

WA'S PARKS, WILDLIFE AND CONSERVATION MAGAZINE

LANDSCOPE

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STRONGHOLD**
Dryandra Nature
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ON THE COVER

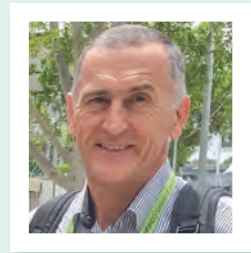
Front cover The numbat (*Myrmecobius fasciatus*) is Western Australia's faunal emblem. Once found across most of southern Australia, they are now endangered. They feed on up to 20,000 termites while they are active during the day.

Photo – John Lawson

Back cover Dryandra Woodland is one of the last strongholds for numbats.

Photo – Tourism WA

Australia has one of the oldest living cultures in the world and we are lucky in Western Australia that there are numerous places throughout the State where we can immerse ourselves in Aboriginal history and experience the deep connection that Aboriginal people have to the land. But it's not just locals who seek out these experiences; recent WA Tourism data reveal that as many as 78 per cent of visitors to WA want a cultural experience of some kind.



Continuing to develop quality Aboriginal tourism opportunities will further establish a unique point of difference for WA as a travel destination, and provide tangible benefits to Aboriginal tour operators, their families and communities. In fact, Tourism WA estimates Aboriginal tourism generates 339 full-time employment positions and generates \$43.8 million in economic impact.

The Department of Biodiversity, Conservation and Attractions' Parks and Wildlife Service is supporting the development of this industry by issuing commercial licences for businesses to offer commercial events and/or tourism and education opportunities on department-managed lands and waters. We are working together with the Western Australian Indigenous Tourism Operators Council to support the development of new and emerging Aboriginal tourism opportunities both in our parks and on adjacent lands that will service both international and domestic visitors and act as a cultural bridge for better understanding and knowledge of traditional owners responsibilities of 'caring for country'.

In this issue of *LANDSCOPE* you can read about the Kings Park Yorga's tour, which provides visitors with a rich cultural experience just minutes from Perth's CBD (see page 37). While, today, many of us think of Kings Park as an inner-city haven, the Whadjuk Nyoongar people know the area as 'Kaarta Koomba', 'Kaarta Gar-up' or 'Mooro Kaarta', and have been connected to it for at least 40,000 years. And there's a lot more to discover.

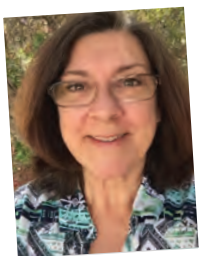
This issue also reports on a recent development at Jarrahdene, in Leeuwin-Naturaliste National Park (see page 40), that pays homage to the State's more recent European settlement history. The area that was once a thriving mill town is now a campground, which has been embellished with stories from yesteryear.

I encourage you to explore our spectacular natural areas and keep an ear out for some of their fascinating stories.

Peter Sharp, Executive Director Parks and Visitor Services
Department of Biodiversity, Conservation and Attractions

Contributing **Lorna Charlton** is a senior communication designer with DBCA's Parks and Visitor Service. She has been with the department for 20 years, where her role has been creating print and digital information products and interpretive installations for visitors to our parks, developing communication strategies that guide the

interpretation of park values and provide for visitor safety, and delivering training to DBCA staff in designing visitor experiences.

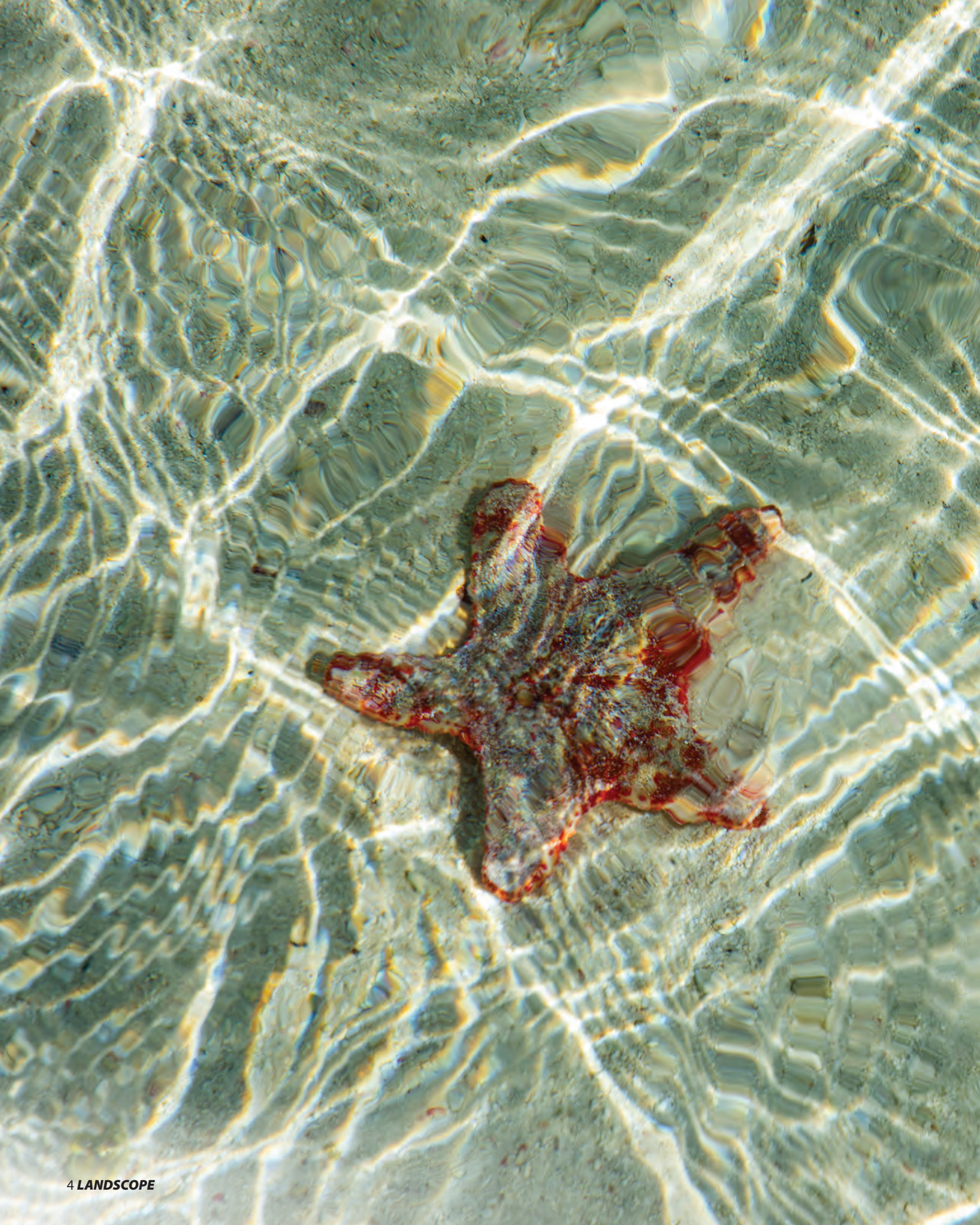


Dr Kelly Waples is a principal research scientist with DBCA's Marine Science Program. She has worked for more than 20 years in conservation and management and coordinates large research programs to improve conservation and management of marine resources. Kelly's interests lie with applied research in the marine environment and how best to translate science into positive management outcomes, and working with scientists, regional staff and Indigenous people to improve conservation of jointly managed sea country.



Richard Pillans has more than 16 years' experience as a marine ecologist. His research provides data on the movement of marine reptiles (turtles), mammals (dugongs), fish and sharks using acoustic telemetry and satellite tags. He regularly advises the State and federal governments on issues related to conservation and management of sharks and rays. Richard is currently leading a CSIRO project to track sharks and turtles.





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LANDSCOPE is printed on paper that is 99% recycled fibre and is FSC® mix certified, which ensures that the pulp is derived from well managed forest and recycled wood of fibre.

This page Houtman Abrolhos Islands National Park.

Photo – Lynne Whittle/DBCA



Department of Biodiversity, Conservation and Attractions

**Snap
shot**



READER'S PIC

Photos and words by Alex Eades and Kelly Clifton

"We are passionate about science, photography and the amazing natural places in Western Australia and have taken to ultraviolet spotlighting, especially on moonless nights. We found these old shells half buried in the soil around the campsite at Cape Arid National Park.

A quick flash with the UV and we were spellbound by what we saw ... one shell changed colour and the other revealed a beautiful hidden pattern!"

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 landscape@dbca.wa.gov.au.

New volunteer hub for Kings Park

A purpose-built volunteer facility has opened at Kings Park, providing 500 regular volunteers with space for workshops, offices, meetings, a kitchen, barbecue area and outdoor seating. The facility has been named 'Wanju Marr' which means 'welcome hand' in Nyoongar in recognition of the vital work contributed by volunteers to the world-renowned park.

The project was organised by the Friends of Kings Park, with funding from Lotterywest and was officially opened by Member for Perth Patrick Gorman, with a smoking ceremony by Dr Richard Walley OAM.



Above 'Wanju Marr' – the new volunteer hub in Kings Park. Photo – David Blume



Hear more about the new trail

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



Above Arklow Forest provides opportunities for a variety of users.

Photo – DBCA

Adventure ahead for cyclists with a disability

A new mountain bike trail in the State's south-west is giving cyclists with a disability the opportunity to ride through the scenic Arklow Forest, north of Collie.

The new 9.5-kilometre loop trail has been designed to accommodate hand cycles and connects to the Munda Biddi Trail. It forms part of the \$10 million Collie Adventure Trails initiative to establish Collie as Western Australia's premier trail adventure town, with 100 kilometres of high-quality mountain bike trails between Wellington National Park and the town of Collie (see also 'Putting Collie on the map', *LANDSCOPE*, Spring 2019).

When completed, these trails will challenge all levels of cyclists and have the potential to attract national and international cyclists and tourists.

Looking for lorikeets

BirdLife WA is calling for volunteers to report hollows (artificial or natural) that rainbow lorikeets have been seen entering or leaving, and monitor specified hollows for lorikeet activity. Rainbow lorikeets are not native to Western Australia and are competing with our local ringnecks and red-capped parrots by aggressively protecting food and nest resources. BirdLife wants to better understand the types of nests rainbow lorikeets use, to inform future nest enhancement projects in urban areas.

For more information or to register, contact Vicki Stokes BirdLife WA at vicki.stokes@birdlife.org.au or phone 0409 033 126.

Happy birthday little mate!

Western Australia's biggest A-lister has been attracting celebrity friends from around the world wanting to snap a #quokkaselfie with the pint-sized smiling superstar.

Selfies with Rottneest Island's now world-famous quokka are becoming so popular that the island's visitor numbers have been boosted by 30 per cent and Tourism Minister Paul Papalia saw fit to celebrate the darling of social media's birthday each year on September 15.

Celebrations included free travel and island admission for kids 12 years and under and discounted \$50 return tickets for adults over three days.

The quokka's famous friends include Roger Federer, Chris Hemsworth, Matt Damon, Margot Robbie, Hugh Jackman, Bill Murray, Adrian Grenier and Kelly Slater.



Above Chris Hemsworth gets a #quokkaselfie
Photo – @chrishemsworth

New-look markers for Cape to Cape

Users of the 125-kilometre Cape to Cape Track in the State's south-west are now being guided by new trail markers. The abstract artwork is an aerial view of the iconic track with a mix of yellow for the earth, blue for the water and dots for the path. Larger dots represent the lighthouses at Cape Leeuwin and Cape Naturaliste that mark each end of the track and the triangular design means the markers can be rotated to give directional instructions.

The logo for the Cape to Cape Track has also been updated to feature a green motif that represents the bush.

Below Cape to Cape Track users are guided by new trail markers.
Photo – DBCA



Guest column



Dr Luke Twomey
CEO Western Australian Marine Science Institution

When I first started as CEO of the Western Australian Marine Science Institution (WAMSI), over two years ago, we were

well on our way to delivering two of the biggest collaborative science projects ever undertaken in Western Australia. One looking into environmental thresholds for dredging and the other creating the first-ever picture of the Kimberley marine environment, how it has changed over time, where it is now, and how it might change in the future (see 'Kimberley's marine ecosystem: Uncovering the secrets of saltwater country' on page 12). Combined, these two projects represent the collaborative efforts of more than 300 scientists from 50 organisations over five years.

The result has been an invaluable amount of new knowledge that has seen us, as a society, jump decades ahead in our ability to understand how best to manage this precious resource.

But collaboration of this scale comes with its challenges, and it's a testament to the will of the WAMSI partnership and all those involved, including the traditional owners, that we have successfully achieved what we set out to do.

The experience has strengthened many new and ongoing science collaborations for the benefit of our environment and 'right-way science' that respects, learns and works with traditional owners is becoming the new norm.

Collaboration is imperative in the current economic and environmental climate. The simple fact is that to be able to achieve a sustainable future, we need to work more cost effectively, faster and smarter than ever before. When we're talking about the marine environment and the 'blue economy', we're talking about understanding large-scale issues, and that can't be done without collaboration.

We all have our different motivations for what we are trying to achieve, both organisationally and individually, but our shared vision is to successfully manage our marine environment for the future. To quote Charles Darwin: "In the long history of humankind (and animal kind, too) those who learned to collaborate and improvise most effectively have prevailed".





Houtman Abrolhos Islands National Park

Often referred to as a 'jewel' in Western Australia's crown, the spectacular coral reef surrounding the Houtman Abrolhos islands, has long been recognised as a magnificent snorkelling and diving destination. In July 2019, the special terrestrial values of the Houtman Abrolhos islands were acknowledged with the creation of the State's 101st national park. This will provide greater protection for the natural and cultural values, while realising opportunities for increased tourism.

On 29 July 1619, Dutch explorer Frederik de Houtman sighted a chain of low-lying islands in what was thought to be open ocean while on board a Dutch East India ship bound for Indonesia. He likely named the Abrolhos after the Portuguese sailors' warning cry of 'abre os olhos' or 'open your eyes'.

This archipelago of 192 islands and islets, consists of three clusters of islands (Wallabi, Easter and Pelsaert Groups) and is located 60 kilometres off the Midwest coast of Western Australia.

ANCIENT LANDSCAPE

The basis of the island clusters is an ancient limestone reef platform that began

forming, layer upon layer, from coral 120,000 to 130,000 years ago when sea levels were much lower than today. As sea levels rose, the coral grew upwards, gradually building the platform over thousands of years.

Today, the coral reef that perches atop these ancient platforms is recognised as the southernmost coral reef system in the Indian and Pacific oceans. The ancient reef platforms and the coral reef lying on top have been created by the Leeuwin Current flowing south from the tropics, bringing warm tropical waters laden with coral larvae that settle and grow, building coral reefs.

During the last ice age, when sea levels were much lower than today, the islands became part of mainland Western Australia.

However, they were separated again by rising sea levels approximately 8000 years ago. This enabled plants and animals, to colonise the islands and evolve in isolation, giving rise to a unique suite of flora and fauna, some of which are found nowhere else on Earth. This high biodiversity also results from the islands' location at the point where northern and southern regions cross over. This overlap accommodates an eclectic mix of both tropical and temperate species, reminiscent of the Galapagos Islands.

In order to protect these conservation values, while providing opportunities for people to appreciate them, the Houtman Abrolhos Islands National Park was declared in July 2019, exactly



**Journey to Houtman
Abrolhos Islands
National Park**

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

400 years to the day after Houtman's discovery. The park includes islands and land not occupied by existing fishing and aquaculture operations. Occupied areas and waters around the islands remain the responsibility of Fisheries within the Department of Primary Industries and Regional Development (DPIRD).

NATURALLY UNIQUE

From the only resident marsupial species – the tamar wallaby (*Notamacropus eugenii*), to the 200 native plants species, 25 reptile species and more than 100 species of birds, the plants and animals of the islands have one thing in common: they are all extremely hardy, being able to survive the harsh conditions of life on rugged coastal islands.

The islands are home to astonishing numbers of birds, both resident and migrant, and the snowstorm of millions of birds in breeding season is a spectacular sight indeed; early explorers likened them to swarms of bees. The islands form the largest and most species-rich seabird breeding area in Australian waters and in the eastern Indian Ocean. In addition to seabirds, the islands provide vital habitat for many shorebirds and migratory waders

that fly from as far away as Siberia to Western Australia each year. These include several critically endangered species like the curlew sandpiper, great knot, eastern curlew and bar-tailed godwit. The inevitable by-product of so many birds using the islands is a build-up of guano that was so abundant it was mined for fertiliser between 1847 and 1946. Relics of this industry can still be seen on several of the islands today.

The wonders of the islands continue in the surrounding waters where the curious Australian sea lion (*Neophoca cinerea*) – one of the world's rarest pinnipeds (marine mammals possessing front and rear flippers), can be spotted in the area. Visitors are often treated to the sight of playful Indo-Pacific bottlenose dolphins (*Tursiops aduncus*) riding the waves of boats and, between June and November, migrating humpback whales (*Megaptera novaeangliae*) can be seen breaching on the horizon.

The high biodiversity continues beneath the waves with algae and 184 species of coral creating magnificent gardens among the seagrass meadows that together provide habitat for 389 fish species.

EXPLORING THE ISLANDS

Day trip and scenic flights are available from Geraldton or Kalbarri, which enable visitors to enjoy the aquamarine blue and green patchwork quilt of the islands from the air and picnic at East Wallabi Island's Turtle Bay, before snorkelling the dive trail that showcases a kaleidoscope of colour from coral and fish.

Visitors can dive into maritime history to learn about the 19 wrecks that have been discovered at the Abrolhos, including Beacon Island's chilling tale of murder and

Opposite page

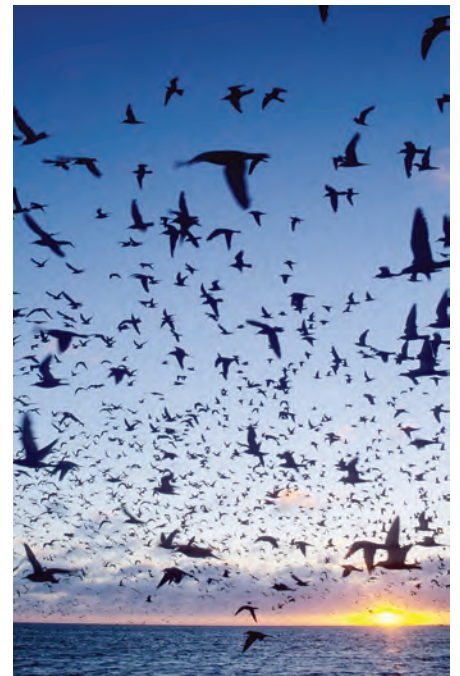
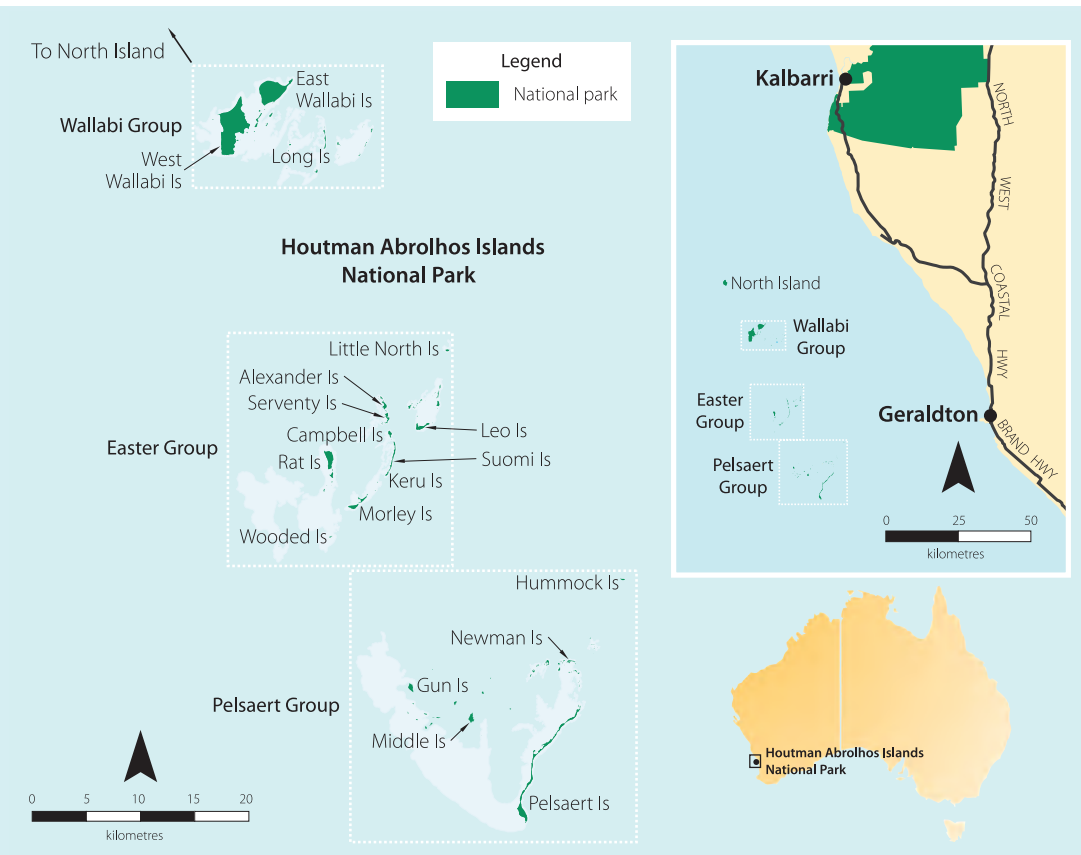
The islands are important breeding habitats for millions of seabirds.

Top left Australian sea lions occur in the area.
Photos – Chris Surman/Halfmoon Biosciences

Above left Tamar wallabies are one species that have evolved in isolation in the archipelago.
Photo – Jiri Lochman

Above The stunning archipelago can be viewed on board one of the scenic flights that operate in the area.
Photo – David Bettini

Parks for people Houtman Abrolhos Islands National Park



mutiny on the *Batavia*, which wrecked on Morning Reef in 1629.

For visitors who want to test their sea legs, there are a number of charter boat tours that operate out of Geraldton and Kalbarri. These offer packages and experiences that include bird and wildlife watching as well as diving and snorkelling. While under water, visitors may see a raft of species including wrasse, parrotfish and clownfish darting in and around the coral of myriad shapes, sizes and colours. Boat tours also offer fishing and the opportunity to drop anchor and land on some of the islands, where visitors can enjoy a picnic or beach walk.

PLAN FOR OUR PARKS

Houtman Abrolhos Islands National Park is the first conservation reserve to

Top right Coastal caper (*Capparis spinosa*).
Photo – Wendy Payne/DBCA

Above right The islands are home to millions of birds including, seabird, shorebird and migratory waders.
Photo – Chris Surman/Halfmoon Biosciences

be created under the Plan for Our Parks initiative, which will see five million hectares of new national and marine parks and conservation reserves added to Western Australia's conservation estate over the next five years. The national park will protect 105 of the 122 islands in the archipelago. Ten million dollars has been committed to the 'Sustainable Tourism Development for the Abrolhos Islands' project, which will focus on three key areas – effective management of the Abrolhos through inter-agency collaboration; growing sustainable tourism in the area; and improving visitor infrastructure and management. As part of this, new jetties, toilets, shade shelters, walk trails and visitor interpretation will be developed on East Wallabi and Beacon islands. The airstrip on East Wallabi Island will also be upgraded.

Additional funding has been secured for the ongoing management of the national park, including for the employment of rangers. And commercial tourism operator licensing will be introduced in 2020, to encourage more visitors to the area while protecting its natural and cultural values for the future.

Do it yourself

Where is it? 60 kilometres west of Geraldton.

Activities: Snorkelling, diving, bird and wildlife watching, beachwalking and fishing.

Nearest Parks and Wildlife Service Office:
201 Foreshore Drive Geraldton WA 6530,
Phone: (08) 9964 0901

Help us care for the environment by respecting the wildlife that inhabits islands and keeping your distance from sea lions and nesting birds or bird colonies to avoid disturbance. Walk only along beaches or designated walking tracks to avoid crushing ground or burrow nesting birds and remember to take all your rubbish with you when you leave. And consider experiencing the area with a licensed tour operator.



BIRDS IN THEIR HABITATS: JOURNEYS WITH A NATURALIST



In his preface to *Birds in their habitats*, author Ian Fraser references a statement in Simon Barnes' *How to be a Bad Birdwatcher* that says "I don't go birdwatching. I am birdwatching". He uses this to demonstrate that committed 'birders' are forever watching and appreciating birds, a state that he likens to being in love. This heartfelt sentiment sets the tone for the book, which is described as a 'birding travelogue'. The book's double-barrel title is perfect; it's as much about Ian Fraser's

experiences as it is about the birds he journeys to see.

The book is separated into habitat type – deserts, rainforests, oceans and islands, mountains, wetlands and rivers, suburbia, and woodlands and grasslands – and provides details about species found in four continents.

Unlike many other books about birds, *Birds in their habitats* contains just 30 photos grouped as colour plates. But Ian Fraser – who is regarded as one of Australia's most accomplished natural history writers – brings the pages to life with his colourful descriptions of places and landscapes, history and geo-political contexts and, of course, the birds themselves. He combines humour with touching anecdotes, which makes it a delightful 'cover-to-cover' read. But its detailed index provides easy access to the well-researched information to those using it as a reference book.

Ian Fraser writes that while he enjoys spotting and recording birds he hasn't seen before, he never tires of the ol' favourites: "the day I get bored with Galahs (an abundant but gorgeous Australian cockatoo) it will be time to hang up my binoculars". However, judging by the passion for the subject matter that exudes from the pages of this delightful book, I can't see that happening any time soon.

Birds in their habitats: Journeys with a naturalist by Ian Fraser is published by CSIRO and available as a 240-page paperback for \$39.95 from www.publish.csiro.au.



PERTH FISH – EXPLORE, IDENTIFY, ENJOY!

Perth fish – Explore, identify, enjoy! was written by fish ecologist Dianne McLean and research assistant Michael Taylor and published by The University of Western Australia's Oceans Institute and is free to schools. As an educational resource, it provides primary and secondary school students with interesting and engaging information that will help foster a love for the ocean and an appreciation for Perth's precious marine life.

The book uses easy-to-digest language to explain accessible concepts, which would suit a range of ages and academic levels, but it contains a wealth of detailed information, making it a substantial and valuable resource. The 'fun facts' that are dotted throughout the pages are particularly interesting, as are the profiles on 106 different species.

The book outlines some of the pressures our oceans face, responsible and sustainable ways we can enjoy them, their cultural significance and the variety of magnificent creatures that call them home.



Perth fish – Explore, identify, enjoy! is available for free download from www.wamsi.org.au/news/scientists-create-perth-fish-book-schools. Schools can access hard copies from the Western Australian Marine Science Institution by emailing info@wamsi.org.au.



SPIKEY: AN INTERACTIVE KEY TO TRIODIA SPINIFEX GRASSES OF THE PILBARA, WESTERN AUSTRALIA

For many of us, spinifex is synonymous with the Pilbara – rounded tufts of spiky grass, which cover the red earth in our State's north-west. However, there is much more to the hummock grasses that belong to the *Triodia* genus than meets the eye. And this app, which has been developed by Kings Park and Botanic Garden, the Australian Government, the National Landcare Programme and Pilbara Corridors, incorporates the results of recent surveys to provide a wealth of information.

SpiKey has been designed for land managers, rehabilitation practitioners, botanical consultants, seed collectors and identification botanists. A key, which contains 28 features, helps users of all technical levels identify 28 species and one hybrid – about one quarter of species found in the genus.

SpiKey is available for free download from the Google Play Store and the App Store.





Uncovering the secrets of saltwater country

Kimberley's marine ecosystem



A \$30 million, five-year research project has seen more than 200 scientists from 25 organisations work with traditional owners and Indigenous rangers from seven saltwater country groups, across 23 projects, to gain a better understanding of the unique marine ecosystem of Western Australia's Kimberley region. This work will inform a balance in protecting one of the world's few remaining near-pristine coastal and marine environments, while supporting the region's social and economic development. It could also help answer some global questions about environments that live on the edge of extreme conditions.

by Kelly Waples and Aleta Johnston

Western Australia's tropical Kimberley region, which extends 12,000 kilometres from Eighty Mile Beach to the Northern Territory border, is well known for its outstanding natural features, vast and remote landscapes and cultural significance for its Indigenous people.

This physically complex inshore environment supports a diverse range of habitats that include seagrasses and coral reefs, many islands, extensive intertidal mudflats and sponge-dominated filter-feeding communities with high levels of biological diversity. The region also supports large and iconic marine fauna including whales, dolphins, dugongs, turtles and estuarine crocodiles.

ANCIENT ENVIRONMENT

Aboriginal people have lived in the Kimberley for millennia and retain strong cultural connections to their saltwater country. In more recent years, this coastal and marine environment increasingly supports other activities, such as tourism, commercial and recreational fishing, pearling, aquaculture and major port facilities associated with resource industries.

Despite this growth in activity, anthropogenic impacts remain low compared with many other parts of the Western Australian coast, and disturbance to much of the Kimberley marine environment is considered to be minor. However, the region is likely to be increasingly affected by a number of pressures, including climate change-related impacts such as coral bleaching; regional development and growth; and increased human access and use of the region.

Being located close to the equator means the Kimberley experiences two seasons: wet and dry, with the dry season taking up most of the annual cycle through the cooler months. When it arrives in January, the wet season brings heavy rainfall and tropical storms, which result in significant flows of fresh water and land runoff into the coastal habitats.

The Kimberley also experiences huge tides that range up to 12 metres during



“Aboriginal people have lived in the Kimberley for millennia and retain strong cultural connections to their saltwater country.”

Previous page

Main The spectacular marine environment of the Kimberley supports a range of species including lyretail fairy basslets.

Photo – Clay Bryce/Lochman Transparencies

Inset Flatback turtles nest on the beaches of the area.

Photo – DBCA

Above Bonaparte Archipelago.

Photo – David Bettini

Right Seaweed collection in Bardi Jawi Indigenous Protected Area.

Photo – Mat Vanderklift/CSIRO



spring tides. The impact of these tides on this structurally complex coastline creates intricate hydrodynamic patterns and is one reason the inshore waters of this region are typically turbid. These features influence patterns of productivity, energy flows and the many key ecological processes that support the Kimberley region's diverse marine biodiversity.

While there are some unique differences between other coastal systems, the average levels of nutrients and productivity in the Kimberley are comparable to those recorded across northern waters of Australia, including the Great Barrier Reef.

UNCOVERING THE SECRETS OF WA'S NORTH-WEST FRONTIER

The Western Australian Government's commitment to develop a network of jointly managed marine reserves across the Kimberley highlighted that there was limited information about the marine physical environment,

its biodiversity and the various human interests and activities that could assist conservation reserve planning and management.

The Western Australian Marine Science Institution (WAMSI) proposed an integrated program of 23 research projects to fill this knowledge gap and support the development and management of the marine reserves.

Supported by government and managed by WAMSI from 2012 to 2018, this cohesive and integrated \$30 million research program drew on the expertise of more than 200 scientists from 25 organisations who worked with traditional owners and Indigenous rangers from seven saltwater country groups.

The key aim of this program, known as the Kimberley Marine Research Program (KMRP), was to get insight into the region's biophysical and social aspects by building foundational datasets and developing an understanding of the key ecosystem processes that support the

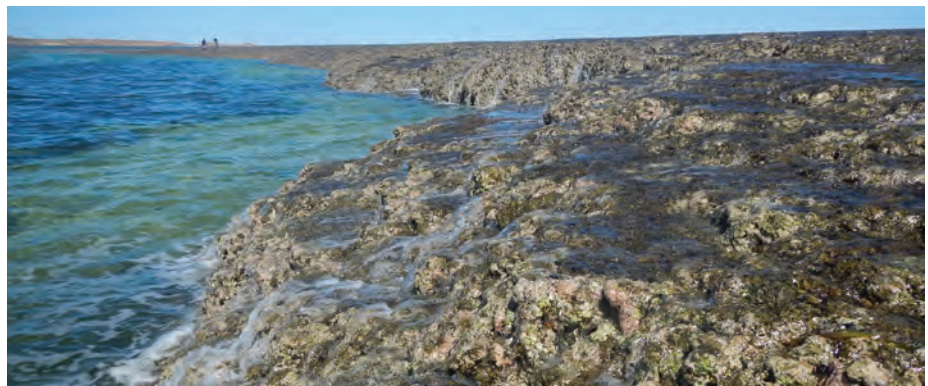
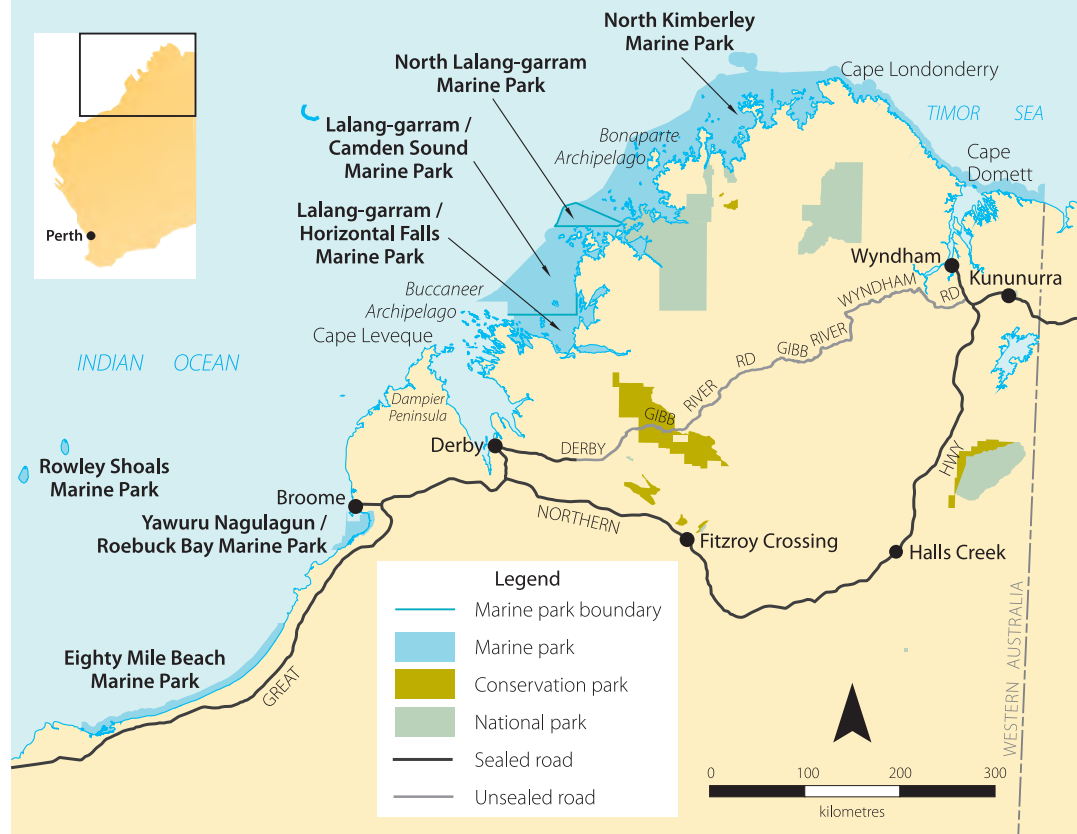


marine environment, including response to change. Integrating with the long and enduring cultural knowledge of traditional owners as land and sea managers, was a key aspect of the KMRP; Indigenous rangers and traditional owners took part in the science projects where possible. This has resulted in an integration of traditional knowledge with western science to better describe and understand marine ecosystems of the Kimberley.

In particular, the Kimberley Indigenous Saltwater Science Project sought to improve the integration of Indigenous knowledge and western science by producing guidelines and tools for scientists working on country as well as a pilot training program to support Indigenous rangers to continue monitoring the environment.

PLANNING FOR THE FUTURE

The KMRP has resulted in a significant increase in our knowledge of the physical and biological factors of



the marine and coastal Kimberley, and a better understanding of the intricate social values and impacts of people across the region. The data have been used to develop numerous products and tools that will be useful to joint managers over the long term, including baseline datasets, standardised monitoring protocols, and models to improve future predictions of change.

The future of the Kimberley will be determined by the interaction of many pressures (economic, ecological and social processes, climate change, human population dynamics, resource extraction and others) and the effectiveness of strategies used to manage them. The insights gained through the KMRP will ensure knowledge-based management

decisions are made for the region and that a sustainable compromise can be achieved, which balances protecting this precious environment for the future with supporting social and economic development in the Kimberley. The collaborations between scientists, managers and Indigenous communities also set a strong stage for ongoing joint management and working together to understand our shared country.

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Above left Humpback whales migrate through the Kimberley region.
Photo – David Bettini

Above Water cascading off the reef at Tallon Island.
Photo – Tubagus Solihuddin/Curtin University



Surveying fringing reefs

The Kimberley is broadly recognised as an important coral reef province, which houses extensive fringing reef around a highly indented rocky coastline with many islands, seagrass beds and mangroves. However, these habitats and the ecological communities they contain remain largely unexplored across most of this vast area.

KMRP studies focused on understanding the unique fringing coral reefs of Kimberley coastal waters, which appear to thrive, despite the extreme environmental conditions caused by large tidal movements and the prolonged exposure of extensive intertidal areas to daytime heat, cyclones, elevated water temperatures and large amounts of sediment runoff from inlets and rivers creating a turbid environment.

While seafloor habitats of the Kimberley are diverse, many are

dominated by patchily distributed sponges and other filter feeders, where many new species are being identified. Almost 2200 species or nominal species were identified from the three areas that were sampled, with sponges, echinoderms, molluscs and crustaceans accounting for 83 per cent of these species.

The force and flow of the water (hydrodynamics) in this system strongly influence the distribution of organisms and how populations are connected. For example, there is little genetic connection between the Dampier Peninsula and Buccaneer Archipelago regions for a range of species. This is most likely due to the extreme environmental conditions, such as currents, turbidity and the periodic discharge of freshwater, at the mouth of King Sound that effectively forms a barrier to dispersal and movement.

SEAGRASS

Seagrasses, macroalgae and microalgae are important benthic (or seabed) primary producers of the Kimberley. The seagrasses *Enhalus acoroides* and *Thalassia hemprichii* (turtle grass) both grow very rapidly and can produce up to two centimetres of leaf growth a day. However, despite being abundant on nearshore reefs, scientists found that both species exist near the limit of their thermal tolerance in the harsh Kimberley environment.

Despite the pressure they are under from such extreme temperatures, these seagrasses appear to thrive and, importantly, provide food and habitat for populations of dugongs, turtles and fish, including the rabbitfish, which is a common food source for local Aboriginal communities. Remarkably, this KMRP research found that the rate of grazing on seagrass was higher in the southern Kimberley at times than anywhere else currently known in the world. In fact, the average consumption of turtle grass actually outstripped growth in some areas, demonstrating the critically important ecological role that this seagrass plays in the region.





CORAL REEF

The distinctive geomorphology of the Kimberley strongly influences how and where coral reefs form in the region. More than 850 nearshore reefs and 2413 islands were mapped as part of the KMRP, comprising 1950 square-kilometres of reef from Cape Londonderry to Cape Leveque – the largest reef system in WA and the second largest reef system in Australia. Most Kimberley reefs occur within 15 kilometres of the coast and have developed a distinctive range of geomorphologies due to underlying substrates, patterns of water movement and turbidity, which will have implications for future management of these reefs. Most importantly, their common proximity to the coast makes them potentially more susceptible to terrestrial influences caused by land use.

Like all other coral reefs in the world, those in the Kimberley are becoming increasingly susceptible to bleaching events caused by gradually increasing water temperature and episodic warm water events. While bleaching events in the Kimberley region are not as well documented as events in other areas, such as the Great Barrier Reef, we do know that coral bleaching has occurred in recent years. For example, regional-scale coral bleaching occurred on inshore Kimberley reefs during the summer of 2015–16, when most coral reefs in the southern Kimberley experienced 30 to 60 per cent bleaching.

DBCA's Biodiversity and Conservation Science marine monitoring program is being implemented as part of marine reserve management in the Kimberley, and will help managers to understand this better. Encouragingly, KMRP research found that calcification rates of Kimberley region corals have been stable over the past 100 years and similar to corals from less extreme reef environments. This suggests they can recover from such impacts. However, while it seems that Kimberley corals have a remarkable ability to thrive under extreme conditions that many other corals would not survive, they are still threatened by the increasing frequency of marine events associated with climate change.

The researchers found that adaptation to the extreme daily temperature range of the Kimberley meant that intertidal corals exhibited greater resistance to heat stress, and that intertidal corals recovered faster from the bleaching events than subtidal corals.

Research will continue to explore the physiological and genetic mechanisms underlying the exceptional heat tolerance of Kimberley corals through collaborations initiated under the KMRP.

Previous page

Above left Long Reef at low tide. *Photo – Col Roberts/Lochman Transparencies* **Left** Turtle seagrass. *Photo – Mat Vanderklift/CSIRO*

Above The North Kimberley is home to a myriad of coral species. **Above inset** The Kimberley has experienced coral bleaching. *Photos – Clay Bryce/Lochman Transparencies* **Right** Training activities undertaken during WAMSI field trips included data collection. *Photo – Tony Tucker/DBCA* **Far right** DBCA vessel *PV Wamdoom* at Kings Cascade, Prince Regent National Park. *Photo – DBCA*

Social research

Managing the environment relies on understanding the spatial and temporal patterns of human use, how people value the region and their aspirations for it. For the Kimberley, this recognises the strong connection to and stewardship of saltwater country held by traditional owners, along with the appreciation for the substantial knowledge they have about the marine and coastal environment. Research on social values highlighted the biodiversity and the physical landscape of the Kimberley coast and marine waters as key, with strong support for marine and coastal protection and conservation along the whole coastline. Visitor use of the Kimberley was found to have a strong seasonal influence and was focused at relatively few sites around population centres, tourist accommodation or road access to the coast. These findings can support management for the future to preserve biodiversity values and manage potential impacts.

Traditional owners were key participants in the KMRP, most notably through a project led by seven saltwater country groups to improve the ways in which research and monitoring of the natural and cultural resources of the Kimberley are planned, assessed and undertaken to include both Indigenous and western science partners. The project produced a rich legacy of strong partnerships between scientists and traditional owners as well as a set of protocols around right-way research and integrating Indigenous knowledge with western science.



Iconic megafauna



Large marine animals are valued for their biodiversity significance, contribution to marine tourism and education, and high cultural significance, including as a traditional food source in some cases. In the Kimberley, iconic species include humpback whales, coastal dolphins, dugong, marine turtles, crocodiles and shorebirds.

These species may be migratory, with wide distributions that cross national and international jurisdictions. Some are considered to be threatened and all are protected by state and/or federal legislation, or are subject to international conservation and management agreements. KMRP research focused on improving knowledge of the distribution and abundance of these species in the region and the importance of different marine and coastal habitats to them.

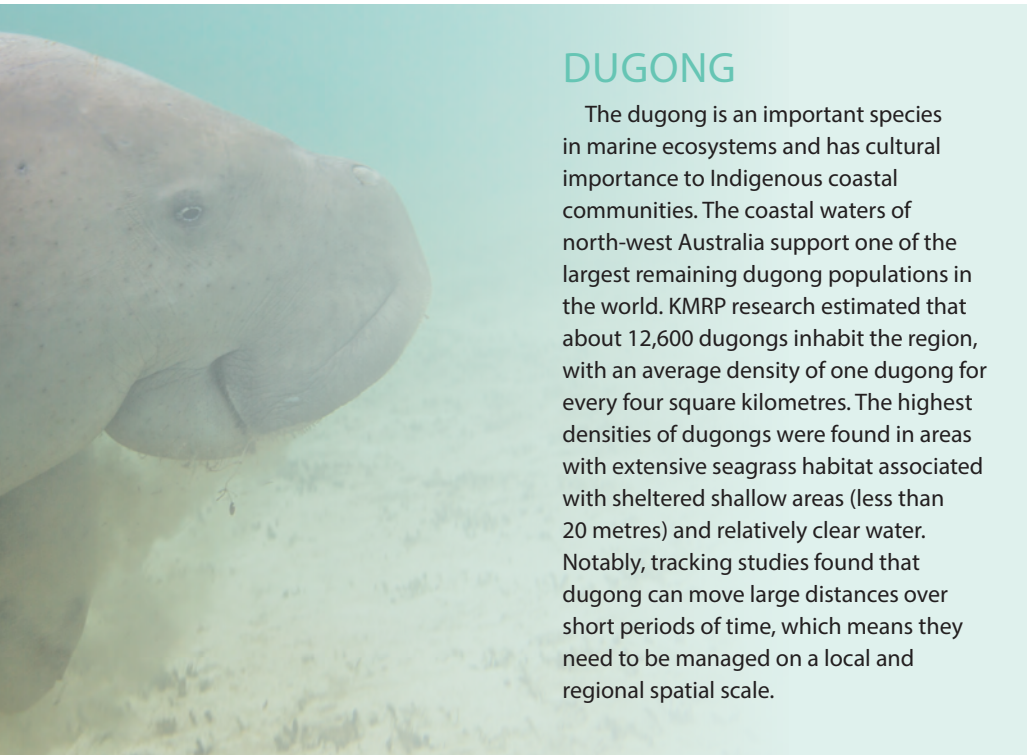
WHALES

Researchers used spatial models that integrated 13 years of aerial and shipboard humpback whale surveys to create distribution and density maps to better understand what drives their distribution and abundance in the Kimberley. This study confirmed that Camden Sound, and its surrounds, is an important calving area for humpback whales, particularly in August. The research also indicated that calving occurs southwards along the Dampier Peninsula. Pender Bay was found to be suitable for humpback whales across the entire breeding season, and is used for resting and transiting.



New tools for research and monitoring

Not only has the KMRP produced a wealth of knowledge and background information on the Kimberley, but it has also been instrumental in developing new tools that can be used in ongoing research and monitoring – an example of the impact of science. A new method of collecting biopsy samples from crocodiles to investigate genetic relationships within and between populations was developed by DBCA scientists. Satellite imagery was explored as a cost-effective method to count humpback whales and better understand population changes over time. A range of monitoring techniques has been developed and shared with Indigenous rangers and DBCA staff to be used in long-term and regional monitoring programs such as the use of drop cameras to assess coral and other seafloor habitats.



DUGONG

The dugong is an important species in marine ecosystems and has cultural importance to Indigenous coastal communities. The coastal waters of north-west Australia support one of the largest remaining dugong populations in the world. KMRP research estimated that about 12,600 dugongs inhabit the region, with an average density of one dugong for every four square kilometres. The highest densities of dugongs were found in areas with extensive seagrass habitat associated with sheltered shallow areas (less than 20 metres) and relatively clear water. Notably, tracking studies found that dugong can move large distances over short periods of time, which means they need to be managed on a local and regional spatial scale.



MARINE TURTLES

While marine turtles nest on beaches throughout the Kimberley, the most important turtle rookeries were found to be at Cape Domett, where flatback turtles nest during winter, the Lacapede Islands, where green turtles nest during the summer, and Eighty Mile Beach where flatback turtles nest during the summer. The biggest pressure facing turtles in the Kimberley is likely to be an increase in temperature caused by climate change; warmer sand at nesting beaches can skew sex ratios of hatchlings to be predominately female, increase embryo mortality and potentially shift the distribution of nesting.

As a result, these areas have been flagged as a high priority for long-term monitoring to provide an indication of the impact of climate change on the system.

Previous page

Far left Humpback whales are known to calve in Camden Sound. *Photo – DBCA*

Inset The great knot is one of the shorebirds that occurs in the Kimberley. *Photo – Danny Barrow*

Below left A new method of collecting biopsy samples has been developed. *Photo – DBCA*

Photo – DBCA

Top left About 12,600 dugong are thought to live in the Kimberley. *Photo – Guy Skillen*

Left Saltwater crocodile. *Photo – David Bettini*

Above A flatback turtle hatchling. *Photo – DBCA*

Photo – DBCA



ESTUARINE CROCODILES

Estuarine crocodiles were protected in Australia in 1969 after an extended period of unregulated hunting depleted their numbers across northern Australia, including the Kimberley (see 'Snapping back', *LANDSCOPE*, Spring 2017). KMRP research found that the population and size of estuarine crocodiles in the region has increased since the 1980s when crocodiles in the area were last surveyed. More than twice as many crocodiles were counted in the Prince Regent and Roe Hunter rivers during surveys in 2015 than in 1986, and the higher number of large crocodiles (greater than 1.8 metres) seen more recently suggests the populations have a mature size structure.

This is pleasing. However, recovery in these river systems does not match that of populations in the Northern Territory in terms of density or biomass, which tells us that the recovery process is continuing.

It is likely that the unique environment and the scarcity of appropriate nesting habitat in the West Kimberley will probably limit the Western Australian populations. In addition, it is likely that the number of interactions between crocodiles and humans will increase, as the crocodile population recovers and the human population increases and expands. In order to manage this conflicting demand on habitat, more information about the amount of available nesting habitat throughout the region will be needed, and additional river systems will need to be surveyed.

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For more information on the KMRP and program findings and outcomes visit www.wamsi.org.au and download the final synthesis report.

Super highway: *safe passage for possums*

A newly installed rope bridge over Beelias Drive in the City of Cockburn provides a safe passage for local possums between Yangebup Lake and Kogolup Lake within Beelias Regional Park.

by Rhianna King





Well before the advent of motorcars and their associated infrastructure, brushtail possums (*Trichosurus vulpecula*) were known as ‘koomal’ by the local Aboriginal people who used the area now known as Beeliam Regional Park for camping, to source food and other materials, and as a trade route. Brushtail possums are believed to have been common in the region but, like so many other native animals, they have been impacted by urban development, increased habitat fragmentation and introduced predators such as feral cats and foxes.

FACTS AND FIGURES

In October 2018, the City of Cockburn conducted monitoring in the 142-hectare reserve to the north of Beeliam Drive, which takes in Yangebup Lake, and the 187-hectare area to the road’s south that surrounds Kogolup Lake. The survey, which was carried out over three weeks, detected 15 brushtail possums in the southern area but none in the northern section.

In order to encourage free movement of the possums between the two fragments of suitable habitat and reduce the risk of them being killed or injured by cars as they cross the busy suburban thoroughfare, the City of Cockburn has installed a 34-metre rope ladder across the four-lane Beeliam Drive.



Left Brushtail possums were once common in the area.

Photo – David Bettini

Below left Beeliam Regional Park comprises 19 lakes and other associated wetlands.

Photo – Ann Storrie

Above The possum highway stretches across Beeliam Drive.

Photo – DBCA

INSTALLING THE BRIDGE

While novel, possum bridges are not new; they have been used successfully in the State’s south-west at Dawesville, and on Caves Road between Busselton and Dunsborough, as well as in other parts of Australia.

The 20-centimetre-wide cable-tensioned rope bridge selected for Beeliam was constructed by Nationwide Netbuilders, which has supplied fauna bridges and animal crossings for use throughout Australia. The company



“Providing the possums with a safe passage between the two areas will give them the best chance for long-term survival.”

has worked with government bodies, construction groups and universities to develop the ladder-style design, which ensures the safety of the animals and the passing traffic underneath.

The ladder is suspended between two 8.7-metre-tall wooden poles, which were installed by Cockburn-based Future Power – a family-owned company that typically works with powerlines but was only too happy to assist with this project. Because the closure of Beeliar Drive was necessary to install the bridge, the project was completed between 10pm Saturday night and 5am Sunday morning and in consultation with Main Roads.

The site for the bridge – about 200 metres east of Dunraven Drive – was selected so that ropes could also be anchored to suitable habitat trees. This provides the possums with access to the structure without them having to descend to the ground below.

REASONS AND RATIONALE

Providing the possums with safe passage between the two areas will give them the best chance for long-term survival in the area. Not only will the bridge reduce the number of possums that

are killed and injured by cars as they try to cross the road, it will also offer protection from the introduced predators, such as foxes and feral cats, that prey on them.

In addition, enabling movement between the two bushland areas will improve the breeding prospects and increase the population’s genetic diversity, which can be hampered when species are confined to small, isolated pockets.

BUILD IT AND THEY WILL COME

It is expected to take some time for the possums to figure out how to use the bridge, but the City of Cockburn is confident that, as has occurred at other sites, once they begin to use it, the possums will travel freely between the two reserves.

There are plans to erect a motion-sensing camera to monitor the possums’ movement across the bridge. And possums that were trapped during the survey were fitted with microchips that will be scanned by microchip readers on the bridge when they are installed in the future.

In the meantime, road users are encouraged to get in contact with the City of Cockburn to report any sightings of possums on the bridge.



Top left The bridge was constructed at night to minimise disruption to traffic.

Photo – City of Cockburn

Top Brushtail possums.

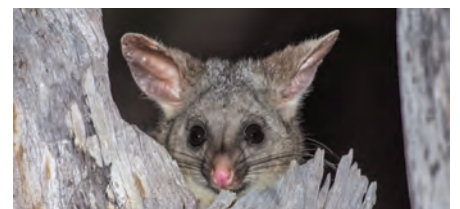
Photo – Jiri Lochman

Above The highway is suspended between two 8.7-metre-tall poles.

Photo – City of Cockburn

Below Possums trapped during the survey were fitted with microchips so they can be monitored in the future.

Photo – Jiri Lochman



Rhianna King is a LANDSCOPE editor and can be contacted by email (rhianna.king@dbca.wa.gov.au)



Rescuing

a cockie in crisis



A rescue effort to free a Carnaby's cockatoo from a tight spot also demonstrated the value of rehabilitation and ongoing monitoring for this endangered species.

by Rhianna King and Matt Swan



On Tuesday 15 October 2019, a call came into DBCA's Wildlife Protection Branch in Kensington from a colleague at the nearby Department of Primary Industries and Regional Development (DPIRD) offices to report there was a bird stuck in one of the building's exhaust chimneys. Staff had heard scratching and squawking from within the eight-to-nine-metre-tall metal chimney for up to 24 hours and had observed another bird – a male Carnaby's cockatoo (*Calyptorhynchus latirostris*) – hanging around the entrance of the cylinder.

.....
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Main Carnaby's cockatoos mate for life.

Photo – Rick Dawson/DBCA

Insets from left The sound of a bird scratching and squawking inside a chimney was detected in Kensington; DBCA staff used a drone to assess the location of the trapped bird; a cherry picker provided access to the top of the chimney; an improvised tool was used to remove the bird.

Photos – Matt Swan/DBCA and Riley Carter/DBCA

Above A male Carnaby's cockatoo was spotted around the entrance of the chimney.

Photo – Matt Swan/DBCA

Above right Accessing the chimney was a challenge overcome with the help of fire crews.

Photo – Riley Carter/DBCA

“... what captured the attention of the team was the silver band on her right leg and the orange and red ones on her left ... she had been rescued before.”

Knowing that Carnaby's cockatoos mate for life, it seemed likely that the bird stuck inside was a female who had been prospecting for a safe place to nest.

CALLING IN THE CAVALRY

DBCA wildlife officers Matt Swan and Riley Carter travelled to the site and liaised with the building's maintenance managers to workshop ways to safely rescue the trapped bird. By listening at the side of the chimney, Matt and Riley determined the bird was still alive. But, because the shaft was so tall, assessing the bird's situation and accessing it was a challenge.

The next step was to deploy a drone above the cylinder to get a better picture of the structure and its accidental inhabitant. The footage provided a clear picture of a miserable-looking female Carnaby's cockatoo that was trapped about a metre down from the entrance. Wildlife officers then enlisted experts in human rescues from the nearby Kensington Fire Station. A fire crew arrived on site, but they were not able to create a safe working environment to rescue the bird. So, they called in another

crew to bring in their cherry picker, to provide deeper and safer access. Armed with an improvised tool fashioned to extract the bird, Matt ascended on the cherry picker, leant over the edge of the chimney, hooked the tool around the bird and lifted it to freedom.

On initial inspection, the bird did not appear to have any obvious sign of injury or trauma, but a health check and flight test at Perth Zoo would confirm that. Instead, what captured the attention of the team was the silver band on her right leg and the orange and red ones on her left. These bands indicated that this was not the bird's first time in trouble; she had been rescued before.

BANDED BIRD

The bird was transported to Perth Zoo where it was confirmed that she had not sustained any injuries. The Perth Zoo assesses and treats more than 250 endangered wild cockatoos each year that have been hit by cars, shot, injured in accidents and even electrocuted.

Those that can be rehabilitated are cared for by registered wildlife carers and



Top Drone vision revealed that the female Carnaby's cockatoo was wedged about a metre down the chimney.

Photo – Peter Nicholas/DBCA

Above DCBA wildlife officer Matt Swan with Fire and Rescue crew members.

Photo – Riley Carter/DBCA

Above right Male Carnaby's cockatoos have a red ring around their eyes, while females have a dark ring.

Photo – Rick Dawson/DBCA

Right The rescued Carnaby's cockatoo was assessed by vets at Perth Zoo.

Photo – Matt Swan/DBCA

Far right Kensington is a known roost for Carnaby's cockatoos.

Photo – Rick Dawson/DBCA

released back into the wild. But, before they're set free, they are fitted with a uniquely numbered leg band.

Perth Zoo Science zoologist Peter Mawson, who has been researching Carnaby's cockatoos since 1996, checked the database for the numbers on the leg bands of the rescued bird, and identified her as 'Female 320-01494'.

Mates for life

Black cockatoo species can live for 30 to 40 years in the wild and they partner with a mate for life. They reach sexual maturity at as young as three years old and typically lay two eggs a year. Usually both eggs hatch, but only one survives to fledge at about 10 weeks. The chick stays with its parents until the next breeding season.

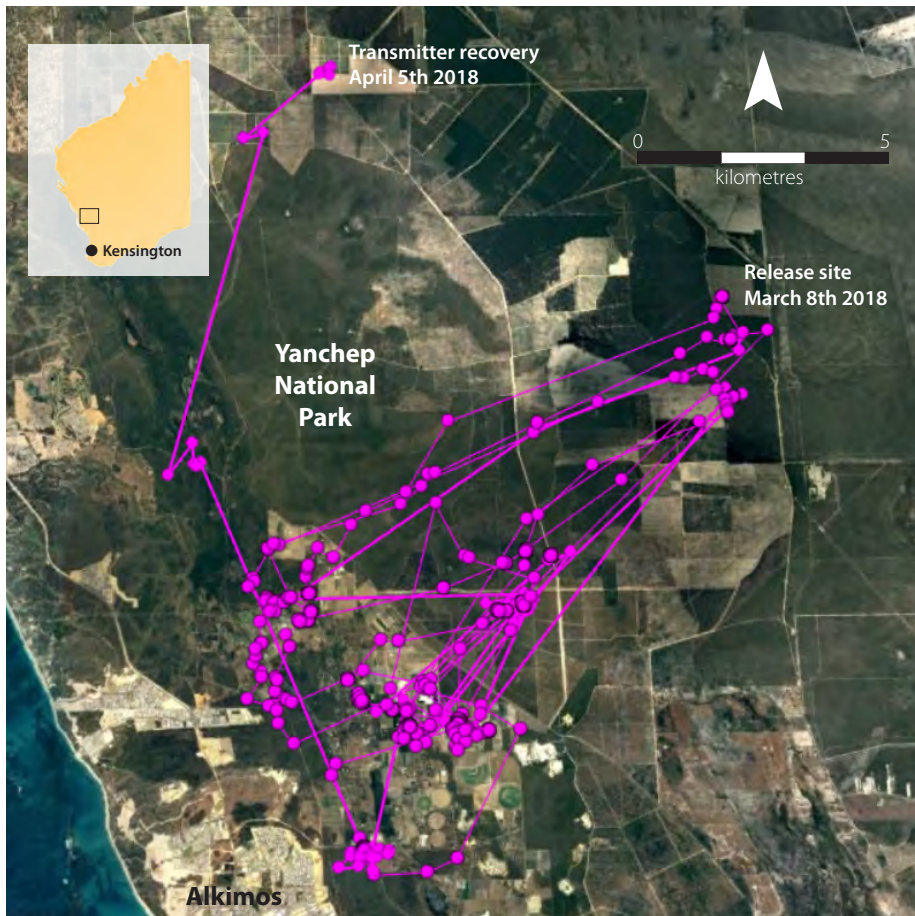
Interestingly, when Perth Zoo vets examined Female 320-01494, they found food in her crop (a pouch for storing food near the throat). This suggests that her mate was bringing food to sustain her while she was trapped.



Hear more about the rescue

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





Left Female 320-01494's flight path, which was tracked between 8 March 2018 and 5 April 2018 by a satellite transmitter that was fitted to her tail feathers.

Map courtesy of Karen Riley/Murdoch University

Above Female 320-01494 was released at Pinjar pine plantation on 8 March 2018.

Photo – Karen Riley/Murdoch University

Below left Artificial hollows have been developed and installed in areas where Carnaby's cockatoos are known to breed.

Photo – Matt Swan/DBCA

Artificial hollows

In his early research on Carnaby's cockatoos, Dr Denis Saunders observed that females return to the same hollow each year to breed, provided it is available and their last breeding attempt was successful.

However, as part of long-term research at Coomallo Creek – an area north of Badgingarra, which is one of the State's most important cockatoo breeding sites – Denis, Rick Dawson and Peter Mawson observed that the number of hollows available were declining. Carnaby's cockatoos were having to compete with other bird species, such as galahs and long-billed corellas, that were being displaced by land clearing, and with feral European honey bees that were taking over hollows.

The research team, ably assisted by volunteers from Palm Beach Rotary Club, got to work to restore derelict natural hollows and expand their focus and experiment with artificial ones to establish if availability of breeding sites was limiting the size of the breeding population. The team worked with Francis Schmidt and volunteers from Serpentine-Jarrahdale Landcare to refine the design and procure the most suitable materials to build hollows that would be large enough for the female to lay and tend to her eggs and nestlings but provide protection from the elements. Denis, Rick and Peter established that breeding sites were a limiting resource. Since the team began the project in 2011, the number of breeding attempts in the area has doubled from 53 in 2011 to 107 in 2018. In the breeding season of 2018, artificial hollows provided 46 per cent of available hollows and 60 per cent of breeding attempts were made in them. Breeding success of birds nesting in artificial hollows is the same as those using natural hollows.



CHECKERED PAST

Female 320-01494 was first rescued on 24 September 2016, when she was less than five years old. She was found caught in a wire fence outside a now-closed restaurant in Caversham and had minor injuries, from which she recovered fully during a stint at Kaarakin Black Cockatoo Conservation Centre.

On 8 March 2018, a satellite tag was fitted to her tail feathers and she was released as part of a Murdoch University PhD research project trial at Pinjar pine plantation. On 4 April 2018, the satellite tag was recovered from Gnanagara pines; it had most likely been shed as part of her annual moult. She had not been recorded again until she reappeared in the Kensington chimney.

After a quick visit to the Perth Zoo, where she was given a clean bill of health, the bird was returned to Kensington where, after a couple of squawks, she flew off to reunite with her mate.

It is encouraging to observe that Female 320-01494 has recovered from



Above Carnaby's cockatoos are experts at biting and tearing open seeds and cones.

Right Carnaby's cockatoos differ from Baudin's cockatoos by the length of their bills.

Below right Carnaby's cockatoos can often be heard before they are seen while flying overhead.

Photos – Rick Dawson/DBCA

Species in decline

It's not uncommon for landholders to describe how in the early- to mid-1900s, flocks of Carnaby's cockatoos would blacken the sky as they flew overhead filling the air with their raucous screeching. During the 1960s and 1970s they were considered vermin, for their impact on apple and pear orchards, almond crops and pine plantations. In fact, they were considered such a nuisance that, for a time, they even had a bounty on their beaks.

However, in the late 1960s and most of the 1970s, Carnaby's cockatoo breeding and feeding habitat was cleared for agriculture at a rate that Dr Denis Saunders puts at 400,000 hectares per year.

By the mid-1980s, the species had disappeared from more than 30 per cent of its range and numbers had declined so dramatically that it was declared 'endangered' at state and federal level.

Nowadays, their range is believed to be half of what it was and the species continues to be impacted by habitat loss, competition for hollows (see also 'Artificial hollows' on page 26), bushfire and risks associated with living among humans.



her 2016 injuries, found a mate and is demonstrating breeding behaviour; this proves that every rehabilitated bird can be an asset to the wild population. However, according to Dr Denis Saunders, who has been surveying the species for more than 50 years, this is the first recorded attempt of a Carnaby's cockatoo to nest this close to the CBD.

We know that female Carnaby's return with their partners to the area in which they were born. So one theory for why she became trapped in the chimney was that she was searching for a suitable nest hollow but has not learned the traditional migration path inland from her mother, because she entered rehabilitation at the start of the 2016 breeding season so missed the first migration.

KEEPING THEM WILD

Carnaby's cockatoos typically nest in remnant woodland vegetation in the inland parts of their range, where the annual rainfall is between 350 and 700 millimetres and the trees are estimated to be 100 to

200 years old. Around suburbia there is not the availability of food that is needed to nurture young during the breeding season. That is why attempts to support their breeding through artificial hollows are focused in natural habitat in regional areas, such as at Coomallo Creek, and why nesting hollows are not installed in and around the city (see 'Artificial hollows' on page 26). If this practice were to be adopted, we would disrupt their natural nesting patterns and behaviour, and compromise the species' survival. In the same way, feeding native wildlife is an offence under the Biodiversity Conservation Act, because if we encourage birds to eat from backyards they will lose the instinct for finding their own food.

So, while Female 320-01494 enjoys her third chance at life, DPIRD is taking steps to cover the top of the chimney, and members of the public are encouraged to provide details of any banded cockatoos they see and report any sick or injured ones to the Wildcare Helpline.

Have you seen sick or injured native wildlife?

Please contact the Wildcare Helpline on (08) 9474 9055.

The Wildcare Helpline provides a service for the public who find sick or injured native wildlife and are seeking advice on what to do or where to find care for the animal.

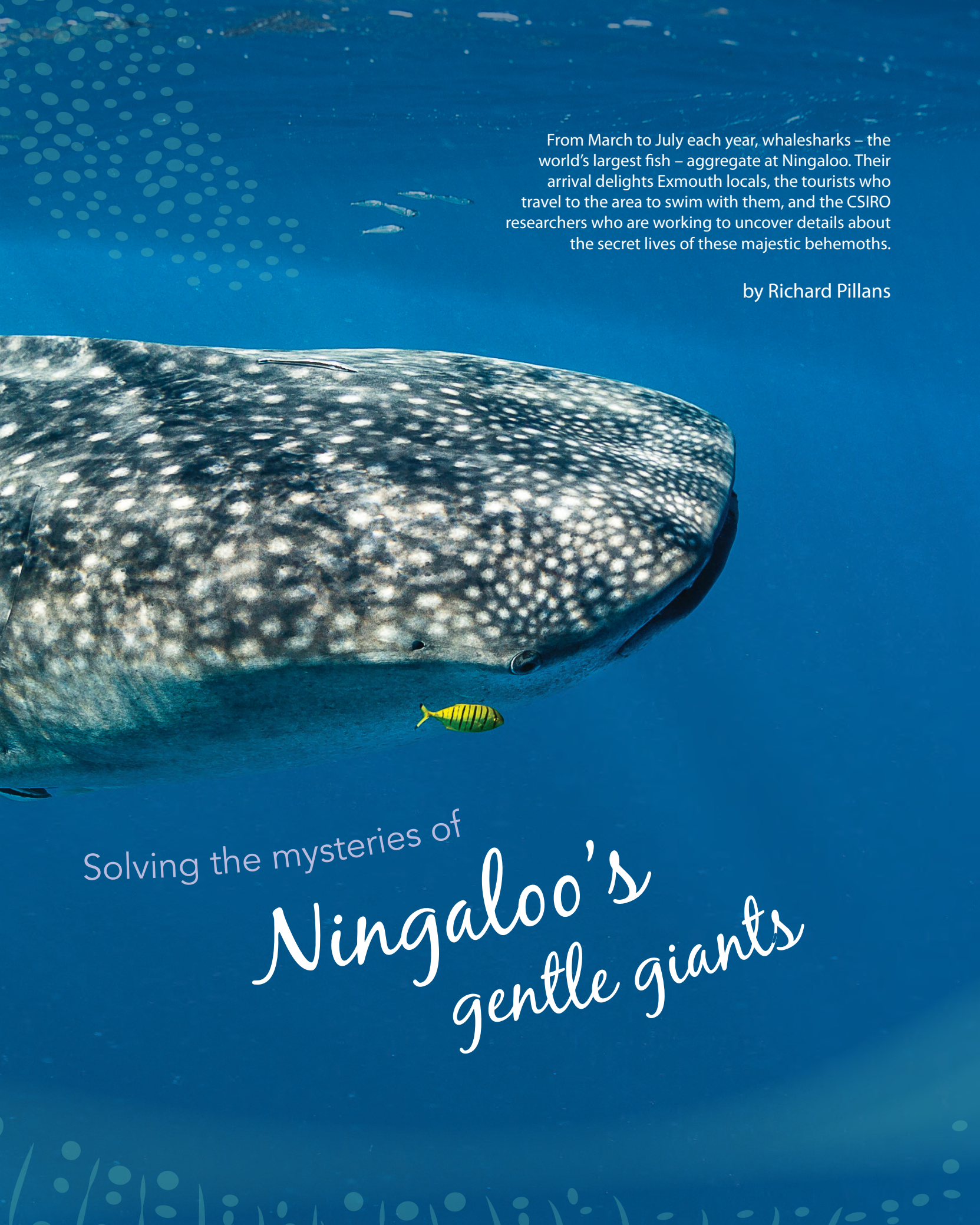
You can download the Wildcare Helpline app to your smart phone by visiting the App Store or Google Play Store.



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From March to July each year, whalesharks – the world's largest fish – aggregate at Ningaloo. Their arrival delights Exmouth locals, the tourists who travel to the area to swim with them, and the CSIRO researchers who are working to uncover details about the secret lives of these majestic behemoths.

by Richard Pillans

Solving the mysteries of

Ningaloo's gentle giants

While individual whale sharks (*Rhincodon typus*) are found off the Ningaloo coast year round, the aggregation of large numbers of sharks begins in March when they can be regularly seen until about July–August. Their arrival coincides with an increased abundance of zooplankton, which occurs as a result of stronger Leeuwin Current flow and increased upwelling (when deep, colder water rises to the surface) as the southward flowing Leeuwin Current meets the northward flowing Ningaloo Current.

Large aggregations of actively feeding whale sharks can often be seen, with feeding activity peaking at dusk. Genetic barcoding has identified tropical krill *Pseudeuphausia latifrons* in the faecal samples of whale sharks at Ningaloo.

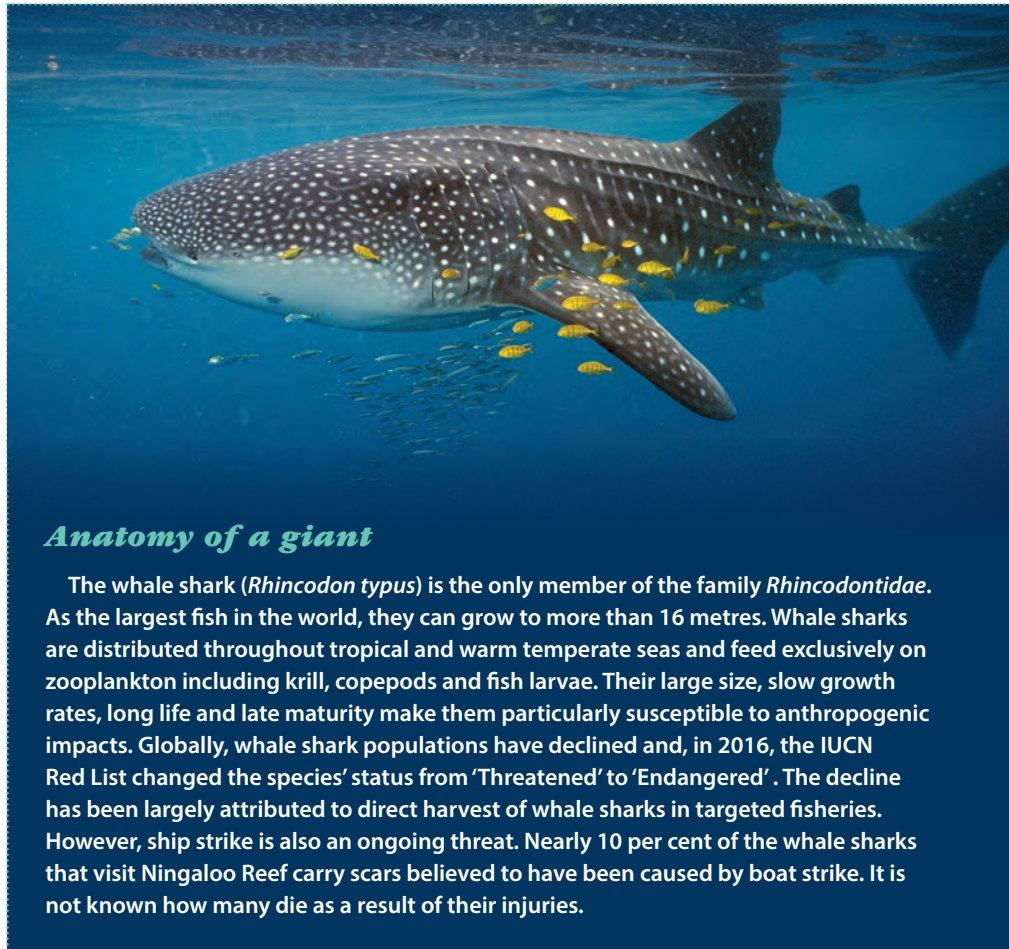
How many whale sharks visit the area depends on the Southern Oscillation Index; more sharks are observed during El Niño years when upwelling is enhanced.

VIEWING THE VISITING WHALE SHARKS

Ningaloo Marine Park and the adjacent Cape Range National Park provide many nature-based activities for visitors to enjoy. The pristine beaches, turquoise waters and diverse and abundant marine life draw thousands of visitors to the area each year.

The regularity and predictability of the whale shark aggregation led to Ningaloo becoming one of the first places to offer in-water interactions with whale sharks. Whale sharks, manta rays and humpback whales play a key role in Ningaloo’s ecotourism industry, which is an important component of the regional economy.

Established in 1989, the industry grew quickly and the number of people swimming with whale sharks each year has increased to nearly 32,000 in 2018. The total direct expenditure by tourists in the whale shark industry in 2014 was estimated to be more than \$11.5 million per year with an additional \$12.5 million spent in the region by tourists for whom the



Anatomy of a giant

The whale shark (*Rhincodon typus*) is the only member of the family *Rhincodontidae*. As the largest fish in the world, they can grow to more than 16 metres. Whale sharks are distributed throughout tropical and warm temperate seas and feed exclusively on zooplankton including krill, copepods and fish larvae. Their large size, slow growth rates, long life and late maturity make them particularly susceptible to anthropogenic impacts. Globally, whale shark populations have declined and, in 2016, the IUCN Red List changed the species’ status from ‘Threatened’ to ‘Endangered’. The decline has been largely attributed to direct harvest of whale sharks in targeted fisheries. However, ship strike is also an ongoing threat. Nearly 10 per cent of the whale sharks that visit Ningaloo Reef carry scars believed to have been caused by boat strike. It is not known how many die as a result of their injuries.

opportunity to snorkel with whale sharks was the primary motivation for their trip.

The management of whale shark watching at Ningaloo is widely recognised as a world-leading example of good practice ecologically sustainable whale shark ecotourism. Only 15 licences are issued for whale shark watching vessels along Ningaloo and there are strict conditions imposed. These conditions regulate how many vessels are permitted near each whale shark (one), how many people can be in the water (maximum of 10), how close they can get to the whale shark (no closer than three metres, and no diving underneath the animal), how people can interact with them (no flash photography and no blocking their path) and regulates appropriate boat positioning, speed and track of vessels relative to the whale shark. A user fee for each customer (\$18 per ticket for adults) is used to facilitate management of the industry and support sustainable ecotourism.

WHO’S WHO IN THE ZOO

In any given year, several hundred whale sharks will visit Ningaloo; the exact number remains a mystery with more sharks seen in some years than others. Male sharks and rays have external reproductive organs (claspers), which means they can be visually sexed. This enables researchers to determine how many of the visiting whale sharks are male, and how many are sexually mature.

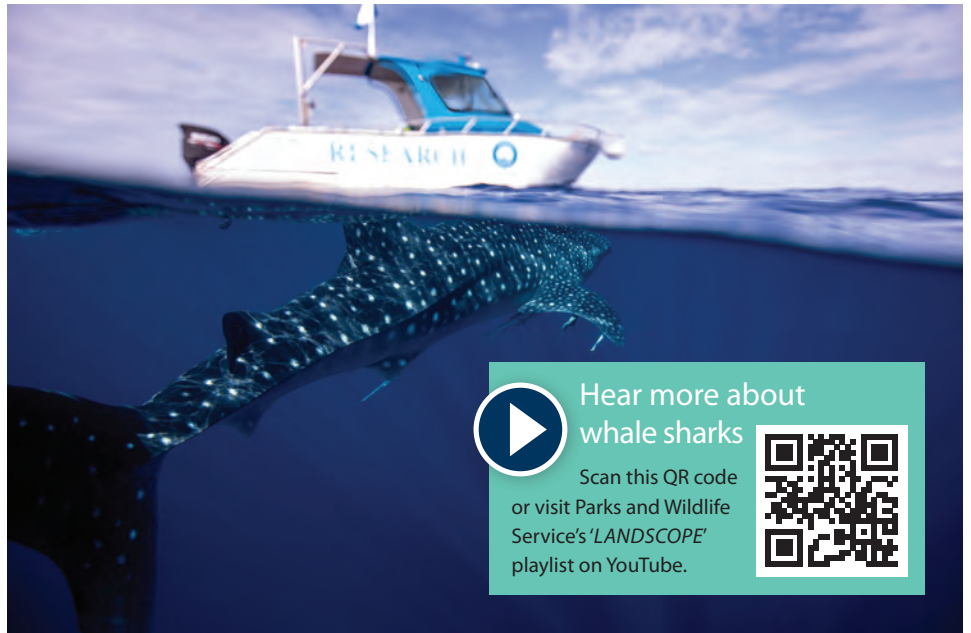
Sexually mature males have long, calcified claspers that extend well past the ventral fin. Based on visual observations, the whale sharks that visit Ningaloo are

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Previous page

Main A gentle giant at Ningaloo.
Photo – Matt Kleczkowski

Above Whale sharks can grow more than 16 metres, making them the largest fish in the world.

Photo – Geoff Taylor/Lochman Transparencies



Hear more about whale sharks

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



“The regularity and predictability of whale shark aggregation led to Ningaloo becoming one of the first places to offer in-water interactions with whale sharks ... The management of whale shark watching at Ningaloo is widely recognised as a world-leading example of good practice ecologically sustainable whale shark ecotourism.”

primarily male (80 per cent), of which most are immature (74–85 per cent); only about 10 per cent of the males are sexually mature.

Mature females make up fewer than one per cent of the visiting population. These females are typically encountered in open sea environments and reported sightings of pregnant females usually originate from oceanic islands surrounded by deep water, such as the Galapagos and Saint Helena islands.

Size and sex segregation in whale sharks has been observed globally and suggest that both ontogenetic and sex-specific habitat or dietary shifts are present in the species. Where mating and birthing occurs remain two of the mysteries of whale shark biology. However, a large mature male whale shark was recently observed trying to mate with a smaller immature female shark (see ‘A love story. Or not?’ on page 33). While the immature female was exhibiting escape or avoidance behaviour, and so it

was not a successful mating union, the event indicates that male whale sharks at Ningaloo will attempt to mate.

SPOTTING INDIVIDUALS

Each whale shark’s spot and stripe pattern is unique, which means individuals can be identified from photographs. The *Wildbook for Whale Sharks* database (www.whaleshark.org) is a platform where photographs can be uploaded and individual sharks identified.

Researchers, including from CSIRO, have used this technique to identify more than 1000 individuals at Ningaloo over the past 20 years, with many individuals returning year after year.

Identifying individuals by their unique patterns has also enabled researchers to estimate population trends. However, results from different studies vary, with some suggesting a decline and others an increase. Regardless of the results, these studies only provide information about the whale sharks that return to the same area;

World recognition for Ningaloo

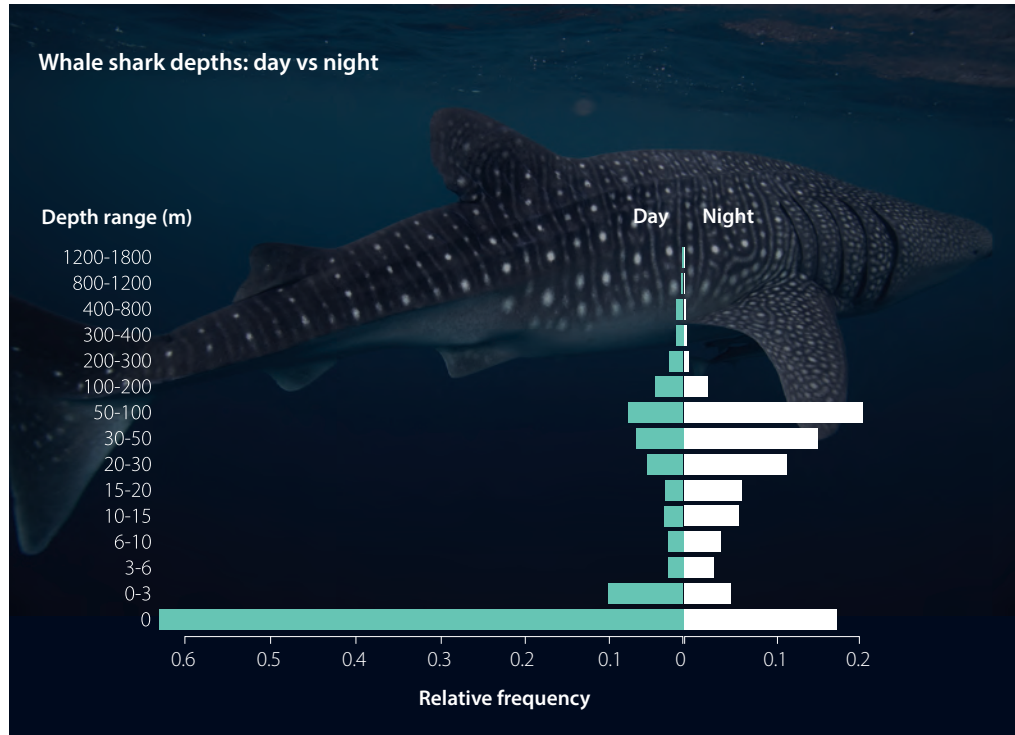
Ningaloo Reef is contained within the Ningaloo Coast World Heritage Area, which includes terrestrial and marine habitats and was inscribed in part because of the high diversity of iconic megafauna including sharks, whales, turtles and whale sharks. Predictable aggregations of whale sharks along the Ningaloo coast were one of the ‘outstanding universal values’ that the Ningaloo Coast World Heritage Area was listed to protect.



Top left Claspers on a 8.5-metre male whale shark at Ningaloo Reef indicate this animal is approaching sexual maturity.

Top A four-metre-long juvenile whale shark takes an interest in CSIRO’s research vessel. *Photos – Richard Pillans/CSIRO*

Above A diverse range of iconic megafauna inhabit the waters of Ningaloo Marine Park. *Photo – Guy Skillen*



they do not provide insight into whale sharks that do not visit Ningaloo during their life or only visit infrequently.

CSIRO researchers have developed a method to study whale shark genetics that may help estimate population sizes, which will help determine the trajectory of the population. Researchers recently used this method to estimate the number of white sharks (*Carcharodon carcharias*) in Australia and have been collecting tissue samples, sex and length measurements from hundreds of whale sharks over the past three years as part of the CSIRO-BHP Ningaloo Outlook Partnership in order to conduct similar research on whale sharks at Ningaloo and the Indian Ocean. The data collected about the population sizes will help determine whether the whale shark population is continuing to decline following the IUCN listing to Endangered.

FAMILY MATTERS

The population of whale sharks at Ningaloo Reef is genetically identical to animals sampled throughout the Indian and Pacific oceans, which suggests there is mixing within the region. Despite genetic similarities, studies suggest that animals tagged at Ningaloo are confined to the

eastern Indian Ocean, and the Arafura and Timor seas. Whale sharks tagged at Ningaloo as part of the Ningaloo Outlook Partnership show long-distance movements, including to Indonesia and Timor Leste. However, most satellite-tagged whale sharks have stayed within 300 to 400 kilometres of Ningaloo. Any long-distance movements away from Ningaloo have been primarily northwards, towards Christmas Island, as well as east as far as the Arafura Sea and Gulf of Carpentaria. Southwards movements are less common, but some individuals have been recorded as far south as Perth during the summer months.

For all published records of satellite-tagged animals at Ningaloo, the extent spans 26.5 degrees of latitude (5.5° to 32°S) and 55 degrees of longitude (85° to 145°E). Tagging has demonstrated that individuals vary their movement patterns once they depart Ningaloo Reef. This suggests that individuals have developed their own strategy of finding sufficient food resources that involves swimming thousands of kilometres in different directions. Data from satellite tags show that some animals swim continuously at speeds of between two to four kilometres per hour in one direction for up to four

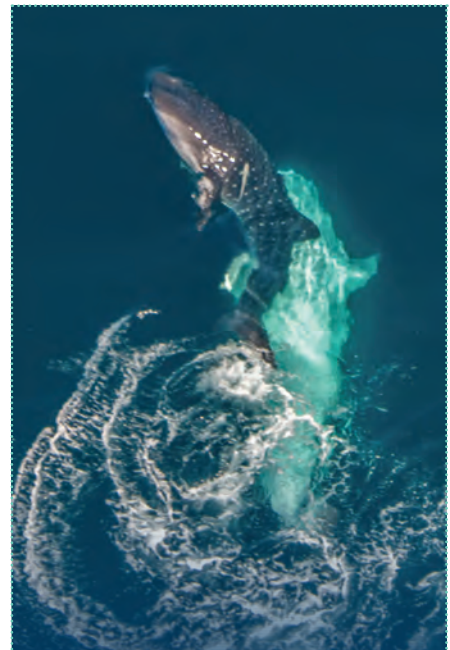
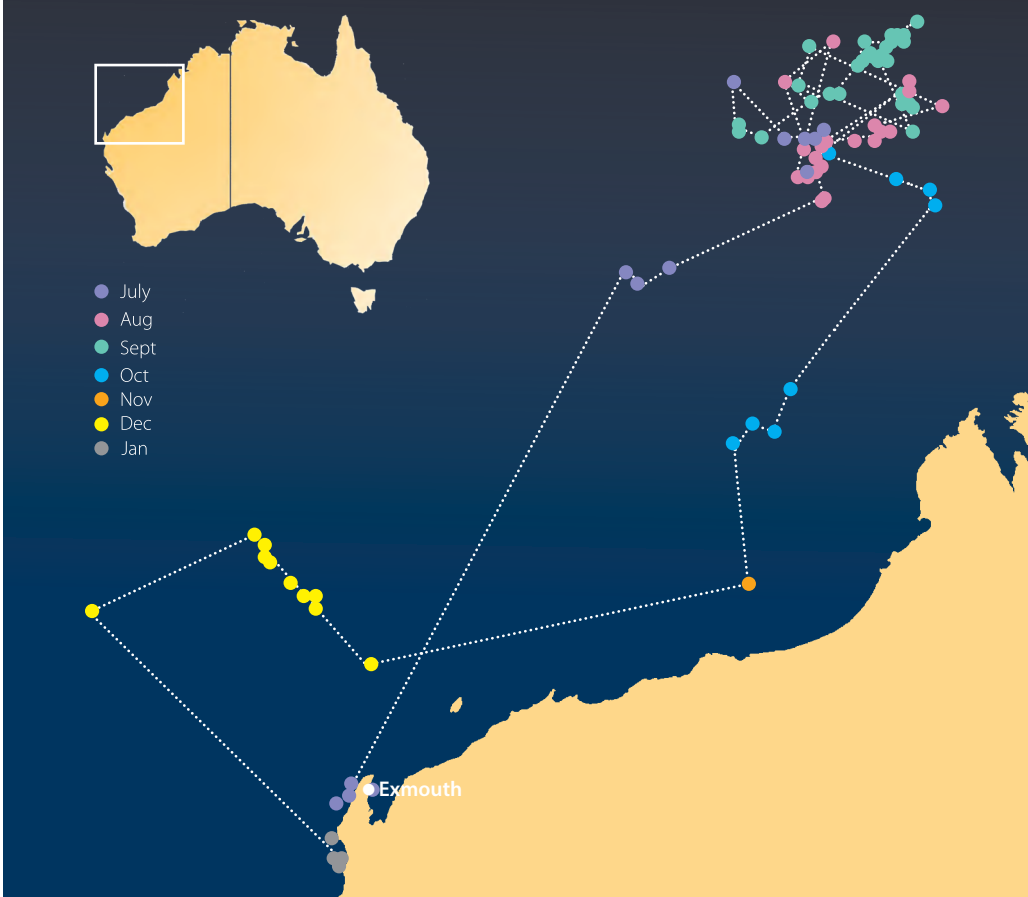
Above left Scarring on a juvenile whale shark hit by a small fast-moving vessel. The size of the scars can provide information about the type of vessel involved.

Above Summarised data from the recovered tag from 'Big Mumma' shows the proportion of time spent at different depths during the day and at night. Whale sharks spend more time at the surface during the day and dive deepest at dawn and dusk. At night they spend more time between 30 and 100 metres. Photos – Richard Pillans/CSIRO

weeks before reaching an area where they spend a few weeks to months before moving on. These long-distance treks in one direction suggest that whale sharks are guided by past experiences or an inherited ability to find sporadic and ephemeral patches of abundant zooplankton resources. Very little is known about why this occurs but it seems that the movements are independent of surface currents and only weakly correlated with sea-surface chlorophyll-a concentrations.

TAG: YOU'RE IT

Satellite tags are very useful for obtaining broadscale data on the



A love story. Or not?

Two of the many mysteries of whale sharks are where mating and pupping occurs. In June 2019, mating behaviour between a male and female shark was observed at Ningaloo for the first time. This encounter was captured on film by Ningaloo Aviation's Tiffany Klein. Photographs from the air as well as images taken by CSIRO enabled the two sharks to be identified and their lengths accurately measured. The male was a 9.5-metre mature shark with fully calcified claspers, however the female shark was only 6.5 metres long – about two metres shorter than whale sharks typically are at maturity.

Therefore, the female was too small to be reproductively active and, although growth rates in whale sharks are uncertain, it is likely that it would be at least another 10 years before the female is large enough to have offspring. These observations reflect attempted mating and it was not surprising that the female did not reciprocate the male's advances. It is unusual for sharks to attempt to mate with females that are not sexually mature. In many species, sexually mature males and females aggregate at specific times of the year with little evidence of mating occurring outside these times.

Above 'Big Mumma' was tracked off Ningaloo.
Data – CSIRO

Right DBCA's Dani Rob and Joe Morgan with 'Big Mumma's' satellite tag.
Photo – Dani Rob/DBCA

Far right Mating behaviour between a male and female shark was observed at Ningaloo in June 2019 for the first time.
Photo – Tiffany Klein/Ningaloo Aviation



movement and diving behaviour of marine animals. However, an animal's location can only be tracked when they are at the water's surface for long enough that orbiting satellites overhead can detect them, which is usually limited to a few times each day.

Other data, such as depth, temperature and light level, are recorded every 10 seconds and stored within the tags. However, only a tiny fraction of this information is transmitted back to the researcher via the satellite network and only in a highly summarised form. Therefore, recovering a tag and the data it stores is like hitting the jackpot for researchers.

CSIRO researchers from the Ningaloo Outlook team have recovered five satellite tags that were attached to whale sharks for up to 311 days. The data within these recovered tags are providing valuable new insight into both the horizontal and vertical (dive behaviour) movements throughout their journey along Ningaloo Reef and the whale sharks move as far away as Indonesia and Timor Leste.

Two of the tags that were recovered were found in the Ningaloo Marine Park by DBCA rangers. The first tag to be recovered had been attached to a seven-to eight-metre female whale shark known as 'Big Mumma' for seven months before it washed ashore north of Coral Bay. Much

Right CSIRO scientist Richard Pillans collecting a small tissue from a whale shark at Ningaloo Reef as part of the BHP-CSIRO Ningaloo Outlook Partnership.
Photo – Richard Pillans/CSIRO

Below Whale sharks have unique patterns, which enable researchers to identify and record individuals.
Photo – Guy Skillen

Below right Whale sharks are filter feeders.
Photo – Gary Bell/Oceanwide Images



to the excitement of the CSIRO researchers, the tag was found by DBCA staff who were tasked with the job of scouring the remote beach, which was covered in seaweed from a recent cyclone.

Data from the recovered tags showed that whale sharks moved between Ningaloo and offshore areas such as Ashmore Reef and Indonesia, diving to depths in excess of 1700 metres, where the water is a very chilly 3.5 degrees Celsius. The majority of these deep dives are fast, with the animal swimming down at a rate of 0.4 metres per second and then back up the surface at similar speeds. The reason for these deep, rapid dives is unknown but may be used to navigate the open ocean. Most deep dives occur

at dawn and dusk. Whale sharks dive much more often at night so their average depth at night is greater than during the day, when they are more likely to be at the surface and dive less frequently (see ‘Whale Shark depths: day vs night’ on page 32). Recovered tags have also revealed that whale sharks behave very differently when they are moving between areas (fast horizontal movement), compared with when they spend days to months in a confined area (slow horizontal movement). During sustained, long-distance swimming, the animals are mainly close to the surface with fewer slow dives. However, when they are within a confined area they dive more often and faster.

Data on the horizontal and vertical (dive) patterns of whale sharks in conjunction with data on shipping activity in north-west Australia are being used by CSIRO researchers to investigate the risk of ship strike to whale sharks (where and when whale sharks are more susceptible to being hit by vessels). Detailed data on dive behaviour are also being used to better understand why whale sharks travel to different places at different times of the year with the dive data used to see which parts of the water column are being used. Temperature logged within the tag also provides valuable oceanographic data to aid in the analysis and interpretation of the whale shark’s complex behavioural patterns.



Richard Pillans is a marine ecologist and is currently leading aspects of Theme 3 of CSIRO’s Ningaloo Outlook, including tagging and tracking of sharks and turtles.

Richard would like to acknowledge the work of the field team: Mat Vanderklift, Anthea Donovan, Mick Haywood, Russ Bradford, Kinam Salee, Emma Westlake, Ningaloo Aviation and Sue Pillans, as well as those who worked from the CSIRO Hobart office, including geneticists and modellers.

Adventure out

KINGS PARK Yorga's tour

Kings Park, or 'Kaarta Gar-up', as it was known by the local Nyungar people, was an important site for womans' business. I joined traditional owner Kerry-Ann Winmar for a cultural walking tour to learn more about the ancient history of this inner-city haven.

by Rhianna King



Located at the heart of Perth's city, Kings Park is many things to many people – an inner city bush setting to explore, a place to bring the kids for some nature play, a stunning setting for a special event or a sacred haven to run, walk or cycle through. For Whadjuk woman and traditional owner Kerry-Ann Winmar, Kings Park is the homeland of her people, and her connection to the area runs deep.

Kerry-Ann is one of three tour operators who provide visitors with an insight into the rich cultural significance of the area, which is known as 'Kaarta Koomba', 'Kaarta Gar-up' and 'Mooro Kaarta' by its traditional owners. I joined her for one of her 70-minute tours, on a beautiful late-spring afternoon. Aboriginal people know this time of year as 'Kambarang' – when rainfall decreases and the 'Moordjarl', or WA Christmas tree as it's commonly known, appears, to indicate they should return to the coast for the warmer months.

NOT JUST A PRETTY FACE

I have visited Kings Park probably hundreds of times over the years and have spent countless hours appreciating the beauty and diversity of the plants that occur there. But Kerry-Ann provided insight into the hidden uses of the native plants, which were crucial to the survival of the Aboriginal people who lived and passed through the area.

The tour started at Aspects of Kings Park Gallery Shop and journeyed through the Western Australian Botanic Garden, where Kerry-Ann provided descriptions of the uses of a number of plants, such as the candlestick banksias that were used to carry fire long distances, the tuarts that were hollowed to make a

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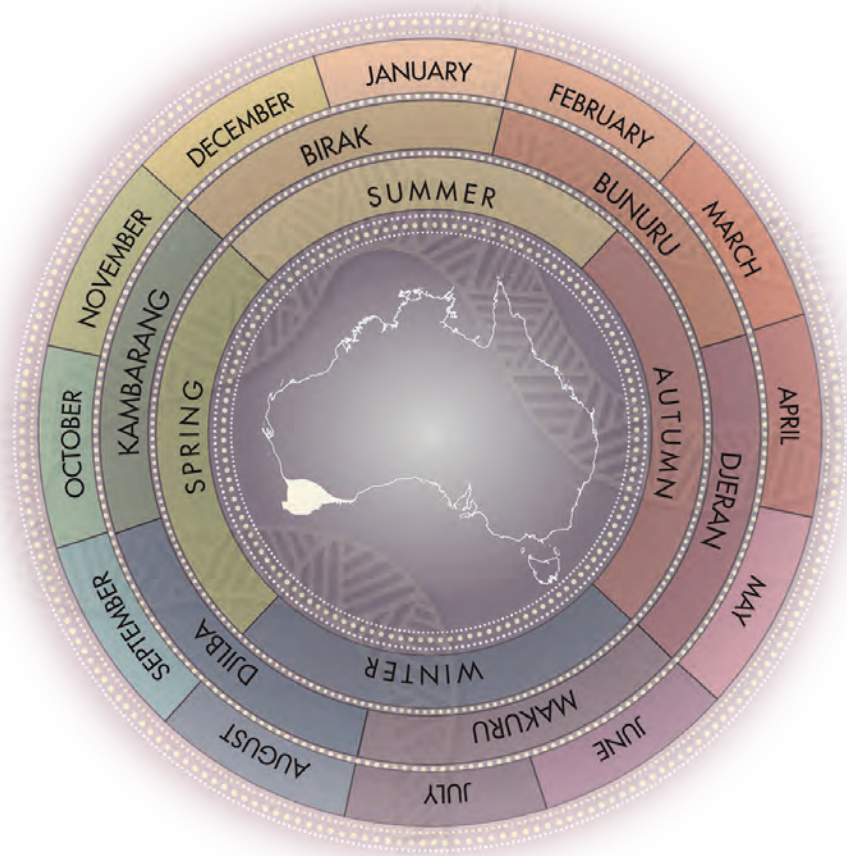
Main Kerry-Ann Winmar takes visitors through the cultural significance of Kings Park.

Photo – Rhianna King/DBCA

Inset Holly-leaved banksia.

Photo – Babs and Bert Wells/DBCA

Above The Nyungar six seasons.



“Kerry-Ann’s connection to family is a strong theme of her tour; she honours her ancestors for the knowledge she has of bush tucker and bush medicine.”

‘yandi’ – a type of dish used to carry babies, the reeds that were used to make baskets, and the various seeds that were ground up to make damper. The uses of these plants, and their fruits and flowers, had been discovered and perfected over eons, and passed down from generation to generation, usually along the female line.

Kerry-Ann explained that the six seasons provided Aboriginal people with guidance about what was available and where, so they always had access to fresh fruit, vegetables, meat and fish. She also explained that Aboriginal people were the first farmers of Australian soil and cultivated vegetables by replanting tubers.

Along the way, Kerry-Ann demonstrated that the bush is a virtual apothecary; peppermint leaves were used to sooth sore throats and as an insect repellent, and holly-leaved banksia were

consumed for their medicinal value. I was also fascinated to hear how mothers used paperbark on their babies for medicinal purposes.

FAMILY MATTERS

For me, one of the most enjoyable features of the tour was hearing how Kings Park was used as a birthing place for local Aboriginal women, including for Kerry-Ann’s great-grandmother who was born near the Pioneer Women’s Memorial fountain. Today, this area houses a bronze statue of a woman holding her child, and boasts a three-minute water dancing sequence, but Kerry-Ann’s great-grandmother was grounded to the land that lay as ‘far as the eye could see’ around her birthplace, a place where Kerry-Ann says she feels good energy and derives strength from while she’s there.



Above left Kerry-Ann shows the tour group a kangaroo skin that was stitched together by her mother.

Above Aboriginal people used native seeds for food and medicinal purposes.
Photos – Rhianna King/DBCA

Left The Pioneer Women’s Memorial Fountain houses a statue of a woman holding her child and a three-minute water dancing sequence to epitomise the significance of the site as a birthing place for local Aboriginal women.
Photo – David Steele/Alamy

Kerry-Ann’s great-grandmother was five years old when she stood with her people on the top of Mount Eliza scarp and watched the European settlers arrive and settle the Swan River Colony. Having never before seen people with pale skin, the local Aboriginal people thought they were the spirits of their dead ancestors.

Kerry-Ann’s connection to family is a strong theme of her tour; she honours her ancestors for the knowledge she has of bush tucker and bush medicine, which has been passed down through her family from generation to generation. And, her eight-year-old grandson was on hand to help demonstrate the use of ochre for ceremonial and traditional body painting. I found it touching to watch him grinding up the rock to make the colour, mix it with water and then apply it to the back of his grandmother’s hand, carrying on the

traditions of his ancestors while providing assurance that their sacred stories and ceremonies were in good hands.

Kerry-Ann spoke of the value she places on being able to pass her knowledge and traditions to her children and grandchildren, and the opportunity to share it with the wider community.

“I want to tell my story my way ... it’s important to keep it strong,” she said.

And I was glad to hear it.



See more of the tour

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



Do it yourself

Where is it? 1.5 kilometres from Perth’s CBD

Facilities: Restaurants, cafes, kiosk, toilets, walk trails, playgrounds.

Tours: Nyungar Tours Kings Park Yorga’s Walk runs at various times throughout the week. For more information visit nyungartours.com.au or call 0477 442 515.

Go Cultural Aboriginal Tours and Experiences operates tours to help visitors learn about Kaarta Gar-up and about Mt Eliza’s intriguing past and its spiritual significance to Nyongar people. For more information contact Go Cultural on 0459 419 778 by email (info@gocultural.com.au) or visit www.gocultural.com.au

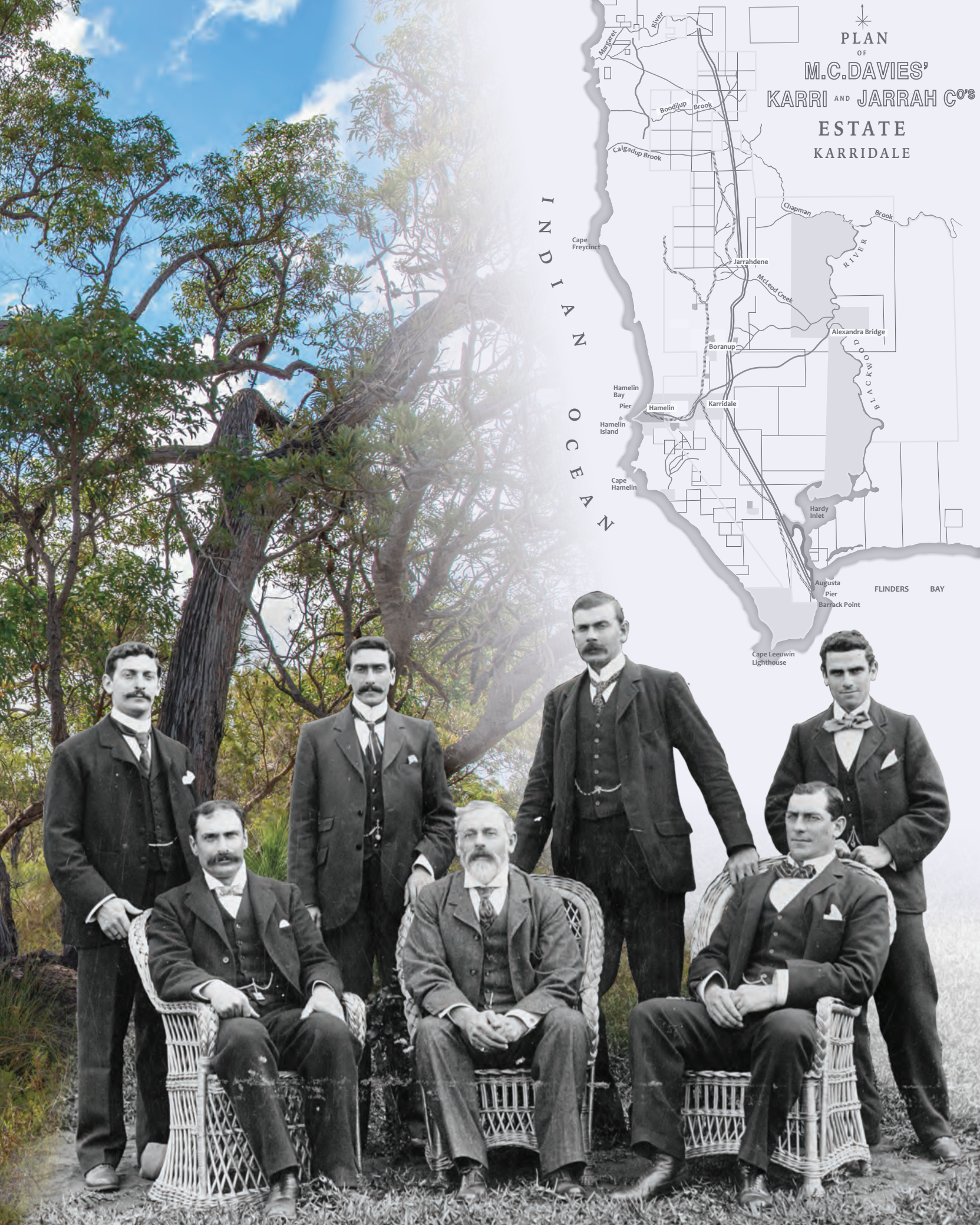
Aboriginal Productions also offers walking and talking on Country for corporate and other groups seeking an authentic understanding of local Aboriginal culture. For more information contact Aboriginal Productions by email (abprodpr@inet.net.au) or visit www.aboriginalproductions.com.au



STEP BACK IN TIME: JARRAHDENE

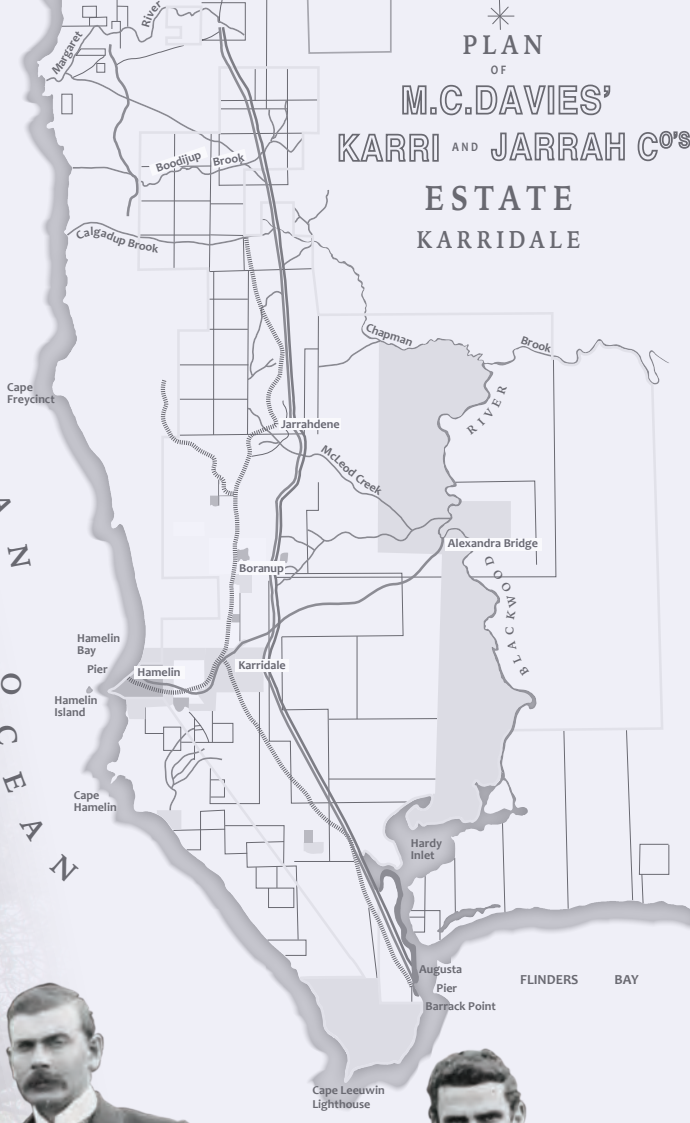
by Lorna Charlton and Rhianna King

More than 120 years ago, Maurice Coleman Davies – an enterprising colonist – established a mill at Jarrahdene in what is now known as Leeuwin-Naturaliste National Park. For 18 years, the mill was a major centre of local employment, and the settlement was home to hundreds of men, women and children. Nowadays, the area is popular among campers, who travel there to enjoy a new campground in stunning natural surrounds, and the opportunity to get a glimpse at yesteryear.



PLAN
OF
M.C.DAVIES'
KARRI AND JARRAH CO'S
ESTATE
KARRIDALE

INDIAN OCEAN





Born in London in 1835, Maurice Coleman Davies was four years old when he and his family set sail to begin their new life in Tasmania. Until his death at age 78, he made a profound impact across the sunburnt country he embraced as his home – from the farmlands of Tasmania to the goldfields of Victoria, through South Australia and to stations in Western Australia’s far north-west. But, perhaps his most significant legacy was founding south-west WA’s karri timber industry.

GROWTH OF A LEGACY

As a young man, Davies was lured to the Victorian goldfields where he worked on the diggings. He then established himself as a merchant in Melbourne and later in Adelaide, where he founded a firm that was involved in a number of key government and municipal public works projects in South Australia, Victoria and Western Australia.

In 1875, while he was involved in constructing a major part of the Melbourne to Adelaide railway line, Davies travelled to south-west WA to source the 14,000 cubic feet of timber needed to complete the job. While he was there, he recognised the abundance of hardwood, so returned the following year to purchase a large share of the Jarrahdale and Rockingham Timber Company – WA’s first timber export company.

Previous page

Main The abundance of karri and jarrah in the south-west inspired Davies to open four mills in WA.

Photo – Jiri Lochman

Inset Maurice Coleman Davies and his six sons (left to right) Robert, Herbert, Walter, Arthur, Frank and Phillip.

Above Stacking timber at a mill in the south-west.

Left Timber workers standing next to a ‘king karri’.

Photos – State Library of Western Australia

In 1878, Davies took out a Government lease for a large area of forest south of Margaret River, which was rich with tall karri trees. The largest karri tree on the Davies’ estate, known as ‘The Giant’, stood 80 metres tall and had a girth of 10 metres and enough timber for 3000 railway sleepers. Until then, Western Australian hardwood timber was thought of as being jarrah. But Davies set to work proving that karri was more durable than jarrah, and introducing it to the global market as an alternative product.

Davies’ first mill was constructed in 1881 at Coodardup (now Kudardup), which was serviced by jetties at Hamelin and Flinders bays. Then, in 1884 a new mill and head office was built at Karridale, which



“Between 1900 and 1914 approximately 17 million sleepers were cut from the Augusta-Margaret River region for railways in Australia and other parts of the world.”

had capacity to process 12,000 superfeet (a unit of volume for timber equal to a board one foot square and one inch thick) per day. Davies also built a mansion at Karridale in 1885, where he lived with his wife, six sons and two daughters. He treated his workers like family and invested in community infrastructure such as a hospital, town hall, school, race course and a library. Davies developed a cashless society where workers had an account that they could use at the local store.



THE HEYDAYS

By 1891, Davies had commissioned a new mill at Boranup. Then, in 1895, when the local timber industry was booming and international demand for WA hardwoods was high, he opened his fourth mill at Jarrahdene. The new mill was the largest in the colony and capable of processing 21,000 superfeet of jarrah per day – twice the capacity of Davies’ other mills.

At the height of operations, Davies was exporting more than 30 per cent of all the timber produced in WA. He was known to boast to his competitors that his timber had paved at least 200 streets in London. It was also used in

the construction of buildings, bridges, mines, telegraph poles, wharves, jetties, piers, tramways and railways. The largest single shipment that Davies ever exported contained two million superfeet of jarrah and karri to Liverpool which, if cut into four-by-two-inch pieces and placed end to end, would have been enough to stretch in a straight line from Jarrahdene to Shark Bay.

Davies’ timber empire continued to prosper and expand and by 1894, all six of his sons were involved in his business. In that year he constructed what became Bussell Highway and in 1895 he was also involved in the construction of the Cape Leeuwin Lighthouse.

Journey to Jarrahdene Campground

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



Top left Drivers maintaining the boilers inside a timber mill.

Top A locomotive named after Davies’ daughter ‘Kate’, hauling a rake of logs in 1889.

Above Felling a jarrah tree near Karridale in the 1900s.

Photos – State Library of Western Australia



Far left Davies was involved in constructing the Cape Leeuwin Lighthouse in 1895.
Photo – Marie Lochman

Above Interpretive signage and installations provide visitors with enriching experiences and stories from the mill.
Photo – DBCA

Left Camp sites at Jarrahdene have their own fire pit and picnic tables and other communal facilities such as barbecues and toilets.
Photo – Cliff Winfield

Between 1900 and 1914 approximately 17 million sleepers were cut from the Augusta-Margaret River region for railways in Australia and other parts of the world. However, Davies’ company had begun to decline in 1900, due to competition, rising freight costs, dwindling timber reserves and the impact of the Boer War. Davies retired in 1902, leaving his sons in charge, and then passed away in 1913, within weeks of the Jarrahdene mill closing.

END OF THE LINE

After the mill closed, a number of the buildings and materials were removed and relocated, including the local store, which was moved to Augusta to become the town’s first hall. By 1917, the mill and associated settlement was fully abandoned.

On Tuesday 9 November 1909, a writer for the *Bunbury Herald* recounted a train journey he took from Jarrahdene to Karridale:

“There is something rather melancholy about these deserted mill centres, where formerly were many full and happy homes, and bright attempts at settlement, are standing empty and

mouldy buildings and weed-covered gardens. The very remoteness from civilisation makes the place even more gloomy and its loss more apparent. These once were cases of progress built into the limitless forest. Now all are but the ruins of man’s achievement and are not even of service as shelters for the homeless.”

PHYSICAL LEGACY

More than 100 years on, there are still clues that Jarrahdene was once a timber mill; metal rails and bolts, the brickwork foundations for the boilers that powered the saws, and mounds and trenches suggest infrastructure, while broken crockery and other artefacts remind visitors that this was also home to the mill workers and their families.

The Jarrahdene mill site, which lies within Leeuwin-Naturaliste National Park, was given heritage status in 2012. The new \$2.7 million Jarrahdene Campground sits adjacent to this historic site and provides 36 camp sites in three loops, and additional areas for large groups at ‘The Siding’ and ‘The Landing’. All the sites are set 15 to 20 metres away from each other so visitors can enjoy a sense

of space. Each site has its own fire pit and picnic table, and campers have access to communal barbecue shelters, toilets, untreated water and rubbish disposal.

An interpretive walk, including a section that is universally accessible, guides visitors around the old mill site. Signage tells stories of the area’s history, and two large-scale installations give visitors a sense of the size and scale of the trees and mill operations that helped shape the area’s history and that will continue to form the experiences of visitors well into the future.

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Rhianna King is a LANDSCOPE editor. She can be contacted by email (rhianna.king@dbca.wa.gov.au).

For more information about the Jarrahdene Campground, including camping fees and how to book online, visit exploreparks.dbca.wa.gov.au/park-stay.

Some of the information presented here first appeared in LANDSCOPE in 1987, in an article written by Cliff Winfield called ‘Maurice Coleman Davies: Timber Tycoon’.

Drawing up a list of things that might potentially ignite passion, it is hard to imagine that 'slime moulds' might make the cut, let alone rise to the top. They must surely have been lumbered with the most unappealing of names for a taxonomic group. One wonders about those who coined the name. Surely 'mould' was bad enough, but add 'slime' to it and you might as well have named a disease. But to those who appreciate them, slime moulds are a fascinating and attractive group.

More formally called Myxogastria or Myxomycetes, slime moulds were once thought to be fungi as both groups reproduce by spores. However, unlike true fungi, slime moulds do not play a direct part in the decomposition of organic material, and their cell walls do not include chitin, a component of all fungal walls. Slime moulds also move, and are predators, consuming bacteria, fungal hyphae and other smaller organisms by phagocytosis, a process in which the prey item is engulfed by the slime mould by encasing it within the cell membrane. Molecular evidence has convincingly placed them as a monophyletic taxon in the phylum Amoebozoa and they are regarded as part of the informal group known as protists. There are approximately 1000 species of slime mould.

Slime moulds occur almost everywhere, and are one of the major components of protist soil biodiversity. Some have even been found in aquatic habitats, where they primarily live underwater, only emerging to reproduce. They commonly occur in forests, growing on the bark of living trees, fallen logs, dead leaves and other organic litter.

The life cycle of slime moulds is quite complex. For the greater part, the 'plasmodial' slime moulds exist as a plasmodium, which is essentially a large, single cell that contains millions of nuclei. This phase can have the viscous, slimy consistency that prompted the name, but many species are not at all slimy. The plasmodium is often small and inconspicuous; some can be transparent, but others are very brightly coloured and striking, even iridescent. In some species



A passion for slime moulds

the plasmodium can be large, greater than a square metre, and the largest weigh in at around 20 kilograms. In contrast, the 'cellular' slime moulds exist as individual, uninucleate cells that can congregate as a 'pseudoplasmodium' before becoming reproductive. They do so by leaving a chemical trail as they move, at the breakneck speed of about one millimetre per hour, which attracts other cells to follow and congregate.

Given the right conditions, the plasmodium will produce fruiting bodies, which is where the slime moulds bear the strongest resemblance to fungi. Slime moulds produce four types of fruiting bodies, which contain a few to numerous spores (depending on their size) that can survive in a dormant state for up to 75 years. Meiosis occurs in the spores, which germinate to produce either flagellated or amoeboid cells. These act as gametes, eventually fusing to form a zygote that ultimately grows back into the feeding plasmodium stage.

Slime moulds are not random in their movements. They are sensitive to chemical stimulants and light, moving towards or away depending on the stimulant. They tend to avoid salt and strong light, and bitter chemicals such as caffeine and quinine. In an interesting set of experiments, scientists have shown that slime moulds can be habituated to such chemicals, and that this tolerance is retained and can even be passed on to other slime moulds. Habituation is regarded as the simplest form of learning; rather than adapting, the slime moulds are able to ignore the stimulus if it is proved irrelevant. Slime moulds are even capable of solving a maze, by finding the shortest route to a food source. There seems to be no end to the amazing feats that these seemingly primitive organisms can perform.

Above Slime mould plasmodium.
Inset Stalked fruiting bodies of *Physarum viride*.
Photos – Peter Davison

DRYANDRA:

*a united
fight for
fauna*



Located in Western Australia's Wheatbelt region, Dryandra Woodland provides a haven for a diverse range of native species, including some of Western Australia's most endangered native animals – woylies and numbats. These species have endured significant ups and downs for decades, and government departments, landholders and community groups have been working to give them the best chance at survival.

*by Karla Forrest, Tony Friend
and Peter Lacey*



A shaft of light pierces a stand of wandoo trees as Parks and Wildlife Service staff make their way through Dryandra Woodland to check the traps they set out the afternoon before. As they come upon the next trap, set beside a *Gastrolobium* thicket, they see the telltale yellowish-brown fur and a long tail with a black brush at its end. It's a woylie (*Bettongia penicillata*); the fourth they've found that morning and one of an estimated 8000 to 9000 now living in the woodland.

After they take a DNA sample and record its size, age and gender, Parks and Wildlife Service staff release the woylie back into the wild, pleased to be able to record another individual of a species whose population was down to only several hundred four years ago, and satisfied that the multi-dimensional approach to their conservation is showing signs of success.

This cage trapping is part of the department's ongoing monitoring in the area, which staff carry out to keep a watchful eye on the health and size of native species populations.

WILDLIFE STRONGHOLD

Dryandra Woodland is the largest area of remaining natural woodland in the western portion of the department's Wheatbelt Region. Just 160 kilometres south-east of Perth, it is associated with wandoo and powderbark wandoo woodlands, heath and sheoak thickets and brown mallet plantations established between the 1930s and 1950s.

Dryandra Woodland is home to a range of both threatened and common



species, including the tammar wallaby (*Notamacropus eugenii*), brush wallaby (*Notamacropus irma*), mardo (*Antechinus flavipes*), brushtail possum (*Trichosurus vulpecula*), red-tailed phascogale (*Phascogale calura*), malleefowl (*Leipoa ocellata*), echidna (*Tachyglossus aculeatus*) and chuditch (*Dasyurus geoffroii*). In addition, it contains a threatened ecological community, the Critically Endangered federally-listed 'Eucalypt woodlands of the Western Australian Wheatbelt'. For the woylie and numbat (*Myrmecobius fasciatus*) Dryandra Woodland is one of only a handful places in Australia where they still occur.

However, managing this area to protect its precious native inhabitants is made difficult by the fragmentation of the habitat. Dryandra Woodland is made up of one large block that is the primary focus for fauna recovery and 16 other smaller blocks, which total 28,066 hectares, set within a network of agricultural properties.

From the early 1900s, parcels of land in this area were snapped up for wheat and sheep farming and stands of the valuable brown mallet on the properties were harvested for the thriving mallet tannin industry. Concerned about the unregulated exploitation of this species, the Western Australian Government set aside as State forest or timber reserves some remaining upland areas less suitable for farming and where natural stands of mallet were found. Approximately one-third of Dryandra Woodland was actually cleared and planted with brown mallet for the tannin industry. After the mallet industry ceased in the late 1950s, the areas that still contained quality wildlife habitat were converted to nature reserves or retained as State forest but managed for conservation. Both natural bushland and mallet plantations in Dryandra became a refuge for many common and threatened species.

Since then, there has been an ongoing push for the area to be afforded greater protection. In 1995, a management plan was developed for the area. This was revised in 2011 and set out the official vision for Dryandra Woodland that continues to guide the management of the area: that it 'continue to be one of the largest and most diverse remnant bushland areas in the Wheatbelt, supporting a range of local flora and fauna species'.

A NEW THREAT

With the arrival of European settlers and farmers to the area came feral cats



.....
Previous page
Main Juvenile numbats at Dryandra Woodland.
Photo – Robert McLean
Inset Woylie.
Photo – Ann Storrie

Above Releasing a woylie at Dryandra Woodland.

Left Foxes have had a devastating impact on a number of native species.
Photos – DBCA

Distribution of numbats and woylies



(*Felis catus*). Foxes (*Vulpes vulpes*) and rabbits (*Oryctolagus cuniculus*) arrived a little later, after spreading across the continent from their points of introduction in the east.

These animals had a devastating impact on native populations and foxes preyed on many native species, including woylies and numbats.

In 1982, department scientists began a fox baiting trial using '1080' – a chemically synthesised version of a toxin found in native *Gastrolobium* plants, to which native animals have a natural tolerance. Initially, the trial was carried out over a 2000-hectare area in Dryandra Woodland. The rate of numbat sightings was monitored inside and outside the baiting area to measure the effect of fox control on numbat numbers. After three years, numbat numbers had increased six-fold in the baited area, with no change outside it. This was one of the first two studies in Australia to demonstrate the positive effect of fox control on an endangered species.

In 1989, the fox baiting program was expanded to encompass Dryandra's main block. Numbat numbers continued to increase and by 1996, woylie numbers were high enough in Dryandra and other sites for the species to be removed from State, national and international threatened species lists. This was the first time a species was removed from the national threatened species list due to conservation action.

During this time, the then Department of Conservation and Land Management established its *Western Shield* wildlife recovery program, with the aim of controlling introduced predators to protect native animals. Dryandra Woodland was one of the first sites incorporated into this baiting program, which has now expanded to cover 3.8 million hectares of the State with the support of industry partners.

In Dryandra, funding from Western Areas has greatly supported recovery efforts. Unfortunately, however, while the risk of being preyed on by foxes had been reduced, Dryandra's native species weren't out of the woods just yet.

OUT OF THE FRYING PAN AND INTO THE FIRE

During trapping and observational surveys to monitor the health and size of Dryandra's native animal populations, conservation staff observed a dramatic drop in numbers of woylies and numbats. By 2004 woylies had declined by 90 per cent, and the species was relisted on the State's threatened fauna list. Numbat numbers had begun to decline from their peak in the early 1990s and by 2014 the population got down to as few as 50 individuals.

Between 2006 and 2012, department scientists carried out two research programs to determine the cause of these declines. By closely monitoring radio-collared woylies and numbats and sampling DNA from collars of preyed



Hear more about the work being done at Dryandra

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



Top *Gastrolobium* plant.
Photo – John Lawson

Above Powderbark occurs widely in the reserve.

Photo – Marie Lochman

animals, they showed that more than 50 per cent of deaths of both woylies and numbats in Dryandra Woodland were due to feral cat predation, while predation by foxes was minimal. Cat and fox numbers were compared in baited and unbaited



areas, and while cats were scarce and foxes common where there was no fox baiting, the opposite was true in Dryandra and other baited areas.

It seemed that the vast reduction in fox numbers meant the top spot in the food chain was up for grabs. Feral cats had been quick to fill the role of primary predator; their good night vision, voracious hunting style and short reproductive cycle meant they were adept and abundant predators of native species.

As part of their work, department scientists had developed a new type of 1080 bait, designed to tempt feral cats, which are notoriously fussy eaters. Named ‘Eradicat®’, this bait was used in Dryandra Woodland as part of a widescale research

trial, before being officially registered for operational use in 2015. During this trial in the main block of Dryandra between 2012 and 2015, feral cat-caused numbat deaths fell from 50 per cent to zero.

That same year, new funding, provided through the Commonwealth Government’s National Landcare Program, enabled department staff to expand cat baiting. In addition, Dryandra Woodland was chosen as one of four Western Australian sites (the others were Upper Warren, Kalbarri National Park and the South Coast) to share in \$1.7 million to carry out broadscale operational trials of Eradicat®. As part of this work, researchers focused on refining the timing and delivery methods of the baits.

During this time, department staff were also implementing a range of other management activities, and Dryandra was chosen as one of the sites to receive federal funding (South West Threatened Fauna Recovery Project) because of the range of threatened fauna that persisted there and the work that was already being undertaken. This funding was for a range of activities including integrating cat baits into the baiting program, continued fox baiting, shooting and trapping cats,

increased monitoring with cage traps and cameras, habitat restoration through the use of fire, translocations of animals into Dryandra to improve genetic diversity and increased community awareness including engaging neighbouring landholders.

BEYOND THE FENCE

Baiting was proving to be very effective, with department staff recording a reduction in feral cat and fox numbers within the reserve. However, data from cameras set up to monitor the reserve’s boundaries, and information from GPS collars fitted to feral cats, revealed they continued to come and go from neighbouring properties, showing little regard for tenure boundaries.

It became apparent that baiting on the reserve alone was not enough; without controlling foxes and feral cats beyond the reserve boundaries, they would continue to threaten populations of numbats and woylies within the reserve.

The Farmers for Fauna Project was formed in 2017 as a collaborative partnership between the Peel-Harvey Catchment Council, community group Project Numbat and DBCA’s Parks and Wildlife Service. The program capitalised on the enthusiasm of neighbouring

.....
Above Dryandra Woodland is surrounded by farmland.

Photo – Marie Lochman

Top right The Farmers for Fauna Project facilitates community workshops.

Above right Cage traps are used to survey the mammal fauna in the area.

Photos – DBCA



Above A feral cat waiting to ambush its prey.

Above right Chuditch also occur at Dryandra Woodland.

Photos – Jiri Lochman

Inset right Numbats shelter in log hollows.

Photo – Kaitlyn York/DBCA

Below right Woylies have a prehensile tail.

Photo – David Bettini

landholders, who were keen to play a role in the protection of native wildlife, and built on community education work that was already underway as part of the operational Eradicat® program.

As part of the project, Farmers for Fauna held community workshops and events; offered training so farmers could become accredited in the use of 1080 baits on their land; and distributed cage traps and cat food for use in the traps. The program also focused on educating landholders and other community members about responsible cat ownership.

Parks and Wildlife Service staff developed a reference book that contained photos and notes on known feral and domestic cats in the area. They gathered the information for this document, which they call 'the CATalogue', by recording the markings and locations of cats sighted in and around Dryandra Woodland, and assigning each individual cat a number.

The battle against feral cats was further bolstered in July 2019, when feral cats were officially declared pests in Western Australia under the *Biosecurity and Agriculture Management Act 2007*. Notably, the declaration differentiated between 'feral', 'stray' and 'domestic' cats, relating to the degree to which the



Our wonderful Wheatbelt wildlife

As Western Australia's animal emblem, the numbat (*Myrmecobius fasciatus*) is much-loved by locals for its striking looks, with distinctive striped fur, long pointed face and bottlebrush-shaped tail. Once widespread in eucalypt woodlands extending into South Australia and New South Wales, the numbat now only exists naturally in the wild in two places – Dryandra Woodland and the Upper Warren area.

Unlike most marsupials, the numbat is diurnal (active during the day), a schedule dictated by that of its only food source: termites. A single numbat can eat up to 20,000 termites in a day, roughly equal to 10 per cent of its body weight.

Perth Zoo contributes to numbat conservation through a breeding program that provides animals for reintroductions in suitable habitat across WA and interstate. Zoo-bred numbats have also been released into Dryandra to supplement numbers there and help maintain genetic diversity.

The numbat is listed as endangered under both WA's *Biodiversity Conservation Act 2016*, and the Commonwealth's *Environmental Protection and Biodiversity Act 1999*.

Perhaps less-known but no less important, the woylie (*Bettongia penicillata ogilbyi*) is another key focus for researchers and conservation staff at Dryandra. The small, kangaroo-marsupial stands about 30 centimetres tall and weighs about one kilogram. It has a prehensile tail that allows it to carry bark, leaves and grass, which it uses to make nests in dense heath and *Gastrolobium* thickets, living mainly on a diet of underground fungi, bulbs, tubers and seeds.

With a State listing of 'Critically Endangered' and a federal listing of 'Endangered', it is at a higher risk of extinction than the numbat.

In 1996, it became the first-ever animal to be removed from the national threatened species list due to conservation action, before a dramatic population decline across its range prompted its relisting as threatened in 2004 and upgrade to critically endangered in 2014 on the State's threatened species list.





cats are living and reproducing in the wild. Armed with the CATalogue, local shooters were tasked with removing the known feral cats, while department staff became familiar with the area's domestic cats that were owned by landholders. Discussions with landholders were used to promote keeping cats in at night and ensuring they are microchipped, sterilised and registered with the local council.

Local landholders have also helped reduce the number of feral cats in the area; since 2015, farmers have removed hundreds of feral cats from properties near the conservation area.

Local Dryandra farmer Cameron Christensen, whose property neighbours Dryandra Woodland, has been involved in the Farmers for Fauna since its inception and said his involvement in the program was driven by a desire to care for the natural environment.

"I'm a conservationist at heart. I like to see our native animals doing better than good in our environment," he said.

"Foxes and feral cats were causing a huge disturbance to the natural environment, through predation."

Cameron said he has witnessed an increase in native wildlife on and around his farm, which lies just to the east of the Dryandra Woodland main block.

"I'm very proud of what we've been able to achieve so far," he said.

He believes feral cat control is essential for all farmers in the area.

"It is something that all farmers need to do to for disease control, but also to keep the natural environment around your farm healthy."

WHERE TO NEXT

Since 2014, department staff have been carrying out fauna monitoring on the main block of Dryandra Woodland using motion-sensing cameras, and have recently set up additional cameras on some satellite blocks. These surveys help to build a picture of the health and abundance of the animals; cameras detect trends in population size, while cage trapping enables staff to determine how the animals are faring and the population age structure. By getting a more holistic view of the species, significant changes in populations can be detected quickly. Pleasingly, these surveys have revealed an increased presence of wallabies, possums, echidnas and phascogales, and, even more encouragingly, greater numbers of woylies and numbats.

Department staff have also received reports of sightings from nearby farmers and John Lawson, the manager of the Lions Dryandra Woodland Village. Meanwhile, regular *LANDSCOPE* contributor and wildlife photographer Jiri Lochman, who frequently visits Dryandra Woodland to photograph the landscape and its native animal residents, has reported a vast increase in mardos.

While these are encouraging signs, work at Dryandra Woodland must continue at a landscape-scale. For numbers of woylies and numbats to increase, their habitat will need to be protected. In particular, maintaining and increasing thickets of the woylie's preferred *Gastrolobium* habitat, ongoing predator control and translocation programs will need to continue and

targeted expansion of suitable new habitat explored.

Recently, additional funding from the Commonwealth Government has been awarded to the Peel-Harvey Catchment Council, which will enable Farmers for Fauna to continue under the Numbat Neighbourhood Project. This extra funding will be used to add value to the work already being done by Parks and Wildlife Service. It will allow for additional baiting, the extension of monitoring surveys within and outside department-managed lands, weed control and ongoing community education.

With a continued emphasis on collaboration, the outlook for these animals, and a variety of other native species that share their special woodland home, is bright.

.....
Above left Echidnas also occur in Dryandra Woodland.

Photo – Sallyanne Cousans

Above Mardo sightings have increased greatly in Dryandra Woodland.

Photo – Jiri Lochman

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by Grace Milne

Kids embrace new nature playground

Established in 1900, John Forrest National Park on Perth's doorstep has long been a favourite for local families and visitors. From waterfalls to walking trails, and close encounters with native wildlife to perfect picnic spots, there is something for everyone. And now Western Australia's oldest national park features a brand new nature playground.

Located in the main picnic area amongst shady trees and next to a flowing creek, the playground offers a perfect opportunity for kids to get dirty, create, climb, splash, burn off some energy and most importantly enjoy the beautiful natural environment around them.

The playground has a timber staircase, teepee, a series of balancing and stepping logs. Unique features of the playground are the two magposts, which work like magnifying glasses and enable kids to collect objects such as sand, woodchips, water, twigs, branches, rocks, fallen leaves or even insects and examine them closely.

The area also features a universally accessible barbecue and interpretative signs at the popular Swan View Rail Tunnel.

This imaginative playground was developed through a partnership between DBCA and the WA Parks Foundation, and funded by Chevron Australia.



Spring into Parks

The opening of the new nature playground coincided with Spring into Parks, a WA Parks Foundation initiative to encourage more people to visit national parks and to ensure our parks are protected, so they can be enjoyed now and into the future.

Spring into Parks celebrates WA's beautiful and accessible regional, national and marine parks, and promotes the health and wellness benefits of spending time in nature.

Left The playground was designed with nature play in mind.

Above It is already proving popular among kids.
Photos – Emma de Burgh/DBCA

John Forrest National Park

Originally declared as a conservation reserve in 1898, and proclaimed a national park in 1900, John Forrest National Park is WA's oldest national park. Formerly Greenmount National Park, it became John Forrest National Park in 1947 in honour of the famous explorer and statesman, Sir John Forrest, who was Premier of Western Australia between 1890 and 1901. The first recreation facilities were constructed in the early 1930s making the park a popular day trip by train for the people of Perth. The rail line was discontinued in 1966 and has been converted into the Railway Reserves Heritage Trail for walkers and cyclists.



Flame-backed fiddler crab (*Uca flammula*)

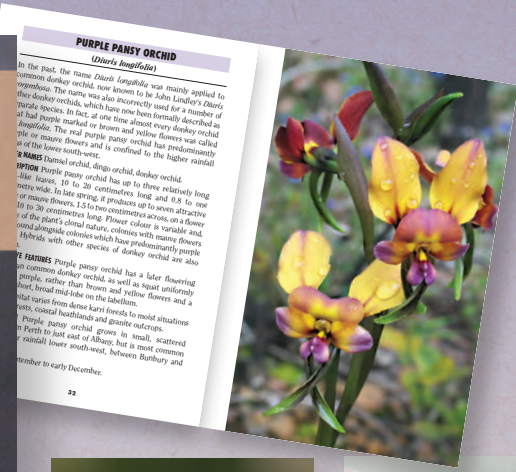
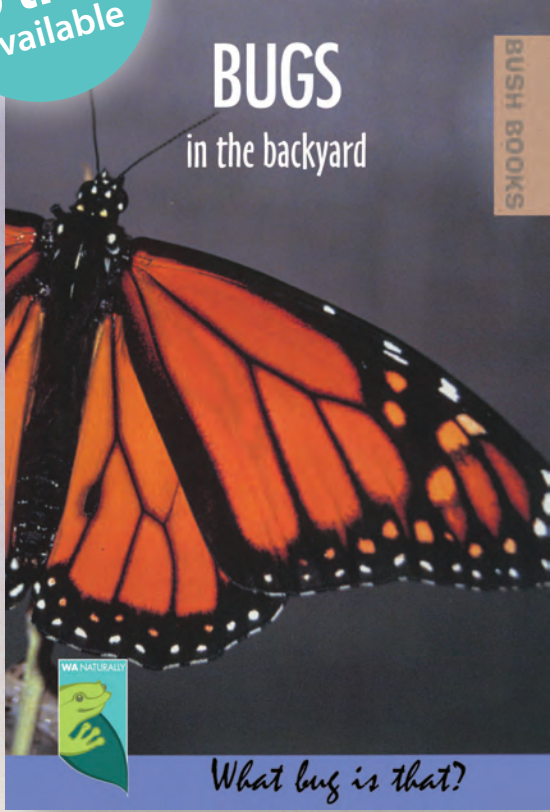
The flame-backed fiddler crab can be found from Mangrove Bay in Western Australia and north into the Northern Territory. Adult males have one small claw and one very large dominant claw, which they use during courtship and combat in a way that looks like they're playing the fiddle, hence their name.

Illustration by Gwendolen Monteiro

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Bush Books are wonderful, practical, pocket-sized field guides that help you learn about and discover WA's unique plants, animals and special features, region by region.

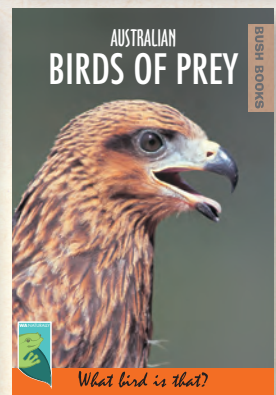
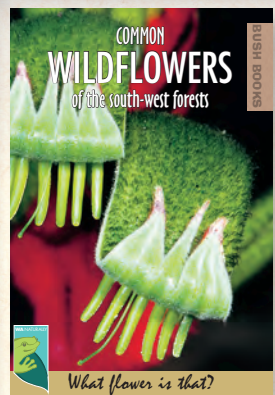
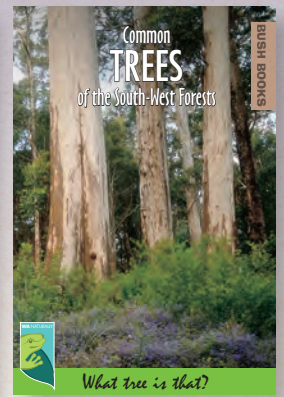
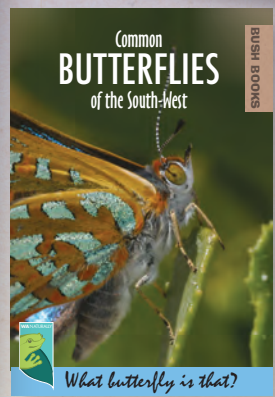
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