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GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**



ON THE COVER

Front cover The WA Christmas tree (*Nuytsia floribunda*) transforms Western Australia's south-west landscape from October to December with its brilliant yellow flowers. The tree grows to 10 metres in a range of soil types and mostly on sandplains, slopes and at the base of rocky outcrops.
Photo – Tourism WA

Back cover Carnaby's cockatoos.
Photo – Sallyanne Cousans



In the past 30 years, information and related technology (IT) advancements have transformed the way the department conducts its 24/7/52 business. IT has brought endless opportunities to the way we work locally and on a global scale. And the department's digital journey has enabled us to work closer and respond faster to the local and global community we work for and with.

The department has long adopted an open and secure IT ecosystem, which fosters collaboration and sharing in our workplace and with our local and global community. This enables people to access our information assets, and, in turn, cultivates and propagates knowledge of Western Australia's plants, animals and the natural areas in which they live. FloraBase, which is celebrating its twentieth year (see 'Twenty years of FloraBase' on page 18), was developed to provide free, globally accessible information about the State's plants. Since its inception, FloraBase has become a 'go-to' for scientists, the public, industry and students, and has earned itself the standing of being a valuable knowledge base that the department will continue to make improvements to.

As a community-based organisation entrusted with the stewardship of WA's natural and cultural values, the department has always operated in a spatially connected global environment. By engaging with Google through Street View (see 'Going off-road: showcasing Western Australia with Google' on page 28) the department is showcasing WA's natural attractions to the world on a popular digital stage.

The Western Australian community can be confident that the department's digital journey will continue to benefit the local and global community and the natural and cultural values we cherish.

Femina Metcalfe, ***Chief Information Officer***
Department of Biodiversity, Conservation and Attractions

Contributing

Dr Dorian Moro is a wildlife ecologist with DBCA's Animal Science Program and holds an adjunct position within the School of Veterinary and Life Sciences at Murdoch University. He has been managing a range of native and invasive fauna projects across a variety of islands off the Western Australian coast, and works closely with industry and wildlife management agencies to support evidence-based management.



Damian Thomson is a coral reef ecologist at CSIRO with expertise in biodiversity and ecology of corals, and in the design and implementation of large-scale and long-term monitoring programs. He has worked in the Pilbara, the Great Barrier Reef, Papua New Guinea and temperate parts of WA. Since 2007 Damian has worked at Ningaloo on understanding the processes that shape benthic ecosystems of north-western Australia. He currently leads the Shallow Reefs program within the *Ningaloo Outlook* project.



Gwendolen Monteiro has worked as a graphic designer with the department since 2009. In this time she has prepared signage for parks throughout the State, which aims to guide visitors and enhance their experiences, and has completed a range of artwork, including for the *Ms Casey Ross* boat that operates in Geikie Gorge National Park. When she's not designing, she enjoys sketching or painting portraits, still lifes, and flora and fauna, particularly on wall murals.



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This page Mottlecah (*Eucalyptus macrocarpa*). *Photo – David Bettini*

Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

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Snap shot



READERS' PIC

Wanagarren Nature Reserve

by Pippa Dallas

"These are the sand dunes in Wanagarren Nature Reserve. I'm 11 and we were driving home from Kalbarri but we pulled over and walked a while to get to the dunes. I did add some filters on the phone to some of the photos. It was really thin sand and when we climbed up it the dune was really, really steep. From the road it just looked like one dune but it was heaps bigger when you were on top."

Have you got a fantastic nature photograph you would like to see published in *LANDSCOPE*? Send it, along with a 100-word description of the species or how and where you took the shot, to landscope@dbca.wa.gov.au.

Curlews at home in suburban bush

Captive-bred bush stone-curlews that were released into Whiteman Park as part of Perth Zoo's Urban Renewal Program have made themselves at home in their new neighbourhood.

The eerie wailing calls of the bush stone-curlew were mistaken by some as the sound of someone screaming in the bush, but many residents who live near Whiteman Park have accepted the new residents and are helping Perth Zoo researchers learn more about their movements.

Perth Zoo's science program leader Dr Peter Mawson said the number of bush stone-curlews had declined across southern Australia due to fox and feral cat predation and changes in land use.

"We are aiming to return native species to their former ranges for future generations to enjoy, engage the community with native species and the conservation issues facing them and help rebalance the ecosystem," he said.

And the collaborative project is working. To date, at least five chicks have been hatched from a Perth Zoo and Caversham Wildlife Park pairing. And Perth Zoo is able to keep abreast of their movements thanks to reports from members of the public who post their sightings on Facebook, into bird watching forums or send in photos taken on their mobile phones.

"These birds are experts at camouflage, and during the day they easily blend into the native vegetation, so the updates from the community have been invaluable," Peter said.





Above right Perth Zoo keeper Kerry Pickles and science program leader Peter Mawson with a bush stone-curlew.
Centre right A banded bush stone-curlew ready for release.
Below Bush stone-curlew.
Photos – Perth Zoo



Correction

In 'Monitoring Matuwa and Kurrara Kurrara' (*LANDSCOPE* Winter 2018) we reported that camping and self-contained bunkhouse accommodation and facilities were available at Lorna Glen homestead. However, these are not available for public use and inquiries about visitation should be directed to the Tarlka Matuwa Piarku (Aboriginal Corporation) RNTBC (TMPAC), which has exclusive possession native title over Matuwa.



Sights on World Heritage listing for Burrup

Murujuga National Park on the Burrup Peninsula contains possibly the world's biggest gallery of Aboriginal art.
Photo – Tourism WA

Plans to nominate Western Australia's magnificent Burrup Peninsula and its surrounds for UNESCO World Heritage listing have been endorsed by the Murujuga Aboriginal Corporation and representatives from five traditional language groups.

The Dampier Archipelago, the Burrup Peninsula and Murujuga National Park are home to the world's highest concentration of rock art engravings, or petroglyphs.

These petroglyphs are thousands of years old and are of immense cultural and spiritual significance to Aboriginal people.

Following this endorsement, the State Government will submit a nomination to the Commonwealth Government, which will then progress the nomination to UNESCO for consideration.

If successful, the Burrup will be one of five World Heritage-listed sites in Western Australia, with the others being Purnululu National Park, Shark Bay, the Ningaloo Coast and Fremantle Prison. And would place it alongside other World Heritage-listed properties such as Stonehenge, the Taj Mahal, the Great Wall of China and Grand Canyon National Park.

mailbox

Dear Karen
Having just read the latest copy of LANDSCOPE and your article on magpies I would like to comment on what I think is a marked decline in the magpie numbers in our district.
I farm 25 kilometres south-west of Kojonup on Parker Road. Over the last 10 years where we used to see small numbers of magpies out in the paddocks alongside the road we now see mainly crows. Our neighbours' paddocks on each side of Parker Road as we head west to home seem to have no magpies, but there were at least 50 crows dominating the paddocks as I drove through the other day.
This is all only of academic interest if nature has taken over and crows are much better suited to our environment, then there is not much we can do to address the situation. If, however there is similar concern throughout the farming areas of the south-west, perhaps – perish the thought – some chemicals being used to control weeds and agricultural pests may be to blame.

Yours sincerely
John Mathwin

Please send your emails to landscope@dbca.wa.gov.au. To be considered for publication they should be no longer than 150 words and may be edited for readability and length.

Dear John,
These days, magpies are predominately associated with areas that are parkland cleared (like many grazing properties in the south-west) and urban environments and have become accustomed to living with people. I would not expect your local raven populations to be having an impact on the local magpies, but rather magpies have adapted to 'built up' areas and parkland cleared areas where vegetation and suitable nesting trees are more accessible. In Perth, we generally observe that raven populations fluctuate according to seasonal influences. Access to food is also a major contributing factor and while ravens will opportunistically predate smaller birds and reptiles, the majority of their diet comes from scavenging. Ravens are highly intelligent, opportunistic feeders and this has enabled them to adapt well to both rural and urban environments, hence the increase in numbers that you are observing. Over the years, targeted local campaigns to reduce food access and cease deliberate feeding has been undertaken and permits have been also been issued for raven destruction. Experience has shown, however, that unless controls are in place to reduce their access to additional food sources, targeted destruction has no long-term impact on local ravens as the populations are directly linked to the volume of food that is available to them.

Karen Smith, Regional wildlife officer, Wildlife Protection Branch, Conservation and Ecosystem Management

Same same, but different

Researchers got more than they bargained for while they were trapping for endangered quolls in the Pilbara, when they discovered an albino northern quoll.

The quoll had eight joeys in her pouch, although it is too early to tell if they have inherited their mother's albinism.

Albinism is extremely rare in any of the four quoll species; there are only about 10 previous records of it even in verbal history dating back to 1850, with most of those being eastern quolls.

The quoll was captured and released as part of a research project examining the habitat required for females to den in, in order to better protect this habitat. This work is a collaborative Honours project between DBCA, Charles Sturt University and is supported by Roy Hill.



Above right The albino quoll.
Photo – Judy Dunlop/DBCA

Hear more about the fascinating discovery

Scan this QR code or visit Parks and Wildlife Service's '*LANDSCOPE*' playlist on YouTube.







Rockingham Lakes Regional Park

This popular regional park, located 39 kilometres south of Perth's CBD, attracts people who come to enjoy water sports such as swimming, scuba diving, snorkelling, fishing, kayaking and boating and to marvel at the park's unique natural and cultural history. And now, upgraded walk and cycle trails, a new lookout and improvements to heritage sites are providing even more to experience.

Just 39 kilometres south of Perth, Rockingham Lakes Regional Park is a patch of paradise nestled within a developing urban area. On the right day, its white sand and sparkling turquoise water provide an idyllic launching pad for water sports such as swimming, scuba diving, snorkelling, fishing, kayaking and boating in the adjoining Shoalwater Islands Marine Park. But there's plenty to discover on dry land too, including some of Earth's earliest life forms and some very special feathered visitors.

Above View to Bird Island and Gull Rock from Point Peron.
Photo – Robert Campbell/DBCA

Top right Tiger snakes are one reptile known to occur in the area.
Photo – Sallyanne Cousans

Above right Red-necked stints are protected under international agreements.
Photo – Rob Drummond/Lochman Transparencies

NATURALLY BEAUTIFUL

Rockingham Lakes Regional Park was established in 1997 to protect a unique and important network of coastal, wetland and woodland ecosystems. Its location, relative to other conservation reserves in the area, makes it important on a regional level, as it contributes to a corridor of bush for native plants and animals to persist in the rapidly changing landscape of the metropolitan area.

The diverse landforms that exist in the regional park are represented in the varied vegetation that occurs there. Coastal shrubland can be found on the northern and southern parts that fringe the ocean, while stands of tuart, jarrah and marri surround permanent and ephemeral wetlands. These wetlands are recognised on a state, national and international level for the role they play in attracting and supporting populations of birds, including





Discover more about Rockingham Lakes Regional Park

Scan this QR code or visit Parks and Wildlife Service's '*LANDSCOPE*' playlist on YouTube.

Above left The spectacular beaches of Rockingham Lakes Regional Park make it popular for visitors.
Photo – Robert Campbell/DBCA

Above Cape Peron K-Battery Complex.
Photo – Tim Fisher/DBCA

"Its white sand and sparkling turquoise water provide an idyllic launching pad for water sports such as swimming, scuba diving, snorkelling, fishing, kayaking and boating in the adjoining Shoalwater Islands Marine Park. But there's plenty to discover on dry land too ..."

trans-equatorial migratory birds such as red-necked stints, curlew sandpipers and the common sandpiper. These birds, which are protected under international agreements and the *Environment Protection and Biodiversity Conservation Act 1999*, travel from Eurasia each year.

The area is also significant for mammals, and western grey kangaroos, black-gloved wallabies, echidnas, bush rats, dunnarts and quenda are known to occur in the park. Meanwhile, sand plain, moaning, Glauert's, marbled burrowing, western banjo, slender tree and motorbike frogs exist in the park and make themselves known in the evenings and after rain. Oblong turtles occur in lakes Richmond, Cooloongup and Walyungup, and carpet pythons, tiger snakes, dugites, Gould's and racehorse monitors and bobtails can occasionally be spotted making their way across the park's paths. The local invertebrates plays a key role in the ecosystem by providing a food source for the park's bird population. And some visitors may be lucky enough to spot a colourful yellow admiral butterfly, which breeds in the coastal areas of the park.

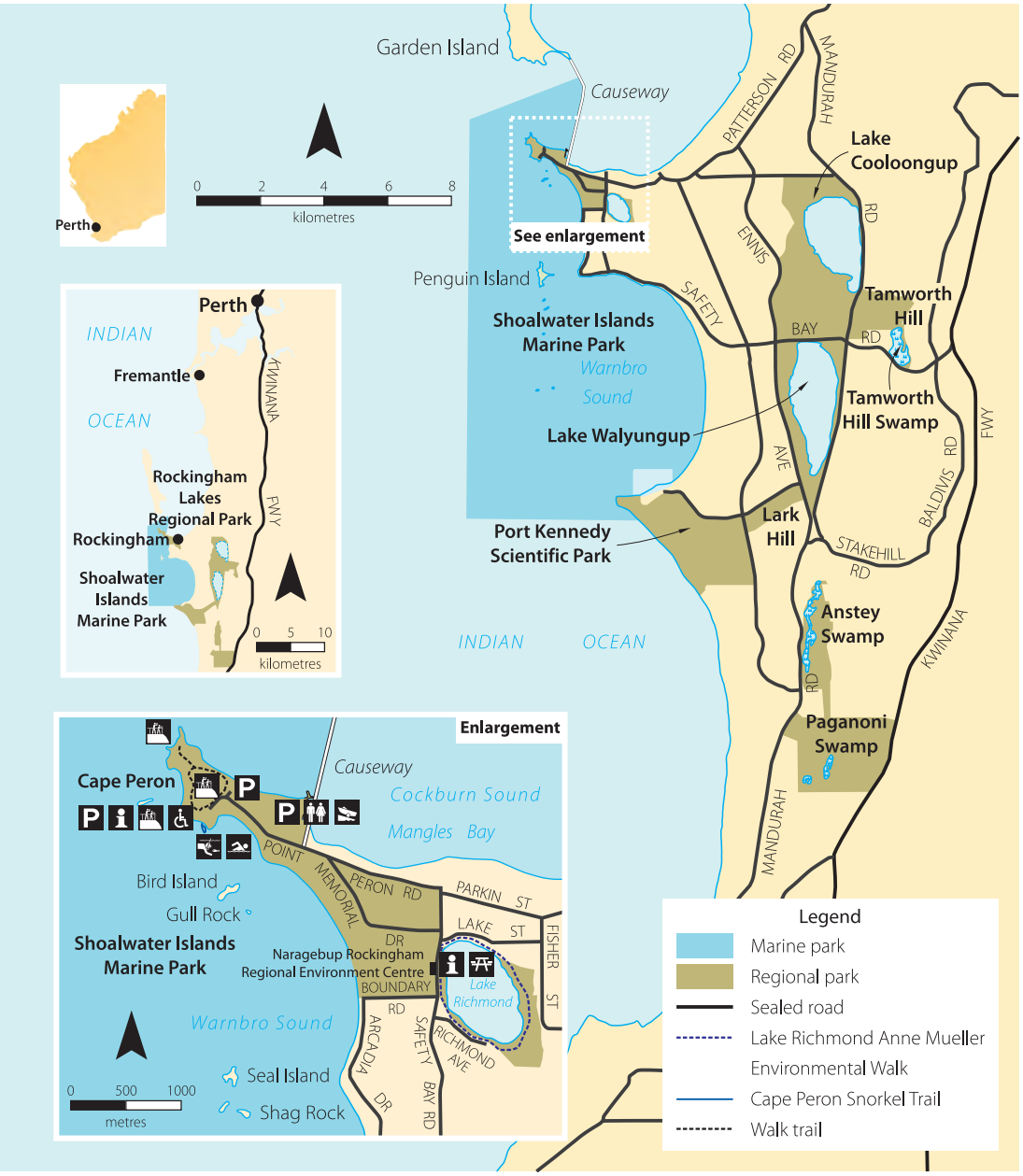
ANCIENT FEATURES

While at first glance they may not appear to be living creatures, the thrombolites of Lake Richmond are another significant organism that occurs in the park. In fact, they represent the oldest living organisms on Earth, having been formed by complex associations of different types of bacteria and microalgae. The thrombolites grow and survive in the fresh waters of Lake Richmond, which is rich in carbonate, bicarbonate and calcium. These minerals are believed to have come from the groundwater that has passed through the sand dunes that surround the lake.

HUMAN INTEREST

What is now Rockingham Lakes Regional Park has been known to the Nyoongar people for eons. The Rockingham area is significant to Aboriginal people and contains a number of sacred sites. The wetlands in the park are believed to have provided the local people with food and were possibly where trade and ceremonies took place. Nyoongar people are known to have camped at Lake Richmond, which is also spiritually significant. According to Dreaming stories, lakes Cooloongup and Walyungup are also significant as the place where the Sea Waugal laid her eggs. These areas got their names from the Nyoongar expressions for 'place of children' (Cooloongup) and 'place where Nyoongars talk' (Walyungup). Karnup, which surrounds Paganoni Swamp, means 'place of dreaming' and is thought of as a place for spiritual beings.

More recently, the park had its name entered into history books for its use during World War II. Gun emplacements, located at the north-western tip of what is now known as Cape Peron, as well as at Garden Island, Rottnest Island and Buckland Hill, were crucial to the local coastal defence system (see also 'Adventure out: Rottnest Island tunnel tour' on page 38). Today, the 1.5-kilometre John Point Walk Trail takes in the Cape Peron K-Battery Complex, which is listed on the Rockingham Municipal Heritage Inventory and on the Register of







Top The boardwalk at Lake Richmond takes in the ancient thromolites.
Photo – Tim Fisher/DBCA

Above Black-gloved wallabies are known to occur in the area.
Photo – Jiri Lochman

the National Estate. The primary circuit, which provides access for prams and wheelchairs, has been recently upgraded as part of a $375,000 two-stage capital works investment. The new pathway replaces a well-trodden track and will cater to the site's 900,000 visits each year. A second stage of improvements at Cape Peron has seen the upgrade of the surrounds of the observation post and the development of a new lookout at John Point. This lookout takes in some of the best views in the park out across the Indian Ocean and Garden Island and is expected to be open before Christmas.

Those wanting to explore one of the park's lakes can enjoy Lake Richmond on the Anne Mueller Environmental Walk. This three-kilometre walk provides an opportunity to see some of the park's spectacular birds and thombolites and can be broken up with a visit to the Naragebup Rockingham Regional Environment Centre or a picnic along the way at one of the tables on the lake's edge.

Meanwhile, those wanting to get their feet (and bodies) wet can explore the underwater wonders of the adjacent Shoalwater Islands Marine Park along the 300-metre Cape Peron Snorkel Trail.

Do it yourself

Where is it? Rockingham Lakes Regional Park is 39 kilometres south of Perth's CBD.

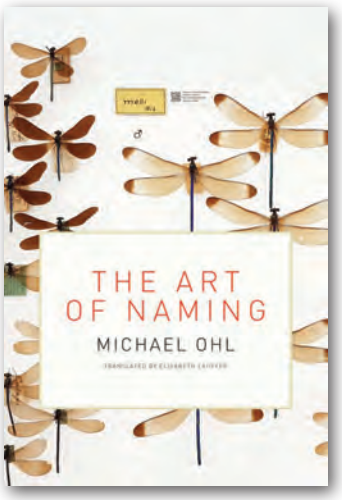
Total area: 4270 hectares

What to do: Walking, snorkelling, diving, fishing, kayaking, boating, birdwatching, cycling.

Facilities: Boardwalks, lookouts, walk trails, boat launching, environment centre.

THE ART OF NAMING

BOOK



In *The art of naming*, Michael Ohl points out that many scientific names have become part of the common vernacular. Toddlers with a fascination with dinosaurs, people who dabble in a spot of gardening or really anyone who identifies as *Homo sapiens* use scientific names. But this highly entertaining book uses interesting and amusing anecdotes to explore what's really behind a species' name.

Ohl provides examples of when species have been named after rock stars *(Heteropoda davidbowie, Scaptia beyonceae* and the pair of extinct trilobites *Avalanchurus simoni* and *A. garfunkeli)*, fictional characters *(Ampulex dementor,* after the dementors of Harry Potter fame) and Japanese emporers *(Platgobiopsis akihito* named after Akihito). He tells the stories of when the naming of a species has been intended to insult (like *Anophchalmus hitleri* – a tiny blind cave ground beetle – named after Adolf Hitler), and describes other times when it's been seen as a sign of respect or affection. And, of course, he points out that in many cases scientific names are simply descriptive, leading the mind to boggle about what *Spongiforma squarepantsii* must look like!

This fascinating and informative book is dotted with photos, illustrations and maps, and causes the reader to consider the naming implications of there being 1.5 million species across the globe that have been identified, catalogued and named, with millions more to be found, while being thoroughly entertained along the way.

The art of naming, *written by Michael Ohl and translated by Elisabeth Lauffer is available from good bookshops and online retail outlets.*

THE NATURAL WORLD OF THE KIMBERLEY

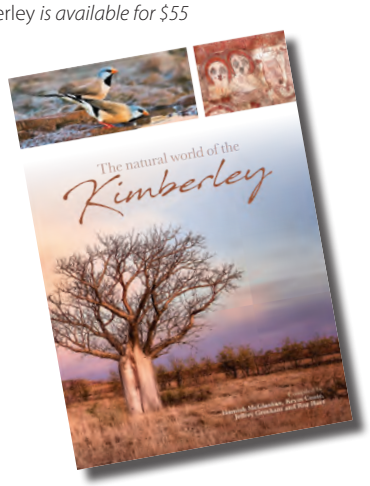
BOOK

Prepared by the Kimberley Society, *The natural world of the Kimberley* is a culmination of papers prepared and presented by a variety of revered experts at a one-day seminar held in 2016. The papers are arranged in five sections – land, plants and fungi, animals, sea and coast and environment – and showcase the area's spectacular and unique natural environment and outline what's being done to conserve it. It also celebrates the special connection that Aboriginal people have had with this area for millennia.

While based on extensive science and research, the papers have been written and edited to appeal to a wide audience, so this book will no doubt become a treasured resource of those living in or travelling through the Kimberley. Stunning photography captures a range of the area's most remote spots and fascinating species, some of which are found nowhere else in the world, while graphs, tables and maps depict a wealth of information.

The natural world of the Kimberley *is available for $55 from www.kimberleysociety.org*







RANGER TO RANGER

FILM

This uplifting documentary follows a group of nine Australian Indigenous rangers as they travel to Africa with The Thin Green Line Foundation as part of a ranger exchange. The Thin Green Line Foundation aims to 'protect nature's protectors' by providing vital support to park rangers and their communities, who are involved in conservation. These inspiring conservation champions work primarily in developing countries and conflict zones and regularly risk their safety when they're dealing with poachers.

Dan Sultan, an Indigenous musician who travelled with the group, summed up the experience perfectly when he said: "It doesn't take long to find the things we share in common, then we learn from the differences". And it is heart-warming to see our local representatives transcend cultural and language differences to connect with their African counterparts, united by their humanity and connection with the land, and the plants and animals that live there.

This documentary is full of endearing characters and the scenery is spectacular. The efforts of The Thin Green Line are inspiring and it is reassuring to know that there are organisations that are supporting those who are working to protect some of the world's most iconic and precarious species.

The film is downloadable by the public for $20 from thingreenline.org.au. People can run their own fundraisers or just watch it for themselves.

I SEE RED...

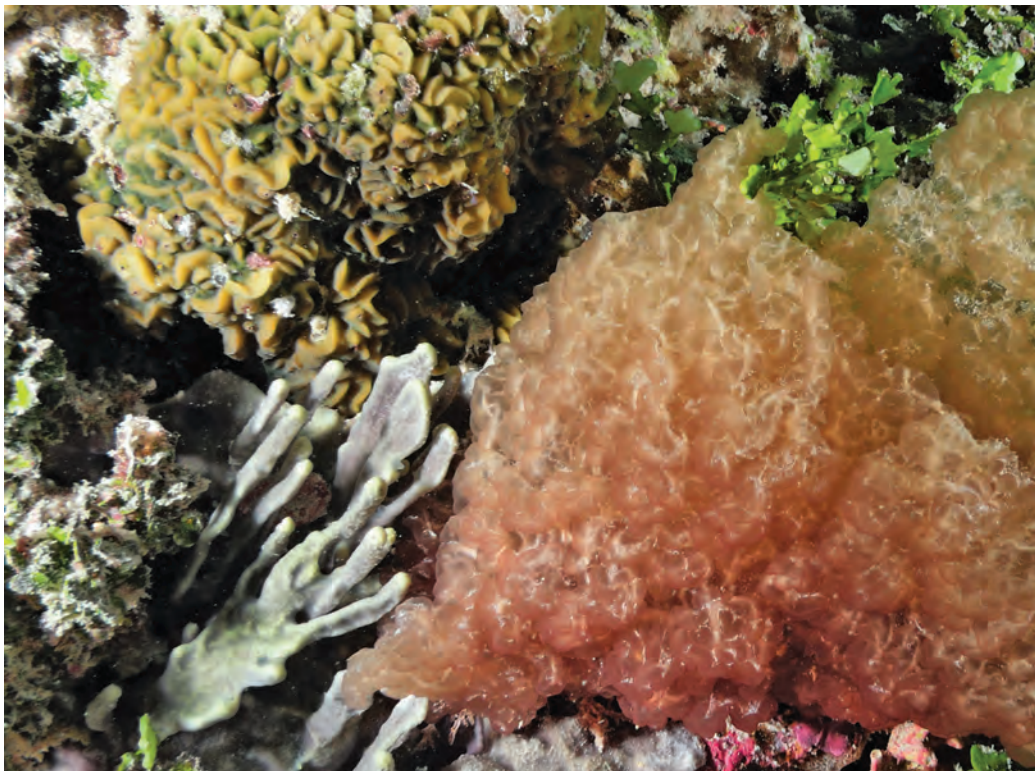


From Ningaloo to the Kimberley and offshore atolls, tropical Western Australia abounds with spectacular and diverse marine life. Amongst the corals and myriad fish, live a group of largely unheralded primary producers, the seaweeds. Research by Department of Biodiversity, Conservation and Attractions biologists has uncovered a startling array of species, and here we take a closer look at one group, the red seaweeds, arguably the least conspicuous, but certainly the most diverse assemblage of marine plants.

photos and words by John Huisman



Seaweeds are unjustly perceived as some of the least charismatic of marine organisms. But despite the negative connotations of the term, this diverse group of plants includes very few actual weeds, and many can be justifiably regarded as some of the most attractive and unique marine organisms. Unfortunately most people's perceptions of seaweed are tainted by visits to the beach where they have encountered large, smelly mounds of wrack; the pungent odour is certainly something to avoid. But seaweeds deserve a closer look, perhaps best while diving or snorkelling and observing living plants. And those who take a moment to enjoy the undersea garden will see colours, shapes and patterns that are sure to amaze.



Previous page
Main *Ganonema robustum*, one of the many new species discovered in north-west Australia.

Above *Rhytimenia maculata* had not been seen for more than 100 years.

TRUE COLOURS

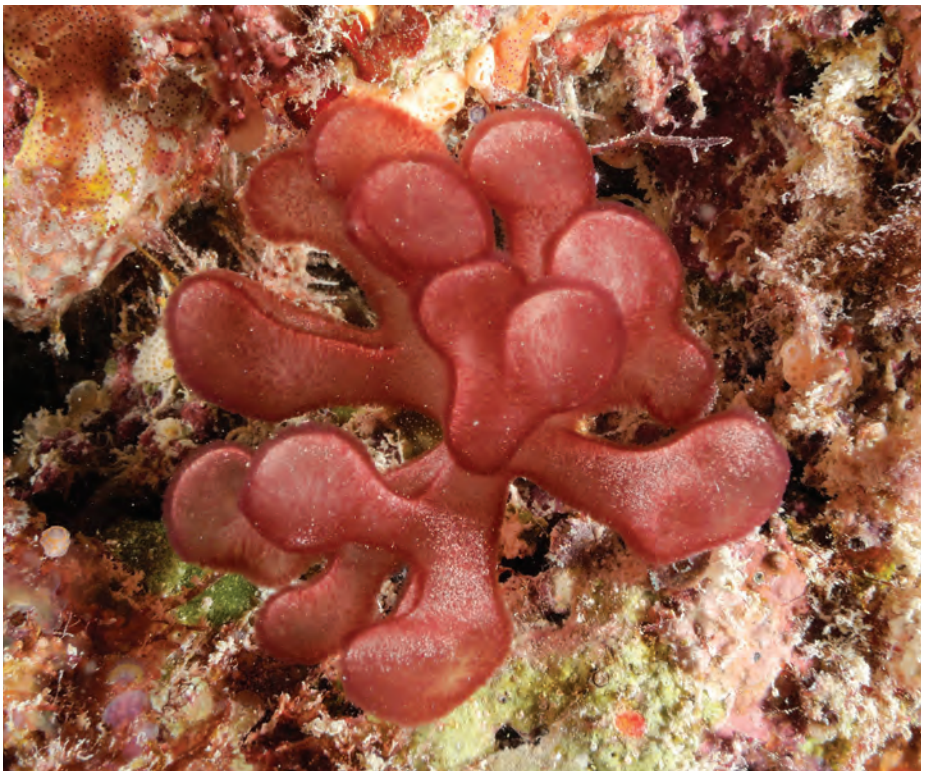
The seaweeds, or 'marine benthic algae' as they are often called, come in a variety of colours, but from a taxonomic perspective they can be divided into four groups: blue-green, green, brown and red, each equating to a different division or phylum. The blue-green algae are actually photosynthetic bacteria, more accurately known as cyanobacteria, and are very widespread in most habitats. In the marine environment they are commonly small turfs that mostly go unnoticed, but anyone that has taken a tumble on slippery intertidal rocks after inadvertently stepping on the 'black tar' coating will know them well. The green seaweeds include several that are well-known, perhaps the most familiar being the 'sea lettuce', the common name of species of the genus *Ulva*, which can be prolific on intertidal rocky shores. Brown seaweeds are easily the most conspicuous, as the group includes the kelps and other large species that wash up on the beach after a storm, forming the banks of wrack that most people do their best to avoid. In terms of biomass, which is essentially the amount of seaweed, the brown algae come out on top. However, if we consider diversity, or the number of different species, the red seaweeds are clearly the winner. If you add up the number of species of green and brown algae combined in a particular region, the total will be less than half the number of species of red algae for the same region. For the most part this diversity goes unnoticed, as the majority of the red algae are relatively small in stature and inconspicuous. Despite this, from a biologist's perspective, they are often the most interesting.

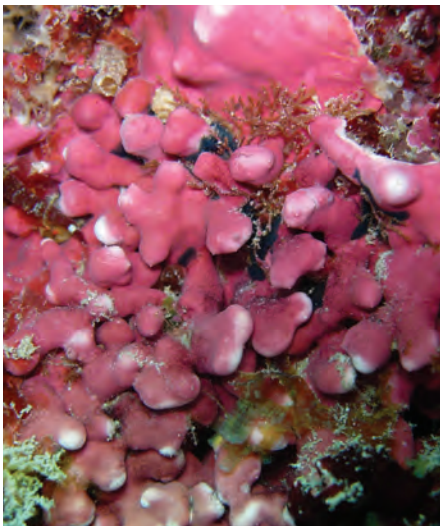
LET'S TALK ABOUT SEX

The red algae are the most structurally and reproductively complex, with most species having three phases in their life cycles and a mind-boggling array of reproductive structures and pre- and post-fertilisation processes. Indeed, red algae have 'sex', but the act is unique to the group, as the process is entirely passive. The tiny sperm cells, known as 'spermatia' and mostly with a diameter of less than 5 µm (1 µm = 1/1000th of a millimetre) do not have flagella (tail-like appendages) and therefore cannot swim. They are released into the ocean and somehow find their way to the egg cell, which is hidden within the female plant. Fortunately, this is made slightly easier by the egg cell having a receptive hair that can project about 100 µm above the surface of the alga. Once fertilisation occurs, the newly formed young is not released, but undergoes even more complex steps to multiply the number of offspring, with the resulting mass of spores from a single fertilisation often numbering in their thousands.

Until relatively recently, the seaweed flora of tropical Western Australia was virtually unknown, with fewer than 30 species recorded for the region. Remedying this gap in our knowledge has been an ongoing mission of mine. And so, for the past 20-odd years, I have regularly joined Western Australian Museum marine expeditions to the Pilbara and Kimberley coasts, as well as offshore atolls such as the Rowley Shoals and Ashmore Reef. The seaweeds I encountered on these trips were photographed, collected and preserved as specimens with the WA Herbarium, with the results compiled into a pair of books with the slightly unwieldy title of *Algae of Australia: The marine*







Top *Gibsmithia indopacifica*, a mucilaginous species that often accumulates sand grains, giving it a dusted appearance.

Above *Lithothamnion proliferum,* a coralline alga with a distinctive lumpy surface.

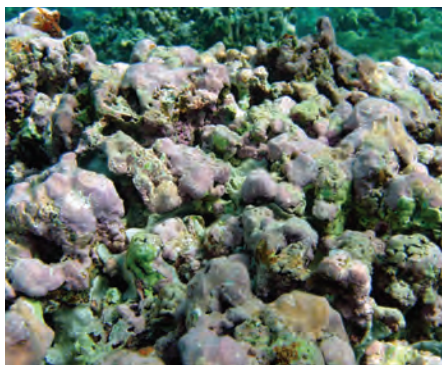
benthic algae of north-western Australia. Part one covered the green and brown seaweeds and was published in 2015, while *Part 2: the red algae* has just been completed. Between them they describe and illustrate more than 520 species, of which 91 are new to science. As might be expected, the red algae were the more diverse, with 351 species recognised, including 88 new species.

HISTORY REPEATING

While historically the seaweeds of north-western Australia have been ignored, those of slightly further north in Indonesia and the southern Philippines were collected and studied as part of the Dutch Siboga Expedition, one of the most significant marine biological surveys of the region. The H.M.*Siboga* visited what was then known as the 'Dutch East Indies' in 1899–1900 and on board was phycologist Anna Weber-van Bosse, who subsequently described the seaweeds collected during the expedition in a series of landmark publications, sometimes in collaboration with other phycologists. Weber-van Bosse's efforts were recognised when she was awarded an honorary doctorate from the University of Utrecht, and became the first Dutch woman to receive one. While the *Siboga* did not visit Australia, many of the species that Weber-van Bosse described have been found on our northern coasts (see 'Rare seaweed rediscovered', *LANDSCOPE*, Winter 2010). Some, such as *Rhytimenia maculata*, were first discovered during the Siboga Expedition but not seen again until the present surveys. This does not mean that the species are necessarily rare; the more likely explanation is that no-one has been looking for them.

Rediscovering species that have not been seen for more than a century also enables us to examine them from a modern perspective, to gain a better understanding of their taxonomic relationships. This is invariably undertaken using molecular methods, or DNA sequencing. This method enables us to examine how closely the species are related to one another, and also to generate a unique 'barcode' that can then be used to assist in the identification of specimens. In the case of *Rhytimenia maculata*, when first described by Weber-van Bosse for specimens collected from Makassar Strait (off Borneo) it was placed in the genus *Kallymenia*, based on the taxonomic concepts of the time. DNA sequencing of the recent collections from Ashmore Reef gave a different perspective and showed the species to be incorrectly placed in *Kallymenia*, and that a new genus was necessary. The name *Rhytimenia* was coined for this species, taken from the Greek *rhyti* (wrinkle) and





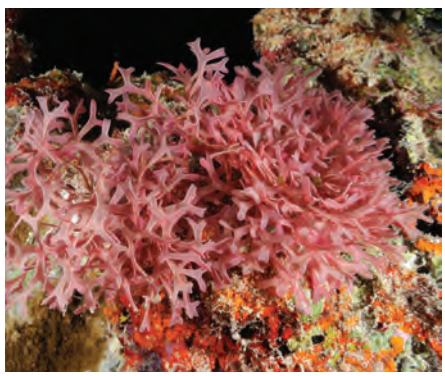


Above *Champia stipitata*, one of several iridescent red algae.

Far left Pink coralline, strengthening and consolidating the reef crest.

Left *Trichogloea requienii,* an extremely mucilaginous species with a calcified core.

Below left *Dichotomaria sibogae,* another species first described from the Siboga Expedition.



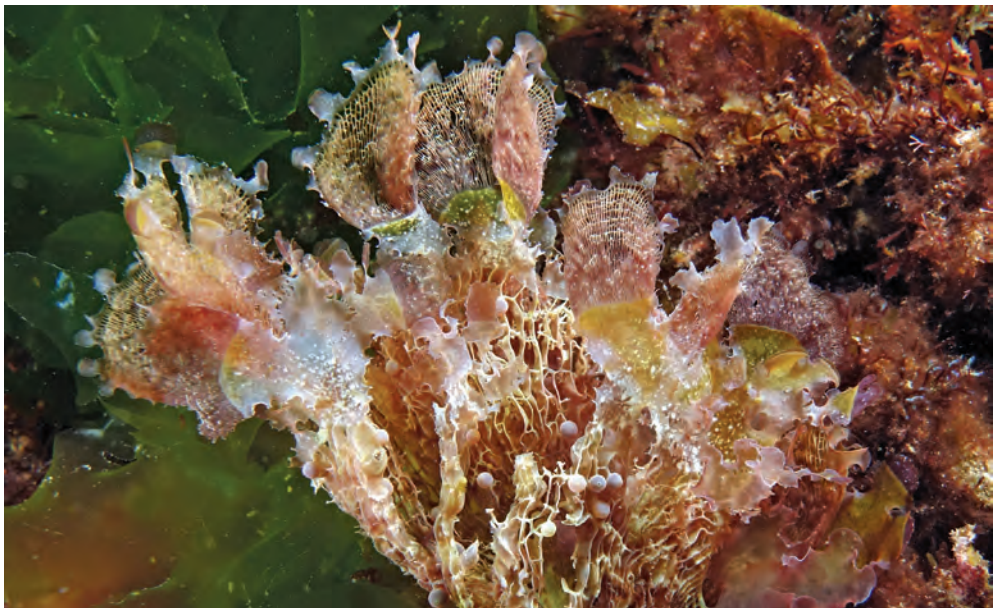
hymen (membrane), in reference to the wrinkled surface of the blade.

THIS IS THE MODERN WORLD

Molecular approaches have revolutionised modern taxonomy, and as methods are streamlined and automated they will be further embedded in taxonomic schemes. There have been numerous positive outcomes, but of greatest significance to the seaweeds is that there are clearly many more species than previously envisaged, and some of these are 'cryptic', differentiated only by molecular tools. Whereas previously many seaweeds were thought to be widespread, we now know that is not the case and some, but not all, species have very restricted distributions. The difficulty arises in matching these cryptic species to names used in the past; how do you know which of the many cryptic species is the one that the name should be applied to? The best solution is to undertake DNA sequencing of the original, or 'type' collections, to generate a definitive barcode, but in some cases this is not feasible. Another option is to revisit the location of the original collection, to re-collect authentic material and generate a barcode from the fresh specimens. Aligning the results of molecular studies with historical perspectives, to ensure that each species is known by the appropriate name, will undoubtedly keep taxonomists busy for many years to come.

Understanding the diversity of the red algae, while important in itself, might feed into other studies that aim to preserve habitats and conserve species. Coral reefs, particularly the outer reef crests that bear the full force of waves, are often strengthened by a coating of coralline red algae, which appear as layers of pink or red paint coating the reef surface. These algae incorporate a calcium carbonate skeleton as part of their structure and, as a result, can be as hard and tough as rock. Most scenarios of future ocean chemistry predict increased acidity, which could potentially remove, or at least lessen, the capacity of algae and corals to produce their calcium carbonate skeletons, leading to a weakening of the reef crest and possible damage. The long-term effects of this are unknown.

In addition to their ecological value in the marine world, red algae have certainly





Above *Martensia denticulata*, with its unusual lace-like fronds.

Above right *Eucheuma arnoldii*, mimicking *Acropora* coral.

Below right Mixed coralline algae, often found growing on shaded reef undercuts.

had a positive impact elsewhere. Their culinary use is well-known, particularly in Japanese cuisine. Nori, the purple-green wrapping around sushi rolls, is in fact a red seaweed known as *Pyropia* (formerly *Porphyra*). Several species of cartilaginous red algae are farmed for carrageenan, a component of their cell walls that is used as a thickening agent. Others are grown for agar, used extensively in laboratories as a substrate for growing micro-organisms and germinating seeds. Perhaps the most unusual potential use of red algae has been the subject of recent research. It was discovered that the addition of small amounts of *Asparagopsis taxiformis* to cattle feed drastically reduced the amount of methane that the cows produced. As the methane in the gaseous expulsions from cows is a significant contributor to greenhouse gases, red algae might have an impact on slowing climate change.

BEAUTIFUL GARDENS

Practical values aside, the red algae command attention due to their amazing appearances. Some species are iridescent, such as *Champia stipitata*, which glows under sunlight in opal-like patterns. Others, such as *Trichogloea requienii*, are highly mucilaginous, but strangely with a flexible calcified core that appears as a white backbone. Many red algae are calcified, but the calcification can take several forms. In *Ganonema robustum*, a new species found at Ashmore Reef and several offshore atolls, the calcium carbonate forms a powdery layer in the outer tissues that remains flexible. In *Dichotomaria sibogae* the calcification is minimal, imparting only a slight whitish hue to the branches. Other uncalcified species, such as the membranous *Martensia denticulata*, form delicate lace-like tissues, the result of very precise simultaneous realignments of cells during growth. The environmental trigger for this still unknown. One very unusual species of red algae is the cartilaginous *Eucheuma arnoldii*, whose appearance precisely mimics that of *Acropora* corals, even down to the presence of a polyp-like growth at the tips of branches. This mimicry has presumably evolved to deter herbivorous fish and is so convincing that during surveys the alga was overlooked by everyone except WA Museum coral biologist Zoe Richards, who was stunned to find that what she thought was a hard coral was actually flexible (see 'Now you see me', *LANDSCOPE*, Spring 2016).

The red algae are aesthetically pleasing, environmentally important, and scientifically intriguing, undoubtedly with numerous new species yet to be discovered. It's no wonder that those in the know are enthralled by them, and hope to spread the enlightenment to those that aren't.

"The red algae are aesthetically pleasing, environmentally important, and scientifically intriguing, undoubtedly with numerous new species yet to be discovered."



John Huisman is the curator of DBCA's Western Australian Herbarium and a seaweed specialist. He can be contacted at john.huisman@dbca.wa.gov.au.

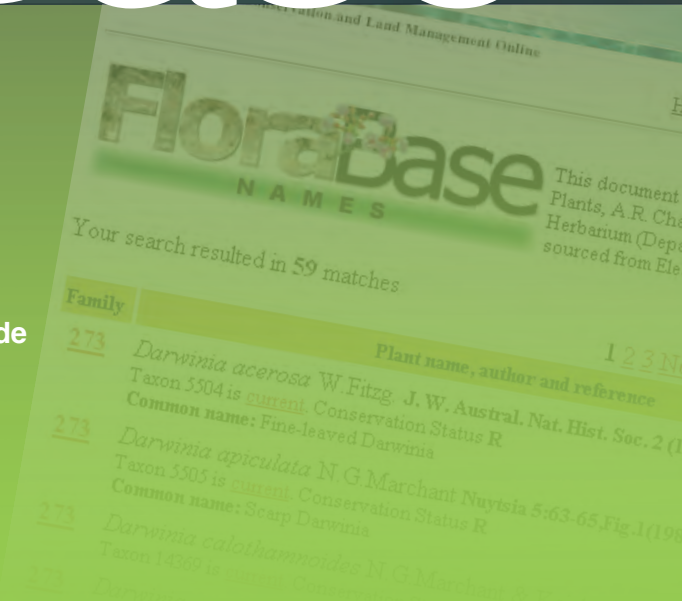
Parts 1 and 2 of Algae of Australia: The marine benthic algae of north-western Australia *are available from from CSIRO Publishing (publish.csiro.au).*



Twenty years of FloraBase

The internet and the ability to immediately access information has become entrenched in our day-to-day existence, but 20 years ago the world was just discovering its potential. A group of visionary scientists at the department's Western Australian Herbarium embarked on an ambitious undertaking: to create the first online Western Australian flora database. And thus was born FloraBase, which is entering its third decade and remains a relevant and invaluable source of information.

by John Huisman, Alex R. Chapman and Ben Richardson









Opposite page
Main Red and green kangaroo paw is one of WA's more than 14,000 recorded flora species.
Insets from top Silky cornflower, WA christmas tree, copper cups.
Photos – David Bettini
Below background The first incarnation of FloraBase was launched in 1998.

Above left A specimen of painted lady (*Gompholobium scabrum*) collected from King George Sound in 1791 by Archibald Menzies and donated to the WA Herbarium by the Natural History Museum, London.
Photo – DBCA

Above WA Herbarium database team and volunteers have input data for 790,000 plant specimens since FloraBase was launched 20 years ago.
Photo – Donna Swan, circa 1996

The Western Australian Herbarium, part of DBCA, houses the world's largest scientific collection of Western Australian plants, with some 790,000 dried plant specimens. These specimens provide the foundation for understanding WA's flora, including its composition, distribution (spatially and chronologically), and taxonomy. As permanent records of where and when species occurred, these specimens are the primary resource for research on the classification and distribution of the flora. Amongst the collection are a significant set of 'type' specimens, those that anchor in physical form the concept of a species name and against which all other specimens can be compared and evaluated.

Prior to the establishment of the Western Australian Herbarium in 1929, scientific collections were commonly sent to overseas herbaria, or later to those in the Royal Botanic Gardens of Melbourne or Sydney. Of course species, and therefore taxonomic research, are not restricted by political boundaries and so the WA Herbarium plays a crucial part of the global scientific endeavour to document and refine our understanding of the world's flora, especially important in the world's oldest landscape, which contains one of the 33 global plant biodiversity hotspots.

A PRICELESS COLLECTION

The specimen collection currently occupies four large vaults at the Keiran McNamara Conservation Science Centre in Kensington. The collection is stored securely, under strict quarantine to prevent ingress of potentially damaging pests, and is sequenced systematically, based on an understanding of plant phylogeny, so that closely related plant families are near to each other. This facilitates ease of access and comparative analysis between related organisms – like a giant physical database of biological knowledge. Botanists and technicians work within and around the collection to identify, research, curate and conserve the specimens, keeping the data they contain up to date and secure.

Apart from physical access to the material, information about the flora has traditionally been available via scientific publications such as papers, Floras (see 'Flora versus flora, Herbarium versus herbarium' on page 21), catalogues and handbooks. However, the incredible diversity of the Western Australian flora,





Insets far left Charles Gardner surveying the Kimberley, circa 1950.
Photo – Howard Coate, courtesy Kevin Coate

Left FloraBase remains the only authoritative source for information about WA's flora.

Far left Royal hakea.

Below Queen of sheba orchid.
Photos – David Bettini

Opposite page
Right The stunning wildflowers at Frank Hann National Park.
Photo – Sallyanne Cousans

The road to FloraBase

1930–31 Government Botanist Charles Gardner (Herbarium Curator from its establishment in 1929 until 1960) published a census of all plants known to occur in Western Australia, titled *Enumeratio plantarum Australiae occidentalis*. 4500 species were recorded.

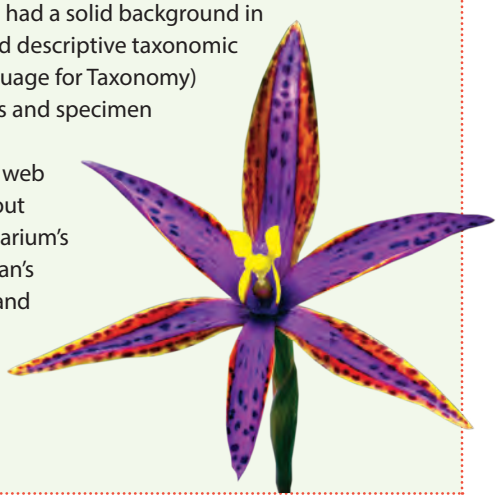
1965 Publication of the *Descriptive Catalogue of West Australian Plants* by Kings Park Director John Beard. This catalogue was based on the incomplete manuscripts of Charles Gardner's *Flora of Western Australia*, augmented by label information on specimens in the Herbarium collection.

1981, 1985 Curator John Green (1975–1987) established an electronically stored updated census, which was the basis for the books *Census of the Vascular Plants of Western Australia* (Edition 1 in 1981, Edition 2 in 1985). The second edition listed 7954 Western Australian plant species.

1990 Herbarium botanist Nicholas Lander converted the Green census into a proper database format from which he published a number of supplements to the census. Initiated by new curator Jim Armstrong (1989–1992), Alex Chapman and Paul Gioia began the design and development of the corporate relational plant names database (WACENSUS) that covers all known Western Australian plants, which to this day is maintained and updated by Herbarium staff.

1985 Herbarium specimen label data (now with attached barcodes) began to be entered into a database named WAHERB, one of the first Australian herbaria to embark on this path. By storing this information electronically the collection could be quantified, managed and interrogated much more efficiently. For the first time instantaneous access to all the label data for every specimen in the herbarium was possible, making the classification, indexing, and updating of the data immensely more efficient. All specimens then in the collection were databased by 1994, and as the collection expands this process remains integral to its management.

2000 *The Western Australia Flora: a descriptive catalogue* by Herbarium botanists Grazyna Paczkowska and Alex Chapman is the last of the catalogues in printed form. In addition to his botanical knowledge, Chapman had a solid background in computer science. He and Paczkowska captured descriptive taxonomic information using the DELTA (Description Language for Taxonomy) data standard, and combined it with the census and specimen database.



1995–1998 The construction of FloraBase – a web portal providing rapid access to information about Western Australian flora, incorporating the Herbarium's census, specimen data, Pazckowska and Chapman's descriptive catalogue, along with plant images and Paul Gioia's specimen distribution maps.

11 November 1998 FloraBase was launched. For the first time, complete taxon profiles for every Western Australian vascular plant species are available online.

and the continuing discovery of novel species as new areas are surveyed, has meant that a book documenting WA's complete flora has never been realised. Given the enormity of the task, Herbarium botanists decided that a different approach was needed, and in the early 1990s the concept of a web-based record was mooted. As is true for all Floras, a portion of the contents is drawn from the past, and updated to reflect current taxonomic concepts. FloraBase, similarly, drew on a long history of botanical studies.

A SIGNFICANT MILESTONE

Since FloraBase's inception 20 years ago, it has been extensively refined and updated, and now incorporates not only the vascular plants but other taxonomic groups including the fungi and algae. Significant additions in later versions include an interactive key to the WA genera, the incorporation of the Herbarium journal *Nuytsia*, an upgrade to the maps, and support for tablets and smart phones. Each year a summary of statistics is presented, with the most recent conservatively indicating that the flora comprises close to 13,000 native species, in addition to nearly 1300 alien species. FloraBase remains the only authoritative source for information about WA's flora.

The success of FloraBase is largely due to the foresight and efforts of Alex Chapman, Ben Richardson, Paul Goia, and Nicholas Lander who conceived the idea in the days of the Department of



Flora versus flora, Herbarium versus herbarium

The 'flora' is the plant life present in a particular region, or at a particular time. A 'Flora' of a region, however, is a published compilation, hopefully comprehensive, of information pertaining to the plant species occuring in the region. Floras typically include names and pertinent nomenclatural information, descriptions, keys, and illustrations. In addition to providing a snapshot of current knowledge, a well-written Flora should enable the reader to identify the plants occurring in the region. Historically, Floras have been published books, but increasingly they are being delivered online (such as FloraBase).

A 'herbarium' is a collection of dried plants, which is often used in schools for teaching botany or kept by wildflower enthusiasts for their own interest. A 'Herbarium' is a botanical research institution, which in addition to housing, maintaining and databasing an official collection, is responsible for naming and describing plant taxa. This information is, for the most part, made freely available.

Conservation and Land Management, as well as contributions from numerous Herbarium botanists and curation staff, and volunteers who provide and curate images. The Herbarium's core datasets, which provide nomenclatural and specimen data to FloraBase, are regularly maintained and updated, with the aim of presenting the WA flora aligned to the most up-to-date, accepted taxonomy. Plant taxonomy is still a vibrant field of research, particularly now with the incorporation of DNA sequencing in systematic studies, and new species and taxonomic revisions are a common occurrence. Much of this taxonomic work is published in *Nuytsia*, which is freely available online via a link on FloraBase. However, studies of the WA flora are not exclusive to *Nuytsia*, and keeping abreast of the current literature is an ongoing task for Herbarium staff.

It is significant to the development and position of FloraBase to note that the WA Herbarium has had a long and consistent involvement in the Taxonomic Databases Working Group, an international body devoted to the development of biodiversity data standards and their implementation. Terry Macfarlane, Nicholas Lander, Alex Chapman, Kevin Thiele and Ben Richardson have all played a role in the work of this group over the past 20 years, culminating in the hosting of the international annual conference in Fremantle in 2008.

In addition to providing this information directly, FloraBase data can be accessed via other websites that aggregate data, such as the Australasian Virtual Herbarium (AVH), which provides specimen-based data for the more than eight million specimens of plants, algae and fungi housed in Australian and New Zealand Herbaria. The AVH is a collaborative project developed under the auspices of the Council of Heads of Australasian Herbaria.

A broader coverage, including all of the Australian plants and animals, is provided by the Atlas of Living Australia (ALA), which provides online access to many millions of occurrence records. Unlike FloraBase and the AVH, in which all records are based on specimens held in Herbaria, the ALA also includes observational records.

THE FUTURE

To this day FloraBase remains a popular resource, with almost 24,000 unique users accessing the application across 28 days in September 2018. The department is constantly striving to maintain FloraBase's relevance and a major revision is currently underway, ensuring that it continues to be a valuable resource for scientists as well as the general community. The last five years has seen an upsurge in the use of tablets and smart phones, with almost half of visitors accessing the site with a mobile phone. It is important that these changes in technology and user preferences are monitored and catered for in updates to the site.

Imminent improvements include the provision of a considerably expanded image library, with a 10-fold increase in the number of images available to users (from about 7000 to about 70,000); zoomable maps with links to the underlying data as well as other mapping tools; and updates to the descriptive catalogue dataset to further enhance search results. With these improvements, and many more planned, FloraBase will remain the first port of call for information about the WA flora for many years to come.

John Huisman is the curator of the WA Herbarium. He can be contacted by email (john.huisman@dbca.wa.gov.au).

Alex Chapman is a consulting scientist at Gaia Resources – Environmental Technology Consultants and a WA Herbarium research associate.

Ben Richardson is a DBCA senior technical officer.

You can access FloraBase at florabase.dpaw.wa.gov.au.

Readers interested in the history of botanical research and the Western Australian Herbarium should seek out A botanical journey. The story of the Western Australian Herbarium *by Roger Underwood (2011), and published by the then Department of Environment and Conservation.*



Browse Island

A journey to Western Australia's most remote nature reserve

A trip to Browse Island highlights the challenges of travelling to, and managing, our remote nature reserves, and the importance of biosecurity vigilance on our offshore islands.

by Dorian Moro, Russell Palmer, Bruce Greatwich, Ruth Dickinson and Hannah Anderson

Located about 450 kilometres north-northeast of Broome, and accessed by a 24-hour boat trip, Browse Island is the most remote island nature reserve in Western Australia. It lies in a vast ocean that straddles the Timor Sea and Indian Ocean. And, at 175 kilometres from the nearest Kimberley coastline, the nature reserve feels more like an Indonesian territory than an Australian one. Browse Island is a small (some 17 hectares) low-lying and densely vegetated coral cay that sits at the middle of a near-circular and spectacular white sandy beach, and is surrounded by a fringing reef exposed to strong winds and swell.

The island had not been visited by department staff since 2005. So, in early August 2018 DBCA scientists and West Kimberley District staff, together with renowned seabird expert George Swann, boarded a 20-metre charter vessel in Broome to make the journey to this remote outpost to record the current status of the island's flora and fauna, particularly seabirds, and report on the presence of introduced weeds and house mice.

THE EARLY YEARS

In 1872, a merchant ship sailing from Darwin to Fremantle was becalmed in waters off the north-west Kimberley coast. To pass the time, its owner George Howlett followed large flocks of seabirds that were converging towards a nearby landmass, which is now known as Browse



Island. However, it is thought that the famed English explorer William Dampier was the first European to record the island in September 1699, when he sighted a "small low sandy Island, … inhabited only by boobies and man-of-war birds



Above Browse Island is located in a vast ocean between the Timor Sea and Indian Ocean.
Photo – Dorian Moro/DBCA

Top right The island was declared a nature reserve in 1991.
Photo – Bruce Greatwich/DBCA

Above right Traps were used to survey for house mice on the island.
Photo – Dorian Moro/DBCA

[frigate birds]". Enterprising companies soon learnt of the substantial deposits of guano (bird droppings) on the island and recognised its value as an agricultural fertiliser for the phosphorus and nutrient-poor farming lands of south-western WA.

The Browse Island Guano Company Limited was established on 26 February 1876 in Adelaide, South Australia to mine the guano accumulation and export it to markets overseas. The company mined the guano deposits extensively for 10 years before operations ceased. Guano extraction on the island continued periodically under separate leases until 1921 when high-quality guano deposits on the island were exhausted.

There is still abundant evidence of the industry on the island today – remnants of the stacked rock phosphate stone walls and supporting structures, rail tracks used to guide loaded carts from the interior to the coast, and even gravesites of deceased miners. Unfortunately, the industry also left behind far more sinister legacies, including introduced species such as cats and house mice. An early painting from 1878, held by the Yarmouth County Museum, Nova Scotia, depicts evidence of significantly altered vegetation, which, while unrecorded, has no doubt impacted the colonies of seabirds that nest there and the nesting turtles that visit the island.

Early shipping reports in newspapers accessed via the National Library of Australia's online newspaper archive, Trove, provide some clues to the impacts of guano mining to the island. The captain of the brig *Silver Stream* called at Browse Island on the way to Darwin in 1885, reporting "two vessels were loading with guano. The flat, scrubby island was covered with one mass of birds, and on

it were also seen a number of wild cats and some fowls and pigs". Surprisingly, feral cats persisted on Browse Island well after guano mining ceased with the naval commanding officer of the HMAS *Canberra* reporting the presence of "a small famished looking cat" in 1929 and the renowned ornithologist Dominic Serventy was "surprised to see the tracks of a domestic cat" during his visit in 1949.

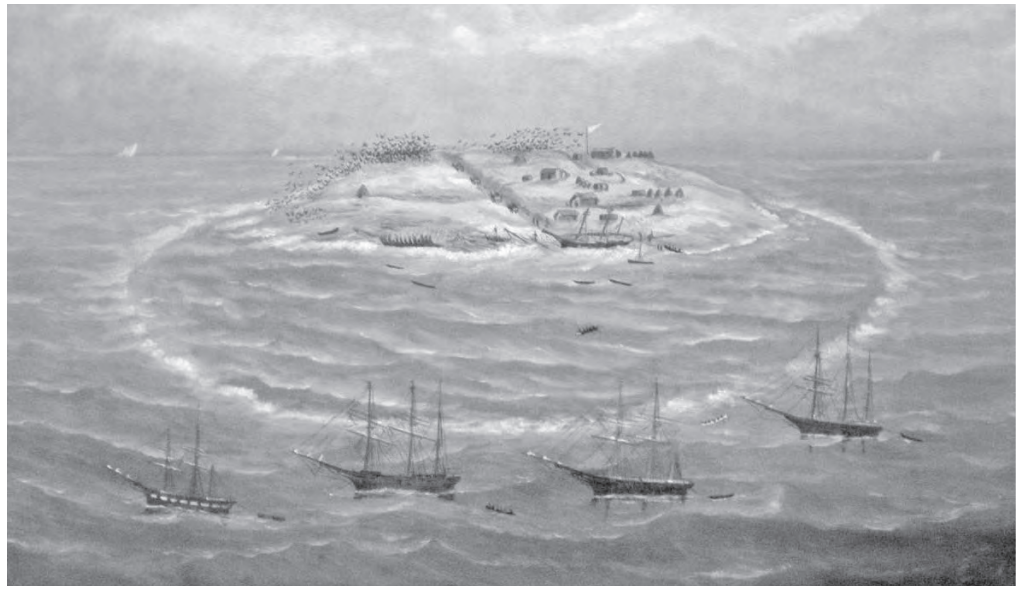
MODERN TIMES

Traditional Indonesian fishing vessels (known as perahus) have frequented Browse Island, which is a class 'A' Nature Reserve, for some time. Since 1974, the Australian Government has allowed these traditional fishers access to the marine area surrounding Browse Island under a Memorandum of Understanding (MoU). The primary market interests of those aboard these vessels are species such as trepang, clam, fish (including sharks) and trochus shells. The MoU does not allow for landings on the island itself, but there is observational and recent historical evidence of human access and wildlife poaching to suggest it occurs anyway.

There are at least six substantial shipwrecks reported around the island, mostly due to periodic cyclones during the guano mining era. All these wrecks are protected under the *State Government Maritime Archaeology Act 1973* and disturbance or removal of any material is illegal.

THE CHALLENGES OF GETTING THERE

Working on island nature reserves off the Western Australian coast presents various logistical challenges. Browse Island's isolation makes it difficult and costly to get to, and probably explains why the last departmental survey of the island was 13 years ago. Coupled with the remoteness of this nature reserve is the uncertainty of the sea conditions, including swell, which made getting to and from the island an adventure in itself. During our August 2018 trip we experienced strong southerly winds, up to 35 knots. Choppy sea conditions made for a rough trip and provided some of us on board with a new definition of what it meant to be seasick.





Top An 1885 painting of Browse Island shows the impact of guano mining on Browse Island. *Image – Yarmouth County Museum and Archives, Yarmouth, Nova Scotia, Canada*

Above Traditional Indonesian fishing vessels are permitted in the waters around Browse Island under an MoU. *Photo – Bruce Greatwich/DBCA*

Sighting the island was a relief, and we observed 13 traditional Indonesian fishing vessels anchored offshore, indicating the continued use of this area. But landing on the island was another challenge, as the dinghy we used to ferry gear and people ashore had to negotiate the outer reef and associated surf breaks. Timing the landing ashore required patience and the right ocean calm to unload the gear, as the tides in the area are large (up to 10 metres) and the resulting currents strong.

THE MOUSE ON BROWSE

A key objective of this survey was to record the status of introduced house mice on the island, and to assess their threat to the island's ecosystem, particularly nesting birds. House mice were initially collected on the island during a visit in June 1972 by departmental staff undertaking the first biological survey of the Kimberley islands from 1971 to 1973. Oil company personnel stationed on the island at the time kindly trapped eight mice for the visiting survey crew.

There are numerous sub-species of house mice worldwide; the western European house mouse (*Mus musculus domesticus*) is currently the only subspecies known from Australia. It is thought to have come from England with the first fleet. In fact, it was not until 2012 that the identity of the 'mouse from Browse' was revealed. A tissue sample from a





Above A survey of house mice aimed to estimate how abundant they were on the island.
Photo – Bruce Greatwich/DBCA

Above right Getting to and from Browse Island involved a 24-hour boat journey.
Photo – Dorian Moro/DBCA

single mouse trapped on Browse Island by a seabird survey team lead by Dr Rohan Clarke from Monash University was forwarded to the house mouse genetics lab of Dr Hitoshi Suzuki at Hokkaido University, Japan. He confirmed that the house mice on Browse and Ashmore Reef islands belonged to a tropical species of house mouse: the south-east Asian house mouse (*Mus musculus castaneus*). Genetically, these mice align with those of the Indonesian islands of Rote and Timor and therefore pose a biosecurity risk to Australia should they stowaway in vessels or cargo that land on the island. Their impact to seabirds on the island also remains unknown.

Our team set up to 600 snap traps across the island as we had no understanding of how many mice we may catch, nor how long our landing may be, due to the uncertainty of the weather. Traps were established on a 15-metre grid across the entire vegetated part of the island.

It became clear the next day that mouse densities were very high; 550 animals were captured overnight. The dry nature of the vegetation together with high mouse densities suggested food was likely in short supply – most mice had cannibalised other dead mice in the traps. We collected liver samples for future genetic analyses, and kept some mice as museum specimens. We also found that this Asian house mouse averaged about 19 grams, making it about 35 per cent heavier than their counterparts from other islands and the mainland.

FLORA AND WEEDS

The island is densely vegetated with the tall spindly shrub Indian lantern flower (*Abutilon indicum* var. *australiense*) cloaked with the tangling creeper *Ipomoea macrantha*, which made walking in straight lines to set mouse traps challenging. While the vegetation complex is relatively uniform, a potential new species of plant was recorded not just for the island, but as a first record for the Western Australian census. This species, the fish plate shrub (*Guettarda speciosa*), is known from nearby islands at Ashmore Reef, so it is likely to have been self-introduced to the island. A representative sample of all flora species observed was taken and subsequently lodged with the WA Herbarium and is awaiting identification.

The only obvious weed observed on the island was buffel grass (*Cenchrus ciliaris*), which has been previously reported there.

MARINE RUBBISH

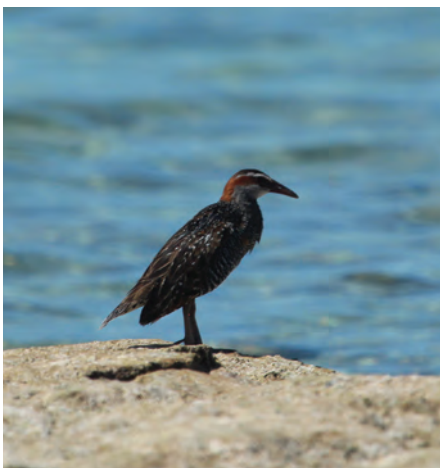
Another objective of the survey was to conduct a beach clean-up. Marine debris that had washed up on the sand was collected, sorted, bagged and removed from the island. We spent considerable time recording the items onto a datasheet and categorising each item into one of 55 possible categories with records contributing to the Australian Marine Debris Initiative coordinated by the Tangaroa Blue Foundation – a not-for-profit organisation focused on protecting our oceans. The rubbish we collected was diverse. Of particular note was the large number of plastic drink bottles, fish netting, aluminium cans, shoes (including thongs), and many other plastics and consumables including an old Asian whiskey bottle with a bracelet inside. Overall, some seven kilograms of rubbish was removed over the one-and-half days we were on the island.

SEABIRDS

Browse Island was the most famous of the northern Australian islands for guano mining, suggesting it was once the 'jewel in the crown' of seabird islands off the Kimberley coast, and leading to it being described in 1876 as having "… been appropriated by millions of the feathered







Left Seven kilograms of rubbish was collected at the island.
Photo – Bruce Greatwich/DBCA

Below left Crested terns occur on Browse Island.
Photo – Rob Drummond/Lochman Transparencies

Below right Buff-banded rail were observed during the survey.
Photo – Bruce Greatwich/DBCA

tribe, whose eggs lie scattered thickly over every available part of the islet".

Unfortunately, it appears a combination of historical impacts including guano mining and the introduction of feral cats and house mice, is likely to have resulted in the abandonment of Browse Island as a seabird breeding colony. Dominic Serventy's visit to the island in 1949 proved a great disappointment as "there were no seabirds of any kind present, nor any indication that the island had been used as a nesting or roosting place for years".

Consistent with more recent visits to the island by ornithologists, our survey reported comparatively little bird life. The most conspicuous birds were pacific reef herons (*Egretta sacra*), and greater crested terns (*Thalasseus bergii*). The island-hopping buff-banded rail (*Gallirallus philippensis*) was also flushed on numerous occasions as we went about setting mouse traps.

However, it's not all doom and gloom. We recorded the first modern record of significant numbers of brown boobies (*Sula leucogaster*) using the island, with up to 200 individuals observed flying in just before dusk to roost on the beach, suggesting birds in the area are again utilising the island. Furthermore, we encountered a small number (six pairs) of bridled terns (*Onychoprion anaethetus*) exhibiting breeding behaviour. Investigating one location where these birds were frequently seen revealed the presence of a single chick – the first documented breeding of this species on the island in modern times.

Off the Kimberley's north-west coast, significant seabird breeding colonies exist at Lacepede Islands Nature Reserve, Adele Island Nature Reserve and Ashmore Reef. Browse Island is positioned between Ashmore Reef and Adele Island and therefore forms a link between these islands. Perhaps with the elimination of modern-day threats such as weeds and house mice, and encouragement of breeding through bird decoys and other methods, we hope the skies of Browse Island may once again be filled with the raucous chatter and breathtaking spectacle of thousands of seabirds.

MARINE TURTLES

The green turtles (*Chelonia mydas*) that nest at Browse Island, together with those that nest 170 kilometres away at Scott Reef, form a discrete genetic stock within the world's green marine turtle populations. This highlights the importance of these islands to this nesting region and demonstrates a lack of movement between neighbouring rookeries on other islands or mainland Australia. The remoteness of Browse Island, and the challenges of visiting there, means that managing the nature reserve and policing activities there are difficult. For example, there are reports over the past 20 years of poaching of adult green turtles that have been found to have been killed on the beach before laying, and their eggs removed.

Our survey of the beach area above the high-water mark confirmed that green turtles still nest on Browse Island, although their numbers remain unknown. Our early morning walks revealed evidence of hatchling tracks in the sand, which suggests some level of successful hatching occurs. One adult female was sighted returning to the sea following nesting. Thankfully, no evidence of illegal harvests were found at this time, however, peak nesting season occurs over





Above left A dual-language sign was installed at the island to communicate with Indonesian fishermen.
Photo – Bruce Greatwich/DBCA

Above The survey will help inform management actions to protect and conserve Browse Island.

Below All equipment had to be transferred on and off Browse Island using a small vessel.
Photos – Dorian Moro/DBCA

the summer period, so we did not expect numbers to be high during our survey.

SIGN INSTALLATION

One final job of our trip was to install a new dual-language (English and Indonesian) sign on the northern part of the island. We hope that by providing information about the importance of this island for the conservation of seabird and nesting turtle populations we can inform those aboard fishing and tourism vessels about the biosecurity risks associated with landing on the island, and we can establish what is hopefully a new chapter in the history of this remote reserve.

LOOKING FORWARD

The (potentially thousands) of south-east Asian house mice on this island present a biosecurity risk to Australia, and most likely threaten the viability of seabird eggs and possibly turtle eggs. Rodents are known to prey on seabird eggs on islands elsewhere around Australia, and globally. The high density of house mice we observed from a single night's trapping on Browse Island, coupled with the lack of nesting seabirds, is concerning. While it has been recognised that Browse Island was historically a significant seabird site, contemporary evidence indicates this is no longer the case.

Given what we know about the high abundance of nesting seabird colonies on nearby Ashmore Reef, Adele Island and Lacepede Islands, it is plausible that high densities of house mice may be one of the key reasons for the lack of seabirds using the island today. Moreover, we know that seabirds recolonise and promptly nest on islands where rodents have been eradicated. So future island management may need to factor in the importance of this island to seabirds – and nesting turtles – and to consider the eradication of house mice to promote seabird recolonisation of this remote, but important land mass.



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The authors thank George Swann for his assistance and valuable knowledge of seabirds in the area.


First Aid



Going off-road

showcasing Western Australia with Google

A partnership between DBCA and Google is showcasing key Western Australian tourist trails and natural attractions to the world like never before.

by Rod Annear

There is no question that the digital revolution has created change in nearly every aspect of our lives. And, while this era of constant connection and access to information can be overwhelming and challenging at times, there's more to the internet than cat videos and narcissistic selfie-takers; it provides an undeniably invaluable resource that can create improvements for almost every industry, including tourism, recreation and land management.

A PICTURE PAINTS A THOUSAND WORDS

Launched in 2007 using the Street View Car, Google Street View – a function of Google maps – is one such example. Google Street View enables people to virtually 'travel' around the world for a detailed street-level perspective. Google Street View provides 360-degree horizontal and 290-degree vertical panoramic views of wherever Google and other contributors have captured images, which is an ever-growing number of streets, tracks and trails around the world, and an increasing number of other significant sites, such as inside buildings and other landmarks as well as at festivals, sporting and other events.

In February 2018, DBCA joined forces with Google to embark on the ambitious task of capturing images of more than 200 trails across WA, covering 3000 kilometres, and taking in some of the State's most stunning and iconic sites, to be made available through Google Street View.

It was recognised that this project presented an opportunity to promote WA's natural attractions and nature-based experiences to a 24-hour global market and share information about the facilities and sites in WA with prospective local, domestic and international travellers. It would also provide a preview of what visitors could expect, including attractions, campgrounds, and road and trail conditions, to help them plan their trip and to aid with navigation once they got there. Recent visitors can also share their experiences, helping to inspire the next generation of tourists. But it's not just people who are planning to come who would benefit from the project – it also provides an opportunity for members of the community who may never get to actually experience our landscapes, parks and trails, due to disability or other access limitations, with the opportunity to 'virtually visit' WA's stunning and spectacular destinations. And, by building awareness of WA's natural areas, this project promotes environmental values and fosters support for biodiversity conservation across the broader population.

The Google Street View project also provides private businesses that partner with DBCA and rely on attractions and facilities in national parks and other reserves with the option of linking to the images on Google Street View, providing a connection to and more information about the real thing.

The collection of Street View imagery is also collecting data that can be used in other Google products, such as Google Story Spheres, a tool that lets you position audio within 360-degree images to create an interactive experience. Virtual reality (VR) apps also leverage Google Street View to provide users with a more immersive experience.

In addition, having a pictorial record of WA's natural assets also provides information about the condition, access, infrastructure and maintenance needs across the DBCA-managed estate, which can be used for auditing and works planning.

I'VE BEEN EVERYWHERE, MAN

So, in 2018, more than 15 DBCA staff and volunteers embarked on this epic project. They were trained in how to use the Google Street View Trekker – a wearable backpack with a camera system on top, which weighs about 18 kilograms and has been loaned to the State Government by Google. By wearing the backpack, 'trekkers' are able to capture images of areas the normal Street View Car cannot access, manoeuvre through tight narrow spaces and visit locations only accessible by foot or bike. This approach of capturing images for Google Street View was first used in the rough, rocky terrain of Arizona's Grand Canyon in 2013. Google has also expanded its camera fleet to include Street View Trollies, Street View Snow Mobiles and even Street View Trikes. Google is now working with partners to collect underwater Street View imagery.

The first pair of WA trekkers started their journey at Cape Peron in Rockingham Lakes Regional Park on 23 February 2018 (see also 'Parks for people: Rockingham Lakes Regional Park' on page 8). For the next three months, the team of trekkers travelled around Perth and through the south-west, capturing images of iconic sites such as Bluff Knoll in Stirling Range National Park, the Granite Skywalk at Porongurup National Park and The Gap and Natural Bridge at Torndirrup National Park. They also journeyed through many regional and national parks. In June, they



Previous page
Main Hakea Trail, Fitzgerald National Park.
Photo – Mark Pybus

Above Cathedral Gorge, Purnululu National Park.
Photo – DBCA

Opposite page
1) DBCA marine vessels were used to collect Google Street View images.
Photo – DBCA
2) Mt Bruce, Karijini National Park
Photo – Mark Pybus
3) Nature's window, Kalbarri National Park.
4) Yanchep National Park.
5) Rottnest Island.
Photos – DBCA

followed the sun and ventured north to places like Purnululu, Windjana Gorge, Geikie Gorge, Karijini and Kalbarri national parks, as well as Yawuru country in Broome. In spring and early summer, they embarked on capturing the long trails in the State's South West and Midwest regions.

While there is some irony, perhaps, in being able to 'virtually visit' some of the world's most remote destinations, which people travel to with the intention of 'unplugging' from technology, these applications present a raft of new opportunities to market WA to the world, showcase our spectacular natural landscapes to foster support for their protection and conservation, and share them with users who may otherwise be unable to visit.

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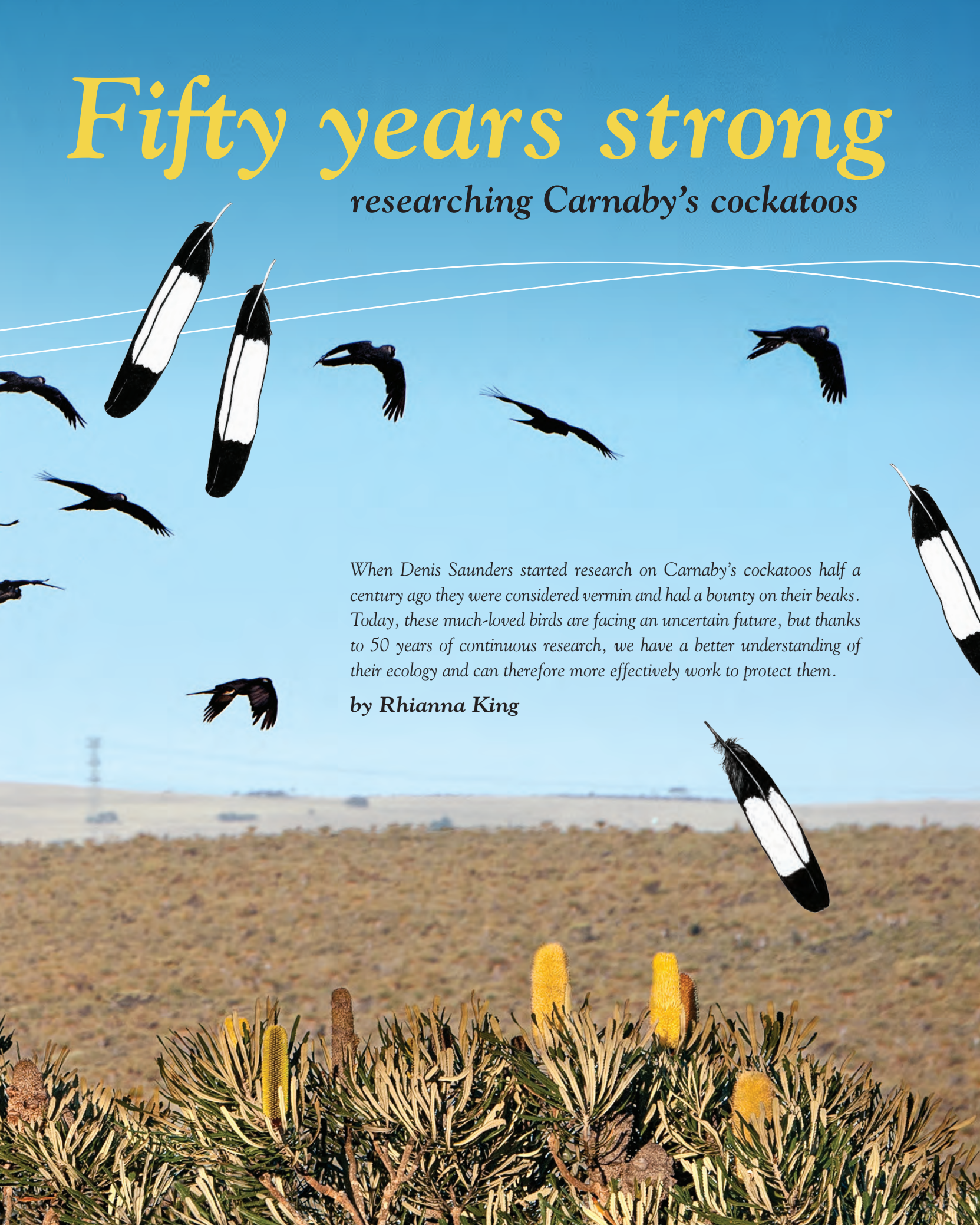
Google Street View can be accessed at www.google.com/maps





Fifty years strong

researching Carnaby's cockatoos



When Denis Saunders started research on Carnaby's cockatoos half a century ago they were considered vermin and had a bounty on their beaks. Today, these much-loved birds are facing an uncertain future, but thanks to 50 years of continuous research, we have a better understanding of their ecology and can therefore more effectively work to protect them.

by Rhianna King

If you ask Dr Denis Saunders AM how long a Carnaby's cockatoo lives, he'll tell you he doesn't know; he hasn't studied them long enough. This is a remarkable answer from someone who has spent the past 50 years gathering information about one of Western Australia's most iconic and long-lived birds. Denis started this project as a 21-year-old CSIRO research scientist to develop methods to minimise the damage Carnaby's cockatoos caused to commercial apple and pear orchards and pine plantations (see 'People in profile: Dr Denis A Saunders, AM', *LANDSCOPE*, Autumn 2015). Fifty years later, it has become somewhat of a labour of love, and he has no plans to stop studying them any time soon.

COUNTING CARNABY'S

It's hard to know exactly how many Carnaby's cockatoos are around today, compared with when Denis started his research half a century ago, but we do know that their range has been reduced by 50 per cent. In the early 1970s, Denis numbered them at between 12,000 and 60,000. He recalls that he would regularly see flocks of up to 3000 birds flying overhead in South Perth, feeding in pine plantations at Somerville (where Murdoch University is now located) and at Gnangara. By 1987 their numbers had significantly declined, leading to them being listed by the federal and state governments as an endangered species. Today, it is a rarity to see flocks larger than a couple of hundred.

HOW TIMES HAVE CHANGED

Denis marvels at how significantly research and collection techniques have changed in the past 50 years. He somewhat sheepishly describes the commonplace method of yesteryear that was used to collect specimens, known as 'last supper biology' or 'shot-gun ecology'. This method involved shooting and collecting birds of interest in order to make observations about their taxonomy, breeding biology and diet. However, he's quick to point out that most of the specimens he collected in this way are now part of collections at the WA Museum and the Australian National Wildlife Collection in Canberra.

Nowadays, he says, once you've banded a bird, you don't have to handle them again to keep abreast of their movements. But it's been a bit of a journey to get to this point. Denis and his team first started fitting wing tags with a two-letter combination to Carnaby's cockatoos in 1970. In order to monitor these birds he used a telescope, and hoped for a cooperative bird that remained still long enough for him to read the letters. Where possible, birds were also fitted with a numbered leg band. Occasionally it was possible to read the numbers from afar, but more often than not it was necessary to re-capture the bird in order to record the numbers. Today, using a technique developed by former Parks and Wildlife senior wildlife officer Rick Dawson, the birds can be positively identified by using telescopic digital camera lenses to take multiple photographs of the birds' legs to record the band numbers. This can be done quickly, and means all banded females in nest hollows can be identified without any need to handle them after they have been banded as nestlings.

Satellite tracking by Murdoch University researchers is also providing Denis and others with a wealth of information about the movements and lifecycles of Carnaby's cockatoos. The data from the trackers can be downloaded to a mobile device in the field, providing instant, real-time information. Improvements to the trackers over the years also means they're lighter and smaller than they once were, so they are less likely to fall off or attract the attention of predators. And now, of course, DNA technology is able to differentiate individuals using a tiny tissue sample from the quill of a plucked feather.





Learn more about Carnaby's cockatoos

Scan this QR code or visit Parks and Wildlife Service's '*LANDSCOPE*' playlist on YouTube.

Previous page
Main Carnaby's cockatoos fly over Coomallo Creek.
Inset A male Carnaby's cockatoo.
Photos – Sallyanne Cousans

Above left Denis Saunders (on vehicle) and John Ingram (on ladder) studying breeding populations of Carnaby's cockatoos at Manmanning in 1972.

Above View to the ground from the top of a ladder at the entrance of a cockatoo hollow.
Photos – Denis Saunders







"This has led to the fascinating observation that ... Carnaby's cockatoos 'perfect' parenting after they've reached 15 years old."

THE GOOD OL' DAYS

According to Denis, developments in technology do not negate the relevance of the meticulous and long-standing research that has been done over the years to learn more about Carnaby's cockatoos, particularly by members of the community. Denis describes farmers and other landholders as excellent naturalists, given their deeply felt and often long-term connection to the land, and has relied on data they have provided to inform his study. He also credits WA school students with helping to plot the distribution of Carnaby's cockatoos at the start of his research. In 1968, he approached the Gould League through the Department of Education to seek permission to engage schools throughout the south-west as, at the time, almost all the small towns throughout the area had a school. More than 80 per cent of the schools (244 government schools) from Kalbarri to east of Esperance became involved and provided an abundance of data about the habits and distribution of Carnaby's cockatoos. Unfortunately, an attempt to repeat this survey 20 years later could not be done on the same scale, as all of the small one- and two-teacher schools had been closed, with students being bussed to schools in the larger towns. Still determined to collect the data, Denis approached landholders throughout the birds' known range in 1987 and asked them to make and record observations about all species of birds they saw on their properties, including Carnaby's cockatoos. A number of those landholders continue to make observations today and Alison Doley AM, who has recorded her observations for 30 years, was the first landholder to be invited to join the Carnaby's cockatoo recovery team (see 'People in profile: Alison Dooley', *LANDSCOPE*, Autumn 2013). Other landholders have provided valuable information too; it was a conversation with a landholder that led Denis to the significant breeding site at what is now known as Coomallo Creek study area.

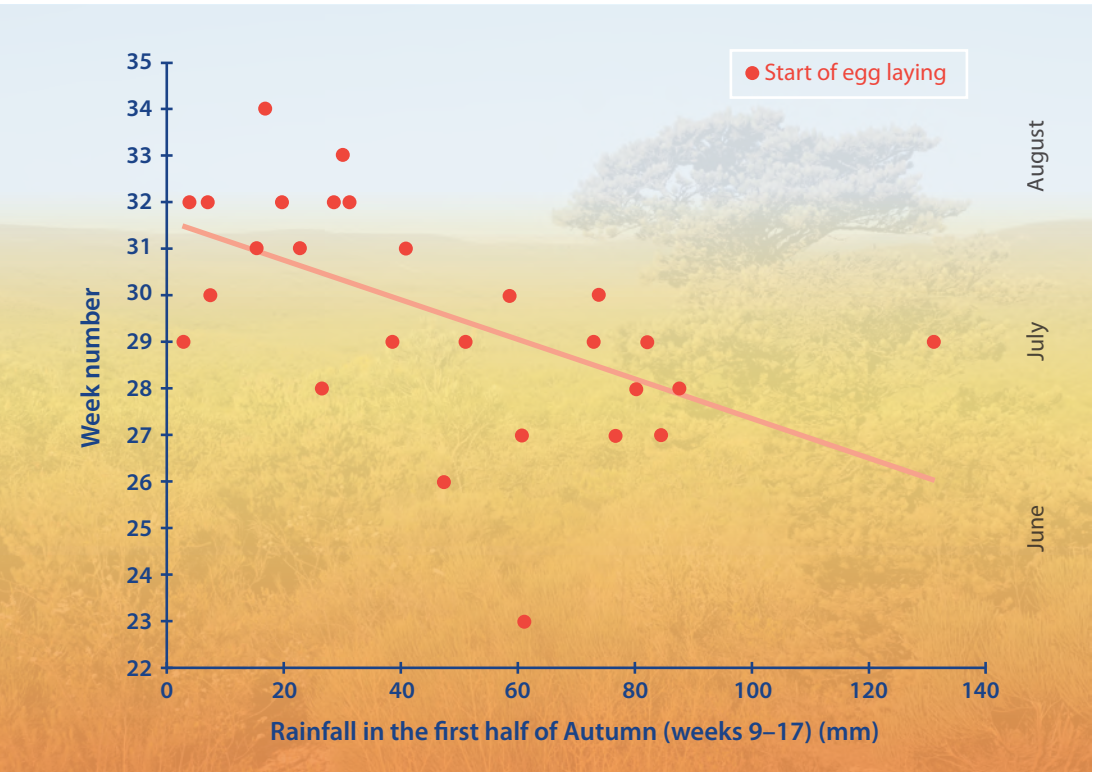
A LONG-TERM RELATIONSHIP

In 1969 and 1970, Denis studied breeding populations of Carnaby's cockatoos at Coomallo Creek, Manmanning, Tarwonga and Moornaming. During this time, he measured the length of the folded left wing of nestlings and recorded their body mass. From these data, Denis demonstrated that the left wing grows proportionately with age, and he was able to develop a formula to determine the age of the nestlings from the length of their folded left wing when their hatching dates were unknown. This has led to the fascinating observation that the size and body mass of a nestling is determined by the age of the parents. Denis has shown that six to 15-year-old parents produce 'fat' nestlings, while zero to six-year-old parents produce skinny ones. When a parent is older than 15 years, the size of their nestlings again reduces, but offspring

Above left Denis's research has revealed fascinating insights into the breeding habits of Carnaby's cockatoos.
Photo – Rick Dawson

Above Peter Mawson, Rick Dawson and Denis Saunders with one of the artificial hollows constructed and installed with help from the Rockingham Rotary Club.
Photo – Matt Swan/DBCA

Inset Carnaby's cockatoos form pairs and mate for life.
Photo – David Bettini



live to fledge nearly 100 per cent of the time (unless an extenuating circumstance befalls them), indicating that Carnaby's cockatoos 'perfect' parenting after they've reached 15 years old.

In 2009, shortly after Denis joined forces with then Department of Environment and Conservation senior wildlife officer Rick Dawson and zoologist Peter Mawson to continue research in the area, Coomallo Creek again became a learning ground. During that same year, a bushfire that was ignited by a harvesting machine destroyed 16 trees with hollows in the study area, including three with nestlings. The following year, birds that were displaced by the fire descended on Coomallo Creek, providing an opportunity to observe whether Carnaby's cockatoo breeding is limited by hollow availability. From 2011 to 2018, 68 artificial hollows were constructed, refined and installed to add to the 96 natural hollows available at the site. These factors have seen the number of breeding pairs increase at Coomallo Creek from 41 breeding pairs in 2009 (down from 88 in 1975) to 127 by January 2017. And three-year-old females have been observed laying eggs, where before 1997 none younger than four had ever been known to attempt to breed. Siblings born an unprecedented 51 days apart were also observed this year.

Another interesting long-term observation that has been made at Coomallo Creek has been the relationship between rainfall and when Carnaby's cockatoos lay their eggs. Between 1969 and 2018, the date that egg-laying started varied from the second week in June to the third week in August, depending on how much rain the area received in the first half of autumn, which affected food availability. This and last year were some of the latest starts to breeding seasons that had been recorded, caused by very dry weather in the first half of autumn. However, 2016 was one of the earliest, after a wet autumn. This observation highlights the potential impact of climate change on the breeding habits of Carnaby's cockatoos.

So, while Denis's commitment to studying Carnaby's cockatoos seems unwavering, we are, at least for now, left wondering exactly how long these iconic birds live for in the wild. But Denis knows of one female who was at least 30 years old. The data collected through Denis's observations demonstrate the value of long-term research, and highlights the vulnerability of all animals, regardless of how abundant they may seem today.

Carnaby's cockatoos

(*Calyptorhynchus latirostris*) can often be heard before they are seen as they fly overhead issuing their undulating wailing cries, which sounds like "whee-la".

Their natural diet consists of seeds of banksia and other kwongan species, but in the past 60 years this has changed to incorporate seed from pine trees planted for timber production.

Their bill, which they use to bite and tear open seed, is short and rounded and is different to that of the Baudin's cockatoo, which has a longer slender bill. They have long tails with a broad white band.

Carnaby's cockatoos pair for life and nest in large hollows in wandoo and salmon gum woodlands in the Wheatbelt. They generally lay two eggs, but usually only one nestling survives. The nestling fledges at about 10 or 11 weeks, but is dependent on its parents until the start of the next breeding season.



Above left Relationship between rainfall and when Carnaby's cockatoos lay their eggs at Coomallo Creek (1969–2016).
Background Carnaby's habitat at Coomallo.

Above Carnaby's cockatoo.
Photos – Sallyanne Cousans

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The Wildcare Helpline provides advice to the public who find sick or injured native wildlife and can be contacted on (08) 9474 9055. Or download the Wildcare Helpline app from iTunes and Google Play.



Wheatbelt *Bothriembryon*



Western Australia's Wheatbelt region is a vast area, well known for its geological structures and diverse floral assemblages. This year's winter rains led to strong spring floral growth, which is expected to continue into summer. However, the Wheatbelt's terrestrial diversity has been impacted by long-term agriculture. While nature reserves are caches of native and endemic terrestrial biota, the area surrounding the reserve islands is usually highly modified. This presents a challenge for animals that evolved in a markedly different habitat – with larger trees and denser understorey – that would have existed before mass agriculture. Native land snails are one such group of invertebrates that have been adversely affected.

Bothriembryon is a genus of large-bodied (up to five centimetres) native terrestrial snails found in the southern half of mainland Australia. The majority of the 37 currently recognised species are limited to the wetter areas of south-west WA. Members of the genus are commonly found near the coast but can also be found inland among woodlands or on rocky areas. They also persist deep into the Wheatbelt, where they inhabit numerous reserves. Five described species are currently known from the Wheatbelt region (*Bothriembryon bulla, B. kendricki, B. perobesus, B. praecelsus* and *B. sedgwicki*). The latter three species are now largely relegated to a patchwork of nature reserves, some of which have also been grazed or were disturbed prior to being gazetted.

A team of scientists at the WA Museum, in concert with international partners, has been working to understand the relationship among species of *Bothriembryon* using a molecular phylogenetic approach. This work is necessary to help to identify the true number of distinct lineages in the genus. To construct this phylogeny we have relied on existing collections in the WA Museum. However, not all species had appropriate vouchers for this work, so new fieldwork was necessary to recollect key species.

Unsurprisingly, some of the species that were the most difficult to find, were rare and endangered. Of those species known to occur in the Wheatbelt, two species (*B. perobesus* and *B. praecelsus*) are of special conservation significance.

During our searches in the Wheatbelt over the past five years, we were fortunate to locate a number of juvenile specimens that could be *B. praecelsus*. This species is listed as presumed extinct and has never been observed live, so it could be an incredibly significant find. Unfortunately, adults are required for conclusive identification, so we are still on the lookout for mature specimens. During the course of our sampling, we visited some new sites across the Wheatbelt. One of these sites was among the giant granite outcrops south of Kellerberrin. Although we did not find *B. praecelsus* there, it seems that we may have discovered something new. While these early results are promising, all of these discoveries require careful study, proper comparisons and a lot of consideration before a new species can be described or a conservation listing updated. However, time may be running out, especially given that on our most recent trip to Kellerberrin and surrounds we came up empty handed – even after good rains! This complete absence of *Bothriembryon*, with no sign of even long-dead shells, is concerning.

Above *Granite outcrop snail from a reserve in the Wheatbelt.*
Photo – Lisa Kirkendale

So while the Wheatbelt region continues to display spectacular wildflowers each year, it also comprises vast areas of highly modified landscape and this presents challenges when we're trying to protect our native biota. But we can all play a role, and we ask everyone to keep a look out for *Bothriembryon* land snails, dead (shells) or alive (crawling)! You never know whether your find might help with a much-needed identification or even provide a species new to science.

For more information or to report possible sightings, please email lisa.kirkendale@museum.wa.gov.au or corey.whisson@museum.wa.gov.au

Rottnest Island TUNNEL TOUR

A pleasant train ride from Rottnest Island settlement takes visitors to Oliver Hill, where remnants of Australia's military history provide a glimpse into the past, when Rottnest Island was not the holiday paradise we know today, but an integral component of a massive war effort. Volunteer tour guides are on hand to take visitors through the tunnels that service the island's 9.2-inch gun, which was installed as Western Australia's first line of defence, and provide insight into the island of yesteryear.

by Rhianna King

Located just 19 kilometres off the coast of Fremantle, Rottnest Island is one of Western Australia's favourite holiday destinations. Its stunning turquoise water plays host to a raft of water sports, its cycle and walk trails provide opportunities for visitors to fill their days exploring the island's natural values, and the laid-back atmosphere makes it the perfect holiday destination for the hundreds of thousands of visitors who travel there each year. But, rewind some 80 years, and Rottnest was an integral part of the Allies' defence against enemy advances during WWII.







Previous page
Main Visitors to Rottnest Island can tour the tunnels at Oliver Hill.
Photo – Tourism WA
Inset far left A wash-down station was used to avoid contamination from explosive materials.
Photo – DBCA
Inset left The tunnels were constructed in the 1930s and then covered over with sand and plants.
Photo – Australian War Memorial

Above The 9.2-inch gun was able to rotate 360 degrees.
Photo – Marie Lochman

A JOURNEY BACK IN TIME

One way to journey up to Oliver Hill, which is located about four kilometres south-west of the settlement, is to catch the *Captain Hussey* train, named after the late Brigadier Frank Hussey, who managed the installation of the gun. The charming open-air train leaves from the settlement three times a day and bumps and rattles along the railway track that was built in 1935 to transport equipment from the Army Jetty to the battery at Oliver Hill. En route, the train passes the island's solar panel farm, which contributes 15 per cent of the island's power, and the airport, and travels alongside the lakes, which are a haven for waterbirds. It then travels through stands of tea trees that have limbs growing low and parallel to the ground – evidence of the harsh coastal environment. Then the train passes the Kingston Barracks, which provides a reminder of the island's military connection.

The barracks were built between 1936 and 1938 to accommodate 75 army and support personnel. In 1942 the number of military personnel stationed on the island peaked at 2500. They were catered to at Kingston Barracks and other camps around the island. Nowadays, the barracks are a popular accommodation option for school, family and social groups.

Once at Oliver Hill, those who are booked on one of the 60-minute tours will be met by one of the island's 340 Rottnest Island Volunteer Guides. I joined one of these tours on a beautiful October day, and was led by volunteer Christine Pickard, whose passion for the island and its history was infectious.

Christine began our tour by explaining that planning for the Rottnest gun and its associated infrastructure began in the 1930s, when tensions were building in Europe. Rottnest Island formed an important component of the Indian Ocean defence system, which was based out of Fremantle and where 167 United Kingdom, United States and Dutch submarines were based. A 9.2-inch gun that was built in the United Kingdom in 1901 was brought to the island in 1937, after spending some time in Hong Kong, and assembled at Rottnest Island by the Royal Australian Engineers Army. The gun, which had a barrel weight and length of 28 tonnes and 11 metres respectively, could rotate 360 degrees and fire shells up to 29 kilometres – roughly the distance from Oliver Hill to the Narrows Bridge – at a speed of 823 metres per second.

We walked around the back of the gun where Christine explained that the 'hills' we were standing among had actually been formed by civilians who



Follow the journey to Oliver Hill

Scan this QR code or visit Parks and Wildlife Service's '*LANDSCOPE*' playlist on YouTube.

Left The *Captain Hussey* train journeys to Oliver Hill.
Photo – Peter Nicholas/DBCA

Below Volunteer tour guides are on hand to guide visitors through the attraction.
Photo – Tourism WA

worked there, armed only with shovels and spades. We also heard that, rather than 'digging' the tunnels, the personnel constructed them out of reinforced cement and then covered them over with sand and plants.

Then we started down a long flight of shallow, small steps, that were cut into the side of the hill and were designed to enable men to manoeuvre the 172-kilogram shells to the gun if the mechanics located inside the tunnels designed for transporting them failed – testament to the intricate planning that went into the construction of the site.

GOING UNDERGROUND

Once we crossed the threshold and entered the tunnel we passed the casualty clearing station – an alcove with a stretcher hanging on the wall and a reminder of the human cost of war. From there we followed the tunnel, guided by lights behind glass cases that were similar to those that would have showed the way to the soldiers who worked there. The smooth cold, damp walls are unadorned and have the kind of flaking and blemishes that you'd expect from being more than 80 years old. I wonder what they would say if they could talk.

We then entered the magazine, which includes the shell store and cordite room. A block and chain gantry was used to move the 172-kilogram shells and cordite cartridges from the storage area to the hoist for lifting to the gun pit above and eventually to the gun platform. There are tell-tale signs that planning for potential disaster was at the fore of the minds of those who designed this space – a deeply corrugated steel roof was installed to minimise explosions by creating an implosion; a rubberised floor was there to minimise the risk of sparks igniting; and double glazing was installed around light fittings. And a changing station is located outside the room, where three army-issued hats hang to show where personnel would change from their clothes that may have had metal on them. A photo on the wall shows two men operating the hoist, who are shirtless save for a protective pad strapped to their chests. This points to the heat they must have endured and causes one to question how protected they'd actually be against an explosion.

From there we journeyed to the pump chamber, where power conversion occurred – from electrical energy to pneumatic (compressed air) and hydraulic (oil under pressure) energies. These energies powered the functions of the gun above. Then we moved to the engine room where a sound simulation experience demonstrates the insufferable conditions in which the men stationed there must have worked. In 1958 the original diesel engines were relocated to Corrigin and Pingelly to provide electricity then eventually sold for scrap metal.

From here we ventured back outside where we went into the gun pit, where the enormous base had the ability to rotate the gun 360 degrees. An ascent up onto the gun platform, which is situated 39 metres above sea level, took us to where the personnel who received information from the nearby battery observation post would have orientated the gun to match the coordinates they were given.

The 9.2-inch Rottnest Island gun was never fired in anger, but its construction was a significant investment – more than $8.9 million in today's terms. The island's wartime association did not start in the 1930s – it was used as a prisoner of war camp during WWI when it housed 989 Austrian and German prisoners. Thankfully in the more peaceful times we enjoy today these structures can be visited as a tourist attraction and hopefully also serve as a reminder of how lucky we are to enjoy freedom.

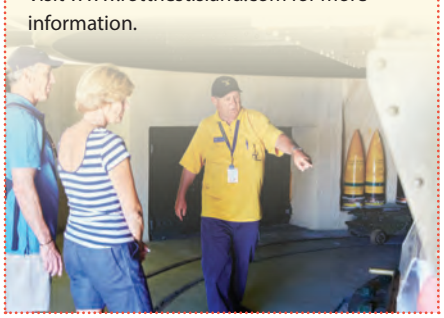
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Where is it: Rottnest Island is located 19 kilometres from Fremantle.

Tunnel and train tours: One-hour tunnel tours operate daily at 10am, 11am, 12 noon, 1pm and 2pm. Tickets are available at Oliver Hill and the Rottnest Island Visitor Centre.

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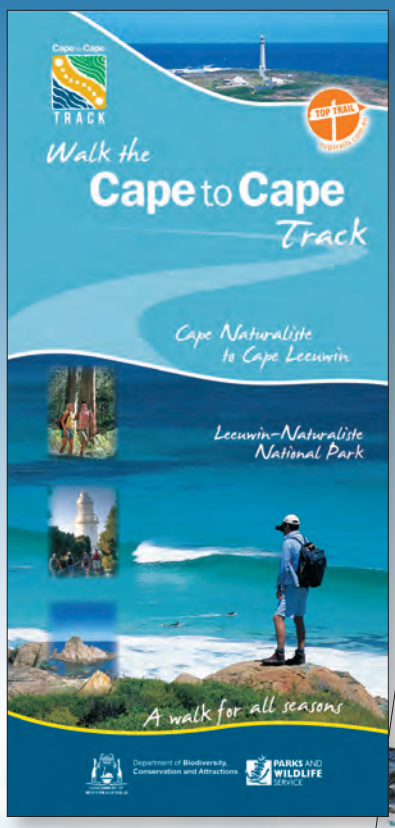
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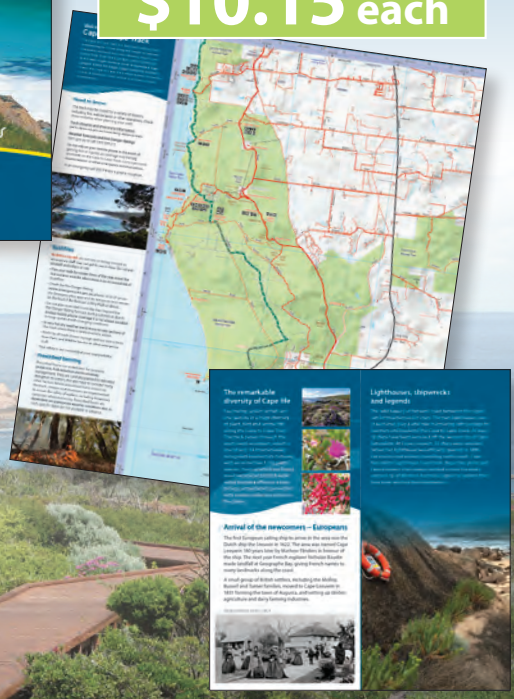


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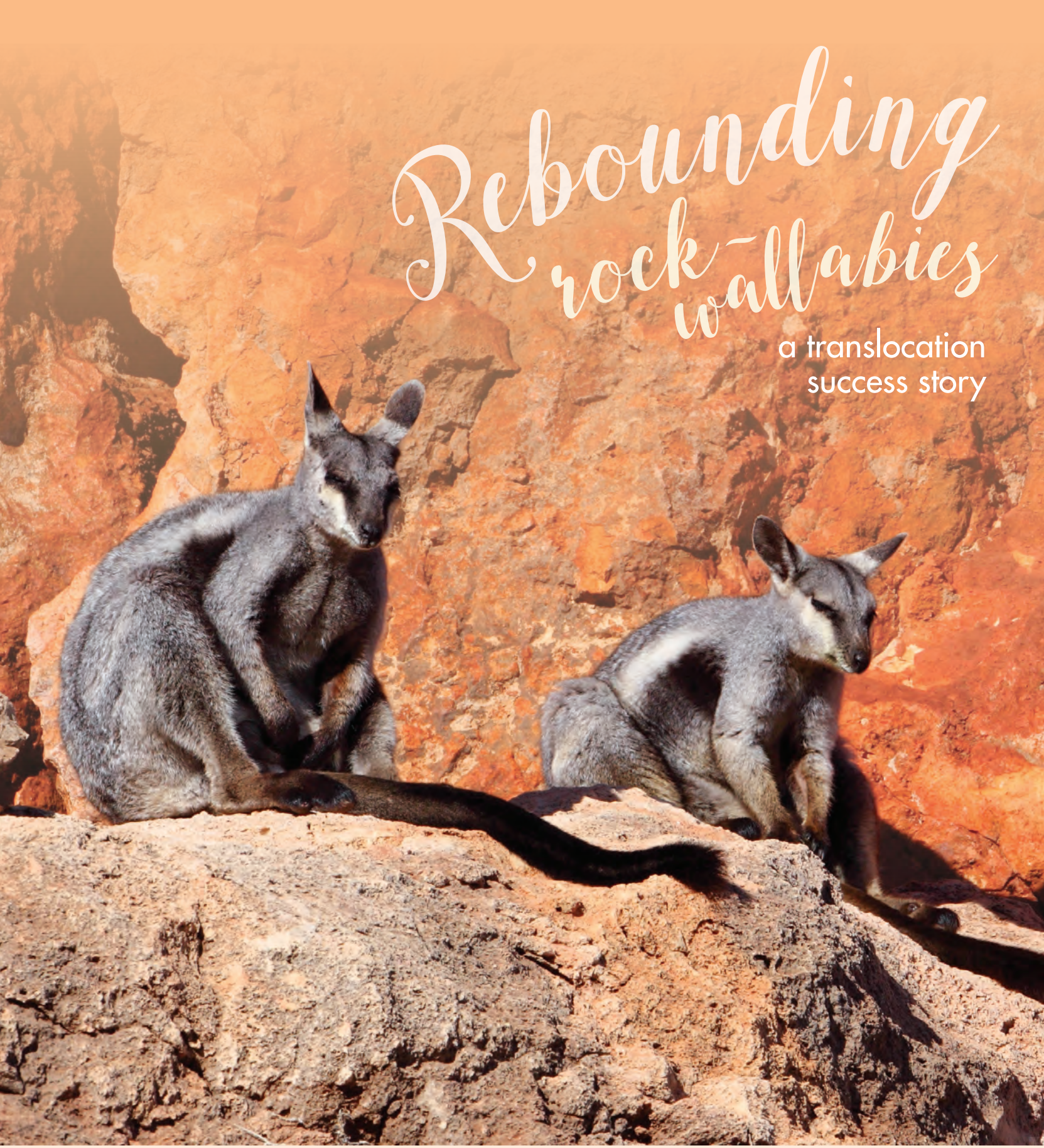
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Rebounding rock-wallabies

a translocation success story



Translocating plants and animals for conservation relies on well-considered planning, based on an understanding of their biology and threats to survival, as well as the skills and expertise of a team of dedicated people. When successful, translocations can provide hope for species with an otherwise uncertain future, as appears to be the case for black-flanked rock-wallabies in Kalbarri National Park.

by David Pearson, Mike Paxman, Anthony Desmond, Jazmin Lindley and Juanita Renwick

Translocation of threatened animals from one place to another to aid their conservation is a widely used technique around the world. It seeks to reduce the risk of extinction or the loss of genetic diversity by establishing new populations. In Western Australia, translocations of animals have been undertaken for more than 30 years.

It may seem a simple enough process: catch animals at one site where they are abundant and then release them at another. Job done. Right? Well, it's not that simple. Sometimes translocations are carried out at short notice because a population is under immediate threat. However, in most cases translocations are the culmination of years of research, careful planning and a coordinated team effort. Each translocation relies on the input of skills and knowledge from many people, who work together to identify what species could benefit from being translocated, where they should be moved and how the success of the translocation will be measured.

The translocation of black-flanked rock-wallabies (*Petrogale lateralis lateralis*) into Kalbarri National Park over a three-year period from 2016 to 2018 is an excellent example of how translocations are organised and the expertise and teamwork required to carry them out. But, despite extensive planning, even this translocation had some unexpected twists.



Previous page
Main Western Australia has five species of rock-wallabies.
Photo – Alice McGlashan/Sallyanne Photography

Above Black-flanked rock-wallabies were known to occur in the gorges of Kalbarri National Park.
Photo – David Pearson/DBCA



ROCK-WALLABIES UNDER DURESS

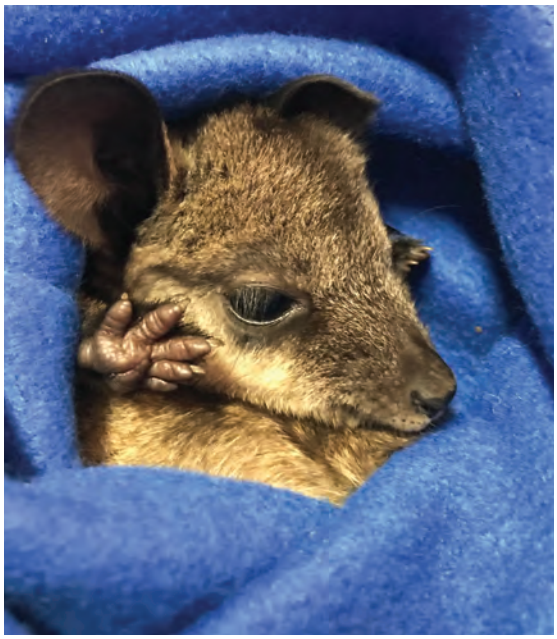
While most species of rock-wallabies are not considered threatened or endangered, there are significant concerns for a few species whose populations are declining. Some are threatened by introduced predators, such as the fox and feral cat, or more subtly by habitat changes due to frequent bushfires or weed invasion.

WA has five species of rock-wallabies, but the most widespread, the black-flanked rock-wallaby, is further divided into two subspecies and two distinct genetic races. This genetic variation has come about because of the isolation of different populations over many thousands of years, leading to the development of distinctive localised populations.

The subspecies *Petrogale lateralis lateralis* has the widest distribution of all, extending from one island off the southern WA coast all the way to Cape Range near Exmouth, and Barrow Island off the Pilbara coast. However, across this vast range, the rock outcrops actually occupied by these rock-wallabies are few and far between. There is a reintroduced population in Cape Le Grand National Park and six small populations that occur in the Wheatbelt, near Kellerberrin. At the time of European settlement there were many more individuals and populations. They were recorded as being very numerous in the Avon Valley, where now only small numbers cling to a precarious existence in Avon Valley National Park and Paruna Sanctuary. Heading north from Perth, scattered populations have been recorded in Kalbarri and Cape Range national parks, and in some remote desert ranges along the eastern edge of the Pilbara. A small population occurs on Barrow Island, and they were driven to extinction by foxes on Depuch Island, near Whim Creek.

HOW ARE THREATENED SPECIES IDENTIFIED?

The federal and state governments each have a listing process for native species that are thought to be in a position where their continued survival is 'threatened' if existing or future conditions prevail. If species are included on these lists then actions to improve their 'conservation status' are given priority where and when resources are available. For some species, recovery plans are prepared, which summarise threats and identify actions to improve their status. Interim recovery plans are prepared in WA where rapid response is required or there is insufficient information to prepare a full recovery plan. WA currently has more than 249 threatened fauna species, including 41 mammal species, so the task to improve the situation for all of these species is a challenge.



Above Ensuring future generations of rock-wallabies have good genetic diversity will help them avoid extinction.
Photo – Jazmin Lindley/DBCA

Right A black-flanked rock-wallaby spotted in Nangeen Hill Nature Reserve.
Photo – Georgina Anderson



Hear more about the rock-wallaby translocation

Scan this QR code or visit Parks and Wildlife Service's '*LANDSCOPE*' playlist on YouTube.

Determining what species go on the threatened species list is based on International Union for Conservation of Nature (IUCN) criteria and is reliant on the species meeting a number or combination of conditions. These include the size of the population, its fragmentation and recent population trends. Typically, a threatened species committee reviews evidence for listing or changes in listing and receives nominations for species to be included on the list.

PREPARATION OF A RECOVERY PLAN

A 10-year recovery plan for rock-wallabies in WA was prepared in 2013 and identified a number of recovery actions. For the black-flanked rock-wallaby, one of the most significant actions to improve its conservation outlook was to carry out translocations to increase the overall size and number of the populations. Why? Because as populations shrink or become fragmented, a species becomes more vulnerable to threats such as predation and environmental catastrophes, and they typically lose genetic diversity, making them at greater risk of extinction. The loss of genetic diversity means a species will be less able to cope and adapt to environmental changes in the future. And so it was for these rock-wallabies.

Genetic work by Dr Mark Eldridge at the Australian Museum used little pieces of ear tissue collected from rock-wallabies captured during regular trapping for monitoring or research. This study indicated that during the past 30 years, the Wheatbelt population had been losing unique genetic material because numbers of rock-wallabies had fluctuated widely and some colonies had declined to just a few individuals. The small size of the outcrops in this area, droughts and challenges associated with the control of foxes and feral cats that infiltrate from surrounding farmland, made the establishment of new populations of rock-wallabies a priority for action. Translocations to large areas of former habitat would serve to increase the number of individual rock-wallabies and to preserve the current genetic diversity.

ASSESSING TRANSLOCATION OPTIONS

The process DBCA uses to consider proposed translocations ensures that each one is well researched and planned. A translocation plan is prepared, summarising the known biology of the species, threats to its conservation, how these threats will be managed, the source population and where animals will be released. Monitoring the source and translocated populations is vital so we can understand why translocations are successful or, if they fail, what needs to be modified before any future translocations are carried out.

Then, experts are consulted and available literature is reviewed. In the case of rock-wallabies, members of the recovery team contributed valuable insights and advice that helped in the preparation of the translocation plan. Once the draft plan is complete, it is









Above DBCA staff carried traps into the gorges.
Photo – David Pearson/DBCA

Top right Releasing a rock-wallaby at Nangeen Nature Reserve.
Photo – Georgina Anderson

Above centre Rock-wallaby droppings can be readily identified from those of the Euro which occur in the same rocky habitat.
Photo – David Pearson/DBCA

Above right DBCA staff fit a radio-collar onto a rock-wallaby before it is released.
Photo – Anthony Desmond/DBCA

subject to an internal DBCA check and may be provided to external reviewers for independent advice. Once any concerns and comments are addressed and any required changes made, the translocation plan is reviewed and then endorsed by senior management. Then the on-ground work begins.

LOCATION, LOCATION, LOCATION

For many threatened species there are few populations, so there is little or no choice as to where founders for a new population can be obtained. Black-flanked rock-wallabies occur in widely separated areas and there are genetic differences between populations. The Wheatbelt population occurs on six outcrops surrounded by agricultural land and is under particular threat because of the small area of habitat and continuing invasion by foxes and feral cats, held back in part by regular DBCA *Western Shield* baiting. In addition, there is a lack of alternative habitat for dispersal when the Wheatbelt population is growing during good seasons. In the past, too many wallabies in dry times has resulted in over-grazing of their habitat and the rise of unpalatable weeds. So the source of rock-wallabies for the translocation was clear.

But where should they be translocated? A large area of suitable habitat was necessary, where threats to the species could be controlled. Kalbarri National Park proved ideal; rock-wallabies once occupied the gorge and were last seen there in about 1985. The Murchison River, which snakes through the park for about 80 kilometres, and its side gorges are fringed by vast areas of rocky habitat. The area receives winter rains, similar to the Wheatbelt. And regular aerial baiting to control foxes and recently feral cats is undertaken, and feral goat control has been in place since 2006, significantly reducing this once-abundant pest. Additional funds were made available from the Australian Government's National Landcare Programme to undertake wider feral cat control using DBCA's *Eradicat* bait and to monitor its effectiveness.





Above Black-flanked rock-wallabies were carefully transported to Kalbarri National Park ahead of their release.
Photo – Jazmin Lindley/DBCA

Above right *Bush Ranger* cadets helped carry the rock-wallabies into the gorges.
Photo – Anthony Desmond/DBCA

SURPRISE!

As we were putting the finishing touches on the translocation plan, a rock climber in Kalbarri National Park snapped a photo of some wallabies near a popular but remote climbing site and sent them to senior park ranger Mike Paxman. He immediately recognised the wallabies as a pair of rock-wallabies (see also 'Surprise! Rock-wallabies found in Kalbarri National Park', *LANDSCOPE*, Autumn 2016).

This prompted a rethink of the translocation plan. Searches on foot by DBCA and World Wildlife Fund (WWF) staff and volunteers tried to establish if other rock-wallabies were still in the park. Large areas of habitat were surveyed to obtain sightings or to find the distinctively shaped rock-wallaby droppings. In conjunction with this work, traps were carried into the site where the 'Kalbarri pair' resided, with the intention of capturing them to get genetic samples so their relationship to other populations could be determined.

Unfortunately, the Kalbarri pair did not enter our traps, despite our best attempts to lure them using every bait we could think of, including 'Pink Lady' apples, a known favourite of rock-wallabies in other areas. So, we resorted to the next best thing – watching the wallabies closely and then racing out to collect any newly deposited droppings. Advances in genetic techniques now make it possible to obtain sufficient genetic material from fresh droppings to identify genetic profiles. While normally sending parcels of poo through the mail would be considered unsavoury, we sent the samples to Dr Eldridge at the Australian Museum who gladly accepted them and determined that the Kalbarri animals were genetically distinctive from other populations. His results revealed that their closest affinities were to the Calvert Range rock-wallabies (about 900 kilometres away in the Little Sandy Desert, east of Newman), then those in Cape Range National Park and finally to the Wheatbelt animals.

> "We were concerned that if anything happened to these precious animals the unique Kalbarri genes would be lost for good."

WHAT NEXT?

The discovery of the 'Kalbarri pair' and a failure to find any further individuals, led to a modification in the translocation plan. We were concerned that if anything happened to these precious animals the unique Kalbarri genes would be lost for good. So it became a priority for us to expand this population and plans were made to translocate 20 rock-wallabies in May 2016 to establish a new population of mixed Wheatbelt (from two of the large outcrops) to ensure the greatest possible mix of DNA, with the intention to include some Cape Range animals later to further improve the genetic diversity.

In addition to the translocation, we undertook a 'supplementation', where three Wheatbelt females were released near the Kalbarri pair so the male could breed with them and perpetuate the unique Kalbarri genes.

A second translocation – this time of 25 rock-wallabies – occurred in May 2017, and then, in May 2018, 20 Wheatbelt rock-wallabies and five from Cape Range National Park were released in the park. Teams of DBCA and WWF staff and volunteers worked through the night before the translocations to check the traps set up to collect the animals, so that by early morning the rock-wallabies were ready to be flown to their new home. Each wallaby was placed in a black cloth bag, put in a 'pet-pack' and then carefully loaded into the plane. Once in Kalbarri, each rock-wallaby was fitted with a radio-collar so their fate could be monitored.





Left A park visitor snapped a black-flanked rock-wallaby near Hawkshead Lookout in Kalbarri National Park.
Photo – Larry O'Brien

Above A brush-tailed possum, a species not known to still exist in Kalbarri National Park, was snapped by a remote-sensing camera.
Photo – DBCA

Each radio-collar transmits on a different frequency and is fitted with a 'mortality' feature, which indicates when there has been no movement for several hours. So, if a rock-wallaby dies or the collar falls off, park rangers can recover it and determine the cause of death. In the late afternoon, the rock-wallabies were gently carried into their new home by an enthusiastic team, which included DBCA and WWF staff and *Bush Ranger* cadets from Kalbarri District High School.

KEEPING AN EYE ON THE WALLABIES

Monitoring translocations is very important. Surveying is carried out at the source site to ensure that the population is not negatively impacted by having animals removed, and at the release site, to determine the success of the translocation. In addition, it is important to monitor threats so these can be adequately managed. Trapping was carried out in the Wheatbelt to estimate numbers of rock-wallabies, while radio-tracking and trapping were used in Kalbarri National Park. Remote-sensing cameras were also set up at each release site to monitor numbers of introduced predators and rock-wallabies. One camera even captured an image of a brush-tailed possum, a species not known to still exist in the park.

Kalbarri National Park rangers regularly travel to high points in the park to listen for radio-collared wallabies. And if any mortality signals are received, they locate the animal and/or collar. So far, one rock-wallaby died in 2016 from a fall; one was killed by a fox in 2017; and in 2018 two were killed by predators and two others apparently died after falls. Male rock-wallabies frequently wander from the release area and a small aircraft fitted with radio-tracking aerials is used to locate them.

VERY GOOD SIGNS

After the 2018 release, follow-up trapping at previous release sites was carried out to collect genetic samples. This resulted in several exciting results. Genetic analysis by DBCA's fauna geneticist Kym Ottewell and university researcher Kristen Nilsson found that a translocated Wheatbelt female had a pouch young that possessed unique Kalbarri genes, but not those of the male of the 'Kalbarri pair'. This indicated that other Kalbarri rock-wallabies were still in the area, albeit at very low density. Kalbarri genes were also present in a juvenile male captured where the supplementation was undertaken, meaning the male of the 'Kalbarri pair' had sired a rock-wallaby with a Wheatbelt female. We were also delighted to get large numbers of recaptures from both of the earlier releases with wallabies in good condition and most females carrying pouch young.

When we considered the translocation of rock-wallabies to Kalbarri, we were motivated by the vision that one day the public could again stand at Hawkshead Lookout and other sites in the park and see rock-wallabies in their natural habitat, basking in the morning sun and hopping around in the outcrops. We thought this might take many years to achieve and assumed the population would have to build up both in numbers and a tolerance to visitors. However, much to our surprise and delight, a visitor captured a photo of a rock-wallaby with radio-collar on, basking in the sun near Hawkshead Lookout in July 2018. And, since then, regular sightings have been reported by park visitors. Those who worked on the translocations – Parks and Wildlife officers from the Wheatbelt, Midwest and Pilbara regions, and DBCA Biodiversity and Conservation Science staff as well as WWF, Kalbarri *Bush Ranger* cadets and numerous volunteers – and the community at large can be optimistic that, with continued monitoring and fox and feral cat control, rock-wallabies will remain a feature of Kalbarri National Park for many years to come.

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Anthony Desmond is DBCA's Midwest Region nature conservation leader. He can be contacted on (08) 9964 0912 or by email (anthony.desmond@dbca.wa.gov.au).

Jazmin Lindley is DBCA's Merredin District assistant operations officer. She can be contacted on (08) 9041 6004 or by email (jazmin.lindley@dbca.wa.gov.au).

Juanita Renwick is a DBCA senior zoologist. She can be contacted on (08) 9219 8709 or by email (juanita.renwick@dbca.wa.gov.au).

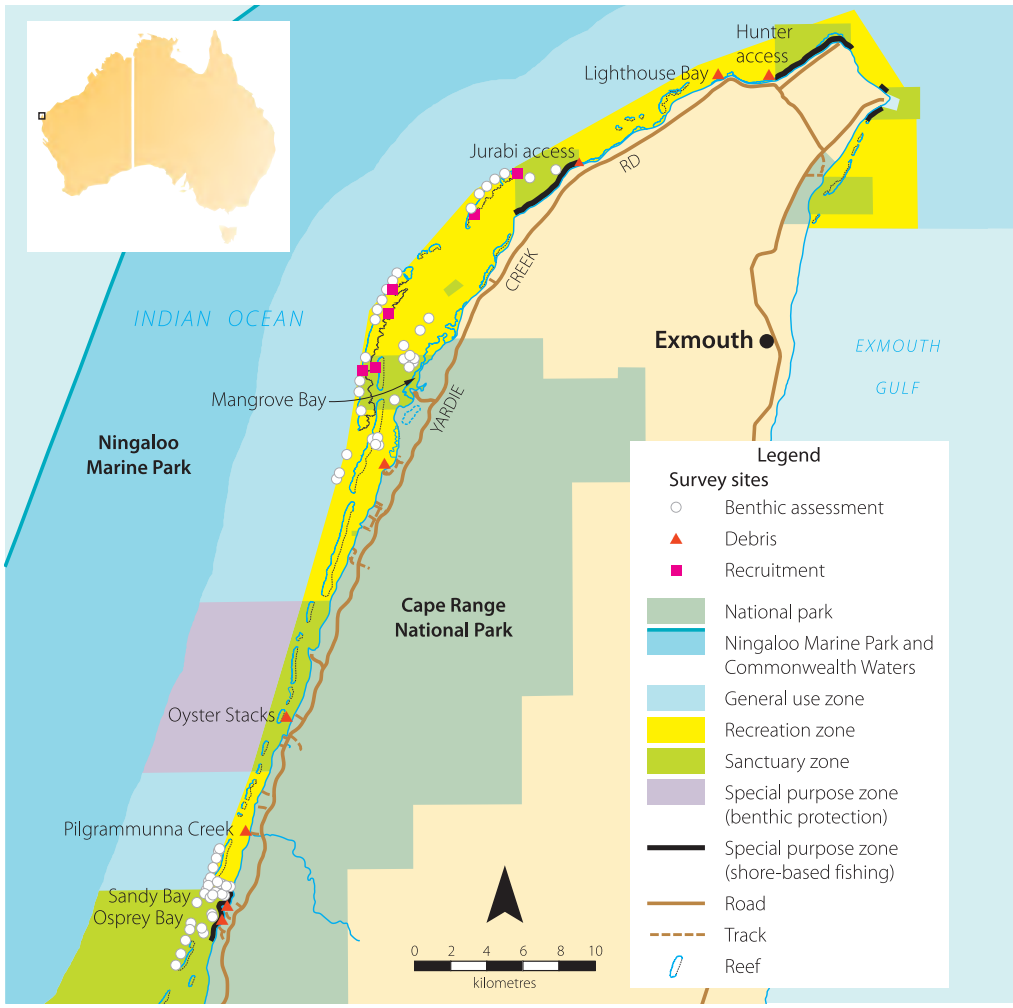
Waste free: protecting pristine Ningaloo reef

A CSIRO study into rubbish at Ningaloo has revealed the World Heritage-listed area is living up to its pristine reputation.

by Damian Thomson and Peter Barnes



At 300 kilometres long, Ningaloo Reef is Australia's largest fringing coral reef. It has long been important to the Baiyunga and Jinigudira people and, today, its turquoise water and pristine sand make it popular among snorkellers, scuba divers and paddlers who travel there to take in its natural beauty and observe the area's rich marine life. Visitors can marvel at the more than 500 species of tropical fish and 200 species of coral, as well as the whales, dolphins, dugongs, manta rays, turtles and whale sharks that occur there. And the annual mass coral spawning – a three-day event that occurs after the full moon in March and April – is a sight to behold. There are also several historic shipwrecks to explore and the area is popular for surfing, fishing and boating. But, like so many other natural areas, the Ningaloo Coast World Heritage Area is in danger of being 'loved to death' – its natural values being compromised by the visitors who, ironically, come to enjoy them – if it is not appropriately managed. And the area is also at risk of being polluted by rubbish that arrives there as a result of a much bigger global problem.



Previous page
Main CSIRO researchers have surveyed more than 35 kilometres of Ningaloo reef.
Photo – Damian Thomson/CSIRO
Inset Debris that washed ashore was collected and catalogued as part of the survey.
Photo – Damian Thomson and Dan Orr/CSIRO

THE SURVEY SAYS …

In 2015 researchers from CSIRO embarked on a study to survey the Ningaloo Reef and nearby coastline to examine the amount of rubbish present. The program – called *Ningaloo Outlook* – is a strategic partnership between CSIRO and BHP that aims to carry out research relating to the Ningaloo Coast World Heritage Area. The program will be carried out over five years and aims to increase our understanding of Ningaloo's deep and shallow reefs and the iconic turtle and reef and whale shark populations.

Since the beginning of the study, researchers from CSIRO have surveyed more than 35 kilometres along the reef using SCUBA and 60 kilometres of the beach on foot. Divers recorded debris in the water at 63 locations along the reef in five by 25-metre transects in May 2016, 2017 and 2018. The debris found was recorded under five categories: fishing lines, fishing hooks, fishing sinkers, plastics and 'other'. Land-based debris was recorded on beaches adjacent to the in-water debris survey locations. Eight intertidal beach locations were surveyed: at Lighthouse Bay, Hunter access, Jurabi access, Mangrove Bay (Mesa Camp), Oyster Stacks, Pilgrammunna Creek, Sandy Bay and Osprey Bay. Land-based debris was recorded using a modified version of the CSIRO land-based debris project methodology. At each location the access point on the beach was recorded using a GPS. The date, observer, weather conditions, wind speed, wind direction and the number of human visitors either in the water or on the beach were recorded. All debris bigger than one centimetre was then recorded within a 10-metre-wide transect from the water's edge to the fore dune (five metres left and five metres right). The size, colour, type and estimated age of the debris was recorded, and if the debris had a legible barcode, a photo of the barcode and the item was captured. Each transect was separated by at least 100 metres to maximise the area of beach surveyed. The observer continued to survey five metres each side of the high-tide line while traversing between transects. Conditions that influenced the amount of debris present on the beach, such as the profile of beach, wind strength, wind direction, visibility and the level of cloud cover, were also recorded.







Top Fishing line and sinkers were two of the most commonly collected items.

Above A suspected vessel fender was also found.

Above right Researchers established 25 by five-metre transects.
Photos – Damian Thomson/CSIRO

Below right Whale sharks frequent Ningaloo Marine Park.
Photo – Gary Bell/Oceanwide Images

Survey results indicated the reef and beaches at northern Ningaloo contain very low density of debris with an average of less than two items per hectare. The most number of items was observed at Lighthouse Bay (3.89 items per hectare), followed by the Osprey Bay boat ramp (3.75 items per hectare) and Oyster Stacks (2.5 items per hectare). The least amount of debris was observed at Sandy Bay and Jurabi (1.25 and 1.2 items per hectare respectively), which also had the least number of people recorded in the water or on the beach at the time of survey. A recent national CSIRO study estimated there were more than five pieces of litter along the coastline for every person living in Australia. Of the rubbish found floating offshore, more than 90 per cent was plastic. However, the amount of rubbish present on the Ningaloo shoreline was incredibly low, particularly when compared to other Australian beaches. And the amount of marine debris on the reef was well below those recorded for many coral reefs worldwide.

"A recent national CSIRO study estimated there are more than five pieces of litter along the coastline for every person living in Australia."

While you may expect to see a reduced amount of rubbish in an area that only a lucky few call home, Ningaloo's local population is 0.9 per cent of Melbourne's, but Port Melbourne's beaches had 500 times the amount of rubbish as Ningaloo's northern beaches. And, the Sunshine Beach in Queensland had more than 350 times the rubbish. But we didn't have to look too much further than the local community to discover why this was.

COMMUNITY SPIRIT

On the whole, the residents of Exmouth have a strong desire to keep their local beaches and reefs clean and clear of rubbish and debris. It is a cultural habit that locals collect rubbish they find along the beach as they're enjoying their daily walk, and there are a number of organisations, such as Sea Shepherd and the Cape Conservation Group, that organise and facilitate regular clean-ups, especially at spots like Jane's Bay – a marine debris hotspot. Volunteers are also on the lookout for rubbish when they are taking part in targeted projects such as turtle monitoring for the four to five weeks between October and February each year.





Protecting an icon

In 2011, the World Heritage Committee inscribed Ningaloo Coast on the World Heritage List to recognise the area's outstanding diversity and abundance of marine life, its amazing cave fauna and the spectacular contrast between the underwater wonderland and the arid and rugged landscape of Cape Range National Park.

The Ningaloo Reef is protected within Ningaloo Marine Park. Thirty-four per cent of the marine park is protected in sanctuary zones, which are areas designated for people to visit and 'look but don't take'. This protects the pristine underwater habitat and marine wildlife and will help to provide a benchmark for evaluating the health of other areas in the marine park, which are open to fishing.

The 'Leave No Trace' approach to waste management in Cape Range National Park also encourages visitors to take responsibility for their rubbish while visiting the area. There are no rubbish bins in the park, which means people must take out what they bring in with them. And, thankfully, most visitors meet this expectation.

ONGOING PROCESS

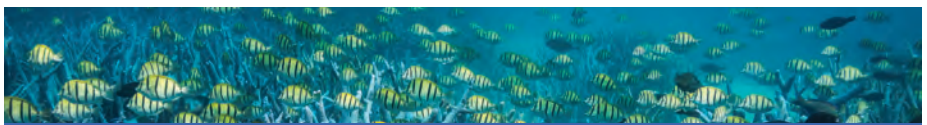
Despite these pleasing results, Ningaloo coast is by no means immune to the effects of rubbish, and a 'debris event' in 2017, when a large amount of floating debris (or a 'plastic soup' as it was known) was detected off the coast and then washed up onto the beaches, was a stark reminder of the importance of ongoing vigilance. It was speculated that an industrial ship dumped the rubbish into the ocean instead of paying for it to be disposed of appropriately in port. Of course, this type of behaviour is short sighted; marine debris is a global issue and impacts every country that has coastal environments. And, in the end, we all pay for rubbish that's disposed of inappropriately.

Fortunately, the local community stepped up to the plate and demonstrated their commitment to keep the area clean. DBCA relied on the reports of local boaters and tour operators, who provided information about where they saw plastic in the ocean; the local school helped with beach clean-ups; local volunteers assisted with sorting plastics and DBCA worked with the Department of Primary Industries and Regional Development to identify any biosecurity risks from introduced animals and algae that might have hitched a ride on the plastics.

Rubbish that is polluting our oceans and beaches impacts tourism, fisheries, aquaculture, human health and the wellbeing of our marine life. Studies such as the one carried out by CSIRO to understand potential impacts on this World Heritage-listed area will inform industry, government and the community, and highlight the importance of protecting our ocean's natural resources.

Above left Visitors to Cape Range National Park, including to Osprey Campground, are expected to follow the 'Leave No Trace' principles.
Photo – Tourism WA

Below Convict surgeonfish can be found along Ningaloo reef.
Photo – Hayley Versace/Oceanwide Images



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For more information about Ningaloo Marine Park and Cape Range National Park, visit parks.dpaw.wa.gov.au

The authors would like to acknowledge the Developing a baseline estimate of amounts, types, sources and distribution of coastal litter – tan analysis of US marine debris data. *(CSIRO: EP167399) by Hardesty D, Wilcox C, Schuyler Q, Lawson TJ and Kimberley Opie for information that went into this article.*

by Grace Milne

kaleidoscope
connecting kids with nature



Above and below Five and eight-year-olds took part in a *Nearer to Nature* activity where they learnt about bees.



The latest buzz

Australia is home to a staggering 2000 species of native bees, of which about 800 species are found in Western Australia. They vary in size, colour and bee-haviour – with the smallest native bees measuring only 2.5 millimetres, while the biggest grow up to 10 times that size.

Native bees play an important role in Australia's natural environment as they pollinate our wildflowers. Unfortunately, Australia's native bees are under competition from the introduced honey bee, which competes with them for food. Land clearing is also reducing the amount of habitat available to them.

'Buzzy, buzzy, Aussie bee'

During the October school holidays, a group of five to eight-year-olds learnt about our special native bees and discovered the important role they play in pollinating our native plants, as part of the *Nearer to Nature* school holiday program. They also heard how our native bees are under threat, learnt the 'buzz pollination dance' and built 'bee-hotels' to take home to encourage native bees to visit their own backyards.

This program will be running again in the summer school holidays. To check out this and other *Nearer to Nature* programs visit parks.dbca.wa.gov.au/group-events/nearer-nature-community-events

Insets top A honey beehive. **Below left** Blue-banded bee. **Below right** Honey bee. *Photos – Jiri Lochman*



Bees in WA

Blue-banded bees *(Amegilla)*

The spectacular blue-banded bee is Australia's most common bee. They are about 11 millimetres long and have bands of metallic blue fur across their black abdomens.

Blue banded bees perform a special type of pollination called 'buzz pollination'. Some flowers hide their pollen inside tiny little capsules. A blue banded bee can grasp a flower and shiver their flight muscles, causing the pollen to shoot out of the capsule. They can then collect the pollen for their nest and carry it from flower to flower, pollinating the flowers.



Honey bee *(Apis mellifera)*

The honey bee was introduced to Australia by the first European settlers to pollinate their fruit trees and to provide honey and beeswax. Honey bees live in hives (or colonies of up to 80,000 members) where they are divided into three types: the queen bee, worker bees and drone bees.

The queen bee runs the hive. Her job is to lay the eggs that will spawn the hive's next generation of bees. She is busiest in the summer months, when she can lay up to 2,500 eggs a day! Queen bees can live for up to five years.

The worker bees are female but may live for just five to six weeks (several months in winter). During their lifetime, worker bees produce about one twelfth of a teaspoon of honey. Their role is to forage for food, build and protect the hive, clean and circulate air by beating their wings.

The drones are the male bees, and their role is to mate with the queen. Several hundred drones live in each hive during the spring and summer. But in winter, when the hive goes into survival mode, they are kicked out.

LANDSCOPE's **Kaleidoscope connecting kids with nature** page is an exciting regular feature for kids.



Gould's monitor (*Varanus gouldii*)

Gould's monitors are found throughout Australia where they shelter in burrows, hollow logs or dense leaf litter. They reach a length of up to 1.6 metres and can weigh as much as 10 kilograms. They are voracious predators and actively forage for insects, mammals, reptiles and, opportunistically, on carrion.

Illustration by Gwendolen Monteiro

Reference photo by Jiri Lochman

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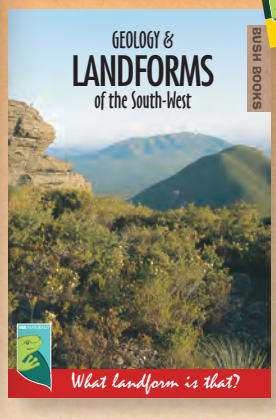


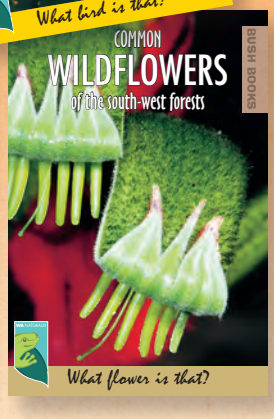


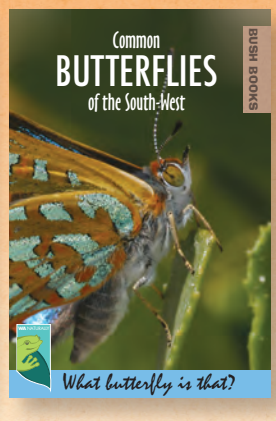
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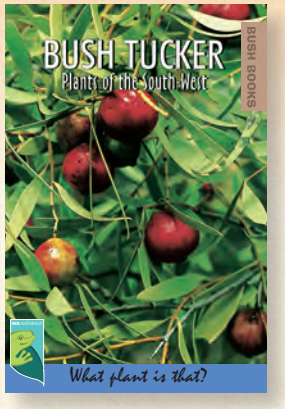














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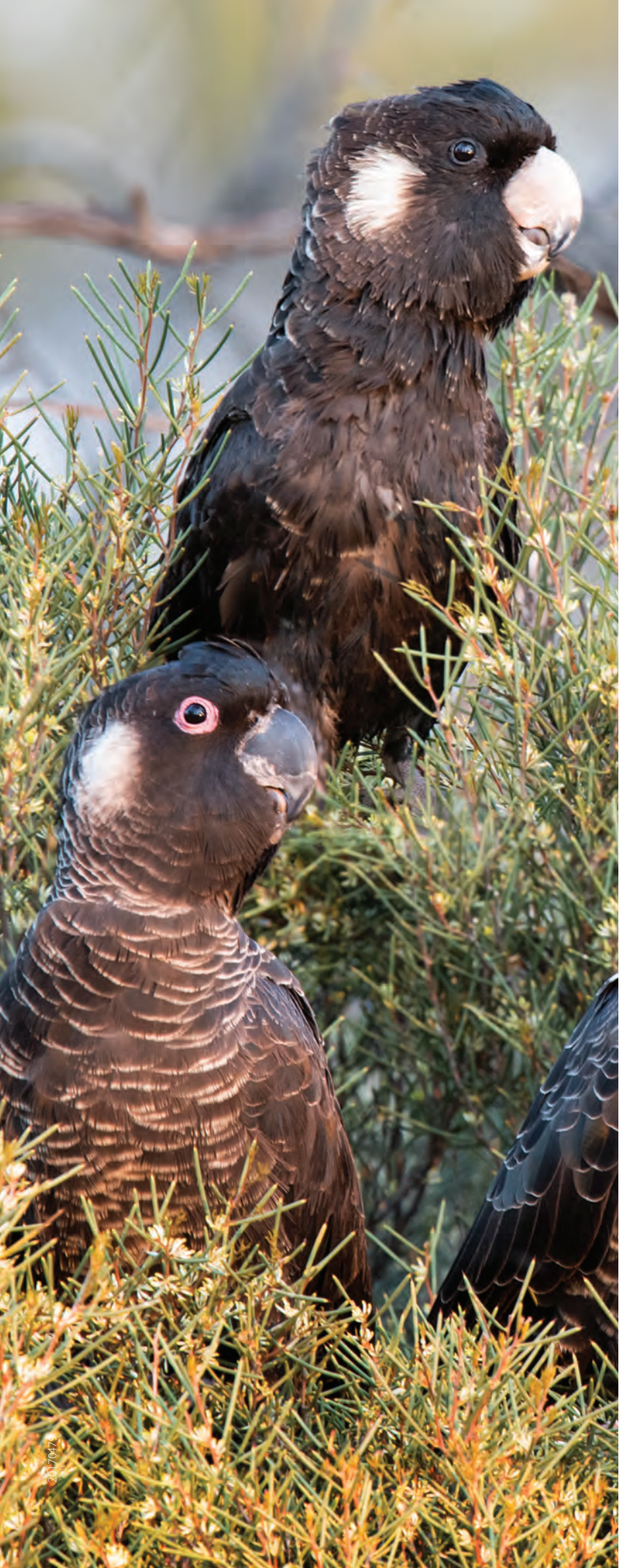
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