmap WA administrator. He can be contacted by email (wa@redmap.org.au).

Redmap is a comprehensive collaborative project led by the Institute for Marine and Antarctic Studies at the University of Tasmania, and involves the University of Newcastle, James Cook University, Primary Industries and Regions South Australia, Museum Victoria, Department of Fisheries WA, the University of Adelaide and the South East Australia Program.

urban antics

by John Hunter



Grass trees

In Western Australia, most of us live in the urban environs of Perth and Fremantle which is, coincidentally, exactly half way between Geraldton and Walpole and therefore about the centre of the habitat of the western grass tree (*Xanthorrhoea preissii*). This common endemic urban tree is the biggest and most spectacular in its genus.

In the Perth region there are several species of grass trees, or balga, along with the kingia, which is uncommon and of a different family. The genus *Xanthorrhoea* is confined to Australia, where there are more than 30 species, of which 10 occur in WA.

If you are lucky enough to have one or some of these small trees on your property you may treasure the feeling of the great outdoors, the artistry of natural sculpture and perhaps an ancient Aboriginal culture that still appreciates and uses the grass tree in daily domestic life. For thousands of years Australian Aboriginal people have probably reaped more resources from this one plant than any other. They collected the resin flakes from the trunk and flower stalk, heated them and rolled them into balls. This gum would then be reheated and used as glue to make and mend traditional weapons and implements. European settlers also harvested the material to make vanishes and lacquers.

The balga grass tree is widespread over its territory and copes well in most soil types from the clay gravels of the Darling Range plateau to the varying sands of the Swan Coastal Plain. Here though, you will also notice smaller grass trees without visible trunks and some others with differing flower spikes. These are of the same genus but differing species. They do not match the mature grandeur of *X. preissii*, which reaches more than four metres high, with multi-branched heads and flowering 'spears' growing up to three metres long.

In earlier times, when urban folk cleared their blocks of land for building, the eucalypts and banksias down by the back fence were sometimes spared, along with the odd wattle, but it was not part of the local psyche or even fashionable to save a common old 'black boy' as they were called then by all and sundry. My father's generation and before used the term simply because, after fire burnt away the dead leaf skirts of a tree, the remaining charcoal stubble on the bared trunk with a head of leafy spiked 'hair' and attached flower spike, especially in front of a setting sun, resembled an ancient proud Aboriginal warrior leaning on a spear while surveying his lands. To my school mates and me, the tree trunk charcoal was just the 'ants' pants' for there was nothing better with which to smudge war paint on our faces and pretend to be warriors of another kind.

As was often the case in the 1950s, rather than spend a 'big quid' on weekend entertainment, Dad would pile everyone into the family Triumph Mayflower sedan and head to the John Forrest or Yanchep national parks for a picnic. Here in the real bush, one could experience just how attractive the grass trees were. From high points on the Darling Scarp, small valleys glistened with armies of grass trees that reflected afternoon sunshine, while on the plain at Yanchep the individual balgas in the back areas of the park stood like giant extraterrestrial 'wookies' from a yet-to-be-invented Star Wars movie.

So great was the impression these plants left on me that when they became available in nurseries for urban gardens some years ago, it bought back fond memories of simpler times.

Have you ever studied the artistry in a mature balga? They are all so different, and they sing when the wind passes through their long slender leaves.

DID YOU KNOW?

- The balga's flowering spear comprises: the scape, the spear's non-flowering stem; and the spike, which is packed with thousands of white flowers that attract honeyeaters, bees, wasps, ants, jewel beetles and butterflies.
- The average growth rate of the grass tree is about one and a half centimetres a year.
- The balga's trunk is built from layers of flat leaf-bases which equates to about 580 new leaves each year. When it dies, fungi and native fly larvae cause it to rot, leaving the cylinder of leaf-bases as reptile habitat.

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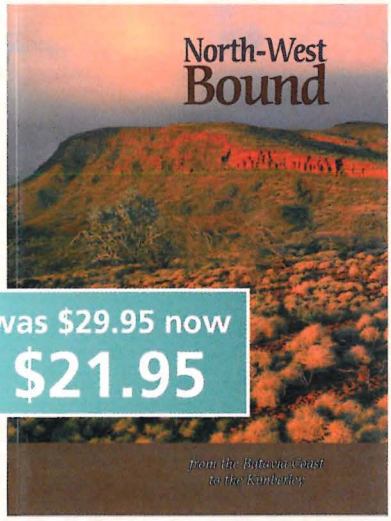

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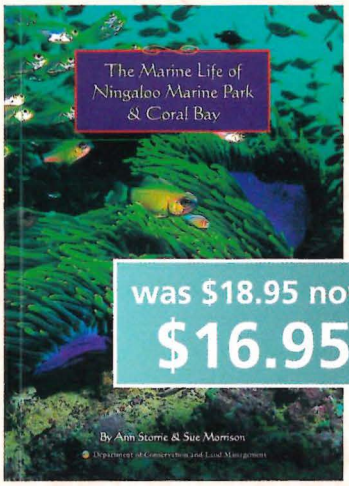

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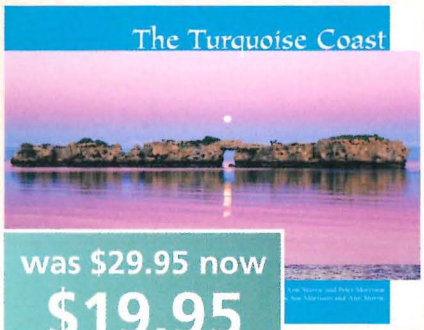

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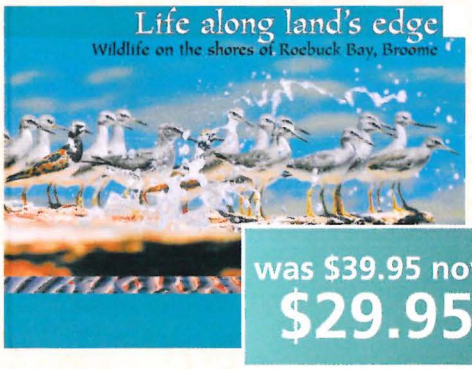

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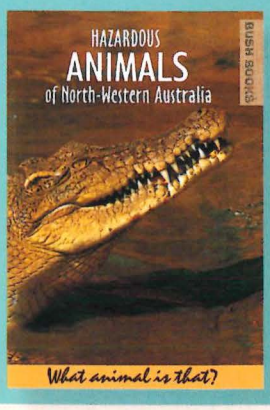

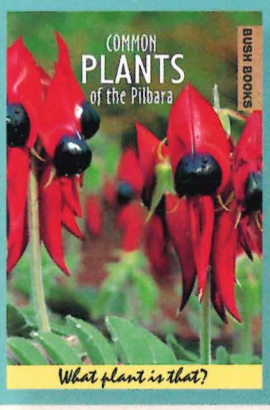

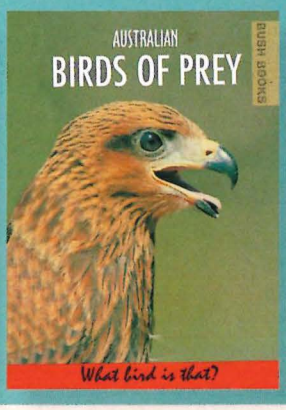

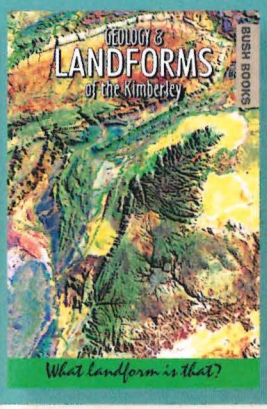

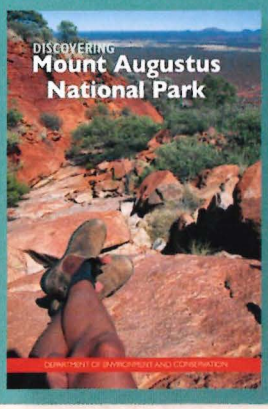

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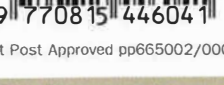

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