WA'S PARKS, WILDLIFE AND CONSERVATION MAGAZINE

LANDSCOPE

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Exploring Collie

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Lesueur National Park

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GOVERNMENT OF WESTERN AUSTRALIA

Department of **Biodiversity, Conservation and Attractions**

Contributing



Stuart Harrison is a project coordinator in DBCA's Parks and Wildlife Service. He studied environmental management and outdoor recreation before starting work with the department in 1995 in the forests around Dwellingup. He is passionate about getting people outdoors to engage and appreciate our natural areas, and spends his spare time exploring with his family any way he can – walking, riding, paddling, sailing and camping.

Sallyanne Cousans has been contributing her wildlife and nature photos to *LANDSCOPE* since 2001. When she is not busy with her imaging work at Fiona Stanley Hospital she can often be found in the bush happily clicking away with her camera. She regularly visits the same locations time and time again in pursuit of that special shot and will often spend hours in her camouflage hide, waiting patiently for an elusive animal. Capturing the beauty of springtime is one of her particular passions.



Shane Heriot is a DBCA operations officer for the Dirk Hartog Ecological Restoration Project. As well as goat and sheep eradication, Shane is master of the project's high-speed landing craft and coordinates biosecurity, weed and fire management on the island. Shane has also undertaken rangeland management and feral animal control throughout the Midwest region and established businesses in environmental consultancy, eco-tourism and animal education.





While bushfires have been a natural part of the Western Australian landscape for millennia, their impacts can be wide-reaching and indiscriminate. In fire-prone areas, preparing for bushfires and facing them when they occur involves the entire community.

As part of its responsibility for managing fire that occurs in the forests, parks, nature reserves and other lands that it manages, the department draws on the skills and experience of up to 900 staff. These staff work to manage fuel loads, predominantly through prescribed burning; respond to bushfires; and undertake research into fire behaviour and effects. Some staff are involved in fire management year round, while others are called on during significant events only. All staff involved receive extensive training and are given opportunities for mentoring and development.

However, as part of the evolution of our organisation, the department has identified that there is currently a significant underrepresentation of women in fire management roles. In order to address this imbalance; harness the best of our entire workforce, regardless of gender; and empower our staff to step up into a variety of roles, the department has released a *Women in Fire Management Action Plan*.

The plan identifies areas for improvement and sets out steps to address them. This is a crucial step in the department's long-term fire management strategy; by enlisting staff who have a vast range of skills, experience and perspectives, we will have the best chance of achieving positive outcomes in an increasingly challenging and changing management area.

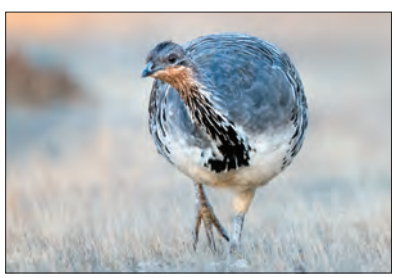
The targets set out in the *Women in Fire Management Action Plan* have been developed through extensive consultation with staff from across the department. And, while they are voluntary, the targets have been developed so they are realistic, to ensure they bring about positive and meaningful change.

The plan complements the department's broader *Workforce and Diversity Plan*, which sets the strategic agenda for achieving current and future workforce needs, and works to achieve the department's diversity objectives, including complying with equal opportunity legislation and reaping the benefits associated with a diverse workforce, such as increased productivity and improved customer service. In addition, the department assembled a Gender Diversity in Fire Working Group in 2018. This group, which is made up of representatives from across the department, is charged with overseeing the implementation of the *Women in Fire Management Action Plan* over the next three years.

Ultimately, these steps will benefit all Western Australians because they will ensure we have the best-available personnel – regardless of gender – working to protect lives and assets when bushfire strikes, and will be well-placed to continue to deliver a prescribed burning program that helps mitigate the impact of bushfire on the community and the environment.

You can read about the *Women in Fire Management Action Plan* on page 12.

Jason Foster, ***Executive Director, Regional and Fire Management Services***
Department of Biodiversity, Conservation and Attractions



ON THE COVER

Front cover Malleefowl (*Leipoa ocellata*) are a large ground-dwelling bird that construct large mounds in which to lay their eggs. Read more about them on page 28.
Photo – Sallyanne Cousans

Back cover Banks Rock, Great Western Woodlands.
Photo – Marie Lochman

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This page Donkey orchid.
Photo – David Bettini

Department of **Biodiversity, Conservation and Attractions**

GOVERNMENT OF WESTERN AUSTRALIA

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Snap shot



READERS' PIC

Red-tailed black cockatoo
(Calyptorhynchus banksii)

Photo and words by Chris Tate

"I had often seen and heard red-tailed black cockatoos in and around the City of Bunbury. It is generally difficult to photograph their coloured tail feathers as they need to be flying towards you. But I caught up with them as they were moving around Bunbury feeding on the seeds of cape lilac trees. After about two hours I had numerous shots of both males and females in flight."

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

Spring blooms at festival

The much-anticipated arrival of spring heralds another Western Australian favourite – the Kings Park Festival. Showcasing thousands of wildflowers and more than 3000 native plant species, the festival is a free celebration of WA's nature and culture held at Perth's Kings Park and Botanic Garden.

The festival is the culmination of a years' work by horticulturalists and volunteers, who grow the plants in the gardens from seed. This year alone, the Kings Park Nursery has grown more than 25,000 plants which will bloom for the first time at the festival.

There will be dozens of free events, outdoor exhibitions, guided walks and talks, photography displays, family activities and more.

The 2019 Kings Park Festival runs from 1–30 September and is made possible by Lotterywest and the Friends of Kings Park.

For more information, visit bgpa.wa.gov.au/kings-park/events/festival.

Below More than 3000 species of native plants will be on show.
Photo – Dave Blumer



New national park for WA

Houtman Abrolhos Islands National Park has become Western Australia's 101st national park.

Located about 80 kilometres west of Geraldton off the State's mid-west coast, the Houtman Abrolhos Islands include one of the world's most important seabird nesting areas and are a popular fishing spot. They were also the site of the notorious *Batavia* mutiny.

Ten million dollars will be invested in park tourism and infrastructure over the next two years, with a further $3.8 million over four years for ongoing management, including ranger jobs.

New visitor facilities will be constructed on East Wallabi and Beacon islands, including jetties, toilets, shade shelters, walk trails and visitor interpretation.

The new park was created under the State Government's Plan for Our Parks initiative, which will add five million hectares to the State's conservation estate over five years.

Above Houtman Abrolhos Islands National Park.
Photo – Peter Nicholas/DBCA

Hear about the Houtman Abrolhos Islands National Park

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



Whale sharks in the spotlight

The World Heritage-listed Ningaloo Coast provided the perfect setting for the 5th International Whale Shark Conference in May 2019, when 120 delegates from 21 countries met to explore the latest research and management of the world's biggest fish.

The Ningaloo Coast is home to the world's largest and most reliable aggregation of whale sharks and is the only place in Australia – and one of a few places in the world – where people can swim with these gentle giants.

Researchers, tourism operators and marine managers came together to discuss the species' behaviour and population health, migration monitoring techniques and findings, ecotourism and the impacts of threats such as microplastics.

The whale shark season on the Ningaloo Coast runs from March to September each year.

Above Snorkelling with whale sharks is a big drawcard for visitors to the Ningaloo Coast.
Photo – DBCA

Combining science and culture for mapping trial



DBCA spatial scientists have teamed up with Kanyirninpa Jukurrpa (KJ) to map broadscale land cover classes in the Little Sandy and Gibson deserts.

The pilot project will help inform fire management by providing a greater understanding of the land covers and vegetation types that occur across the vast landscape KJ manages. Early results have mapped eight broad land cover types, including spinifex and mulga, which have very different fire resilience and fire regime requirements.

If successful, the developed methodology could be adapted for different landscapes and applied across the Western Desert.

In May 2019, KJ Rangers led a four-day field trip to collect data via remotely piloted aircraft to assess the accuracy of the land cover maps that were produced.

This project is funded under the State Government's Aboriginal Ranger Program.

Above Kanyirninpa Jukurrpa Rangers and DBCA remote sensing specialist Jane Chapman collecting validation data.
Photo – DBCA

Guest column



Keith Bradby
CEO of Gondwana Link

In 1967 the eminent ecologists WH Macarthur and EO Wilson published their seminal book *The Theory of Island Biogeography*, setting out with great clarity the basic principles through which the geographic size of islands determines the number of species they can hold over time. Their work built on centuries of ground-breaking science, back to the 18th century work of notables such as Charles Darwin, in the Galapagos, and Alfred Wallace, in the islands north of Australia.

Macarthur and Wilson took the principles that helped us understand our ecological past, and applied them to our ecological future.

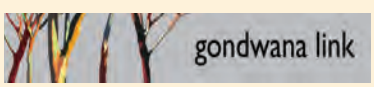
For much of south-western Australia, that could be a grim future. In 1980 and again in 1982 the WA Museum published analysis of the principles of island biogeography applied to the 'islands' of habitat left in a sea of modern agriculture. Taken over time, the prognosis was not good – a halving of bird species and only one nature reserve, Lake Magenta, large enough to hold its full complement of mammals. That work, shocking as it is, still holds true, but was done before the full scale of climate change impacts was recognised.

As no island of habitat does well in isolation, we need to stop regarding the isolated habitats we have left as 'remnants', the bits left-over, and see them as the strategic habitats we can build from.

That's why our road reserves are so important, why landcare programs help farmers fence, protect and connect what bush they have left, and why nature reserve managers are reaching out to their neighbours. The great work done around Dryandra and Dongolocking in the last few decades are good examples of this.

Australian ecosystems work at large scales – so the program I'm proud to be part of, Gondwana Link, supports local efforts and communities restoring ecological connections across 1000 kilometres of south-western Australia.

The United Nations has declared 2021–30 the 'Decade of Ecological Restoration' and our current collective efforts in southern WA can be swiftly built on to match this ambitious global approach.





Lesueur National Park

With more than 900 known plant species, Lesueur National Park erupts into colour from late winter, delighting its visitors with a stunning floral display.

Located just a three-hour drive north of Perth and 20 minutes from Jurien Bay, Lesueur National Park is a must-see for wildflower enthusiasts. In late winter and early spring, many of the park's 900 species, including acacias, hibbertias, leschenaultias, melaleucas, gastrolobiums and orchids bloom and blanket the landscape with a riot of colour. Remarkably, 111 species that occur in the park are found nowhere else, and 81 species are at their northern limit. The park's species richness has led to it being named a biodiversity hotspot and it ranks as one of the State's most important reserves for flora conservation. It has also been registered on the National Heritage List.

Above The Lookout at Lesueur National Park. *Photo – Marie Lochman*

DIVERSE LANDSCAPE

The diversity of plants found in Lesueur National Park is caused in part by the park's variety of geological formations, landscapes and soil types. At 26,987 hectares, the national park is made up of salt lakes and remnant coastal dunes in the north-west, and laterite ridges and hills and gullies in the east.

The park's abundant and diverse plant life also provides habitat for the 29 species of jewel beetle, which occur in the area. These stunning insects can be spotted by their bright metallic colours of yellow, blue, red and orange.

As well as being a stronghold for jewel beetles, the park is home to 52 species of reptiles, including 41 lizard species such as the western bearded dragon (*Pogona minor minima*) and the western spiny-tailed gecko (*Strophurus spinigerus*), and 11 species of snake, including Gould's hooded snake (*Parasuta gouldii*) and the western brown snake (*Pseudonaja mengdeni*). The range of reptiles found in Lesueur National Park is believed to be the world's highest reptile diversity of any Mediterranean climate ecosystem.

The park is also rich in birdlife, with 122 native species and two introduced species known to occur there. The park's sandplain area attracts honeyeaters, thornbills, fairy-wrens, southern emu-wrens, white-breasted wrens and field wrens. The woodlands also provide one of the region's last breeding habitats for Carnaby's cockatoos. The park is the northern limit of the known range for many other species, including the western rosella, the little wattlebird and the shy hylacola. In summer, the salt lakes and freshwater springs come alive as several species of water bird, including waders, which migrate from the northern hemisphere, descend on the area.





Discover more about Lesueur National Park

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



Top left Twenty-nine species of jewel beetle occur in the park.
Photo – Marie Lochman

Left Wandoo woodlands in Lesueur National Park.
Photo – DBCA

Above Forty-one species of lizard are found in the park, including dwarf bearded dragons.
Photo – Jiri Lochman

"The Lesueur area has long been known to the Yued people, who are believed to have lived there for tens of thousands of years."

The park is also home to 15 species of native mammals, including four species of dunnart (*Sminthopsis* spp.), ash-grey mice (*Pseudomys albocinereus*), honey possums (*Tarsipes rostratus*) and bush rats (*Rattus fuscipes*). Unfortunately, feral cats, European foxes and house mice have also taken hold in the park and threaten native populations.

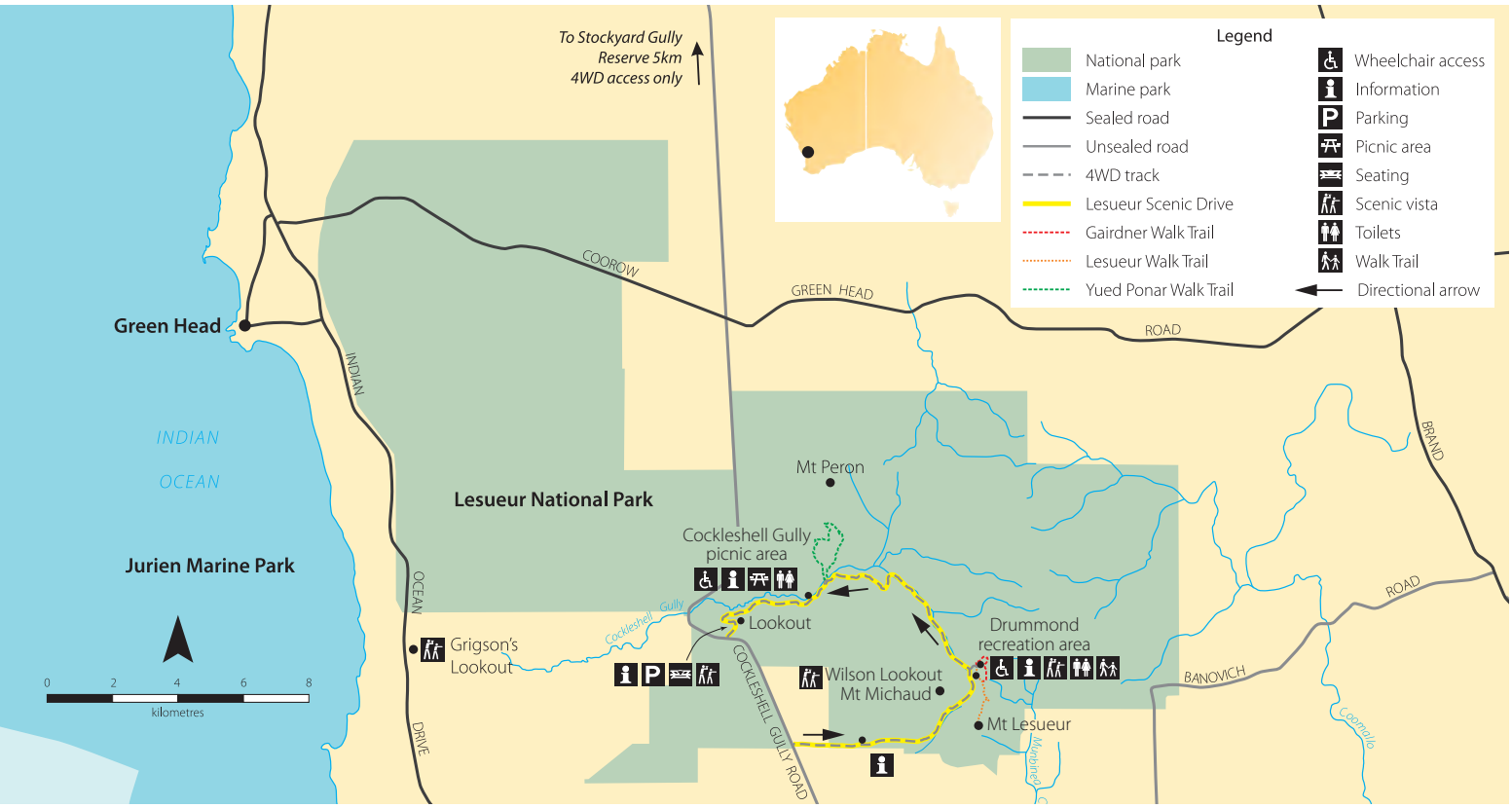
BECOMING A NATIONAL PARK

The Lesueur area has long been known to the Yued people, who are believed to have lived there for tens of thousands of years. The Yued people refer to Mount Lesueur as Koomba Chiler and used it as a landmark for people who travelled there to trade shields, flint spearheads, stones, shells, animal skins and even women's hair.

The area was named by Europeans in 1801 as part of the expedition led by French navigator Nicolas Baudin to map the coast of Australia, which was known at the time as New Holland. The Lesueur area was surveyed by those aboard the *Naturaliste*, captained by Jacques Hamelin, and named after Charles-Alexandre Lesueur – one of the natural history artists travelling on the voyage.

In the 1950s, government botanist Charles Gardner recommended the area be protected, as he was concerned about the effects of agriculture on native vegetation. No action was taken, apparently because the area contained a reserve for horse breeding, which dated back to the early 1900s when horses were bred for the Australian army in WWI. However, Mount Lesueur itself was afforded protection for 'educational purposes'.

In 1962, a review of WA's national parks and reserves by the Australian Academy of Science Committee on National Parks identified that the area deserved protection as a national park. This was endorsed again as part of another review in 1974, however was not progressed because it was believed that coal deposits in the area should have been available for exploitation. A compromise was reached in 1983 when a 'C' class reserve was agreed upon, which protected the area but allowed access for mineral and petroleum exploration, but the reserve was never created. Finally, in 1992, Lesueur was gazetted as a national park, following public pressure to stop a major coal mining development.



EXPLORING THE PARK

One of the best ways to explore the park is on the 18.5-kilometre one-way bitumen road, which loops from Cockleshell Gully Road. This road provides users with several pull-over bays to stop and get up close to wildflowers. The Drummond recreation area and Wilson Lookout provide views through the valley, which is bound by the Gairdner Range, to the Indian Ocean. Visitors should look out for wedge-tailed eagles that cruise on the updrafts adjacent to the ridgelines. From here you can learn about the park from informative signage and use the toilets, before embarking on either the 2.5-kilometre loop class three Gairdner Walk Trail or the four-kilometre-return class three Lesueur Walk Trail, which provides spectacular views across the national park.

North-west from there is the Cockleshell Gully picnic area, where you can enjoy a picnic and set off on the 7.1-kilometre Yued Ponar Walk Trail. This provides a good leg stretch to the top of Mount Peron, taking walkers through the species-rich Kwongan heath, up to the top of the scarp and breakaway country where magnificent views of the park can be seen. Interpretive signage along the way tells the story of the six Yued seasons.

These walks are most beautiful in spring when the wildflowers are blooming, but there is plenty to see and enjoy during other times of the year as well.



Below The park can be explored on one of the walk trails.
Photo – Marie Lochman

Do it yourself

Where is it? 250 kilometres north of Perth along the Brand Highway, 20 kilometres from Jurien Bay.

Total area: 27,987 hectares.

What to do: Walking, scenic driving, photography, birdwatching, wildflower appreciation.

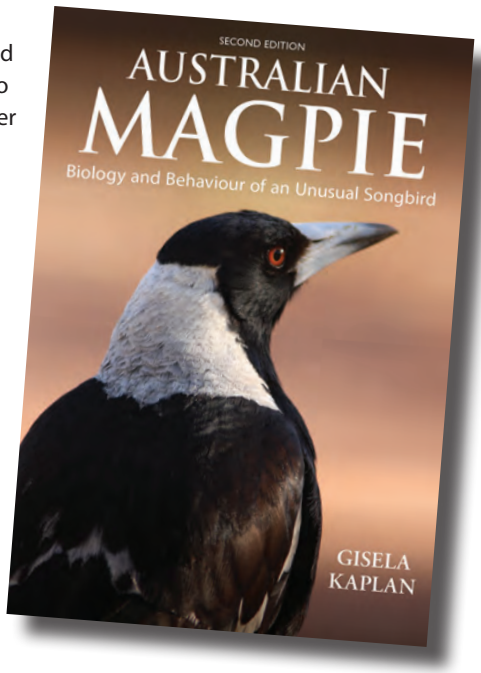
Facilities: Toilets, picnic tables, information shelters, seating, parking.

Nearest Parks and Wildlife Service office: Moora District Office, 67 Bashford Street, Jurien Bay, phone: (08) 9688 6000 or jurien@dbca.wa.gov.au.

Please note that entry fees apply.

For more information, visit exploreparks.dbca.wa.gov.au.

AUSTRALIAN MAGPIE: BIOLOGY AND BEHAVIOUR OF AN UNUSUAL SONGBIRD



Ah, springtime; the glorious time of the year when we unfurl after a few cold months and head outdoors in droves to enjoy the blooming wildflowers, warmer days and signs of new life. But there's one annual springtime occurrence that Australians are less fond of – the period between the AFL grand final and Melbourne Cup when magpies swoop anyone (or thing) they perceive as a threat to their young. But this act of parental protectiveness is just one characteristic of this charismatic bird that, for the rest of the year, is a much-loved feature of our urban and bush landscape.

Author Gisela Kaplan has recently completed the second edition of *Australian Magpie: Biology and Behaviour of a Unusual Songbird* – a comprehensive treatise on the behaviour of these fascinating birds. The book provides information about the origin of the magpie, which Aboriginal people believe dates back to the Dreaming time, and examines the differences between the eight sub-species found in Australia.

It presents a wealth of technical information, including a fascinating section about the magpie brain, as well as information about the magpie's diet, mating rituals, social dynamics, song and relationships with humans. It would make a valuable reference for people with a scientific background or professional interest in ornithology, but the information is presented in a way that makes it is accessible to amateur bird lovers and naturalists as well.

The 280-page Australian Magpie: Biology and Behaviour of a Unusual Songbird *is available for $45 from CSIRO by visiting publish.csiro.au.*

AUSTRALIAN MARINE DEBRIS INITIATIVE

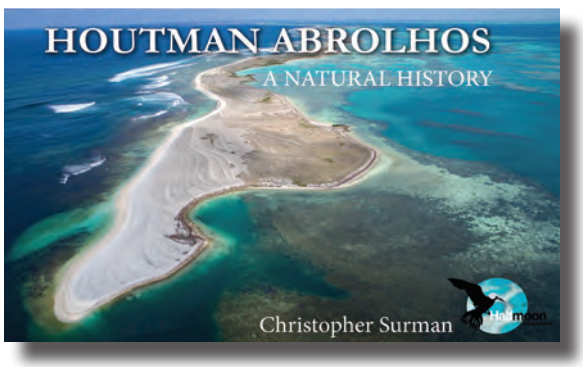
Tragically, it is estimated that there are up to 40,000 pieces of plastic in every square kilometre of ocean. This is a global crisis that is having a devastating impact on the marine environment. In order to tackle this issue, the Australian-based Tangaroa Blue Foundation established the Australian Marine Debris Initiative, which collects data about what rubbish is found and where, to help inform solutions to stop the flow of litter at the source. Since its inception in 2004, more than 140,000 volunteers have collected more than 13,655,000 items of rubbish.

The Australian Marine Debris Initiative app lets users record litter they find by selecting from a pre-populated list. There are the usual suspects – old boots, boating and fishing debris, and bottles, but there is a depressingly long list of other items that all too often end up in the ocean too.



Inputting data into the app can be a fun way to engage kids, and it is a good way for us all to stay committed to doing our bit for our oceans.

The Australian Marine Debris Initiative app is available for free from the App Store.



HOUTMAN ABROLHOS: A NATURAL HISTORY

From the moment you open the first page of this stunning book you can tell that putting it together has been a labour of love for author Dr Christopher Surman, who first visited the area 40 years ago.

Houtman Abrolhos: A Natural History is spectacularly illustrated by stunning aerial, underwater and landscape photography. But it is much more than just a nice coffee table book; it is the culmination of 28 years of research into the fascinating plants and animals that occur on the islands and in the surrounding water. This information is combined with historical accounts, scientific observations, geological information, interesting fact boxes and the occasional personal anecdote, which are all brought to life by photos, graphs, maps and other diagrams.

In the foreword, Chris outlines that he hopes the book will highlight the natural values of the Houtman Abrolhos and raise awareness of the area in the context of a changing climate. I think this beautiful book will go a long way to help people appreciate why this area should be protected. It will also make a lovely addition to any bookshelf and a treasured souvenir of a trip there.

Houtman Abrolhos: A Natural History *is available for $59.95 from halfmoonbiosciences.com/shop-1. Proceeds from the book sales will be reinvested into future research.*

Sparking change for women

Women are currently underrepresented in DBCA fire and leadership roles. However, the department has developed a bold new action plan, which aims to increase the number of women in fire management as part of a whole-of-department approach to improve equity and diversity across its workforce.

by Meg Porter, Katie MacWilliams and Rhianna King





As few as twenty years ago, it would have been rare to see a woman on the back of a fire truck, hauling a water hose as it moves past a wall of flames. Fifty years ago, it would have been unheard of. Nor have women historically been involved in planning or carrying out prescribed burns. But, kitted out in regulation 'personal protective equipment' and standing in front of a blackened, smoking landscape, Parks and Wildlife Service Wellington District conservation officer Emma Atkinson can't hide her enthusiasm as she describes how much she enjoys the variety of her job. Surveying for populations of rare flora or tracking quokkas one day, and fighting a fire or planning a prescribed burn the next, Emma is one of a growing number of women who are keen to contribute to fire management, in all areas of the operation.

DREAM JOB

When asked to sum up her job in one word, Emma's face is transformed by a huge and infectious smile.

"Does the smile say it all?" she asks.

"It's pretty awesome."

Emma is one of between 800 and 900 DBCA staff who play a role in Parks and Wildlife Service fulfilling its responsibility of managing fire in forests, parks, nature reserves and other Parks and Wildlife Service-managed lands. The department achieves this through managing fuel loads by prescribed burning and other mitigation activities; responding to bushfires; and undertaking research into fire behaviour and effects.

Emma has been involved in fire management for most of the six years that she's been with the department. She spent

Main Prescribed burning is carried out around the State to manage fuel loads.

Inset far left Jessica Newman, Vicky Reynen and Emma Atkinson are some of the 800 to 900 DBCA staff who are involved in fire management.

Inset below left Aimee Gomm.
Photos – DBCA

two summers 'working on the back of a truck', which provided her with first-hand experience into what it's like at the fire front and enabled her to build relationships with people working in the field. She then became a shadow officer, during which time she accompanied a number of personnel in a variety of roles and had the opportunity to learn from their experience by watching on the job. Now, she works in a fire line leadership position as a sector commander and is responsible for up to 15 crew, five trucks and one machine during prescribed burns and is a first arriving officer during bushfires.

Emma credits the training she's received and the opportunities she's had to learn from others for her success in fire management and hopes to progress into an operations officer role.

"The skills and knowledge I've learnt and picked up have been based on the people I've worked with – the overseers who have years and years of experience and officers who have been with the department for many years," she said.

"It's been so valuable to spend time with these people and learn from them."

THE NEED FOR ACTION

While Emma has achieved success in her fire-related career, and there has been a slight increase in the number of women in fire roles in the department in the past 20 years, females are still underrepresented in fire management and fire line positions. And of the positions that are held by women, there is a bias in the types of roles they occupy. Currently, 83 per cent of fire management positions, 95 per cent of frontline fire fighter positions and 96 per cent of fire duty officer positions are held by men, while women occupy the majority of administrative-type roles, such as management support and resources.

In order to address this imbalance, and as part of its department-wide *Workforce and Diversity Plan*, which sets the strategic agenda for achieving current and future workforce needs, DBCA assembled a Gender Diversity in Fire Working Group in 2018. This group, which is made up of representatives from across the department, was charged with developing a *Women in Fire Management Action Plan* to support women and improve gender diversity in fire management over the next three years.



Above The department is supporting women to assume frontline roles.

Below Allison Donovan (centre) with Jessica Correia Henriques and Jessica Greenfield. *Photos – DBCA*

ASKING TOUGH QUESTIONS

Shortly after its inception, the group distributed a survey to department staff to gain insight into what issues, perceptions, biases and barriers were contributing to women being underrepresented in



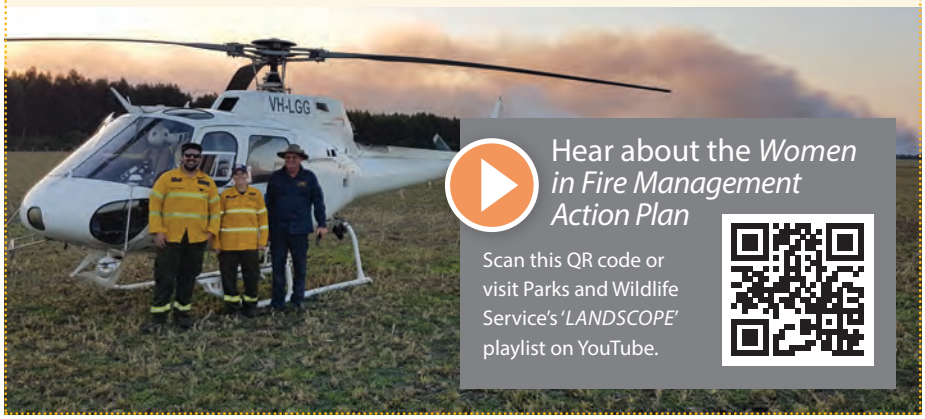
Champion of Change

Parks and Wildlife Service Moora District manager and 'Champion of Change' Allison Donovan began her career with the department in 2001 as part of the Graduate Recruit Development Program, where she received training in all aspects of fire management. For the next five years, she was based in Collie and contributed to the department's bushfire suppression operations, primarily in catering and non-operational support roles. In 2005, Allison transferred to Walpole as the parks and visitor services coordinator and, in 2010, became the Frankland District manager. Shortly after that, she became a district duty officer, charged with coordinating the department's response to local fires on a roster basis. She credits the mentoring she received from other more experienced staff for her successful transition into the role.

Allison says she never felt she was treated different during her career for being a woman, but recognises that unconscious biases exist throughout the whole workforce. As part of her role in the Gender Diversity in Fire Working Group she has challenged her own unconscious biases and is committing to ensuring that roles and positions are allocated based on merit and not on a preconceived notion of what constitutes 'male' and 'female' roles. She also hopes women will put themselves forward for roles that were traditionally held by men.

It is the department's aim that through the implementation of the Women in Fire Management Action Plan 2019–22:

- equal opportunities will exist for those who are suitable to progress their career in fire management
- there is an increased awareness and use of flexible working arrangements in fire management
- 'Champions of Change' – staff who have made a commitment to build a positive workplace culture – are visible at all levels of the agency
- staff are empowered to counter negative behaviours that hinder achieving gender diversity in fire management
- there is an increase in the number of women applying for and being successfully appointed to fire management positions
- there is increased participation of women in fire management roles across the agency
- there is a balance of gender representation at meetings and forums.





Above Women currently hold just five per cent of frontline fire fighter positions.

Left The department is committed to ensuring mentoring opportunities are available for all its staff.
Photos – DBCA

fire management. More than 400 staff members responded to the survey, of whom half were women. The survey revealed that 72 per cent of women in operational roles felt they had faced barriers in taking on fire leadership roles. And nearly two thirds of responding women who are not currently involved in fire management said they would like to be, but cited family and personal commitments, that it wasn't a requirement of their current duties, and concerns about how it would impact their everyday jobs as hurdles to becoming involved.

The group then held two workshops to discuss the survey findings and leverage off the collective experience of the more than 50 attending participants, to develop strategies for inclusion in the plan. Six areas were identified for improving gender diversity in fire management: building an inclusive workforce; flexible work arrangements; building confidence; staying connected; continual improvement; and recruitment.

DEVELOPING AN ACTION PLAN

The working group then developed the *Women in Fire Management Action Plan 2019–22*, which identifies key actions to address the six areas, and sets out clear targets to aspire to and timeframes in which they are achieved.

By achieving these actions, the department is optimistic that, by 2024, women will hold 30 per cent of Public Service Award positions (up from 17 per cent in 2019), which are typically assistant fire operations officers, operations officers, district fire coordinators and regional fire leaders; 20 per cent of Australian Workers' Union positions (up from five per cent in 2019), which are typically conservation employee and overseer positions; and 10 per cent of fire leadership positions (up from zero in 2019). The progress of the plan will be evaluated each year and a comprehensive overview will be carried out at the end of three years.

While it's true that the development of the action plan is designed to increase participation of women in fire management, the outcomes will benefit everyone, within the department and the wider community. This initiative is based on the premise that equality and diversity do not only relate to matters gender, but on having a diverse representation of skills, ideas and approaches from all staff. Achieving a broader range of diversity will assist in improving organisational productivity, performance and capability.

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Working together for Ngwayir

by Deon Utber and Kim Williams

Recently upgraded to 'critically endangered', the ngwayir, or western ringtail possum, is receiving reinvigorated attention from members of the community, scientists and government agencies, as they work collaboratively to implement conservation actions under the guidance of a new recovery plan and recovery team.

The western ringtail possum (*Pseudocheirus peregrinus occidentalis*) or ngwayir, as it is known by Aboriginal people, is often encountered by people who live within its range in the State's south-west. However, despite being commonly seen within urban areas, this arboreal marsupial is threatened and was upgraded from 'endangered' to 'critically endangered' in 2017. This has led to a higher degree of scrutiny among community members and increased efforts into recovery actions for its conservation.

DISTRIBUTION AND BIOLOGY

Today, ngwayir occur in three distinct subpopulations – on the Swan Coastal Plain, in the southern forests and on the South Coast. However, sub-fossil data indicate it once had a much broader distribution. When the *Western Ringtail Possum Recovery Plan* was prepared in 2014 it was believed there were fewer than 8000 mature individuals in the Western Australian subspecies. However, it is necessary to review and update this data to gain a better understanding of how the western ringtail possum is faring today across the full population range.

Ringtail possums are a tree-dwelling, leaf-eating (folivorous) marsupial, which have a prehensile tail. They are easily distinguished from brushtail possums (*Trichosurus vulpecula*), or 'koomal' due to their slim, white-tipped tails, darker fur and smaller, rounder ears. Along the Swan Coastal Plain, core habitat for the ngwayir is primarily peppermint woodland (*Agonis flexuosa*) and tuart woodlands (*Eucalyptus gomphocephala*) containing peppermint. However, they are not dependent on peppermint for habitat and have been known to utilise other types of vegetation – such as marri, jarrah and sheoak – in areas outside the Swan Coastal Plain.

Ngwayir can start breeding at about 12 months of age and usually have a litter of one. However, on rare occasions, they have been recorded with two or three young. After a brief gestation period – two to four weeks – the neonates spend about three months in the pouch and are then weaned at six to eight months. Young ngwayir stay with their mothers for eight to 12 months, and then disperse to make their own way. They can live for up to four years.

Reproductive success can be dependent on habitat quality; there is a strong correlation between low nitrogen content in tree canopies and lower birth numbers. This is evident in peppermint woodland that has a higher nitrogen content and a subsequent higher birth rate.



"Ringtail possums are ... easily distinguished from brushtail possums (*Trichosurus vulpecula*), or 'koomal' due to their slim, white-tipped tails, darker fur and smaller, rounder ears."

THREATENING PROCESSES

Ngwayir face a number of threatening processes that are all too familiar to many native Australian animals: habitat removal, fragmentation and predation, and the impacts of climate change. These threats can impact ngwayir populations to varying degrees, depending on whether they occur near coastal populations where housing development and predation pressures are high or inland where other land management practices and introduced predators are the primary concerns.

Historically, clearing for agriculture along the southern Swan Coastal Plain, between Mandurah and Busselton to Dunsborough, targeted the fertile soils and low-lying lands, which formed much of ngwayir's key habitat in this area. Further fragmentation of vegetation by urban development has increased pressure on the ngwayir across its range because of reduced vegetation patch size and isolation of remnants, as well as

Previous page
Main Ringtail possum.
Photo – Geoff Taylor/Lochman Transparencies
Background Peppermint and tuart woodlands are key habitat for the ringtail possum.
Photo – Brett Dennis/Lochman Transparencies

Above Ngwayir young stay with their mother for eight to 12 months.
Photo – Ann Storrie





increased risk of predation by cats, dogs and foxes. Increasing urbanisation has also led to higher numbers of possums being struck by vehicles and electrocuted on power lines as they attempt to move through suburbia between remnants. Urban development and fragmentation are particularly prevalent threats in the Swan Coastal and South Coast management zones.

Away from the coast, in the southern forests zone, impacts by land management practices and predation by introduced predators are of greater concern than development. Activities such as forestry and inappropriate fire regimes can impact the quality of habitat for food and refuge and expose ngwayir to predation by introduced predators.

The impacts of climate change are also likely to affect all populations of ngwayir due to its habitat requirements, its poor ability to migrate and its sensitivity to drought-induced stress. Rainfall has reduced by at least 20 per cent in the past 30 years, and it is predicted that increased average temperatures will cause further decline. It is likely that these changes will lead to increased fire frequency and intensity, which will cause a reduction in habitat quality and result in the further contraction of the possums' range into more fertile and mesic environments, where they are available.

A LITTLE HISTORY

The western ringtail possum was listed as specially protected fauna in 1983 and a dedicated recovery team was assembled during the late 1990s. The team developed an *Interim Recovery Plan*, which was released in 1997, to address urgent recovery actions. The plan focused on improving knowledge of the biology and ecology of ngwayir, much of which was initially established by independent researcher Barbara Jones, and the effect of threatening processes on the species' long-term survival.

The rapid urban development on the southern Swan Coastal Plain was having a dramatic impact on key possum habitat through habitat loss and fragmentation. So, in 1991, the first trials of capturing and translocating possums from development sites to habitat in secure conservation reserves were undertaken.

Translocations from development sites over the next 10 years provided opportunities for a number of PhD and Masters level studies into translocation techniques and survival, animal diseases, best practices for rehabilitation of sick and injured western ringtail possums, population genetics, animal physiology and the development of new capture techniques such as 'darting'.

The development of 'possum-friendly' protocols to reduce the likelihood of physical harm or death to the possums during vegetation clearing operations were introduced, as were the requirements for experienced fauna spotters to be present, to direct machine operators and ensure animal welfare issues are implemented.

Hear more about the ngwayir

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

Above left Brushtail possums (koomal) are distinguishable from the ringtail possum by their lighter fur, thicker tails and pointed ears.

Above Ngwayir are also known to utilise marri, jarrah and sheoak.
Photos – Jiri Lochman





Above and far right Artificial possum boxes are supporting breeding.
Photo – Ann Storrie

Right Local arborists have joined forces with GeoCatch and the Western Ringtail Possum Recovery Team to install nesting boxes.
Photo – GeoCatch



Below Ringtail possum.
Photo – Ann Storrie

Western ringtail possums

Ngawyir have dark-brown fur with a lighter-coloured belly. Their tail grows to 30–35 centimetres and has a white tip. It is prehensible, which means it can curl around branches and aid in climbing. Ringtails have large, brown eyes and small, rounded ears. Adults weigh about one kilogram and have a body length of about 30–35 centimetres.



A series of trials were undertaken to evaluate the use of mitigation actions on or adjacent to development sites, including the use of artificial dreys and nest boxes and habitat planting and creation.

In 2006, a project was started to map the extent of habitat in the core Busselton to Dunsborough area. The information gathered provided a baseline from which the distribution and rate of habitat loss could then be evaluated. This was expanded in 2014 to include habitat suitability mapping and a habitat classification system across the Binningup to Dunsborough area, which continues to be used by government agencies to assess the likely impact of vegetation clearing proposals.

Population monitoring programs in the southern sections of the Swan Coastal Plain were established in locations such as the Tuart Forest National Park and Locke Nature Reserve, and the use of innovative techniques such as scat counts as well as traditional spotlighting were introduced.

Guidelines for developers and planning consultants were developed and the recovery team worked with the State and Federal governments on procedures to identify 'impact significance guidelines' and establish the criteria for offsetting habitat loss in addition to standard approval conditions.

A CALL TO ACTION

In January 2017 the western ringtail possum was upgraded to 'critically endangered' after a review of its conservation status by the Western Australian Threatened Species Scientific Committee.

The Federal Government released a *National Threatened Species Action Plan* with the aim of improving the trajectories of 20 threatened mammal species by 2020, including the western ringtail possum. The national action plan and the recent conservation status upgrade has reinvigorated activity for the plight of the ngwayir and led to a rapid increase in the number of community-based conservation projects being developed and funded through State and national natural resource management programs. These projects include surveys in areas of potential western ringtail possum habitat,





Left DBCA held a community and stakeholder workshop to discuss the conservation of ngwayir.
Photos – GeoCatch

Above Displaced and injured possums are cared for by wildlife rehabilitators.
Photo – Ann Storrie

for which there is little data, to improve our knowledge and understanding of where possums occur. Natural resource groups are also engaging with land managers and the general community to provide information about practical activities that can support possum conservation, and predator control.

In response to the increased attention and concern for the ngwayir, DBCA held a workshop with community and stakeholder groups to discuss the conservation of ngwayir and the need to re-form the Western Ringtail Possum Recovery Team. The object of re-forming the team was to ensure a coordinated approach to implementing the 2017 recovery plan. Workshop participants provided information on activities currently being undertaken and mapped these against the recovery plan actions. With these actions documented, continuing and future plans were discussed, and it was agreed that re-forming the recovery team was essential to enable collaboration and coordination of conservation efforts across community groups and government agencies.

The team reconvened in late 2017, with representatives from DBCA, local government, Main Roads and tertiary institutions and community members from the three management zones. The enthusiastic team has met regularly and is progressing the highest priority actions including developing consistency in survey and monitoring techniques, improving knowledge on the population status through a regional context survey, coordinating and advocating communication and identifying and promoting research into ringtail possum biology and behaviour.

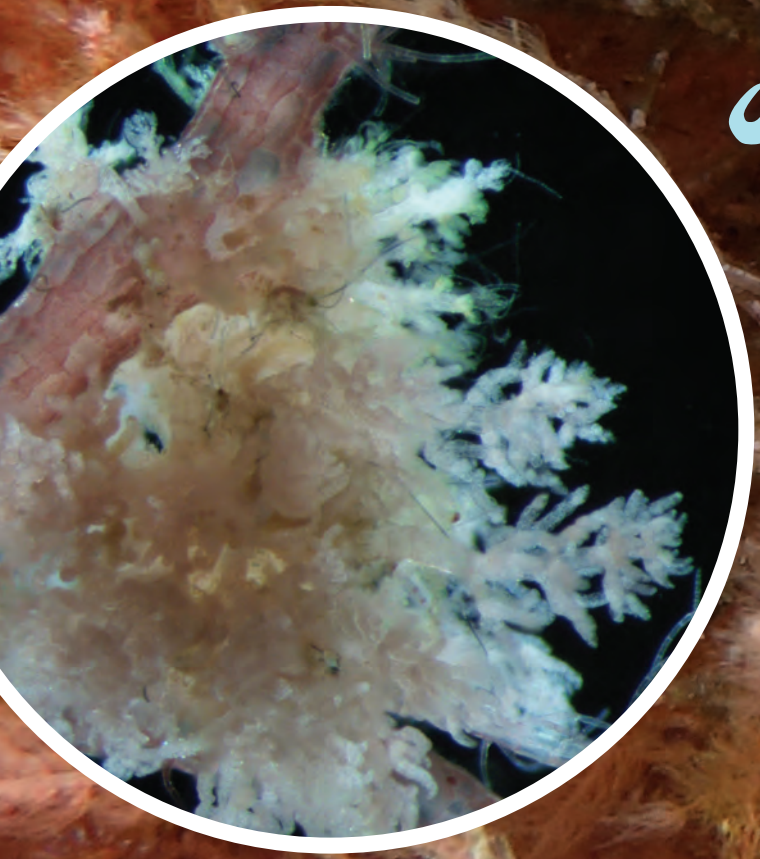
The benefits of the re-convened recovery team are already being realised through interaction and advice being provided to natural resource management groups undertaking on-ground works, student research aimed at increasing the knowledge base for management, local government in developing a ringtail possum strategy, and government agencies investing in roadkill impact mitigation and regional context surveys. The team is working with wildlife rehabilitators to improve the delivery of care to displaced and injured animals and the understanding of changes introduced by the new Biodiversity Conservation Regulations 2018.

The recovery team is committed to a holistic approach to improve our understanding of ngwayir's conservation status across its full range and achieve practical conservation that will ensure the long-term preservation of this iconic Western Australian species.

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Kim Williams is the Parks and Wildlife Service's South West Region Conservation Regional Leader. He can be contacted on (08) 9725 4300 or by email (kim.williams@dbca.wa.gov.au).
Other contributors to the project included DBCA staff Ian Wilson, Sarah Comer and Geoff Barrett.

Parasitic Seaweed

photos and words
by John Huisman



Rarely seen, a group of miniscule seaweeds have adopted a seemingly alien lifestyle and become parasites, often of their close relatives. Here we look at how this unusual behaviour might have evolved, what it takes to be a parasite, and a closer look some of the distinctive species found in Western Australian seas.



Opposite page
Main The red seaweed parasite *Trichidium*, visible as white tufts on *Lophocladia kuetzingii*.
Inset Close-up view of the branching *Trichidium pedicellatum*.

Above The mistletoe *Amyema xiphophylla*, a hemiparasite on *Acacia*.
Photo – William Muir

Seaweeds are often described in derogatory terms such as 'foul smelling' and 'rotten'. Even 'weed' has negative connotations, despite very few seaweeds being actual weeds. 'Parasite' is a term that we rarely use when we refer to seaweeds. After all, seaweeds are photosynthetic, and, for all intents and purposes, are usually classed as plants, able to generate their own energy.

Parasitic plants do occur, and are common in Western Australia's terrestrial environment. The Christmas tree (*Nuytsia floribunda*, 'Moodjar' in Noongar), with its bright orange flowers, is hemiparasitic and gains part of its energy by stealing sap from the roots of neighbouring plants. The tree is a mistletoe, closely related to spectacular aerial species such as *Amyema xiphophylla* that are hemiparasites on *Acacia*. Despite these examples, the more common perception of parasites is of animals.

There is, however, a relatively small group of red seaweeds (approximately 120 species) that qualify for the term 'parasites', as they grow on and parasitise other red seaweeds. These parasites can usually be recognised by their appearance – white and unpigmented; their classification as 'red' algae is based more on their structure rather than their colour. They are typically small, often pustular, although several are branched and might easily pass for regular seaweeds if it wasn't for their lack of colour.

BIOLOGICAL BACKGROUND

That the red algae have been capable of adopting a parasitic lifestyle is most likely due to an unusual feature of this group: the ability to form secondary connections between cells, which often then leads to fusion of the cells and the sharing of cell contents. These connections and subsequent fusions are common in several groups of red algae, and is likely the same process when cells of the parasite connect and fuse with host cells. The fusion of cells allows the passage of cell contents between host and parasite, including organelles such as chloroplasts.

To qualify as a parasite, these seaweeds have to conform to a set of characteristics. Firstly, they should penetrate beyond the superficial layer of the host; secondly, they should be relatively small (generally less than one centimetre tall); thirdly they have minimal or no colour; and lastly all phases of the life cycle should be present on the same host.

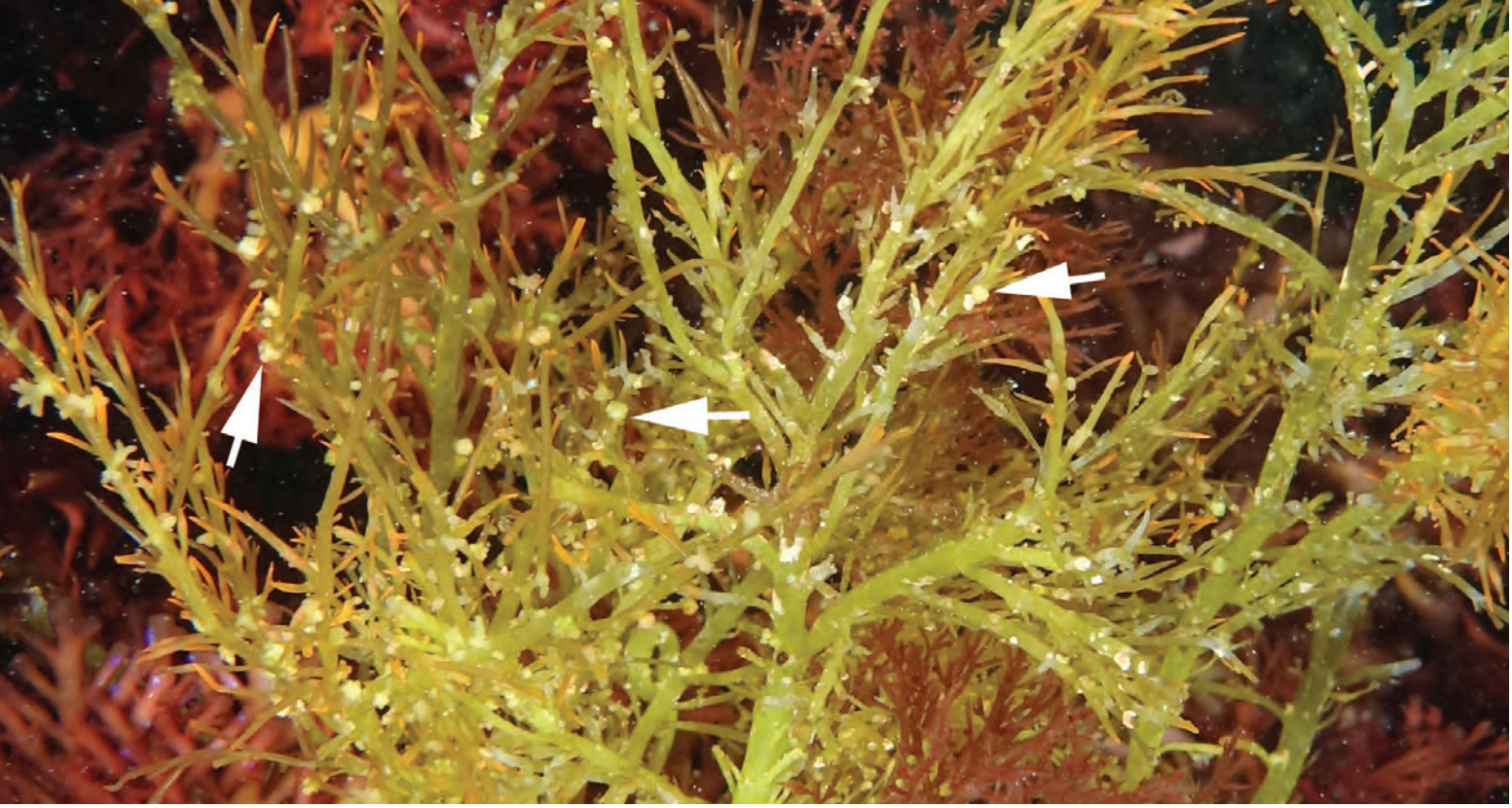
All parasites sexually reproduce, so it is clear that they are not just galls or deformities of the host seaweed. Red algal parasites are generally recognised as independent genera that include only parasitic species. They are often closely related to the host species (in the same taxonomic family) and in many cases DNA sequencing has placed them in the same genus, suggesting they may have evolved directly from the host. Some parasites have evolved from species closely related to the host, but no longer live on their direct ancestor. DNA analyses of the phylogenetic origin of red algal parasites, has suggested multiple independent origins, but equally that the parasite can be nested within the host genus. This could result in taxonomic changes where parasites lose their generic status.

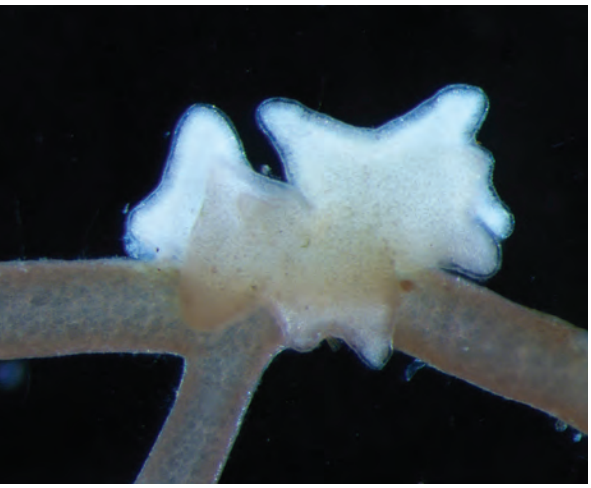
COST OF THE RELATIONSHIP

Superficially there does not seem to be any significant detrimental impact on the host plant, although this is difficult to assess in field material as the host seaweeds do not show obvious damage. However, a study that looked at growth rates of *Hypnea musciformis* infected by the parasite *Hypneocolax stellaris* in Hawaii found that, relative to uninfected plants, growth was reduced by up to 40 per cent in field material and 70 per cent in laboratory grown plants. *Hypneocolax stellaris* is a pustular species common in southern Australia, where it parasitises *Hypnea ramentacea*.

The biology of these parasites has been investigated in detail in only a small number of species, but of those species the parasite establishes a cellular connection with host cells by fusion, and then transfers organelles (nuclei, plastids and mitochondria) into the host cells. The parasite can then exert control over the host cells for its own benefit.

Parasites that infect closely related species (within their own family) have historically been known as 'adelphoparasites', and account for about 80 per cent of red algal parasites. While those that infect more distantly related species are termed 'alloparasites'. These categories are being replaced with terms that more closely reflect the biology of the parasites, with 'archaeplastic' referring to those parasites that retain a native chloroplast (formerly most alloparasites), and 'neoplastic' for those that 'hijack' host chloroplasts that are incorporated into





Top *Hypnea ramentacea*, with numerous pustular *Hypneocolax stellaris* (arrows).

Above Close-up view of the pustular *Hypneocolax stellaris.*

developing spores, rather than retain their own.

While native chloroplasts are retained in archaeplastic species, they have lost the genes for photosynthesis. However, they retain genes for other functions such as the synthesis of important compounds like amino acids. All parasites maintain a fully functioning mitochondrion (the organelle responsible for energy production) in their cells.

TAKING A CLOSER LOOK

Being small and inconspicuous, red algal parasites are often overlooked, and even diligent observers can miss them. In the early 1970s, the phycologist (a person who studies seaweeds) Gerry Kraft collected an unusual seaweed parasite growing on the red alga *Lophocladia kuetzingii* (at the time known as *Lophocladia harveyi*), from Port Denison in Western Australia. Realising the novelty of his find, Gerry returned to the locality twice in 1979 and 1980, but despite *Lophocladia* being present in abundance, there were no further traces of the parasite. A few years later, student Joanne Noble and Gerry formally described the parasite as the new genus and species *Trichidium pedicellatum*, along with two other red algal parasite species in the genera *Holmsella* and *Meridiocolax*. Currently there are 12 species of parasitic red algae known in Australia, in 12 separate genera. Many of these are poorly known, and *Trichidium pedicellatum* has remained unobserved in the almost 50 years since its first discovery.

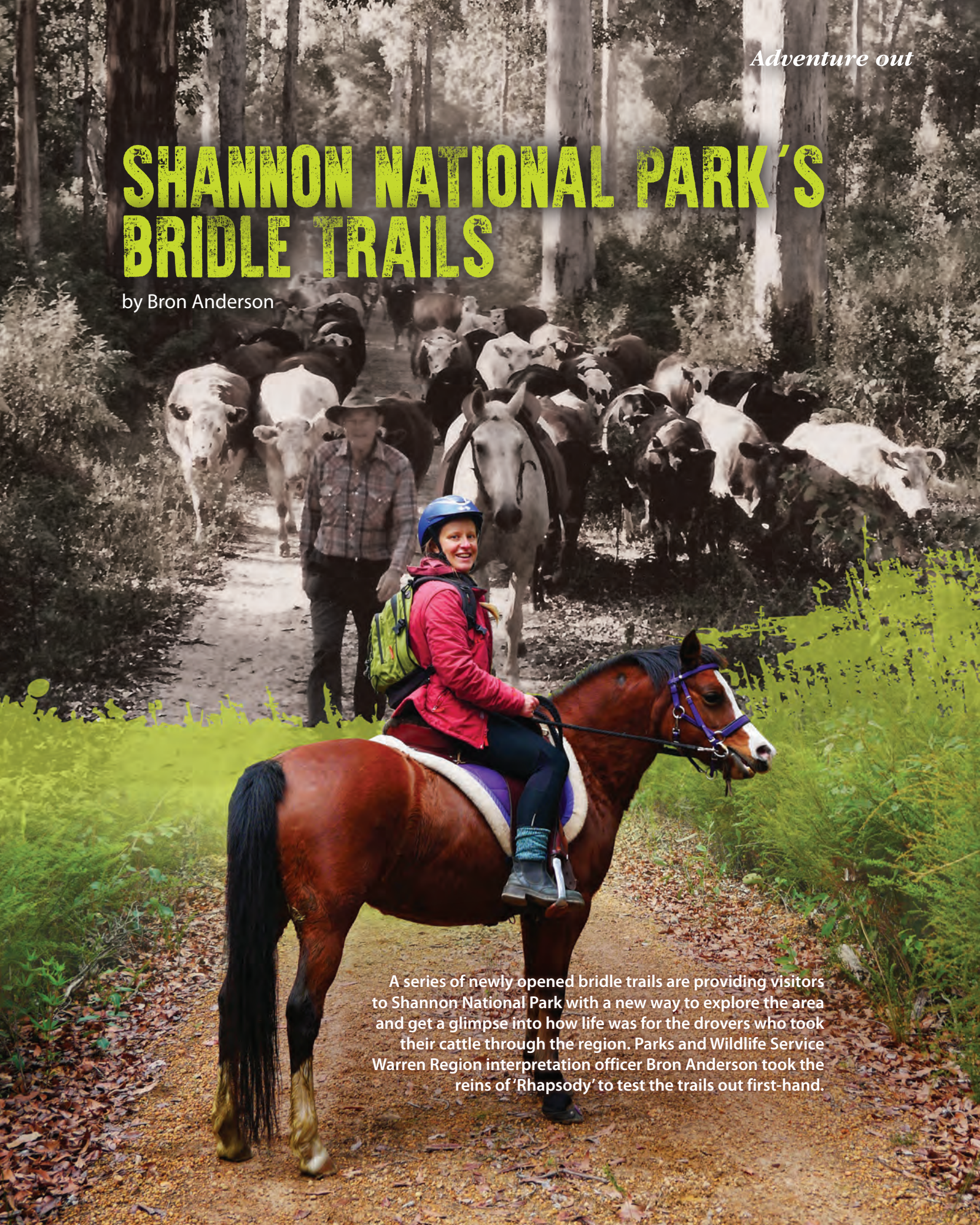
The only known host of *Trichidium*, *Lophocladia kuetzingii*, is seasonally common at Cape Peron, south of Perth. While snorkelling there recently I noticed unusual white tufts growing on some of the plants, the tufts at most maybe half a centimetre tall. Initially suspecting them to be a reproductive structure, I collected some material and examined it in the laboratory under a microscope and discovered that these white tufts were in fact the long-lost *Trichidium*. Despite their small size, all the plants were reproductively mature and all life cycle stages were present. In the red algae this encompasses three phases, including a spore-bearing stage, which releases spores that grow into separate male and female plants, and a second spore-bearing stage that develops on the female plant after fertilisation.

The discovery of fresh material will enable us to assess whether *Trichidium* is indeed a parasite, and to undertake genetic analyses to better understand its relationship with the host *Lophocladia*. Despite their small size, red algal parasites are a fascinating group and there is still plenty to learn about their diversity and the evolution of their unusual lifestyle.

John Huisman is DBCA's Herbarium curator. He can be contacted on (08) 9219 9137 or by email (john.huisman@dbca.wa.gov.au).

SHANNON NATIONAL PARK'S BRIDLE TRAILS

by Bron Anderson



A series of newly opened bridle trails are providing visitors to Shannon National Park with a new way to explore the area and get a glimpse into how life was for the drovers who took their cattle through the region. Parks and Wildlife Service Warren Region interpretation officer Bron Anderson took the reins of 'Rhapsody' to test the trails out first-hand.





Previous page
Background The area is steeped in history from when it was used by drovers as a thoroughfare to the south coast.
Foreground Bron Anderson explores the Cowbells Loop with 'Rhapsody'.
Photos – Erin Graham (background) and Tracey Lynn

Above left and right Droving cattle to the coast for summer grazing was a way of life for many farming families.
Photos – Erin Graham (L) and Muir family (R)

Former residents of the Shannon Mill townsite may remember the great excitement of seeing the drovers and their cattle pass through the area that is now Shannon National Park. Maybe they recall the rattle of the timbers as the cattle crossed the bridge over the Shannon River, or remember when the drovers let the town kids have a ride of their horses. Perhaps they were even part of the contingent of children who followed the parade of cattle up the road.

Thirty years after Shannon was declared a national park, the sound of horses' hooves can again be heard clip-clopping along the forest floor on three bridle trails that opened in May 2019.

ALL ABOARD

I hadn't been on a horse since I was a child, so I was apprehensive about taking up the reins. But an offer from local horsewoman Tracey Lynn to lend me a horse and be my guide for the day was too good to pass up. So, with images of drovers in my mind and the ghosts of yesteryear spurring me on, I saddled up on 'Rhapsody' to explore Shannon National Park on horseback on one of the new trails.

The trails all start and finish at the Shannon Horse Camp, which is on the road into the Shannon Campground. From here, you can choose to take the seven-kilometre Showpony Circuit, the 17-kilometre Cowbells Loop or the 20-kilometre Saddlebags Trail. Each trail passes through a variety of vegetation types, including tall karri forest and drier jarrah and marri forest. The Saddlebags Trail also journeys through low-lying swampy heathland.

The first thing that struck me as we set off on Cowbells Loop, was how much better the view was from high up on Rhapsody's back. The first section of all three trails passes through a tract of karri forest that I've walked many times before. Usually I can only see tree trunks and a wall of karri, but from my new vantage point, I could see the undulation of the landscape, which would be spectacular in spring.

When we first set off, the forest seemed quiet. But soon my ears became attuned to the sounds of the horses' hooves crunching on the gravel track, the breeze through the trees and the chorus of birds. It was incredibly peaceful.

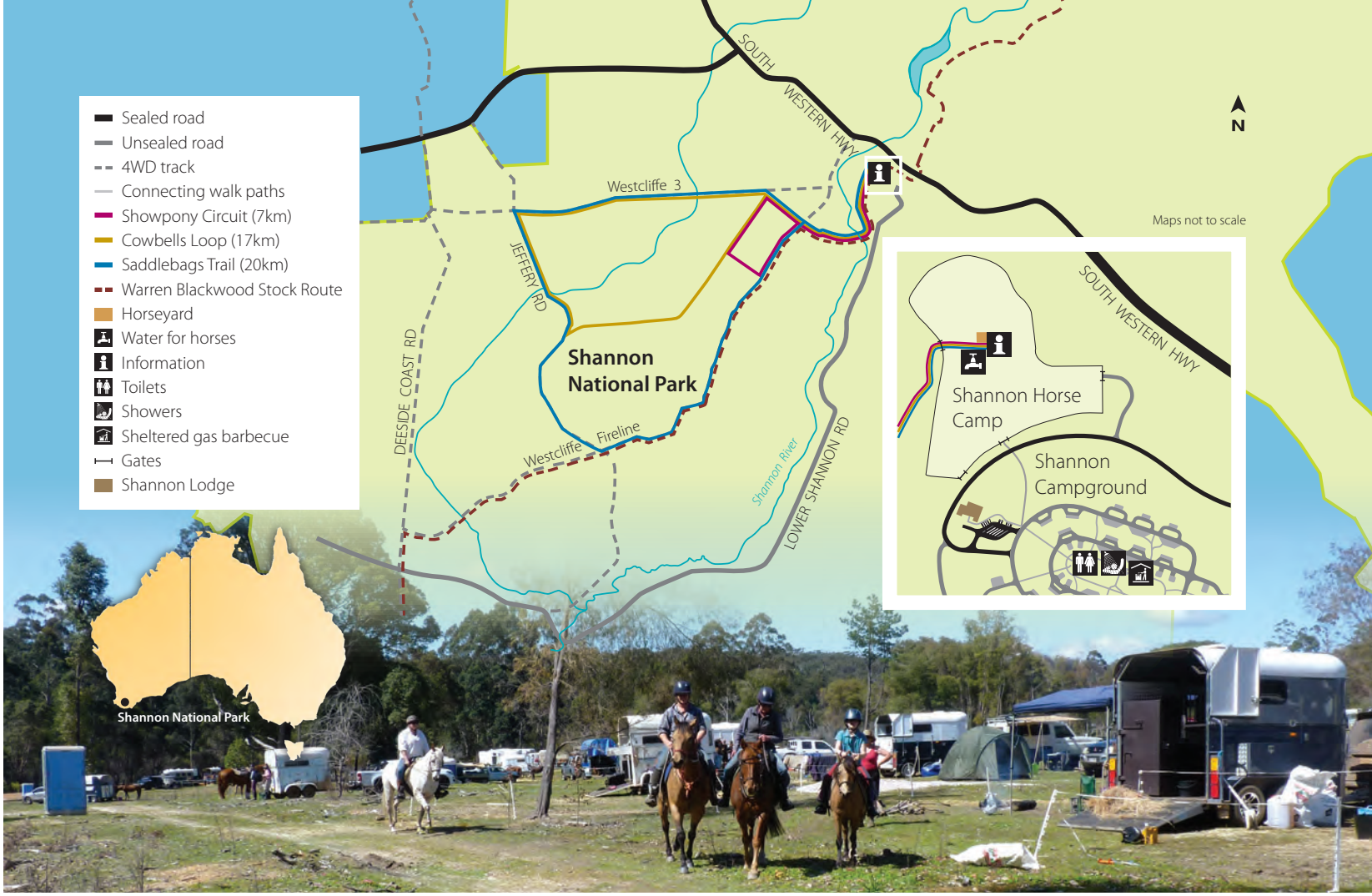
We crossed the Shannon River and headed uphill into more open jarrah forest. I was just beginning to relax into Rhapsody's gentle rocking and was happily taking in my surroundings, when Tracey suggested that we trot. Trotting is certainly easier said than done, and I bounced around like a piece of popcorn in a pan until I managed to find my rhythm about two kilometres before the end of the ride.

"Visitors can camp with their horses and take their time exploring the area ... [and] there's plenty of room to spread out and relax in at the end of a day of riding."

HORSEY HISTORY

The Shannon area has a long association with horse riding. Droving cattle to the coast started in about 1860 and continued until the latter half of the twentieth century. Droving as many as 300 cattle to the coast on horseback for summer grazing was a way of life for many farming families who took up freehold and leasehold properties on the south coast. The natural grasses and creepers sustained livestock and the State Government regulated the use of bushland areas by granting grazing leases. Then, when the first rains of winter arrived to replenish the farms, the cattle would be brought home – just in time for calving.

The local roads that pass Shannon National Park, such as Wheatley Coast and Deeside Coast roads, are former droving routes. But, as forested areas



Above Shannon Horse Camp allows visitors to camp with their horses and take their time exploring the area.
Photo – Tim Foley/DBCA

Right The three trails provide a range of vegetation types to enjoy.
Photo – Bron Anderson/DBCA

were developed, and traffic increased, droving on the highways became more difficult.

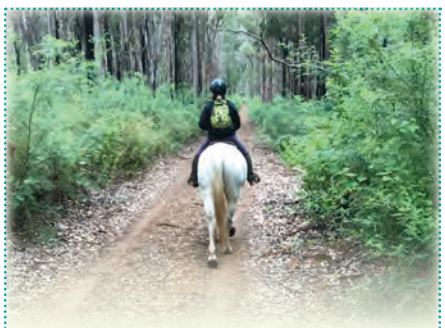
A change in government policy in the late 1970s signalled the end of the droving era. Restrictions on how farmers could manage their coastal land and the protection of large areas of land for conservation reduced access to the coast. Then, in the 1980s, many of the remaining pastoral leases were cancelled.

EQUINE ENVIRONMENT

In addition to the three bridle trails, DBCA's Parks and Wildlife Service has opened the Shannon Horse Camp so visitors can camp with their horses and take their time exploring the area. Horse yards, compost bays, a tap and hitching rails are provided at the camp, and toilets and showers are a short walk away at the main campground. There's plenty of room to spread out and relax at the end of a day of riding.

This campground provides the perfect place to stage horse riding events. The Bannister Downs Dairy Shannon National Park Endurance Ride was held at Shannon Horse Camp in May 2019. More than 80 horses, their riders and support crews took part in the event and the campground accommodated everyone nicely.

I couldn't wipe the smile off my face as Tracey and I rode back to the campground. Riding through Shannon National Park was spectacular and gave me a totally different perspective of the landscape than I've ever got from walking or driving. I thought about the experience a lot the next day, thanks to my aching muscles, but it's one I'll remember forever.



Do it yourself

Where is it? Shannon National Park is 33 kilometres east-north-east of Northcliffe and 53 kilometres from Pemberton and Manjimup.

Park facilities: Information, toilets and showers, barbecues, campgrounds and horse yards, compost bays and hitching rails.

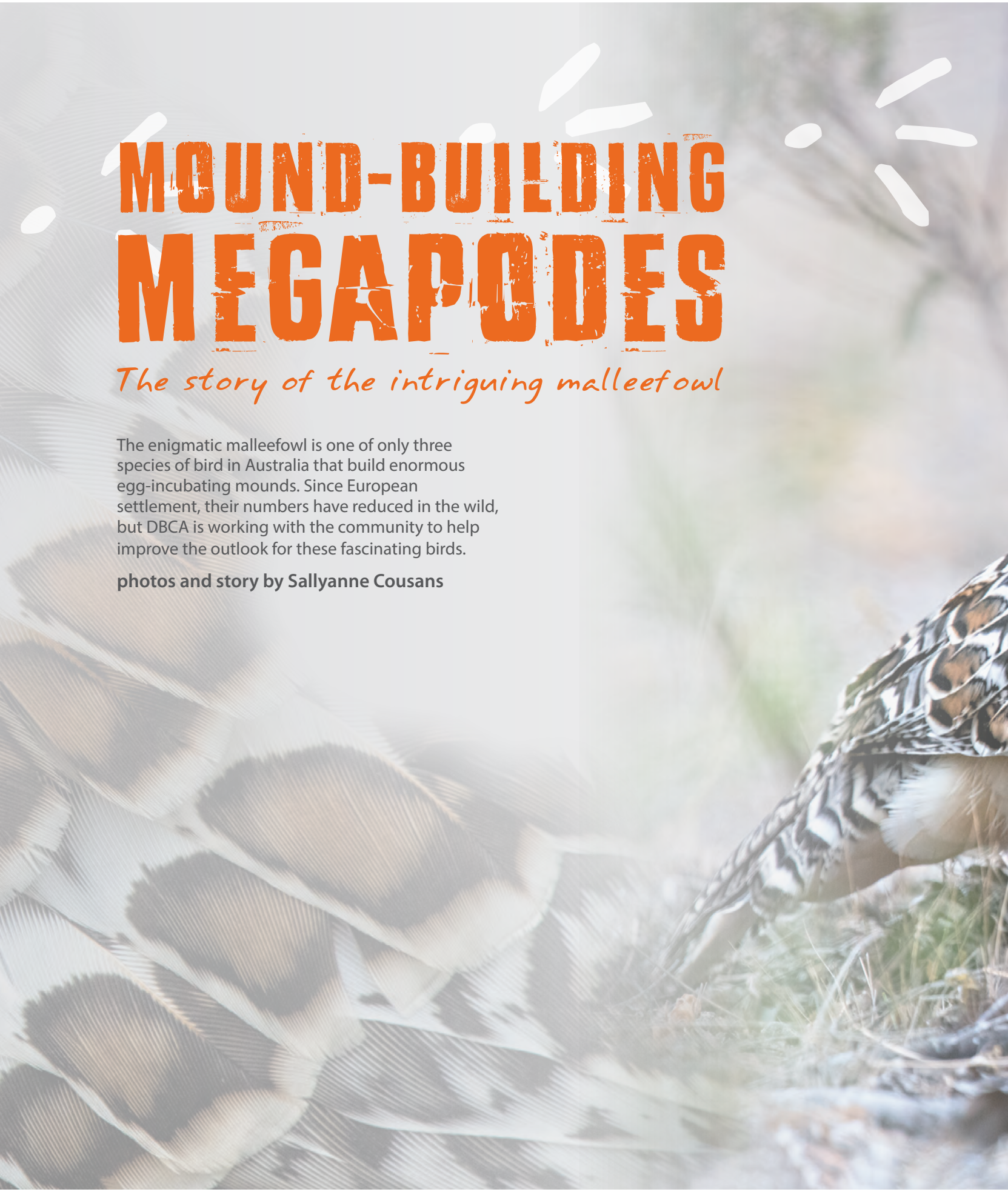
For more information about Shannon National Park, visit exploreparks.dbca.wa.gov.au. For more information about the bridle trails, visit trailswa.com.au/trails/shannon-national-park-bridal-trails.

MOUND-BUILDING MEGAPODES

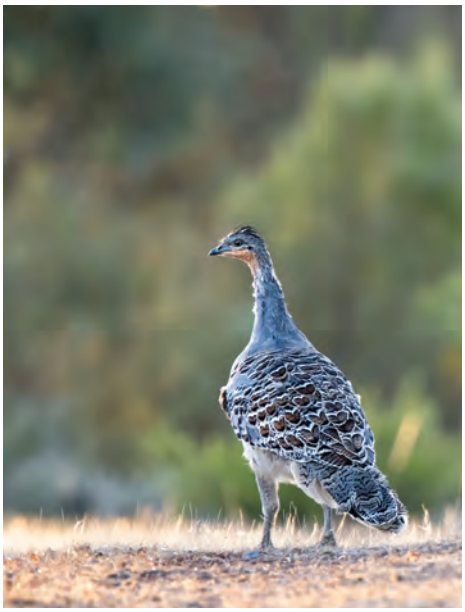
The story of the intriguing malleefowl

The enigmatic malleefowl is one of only three species of bird in Australia that build enormous egg-incubating mounds. Since European settlement, their numbers have reduced in the wild, but DBCA is working with the community to help improve the outlook for these fascinating birds.

photos and story by Sallyanne Cousans









Previous page
Main A malleefowl rakes the leaf litter to forage for invertebrates.
Inset The back and wings of a malleefowl have intricate patterning.

Above left The malleefowl that Sallyanne tracked through her lens on a property south of Ongerup.

Above Adult malleefowl.

Earlier this year I was sitting quietly in my camouflage hide on a property south of Ongerup, with my camera poised, when a large, mottled bird emerged from the scrub and walked elegantly about 20 metres in front of me. Recognising it as a malleefowl (*Leipoa ocellata*), I excitedly tracked its movements through my lens and watched as it stopped beneath a tree where the ground was thick with leaf litter. With a powerful foot, it raked methodically at the fallen leaves then stooped and pecked quickly at the disturbed ground. It fed for a minute or two, presumably on a smorgasbord of wriggling insects, before continuing on its way. Then it disappeared from my line of sight, as it passed behind a dense shrub. I waited in anticipation for it to reappear. But it didn't. I was perplexed. Where did it go?

DISAPPEARING ACT

Malleefowl once occurred over much of the southern half of Australia, but their current range is believed to be half of what it was before 1992. They are now listed as 'vulnerable' under both the national *Environment Protection and Biodiversity Conservation Act 1999* and the Western Australian *Biodiversity Conservation Act 2016*. However, surveying them is problematic; sightings are uncommon and are often by chance. The birds are often solitary, so you are only likely to see one individual, and they are so well-camouflaged that you could walk right past one without even realising. They can even seem to just disappear from sight, like I witnessed that day in the bush.

The bird I saw most likely passed behind the shrub and, using it as cover, had immediately changed its course and walked purposefully away from me. Or it stayed behind the shrub to rest, camouflaged by its cryptic plumage.

WHAT'S ALL THE FUSS ABOUT?

Malleefowl are large terrestrial birds that stand about 60 centimetres tall. The males and females are similar in appearance and have large feet and powerful legs. The back and wings are coloured with an intricate mosaic of grey, white, black and russet. The head and neck are grey and the dark-grey crown feathers can be held flat to the head or raised in a spiky crest. The chin and upper throat are chestnut and there is a long, black stripe, which is streaked with white, that extends from the fore-neck to the lower breast.

Their diet is varied and omnivorous, and includes insects, plants, berries and seeds. They have even been known to eat bees and wasps.

MOUND-BUILDING MEGAPODES

The main claim-to-fame of these intriguing birds is their extraordinary nesting habits. As megapodes, malleefowl do not sit on their eggs like other birds, but bury them in a large mound, which can be up to four metres in diameter and about a metre high. Malleefowl build these nests out of leaf litter and sand, and the heat that is generated from the decomposing plant matter incubates the eggs. By building a sophisticated incubation chamber, the female is able to deposit her eggs and leave them to safely develop; a characteristic that led renowned ornithologist John Gould to refer to the malleefowl as 'the spotted egg-leaver'.

But it takes a while to get to this point. Before the first egg is laid, malleefowl spend months planning and preparing the mound for nesting. Usually, a pair will renovate an existing mound and begin excavating a large hole in the ground, which they fill with leaf litter that they have collected over the previous weeks. After a good downpour of rain, and the litter is sufficiently wet, the composting





"... malleefowl do not sit on their eggs like other birds, but bury them in a large mound... "

process is activated and the birds cover the litter with a thick layer of sand.

Before and during egg-laying and throughout the incubation period, they constantly monitor and adjust the mound to make sure its internal temperature is just right. It is believed that sensory membranes within the bill, or the tongue itself, act like a sort of in-built thermometer and enable the birds to check the temperature and act accordingly.

During the composting process, the malleefowl adjust the temperature by removing or adding sand – raking it off to vent the heat and returning it when the temperature has stabilised. Later in the cycle, as the composting winds down, solar becomes their prime source of heat; sand from the mound is spread out in the sun to warm up and is then raked back in.

When the internal nest temperature is a steady 33 degrees Celsius, the female lays the first of her many large eggs. The male digs the mound out, a process that can take up to two hours, and the female enters the hole and scrapes a small niche in which she deposits her egg. The male gently covers it with soil and starts the two-to-three-hour job of filling the mound back in. The nest is dug out and a new egg is laid every three to eight days over the next few weeks, amounting to an average of 15 to 25 eggs. During this time, the male takes most of the responsibility of mound maintenance while his mate dedicates her time to foraging for food to sustain her for the continuing egg-laying.

This remarkable process can see the birds shifting a tonne of sand each day and can occupy them for nine to 11 months of the year.

SUPERPRECOCIAL CHICKS

Sixty days after the egg is laid, the chick uses its big feet to break through the shell and into the surrounding earth. Its next journey – the upward climb to the surface through a metre or more of sand – can take hours. It is tiring work and the malleefowl chick must stop for frequent rests. When it finally pops its head through the earth's surface, it opens



Above A camera trap image of malleefowl filling in their nest mound with leaf litter. *Photo – Eddy Wajon/Sallyanne Cousans Photography*

Above right (from left) Emu, malleefowl and chicken eggs.

Right Malleefowl chicks are completely independent from birth.





its eyes and finds itself totally alone. Without any parental guidance on what to do next, the small, quail-like chick stands upon wobbly legs, and struggles for a moment with unsteady balance. It then scurries across the top of the mound, slipping and tripping on the uneven surface, and topples over the edge and runs down the slope. It quickly collects itself and scuttles directly into the cover of the bush, blending with its surroundings and disappearing from sight.

Like all megapodes, malleefowl are superprecocial, which means that when chicks hatch from the egg they are completely independent. Chicks are fully feathered and already have the ability to run, forage and look after themselves.



They are even able to fly on their first day of life.

Despite their amazing self-sufficiency and camouflage, mortality is high; only one to two per cent of wild malleefowl chicks make it to maturity. They can quickly succumb to hunger and predation. Natural predators, such as raptors, goannas, currawongs and crows, and introduced animals, such as foxes and feral cats, are quick to make a meal of them.

TOUGH ODDS

The main cause of the decline of malleefowl is loss of habitat. Historically the birds occurred across the southern half of mainland Australia except for Queensland. But, due to extensive land clearing for agriculture, much of the prime malleefowl environment is now gone. The remaining habitat is severely fragmented and malleefowl now exist in isolated pockets of remnant bushland; the vast, cleared landscapes are just too great for them to cross. This is not good news for their genetic diversity. Roads also divide habitat and present a constant hazard; it is not uncommon to see a dead malleefowl lying on the roadside.

Bushfires also present a threat to malleefowl, as their preferred habitat is bush that has been unburnt for 20 to 30 years. A bushfire in this type of environment could be catastrophic and, even if breeding pairs were to survive a blaze, it would be unlikely that they would ever breed again.

Malleefowl are forced to compete for food with herbivores such as feral goats, sheep and rabbits. These animals can significantly reduce the amount of food available, especially in the smaller remnants and during lean times such as drought.

Red foxes are a threat to malleefowl at each stage of their lifecycle. They are known to dig eggs from the mound and are not deterred by an adult malleefowl frantically flapping its wings and running around.

CONSERVATION MEASURES

Over the past few decades, work has been underway to understand the

Above left A track winds through mallee country, typical malleefowl habitat.

Above right Grey currawong (*Strepera versicolor*) eat malleefowl chicks.

Left The introduced European red fox preys on malleefowl at each stage of their life cycle.





Above left A malleefowl mound in a revegetated site on private land in the Gondwana Link.

Above Setting a camera trap for mound monitoring.

needs of the malleefowl, identify threats to their survival and help protect them. A *National Recovery Plan for Malleefowl* was prepared, which addresses several key threats, including habitat loss and fragmentation, fire and predation, and identifies ways to promote malleefowl-friendly farming practices.

In WA, government and non-government organisations, community groups, friends' groups, private landowners and volunteers are protecting remnant reserves, restoring degraded farmlands, and tackling weeds and introduced animals.

The Malleefowl Preservation Group was formed in 1992 and was instrumental in conserving these elusive birds and protecting critical habitat. The group operated for 21 years, grew to 650 members and initiated several projects, which are being continued today by different organisations, including a program to encourage the public to report sightings, introduced animal control, identification and monitoring of mounds and the development of *The Malleefowl Magic School Education Package* – a school education program. Members also established 65 kilometres of wildlife corridors by linking remnant malleefowl habitat.

Since then, addressing the problem of fragmented habitat has also been achieved by Gondwana Link – an ambitious project to reconnect isolated pockets of remnant bushland (see also 'Guest column' on page 7). Through land purchased by organisations and private individuals, degraded farmlands are being rehabilitated and secured for the future by covenant. Ultimately, a continuous wildlife corridor will extend some 1000 kilometres from the south-west corner of the State to near the edge of the Nullarbor Plain.

North of the Wheatbelt – another stronghold for the malleefowl – several pastoral leases have been purchased by DCBA, Bush Heritage and the Australian Wildlife Conservancy. These former farms are being returned to nature by removing introduced animals such as sheep, goats and rabbits.

Creating and protecting habitat has been complemented by re-introduction of malleefowl to areas they once inhabited. Through its *Western Shield* program, DBCA and its predecessors have successfully reintroduced malleefowl to Francois Peron National Park in Shark Bay. The Yongergnow Australian Malleefowl Centre, in association with DBCA has boosted malleefowl numbers in the wild with the release of its captive-raised birds.

MONITORING MALLEEFOWL

In order to ensure their survival, it is necessary to monitor the malleefowl populations and gauge how they are responding to recovery plans. But, monitoring an elusive and seldom-seen subject relies on gathering information from their nesting mounds, rather than counting the birds themselves or using other common survey methods. Each year since the 1980s an army of volunteers has committed time to collecting and recording data to contribute to the National Malleefowl Monitoring Database, which is administered by the National Malleefowl Recovery Team as part of the national recovery plan. The volunteers are guided by the *National Malleefowl Monitoring Manual* – a comprehensive, online document, which ensures that data are collected in a standardised way.

Nearly all the mounds currently being monitored were located by systematic foot patrols, whereby a line of people walk as one, often through impenetrable, prickly scrub in inhospitable conditions. Hundreds of mounds across the country have been located in this way. It is time-consuming, labour intensive and for large areas, impractical.

Airborne trials using Light Detection and Ranging (LiDAR), also known as 3D laser scanning, are proving most effective, especially for searching large and remote areas. LiDAR technology is not new but has only recently been employed for mound detection. Once the mounds have been located using this method, they







Top Inside the Yongergnow Australian Malleefowl Centre.

Above A malleefowl pair on their mound at Yongergnow.

Above right Visitors can view malleefowl in large, bush aviaries at the Yongergnow centre.

Below right Signage warns motorists to slow down for malleefowl.

can be visited to conduct an on-ground physical survey.

Camera traps, which are specialised cameras with in-built motion-detectors, are another useful tool. They can be erected at active mounds and left for weeks at a time to record activity in detailed clarity.

YONGERGNOW

Another key tool in the plight to protect the malleefowl is to increase community awareness through education. The Yongergnow Australian Malleefowl Centre is an educational facility focused on the protection of the malleefowl and its habitat. The centre is known simply as 'Yongergnow', which comes from the Noongar words 'yonger', which means 'male kangaroo' and refers to the location of the centre in Ongerup – the place of the male kangaroo, and 'gnow', which means 'malleefowl'.

Located in the town of Ongerup, about 400 kilometres south-east of Perth, Yongergnow is a state-of-the-art facility, which showcases the amazing natural history of this remarkable bird. It houses a sleek, modern exhibition centre, cafe, gallery and – the star attractions – free-ranging malleefowl.

Inside the centre, malleefowl footprints painted on the floor lead visitors into a large, bright space filled with a wonderful and varied display of themed panels, photographs and museum specimens and an area to view audio visual presentations.

The building is situated in five hectares of pristine mallee bush, which is protected by vermin-proof fencing. Within this reserve are two large open-air bush aviaries, which house a thriving population of malleefowl.

To the amazement and delight of the Yongergnow staff, malleefowl have paired and built impressive mounds three times in the past five years. A succession of healthy chicks have grown and thrived from eggs that were laid up until the 2018–19 breeding season, and from eggs that were incubated at Yongergnow. At eight months old, when they are big enough, the juvenile birds are fitted with a colour-coded leg band. These bands will help to identify them when they are re-sighted in the future after they have been relocated to approved DBCA reserves at various locations across the State.

WHY SHOULD WE CARE?

These measures are being taken to ensure this unique and extraordinary bird does not disappear forever and cause the domino effect that is commonly seen when one species is omitted from a landscape. And we can all do our bit. If you are lucky enough to spot a malleefowl while you're out in the bush, you can fill out a malleefowl report form and contribute much-needed data about these magnificent and elusive creatures.



Sallyanne Cousans is a Western Australian-based freelance photographer who specialises in nature and wildlife. She can be contacted on 0428 888 301, or by email (s.cousans@bigpond.com).

Malleefowl Report Forms are available for download from DBCA's Parks and Wildlife Service website.

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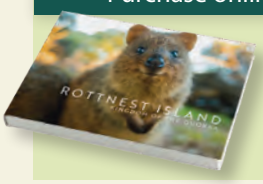
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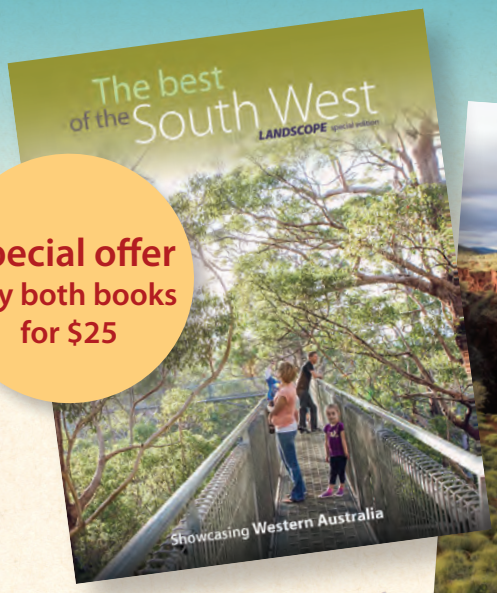
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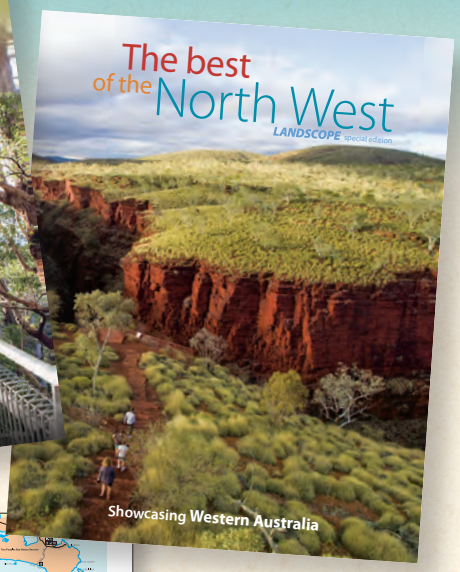
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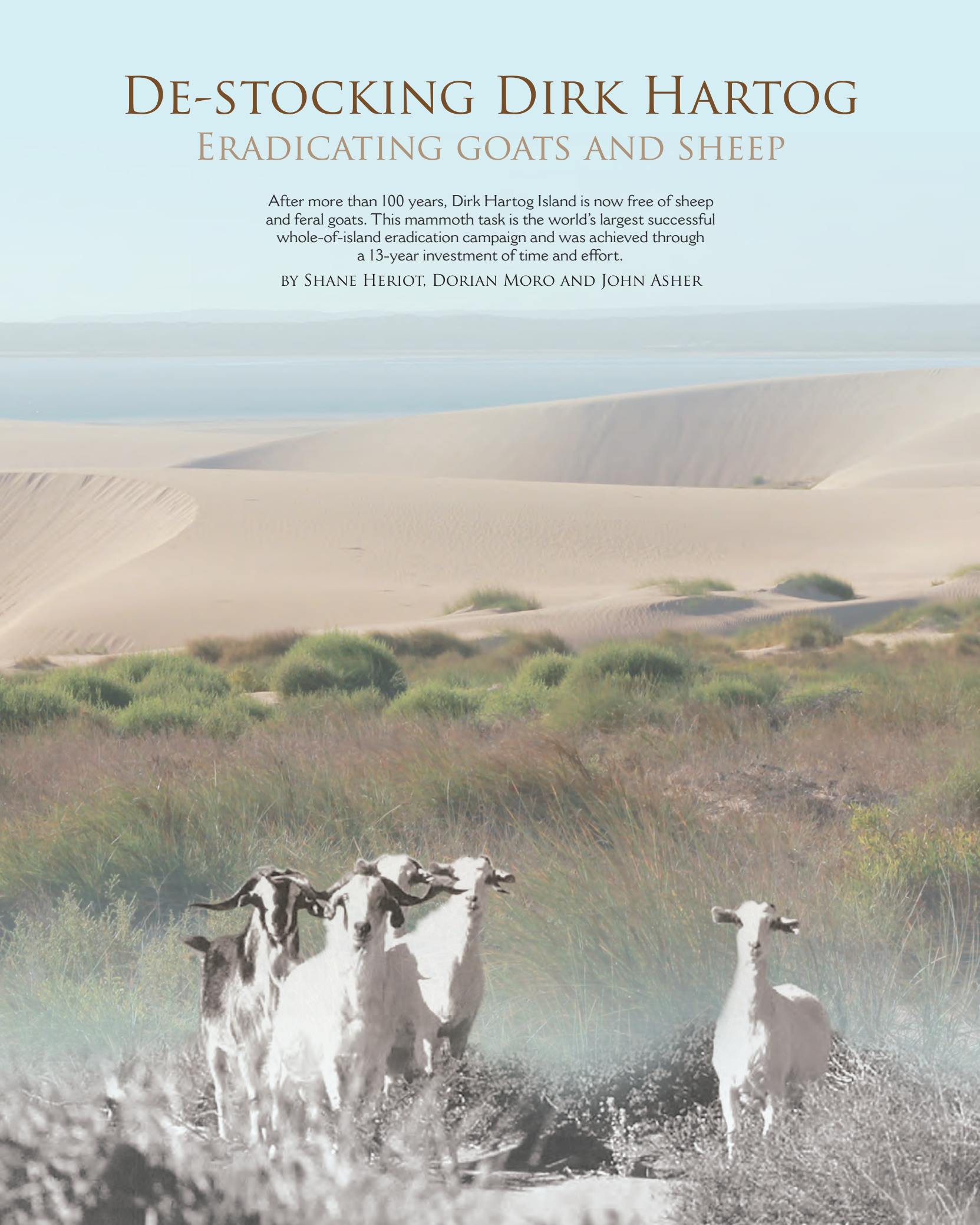
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De-stocking Dirk Hartog

Eradicating goats and sheep

After more than 100 years, Dirk Hartog Island is now free of sheep and feral goats. This mammoth task is the world's largest successful whole-of-island eradication campaign and was achieved through a 13-year investment of time and effort.

by Shane Heriot, Dorian Moro and John Asher



Dirk Hartog Island has been settled and inhabited for more than 100 years. Due to the remoteness of the Shark Bay settlement – including its islands – food had to be shipped to the area, albeit infrequently. Settlers introduced sheep to Dirk Hartog Island in the 1860s to grow the sheep industry and then, in the early 1900s, lighthouse keepers brought goats to the island as a ready source of milk and meat. In its heyday, some 26,000 sheep and goats grazed the remote expanse of Dirk Hartog Island. Unfortunately, the animals' intense grazing and trampling denuded the island's vegetation and left a lasting legacy.

'RETURN TO 1616'

In the 1970s, well before the island became a national park in 2009, a bold vision was proposed to return Dirk Hartog Island to the ecological condition it was in when seen by the Dutch mariner Dirk Hartog and his crew in 1616. The Dirk Hartog Island National Park Ecological Restoration Project *Return to 1616* was started in 2012, substantially funded through the Gorgon Barrow Island Net Conservation Benefits Fund (see 'Welcoming wallabies to Wirruwana', *LANDSCOPE*, Winter 2018). This ambitious program set out to eradicate feral cats and all sheep and goats from the 63,300-hectare island in order to restore the island's environment, and to support the reintroduction of native fauna.

EARLY DE-STOCKING

Removing sheep and goats from Dirk Hartog Island was first started in 2007 by the former pastoral lessee. Four thousand sheep and 750 goats were transported off the island. However, several thousand more feral goats and sheep roamed the vast island and were difficult to herd; ground shooting was limited to direct line of sight, which was challenging among the thick scrub, and the high cliffs on the west coast could not be traversed easily on foot.

In 2009, most of the island was declared a national park. Several small freehold properties remained on the island, and the owners supported the total eradication of sheep and goats, including from their properties. This enabled the successful implementation of a whole-of-island eradication plan.





Previous page
Main The inland moving sand dunes.
Photo – Dorian Moro/DBCA
Inset Feral goats on Dirk Hartog Island.
Photo – Shane Heriot/DBCA

Top The rugged coastline of Dirk Hartog Island National Park.

Above The island lighthouse keeper's house.
Photos – Dorian Moro/DBCA



AERIAL SHOOTING

In 2010, the then Department of Environment and Conservation (now DBCA) commenced aerial shooting operations using dedicated helicopters and skilled shooters. Flights over the island were conducted year-round: during the cooler winter months when animals foraged in the open all day, during spring to detect breeding animals with young, and during summer – the hottest and driest part of the year – to target the dawn and dusk feeding times. From February 2010 to November 2017, 20 aerial shooting operations were carried out, and 6933 feral goats and 124 feral sheep were removed from Dirk Hartog Island. Aerial shooting proved to be highly effective in





Above Motion-sensor cameras capture a 'Judas' goat with her kid.

Above right Goats were aerially tracked.
Photos – Shane Heriot/DBCA

Right Banded hare wallabies were released on Dirk Hartog Island in 2017.
Photo – Richard Manning

reducing and ultimately eradicating sheep and goats from the island, especially when 'Judas' goats were used to reveal the goats' locations.

JUDAS GOATS

Goats, particularly females, are very social and aggregate to acquire mates and attract companions. Male goats tend to be more cautious and wary. So, 20 healthy adult female goats were captured on the island and used as 'Judas' goats. These goats were fitted with radio collars so they could be tracked, and released back into the wild population on the island. These animals were checked during the aerial program to determine whether they had adult companions or young, which betrayed the presence of males. Using this method was an extremely effective way of locating and removing uncollared goats. By undertaking this program three times a year, the number of goats was reduced to nearly zero within a reasonably short timeframe. The last Judas goat was removed from the western cliffs of Dirk Hartog Island in November 2017, two years after the last uncollared goat was sighted and removed.

Drones monitoring on Dirk Hartog Island

Hare wallabies on Dirk Hartog Island have been part of a WA first trial to use drones for radio-tracking.

Banded and rufous hare wallabies were translocated to Dirk Hartog from nearby islands in 2017 as part of the *Return to 1616* initiative (see 'Welcoming wallabies to Wirruwana', *LANDSCOPE*, Winter 2018). The animals were fitted with radio collars in order to track their survival and movement and were monitored daily for 12 weeks using traditional on-ground tracking, which proved time consuming and labour intensive.

This year, the use of drones has been trialled to locate the collared hare wallabies. And, so far, the trial has had positive results.

The new technology has made it possible to track multiple animals in real time from the air, which is far more efficient than manually following one animal at a time on the ground. The use of drones has also meant that large areas with difficult terrain can be searched rapidly with minimal effort.

The data collected from the trial suggest the reintroduction program of the hare wallabies has been a success. All the wallabies appeared to be in good condition and all females either had joeys in their pouch or at-foot. More than 28 offspring have been recorded since the first wallabies were released on Dirk Hartog Island in 2017.



MONITORING TRACKS

Following fresh tracks from the air was also an effective method to locate goats and sheep, as fresh prints contrast well against the white sands of the island. The shallow topography on Dirk Hartog Island is also conducive to tracking from the air, as there is little relief except on the west coast, and relatively low vegetation, which results in few gullies or vegetated thickets for the animals to hide in. Dirk Hartog Island has predominantly strong southerly winds that prevail for most of the year, which quickly remove fresh tracks from the soft sand. This enabled the helicopter crew to easily determine that any tracks they saw were most likely fresh ones. The west coast cliffs and caves provided the only refuge for animals to evade detection. However, the animals that sheltered in these areas still needed to emerge from the caves and onto the open cliff top areas to feed, so fresh prints could still be observed.

ATTRACTING ANIMALS WITH WATER

Motion-sensor cameras were set up at watering troughs on the island as another method to detect any remaining goats and sheep. Dirk Hartog Island has no fresh





"It took 13 years (2005–2017) to remove a combined total of 16,318 sheep and goats from Dirk Hartog Island ... "

permanent surface water. Historically, a network of wells and windmills were established across the island to provide water for sheep, but as sheep numbers diminished so did the permanent watering points. Water troughs were an effective tool to attract animals during the hot dry months, and images of goats at water troughs taken by the motion-sensor cameras confirmed whether goats remained. The last four uncollared goats on the island were all juveniles that were detected with a Judas female, by motion-sensor cameras in November 2015.

ISLAND-WIDE ERADICATION

No sheep or uncollared goats have been detected, nor tracks or images of grazing animals recorded, since November 2015. Statistical modelling of the data confirmed that there was only a very low likelihood that goats or sheep remained on Dirk Hartog Island. The island was declared free of sheep in 2016 and, following the removal of the last Judas goat, free of feral goats in November 2017. Shortly after this milestone, it was declared that feral cats had also been eradicated from the island (see 'Declaration on Dirk', *LANDSCOPE*, Autumn 2019).

CONSERVATION OUTCOMES

This project has shown that the size and complexity of an island is no longer an impediment to achieving a successful eradication outcome to benefit conservation. It took 13 years (2005–2017) to remove a combined total of 16,318 sheep and goats from Dirk Hartog Island and to confirm their eradication, making this program the largest successful whole-of-island ungulate eradication program in the world. Dirk Hartog Island, Western Australia's largest offshore island, is already showing recovery following the eradication: increased vegetation cover and reduced erosion is apparent, and the successful reintroductions of native mammals continues.

Above left Wells were used on the island to provide water to stock.
Photo – Dorian Moro/DBCA

Above A motion-sensor camera detects uncollared goats at a watering point.
Photo – Shane Heriot/DBCA

Below left Vegetation on the island is recovering after the de-stocking.
Photo – Dorian Moro/DBCA



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The authors thank Geoff Wardle, former lessee of Dirk Hartog Island, for beginning sheep and goat removal prior to the island becoming a national park and for allowing the department early access to his pastoral lease for ground shooting. Thank you Jock Clough and the Wardle family for allowing their private land on Dirk Hartog Island to be included in the whole-of-island eradication program, and Tory and Kieran Wardle for their hospitality during the aerial shooting operations. Thanks to Butch Maher for his piloting expertise, and skills in aerial shooting and animal tracking. Aerial shooting was initially funded through the Australian Government's Caring for Our Country *Program and ongoing funding was through the Gorgon Barrow Island Net Conservation Benefits Fund.*



Millipedes, it's all in the prongs

Above Male and female *Antichiropus rupinus* mating.
Inset The gonopod prongs of *Antichiropus rupinus*.
Photos – Mark Harvey/WA Museum

Discussions about millipedes with most people invariably lead to comments about the Portuguese millipede, a nuisance pest that has colonised many regions of the world, including southern Australia. Indigenous millipedes are, however, found all over Australia and hundreds of species have been described. The largest genus, *Antichiropus*, is widespread across the southern two-thirds of Western Australia extending as far north as the Pilbara, with a single species in South Australia. The genus was first described in 1909 by Austrian scientist Carl Attems based on specimens collected during the Hamburger Südwest-Australischen Forschungsreise by Wilhelm Michaelsen and Robert Hartmeyer in 1905–1906. They collected a treasure-trove of natural history specimens in south-western Australia, many of which were described as new species by European scientists.

Antichiropus mostly languished in obscurity until it became the subject of a research project by a Western Australian team led by Cathy Car. The first task was to redescribe the nine previously described species, followed by a review of the species in the Great Western Woodlands. This biologically significant area is relatively well collected for millipedes and Cathy described 30 new species. The third instalment, which was recently reported in the journal *Zootaxa*, concentrated on the species in the Pilbara where 33 new species were described and named. Further regions will be investigated in the future and there are about 160 species in the collections of the Western Australian Museum.

So, how does one distinguish between millipede species, which all seem to look the same? Most male millipedes transfer sperm to the female via modified legs on the seventh body segment. In many millipedes they are rather small and embedded within the body. In *Antichiropus* and its relatives, the gonopods are quite large and are adorned with various spines and processes. Each species has its own characteristic shape: big prongs, curved spikes, concave prongs, serrate processes – the variation is nearly endless. And each new locality in WA seems to harbour another new species, so it's likely that the true number of species hasn't yet been reached.

Species of *Antichiropus* have small distributions. This is not surprising given their lack of dispersal capabilities; they can only move to adjacent habitats by walking and, although they have many pairs of legs, they can't get very far in their relatively short adult lifetime. More importantly they are usually restricted to specific micro-habitats such as deep leaf litter or near granite rocks, and are unable to traverse unsuitable habitat. This leads to the isolation of populations and the restriction of gene-flow, which over time leads to significant changes in their genetic make-up and eventually, speciation.

Taxa with naturally small distributions are sometimes called short-range endemic species, and *Antichiropus* are a classic example of this natural phenomenon in WA. To ensure that proposed developments that involve the substantial loss of natural habitat in WA do not lead to irrevocable species loss, proponents are mandated by the Environmental Protection Authority to survey for short-range endemic species. Species of *Antichiropus* have thus been actively collected across WA, resulting in excellent collections on which to base the taxonomic work.

Such amazing species diversity within a single genus is not unusual in many terrestrial invertebrate groups, but understanding how this diversity evolved in *Antichiropus* takes clever detective work. A study by Janine Wojcieszek and Leigh Simmons at The University of Western Australia found evidence for divergence in gonopod shape among populations of the marri millipede, *Antichiropus variabilis*. Nevertheless they also found evidence of stabilising selection where extreme versions of male genital shape are selected against. Sexual selection probably plays a significant role in speciation of this genus with transitions to new genitalic shape occurring over time.

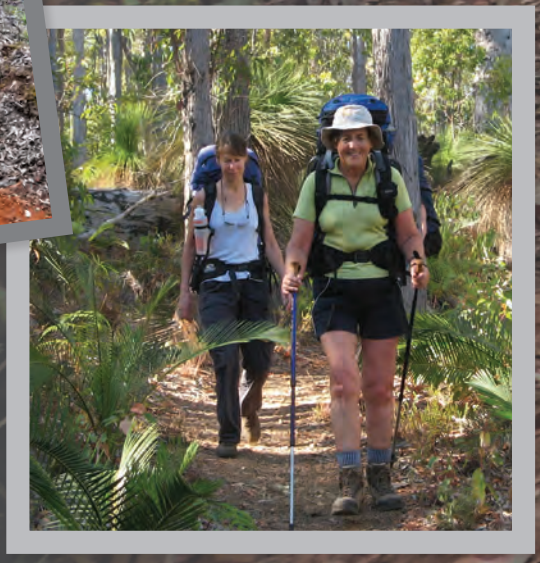
Very little is known of their life cycle. Adults emerge on the surface during the rainy season but no-one knows where they spend the dry months. They presumably reside deep in the soil as juveniles. But what are they feeding on? We know that millipedes are detritivores, which feed on rotting plant matter. But what do they target when underground?

Next time you see a millipede in a bushland habitat, spare a thought for their evolutionary history and complex male genitalia. And if you're lucky, you might have found a new species.

PUTTING COLLIE ON THE MAP:

gearing up for new mountain bike and hiking trails







A $10 million investment to create 180 kilometres of hiking and mountain bike trails in and around Collie will put the south-west town on the map as Western Australia's premier trail town, and boost the local economy.

by Stuart Harrison, Rod Annear, Paul McCluskey and Rhianna King.





Located 213 kilometres from Perth's CBD and 60 kilometres from Bunbury, Collie has long been popular for adventure camping, water skiing and outdoor activities. Now, thanks to a $10 million State Government investment, Collie is set to become a 'Trail Town' and home to a world-class network of trails that will attract mountain bike riders and bushwalkers from across Australia and the world.

INTUITIVE INVESTMENT

In 2015, the *South West Mountain Bike Master Plan*, which was prepared by WA's peak cycling body WestCycle, with support from the then Department of Parks and Wildlife, was released. This document identified five future mountain bike development opportunities in the south-west – at Margaret River, Pemberton, Dunsborough, Nannup and Collie. Each area was selected for its ability to provide visitors with a unique experience – Dunsborough for its magnificent coastline, Margaret River for its proximity to 'gourmet' experiences, Nannup for its rolling hills and Pemberton for its tall trees. Collie was already popular among mountain bike riders and hikers for its stunning river valleys, deep gorges, granite outcrops and diverse vegetation types, and the opportunity was identified to capitalise on these natural features and develop it into an internationally significant trail destination.

In April 2019, a significant step in realising Collie's potential as a premier Trail Town was taken, with the announcement of the Collie Adventure Trails initiative, which will see $10 million invested in mountain bike and hiking trails for the area. A key outcome of this initiative is to grow and diversify Collie's economy, create jobs across a range of industries and maintain a vibrant community.

The construction of the trails will generate local employment opportunities. And it is estimated that more than 30 jobs will be created in the tourism sector to cater to the more than 11,000 additional visitors to the area each year, of whom 6901 are expected to stay overnight. Financial modelling predicts that these visitors will inject $3.78 million per year into Collie, which will generate $6.92 million per year in the wider community.

Nuts and bolts of building the trails

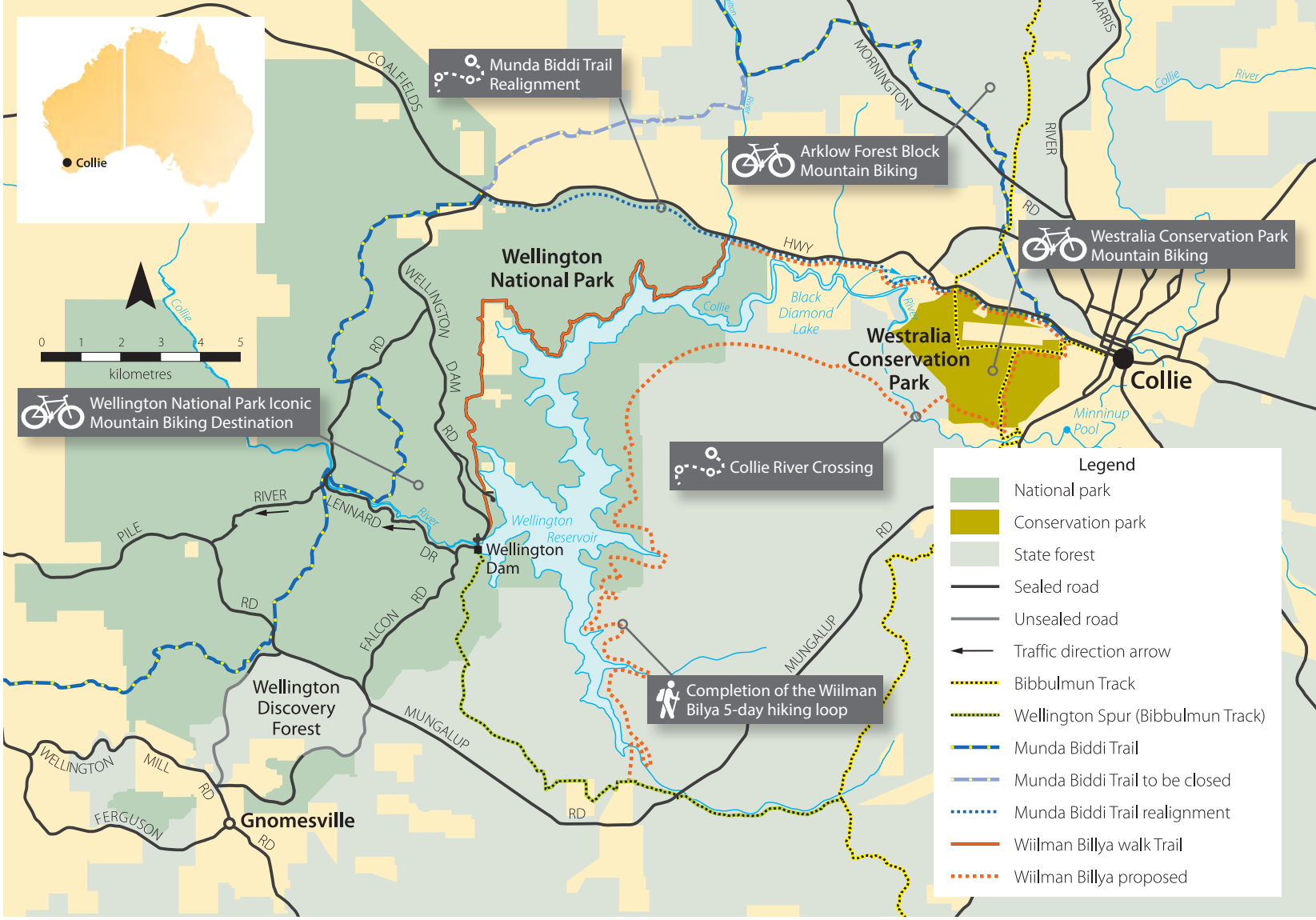
Constructing and managing the trails will be led by DBCA with support from a project reference group, made up of representatives from the Shire of Collie; Tourism WA; the Department of Local Government, Sport and Cultural Industries; Collie Chamber of Commerce; Department of the Premier and Cabinet; and the South West Development Commission. Advice and input will also be sought through WestCycle and the Collie Mountain Bike Club.

The trails will be constructed in line with the *Western Australian Mountain Bike Management Guidelines* released in August 2019 at the Trails Forum. These guidelines inform the methods for site assessments, and outline relevant environmental legislation and methods of managing flora, fauna, Aboriginal and other heritage considerations, and other issues such as weeds, pests and dieback. As part of this best-practice approach, there is also a disturbed approval system, which comprehensively assesses values that need to be considered and protected.

Previous page
Main Mountain bike riding grows in popularity each year.
Inset left 180 kilometres of mountain bike and walking trails are set to be created.
Photos – Rod Annear/DBCA
Inset right The Bibbulmun Track passes through Collie.
Photo – Bibbulmun Track Foundation

Above left Wellington National Park.
Photo – David Willcox

Above Mountain bike events attract local, national and international visitors.
Photos – Rod Annear/DBCA



This will build on the already growing popularity of Wellington National Park among visitors who travel there to enjoy recently upgraded campground facilities, toilets, barbecue shelters, roads, paths and day-use areas, as well as 'glamping' opportunities (see also 'Too posh to pitch', *LANDSCOPE*, Summer 2016–17). These facilities are the result of a $5.2 million investment in the Collie–Wellington area since 2013–14. A further $6.8 million is earmarked to improve tourist roads and establish Lake Kepwari as a water-based recreation destination.

ON YA' BIKE

Mountain bike riding is one of the world's fastest growing recreational, sport and tourism activities and mountain bike tourism is becoming increasingly popular. It is estimated that more than 120,000 mountain bikes are sold in Western Australia each year and almost half a million Western Australians own one. But it's not just getting out on the trails that is increasing in popularity; crowds at mountain bike events draw competitors, spectators and families and events often sell out quickly.

Collie's topography and landscape provide mountain bike riders with an array of landscapes to enjoy and challenges to tackle. The spectacular Collie River, which stretches from the town through Westralia Conservation Park and Wellington National Park; imposing granite outcrops; lush vegetation; and steep and varied natural features create an ideal foundation on which to build the world-class trails network.

The cornerstone of the Collie Adventure Trails initiative is a 65-kilometre network of high-quality, dedicated mountain bike trails in Wellington National Park, including 'epic' standard trails, which will suitable for



Above A 35-kilometre trail network in Westralia Conservation Park will link Collie with attractions such as Minninup Pool. *Photo – David Willcox*





hosting national and international events. The area chosen for the trails will guide users through spectacular scenery and offer height differences of up to 240 metres along the valley. Concept planning has been completed for these trails and it is expected that some trails will be opened in 2019–20 with the rest opened in stages over the next four years.

Trails WA mobile app

For access to information about WA trails, download the free *TrailsWA* app. You can filter searches for information about:

- location
- trail type
- level of difficulty
- time needed
- wheelchair accessibility
- dog friendliness
- WA's top trails.



Each trail description contains information about:

- facilities on site
- road access
- directions to the start
- best time to undertake it
- how long it will take.

The app was developed in partnership between Trails WA and the then departments of Parks and Wildlife, Regional Development and Sport and Recreation.

The development of a 35-kilometre world-class trails network at Westralia Conservation Park is another feature of the strategy. Located on the western fringe of Collie, riders will be able to access the trails right from the town centre. From there, the trails will take riders past some of the most iconic scenery in the region, and link to Black Diamond Lake and Minninup Pool.

A river crossing at Westralia Conservation Park will support the local mountain bike and walk trails by enabling trails along both sides of the spectacular Collie River Valley. It will also provide opportunities for improving the alignment of the Bibbulmun Track, which currently detours to the road to cross the river.

A new five-kilometre section of mountain bike trail at Arklow Forest Block – located north of Collie – was opened in September 2019. A further 11-kilometre section of trail at Arklow Forest Block is planned for 2019–20. These additional trails will complement recently built trails and now provides users with more than 20 kilometres to explore.

The trails here are suitable for a range of riders – from beginners to advanced – as well as for adaptive mountain bikes, including hand-cycles, leg-cycles, tandem and gravity bikes. This provides opportunities for people with disabilities to access the trails.

Another component of the Collie Adventure Trails initiative is the realignment of the Munda Biddi Trail – the 1000-kilometre trail that runs from Mundaring to Albany. Currently, the 50,000 riders who use the Munda Biddi Trail each year do not pass directly through Collie. However, a 20-kilometre realignment will link Wellington National Park with Collie and divert the trail off sealed roads and into bush areas, enhancing the off-road experience. This will provide opportunities for multi-day cycling loop tours and encourage users to take advantage of the local tourism opportunities.

TAKE A HIKE

WA's premier walking trail – the Bibbulmun Track – journeys 1000 kilometres from Kalamunda to Albany and attracts 303,000 hikers each year. Collie is one of the towns that the track passes through, but walkers will have one more reason to visit the area when a 50-kilometre addition to the Wiilman Bilya walk trail is complete in 2020–21.

The extension of the existing 20-kilometre trail will provide hikers with a five-day hiking loop, or shorter day options, that start and finish in the Collie town centre. The trail, which is named after the traditional Noongar group (Wiilman) and the Noongar word for 'river' (Bilya), travels along the Collie River into Wellington National Park and

Above Natural features challenge riders.
Photo – Rod Annear/DBCA

Above right The Bibbulmun Track attracts 303,000 hikers each year.
Photo – Paul McCluskey/DBCA

Anticipated timeline

2019/20	2020/21	2021/22	2022/23
Works • Mountain bike trails in Wellington National Park and Arklow forest block • Wiilman Bilya walk trail • Trail Town marketing	**Works** • Mountain bike trails in Wellington National Park and Westralia Conservation Park • Collie River crossing • Trail Town marketing	**Works** • Mountain bike trails in Wellington National Park • Collie River crossing	
Projects completed • Trails in Arklow Forest Block • Some trails in Wellington National Park	**Projects completed** • Wiilman Bilya walk trail • Some trails in Wellington National Park	**Projects completed** • Mountain bike trails in Westralia Conservation Park • Extension to Munda Biddi Trail • Trail Town marketing • Some trails in Wellington National Park	**Projects completed** • All mountain bike trails in Wellington National Park • Collie River crossing

then around the Wellington Dam – the largest reservoir in the south-west. Users are guided by a walking boot symbol through stunning jarrah, marri and yarri forests, across a series of bridges to Nyingarn – a group campsite, which can accommodate groups up to 25.

Those who would like to add a bit more adventure to their experience will be able to swap their hiking boots for their kayak or canoe, and paddle between Nyingarn and future campsites within Wellington National Park.

CENTRED ON COLLIE

While much of the work of this initiative will be in developing the trails themselves, a key aspect will be to establish Collie as a Trail Town. As home to the primary Trail Town facilities, Collie will house bike hire and repair facilities, trail information, toilets and showers. By providing these amenities, Collie will be an attractive destination for mountain bike riders and hikers to begin and end their journey, and as a mid-way pit stop. By creating a network of trails around the town centre, Collie will be put on the map as an attractive 'multi-night stay' destination. This will benefit local businesses who service the visitors, and provide facilities that make the region a more attractive place to live.

The new trail network will also provide opportunities for new businesses to cater to adventure and eco-tourism in the area, such as a commercial bike hire business in Wellington National Park. There will also be training, employment, heritage interpretation and business development opportunities for the local Aboriginal community.

ONWARD JOURNEY

The new trail network will be completed in stages over the next four years and DBCA is exploring options for new events on the trails. Events have the potential to accelerate the exposure of Collie as a world-class trail destination and showcase what this magnificent area has to offer visitors from around the world.

Broadly speaking, these trails will play a role in arresting the trend of Australians becoming increasingly inactive, overweight and screen obsessed. Research has shown it is especially important for kids to spend time outdoors in natural areas for healthy development and wellbeing, and to foster an appreciation of the environment. Mountain bike riding and bushwalking are activities that the whole family can enjoy, and by encouraging a new generation onto these trails and into our natural areas, we are shaping the advocates of the future.



Top A new bridge will cross Collie River.

Above There will be trails for the whole family to enjoy.
Photos – Rod Annear/ DBCA

Stuart Harrison is the project coordinator and can be contacted by email (stuart.harrison@dbca.wa.gov.au).
Rod Annear is DBCA's Parks and Wildlife Service Visitor Services assistant director.
Paul McCluskey is DBCA's capital works and roads coordinator.
Rhianna King is a *LANDSCOPE* editor. She can be contacted by email (rhianna.king@dbca.wa.gov.au).



Monitoring mangroves

Mangroves play an important ecological role in many of Western Australia's tropical and sub-tropical environments. In several areas, mangroves also have strong social and cultural significance. DBCA's Biodiversity and Conservation Science is carrying out a State-wide monitoring program to keep a long-term watch on the health and extent of mangroves, to observe changes in their condition caused by factors associated with climate change, and in order to respond to direct human-caused threats.

by Kevin Bancroft









Previous page
Main Mangrove forests line the Kimberley coast.
Photo – David Bettini
Inset left DBCA scientists are monitoring the health of mangroves throughout the State.
Photo – Kathy Murray/DBCA
Inset right Mangrove heron.
Photo – Jiri Lochman

Above left Grey mangroves are found in Bunbury.
Photo – Cliff Winfield

Above Some mangroves species have special above-ground roots.
Photo – Kevin Bancroft/DBCA

It is estimated that there are 352,000 unique flowering plant species on Earth, of which approximately 140 species are found in marine environments. True mangroves – plant species that occur only in mangrove forests and are not found in terrestrial communities – account for 69 of these species. Of these, 41 are found in Australia, and nearly half in Western Australia.

SPECIES DIVERSITY

Mangroves have adaptations that enable them to survive in salty environments. For example, special glands in their leaves excrete excess salt, and enable mangroves to expel up to 90 per cent of the salt content taken in through their root systems. Also, some species have special above-ground roots, called pneumatophores, which transport oxygen throughout the plant to regions located in low-oxygen muddy sediments.

Mangroves occur in both tropical and subtropical areas. They vary in height from less than a metre up to 20 metres tall, and usually occur above mean sea level in the intertidal zone of marine and estuarine environments. However, the most inland occurrence of mangroves in WA is at Mandora Marsh wetlands in Walyarta Conservation Park, approximately 60 kilometres inland from Eighty Mile Beach.

In WA, mangroves occur in stands of a single species, such as the grey mangrove (*Avicennia marina*) found in Bunbury (see also 'Kaleidoscope' on page 53), the Abrolhos Islands and Shark Bay areas, or in multispecies assemblages of up to eight or even 20 species in the Pilbara and Kimberley regions, respectively. Structurally, mangrove areas range from sparsely treed stands no taller than five metres in Shark Bay, to dense forests of up to 20 metres tall in the Kimberley.

UNSUNG HEROES

Mangroves serve an important ecological role. They protect the shoreline from coastal erosion, particularly in the tropical areas where cyclones and severe monsoonal storms routinely occur. They also have a substantial capacity to convert atmospheric carbon dioxide and other greenhouse gases into oxygen and can fix the carbon in the muddy, oxygen-poor substrate that supports them, for thousands of years. They also have the potential to sequester (capture) up to six times more carbon than rainforests. Indeed, the average carbon captured by one hectare of mangroves, including soil carbon, has been estimated at around 1000 tonnes – about the same amount as the annual carbon emission of approximately 700 cars.

The structural complexity of mangroves provides nursery habitat, shelter, nesting and foraging habitat for numerous resident and transient invertebrate, fish, bird, reptile and mammal species, including prized recreational species such as barramundi (*Lates calcarifer*), mangrove jacks (*Lutjanus argentimaculatus*) and mud crabs (*Scylla serrata* and *S. olivacea*). Other species that utilise mangroves include the estuarine crocodile (*Crocodylus porosus*), green turtles (*Chelonia mydas*), flying foxes (*Pteropus* spp.), microbats such as the northern pipistrelle (*Pipistrellus westralis*) and the mangrove free-tailed bat (*Ozimops cobourgianus*), northern brushtail possums (*Trichosurus arnhemensis*), native rodents such *Melomys burtoni* and more than 200 bird species such as the great-billed heron (*Ardea sumatrana*), mangrove heron (*Butorides striata*), the mangrove kingfisher (*Halcyon chloris*), pied cormorant (*Phalacrocorax varius*) and the mangrove flyeater (*Gerygone levigaster*).

Mangroves also have cultural significance and are used for food, medicines, shelter and as a wood resource. Traditional owners harvest the mangrove snail (*Nerita* spp.), 'long bums' whelks (*Telescopium telescopium* and *Terebralia* spp.), fish, turtles and mud crabs for food, while the leaves of the mangrove myrtle (*Osbornia octodonta*) are rubbed on the skin to repel insects and chewed to relieve toothaches. The Aboriginal people of the Dampier Peninsula traditionally sought out a particular mangrove – the kapok





Above Mangrove loss.
Photo – Kevin Bancroft/DBCA

mangrove (*Camptostemon schultzii*), and used its wood to construct rafts, paddles, and spears for hunting of dugong, fish and turtles.

MONITORING MANGROVES IN WA

DBCA's Biodiversity and Conservation Science has established a State-wide monitoring program, to evaluate the condition of mangroves and to detect the effects of pressures on mangrove communities. WA mangroves are subject to lower levels of human-caused pressures, such as from coastal development and nutrient enrichment and sediment run-off from agriculture and industrialisation, than other more densely populated areas in Australia. The main pressure on Western Australian mangrove communities comes from long-term changes in climate conditions, such as rising sea levels, rising seawater and air temperatures, changing rainfall patterns, and increased storm intensity and frequency. With the exception of the Rowley Shoals Marine Park, mangroves are present in all CALM Act marine conservation reserves north of and including Shark Bay Marine Park. In each of the reserves, the department uses satellite imagery and aerial photography together with on-ground surveys to assess the health of the mangroves, based on two key condition indicators – spatial extent (area) and canopy density.

EVALUATING CHANGES

Routine monitoring between 2010 and 2015 in Shark Bay Marine Park highlighted losses in spatial extent and in canopy density, particularly along the Carnarvon coast. In 2010, Carnarvon coast mangroves spanned approximately 850 hectares, but, by 2015, this was reduced to approximately 720 hectares – a loss of about 15 per cent.

Further investigation of satellite data showed this loss was not gradual, and a significant mortality event occurred in February 2011. Carnarvon climatology and environmental data suggests that the loss of mangroves coincided with four environmental pressures. Firstly, there were record-high sea levels peaking in 2011, which would have drowned the mangroves that were already at their maximum depths. Secondly, prolonged record-high air temperatures were experienced, and sustained high seawater temperatures would have added further pressure to the already-

Hear about mangrove monitoring

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



"DBCA's primary focus for mangrove conservation is to minimise the loss of diversity and spatial extent, caused by human activity."

stressed mangroves. Lastly, the worst flooding of the Gascoyne and Wooramel rivers since 1960 eroded mangrove habitat and smothered other areas with terrestrial sediments. Prolonged high air and seawater temperatures, and low rainfalls would have further hampered recovery in some areas.

A minor mangrove loss (less than two hectares) was also observed at Big Lagoon, in Francois Peron National Park, during routine monitoring. Subsequent field investigation revealed that the cause was a flock of nesting cormorants that were directly impacting the mangroves through defoliation and by depositing high levels of nutrients via their guano.

Losses in mangrove spatial extent in Ningaloo Marine Park in 2015 and 2016 were attributed to a short-term drop in sea level and increasing sediment interstitial water salinity – the water in between sand grains. Declines in mangrove spatial extent and canopy densities have been observed in the Montebello/Barrow Islands Marine Conservation Reserves since 2011. These are more than likely related to a short-term drop in sea level, increasing sediment porewater salinity and higher-than-average atmospheric temperatures since 2012.

In contrast to these Gascoyne and Pilbara reserves, the mangroves in the Kimberley (Eighty Mile Beach and Lalang-garram / Camden Sound marine parks), experienced increases in distribution and in canopy cover. Between 1989 and 2015, there has been an increase of 214 hectares (about 25 per cent) and 2909 hectares (about 12 per cent) at Eighty Mile Beach and Lalang-garram / Camden Sound marine parks, respectively. In both marine conservation reserves, significant increases in rainfall and moderate air temperatures have provided optimum growing conditions for the mangrove communities.

GROWING FORWARD

WA's mangrove communities, in general, are not under immediate direct threat from human activity. However, they are susceptible to human-induced climate change. DBCA's primary focus for mangrove conservation is to minimise the loss of diversity and spatial extent caused by human activity.

In the same way that humans monitor their blood pressure to identify heart disease, DBCA researchers will continue to monitor changes in mangrove spatial extent and canopy density to indicate the health of these ecosystems. Further research is required to understand the potential effects of sea level rise, sediment interstitial salinity, and to obtain estimates of the area of inundation from rising sea levels, which may influence mangrove inshore migration. DBCA is currently exploring the use of remotely piloted aircraft technology (drones) to obtain valuable on-ground data at larger spatial scales and at sites inaccessible by field staff. Ongoing monitoring using established techniques, combined with these innovative new approaches, will enable the continued evaluation of these valuable mangrove ecosystems.





Above left Grey mangroves at Roebuck Bay in Broome.
Photo – Damon Annison

Top Kevin Bancroft and marine ranger – vessel mate Adrian Lane examining mangroves.
Photo – Daniel Barrow/DBCA

Above Club mangroves.
Photo – Kevin Bancroft/DBCA

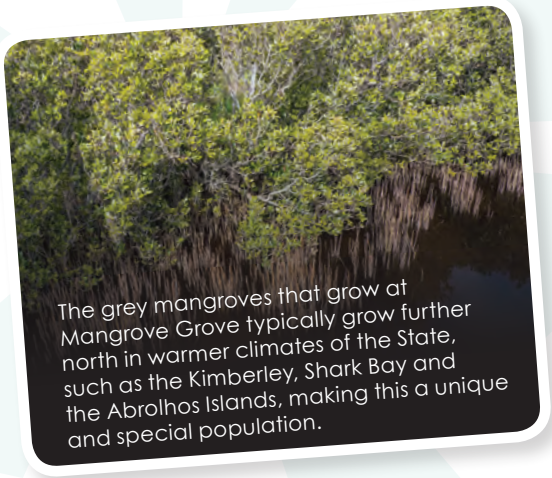
Below Stilted mangrove is one species that grows in WA.
Photo – Sue Osborne/DBCA



Kevin Bancroft has been involved in marine conservation and management with the department and its predecessors for 20 years. He can be contacted on (08) 9219 9792 or by email (kevin.bancroft@dbca.wa.gov.au).

by Sophie Henderson

kaleidoscope
kids exploring nature



The grey mangroves that grow at Mangrove Grove typically grow further north in warmer climates of the State, such as the Kimberley, Shark Bay and the Abrolhos Islands, making this a unique and special population.

Discovering **mangroves**

Mangrove Cove, located in Leschenault Inlet near Bunbury, is home to a special population of mangroves – Western Australia's most southern population of grey mangroves (*Avicennia marina*).

This ancient mangrove population plays an important role in converting carbon dioxide and other greenhouse gases in the area into oxygen (see also 'Monitoring mangroves' on page 49) by 'breathing in' carbon dioxide and 'breathing out' oxygen. It also supports more than 60 species of water bird, is an important habitat for invertebrates and crustaceans and acts as a nursery for fish, which then move out the ocean when they are old enough.

Did you know that Australia has the world's fifth highest amount of mangroves?

Local learning

More than 150 Year 3 Bunbury primary school students recently visited the new education facility at Mangrove Cove where they learnt about mangroves, and got up-close to some of the critters that live in them.

The students were taking part in a *Nearer to Nature* excursion and heard about the role mangroves play in protecting and maintaining our natural environment, as well as about food chains, nature conservation and the area's geological history. Local Noongar man Troy Bennell was on-hand to give a Welcome to Country and spoke about the area's Indigenous heritage.

Students got their hands dirty and helped with some native vegetation rehabilitation, which will provide food and shelter for native wildlife. They also met some joeys and heard from FAWNA and Roo Rescue wildlife rehabilitators and volunteers from the Dolphin Discovery Centre.

A guided walk along the estuary with volunteers from Birdlife Bunbury, revealed a number of native birds, including a sleeping boobook owl and ospreys, which nest in the park.

Students also had the opportunity to touch, feel and even smell some of WA's unique biodiversity as part of a taxidermy and touch table display, and Parks and Wildlife Service rangers talked to students about planting native seedlings.

This excursion was the first time the new education facility had been used, and DBCA *Nearer to Nature* project officer John Anderson said he looked forward to welcoming other teachers and students to the centre in the future.

"Apart from providing a fun and educational day for the students with a wide range of activities, it really highlighted the fact that there are outdoor classrooms throughout the Greater Bunbury region that can be used for meaningful learning and hands-on environmental activities," he said.



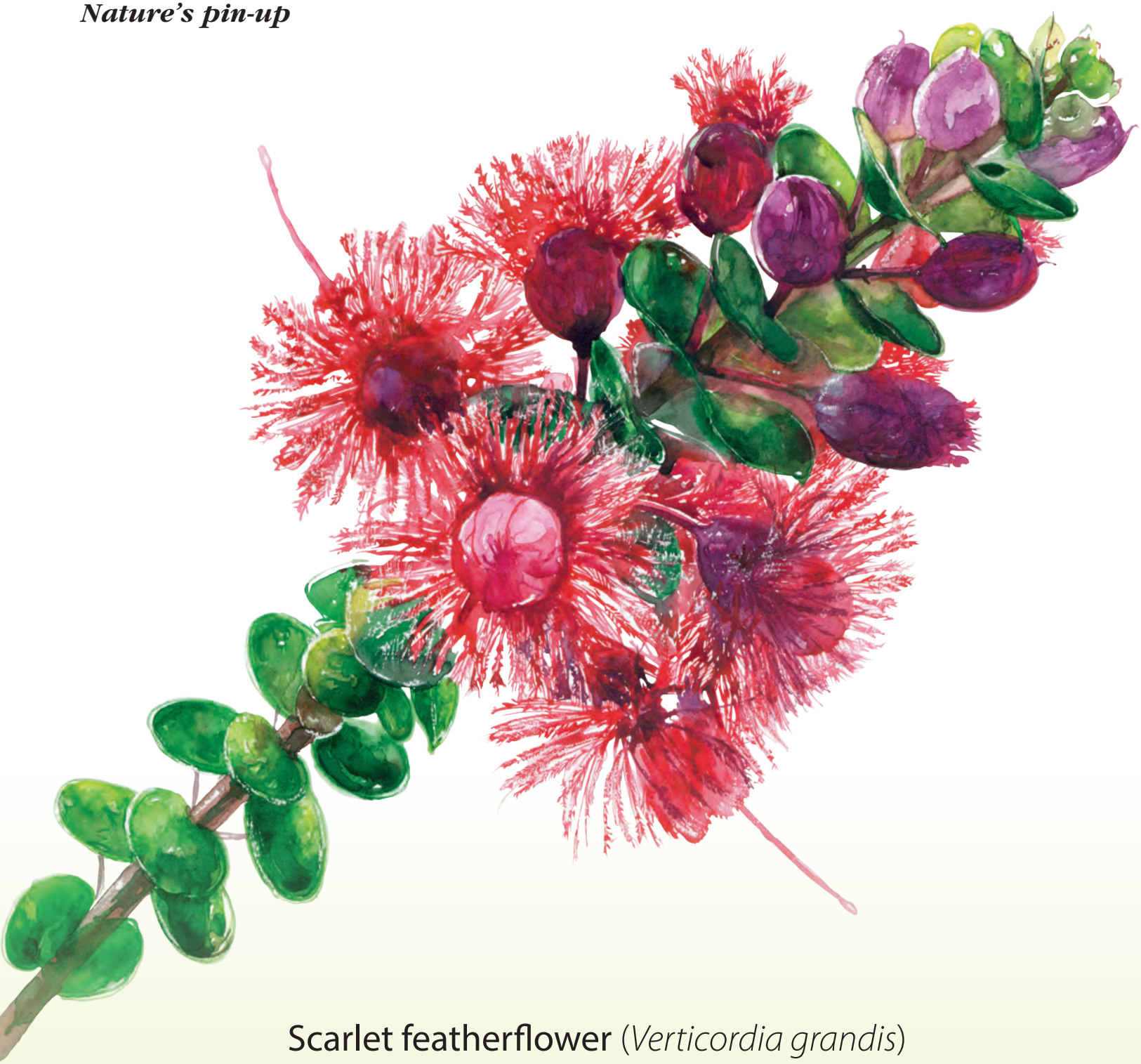




Above Grey mangroves at Mangrove Cove in Bunbury.
Photo – Cliff Winfield

Right from top Students received a Welcome to Country from Troy Bennell and took part in hands-on activities.
Photos – DBCA

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



Scarlet featherflower (*Verticordia grandis*)

Scarlet featherflower is a straggly, slender shrub that grows to 3.5 metres tall in sandplains between Yanchep and Geraldton. They display stunning large red fringed flowers between August and December. The type specimen for this species was collected by James Drummond.

Illustration by Gooitzen van der Meer

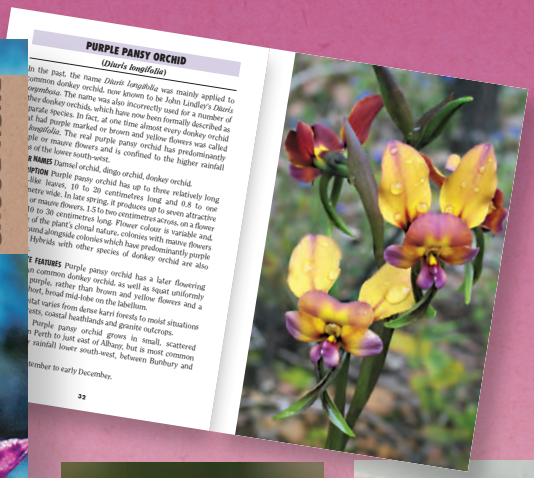
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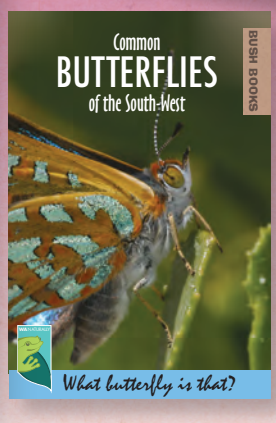




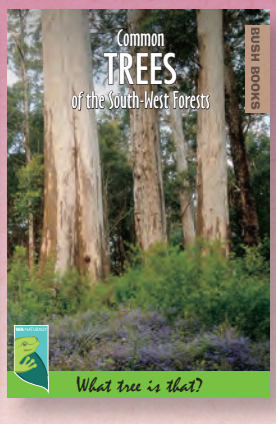
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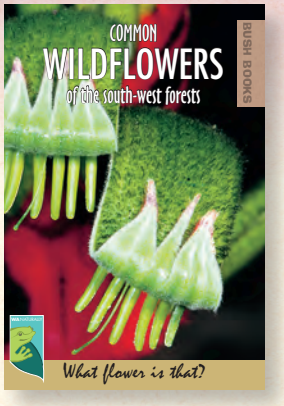
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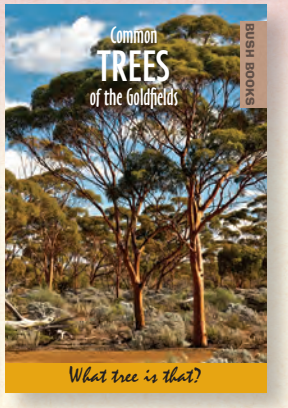














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