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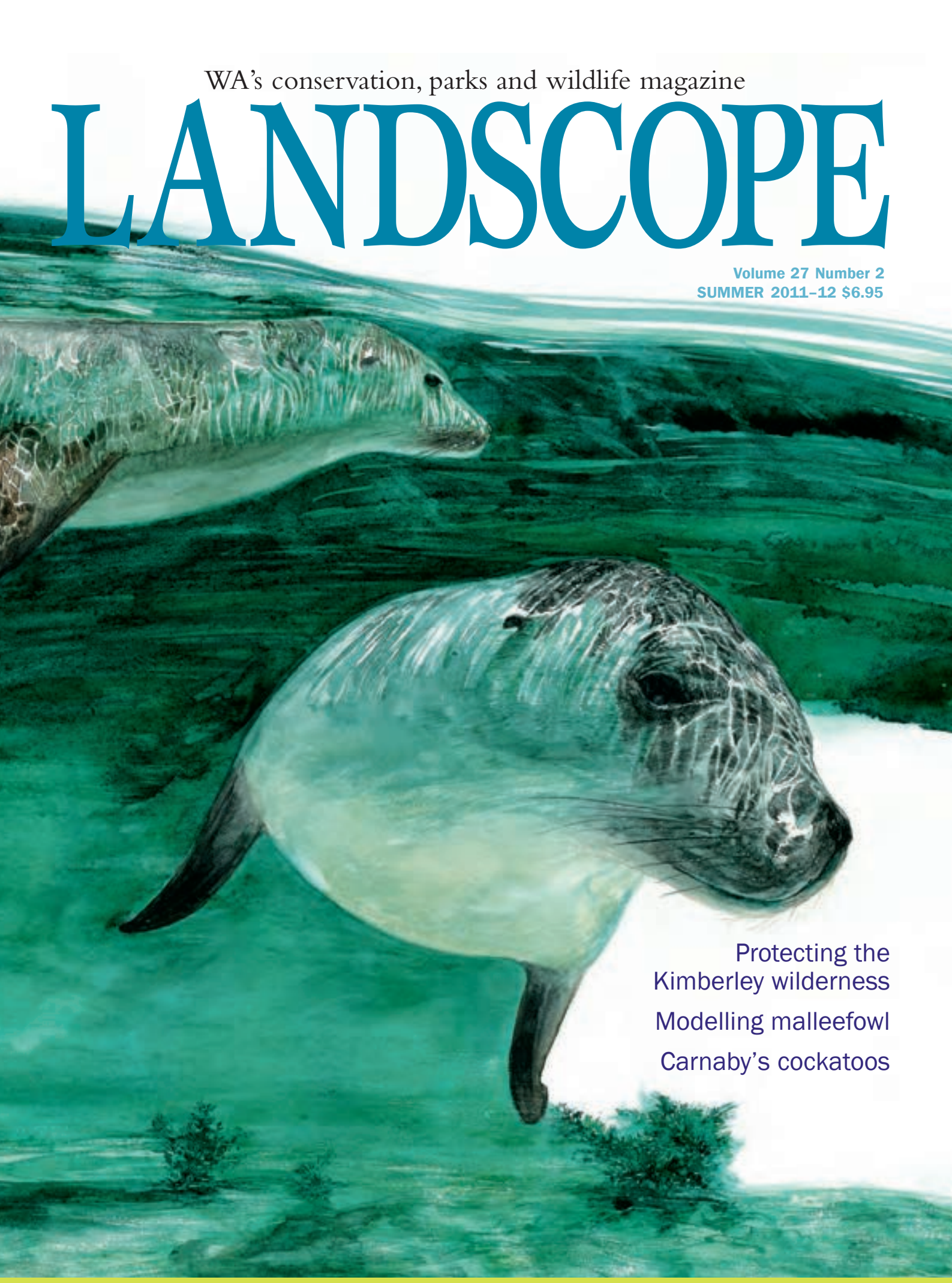

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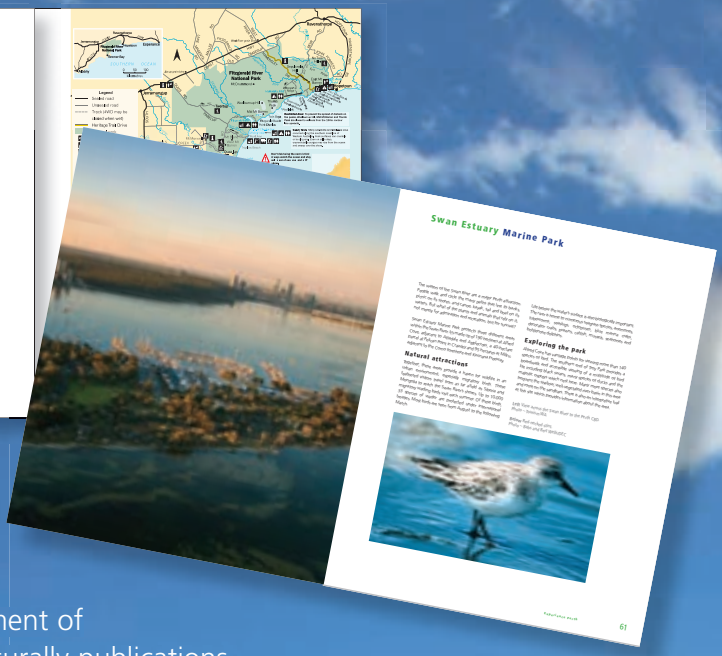

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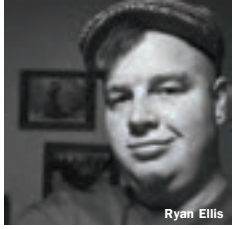
Department of Environment and Conservation


Teagan Johnston


Ryan Ellis

contributors

Teagan Johnston is a project officer for the Department of Environment and Conservation's (DEC's) Species and Communities Branch and a Masters candidate at Edith Cowan University. She has been working on a unique Carnaby's cockatoo project for two years. One of her favourite aspects to her role is observing the seasonal changes in the bush, the arrival and departure of different wildlife. Teagan has been with the department since 2005, in a variety of programs including *Land for Wildlife* and *Healthy Wetland Habitats*. More recently, she was the executive officer of the Animal Ethics Committee, which oversees the compliance of fauna research undertaken by DEC.

editor's letter

Deep into November, rain was bucketing down in the wheatbelt, to the frustration of famers, not to mention the general bemusement of city dwellers at the protracted finale to a winter that has been somewhat wetter than we have come to expect in recent years. This summer issue of *LANDSCOPE*'s final forest-related story for the International Year of Forests 2011, 'Dry times in the northern jarrah forest' (page 47), might seem a little hard to reconcile with spring conditions that have bucked the recent drying trend in the south-west.

Story author Frank Batini, a seasoned Western Australian forest scientist, reviews changes in the hydrology of this forest area over the past three decades and the impact of the falling watertable and decreasing groundwater on the forest, the riparian systems and the fauna species that live there. The outlook is not good. In short, without some sort of management intervention, biodiversity is under threat, with vegetation dying and animals facing loss of habitat and increased predation. On the surface, following the seemingly wet season we have just had, it may seem the picture shouldn't be so bleak, but rainfall this year has, in fact, barely made the average for the south-west, and one season in the normal range is not going to reverse the effects of long-term trends of years of drought. In any case, science doesn't allow for such cherry-picking of figures, and Frank's work is founded on decades of established research and rigour of method.

Western Australia's proud and continuing history of conservation science owes a great debt to forestry. It was nearly a century ago, in 1916, that Charles Lane Poole was appointed as the state's first Conservator of Forests. In the words of his biographer, John Dargavel, "if policy was the most important side of Charles' work, it was science—careful, rational, systematic, impersonal work—that he loved".[1] In 1920 Lane Poole would appoint pioneer Western Australian botanist Charles Austin Gardner as departmental botanist, who would in turn go on to become the inaugural Government Botanist and Curator of the newly founded State Herbarium. Today the Western Australian Herbarium is not only pivotal in this state for the resources it brings to conservation and land-use planning, but is also renowned the world over for the quality of its scientific endeavour.

You can find out more of the story of the Western Australian Herbarium in a new book, *A botanical journey: The story of the Western Australian Herbarium* (see 'bookmarks' on page 9), written by well-known Western Australian forester Roger Underwood. As the curtain falls on the International Year of Forests, it is fitting both to celebrate the achievements of forest science in the past, and to contemplate the challenges that lie ahead.

Madeleine Clews
Executive Editor

[1] *The Zealous Conservator—A Life of Charles Lane Poole*, University of Western Australia Press, 2008, p. 56.

INTERNATIONAL YEAR OF FORESTS • 2011

Ryan Ellis is a technical officer for DEC's Science Division. He has been involved in numerous research and monitoring projects on a number of Western Australia's threatened vertebrate and short-range endemic invertebrate species including the translocation of fauna from Barrow Island. This project also involved a number of trips to Lorna Glen, a former pastoral station, to monitor the health and population status of the translocated species which included boodies, bandicoots, mala and Shark Bay mice.

Frank Batini graduated in forestry from The University of Western Australia, the Canberra Forestry School and Oxford University. Work for various agencies including the Environmental Protection Authority and the departments of Forests, Premiers, and Conservation and Land Management (CALM) took him into many of the most remote and beautiful places in the state. Frank retired as manager of CALM's Environmental Protection Branch in 2000. Since then he has consulted in the management of natural resources to industry, government agencies, Indigenous corporations and conservation organisations. Frank's voluntary work includes being acting chair for the Centre of Excellence for Climate Change, Woodland and Forest Health and as an Adjunct Professor in Environmental Sciences at Murdoch.

Daryl Moncrieff joined CALM in 1994 and has been DEC's Kimberley regional manager since 2007. Before heading north, and after a 12-month work exchange to British Columbia, Daryl led the department's Management Planning Unit for five years. He has a particular interest in joint management, and is responsible for overseeing the implementation of the landmark Miriuwung Gajerrong and Yawuru joint management agreements. This experience will no doubt be invaluable in rolling out the government's major new conservation initiative, the Kimberley Science and Conservation Strategy (see 'Protecting the Kimberley wilderness' on page 32).


Frank Batini

also contributing . . .

Richard Campbell, Carolyn Thomson-Dans, Jacinta Overman, Karl Brennan, Michael Bode, Jennifer Higbid, Paul Drake, Kelly Griffiths, Karla Forrest, Barb Green, Rhianna King, Kate Nye-Butler and John Hunter.


Daryl Moncrieff

Features

Cover illustration
by Gooitzen van der Meer
The Australian sea lion (*Neophoca cinerea*) was added to the threatened species list under the federal *Environment Protection and Biodiversity Conservation Act 1999* in 2005. The species is ranked as vulnerable due to concerns over its lack of recovery from the commercial sealing era. Female sea lions always return to their own birth site to breed, a factor which contributes to the slow recovery of small colonies from population decline. Pleasingly, a new breeding colony for the sea lion was recently discovered at Draper Island in the Recherche Archipelago.
Illustration reference photo by Peter Nicholas/DEC

Back cover photo by Jiri Lochman
Mondrian Island in the Recherche Archipelago on the state's south coast, regarded as one of Australia's most spectacular seascapes.

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Department of
Environment and Conservation

Modelling malleefowl:
using maths to conserve threatened species

A research project in the Great Western Woodlands is using an advanced technique to find the best and most cost-effective way to protect the fascinating malleefowl.

by Karl Brennan and Michael Bode

In the TV show *Numb3rs*, the FBI is aided in its attempts to catch criminals by mathematician Charlie Eppes, who uses equations to help solve crimes. The show demonstrates how mathematics and policing can work together to find solutions to problems that are otherwise elusive. Similar to the TV show, mathematical equations and partnerships between mathematical modellers and land managers can also reveal clues that lead to informed decisions about conservation. A good example is recent research into malleefowl (*Leipoa ocellata*) undertaken for the Cliffs Natural Resources-Department of Environment and Conservation Land Management Project in the Great Western Woodlands.

Malleefowl are large, secretive birds inhabiting arid and semi-arid central and southern Australia. Although these birds are rarely seen, the mounds of earth, rocks and leaves they construct to incubate their eggs—structures which can be up to five metres across—are sometimes seen in southern semi-arid and arid Australia. Heat from the decomposing leaf litter keeps the eggs warm, with the male bird continually piling the mound higher, or opening it up to make sure it stays at the right temperature. The birds' curious behaviour and intense work ethic have long attracted the attention of both naturalists and landholders, and hundreds of volunteers take part in a national survey of malleefowl mound activity each year.

Facing threats

Despite this goodwill, malleefowl face many threats. The habitat that once supported the greatest malleefowl densities has been extensively cleared for agriculture, and the isolated fragments that remain are often degraded by stock. Worse, malleefowl are preyed upon by introduced foxes (*Vulpes vulpes*) and cats (*Felis catus*). Bushfires can also kill birds by removing the vegetation that keeps mounds warm and hides the birds from predators.

Malleefowl epitomise the complex land management issues that confront much of semi-arid and arid Australia. For more than a decade, private property owners, government and non-government organisations have made a concerted effort to increase malleefowl populations (see 'Saving the malleefowl', *LANDSCOPE*, Summer 1999–2000). Fencing out stock, shooting and baiting introduced predators, and breeding programs in zoos have all been tried but, despite a century of research, it's still not clear which actions are most effective.

Opposite page
Malleefowl are large birds—adults can weigh up to 2.2 kilograms.
Photo – David Bettini

Top A malleefowl chick.
Photo – Hans and Judy Beste/Lochman Transparencies

Above Malleefowl use the heat produced from decomposing leaf litter to incubate their eggs in a mound.
Photo – Cliffs Natural Resources

Maths to the rescue

So how can mathematics help? To start with, we created a computer model of the malleefowl population. This computer model—known to ecological scientists as a population viability analysis (PVA)—simulates a small population of the birds, watching each computer bird as it grows, reproduces and then dies. We know something about each of these events. For example, it is known how many eggs each malleefowl normally lays, and there are estimates of how long an adult can live. The problem is that no-one has joined them up into a single picture of a malleefowl's life. The PVA model does just that. Using the model, it's possible to simulate 50 years of changes in a small population within a few seconds.

Armed with this information, researchers can then 'try out' different management actions, such as releasing captive bred chicks from a breeding program, or baiting for foxes to enable more chicks to survive to adulthood. It's true that a computer model isn't the same as the real thing, but in some ways it's better. Hundreds of actions can be trialled in a single day. One management option can be 'trialled' for a simulated period of 10 years, then we can go back and see if all that effort was necessary. Importantly, we can instantaneously compare the performance of various conservation actions with their different costs, looking for the best return on investment.

Answers

So what did the modelling for malleefowl show? The PVA showed that if nothing is done to save it, an isolated population of 32 adult birds will decline to extinction within 20 years. If we release captive-reared chicks, this decline rate slows, but doesn't stop. However, if we invest in fox baiting in the Great Western Woodlands, we could turn this decline around and enable the population to grow, as well as help other species that are affected by foxes.

Developing a PVA model for malleefowl also tells us where to focus future research. Some of the data used in the model wasn't of very high quality. For example, maximum age was estimated based on a single captive malleefowl that lived in a zoo until it was 30, but no-one really knows how long the animal can live for in the wild. We wouldn't estimate the maximum age of a human by going into a retirement home and asking a random person how old they were. If we wanted to, we could spend tens of thousands of dollars and decades researching malleefowl age statistics. But if we run the PVA model thousands of times, with maximum ages ranging from 20 to 50, we find out that it doesn't really make a difference to our best choice of management. No matter how long a malleefowl lives, the model still shows that it is better to bait for foxes than to release captive-reared chicks. So, even when some of the input information isn't good, a computer model can tell us useful things.

Just like in *Numb3rs*, a partnership between a mathematical modeller and an ecologist has given new insight into a detective case—in this instance, how to save the malleefowl. Importantly, it has also helped assess the cost-effectiveness of alternative conservation actions, and identified some priorities for future research.

Top A male and female malleefowl near Ongerup, about 150 kilometres north-east of Albany.
Photo – David Bettini

Above Introduced predators such as the fox impact on malleefowl populations.
Photo – Sallyanne Cousans

Karl Brennan is the Department of Environment and Conservation's (DEC's) regional ecologist for the Goldfields. Karl can be contact on (08) 9333 7465 or by email (karl.brennan@dec.wa.gov.au).

Michael Bode is an ecological modeller with the Australian Government's Centre of Excellence in Environmental Decision based in the School of Botany at the University of Melbourne. Michael can be contacted by email (bodem@unimelb.edu.au).

This research was completed as part of the Cliffs Natural Resources–DEC Land Management Project. The authors would like to thank Ian Harris, Mike Bamford and Paul West for useful discussions and access to their unpublished data.

For more information see the scientific paper: Bode M and Brennan KEC. 'Using population viability analysis to guide research and conservation actions for Australia's threatened malleefowl Leipoa ocellata'. Oryx. Vol. 45, pp 513–521.

To view a video of a malleefowl pair recorded as part of this project go to www.youtube.com/user/OneCliffs.

bookmarks by Rhianna King

A botanical journey: The story of the Western Australian Herbarium

Author: Roger Underwood
Publisher: Department of Environment and Conservation
www.dec.wa.gov.au
276 pages, available in hard cover and soft cover, colour and historical photographs and illustrations
ISBN: 978 192 170 3126
RRP: $49.95 (soft cover), $64.95 (limited edition hard cover)

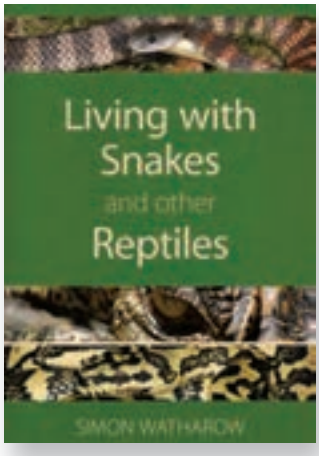
Written by Roger Underwood, former General Manager of the Department of Conservation and Land Management, *A botanical journey* gives readers a thorough account of the botanical exploration of Western Australia and history of the Western Australian Herbarium. It tells the stories of key figures who have shaped the state's flora collection and guided the development of the herbarium and offers fascinating anecdotes about challenges and achievements encountered along the way.

The insightful text is illustrated with photos and drawings from yesteryear as well as stunning landscape and species shots.

Axel The Western Swamp Tortoise

Author: JL Gargett
Publisher: Benarca Books
50 pages, paperback
ISBN: 978 098 709 8306
RRP: $9.99

Aimed at four to 10-year-olds, *Axel The Western Swamp Tortoise* is a charming book about Australia's most endangered reptile. The book contains six stand-alone stories and has a 'quick facts' section at the back that details the species' conservation status, distribution, habitat, diet and its physical features. This entertaining story would make an ideal addition to any school or home bookshelf.

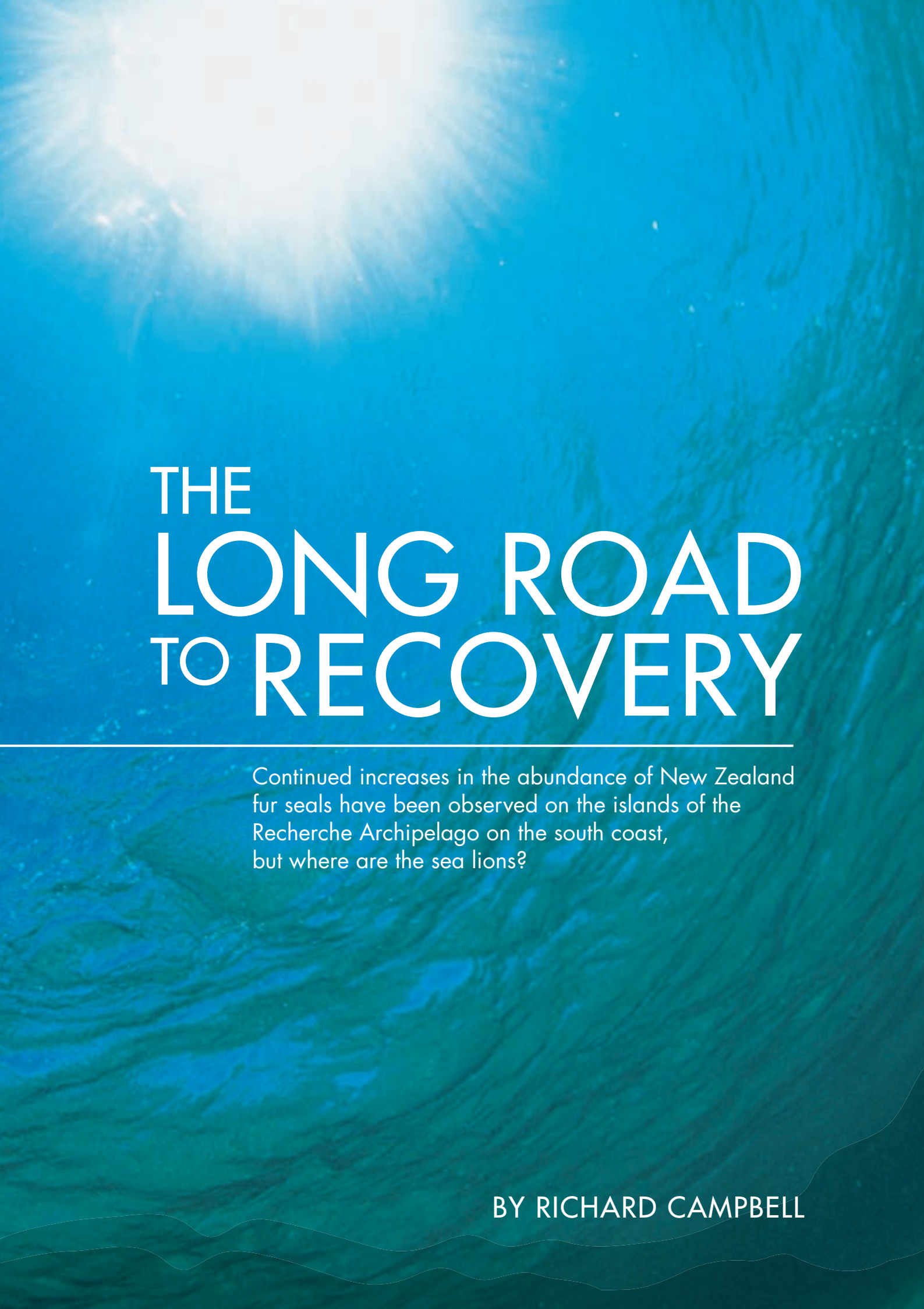


Living with Snakes and other Reptiles

Author: Simon Watharow
Publisher: CSIRO Publishing
www.publish.csiro.au
160 pages, paperback, colour photographs
ISBN: 978 064 309 7216
RRP: $29.95

Love them or loathe them, snakes and other reptiles are part of our landscape. *Living with Snakes and other Reptiles* is designed to arm the layperson with information about snakes, lizards, crocodiles and cane toads, and what to do if they're encountered.

This easy-to-digest book includes descriptions and colour photos to help with identification and provides helpful tips about how to prevent snakes and other 'scaly' creatures getting into backyards and workplaces. The book also aims to dispel myths and fallacies and looks at snakes in cultural beliefs and folklore. It even delves into the psychology of what makes some people afraid of them.



THE LONG ROAD TO RECOVERY

Continued increases in the abundance of New Zealand fur seals have been observed on the islands of the Recherche Archipelago on the south coast, but where are the sea lions?

BY RICHARD CAMPBELL

As we walked into the small, dank cave on Middle Island in the Recherche Archipelago, the roar of the Southern Ocean swell as it landed on the granite shoreline faded and we crowded into the space of one of 'Black Jack' Anderson's hideouts. Black Jack was an infamous African-American sealer and pirate who ruled the south coast of Western Australia in the early 1800s until his demise at the end of a fellow crewman's sword. How many seals had come to the same grisly end we can't be sure, but a recent survey of New Zealand fur seals has shown that the species has made a long and nearly complete recovery from those days of the sealing era. There are two resident pinniped (seal) species in WA waters—the New Zealand fur seal (*Arctocephalus forsteri*) and the Australian sea lion (*Neophoca cinerea*)—and their respective stories of recovery are still playing out across the windswept landscape of the south coast of WA.

Following in the footsteps

As part of the Western Australian Marine Monitoring Program (WAMMP), a team of Department of Environment and Conservation (DEC) marine scientists, accompanied by a terrestrial survey team, made a complete census and survey of the islands of the Recherche Archipelago and many of the islands from Esperance to Augusta. The trip followed in the wake of the historical voyages of great explorers and naturalists such as Baudin and Péron in the early 1800s, who named many of the features of this part of the state, as well as more recent surveys such as that done by the Australian Geographical Society. The society's survey report, *The Archipelago of the Recherche*, was an invaluable guide and a fascinating insight into the changes that have occurred over time even in this relatively remote landscape. The contemporary marine survey group was also retracing the more recent steps of Nick Gales and his team (see 'A tale of two seals', *LANDSCOPE*, Summer 1999–2000) in conducting the roughly 10-yearly count of New Zealand fur seal pups at the 18 breeding colonies identified across the south coast. At the same time, during this 2010-11 count, the terrestrial survey team examined the fauna and flora of the spectacular islands of the Recherche, many of which were being surveyed for the first time.

Pupping among the rocks

The marine survey team plotted a course from Esperance out to the eastern group of the island chain to cover all the breeding colonies that had been visited in the previous fur seal surveys of 1989 and 1999. Surveying populations of seals requires all pups born in a single pupping season to be counted. To this end, members of the research team landed on as many of the rocky shores as possible and proceeded to stick their heads in and under as many rocks, and into as many nooks and crannies, as they could find to count the young pups. The breeding and pupping season for New Zealand fur seals lasts for about six weeks—from mid-December to the end of January every year—with the pups remaining on land while their mothers leave the colony to forage at sea for a day or two at a time.

The most recent survey in 1999 had shown that the population was undergoing a fairly rapid expansion—growing at an impressive rate of 10 per

Previous page
Australian sea lion.
Photo – Alex Steffe/Lochman Transparencies

Left Recherche Archipelago.
Photo – Jiri Lochman

Above New Zealand fur seal.
Photo – Jiri Lochman

cent each year, meaning it doubles in size every seven years. The researchers wondered whether they would still see that pattern of increase this time. If so, there might be nearly 30,000 fur seals across the south coast and they would be counting some 7,000 pups. As with most expeditions, expectations did not match reality. While the numbers of seals had increased, it was nowhere near at the same rate as had previously occurred. On this WAMMP survey, more than 3,500 pups were counted and it was estimated that there were now about 17,500 New Zealand fur seals in WA. This suggests that the population has been increasing by only about one per cent each year over the past decade.

However, the group noticed some interesting patterns in the changes in abundance of pup numbers across the range. Clusters of colonies showed a large reduction in pup numbers—two groups between Bremer Bay and Esperance showed up to a 50 per cent decline for example—while others had remained stable or even nearly doubled in size compared to the last count more than a decade ago.

Expanding territories

Interestingly, two new breeding colonies of New Zealand fur seals were found, not in the heart of their range in the Recherche Archipelago, but further west on Chatham Island and nearby Stanley Island, both near Walpole. While the breeding activity had been noticed at Chatham Island previously, this was the first time an accurate count had been conducted at the end of the breeding season. DEC marine park coordinator Shannon Armstrong and DEC rangers from Walpole—the first to survey the island—were amazed to see such a healthy and large population with about 150 pups. Chatham Island now ranks as the seventh largest breeding colony of fur seals in WA, and serves as a reminder that it can take a long time for populations to recover from the effects of historical hunting.

It was difficult to know what was driving the patterns in the changing abundance of New Zealand fur seals across the range. One possible explanation is that the species may be reaching a plateau in numbers due to the amount of food available in the area. This explains why new breeding colonies weren't seen in the centre of the seals' range, but were found further west. The establishment over the past five to six years of a small breeding site near Cape Naturaliste and a new haul-out site for the species at Cathedral Rocks on Rottnest Island supports this theory. No record of this species coming so far north could be found in historical accounts and these sites suggest that the species is expanding from its previous range looking for food.

While the population may still be increasing, the fur seal is still at relatively low densities within the breeding colonies here in WA, about 10 times lower than in South Australia and New Zealand. From this it is possible to assume that the availability of suitable breeding and pupping habitat on the islands is not a limiting factor, and the low mortality rates of newborn pups from this and previous surveys (one to 1.5 per cent) supports this as well.

Looking for sea lions

The story of the New Zealand fur seal still contrasts markedly with that of the Australian sea lion. The sea lion was added to the threatened species list, ranked as vulnerable, in 2005 under the federal *Environment Protection and Biodiversity Conservation Act 1999* due to concerns over its lack of recovery from the commercial sealing era. This species displays a completely different pattern of reproductive biology to the New Zealand fur seal. Unusually, Australian sea lions only breed every 17.5 months and the breeding season is at a different time for nearly every breeding colony across the species' range. This system is not replicated in any other species of seal throughout the world and is thought to be a response to living in a marine system with unpredictable, low levels of productivity. One of the consequences of this is that female sea lions always return to their own birth site to breed and do not move out into other colonies. This means that small colonies are very slow to recover from any population decline.

Furthermore, once a colony has become extinct it is unlikely to be recolonised, as observed in the Bass Strait and as most likely happened at Carnac and Rottnest islands near Perth, where no breeding occurs today. During the recent survey, the team was fortunate enough to make stops at some of the sea lion colonies known to be breeding at that time. Using the same technique as when counting the newborn pups, the researchers were able to confirm that sea lion numbers were still very low throughout the south coast, a concerning trend which needs further monitoring.

Top left Australian sea lion.
Photo – Jiri Lochman

Left DEC wildlife officer Jon Pridham and senior operations officer (marine) John Edwards marking and counting New Zealand fur seal pups on Salisbury Island, the largest fur seal colony in WA.
Photo – Richard Campbell/DEC

Above left Researchers conducting a pup count on Cooper Island in the Recherche Archipelago. A group of fur seal pups can be seen in the background.
Photo – Sarah Comer/DEC

Above Australian sea lion pup.

Below left A female Australian sea lion with its pup.
Photos – Jiri Lochman

Pleasing discoveries

On a positive note, the team did manage to find a new breeding colony for the sea lion at Draper Island in the Recherche Archipelago, albeit a small colony with only a handful of pups. This is the first time in a decade that a new breeding colony has been found. The results from this survey showed that it is still possible for new discoveries to be made throughout the south coast of WA. The terrestrial survey team has also been describing new species of plants and animals as part of its research during the past five years. See the next edition of *LANDSCOPE* to find out about discoveries made as part of the terrestrial survey of the Recherche Archipelago.

The one unknown that had to be considered in this survey was the effect of an exceptional La Niña event, where warm water from the Leeuwin Current travelled further south than is usually the case. Instead of seasonally normal water temperatures of below 20 degrees Celsius, we were basking in water temperatures three to four degrees warmer than expected. What isn't known is how this change in conditions may have affected the breeding performance of the New Zealand fur seal for the 2010 season and its influence down the track as the effects of this anomaly filter through to the prey species of fur seals and the many trophic levels of this ecosystem. As such, it isn't known if this was a good year or a bad year in fur seal performance. Subsequent assessments will need to start looking at the year-to-year fluctuations in pup numbers at a subset of breeding colonies to determine whether the recovery of this species is indeed nearing its completion, or whether the species will continue to expand its range and grow in numbers.

Richard Campbell is a research scientist jointly employed by the Marine Science Program at the Department of Environment and Conservation (DEC) and Edith Cowan University at the Centre for Marine Ecosystem Research. He can be contacted on (08) 9219 9751 or by email (richard.campbell@dec.wa.gov.au).

The author would like to thank the other members of the DEC marine survey team—marine park coordinator Dave Holley, wildlife officer Jon Pridham, nature conservation coordinator Steve Butler, senior operations officer (marine) John Edwards, marine conservation officer Dave Lierich, marine ranger Sean Emmett, marine park coordinator Shannon Armstrong and project officer Mike Raykos.

Wellington National Park

Wellington National Park is a natural playground boasting a range of activities for adventurous weekenders. Within the park, visitors will find secluded camping in a relatively untouched wilderness area.

Above Honeymoon Pool.
Photo – Cliff Winfield

Opposite page
Top right The Wellington Dam was built as part of an unemployment project during the Great Depression. The dam wall rises 34 metres.
Photo – Vicki Winfield/DEC

Above right A splendid fairy-wren pair.
Photo – Wayne Eddy/Sallyanne Cousans Photography

Far right Near Long Pool on Lennard Drive.
Photo – Cliff Winfield

An easy drive for a weekend away and with camp sites nestled within thick forest, Wellington National Park provides a great setting to escape the busy city life. The reserve encompasses thousands of hectares showcasing the flora and fauna of the state's south-west, a region that attracts 3.4 million visitors a year.

During winter, fog rising off the Collie River drifts in between the blackbutt trees (*Eucalyptus patens*) and over moss-covered logs. In summer, the river becomes an ideal spot for canoeing and swimming. Early morning in the camp site sees noisy birdlife flit among the trees and along the decking constructed at the water's edge.

Listed as an 'A' class reserve in 2000, the park contains the largest reservoir in the south-west—the Wellington Dam—and a diverse landscape composed of seasonal wetlands, and forest and woodland vegetation. The park is punctuated by granite outcrops and visually dominated by marri (*Corymbia calophylla*) and jarrah (*E. marginata*) trees that overhang lush undergrowth.

The river system ensures the park is composed of a variety of distinctive micro-habitats, numbering seven forest ecosystems. A highlight of the park is a number of deep, clear pools, well flushed by small falls.

Although Collie has a history of timber harvesting, some sections in the lower river valley proved inaccessible to workers. As a result, the park contains mature vegetation now atypical of the former logging region.

History

The boundaries of the Kaneang and Willman Aboriginal groups intersect within the park. Nyoongar migratory routes incorporated the area for use as a water source and a hunting ground. The river is believed to be sacred and created by a Walgu spirit that formed the surrounding hills while manifested as a water snake.

European exploration of the area began in the mid-1800s. After Captain James Stirling ventured up the river

in the 1830s, Collie developed a coal industry. Workers' cottages still present in the park are evidence of the Wellington District's forestry history.

During WWII the park hosted a number of army training camps for young men preparing to go to New Guinea. They stumbled upon local couples honeymooning alongside the river; hence the pool earned its colourful nickname, Honeymoon Pool.

Natural attractions

The park is ecologically diverse, with 331 native plant taxa found there. The forest provides a home for a number of protected species, six of which are on the Department of Environment and Conservation's conservation priority list. Bull banksia (*Banksia grandis*), sheoak (*Allocasuarina fraseriana*), water bush (*Bossiaea aquifolium*), snottygobble (*Persoonia longifolia*) and grasstrees (*Xanthorrhoea* sp.) provide habitat for chuditch (*Dasyurus geoffroii*), brush-tailed phascogale (*Phascogale tapoatafa*), forest red-tailed black cockatoo (*Calyptorhynchus banksii naso*), ducks, wrens and owls. Some 66 species of native bird are found in the park, three of which are specially protected.

Exploring the park

Places of interest in the park include the King Jarrah site, Rapids, Little Rock and Long Pool. The 20-kilometre Wellington Trail is aimed primarily at group walkers and provides a connection from Wellington Dam to the Bibbulmun Track, which runs to the east of the park. The Munda Biddi Trail and Mt Lennard Bike Trails provide opportunities for cyclists.

Wellington Discovery Forest within the park is a living classroom popular with school groups as well as tertiary institutions and professionals. Here visitors can learn about forest ecology, research and management zones, including on a self-guided interpretive trail. Sections of the forest are used as a silvicultural demonstration area.

A number of camp sites are available and feature excellent facilities including fire pits, toilets, gas barbecues and a camp kitchen. Honeymoon Pool camp site is dominated by a large swimming hole, perfect for a dip in summer and a tranquil sight in winter. Gelcoat camp site is 500 metres further downstream, and Stones Brook is also nearby. Potters Gorge is able to accommodate camping vehicles and provides users with a view over Wellington Dam.

park facts

Where is it? Eight kilometres from Collie, a two-and-a-half hours' drive from Perth.

Total area: 17,000 hectares.

What to do: Camping, fishing, swimming, seasonal marroning, abseiling, rock climbing, bushwalking, canoeing/kayaking, mountain bike riding, white-water rafting.

Facilities: Wood and gas barbecues, Wellington Dam Cafe, Wellington Mill Cottages, parking, two-wheel-drive and four-wheel-drive access, toilets, picnic tables, camp kitchen, fire rings with firewood supplied, access to water for swimming and canoeing.

Camping: Camping is permitted at Honeymoon Pool, Potters Gorge, Gelcoat and Stones Brook. Fees apply.

Park fees: No entry fees to the park apply.

Nearest DEC office: Wellington District Office, 147 Wittenoom St, Collie, phone (08) 9735 1988.

Whether they fascinate or repulse you, there's no doubt that wolf spiders are intriguing creatures.

by Ryan Ellis

Out come the wolves: wolf spiders

As the sun sets and darkness prevails, the wolves emerge from their daytime retreats to hunt, eyes glistening in the moonlight. But, each with eight hairy legs, eight beady eyes and a pair of fearsome fangs, these are not your usual four-legged wolves. Wolf spiders are loathed and feared by some but loved and admired by others. Whether you love them or hate them, these spiders are undoubtedly celebrities of the arachnid world.

The common name wolf spider is applied to a family of ground-dwelling spiders scientifically known as Lycosidae (from *lycos*, Greek for wolf). This large group of spiders is found around the world and is particularly abundant across Western Australia in a variety of habitats. Known for their diverse adaptations to different environments and their effective hunting ability, the wolf spiders are an impressive group of harmless spiders that defy their bad reputation once you get to know them.

What makes a wolf?

The name wolf spider was originally given to the family based on the belief these spiders hunted in packs much like wolves; they are often seen in high abundance in areas where they are present. However, like most other spiders, wolf spiders are solitary. They generally come into contact with other wolf spiders only for reproduction, to fight for a mate (in the case of males) or, on occasion, to eat each other. A different explanation for their name is based on the way they hunt, chasing down their prey much like a wolf or wild dog. Only a few groups of wolf spiders use prey-capture webs.

Wolf spiders are distinguishable from other spider families by the arrangement of their eight eyes. Four eyes are evenly spaced in a square on top of their carapace (the upper section of their exoskeleton) and a row of four small frontal eyes is situated above the base of the fangs. At night it is easy to locate wolf spiders by looking for their shining eyes, which reflect incoming light. This green or bluish shine is caused by a highly reflective structure called a 'tapetum' in the spider's secondary eyes. Even the smallest of individuals and hatchlings can be located using a spotlight at night.

Each foot, or 'tarsus' (the terminal segment of the leg), carries three small claws. The absence of claw tufts renders the spider incapable of movement on smooth surfaces such as glass, metals and plastics, and for this reason wolf spiders are almost always found running on the ground. Rarely do wolf spiders venture into even low vegetation.

Wolf spider species vary greatly in size with different species ranging in adult size (body length, without legs) from a tiny 1.5 millimetres in the genus *Zoica* to about 35 millimetres in the larger species, for example in the genus *Hoggicosa*. Wolf spiders also vary

Previous page
Wolf spiders have eight eyes arranged in a distinctive pattern.

Left An undescribed species photographed near Fitzgerald Inlet.
Photos – Ryan Ellis/DEC

Below Forrest's wolf spider (*Hoggicosa forresti*) consuming another spider.
Photo – Jiri Lochman

greatly in colour, and their markings include shades of brown and grey with scattered and sometimes intricate markings of contrasting colours making up radiating bands or blotches. Species in the web-building genus *Venonia* are uniformly black with a white spot on the tip of the abdomen almost like white-tailed spiders (*Lampona* spp.), which belong to a very different spider family, Lamponidae.

While some species of wolf spider can be identified easily, for example the abovementioned *Venonia*, identification of most species requires a detailed examination of the reproductive organs, because within genera, colour patterns are generally very similar.

Part of the pack

Across the globe more than 2,300 species of wolf spider are currently described, of which about 160 species in 28 genera occur in Australia. However, this represents less than half of the known species of this continent. Within the Lycosidae, there are four subfamilies known from Australia—the Zoicinae, Venoniinae, Artoriinae and Lycosinae. Zoicinae and Venoniinae are small families by number of species and genera, and they are also the smallest by size. With a body size of less than two millimetres, the Western Australian *Zoica minuta*, originally described from the Kimberley, belongs to one of the smallest wolf spider species worldwide. The Artoriinae is made up of almost 50 species in at least five genera. This subfamily contains species in the genus *Tetralycosa* which have adapted to one

Above The eight eyes of a wolf spider include four large and four small eyes.
Photo – Ryan Ellis/DEC

Left Salt Lake wolf spider (*Tetralycosa alteripa*).
Photo – Volker Framenau

Above Desert wolf spider.
Photo – Ryan Ellis/DEC

Left Polished wolf spider.
Photo – Volker Framenau

of the harshest environments in the country, saltlakes. The fourth subfamily and the largest in both species number and size of the spiders is the Lycosinae. This group includes almost all of the arid-adapted wolf spiders that spend their days in burrows to escape the heat and venture out at night.

Wolf spiders occur in almost all habitats, an ecological success that is probably due to their unique combination of a variety of hunting, breeding and dispersal strategies. From coastlines to mountain tops, rainforests to deserts, these spiders occur in habitats ranging from dense leaf litter to barren sandy plains. Some species have adapted to extremely harsh conditions and environments including hot, dry deserts, saltlakes, desolate sand dunes and monsoonal rainforests. Wolf spiders have also adapted to disturbed habitats, including suburban backyards and parks and other man-made environments in great numbers.

One of the most common species likely to be encountered in the Perth region is the western rough wolf spider (*Hogna immansueta*) (subfamily Lycosinae), which is often found in backyards and local areas of remnant bushland in autumn. Where reticulation provides regular moist conditions, the beautiful polished wolf spider (*Artoriopsis expolita*) (subfamily Artoriinae) is abundant. It is a vagrant hunter so does not excavate a burrow. The impressive two-coloured or desert wolf spider (*Hoggicosa bicolor*) (subfamily Lycosinae) occurs in arid areas across the state, although this spider will only be found at night when it leaves its burrow to hunt.

On the hunt

Wolf spiders primarily feed on small ground-dwelling invertebrates such as small insects, but are known to also hunt prey larger than themselves, such as other spiders and small lizards. Three basic hunting strategies are known in wolf spiders. Species in the genus *Venonia* (subfamily Venoniinae) build small sheet-webs close to the ground. Spiders sit in a silken funnel at the end of the web and wait for prey to get entangled in the sheet. Spiders in the Zoicinae and most species in the subfamily Artoriinae are vagrant hunters. These wolf spiders roam through leaf litter to find prey, a strategy most closely resembling that of their mammalian namesakes. The larger species, mainly those in the subfamily Lycosinae, excavate burrows in which they spend most of their time. Often spiders can be seen sitting in the entrance of their burrow waiting for prey to pass by. They may also

Right *Dingosa* sp. in a burrow entrance. *Photo – Dennis Sarson/Lochman Transparencies*

Centre right An undescriped species photographed at Lake Corin.

Below right Predator and burrow thief Main's ground gecko (*Lucasium maini*) using an old wolf spider burrow. *Photos – Ryan Ellis/DEC*

leave the burrow for short distances to hunt. Once prey has been spotted or its vibrations felt, the spider is on the move. The spider's relatively long legs enable it to outrun and capture prey easily. Prey is generally consumed on the spot immediately after capture, before the spider continues to forage or retreats to its burrow.

Breeding

Once a male wolf spider has reached maturity, all of its energy is directed to locating females to mate with. In burrowing species, males will abandon the retreat for good and venture out to look for a mate. The search for a mate is often based on chemical communication. Roaming females leave a 'dragline' of silk behind them that carries male-attracting pheromones. Reproduction being the one thing on its mind, the male generally ignores prey in the search for a female.

As a male spider's primary genital organs and sperm-transmitting structures, its 'pedipalps', are not connected, it builds a sheet of web onto which it deposits its sperm before trying to find a mate. He then inserts the bulb of its pedipalps into the seminal fluid which is sucked into the bulb. Once the male has found a suitable mate it must take extreme caution to not be mistaken for food and to avoid the female becoming agitated and trying to kill the male. To achieve this, the male wolf spiders engage in a complex mating 'dance' that includes pedipalp scratching, drumming on the ground with the pedipalsps or a percussive performance conducted by hammering the abdomen on the ground. The male will also caress the female, aiming

to keep it in a trance-like state and preventing it from becoming aggressive.

Reproduction occurs in summer in most species, although some are winter mature, such as the yellow-handed artoria (*Artoria flavimana*). After mating, the female will construct a large spherical egg sac in which it lays eggs. From three to more than 1,000 eggs may be laid in the egg sac, depending on the species. The egg sac is then attached to the female's spinnerets and is carried everywhere the female goes, even when it is hunting for food. Some burrowing species have been observed exposing the egg sac to the sun at the burrow entrance, possibly to help speed up development.

After the young spiderlings have hatched from their eggs, they leave the egg sac with the help of their mother. The young do not immediately disperse. They climb onto the mother's abdomen where they hold onto special hairs. Attached to the mother's back, the young spiderlings continue to accompany the female and thereby avoid hazardous situations. Often there will be so many spiderlings on the female's back it is difficult to see it, apart from its eyes and legs.

Eventually, after a few days or weeks, the spiderlings will disperse from the mother's back. Some disperse on the ground while others climb onto vegetation or rocks where they release a strand of silk, known as gossamer, which the wind catches, thereby carrying the little spider to a new, hopefully hospitable, home.

Left A female western lawn runner (*Venatrix pullastra*) spider with its spiderlings emerging from its egg sac. *Photo – Volker Framenau*

Below Leuckart's wolf spider (*Lycosa leuckartii*) with its spiderlings. *Photo – Wade Hughes/Lochman Transparencies*

The female's mobile technique of caring for its brood is unique to wolf spiders and contributes to the ecological success of the spiders. For example, wolf spiders are particularly abundant in environments prone to inundation, such as river banks, lake shores or even sandy beaches. In times of floods or tidal movements, females simply carry their brood to safe ground. Other common ground-living spiders, such as jumping spiders (family Salticidae) or ground spiders (family Gnaphosidae) fix their egg sacs to substrate and the brood may not survive rising water levels.

Daytime retreats

Being largely nocturnal, wolf spiders need a daytime retreat. Some species roam freely and hide among leaf litter and vegetation or underneath fallen logs, bark or human building materials, while others construct burrows. Spiders use their strong chelicerae, or fangs, to excavate burrows up to 30 centimetres deep, depending on the soil type. Sometimes they will use the abandoned burrows of other spiders or insects.

Burrows may be constructed in areas consisting of sandy, clay or rocky substrates which can cause the spider to vary the length or direction of its burrow. Burrows are silk-lined, albeit often very thinly, and many have a large open cavity at the base. Wolf spiders seem to take pride in their burrows and are quick to repair any damaged silk linings or lids. They will renovate the burrow as they grow by widening it and excavating a larger cavity at the base.

While burrow entrances are generally uncovered, they can be decorated with small leaves, twigs and bark. Trapdoor-like lids from silk and soil, stones and leaves and even pebbles or rabbit or sheep scats are constructed by some wolf spiders, for example in the genus *Hoggicosa*. Burrows with lids are often indistinguishable from the surrounding substrate, making it difficult for predators to locate burrows and prey on the spiders. The shuttlecock wolf spider (*Mainosa longipes*) (subfamily Lycosinae) and species in the genus *Dingosa* (Lycosinae) build remarkable turret-like structures around the entrance of their burrow from leaves, fine twigs or pebbles. Wolf spider burrows are sealed and lids closed when the spider is moulting or during adverse conditions outside the burrow.

A bite from the beast

Wolf spider bites, even those of the larger species, are not known to cause serious injuries or necrotic lesions in people. Bites are known to be mildly painful causing only local pain and swelling, and systemic reactions are rare and mild. There have been no reports of allergic reactions to a wolf spider bite. Wolf spiders are generally not very aggressive and bites are rare. In contrast, and curiously, bites of larger species, for example the common garden wolf spider (*Lycosa godeffroyi*) (subfamily Lycosinae), have been reported to be fatal to dogs.

With a large number of undescribed and even undiscovered species roaming WA, there is still much to learn about our Australian wolves.

Above The turret entrance of a shuttlecock wolf spider.
Photo – Ryan Ellis/DEC

Above right Turret-building wolf spider (*Dingosa humphreysi*) at the nest entrance.

Right Garden wolf spider.
Photos – Jiri Lochman

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The author would like to thank Volker Framenau (Phoenix Environmental Sciences) for technical advice and assistance with species identification.

Just add **water:**

the Toolibin Lake inundation experiment

by Jennifer Higbid and Paul Drake

Surface water at Toolibin Lake has been a rare sight of late. Since 1997, the lake has only partially filled twice. So when a pool of water materialised on the lake bed during a sunny Tuesday morning in March it caused quite a stir.

Toolibin Lake, 200 kilometres south-east of Perth, is one of the last remaining fresh-to-brackish wetlands in the wheatbelt and has been recognised as a Wetland of International Importance under the Ramsar Convention for its flora and fauna. Toolibin Lake has recorded the highest number of breeding waterbird species of any inland wetland of the south-west and has historically been considered important for the freckled duck (*Stictonetta naevosa*), which is uncommon in the south-west. Toolibin Lake is also a natural diversity recovery catchment and the lake bed vegetation is listed under national legislation as a threatened ecological community.

The lake's catchment was mostly cleared by the 1950s and the first sign of secondary salinity at the lake was observed in the mid 1970s when trees began to die. Land clearing had caused salt stored in the soil to mobilise and this was entering the lake as saline surface water from the catchment and rising saline groundwater from beneath the lake. In response to these threats, the state government together with the local community began a process to protect the valuable wetland. In 1994, the *Toolibin Lake Recovery Plan* was released which outlined the activities and monitoring that were needed to manage and protect the lake.

Recovery plan

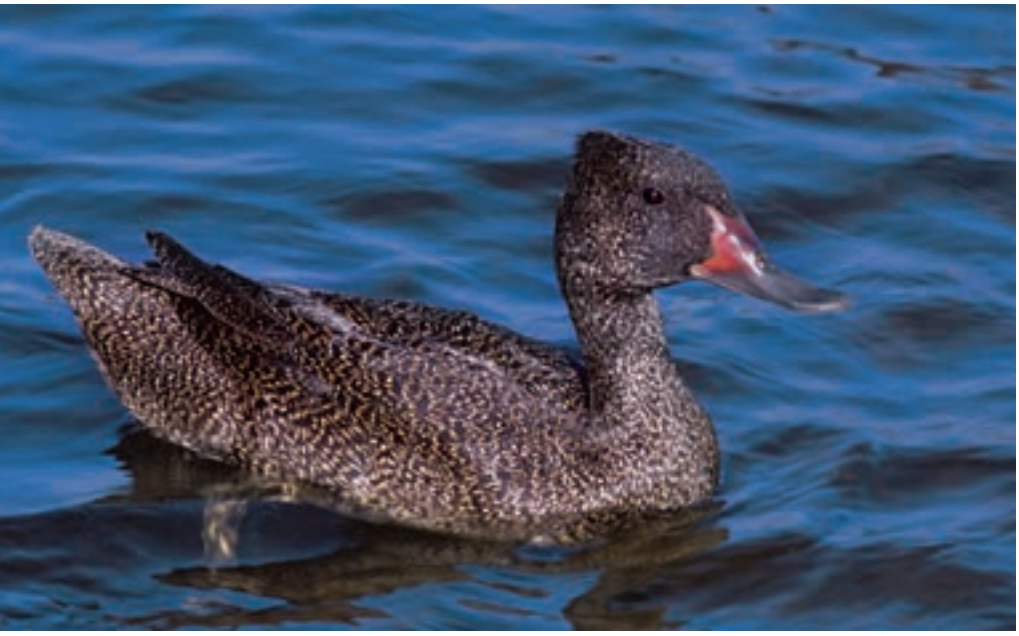
Under the guidance of the recovery plan, a variety of works, including revegetation and engineering interventions, have been implemented. The engineering works were designed to reduce the salinity of surface inflows and lower the saline groundwater beneath the lake. Works began in 1995 with the construction of a levee to divert saline surface water away from the lake, and in 1997 the first system of pumps was installed on the lake bed to lower the watertable (see 'Triple test: recovering natural biodiversity at Toolibin Lake and Lake Bryde', *LANDSCOPE*, Winter 2010).

More recently, infrastructure that controls the outflow of water has been upgraded with a sump and shallow channels constructed on the lake bed to enable surface water to drain before it becomes too saline from evaporation. Importantly, better outflow control also means that surface water can now be removed from the lake before it connects directly with the groundwater. Other actions across the catchment area have also occurred, including revegetation of public and private lands. Without these actions the vegetation on the lake would have been lost.

Long-term biological and hydrological monitoring indicates that these management actions have largely halted the decline of vegetation since about 2006, with recovery of some smaller sections of lake bed vegetation during the past decade. However, there has not been large-scale recovery of the lake bed vegetation. This prompted an investigation into the tolerances and life history strategies of the dominant lake bed flora to help guide the future management of the lake.

BioRisk project

The Department of Environment and Conservation (DEC) is coordinating the BioRisk project, a partnership between DEC, Future Farm Industries Cooperative Research Centre and The University of Western Australia. The project is researching the water requirements and tolerances of the dominant trees on the lake bed—sheoak (*Casuarina obesa*) and paperbark (*Melaleuca strobophylla*), which are the most deep-rooted plants growing on



Previous page
Main Toolibin Lake.
Photo – Jiri Lochman
Inset Measuring surface water at Toolibin Lake.
Photo – Jennifer Higbid/DEC

Above Maintaining equipment at Toolibin Lake.
Photo – Cliff Winfield

Left Freckled duck.
Photo – Jiri Lochman

Right Toolibin Lake pumping station.
Photo – Marie Lochman

Centre right The bund established for the flooding trial.
Photo – Jennifer Higbid/DEC

Below right Red-capped robin.
Photo – Jiri Lochman

the lake bed. These trees are good indicators of hydrological change in groundwater as they are sensitive to fluctuations in the quantity and quality of water in the unsaturated zone of the soil profile. The quantity and quality of water in the unsaturated zone, in turn, is influenced by surface water inflows and the depth to groundwater from the soil surface.

The lake bed trees are also highly responsive to the hydroperiod (the timing and frequency of flooding), and the length of time that water remains in the lake. In particular, the regeneration and survival of seedlings depends on certain aspects of the lake's hydroperiod. For example, a flooding event is needed for seeds to germinate but the lake bed has to then remain relatively dry for some years after germination to enable the seedlings to become established.

To help understand how the trees of the lake bed interact with surface water and saline groundwater, the BioRisk project team has installed sensors to record changes in the soil's physical environment (soil moisture and salinity), the underlying hydrology (groundwater depth and salinity) and growth and water use in trees (tree girth and sap flow).

While the data obtained from these sensors have shown how the trees respond to seasonal cycles, there hasn't been enough rainfall in the past three years to cause new water to flow into the lake. This has meant that our understanding of the interaction of surface water inflows with the soil and plants has been largely derived from models. To confirm some of the assumptions of these models and to understand the dynamics of salt and water movement during lake inundation, a small flooding trial was conducted on the lake bed.

Pond within a lake

A bund was created with sandbags, forming a rectangular plot about 15 metres long by 10 metres wide by 0.5 metres high. The bags were covered with polymer film to limit leakage. The plot contained more than 100 trees, both sheoaks and paperbarks, and a small group of these was fitted with sensors to measure tree girth and sap flow. Sensors were also set up to record changes in the depth and salinity of groundwater and surface water, and moisture and salinity in the soil profile. This design was replicated in a plot adjacent to the bund and a control plot about 50 metres from the bund. The bunded area was made watertight and fenced to keep kangaroos out of the plot and away from the sensitive equipment. Now to add water.

On Tuesday 22 March 2011 the water truck rolled up to Toolibin Lake and fresh water was gravity fed into the bund from two 9,500-litre storage tanks. Very soon the glorious sound of trickling water could be heard among the whistling sheoaks. The water truck returned throughout the day and replenished the tanks to provide a near-continuous water flow into the bund.

The seal of the bund was closely monitored and leaks were quickly plugged with clay spoil. During the first day, 60,000 litres of water were fed into the bund and the water depth increased at a rate of nine centimetres an hour and peaked at 42 centimetres. Another 20,000 litres of water were delivered three days later and the following week an additional 20,000 litres were applied, bringing the total to 100,000 litres. While some surface seepage did occur, a water depth of more than 30 centimetres was maintained for seven days. When the input of water ceased, the standing water slowly declined at a rate of about 0.14 centimetres an hour.

Happy dragonflies

Some of the lake's resident fauna were soon to arrive to inspect the newly formed pond. Within a couple of hours of the plot flooding, Australian emperor dragonflies (*Hemianax papuensis*) were zooming along the water surface. They were quick to seize the opportunity—by the afternoon, mating had already occurred and couples were observed laying eggs in tandem. Three different species of dragonfly were seen at the pond during the first three days of inundation.

Some of the local birds were also curious about the unusual water activities. A family of white-eared honeyeaters (*Lichenostomus leucotis*) flew in and before long they were enjoying a rare swim on a warm autumn day. A red-capped robin (*Petroica goodenovii*) dropped in for a quick dip while a grey butcherbird (*Cracticus torquatus*) surveyed the scene from the surrounding fence.

Results

The sensors within the bund detected a rapid increase in soil moisture almost immediately after flooding started and the soil profile remained saturated for several weeks after the initial rise. Soon after inundation, groundwater beneath the bund was observed rising toward the surface. Groundwater also rose adjacent to the bund but the rise was less than that observed below the bunded area.

Left New paperbark growth.
Photo – Jennifer Higbid/DEC

Water in, water out

The management actions implemented from the *Toolibin Lake Recovery Plan* have succeeded in reducing saline surface water flowing into Toolibin Lake and have also increased the depth to groundwater beneath the lake. Unfortunately, there is still a lot of salt in the soil and this has slowed the recovery of sheoaks and paperbarks. To help flush salt through the soil profile, surface water inflows must be carefully managed and an adequate depth of groundwater has to be maintained. For example, if fresh water enters the lake and remains there for longer than a month when the saline groundwater is near the surface, there is a high risk of bringing saline groundwater into the root zone, which would be detrimental to tree health.

Water inflows from the catchment that are greater than 1,000 milligrams a litre of total dissolved salts are currently diverted away from Toolibin Lake. While this saline surface water is being kept out to protect the lake bed vegetation, it also means that less water has been going into the lake for waterbirds. A modelling study in 2008 proposed raising the current salinity threshold to increase the frequency and extent of inundation, which would then improve habitat for waterbird breeding. The recent upgrade to outflow infrastructure means that water can now be released from the lake when needed; for example, when salts start to concentrate due to evaporation. However, before the threshold is increased, a better understanding of the risks to the lake bed vegetation is needed. Data from the inundation experiment will be useful for refining the salinity threshold and also for understanding the benefits and risks to the lake's biota from surface water inflows.

Right A stand of sheoaks on the lake bed. *Photo – Cliff Winfield*

Centre right Mating dragonflies.

Below right Measuring sap flow. *Photos – Jennifer Higbid/DEC*

Two weeks after inundation, salt was recorded flushing down through the upper soil profile.

Tree sap flow rose in both species, but mainly in the sheoaks, within several hours of inundation, as the rate of tree water use increased. Tree girth also increased—the sheoaks responded immediately to the available water while the paperbarks showed a slower, steadier response. Two months after the flooding trial, new growth was observed on the paperbarks and sheoaks within the bunded area. One male sheoak had even begun to produce flowers.

Next step for Toolibin Lake

The experiment showed that the lake bed vegetation responds rapidly to inundation with fresh water. During the experiment, sensors also detected flushing of salt from the upper soil profile. These benefits were somewhat offset by a rapid rise in highly saline groundwater toward the root zone. So the duration of inundation events at Toolibin Lake must be carefully regulated to ensure that salt is removed from the soil profile without bringing saline groundwater into the root zone. Alternatively, pumping must be used to further lower groundwater to the point that it does not represent a risk during inundation events. This information will be incorporated into hydrological models to improve management of the lake for conservation. Information from the BioRisk project will be instrumental in guiding the revision of the recovery plan and setting new goals and targets.

The flooding trial at Toolibin Lake has been a great success and the results will contribute to an informed management process that aims to improve the health of the lake bed flora of this internationally important wetland. As a bonus, the dragonflies were happy!

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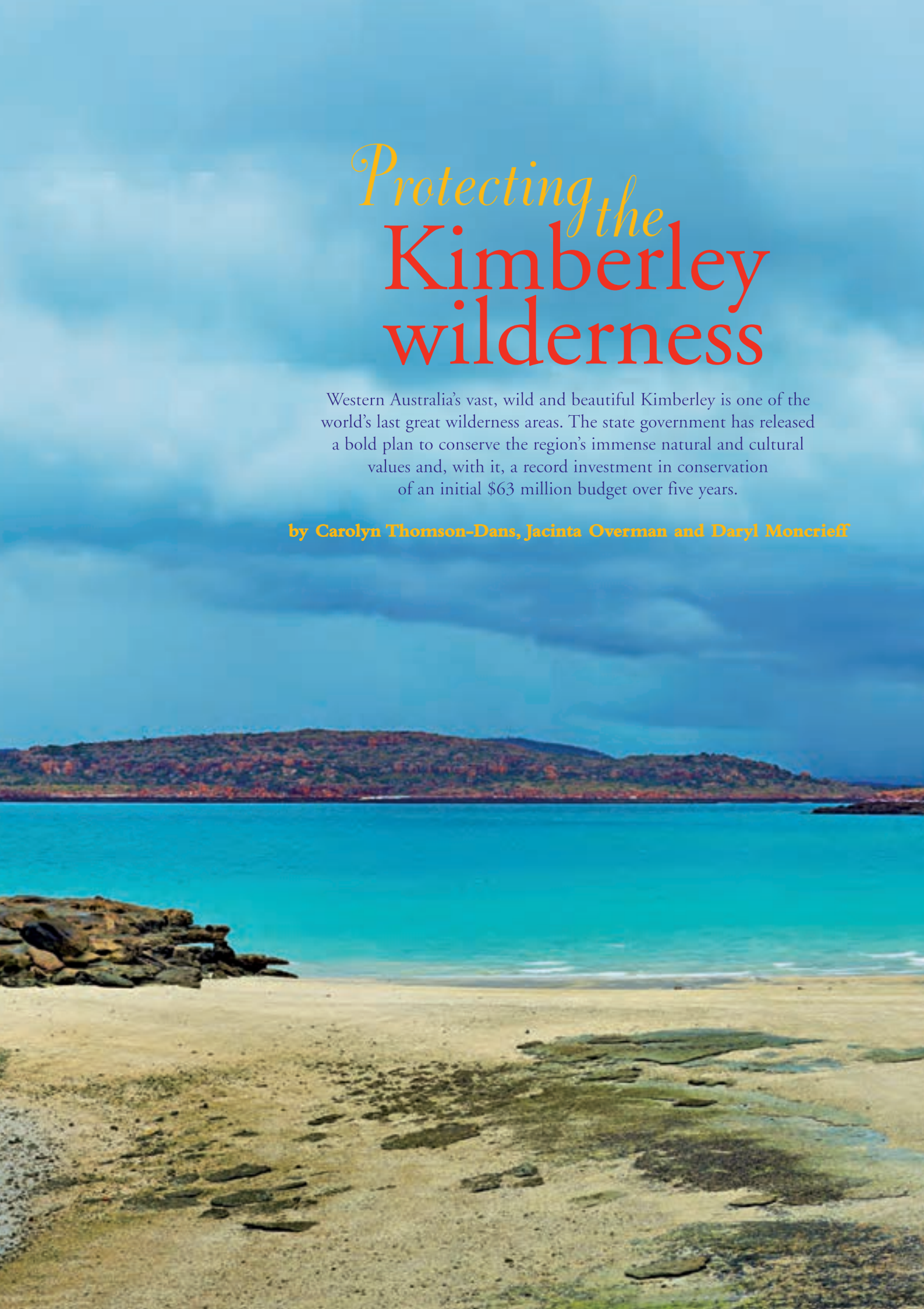
For more information on the Natural Diversity Recovery Catchment Program visit the 'Salinity' section of DEC's website at www.dec.wa.gov.au.

Protecting the Kimberley wilderness

Western Australia's vast, wild and beautiful Kimberley is one of the world's last great wilderness areas. The state government has released a bold plan to conserve the region's immense natural and cultural values and, with it, a record investment in conservation of an initial $63 million budget over five years.

by Carolyn Thomson-Dans, Jacinta Overman and Daryl Moncrieff



The Kimberley region is a national biodiversity hot spot and its marine environment is internationally renowned as one of the world's most unspoilt and ecologically diverse. It has some truly awe-inspiring landscapes, from the beehive formations of Purnululu World Heritage area to such spectacles as the Horizontal Waterfalls in the Buccaneer Archipelago.

The region also offers less tangible but no less important values. A great many people all over the world feel a spiritual connection with the Kimberley and desire to protect it, even if they have never been there. As American novelist and environmentalist Wallace Stegner so eloquently put it:

> "Something will have gone out of us as a people if we ever let the remaining wilderness be destroyed ... We simply need that wild country available to us, even if we never do more than drive to its edge and look in."

The state government's bold vision for this region's long-term conservation—the Kimberley Science and Conservation Strategy—was released in June 2011. Many of the strategy's major initiatives are already underway.

Landscape-scale conservation initiative

Parts of the far north-west Kimberley are among the least disturbed environments in Australia. There are no recorded mammal extinctions from this area. However, the rugged and remote nature of the Kimberley does not mean the region has remained undisturbed. The spread of cattle and major changes to fire regimes have caused the most obvious impacts on the natural environment. Feral donkeys and other introduced pests have compounded these effects. Feral cats are thought to be causing significant impacts on native species and introduced cane toads recently arrived in the region. Weeds have been introduced to, and taken hold in, many parts of the region. Global climate change is also likely to affect the region, with significant increases in both average rainfall and temperatures projected to occur in the Kimberley during the next few decades.

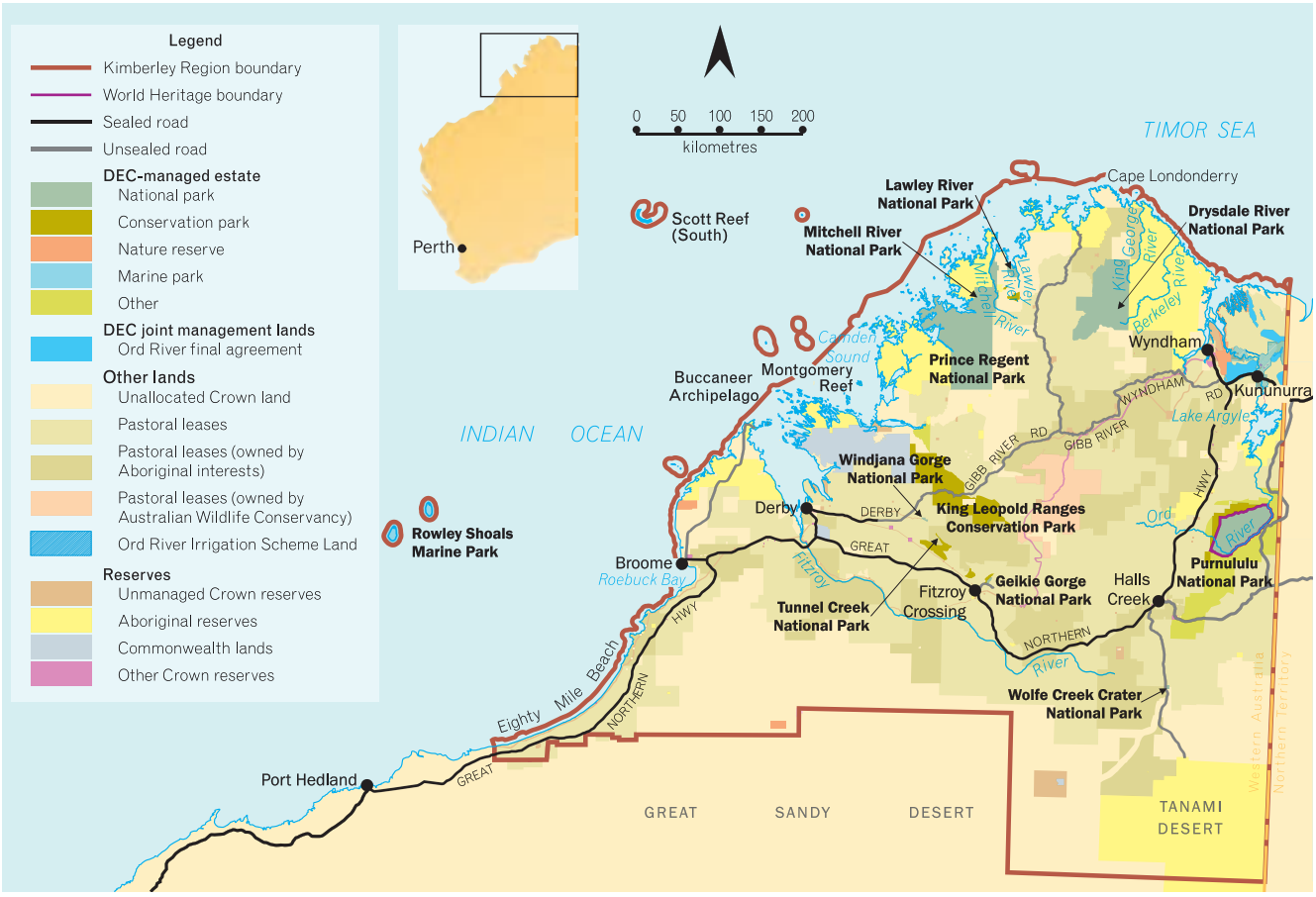
All of these threats and disturbances cut across property boundaries and affect parks, pastoral lands, Aboriginal lands and other areas alike. So, the most effective conservation strategy in the Kimberley is to protect, maintain and restore ecosystems at a whole-of-landscape scale, regardless of tenure. The Kimberley Science and Conservation Strategy has therefore taken a tenure-blind approach. This means managing threats—such as fire, introduced animals and weeds—cooperatively across property boundaries and in partnership with traditional owners and key stakeholders including pastoralists and the Australian Wildlife Conservancy, to increase the resilience of ecosystems across the whole landscape. The government has committed $21.5 million over five years for this landscape conservation initiative, with ongoing funding of $5.5 million per year.

One of the most significant initiatives under the strategy addresses the greatest threat to the biodiversity of the region—bushfires. Large and intense fires in the late dry season have caused changes to vegetation structure such as loss of overstorey woodlands, soil erosion and declines in native animal populations. Often these fires rage across hundreds of thousands of hectares because, once started, and in the heat of the dry season, they are almost impossible to contain. This is

Previous page
Bonaparte Archipelago in the north-west Kimberley.
Photo – David Bettini

Above Releasing a northern quoll captured in a biological survey.
Photo – Lesley Gibson/DEC

Left Prescribed burning is undertaken in areas such as Silent Grove in King Leopold Ranges Conservation Park to control fuel levels.
Photo – Ed Hatherley/DEC



particularly the case in the rugged parts of the region. Not only are these fires on a grand scale, they often occur in the same areas year after year, providing insufficient time for plants and animals to recover.

The Department of Environment and Conservation (DEC), in collaboration with traditional owners, the Kimberley Land Council, Aboriginal ranger groups, the Fire and Emergency Services Authority, pastoralists, the Australian Wildlife Conservancy and other partners, is developing and applying improved fire management strategies. Contemporary science is being integrated with traditional Aboriginal knowledge to restore nature's balance and create a mosaic of burnt and unburnt areas in the late wet and early dry seasons. The resulting patchwork effect from these prescribed burns reduces the amount of fuel available and therefore reduces the risk of large, intense and damaging fires later in the dry season. This is a mammoth effort across almost 20 million hectares of land and it is estimated that it will significantly reduce the amount of carbon released into the atmosphere every year.

Planning for these expansive seasonal fire management and introduced animal and weed control projects will be reviewed annually. On-ground works have already started.

Expanding the reserve system

The centrepiece of the Kimberley Science and Conservation Strategy is the creation of the Kimberley Wilderness Parks, one of the most significant environmental initiatives in Western Australia's history. The Kimberley Wilderness Parks will include the state's largest interconnected system of marine and terrestrial parks, covering 3.5 million hectares stretching from the seaward edge of the proposed Great Kimberley Marine Park (see page 36) through the new Prince Regent National Park to the remote Drysdale River National Park.

The government has already made significant progress on this initiative. The unclassified Prince Regent Nature Reserve has been upgraded to a class 'A' national park, in order to provide the highest level of protection to this internationally recognised area. The 635,000-hectare park is home to more than half of the mammal and bird species found in the whole Kimberley region and more than 500 plant species.

At the heart of the Kimberley Wilderness Parks, the new Prince Regent National Park—WA's 99th national park—protects many areas of scenic grandeur, including Kings Cascade, Pitta Gorge, Mount Trafalgar and Python Cliffs. Prince Regent River runs almost straight for most of its length, often between near-vertical cliffs. The adjoining Camden Sound Marine Park will create a continuous terrestrial–marine reserve system. The park has no facilities or road access, but many private boats include Prince Regent River on their itineraries during coastal cruises.

A conservation park will also be created in the Willie Creek Wetlands on Yawuru Aboriginal lands, to be jointly managed with the Aboriginal owners. DEC and the Miriuwung-Gajerrong traditional owners will also move to protect the globally significant flatback turtle rookeries at Cape Dommett at the mouth of the Cambridge Gulf, by adding the area to the jointly managed Ord River Nature Reserve.

There are more than 2,500 islands off the Kimberley coast, spectacularly

Top Talbot Bay, Buccaneer Archipelago, Kimberley.
Photo – David Bettini

Above A resting humpback whale.
Photo – Micheline Jenner

beautiful places with plunging sea cliffs, tropical vegetation and secluded beaches. Most importantly, they are refuges for wildlife, wildflowers and ecological communities, many of which have disappeared from similar areas on the mainland. This is because the islands have mostly been spared from disturbances such as fire and introduced animals such as cattle. Unlike other parts of WA, at present few islands in the Kimberley are conservation reserves. The strategy will protect priority Kimberley islands through reservation and joint management arrangements with traditional owners.

Marine protection

Four new Kimberley marine parks are proposed under the Kimberley Science and Conservation Strategy at Camden Sound, North Kimberley, Roebuck Bay, and Eighty Mile Beach. These new multiple-use marine parks will protect 48 per cent of Kimberley coastal waters, and almost treble the area of marine parks and reserves in WA, from approximately 1.5 million hectares to 4.1 million hectares.

The proposed Camden Sound Marine Park is the biggest calving area for humpback whales in the southern hemisphere and is rich in other marine life, ranging from coral reefs and mangrove forests to turtles and dugongs. Most visitors to the proposed marine park arrive aboard cruise vessels. Passengers take part in activities such as sightseeing, appreciation of Aboriginal cultural sites and fishing. The spectacle of the massive Montgomery Reef emerging from the sea on a falling tide is a significant tourist attraction with the water cascading from the reef top and the abundant range of wildlife that is regularly observed.

The Camden Sound and North Kimberley marine parks will be managed together as the Great Kimberley Marine Park. Great Kimberley Marine Park will extend from Montgomery Reef in the south to Cape Londonderry in the north and will cover more than 17 per cent of WA waters, making it Australia's second largest marine park in coastal waters after the Great Barrier Reef Coast Marine Park.

The proposed Roebuck Bay and Eighty Mile Beach marine parks are two of only a dozen or so areas in the world with huge intertidal flats rich in shorebirds. These amazing areas offer summer refuges to hundreds of thousands of migratory waders, protected under international agreements, that fly from as far away as Siberia. The marine park in Roebuck Bay will be managed jointly with the Yawuru traditional owners.

The state government has already released indicative management plans for Camden Sound and Eighty Mile Beach marine parks. It has provided new funding of $15.2 million over four years with ongoing funding of $3.7 million each year for management and compliance activities in both marine

parks. This is in addition to new funding of $1.1 million over four years for a Kimberley marine education program for recreational fishers and charter operators.

Extending visitor experiences

The national parks and reserves of the Kimberley collectively attract about 300,000 visits each year. People visit the Kimberley to experience what our parks have to offer, and depart with memories of wild and spectacular places that are found nowhere else in the world. As well as protecting natural landscapes, wildlife, heritage, Aboriginal rock art and other sites of cultural significance, Kimberley parks also support a valuable and expanding nature-based tourism industry.

Thus, an important objective of the strategy is to increase the range and amenity of ecotourism experiences across the Kimberley. The government is providing new funding of $9.6 million over four years for tourism initiatives in the Kimberley including development and promotion of new tourism corridors and assistance for Aboriginal communities to identify and develop nature- and culture-based tourism services. The first new tourism corridor—Gibb River Road to Kalumburu—has already been identified and will be developed in conjunction with traditional owners and other stakeholders, including pastoralists and tourism operators.

Mitchell River National Park, King Leopold Ranges Conservation Park, Purnululu National Park and Windjana Gorge National Park will all benefit from improved camping, picnic, interpretive and other facilities. Site improvements have already been completed at Geikie Gorge National Park, with support from the Bunuba people, and at Tunnel Creek National Park.

Works to protect the highly visited Mermaid Boab Tree in Prince Regent River National Park, through the construction of a boardwalk, have also been completed with assistance from the Uunguu rangers. The boab tree at Careening Bay is inscribed with the words 'HMC MERMAID 1820' and is an important relic of the voyages of Lieutenant Phillip Parker King, the first person to accurately chart the Kimberley coast in the *Mermaid* and the *Bathurst*.

Indigenous management of country

Today, there are 22 Aboriginal language groups across the Kimberley, a reflection of the region's diverse and living Aboriginal culture. Aboriginal people have inhabited the region for up to 60,000 years, and with other Indigenous Australians have the oldest continuing cultures in human history. The region has an exceptionally high Indigenous population, with 47.7 per cent of Kimberley residents being of Aboriginal or Torres Strait Islander descent in 2006, compared to about 3.5 per cent in WA as a whole.

The involvement and employment of Aboriginal people in conservation and land management is central to

Top left Carrying out prescribed burning operations by helicopter.
Photo – Ed Hatherley/DEC

Top New marine reserves at Eighty Mile Beach and Roebuck Bay will give greater protection to migratory waders.

Above Raft Point near Doubtful Bay.
Photos – David Bettini

Left A magpie goose in Parry Lagoons Nature Reserve.
Photo – David Bettini

Below left Cave painting.
Photo – Jiri Lochman

the strategy. The state government has passed the Conservation Legislation Amendment Act 2011 through Parliament to allow for joint management of land between DEC and other parties, including traditional owners, and to expand the range of Aboriginal customary activities that can be undertaken in conservation reserves. Successful joint management programs are already in place in Broome and Kununurra, with the Yawuru and the Mirriuwung-Gajerrong traditional owners respectively employing more than a dozen Aboriginal staff.

The Kimberley Science and Conservation Strategy will also support ranger programs already in place including those managed by the Kimberley Land Council, and provide mentoring, training and career pathways for Aboriginal people. Training was recently provided by DEC for Aboriginal rangers in fire management and introduced animal control. More than 40 rangers attended a feral pig management workshop in Fitzroy Crossing in August, where they received training to increase their capacity to undertake pig control. Having Aboriginal people employed on their own country, assisting in delivering the coordinated management of fire, introduced animals and weeds as part of the landscape-scale conservation initiative, will deliver significant social and environmental outcomes. Rangers will also work with tour operators and visitors to promote positive visitor experiences while protecting Indigenous values.

The strategy will assist Aboriginal communities to identify and develop culture- and nature-based tourism opportunities at key sites, including those along the Kimberley coast visited by cruise ships. Tourism WA and other stakeholders will work together to build the capacity of Aboriginal tourism businesses, and work with Aboriginal coastal communities to establish tourism products to service the cruise tourism market.

Better science for decision-making

While scientists have made substantial inroads in documenting the landscape and biological values of the Kimberley in recent decades, the region remains one of the last great frontiers for science. The central and south-eastern Kimberley, vast tracts of Aboriginal land along the north-west coast and most of the coastal waters remain largely unexplored. Data from the WA Herbarium reveal one in eight plants collected in the wet season are new species for the Kimberley.

Above Mitchell Falls in Mitchell River National Park.
Photo – David Bettini

Right Tourists at Steep Island.
Photo – Alex Steffe/Lochman Transparencies

An important goal of the Kimberley Science and Conservation Strategy is to increase knowledge to support informed decision-making, planning and management. The state government has provided significant new funding of $14.2 million for a major marine science program in the Kimberley, to be coordinated by the Western Australian Marine Science Institution.

The Department of Commerce, in partnership with DEC, the WA Museum and other key government agencies, has already started the development of a Kimberley knowledge portal which will improve access to existing environmental knowledge on the region, including science and research.

The Kimberley Science and Conservation Strategy also provides new funding of $300,000 over three years to The University of Western Australia's Centre for Rock Art Studies to support immensely important rock art research in the Kimberley. The Kimberley has most of the oldest archaeological sites known in the country and the greatest diversity of rock art in the country, a cultural treasure of international significance and scale.

In partnership with scientists from four universities, Indigenous organisations and the Australian Research Council, DEC is taking part in a large-scale archaeological research program in the north-west Kimberley encompassing the Mitchell River and Lawley River national parks. Scientists are working alongside traditional owners to investigate the timing of the earliest human occupation in the region. An extensive excavation program is underway and comprehensive rock art mapping, recording, dating and sampling is in progress. Results of the project will assist DEC, Indigenous bodies and tourism operators to make informed management and conservation decisions concerning the rich and unique cultural heritage of the region.

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This article provides only a brief overview of the Kimberley Science and Conservation Strategy. The full strategy can be downloaded at www.dec.wa.gov.au/kimberleystrategy. In the near future, LANDSCOPE *will feature an article on the landscape-scale conservation initiative.*

endangered

by Kelly Griffiths

Stylidium semaphorum

A member of the trigger plant family, *Stylidium semaphorum* is a small delicate plant 15 to 20 centimetres high. The small lance-shaped leaves, which are two to four millimetres long and 0.7 to 0.9 millimetres wide, are pressed to the stem and hairless. The tip of the leaf has a short, hard and flexible point, and the leaf margin is thin and translucent. The flower spike comprises attractive pink and white flowers, which usually appear between September and October. *Stylidium semaphorum* is distinguished from related species by its sepals which have a short brownish tip.

The species was described by Allen Lowrie and Kevin Kenneally in 1997 from a collection made by Allen in October 1993. The name *semaphorum* is derived from the Greek *sema* (sign) and *phoros* (bearing) and alludes to the signalling method of sending messages by semaphore, whereby a person holding a flag in each hand angles the flags to represent different letters to relay a visual message. *Stylidium semaphorum* exhibits a similar trait. It displays its upper corolla lobes to signal its position in order to attract pollinators. Interestingly, the upper corolla lobes are also positioned in a V-shape which is the semaphore code for 'U' and 'attention'.

The first known collection of the species was made from a nature reserve north of Bindoon by Rica Erickson in October 1966. It is still only known from this one population, which consists of 118 plants on a hill summit in lateritic loam soil. Associated species include *Banksia dallanneyi*, *B. nivea*, *B. sessilis*, *Hakea undulata*, *H. trifurcata*, *Hibbertia hypericoides* and *Stylidium brunonianum*. Volunteers have conducted surveys near Bindoon but recorded no new populations. The species has deciduous leaves which die back to a rhizome during summer, making the plant very hard to find outside its flowering period.

Stylidium semaphorum's ranking of critically endangered places it at severe risk from a single threat. It is threatened by introduced weeds, while inappropriate fire regimes are a minor threat.

Different techniques such as fire and soil disturbance need to be investigated to determine if disturbance will stimulate germination, as is thought to be the case with other *Stylidium* species. However, until the ideal fire frequency for optimal response has been determined, fire should, where possible, be prevented from occurring in the area of the only known population.

The Department of Environment and Conservation's Swan Region Threatened Flora and Communities Recovery Team is overseeing the implementation of an interim recovery plan for the species. Recovery actions include further surveys, monitoring, seed collection, disturbance trials and weed control.

Photos by Jean Hort

People in profile

Story by Karla Forrest
Photographs by Fred and Jean Hort

Herbarium volunteers
Fred and Jean Hort

For long-time Department of Environment and Conservation volunteers Fred and Jean Hort, the most fascinating part of nature lies within the often under-appreciated world of flora.

Fifteen years have passed since retirees Fred and Jean Hort first signed on as volunteers with the then Department of Conservation and Land Management (CALM). During that time they have dedicated themselves to finding, recording and reporting rare and endangered plants and insects throughout the Perth hills and beyond, and can lay claim to a wealth of achievements.

Fred and Jean have supplied countless high-quality plant samples to the Western Australian Herbarium's collection, many of which have been used as type specimens—the all-important original specimen from which the description of a new species is derived. Through this and their other volunteering activities, they have contributed a great deal to our knowledge of the state's flora. The productive duo have discovered many new species of plant, and have found new populations of species once thought rare. More recently, they have extended their interest and enthusiasm to surveying for rare insects such as butterflies. Along the way, they have worked with dozens of like-minded people, including botanists, lepidopterists, entomologists and conservation officers who encourage and support them.

An intense curiosity drives the Horts' dedication to volunteering. Each time Fred and Jean step out the back door of their Swan View home on a field trip, they cannot predict what they will find. This, they say, is what makes their work so exciting. Armed with a camera, GPS, plant press, aerial photographs and notebooks, the pair spend a great deal of time in the bush, seeking out rare flora species to record and collect, or fascinating invertebrates to photograph.

The couple's commitment has seen them recognised as Research Associates of the WA Herbarium, as well as jointly being named Department of Environment and Conservation (DEC) Volunteer of the Year twice, with Fred receiving the award individually on a third occasion. But arguably their most notable honour is having several plant species named after them. *Stylidium hortiorum*, *Darwinia hortiorum* and *Lechenaultia hortii* now bear the Hort name in recognition of their discoverers.

A family affair

Fred Hort grew up in Darlington, at the top of Greenmount Hill in WA, on a property almost surrounded by bushland. Despite living in a large family where there were always chores to be done, Fred and his siblings found time to thoroughly explore the bush around them. A particular interest in wildflowers saw them try to learn the names of various species using whatever books or resources they could get their hands on. They were fascinated by the many native orchids that grew around them and delighted in seeing them each year. Years later, that fascination has not waned.

Previous page
Fred Hort teaching his grandson about nature.

Above Lemon migrant butterfly (*Catopsilia pomona*).

Left *Stylidium hortiorum*, a trigger plant discovered by, and named after, Fred and Jean. A bee-fly (family Bombyliidae) feeds on the flower.

Left A female yellow colour-morph *Diaea* sp. spider (family Thomiside) rests on a *Darwinia hortiorum* flower.

Below Photographing spiders with Farhan Bokhari in Wandoo National Park.

Below left Cinnamon sun orchid.

Jean's love of the natural environment also began early in life. Growing up in Kadina on the Yorke Peninsula in South Australia, Jean attributes her interest in the environment to her grandfather and her mother. "They would point out specific plants and animals during our many bushwalks through the area," she says. "I was a bit of a tomboy. I loved being out and about, exploring and learning about the bush."

In 1972, Jean moved to WA with her family. She met Fred, and in 1974 they married. The couple lived in a number of places around the state, including Yarloop and later Esperance, where Fred worked for the Department of Education as a primary school teacher and principal. Eventually they moved back to Perth and Jean began studying information technology, later becoming a part-time TAFE lecturer. By 1995, Fred had clocked up 35 years working in schools and decided it was time to retire and pursue his interest in orchids. Fred and Jean both signed up as volunteers in CALM's Perth Hills District and obtained the necessary licences to collect rare and endangered flora for research. Trips into the field became a frequent occurrence, with Jean joining Fred as often as she could on her days off and on weekends.

A love of orchids

One of Fred and Jean's first assignments as volunteers was to survey and report on the status of the star sun orchid (*Thelymitra stellata*), which grew in a few scattered populations in the Mundaring area. Yet when they began looking for it, they came across something even more exciting. It was thought to be the much rarer cinnamon sun orchid (*T. dedmaniarum*), a critically endangered plant with a distinct cinnamon perfume. Very little was known about it at the time, so the survey of the star sun orchid was temporarily shelved and the hunt for more cinnamon sun orchids began. Fred and Jean recorded the species in a number of locations in what is now Wandoo National Park.

Left Bronze sun orchid.

Below left Fred and Jean discovered a new population of the pink starbush.

However, its taxonomy had been confused for many years; the species that Fred and Jean had found was later recognised as a related but new species, the bronze sun orchid (*Thelymitra yorkensis*). This prompted a re-examination of the true cinnamon sun orchid, which corrected some previous misconceptions and enabled it to be properly identified and described. Looking back, Fred and Jean believe they first encountered what they now know to be true cinnamon sun orchid back in 1974 near Gidgegannup on a family field trip. "To us it was such a special orchid that we would visit it every year," Fred says.

Fred and Jean say it wasn't until they made the transition from reporting on orchids to many other types of plants that they began to truly realise the extent of WA's remarkably diverse floral life. The fascinating discoveries became more frequent as they expanded their focus. Shortly after becoming volunteers, the pair's efforts were again rewarded with the discovery of a new population of the threatened pink starbush (*Asterolasia grandiflora*), previously known from only a few populations.

Next, they worked on surveying populations of the summer pimelea (*Pimelea rara*), a species that had been presumed extinct until it was rediscovered in 1987. However, it was still considered rare until the Horts conducted a survey in 1997–98, finding many new populations along the Darling Scarp. Following this, DEC threatened flora coordinator Andrew Brown lightheartedly suggested it should be renamed *Pimelea commoner* (see 'People protecting plants', *LANDSCOPE*, Spring 1998). In 2005 came one of Fred and Jean's most remarkable finds—the rediscovery of a subspecies of black-eyed susan

Right Feather horned beetles (*Rhipiceridae* sp.).

Below right Fred's photograph of the underground orchid.

(*Tetratheca spartea*) that had not been seen for 160 years, ever since it was first collected by colonial botanist James Drummond in 1843.

Discovering more than plants

Trips into the field sometimes yielded discoveries not limited to the flora variety, and on some occasions this resulted in a chance for Fred to express his sense of humour. Years ago, when walking in the bush near Wandering, Fred stumbled across an old tin toilet left by loggers. Ironically forgetting it was April Fools' Day, he sent a rather tongue-in-cheek email to CALM conservation coordinator at the time, John Carter: "Can you imagine my surprise and gratitude to find that you had provided a dunny for your volunteer workers? Yes … there it was in the bush west of Metro Road. Despite the fact that it was located two kilometres west of my worksite, your kind thought was what counted. I noticed that the door is missing but don't fret about replacing it, as the view out front is wonderful."

Building and sharing knowledge

Having taught photography as part of her TAFE lecturing role, Jean is perfectly placed to use photography as a way of sharing her work with others. Her high-quality photographic work depicts her passion and skill perhaps better than words could. Jean's collection—which she shares with the world on the photo-sharing website Flickr—is filled with stunning photos of the plants and animals she and Fred encounter in their adventures. Many of these photographs have been used on the WA Herbarium's *FloraBase* website and in online encyclopedias and digital libraries. Fred, too, takes remarkable shots, such as his image of the bizarre underground orchid (*Rhizanthella gardneri*), an endangered species that produces its flowers just below the soil surface. And it is this type of find, and the chance to photograph it, that gives Fred and Jean the greatest satisfaction. Because for some, nature might be best appreciated on a landscape scale, taking in the immense height of the karri forest in the state's south-west, or watching the sunset over Cable Beach. But for Fred and Jean, the best parts are the subtleties: the little things just waiting to be found—like the underground orchid—often overlooked and under-appreciated.

Fred and Jean have long remembered an editorial by former CALM Executive Director Syd Shea that stressed the importance of building knowledge about the environment

with the aim of conserving and protecting it. The idea that we don't know what we need to conserve until we know what we've got is one that really resonated with Fred and Jean, and is reflected in their efforts to record and report on poorly known flora, in order to give it a chance to be conserved. Having started with no formal qualifications or prior study in botany or conservation, Fred and Jean had to work hard to build up their knowledge. Mike Hislop, a WA Herbarium identification botanist who works closely with the Horts, believes this is why they have been so successful. "They have built up their knowledge systemically, giving them a wider understanding of many plant groups, rather than focusing on just one area," he says.

While the Horts' tremendous enthusiasm and energy has been a valuable asset to DEC over the years, it has also benefited Fred and Jean themselves, by enabling them to form strong friendships with like-minded people, and giving them the chance to study amazing rare and endangered plants. Fred and Jean are a testament to the value of volunteers. Adding to the work of conservation agencies and the many other groups which make up the greater environmental community, the Horts' work is part of the all-important task of continually increasing our knowledge about, and so our ability to conserve, the natural environment.

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DEC is always looking for people who want to contribute their time to helping the environment. Opportunities are available in many areas ranging from conservation and science, to education and helping visitors enjoy our national parks and reserves. If you are interested in volunteering please contact DEC's Community Involvement Unit on (08) 9334 0468 or by email (community.involvement@dec.wa.gov.au).

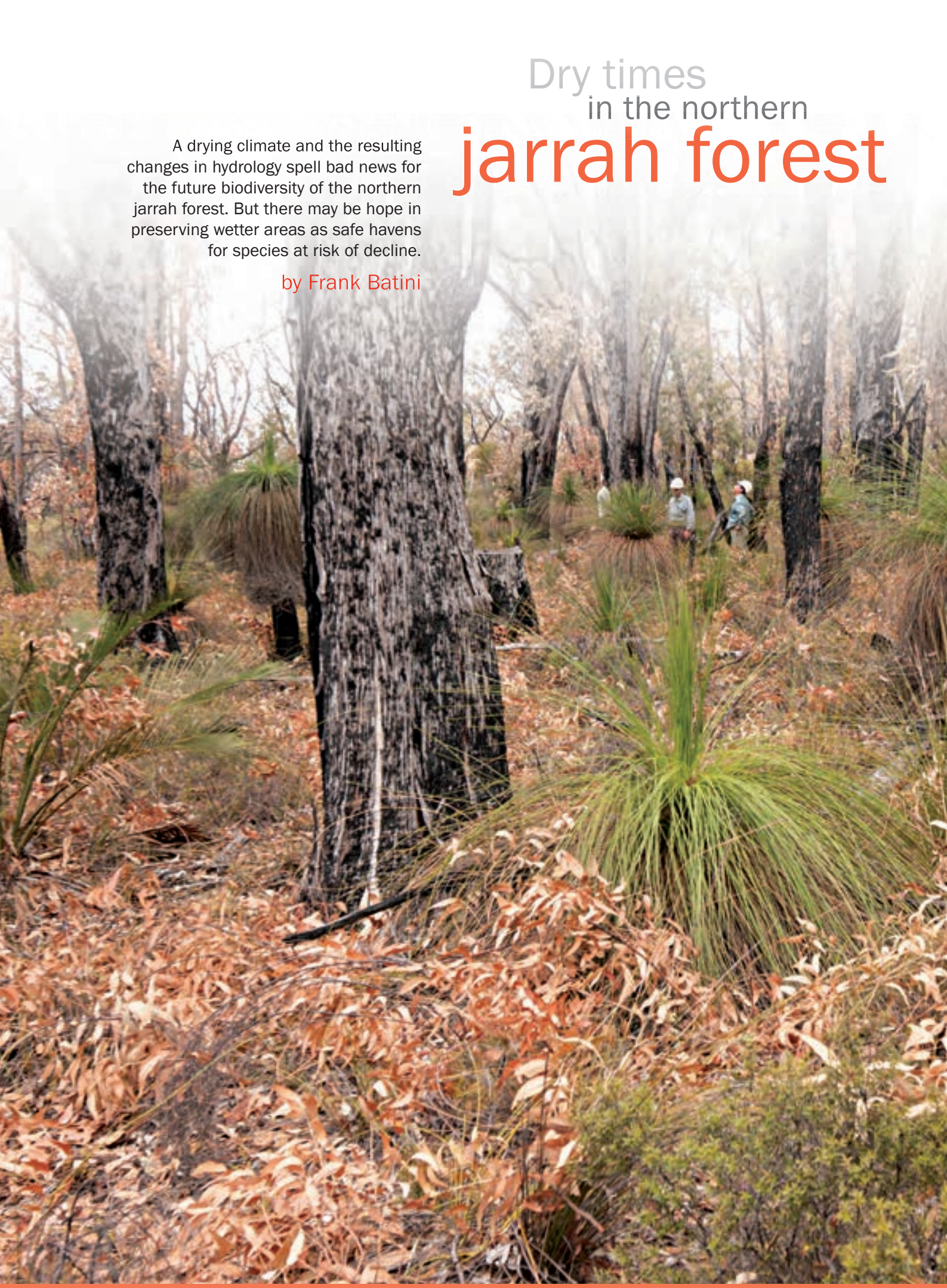
Above A pair of wasp-mimicking mydas flies (*Miltinus maculipennis*).

Right Scarlet leschenaultia (*Lechenaultia laricina*).

Dry times in the northern jarrah forest

A drying climate and the resulting changes in hydrology spell bad news for the future biodiversity of the northern jarrah forest. But there may be hope in preserving wetter areas as safe havens for species at risk of decline.

by Frank Batini



The hydrology of the northern jarrah forest has experienced several changes during the past 30 to 35 years. Rainfall has reduced by about 15 per cent and is forecast to drop further. In addition, watertables have fallen by about half a metre each year; base flow (groundwater which contributes to the water in streams during dry months) has decreased and stream flows have plummeted by up to 50 per cent. In some cases, streams which used to flow year-round are now dry for several months. These changes are due in part to lower rainfall, but also to the continued growth of the forest canopy in areas not recently logged and those that have been rehabilitated after bauxite mining, and to changes in the management of forests.

Water Corporation consultant James Croton has conducted modelling at three catchment areas near Jarrahdale —31 Mile Brook, Chandler and Cobiac—to project similar rainfall patterns from the past decade continuing into the future. The results show that, without any silvicultural intervention, there will be further declines in stream flow, catchment soil storage and groundwater levels in all three catchments. This is likely to lead to groundwater disconnecting from water systems above ground.

31 Mile Brook catchment

31 Mile Brook catchment was gauged between 1985 and 1998 and then again between 2006 and 2010, with an average annual rainfall of about 1,150 millimetres recorded. This catchment has not been greatly disturbed by bauxite mining or large-scale logging for many years and was studied in detail by forester Joe Havel in the early 1970s. Joe collected data on a grid pattern for slope, soils and rock outcrops, and examined the extent of dieback disease, tree density (basal area), indicator tree and understorey species distribution and, most importantly, he produced a vegetation map.

Since 2008, CSIRO researchers have conducted experiments on transpiration, soil moisture, groundwater and soil evaporation within this catchment, on strips that have been thinned, as well as in untreated controls. The Forest Products Commission has recently thinned a small (10 per cent) area in the upper part of the catchment.

This catchment is a very useful experimental area where the predicted impacts of hydrologic change on biodiversity can be evaluated. The modelled results showed that water tables that discharged into streams (base flow) in 1974 were forecast to drop to between four and eight metres below ground level by 2076. Streams that flowed year-round in 1974 flowed for seven months in 2008 and are predicted to flow for only four months in 2076. Essentially, this means that while the streams in this catchment were previously fed by both rainfall and groundwater, they are now fed just by rainwater.

Impacts on biodiversity

Such changes in hydrology are expected to have an impact on the biodiversity in the area. A major reduction in the period of stream flow and the drying of perennial streams will affect aquatic invertebrates that have long life cycles. There will be shifts in species richness, abundance and food chain organisation. These changes and loss of some species are already being recorded by sampling work carried out for the Water Corporation by The University of Western Australia's (UWA's) Andrew Storey. The drying

Previous page
Native forest under stress in the Wungong catchment.

Left A dry water point in 31 Mile Brook.
Photos – Keith Barrett/Water Corporation

Above DEC's Frank Bailey with Curtin University environmental studies students.
Photo – Rima Itani/Water Corporation

Above right Bullich dying around a large dead marri tree in the Chandler catchment.
Photos – Keith Barrett/Water Corporation

Right Recent tree deaths in the Wungong catchment.
Photo – Des Birt/Water Corporation

of streams and of major pools will also undoubtedly affect the survival of some species of fish and crustacean that are dependent on these habitats. However, UWA studies have not yet recorded any changes.

Vegetation is also set to suffer. The current distribution of plant species that grow alongside streams—known as riparian vegetation—has developed under conditions where the near-surface groundwater was actively discharging into the stream, increasing streamflow and maintaining it well into the drier summer months. Once the groundwaters become disconnected, the lack of water is likely to lead to a reduction in the range and number of plants as well as localised species extinctions.

The riparian species most likely to be affected—blackbutt (*Eucalyptus patens*), bullich (*E. megacarpa*), flooded gum (*E. rudis*), river banksia (*Banksia littoralis*) and paperbark (*Melaleuca preissiana*)—already have a very restricted range within the northern jarrah forest. The most likely impact on understorey species will be on the very dense willow myrtle (*Taxandria linearifolia*) and *Astartea scoparia* swamps and wetlands that follow the creek lines.

Additionally, dry vegetation which provides fuel for fires will now be drier for longer and is more likely to burn more frequently and hotter. These fires will lead to the landscape being more open. A reduction in the extent and density of riparian vegetation will affect the vertebrate species that depend on these riparian habitats and will make some species more vulnerable to predation by cats (*Felis catus*) and foxes (*Vulpes vulpes*).

The current distribution of vegetation on slopes and uplands is determined by underlying factors such as landforms, soils, climatic conditions and soil moisture availability. With lower rainfall there will be a shift towards species which are drought tolerant. Forests (which have dominated the higher rainfall areas) could be replaced by more open woodland. Deaths of jarrah (*Eucalyptus marginata*), marri (*Corymbia calophylla*) and associated species were obvious in summer 2007 and 2011, following dry winters in 2006 and 2010, especially on shallower soils.

Fauna under pressure

Western Australian Museum curator of ornithology Ron Johnstone has been monitoring bird populations in the forest within the Wungong catchment and has observed dynamic negative changes in status and abundance in

Above Red-eared firetail finch.

Above left Glauert's froglet (*Crinia glauerti*).

Below left Quenda.
Photos – Jiri Lochman

recent years. The species most likely to be affected are those that require dense riparian vegetation, such as the red-eared firetail finch (*Emblema oculata*), white-breasted robin (*Eopsaltria georgiana*) and golden whistler (*Pachycephala pectoralis fuliginosa*). In addition, most seed-eating birds that require access to water, such as the forest red-tailed black cockatoo (*Calyptorhynchus banksii naso*) and brush bronzewing (*Phaps elegans*), will also be adversely affected.

A number of mammals also require the shelter of dense riparian vegetation, particularly as protection from predation. These include the mainland quokka (*Setonix brachyurus*) and the quenda (*Isoodon obesulus*). The water rat, or rakali (*Hydromys chrysogaster*), would also suffer from drier streams.

Many amphibians rely on standing water and moist soil to complete their life cycle. Reduction in the extent of riparian vegetation and reduced stream flow are very likely to disadvantage most frog species.

Possible havens

In all, some 25 to 30 species that occupy riparian and upland sites within the northern jarrah forest will be at risk from the hydrologic changes that have been observed and those that are predicted. Adverse effects have already been seen on the more sensitive species, such as some aquatic invertebrates, some bird species and trees growing on upland shallower soils.

But all is not lost. The maps of vegetation prepared by ecological consultant Libby Mattiske and forester Joe Havel define areas that may become refuges for certain species as the climate becomes drier. These include valley complexes known as 'Helena', areas characterised by shallow soils associated with granite on steep slopes of valleys in the high rainfall zone. However, in many cases these areas now occur below sites that have been dammed for water supply and where the natural water regime has been disrupted. The major valley as yet without a dam is that of the Murray River. The valley of the Gooralong Brook below Jarrahdale is another example, as is the Serpentine River below the pipehead dam.

Valley complexes known as 'Murray'—found on the more fertile valley floors and slopes in the higher rainfall zone—may also act as future safe havens for some species. However, many of the better sites have been flooded by dam construction and now remain as narrow remnants on either side of the reservoir.

Above Bullich Swamp, Chandler catchment.

Right Healthy crowns in thinned native forest near Jarrahdale Road.
Photos – Keith Barrett/Water Corporation

Species retreating from drier areas may also survive in valley complexes known as 'Lowdon', which occur in the lower Collie, Brunswick, Harvey and Ferguson valleys and comprise of marri, jarrah and peppermint (*Agonis flexuosa*) forest with some wandoo (*Eucalyptus wandoo*) on slopes and flooded gum (*E. rudis*) and paperbark on valley floors in the higher rainfall zone. Some such valley complexes are located below existing dams and other parts are mostly in private property. Swamp complexes—which occur on seasonally moist or wet sand, peat or clay soils in valley floors, especially in the higher rainfall zone—will also become safe havens for some species. These are typical habitats for bullich, river banksia and paperbark and are well represented in parts of the Wungong, North Dandalup, Little Dandalup, Waroona, Sampson and Stirling Dam (Harvey River) catchments.

Management benefits

Saving biodiversity from the forecast hydrological changes will mean identifying suitable safe havens for plants and animals and actively managing them to enhance their value as refugia (also see 'Just add water: the Toolibin Lake inundation experiment' on page 26). Management actions that could be considered include silviculture and regular prescribed burning. These can potentially reduce competition and increase the availability of water and nutrients to a forest ecosystem which is already under stress. Regular prescribed burning will also minimise the damaging effects of large-scale bushfires on fauna, erosion and nutrient loss. Riparian areas will require additional protection by baiting to reduce fox and cat predation. Near-stream areas will also need to be protected from weed invasion as well as any artificial spread of the *Phytophthora* fungus. Selected areas in the high rainfall zone (which receive above 1,100 millimetres a year) could be actively managed to maintain or improve soil moisture, watertables and to increase run-off into streams. This includes native forest, pine plantations and areas subject to rehabilitation after mining. With such safeguards, the plants and animals of the northern jarrah forest may survive in the face of an increasingly drying climate.

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Five-star dining for *Carnaby's*

'Weloo weloo weloo' rings out in chorus—Carnaby's cockatoos have returned to the coast once more, seeking their preferred food. These distinctive birds were once abundant throughout the south-west but their population is now in decline, pressured by a loss of feeding and breeding habitat. It is hoped that an investigation into food resource availability will enable systematic conservation planning for this threatened species.

by Teagan Johnston

Well known for being spectacular and loud, Carnaby's cockatoo (*Calyptorhynchus latirostris*) is among the most recognised bird species in Western Australia. Ranging from the Murchison to Esperance, the endemic Carnaby's cockatoo occurs in areas receiving more than 300 millimetres of rainfall annually. During the 'holiday' (non-breeding) season these gregarious birds, like many Western Australians, head to the coast. The non-breeding season occurs from January to July, during which time Carnaby's cockatoos aggregate in large flocks in search of food. For many of the birds which breed in the northern wheatbelt, the higher rainfall Swan Coastal Plain is their preferred holiday destination.

Carnaby's cockatoos are visible in much of Perth's metropolitan landscape. However, WA's pattern of urban development and agricultural activity on the Swan Coastal Plain has historically contributed to a substantial loss of habitat and a decline in numbers (see 'Carnaby's black-cockatoo', *LANDSCOPE*, Winter 2009). As a consequence, Carnaby's cockatoo has to work harder to find suitable 'restaurants' on the Swan Coastal Plain due to continued reduction in food resource availability.

Threat to survival

During the past 60 years, a population decline in Carnaby's cockatoos associated with the loss of breeding and feeding habitat has been observed. As a result, this once-abundant species is now listed as threatened under both state and federal legislation.

Birds Australia carried out two surveys—between March and August 2010 and between March and August 2011—using specific night-time Carnaby's roosts. These were each referred to as 'The Great Cocky Count'. These surveys have estimated the non-breeding greater Perth region population to be 3,100 to 5,100 using the night roosts that were surveyed.

Feeding locations

On the Swan Coastal Plain, Carnaby's cockatoos dine primarily in proteaceous woodland, kwongan heath and commercial pine plantations. Seeds from genera including *Banksia*, *Eucalyptus*, *Corymbia*, *Grevillea*, *Hakea* and *Pinus* constitute more than two-thirds of the birds' diet. In particular, proteaceous species (*Banksia*, *Grevillea* and *Hakea*) are highly sought after, making banksia woodlands a preferred feeding location.

Around 60 per cent of remnant vegetation on the Swan Coastal Plain has already been removed from the landscape for urban development and farming. Therefore, quality and abundance of food resources across the Swan Coastal Plain are likely to be major factors in the sustainability of the Carnaby's cockatoo population. With Perth's human population predicted to triple in the next 50 years, strategic and informed land-use planning is critical for the survival of the species.

Action needed

Conservation and management of threatened plants and animals is rarely easy. Carnaby's cockatoos pose a dynamic and multifaceted challenge to land managers, due to their movement throughout the landscape and reliance on a variety of habitats for breeding, feeding and roosting. To conserve the Carnaby's cockatoo, informed

Previous page
Carnaby's cockatoo eying off acorn banksia.
Photo – David Bettini

Above Carnaby's cockatoo feeding on slender banksia seed.
Photo – Rick Dawson/DEC

Left Firewood banksia is one of the species which makes up the Carnaby's diet.
Photo – Sallyanne Cousans

Above Banksia woodland.
Photo – Jiri Lochman

decisions about where development should occur in the future need to be made in relation to the importance of known and potential habitat. Finding an acceptable balance between human needs and the birds' requirements will be needed to ensure Carnaby's cockatoos are around for generations to come. Understanding the availability of food resources and determining whether those resources can support the current and future cockatoo population is important to successfully manage the species.

With funding assistance from the environmental offsets package associated with the construction of the Fiona Stanley Hospital, the Department of Environment and Conservation (DEC) has begun a research project to investigate where Carnaby's cockatoos like to dine on the Swan Coastal Plain and what banksia delicacies they most enjoy feeding on.

Filling the information gap

DEC plans to identify what food the Carnaby's cockatoo prefers to eat, in order to provide a food critique of Carnaby's eating patterns. But rather than finding the birds and determining what they like through observation, DEC staff and volunteers have been venturing out into banksia woodlands to hunt for banksia cones and other food leftovers, referred to as 'feeding traces'. At 21 sites, 84 randomly stratified feeding locations (quadrats) have been established in banksia woodlands across the Swan Coastal Plain, from Yanchep to Waroona.

Carnaby's cockatoo feeding traces include eaten and manipulated fruits and cones, flower spikes, bark and green twigs. Feeding traces vary for each plant: some show distinctive signs of Carnaby's presence while the indicators on others are less obvious. As is the case in any good detective work, evidence or signs are the key to finding out where the birds have been and on what they have been feeding. Slender banksia (*Banksia attenuata*), firewood banksia (*B. menziesii*), acorn banksia (*B. prionotes*) and parrot bush (*B. sessilis*) are prime suspects and have been targeted in this research. Surveys aim to identify the proportion of the year each area is being used and the change in food type (for example cone or flower) and species used throughout the year.

Health inspection

As part of the project, threats to the plant species will be examined to determine how they influence the availability of food resources. In particular, fire and dieback disease (caused by *Phytophthora cinnamomi*) have been singled out for further investigation as they are major threats to biodiversity on the Swan Coastal Plain, especially in banksia woodlands.

WA's vegetation has evolved to persist with fire. However, banksia species have developed different methods of coping with fire which affect flower and seed productivity and therefore dining potential for Carnaby's cockatoos. Some banksias resprout after fire—such as the slender banksia—whereas other species, such as parrot bush, reseed. Resprouters can produce flowers within as little

Left Carnaby's cockatoos feeding.

Below left Holly-leaved banksia (*Banksia ilicifolia*).
Photos – Teagan Johnston/DEC

as 12 months but reseeders require more time before seed is available, taking up to seven years in some cases. Consequently, after fire, Carnaby's cockatoos are forced to feed in other areas while the vegetation recovers. Of concern, Carnaby's cockatoo habitat is constantly under pressure from the threat of arson and other causes of bushfire. Increased frequency of fire is a major problem in banksia woodlands as areas may not have enough time between fires to fully recover.

Dieback disease is a threat to native plants. However, unlike fire, this soil-borne pathogen causes irreversible damage to native plant communities, altering their diversity, productivity and ecological processes. Unfortunately, proteaceous species, which include banksias, are highly susceptible. Defenceless against the disease, infested banksias eventually succumb. Despite the presence of dieback disease in many banksia woodlands, the disease is often patchy with islands of vegetation persisting. Although less desirable, as food availability is reduced, these areas still appear to be important in providing a dining opportunity for Carnaby's cockatoos, albeit at only half a star rating. The potential implications of increased fire frequency and dieback disease on food resource availability for Carnaby's cockatoos are significant.

This research project aims to determine the abundance and density of food resources for Carnaby's cockatoo in a variety of banksia woodlands on the Swan Coastal Plain. Understanding the influence of fire, disease and soil type on food availability is needed for the future conservation management of Carnaby's cockatoo habitat. Hence, each dining location (quadrat) has been assessed to determine the time since the last fire, the presence or absence of dieback disease, soil type and biodiversity characteristics to examine how they effect the availability of banksia cones.

Mysteries unravelling

The research is already revealing that Carnaby's cockatoos have preferences for different food resources at different times of the year and at different sites. Selection appears to be based on the availability and type of food and the size and location of remnant vegetation. Some sites are visited frequently, whereas others appear untouched. A site not being used doesn't necessarily mean it is not important—rather it may be too far from the nearest roost site, may lack vegetation linkages in the landscape or may be yet to be explored, as Carnaby's cockatoos appear to be habitual in nature. Unlocking these mysteries will help conserve and protect both known and potential habitat for the Carnaby's cockatoo.

Outcomes

In an attempt to assess relative habitat importance, survey data collected on banksia productivity, distribution and disturbance factors will be used to develop a comprehensive but concise rapid-assessment protocol to guide surveys of bushland areas for determining those that

Above Carnaby's resting.
Photo – Rick Dawson/DEC

Right A volunteer taking plant measurements.

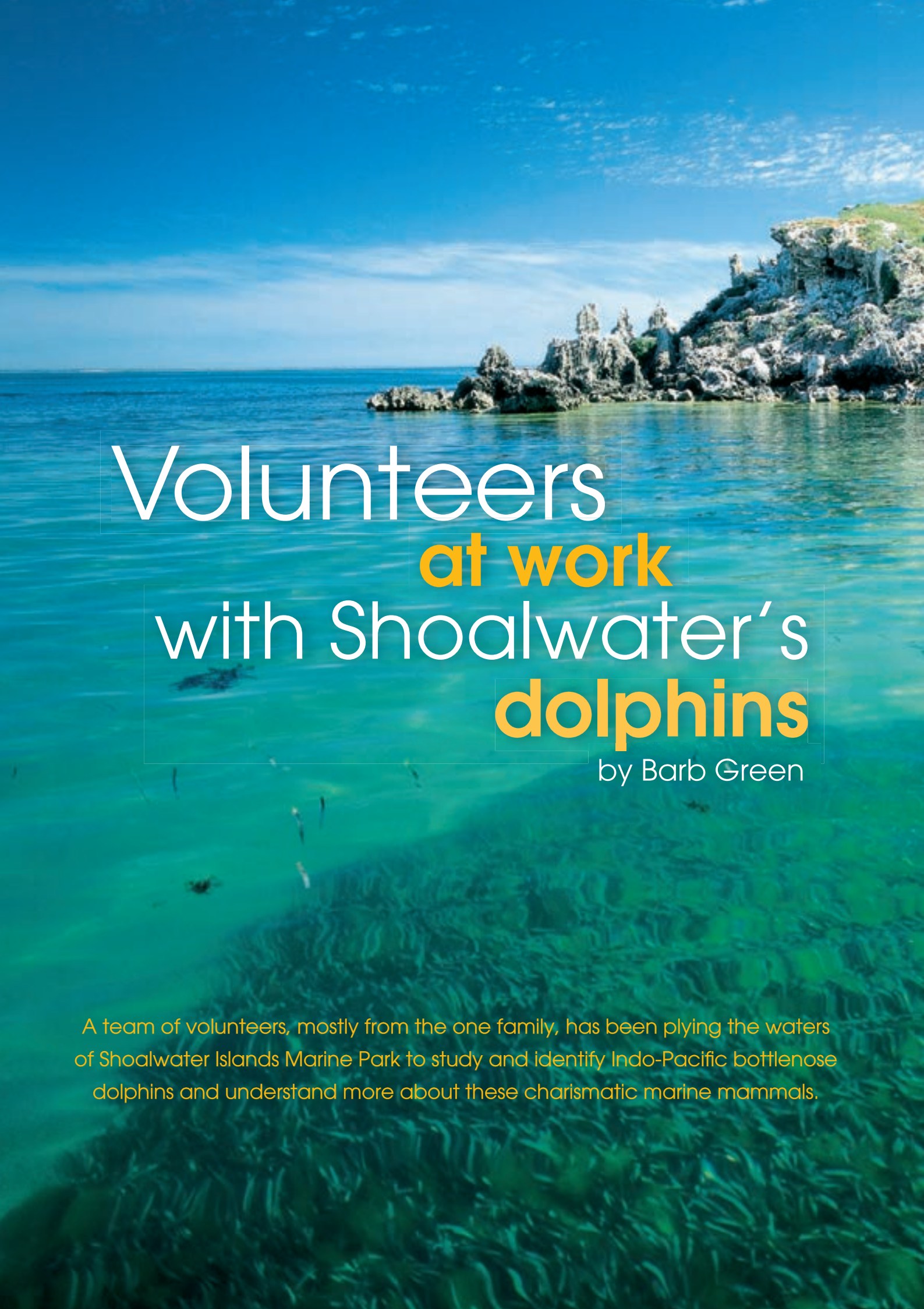
Below right Parrot bush.
Photos – Teagan Johnston/DEC

warrant priority management to benefit Carnaby's cockatoo. Outcomes will include evaluating proposed conservation areas, or identifying prospective areas for addition to the national reserve system and development offsets for Carnaby's cockatoo.

Bushland that is aesthetically pleasing to us is often different to what the birds prefer. For example, weed-infested sites which may appear unhealthy are in some cases proving to be prized feeding locations for Carnaby's cockatoos—but may require management intervention to maintain them into the future. By creating a rapid-assessment protocol based on research findings, assessments will become standardised and aligned to the tastes of Carnaby's cockatoo.

This research will provide a greater understanding of available food resources for the Carnaby's cockatoo, identify the limitations and influence of threatening processes, and develop a method to prioritise remnant vegetation on the Swan Coastal Plain. Information generated from the research aims to guide and support land managers by providing a systematic approach to conservation planning for the Carnaby's cockatoo in this area. In addition, it will provide guidance for environmental consultants and environmental protection agencies when carrying out environmental impact assessments or assessing future development proposals. Systematic conservation planning will ensure the Carnaby's cockatoo can continue to enjoy its sojourns on the Swan Coastal Plain for years to come while dining at five-star banksia restaurants.

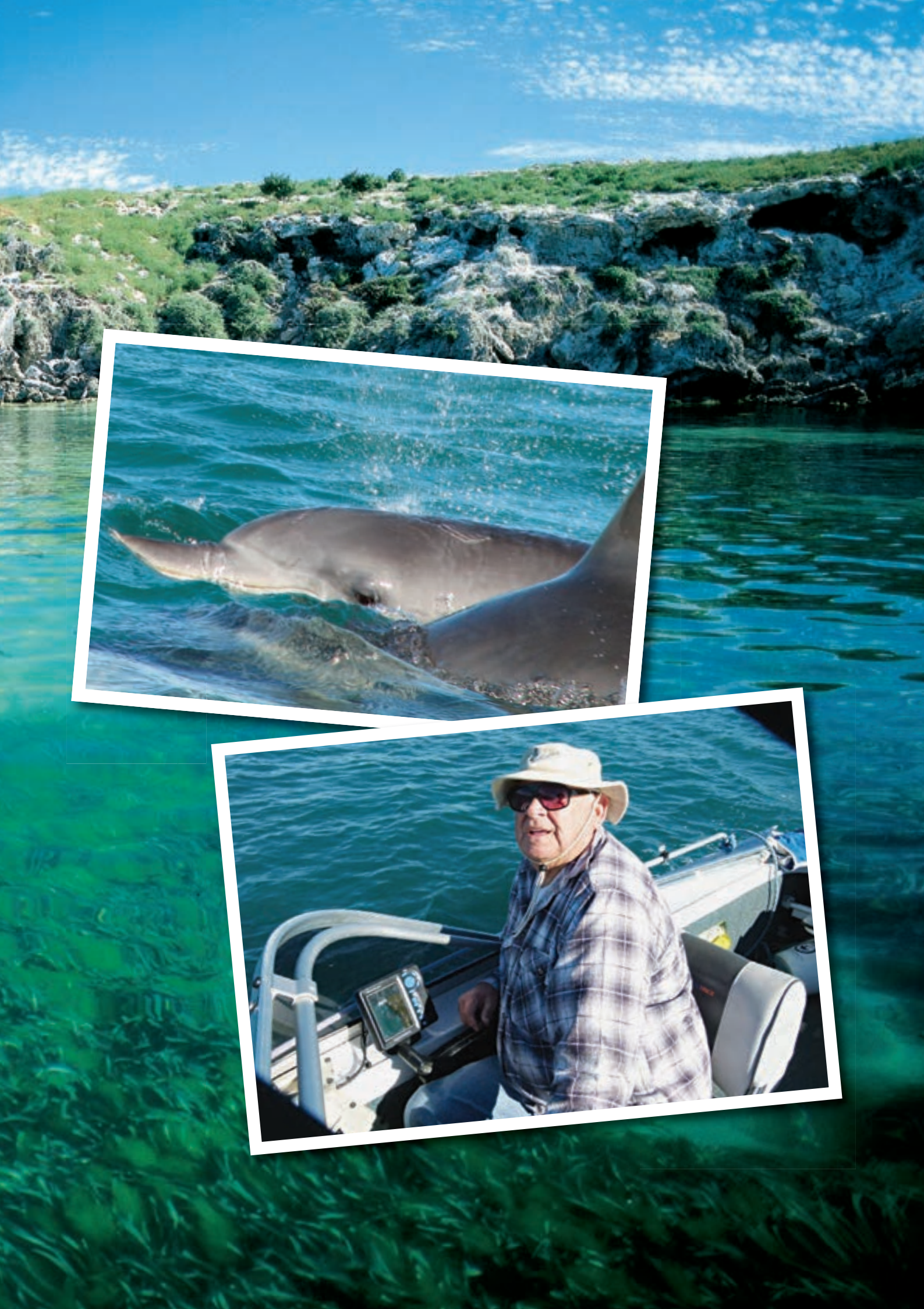
Teagan Johnston is a project officer with the Department of Environment and Conservation's Species and Communities Branch at Kensington and a Masters Candidate at Edith Cowan University. She can be contacted on (08) 9334 0196 or by email (teagan.johnston@dec.wa.gov.au).



Volunteers at work with Shoalwater's dolphins

by Barb Green

A team of volunteers, mostly from the one family, has been plying the waters of Shoalwater Islands Marine Park to study and identify Indo-Pacific bottlenose dolphins and understand more about these charismatic marine mammals.



Searching for dolphins in a small open boat during the coldest months of the year, sometimes in difficult sea conditions, may not be everyone's cup of tea, but it has become a regular undertaking for a small group of volunteers in Shoalwater Islands Marine Park off the coast of Rockingham, south of Perth.

The group regularly ventures out onto the waters of the marine park in an effort to gain an understanding of the ecological requirements of Indo-Pacific bottlenose dolphins (*Tursiops aduncus*). The volunteers, who are all family members, include keen wildlife photographer Peter Machen, grandfather Ron Green and 24-year-old Tom Mickle, who hasn't let blindness stop him from enjoying a keen love of fishing and the ocean.

This community-initiated and self-funded research effort started in November 2009 and is the first study of dolphins in Shoalwater Islands Marine Park since the park was established 21 years ago. The effort has resulted in identifying at least 85 individual dolphins that use the area. A photographic identification catalogue of these animals has been compiled along with additional data collected during surveys, which will enable an analysis of dolphin use of the marine park and help to ensure increasing commercial and recreational activities do not affect dolphins directly, or the areas that may be critical for their long-term survival.

Distinguishing dolphins

Using a technique similar to that used in studies in the waters of other areas such as Cockburn Sound, the Swan River and Bunbury, members of the research group take and use photographs to identify individual dolphins.Each dolphin identified is given a number and a name and added to a photographic identification catalogue. The choice of a name is often based on a distinguishing mark, or an observed behaviour. One female dolphin is named 'Kite' because it has a small flap of tissue sticking out of its dorsal fin from a previous injury. Another female is 'Mum' because it was always seen with its two-to-three-year-old calf. Another is 'Chalkie' because the white markings on the base of its dorsal fin resembles chalk dust.

Dolphins regularly rake (scrape) each other with their sharp teeth when mating and socialising, leaving marks and minor injuries that can scar. These, together with injuries and scars they get from interactions with fishing gear or vessels or from predators such as sharks, help to distinguish one from another.

Photographic models

Photographic identification of individuals relies on the collection of quality images. An ideal photograph shows the dolphin's dorsal fin outline and other markings clearly and is taken in profile to the camera lens. However, as dolphins spend most of their time underwater and are always on the move, getting a good photograph from a bobbing boat can be tricky.

Researchers make every attempt to photograph all dolphins seen during an encounter. But this is not always possible because of challenging sea conditions, because the water becomes too shallow to follow them (such as at reefs and sand bars) or because dolphins are evasive or are moving too quickly.

Previous page
Main Shoalwater Islands Marine Park. *Photo – Michael James/DEC*
Inset top Indo-Pacific bottlenose dolphins.
Inset bottom Volunteer Ron Green searching for dolphins.

Above left 'Hack', one of the dolphins in the photographic identification catalogue, sustained injuries from a great white shark.

Left 'Chalkie' was named because of the white specks beneath its dorsal fin.
Photos – Barb Green

Above A pod of Indo-Pacific dolphins. *Photo – Alex Steffe/Lochman Transparencies*

Below Shoalwater Islands Marine Park. *Photo – Jiri Lochman*

Young adults and calves are generally not included in the identification catalogue as they don't always have distinguishing markings and can't easily be re-identified. It is likely these 'missed' identifications will be added to the catalogue as the individual ages, and acquires more marks or scars.

Battle scars

Analysis of the photographic identification catalogue for the marine park shows that 14 of the 85 identified dolphins have some form of injury not likely to have been caused by another dolphin. Ten of these dolphins, most of which are females, have markings consistent with shark bites. Dolphins typically heal quickly when injured and their recovery from bites that cut deep into their body can be remarkable. One pregnant dolphin, named 'Hack', was badly bitten around the dorsal fin and upper body by a great white shark in September 2010. Incredibly, Hack recovered after spending a short time swimming around the marine park alone, and gave birth to a healthy calf in January this year. Hack is now regularly seen in a nursery group of mothers, aunties and calves, and appears to be doing well.

A male dolphin, 'Abicus', is thought to have had the tip of its dorsal fin cut off by a boat propeller because of its propensity to beg boat fishers for their catch. Abicus is estimated to be about 30 years old and one of the oldest dolphins in the marine park. It has a wily character and often hovers by boats blowing bubbles and holding its head above water. The placement of educational signage at boat ramps around the marine park asking people not to feed dolphins will hopefully lead to Abicus becoming used to catching its own fish rather than begging. This will decrease the risk of it being injured further and will reduce the risk of it teaching other dolphins the same behaviour.

Homebodies

Recently, the identification photographs of 100 dolphins known from Cockburn Sound were compared with the 85 dolphins of Shoalwater Islands Marine Park. Interestingly, Abicus was the only individual known to both areas, which are only three kilometres apart.

The lack of movement of the dolphins between Cockburn Sound and Shoalwater Islands Marine Park may indicate that Indo-Pacific bottlenose dolphins hold a strong affinity for certain coastal areas and there may be discrete populations of this species along the Perth coast. If this proved to be the case, the finding would have important ramifications for the conservation of the species in their preferred habitats. An examination of this issue in coastal waters extending from Cockburn Sound northward to Marmion Marine Park has recently been initiated by Murdoch University's Cetacean Research Unit. Complementary to this, volunteers in Shoalwater Islands Marine Park will extend their surveys southward to include Comet Bay and the Mandurah estuary system as opportunity, weather and sea conditions permit.

Barb Green led the group of volunteers and works as a senior marine conservation officer with the Department of Environment and Conservation. She can be contacted on (08) 9219 8641 or by email (barb.green@dec.wa.gov.au).

urban antics by John Hunter

Acacia

This last antic celebrating the 'International Year of Forests' is about a plant genus which is both species rich and prolific in our country ... far exceeding the great eucalypts in abundance, while also being our national floral emblem.

Acacia, from the Fabaceae (legume or pea) family, are found virtually everywhere throughout the state and indeed across the whole country. They also inhabit, naturally, the tropical to arid warmer terrestrial parts of the world. However, what is significant, is that of the about 1,500 species in the world, some 1,000 are found in Australia, with well over half that located in Western Australia.

Not your generally accepted 'forest'—where wall-to-wall tree trunks and closed canopies of leaf and branch dominate—wattles are an understorey family found as single prostrate plants, groups of trees, sporadic woodlands, dense shrubs in vast carpets of loosely mixed vegetation and ... tall individual trees.

Within Australia, acacia are called wattles, the name dating from Anglo-Saxon times and signifying the activity of 'wattling' where twigs, saplings or flexible rods were interwoven to build frameworks for dwellings. In Australia during early settlement, this was done with wattles; thus the common name for the genus arose.

To me, wattles are the enigma of the plant world. Not only are they prolific in number and diversity, but there are many varieties within their own species. In fact, it is inevitable that in time, new species will be described by further research and exploration of those areas and types already known. To fully describe the genus, its species, its idiosyncrasies and natural history on one page is virtually impossible.

For me, walking to school in spring was a time which pleasantly assaulted one's senses, particularly at a time of youthful sensitivity and learning. The noise of birdlife was frenetic, dull bushland gave birth to multicoloured rashes of colour, and pollens from ripening winter grasses irritated the membrane of many an urban 'nosey parker'. This 'excitement' always heralded the golden wattles that burst into cascading racemes of cylinders and pompoms. This was, and still is, a time that no clock can ever tell.

The most prevalent of the urban wattles was prickly moses (*Acacia pulchella*). This normally scraggly shrub of no fixed address loiters randomly across the Swan Coastal Plain and through our suburbs. In spring it sports wonderful globules of inflorescence among its inconspicuous leaves. Occasionally, unwary bushwalkers have been easily mesmerised and caught in its dense spiny thickets and heard to exclaim, 'watch out for the bloody prickle bushes!' Meanwhile, attendant ants busy themselves for the coming harvest of seeds while many-coloured Christmas spiders prepare to weave magic between the thorns.

Then there is the coojong or golden-wreath wattle (*A. saligna*), now common along the freeway or evident as invading seedlings on many a construction site. In times past, exploring children sought solace and protection among the large, dark blue-green leaves (called phyllodes in this species) and weeping habit of this medium-size tree, particularly near wetland areas where it originally occurred in large numbers. This beautiful tree supports burrowing jewel beetles within its stems, geckoes, butterflies and nesting birds among its branches and insects within strange rust-fungus galls among its foliage.

There is so much more to the story of wattle ... the rest can be found on the website 'World Wide Wattle'... check it out, it will be worth it.

DID YOU KNOW?

- Dallwalinu is the centre of the greatest concentration of wattle species in the world.
- Mulga is the Aboriginal word given to vast tracts of wattle vegetation in the north eastern wheatbelt of WA.
- Some fascinating common names for the wattle include brigalow, myall, jam, bowgada, gundabluey, gidgee, kurara, old man wodjill and Cootamundra wattle.

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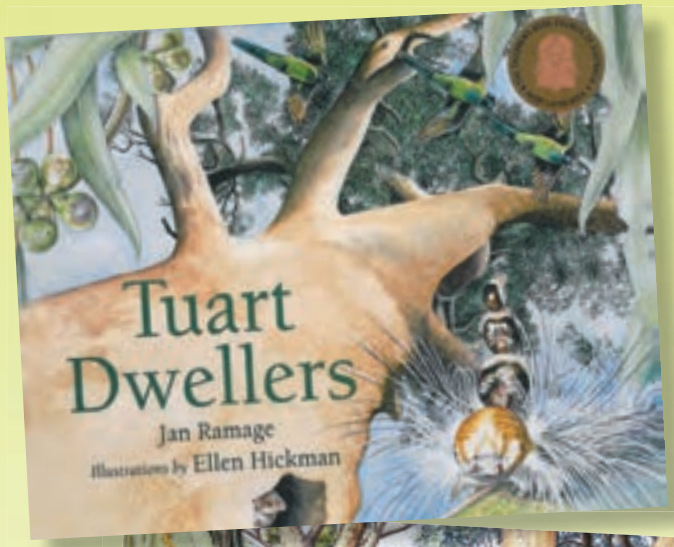

Tuart Dwellers

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