WA's conservation, parks and wildlife magazine

LANDSCOPE

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The jewel in the crown:
Perup and the Upper Warren

Parry Lagoons and
Ord River nature reserves

New national park to be cat free

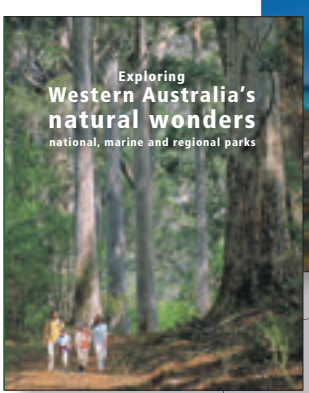
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Roger Underwood


Shaun Wilson

contributors

Roger Underwood worked for 34 years for the Department of Environment and Conservation (DEC) predecessors, the Forests Department and the Department of Conservation and Land Management in Western Australia. He has a passionate interest in the history of land management and conservation, and in bushfire science and management, and has published a number of books and articles on these subjects. He has also spent 20 years developing an arboretum of WA's arid land eucalypts and acacias on his property at Gwambygine.

editor's letter

Over the New Year we saw out the UN International Year of Biodiversity, and welcomed the International Year of Forests—with the theme 'Celebrating forests for people'—which *LANDSCOPE* is recognising with at least one forest-themed article planned for each issue of 2011. This issue commemorates the 50th anniversary of the bushfires that devastated the south-west forest communities of Dwellingup and Crowea, drawing on a new book by Roger Underwood, *Tempered by Fire—stories from the firefighters and survivors of the 1961 Western Australian bushfires* ('The great teaching event', page 23). We also focus on the highly significant protected forest areas of Perup and the Upper Warren, whose near-intact suite of mammals includes many threatened species that are disappearing from other Australian habitat ('The jewel in the crown', page 12).

Meanwhile, in a typically thought-provoking edition of 'urban antics' (page 62), John Hunter challenges readers' ideas about what the word 'forest' might mean for town-dwelling Western Australians, with a nostalgic snapshot of mangroves in Bunbury. Yes, mangroves. Yes, Bunbury. Does this rare temperate-zone population of *Avicennia marina* count as a forest? Strictly speaking, no. But it comes very close. Forests are generally described as having an overstorey over two metres in height and greater than 50 per cent crown cover, although you can pick your classification system. The mangroves at Bunbury fall a bit short of this measure. But in the tropics, mangroves grow taller—reaching well over two metres in height—and denser. So it is that the state's forests, normally thought of as a feature exclusive to the south-west, can be understood to occur in large areas of the intertidal zone of the Kimberley coastline.

Still, John's fond memories of quaffing copious quantities of ale at Koombana Bay notwithstanding, few people would describe any mangrove forest as a prime picnic destination. No one who has fought their way through these smelly humid obstacle courses, whipped by scratchy branches, tripping over muddy tangles of roots and stirring up swarms of sandflies, pausing frequently to wipe sweat from their eyes and swat at mosquitoes, would describe these areas as hospitable to human beings, much less something to be celebrated. But in the larger scheme of things, they are a coastal ecology's equivalent of luxury resorts, providing prime habitat to fish and other estuarine life, and accommodating a wide range of birds and mammals. Like any forest, healthy mangroves are vital to supporting the delicate balance that is life on Earth.

The point in all this is to take a different tack in counting the value of forests. The traditional idea of a forest—a shady stand of tall trees and plants, supporting lots of terrestrial wildlife and providing timber resources as well as a pleasant place to recreate—should be no more challenged by notions of mosquito-ridden coastal swamps than it is by the memory of a horrific destructive bushfire. These places are no less awesome for being hostile or dangerous, and indeed are perhaps more so, driven by forces outside human will or control. The theme of 'Celebrating forests for people' is about appreciating any forest as a mysterious, complex system that sustains life itself—affirming us as part of something bigger.



Madeleine Clews
Executive Editor



Shaun Wilson is a senior research scientist with DEC's Marine Science Program. He has been with DEC since 2008, where he oversees research in the state's tropical marine parks. Shaun previously worked at James Cook and Newcastle (UK) universities, examining the effects of climate change on coral reef fish. His research at DEC builds on this knowledge, examining how coral reef communities are affected by the interaction between fishing and habitat changes.

Corrin Everitt has been DEC's state Cane Toad Initiative program leader since 2008, based in Kununurra. Corrin has been in the region for seven years and worked in a number of different organisations before her employment with DEC, including an environmental consultancy, Indigenous organisations and on cattle stations. She has been instrumental in delivering many new Cane Toad Initiative programs, such as collaborative biodiversity surveys in the east Kimberley and programs involving DEC Bush Ranger cadets and EcoEducation. A major part of her role is listening to people and providing information about what they can do to help reduce the impact of cane toads on WA's native fauna. She believes education is the key to empowering people to respect their environment and become engaged in conservation and land management.

Lauren Wright is a DEC graphic design coordinator based in Crawley. She has been working with the department for more than a year. Lauren has been involved with the design and production of printed brochures, booklets, flyers, logos and particularly enjoys designing *LANDSCOPE* articles. Lauren previously worked in London for five years as a graphic designer, returning to Perth in 2009. Lauren is extremely passionate about the environment and spends most of her spare time exploring the beauty WA has to offer.


Corrin Everitt

also contributing . . .

Thomas Holmes, Troy Sinclair, Brent Johnson, John Hunter, Samille Mitchell, Joanna Moore, Val English, Karla Forrest, Dave Algar, Steffi Hilmer, Mike Onus, Neil Hamilton, Adrian Wayne and Michael Coote.


Lauren Wright

Features



Cover illustration by Gooitzen van der Meer
Star finches (*Neochmia ruficauda*) are one of a number of finch species which use the Parry Lagoons and Ord River nature reserves in the remote east Kimberley as feeding and breeding grounds.
Illustration reference photo by David Bettini

Back cover photo by Marie Lochman
Parry Lagoons at sunset. The Parry Lagoons and Ord River nature reserves are significant for seasonally supporting large numbers of migratory wader birds and Marlgu, Parry Lagoons Nature Reserve's most prominent lagoon, is known for its amazing array of waterbirds.

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Though it is found in scattered locations across our state, little is known about Australia's native water rat and some believe the species is under threat.

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Publishing credits

Executive editor Madeleine Clews.

Editors Joanna Moore, Samille Mitchell.

Scientific/technical advice Kevin Thiele, Paul Jones, Keith Morris, Chris Simpson.

Design and production Natalie Jolakoski, Peter Nicholas, Tiffany Taylor, Lauren Wright, Gooitzen van der Meer.

Illustration Gooitzen van der Meer.

Cartography Promaco Geodraft.

Marketing Cathy Birch.
Phone (08) 9334 0296 or *fax* (08) 9334 0432.

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Department of
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Rakali: the Aussie otter

The native aquatic rodent, the rakali (*Hydromys chrysogaster*), is found throughout Australia and New Guinea in lakes, rivers, dams and coastal and estuarine habitats. Also commonly referred to as the water rat, the rakali has dark, lustrous and dense water-repelling fur and grows up to one kilogram in weight. It also possesses highly specialised features that enable it to swim underwater for long periods and seek out food in dark, murky waters. It is distinguishable from introduced brown and black rats by a white tip at the end of its tail.

The rakali's primary diet appears to consist of fish and invertebrates such as mussels; however, the animal also has a taste for important secondary items such as waterbirds, bush birds and crustaceans. Young tortoises, frogs, bats, turtles and small terrestrial mammals have also been recorded as prey species.

Two or more litters of three to four young rakali are produced each year and are raised in burrows dug into dam walls and riverbanks. The entrances to these are often located underwater so they can be very difficult to spot. The young leave the den at about eight weeks old to seek out their own territory.

Water rat whereabouts

Most Western Australian Museum records of the species are from the south-west of the state, although historically the species also occurred further inland to the wheatbelt. A number of records of the rodent also come from the Kimberley and Pilbara regions. The population hot spots from the museum's records are the Swan and Canning rivers in Perth and around Albany. Gingin and Ellen brooks, just north of Perth, once boasted large numbers of rakali, but hunting for the fur trade up to the 1950s saw the population decimated. While few sightings are made around Perth today, rakali may continue to reside in watercourses in less developed and more natural habitats around the metropolitan area. Their presence is often indicated by middens of mussels and crustaceans on riverbanks.

Rakali's listing as 'secure' in the *Action Plan for Australian Rodents* came about primarily due to its Australia-wide distribution. But the listing came with the qualifying statement that there had been "a substantial decline in south-west Australia …". This species is on WA's priority fauna list, meaning it is in need of further study before being regarded as secure. However, there is some evidence that the species is under threat and deserves closer attention.



Hunted to local extinction in some places for their fur, removed by marron farmers due to a liking for the succulent crustacean and suffering from a drying climate and degradation of waterways, rakali is certainly a special Australian mammal with difficult times ahead.

by Brent Johnson

Above Rakali habitat, Canning River.
Photo – Marie Lochman
Inset Rakali.
Photo – Hans and Judy Beste/Lochman Transparencies

Right Rakali are also known as water rats.
Photo – Jiri Lochman



Species in decline

As the top-order mammal predators in their aquatic environment, rakali might be considered a 'keystone species' when considering the environmental health of aquatic ecosystems; that is, if rakali exist in an area, the whole ecosystem must be intact to support them. But in a worrying indication for wetland ecosystem health, recent studies by Department of Environment and Conservation (DEC) staff and university students have revealed that many of the wetlands on the Swan Coastal Plain no longer contain rakali. These wetlands have been in decline for many years and their ability to hold water, support aquatic and fringing vegetation and provide sufficient food for rakali have been greatly diminished. Nutrient and salinity levels have risen, some toxins and pollutants have entered the waterways and declining rainfall has greatly amplified the destructive influence of these factors. In addition, many other wetlands in this area have been drained and filled to allow for urban development. Elsewhere in the state's south-west, rising salinity levels from over-clearing have completely destroyed wetland ecosystems. This severe reduction in suitable habitat has created too few places for rakali to live and the large distances between those that do remain make it difficult for

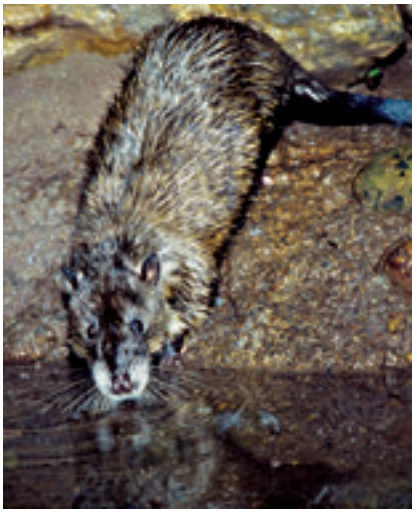


young rakali to seek out new territories. The genetic diversity of the population may also suffer from limited breeding opportunities. Despite declines in some areas of the south-west, some marron farmers consider rakali to be a pest as their commercially raised crustaceans are a desirable food source for rakali. More work is needed to quantify the extent of predation and to develop management tools that enable rakali and marron to co-exist.

Hanging on

But there is hope. Other recent investigations completed during fauna surveys on the area of the northern Swan Coastal Plain known as the Gnangara Mound have revealed that small populations of rakali still exist in Yellagonga Regional Park. A band of wetlands stretching from Lake Goollelal in Kingsley to Loch McNess in Yanchep National Park continues to hold water for much of the year and, in places, the surrounding vegetation appears relatively healthy. Trapping surveys in these wetlands have shown that Lake Goollelal in particular has a significant population. Individuals radio-tracked at this site in 2009 provided a little more information about their behaviour. At Goollelal the presence of small islands and floating reed beds is considered important; introduced predators such as cats and foxes are implicated in the decline of many species of similar size to rakali and this type of habitat provides safe refuge. It may also act as a buffer from human interference.







In the north?

Much of the local knowledge about rakali comes from the south-west, yet they have also been recorded along

Above DEC officers prepare to process a captured rakali.
Photo – Janine Kuehs/DEC

Centre left Rakali have long whiskers to help find prey in murky water.
Photo – Brent Johnson/DEC

Centre right Rakali are occasionally seen on wetland fringes and river banks.
Photo – Hans and Judy Beste/Lochman Transparencies

Left Lake Joondalup.
Photo – Marie Lochman





the northern coastline and on offshore islands in saltwater environments. Little is known about the ecology of these northern water rats, or their genetic relationships with the southern and the eastern states populations. Fauna surveys on Kimberley islands along with fauna monitoring on Barrow Island in the Pilbara have shown that rakali in the north inhabit zones close to the beach, but we have little more information. The permanent presence of DEC officers on Barrow Island (see 'Giant steps: industry and conservation make history through Gorgon', *LANDSCOPE*, Winter 2010) and the ongoing fauna translocation program here may now provide the opportunity to undertake further investigation. If this work reveals a substantial population, rakali may be considered for translocation to the nearby Montebello Islands (see 'New island home', *LANDSCOPE*, Summer 2010–11).

Next time you visit your local lake or river, keep a lookout for this little Aussie otter swimming swiftly along the water's edge or foraging among the reeds. Rakali are a unique Australian mammal but, sadly, their habitat is under severe threat in WA and much more needs to be learned to ensure this species is not added to the threatened fauna list.

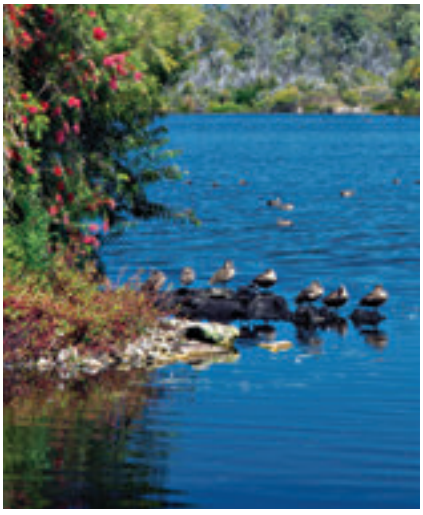
Above left DEC nature conservation officer Alice Reaveley prepares to release a male rakali.
Photo – Kristian Pollock/DEC

Above Healthy wetland ecosystems provide essential rakali habitat.
Photo – Brent Johnson/DEC

Below Loch McNess, Yanchep National Park.
Photo – Peter Nicholas/DEC

Below left Aquatic crustaceans are preferred rakali prey.
Photo – Jiri Lochman





Brent Johnson is a principal technical officer based at the Department of Environment and Conservation's (DEC's) Wildlife Research Centre in Woodvale. He can be contacted on (08) 9405 5106 or by email (brent.johnson@dec.wa.gov.au).

The author wishes to thank DEC nature conservation officer Alice Reaveley and University of Western Australia student Claire Smart for their contributions to rakali research on the Swan Coastal Plain.



The jewel in the crown:
Perup and the Upper Warren



It is more than four decades since foresters and locals began to recognise the forests around Perup and the Upper Warren for a diversity of wildlife that had become extinct elsewhere. These discoveries led to some important research projects, as well as education, interpretation and ecotourism activities. Today the area is still one of the best places on mainland Australia to find many threatened vertebrate species in abundance—a priceless biodiversity and conservation treasure.

by Adrian Wayne and Joanna Moore

Some 300 kilometres south of Perth and lying between Bridgetown, Manjimup, Boyup Brook and Lake Muir, the catchment area of the upper reaches of the Warren River remains one of Australia's best-kept secrets for forest biodiversity, especially threatened marsupials.

Threatened species that have disappeared elsewhere or are now rare across Australia are still found in the area, including one of the two remaining indigenous populations of the numbat (*Myrmecobius fasciatus*), two of the four remaining indigenous populations of the woylie (*Bettongia penicillata ogilbyi*), the largest inland population of western ringtail possum, or ngwayir (*Pseudocheirus occidentalis*), the largest known population of the south-west species of brush-tailed phascogale, or wambenger (*Phascogale* sp.), and large and important populations of the tammar wallaby (*Macropus eugenii*), chuditch (*Dasyurus geoffroii*), quenda or southern brown bandicoot (*Isoodon obesulus fusciventor*) and western brush wallaby (*M. irma*). The region is also home to threatened birds such as Muir's corella (*Cacatua pastinator pastinator*) and Baudin's (*Calyptorhynchus baudinii*) and Carnaby's (*C. latirostris*) black cockatoos, as well as threatened and endemic flora.



The Upper Warren region refers to around 285,000 hectares of publicly managed forest within the river catchments of the Wilgarup, Yerraminup, Perup and Tone rivers, all tributaries to the Warren River. The area includes State forest, the 56,000-hectare Tone-Perup Nature Reserve, the 21,000-hectare provisionally named 'Greater Kingston' National Park and several other smaller nature reserves. Across a rainfall gradient ranging (roughly west to east) from 1,000 millimetres to less than 700 millimetres per year, the area supports a diversity of forest and woodland types including those dominated by jarrah (*Eucalyptus marginata*), marri (*Corymbia calophylla*), wandoo (*E. wandoo*) and flooded gum (*E. rudis*).

The Upper Warren and adjacent Lake Muir area is a biodiversity hot spot. It is home to 925 vascular plants (of which 10 are rare or endangered), 497 non-vascular plants, hundreds of fungi species, around 1,000 terrestrial invertebrate species, 216 aquatic invertebrate species, six fish species—all of which are locally endemic—13 species of frog, 26 reptiles, 130 birds and 30 mammals.

There is also profound cultural significance in the area. In the north, the Perup and the Upper Warren were once home to the Kaneang Aboriginal people, in the south the Minang people and, in the west, the Pibbelmen. As a site of early European settlement, the region also has non-Aboriginal cultural significance, with pioneering forestry and farming activities occurring in the area.

Research in the Upper Warren region, especially around Perup, into the conservation of threatened mammals has played a major role in providing new knowledge and understanding of wildlife in Western Australia. It is the site of numerous research programs carried out by the Department of Environment and Conservation (DEC) and some of its predecessor departments, the Department of Conservation and Land Management (CALM) and the Forests Department, since the early 1970s. Today, Perup and the surrounding Upper Warren stand to be one of the most important areas in nature conservation in south-west WA, a 'jewel in the crown' of the state's biodiversity.

Early days of conservation

But how did it all start? Perup and the surrounding forests were gazetted State forest and harvested for timber, particularly in the 1940s and again



Previous page
Main The population of woylies in the Perup and Upper Warren region is highly significant.
Photo – Jiri Lochman
Insets Numbat (*Photo – Jiri Lochman*); tammar wallaby (*Photo – Sallyanne Cousans*); jarrah (*Photo – Marie Lochman*); Baudin's black cockatoo (*Photo – Jiri Lochman*).

Left Brush-tailed phascogale and young.
Photo – Jiri Lochman



Above Southern brown bandicoot or quenda.

Right The Indigenous name for the western ringtail possum is ngwayir.
Photos – Jiri Lochman



from the 1960s to the early 1970s. In the 1960s, scientists from the then Forests Department were alerted to the presence of tammar wallabies and woylies in the Perup area by a forester based at the Tone River settlement, Harry Winfield (see 'Possum magic', *LANDSCOPE*, Spring 2004). In 1971, researcher Per Christensen with Graeme Liddelow, Dave Fauville, Tom Leftwitch, Chris Vellios and the late Peter Skinner verified these reports by trapping and spotlighting: they found that tammar wallabies, woylies, numbats, chuditch, quenda and koomal, or brushtail possums (*Trichosurus vulpecula hypoleucus*), were present in the forest. In recognition of its importance to conservation, the Forests Department zoned the Perup area a management priority area for fauna, flora and landscape values in 1971. The Perup has been effectively managed as a nature reserve since.

Parts of the area had also been cleared for farmland and leased for stock. Keen for the opportunity to do more research into fauna in the area, the department acquired 'Perup' farm in 1972 as part of an amicable land swap. The old farmhouse was useful as a base for research staff and, with some improvements and additions, became a research station known as the Perup Field Ecology Centre. As much of the research on threatened species was carried out at night, having an overnight base was particularly useful.

A number of important research projects began at Perup in the 1970s, including work on woylies and tammar wallabies and the impact of fire on habitat. Through his work during the mid and late 1970s, Per and his team discovered that both species were well adapted to the environments in which they lived and had a marked degree of 'fire dependence'. This was related to the fact that the food and plant species on which they depended for shelter and protection from predators were themselves reliant on fire to stimulate regeneration and growth.

Per's team discovered that both species had remarkably high survival rates during experimental burns, with woylies showing what is described as 'high home-range fidelity'—that is they retreated to unburnt patches or jumped back through the flames onto burnt ground to stay within their territory. Woylies were found to be particularly reliant on the abundance of post-fire 'fruiting' of hypogeal fungi (native underground truffles), which is their staple diet—another important discovery made by Per at the time. Perhaps most importantly, it was while studying woylies and tammars that Per discovered that the fox (*Vulpes vulpes*) was a deadly predator. He demonstrated that the fox was a serious threat to native mammals of the south-west and initiated the first fox baiting program to protect native wildlife in WA.



Left Carnaby's black cockatoos.
Photo – Jiri Lochman



Below left The Perup Field Ecology Centre is used by many researchers including students.
Photo – Sabrina Trocini

Thirty-five years of knowledge

The 1970s also saw the beginning of long-term monitoring at Perup. With detailed studies starting in 1974 and continuing ever since, Perup is the site of one of the longest fauna monitoring studies in Australia. Building on the early work started by Per and his colleagues and followed on by then Forests Department researcher Neil Burrows and others, regular monitoring by live cage-trapping has provided important data on the abundance and population changes of marsupials such as the woylie, chuditch, quenda and koomal in relation to increasing fox control over time and ongoing fire management including prescribed burns.

In 1976, the first formal fauna reintroduction program in WA was successfully conducted by Per and Tom Leftwich with the establishment of a new population of woylies in the northern part of Perup, using animals from southern Perup. The success of the translocation was largely attributed to the commencement of fox control at the reintroduction site, using baits containing the 1080 toxin. Fox baiting has continued ever since, culminating in 1997 when it was integrated into the broader-scale *Western Shield* program. Woylie numbers have grown steadily since the 1970s, with marked increases corresponding with improvements to the fox baiting regime, peaking around 2000 when numbers were so abundant it became increasingly difficult to catch other species due to the saturation of traps by woylies. The recovery of the woylie in Perup and surrounding forests played a crucial part in it becoming the first Australian vertebrate species to be downgraded from an endangered conservation status in 1996 (see 'It's back… the woylie', *LANDSCOPE*, Autumn 1996).

The long-term monitoring continues with the involvement of Bush Rangers WA—an extracurricular high school program run by DEC as part of Cadets WA, focusing on biodiversity conservation and land management. Bush Ranger cadets visit Perup as one of their reward experiences, where they help with work such as monitoring the effect of fox baiting on native animal populations. Through this they learn how to bait and clear fauna traps, monitor and record information, carry out night fauna counts, use GPS units, handle native animals safely and effectively and analyse results. These young volunteers are 'skilled up' to be the conservation workforce of the future.

Significant studies

In 1981, Neil established a project in Perup that aimed to test the long-term effects of different fire regimes and seasonality on understorey vascular flora species in the jarrah forest. This involved burning plots of forest in short, normal and long rotations as well as leaving some areas unburnt. Many strategically timed experimental burns later, significant findings about fire regimes have been published in a number of papers, informing other researchers and land managers.

Immediately to the west of Perup, the Kingston Study began in 1994 to investigate the responses of biodiversity

to timber harvesting in the jarrah forest and help improve ecologically sustainable forest management practices. Gazetted as State forest at the time, this area was chosen because of its abundance and diversity of wildlife, particularly threatened mammals. This comprehensive scientific study involved a large team of CALM (now DEC) scientists, local district staff, university students and volunteers, investigating plant diversity, abundance and structure, soils and the distribution and abundance of tree hollows, as well as frogs and reptiles, invertebrates, birds and mammals. Findings from the study have significantly shaped the management of south-west jarrah forests including increased protection of habitat trees and other important habitat such as balga (*Xanthorrhea priessii*), the development of fauna habitat zones and the increased control of introduced predators.

In 2001, a long-term ecological monitoring program called FORESTCHECK began in the area and has subsequently been expanded more broadly across the forest. A complement to the Kingston Study, FORESTCHECK monitors changes and trends in key elements of forest biodiversity associated with forest management activities (particularly timber harvesting and fire) across forest landscapes throughout the south-west. Nearly 3,000 species, many not yet scientifically named, have been sampled in this study so far, only 0.6 per cent of which are mammals. Like the Kingston Study, FORESTCHECK continues to improve understanding of the biodiversity and ecology of the jarrah forest with the aim of ensuring positive conservation outcomes based on solid science.

Earlier findings from the Kingston Study showed that the ngwayir and, to some extent, the koomal were sensitive to timber harvesting and predation. This led to a broader study in the Upper Warren between 2001 and 2005 which focused on aspects of the possums' ecology and biology with the aim of managing and conserving these species and their habitat more effectively.



Above A majestic jarrah tree.
Photo – Marie Lochman

Ongoing successful projects in Perup and the Upper Warren are built on the shoulders of these early projects. The area deserves ongoing recognition as an important and unique place: important because it supports several threatened species that have undergone massive range contractions across Australia, and unique because it has a mammal suite almost completely intact (except the bilby and boodie—although moves are afoot to once again see these species at home in the Upper Warren). Other than Dryandra Woodland and offshore islands, there is no other area in WA like it in terms of supporting so many threatened marsupial species.

Ecotourism, education and experiences

From early beginnings and a constantly evolving range of activities, ecotourism in the Upper Warren is bigger than ever. Since the mid-1970s, alongside projects on forest ecology and management, training for Forests Department staff began at Perup.

Volunteers, students and paying guests also joined researchers to camp at Perup and be involved with wildlife research. These were soon extended to include courses for school teachers and participants of The University of Western Australia's extension program '*LANDSCOPE* Expeditions' (see 'A wild weekend', *LANDSCOPE*, Summer 1990–91).

The 1980s saw the expansion of facilities at Perup, with temporary 'donga' accommodation brought in to accommodate course participants and researchers. The late 1990s saw a major upgrade of facilities, and dongas were replaced with eco-sensitive buildings including several cottages, a lodge, bunkhouse, classroom and laboratory and a caretaker's house to accommodate small to large groups, ranging from couples to school and corporate groups. Using renewable solar and wind-generated power and rainwater, guests can stay and have a genuine wilderness experience within the heart of one of the country's key locations for fauna conservation and research. The public can also visit and stay in 'Perup – Nature's Guesthouse' to learn about nature conservation and forest management. Special night spotlighting wildlife walks are run out of the guesthouse.



Today, Perup is also the site of numerous university student projects and a range of education and training activities. It is also the destination of national and international science groups and school excursions. Volunteers, students, local interest groups and local landholders have been a substantial and important part of all of the major research in the area and continue to play a key role in the ongoing conservation and management of the region.

Worrying about woylies

In recent years, a major project to identify the causes of decline in woylie populations has been under way at Perup (see 'Down but not out: solving the mystery of the woylie population crash', *LANDSCOPE*, Winter 2008). Following the success of recovery programs for the woylie during the late 20th century, woylie numbers started to plummet. Numbers across the country have dropped around 80 per cent since 2001 and at some sites numbers were recorded as dropping up to 97 per cent. As a result, the woylie has been relisted on state and federal threatened species lists and is now listed as critically endangered on the International Union for the Conservation of Nature 'Red List'.

The Woylie Conservation Research Project was set up to identify the causes of this baffling decline, focusing on the Upper Warren region. The project joined the forces of DEC, Murdoch University, the Australian Wildlife Conservancy (AWC), Perth Zoo and South Australian Department of Environment and Heritage. While predation, especially by feral cats, is involved, and disease is a suspected potential factor, this major collaborative research program has so far been unable to definitively prove the causes of the woylie decline. And it's getting critical: in 1999, there were about 240,000 woylies in the Upper Warren region—perhaps more than two-thirds

Left DEC Senior Technical Officer Chris Vellios with a woylie to be released into the Perup Sanctuary.
Photo – Emma O'Leary/DEC



Above Woylie.
Photo – Sallyanne Cousans

Below Perup entry sign.
Photo – Cliff Winfield

Below left Jarrah forest at dawn.
Photo – Jiri Lochman

of the estimated animals in the wild—and there are now estimated to be just 10,000. Given the rapid species collapse, and the risk of extinction of the woylie, it was decided that emergency conservation action was needed.

Perup Sanctuary

An exciting new phase in the Upper Warren's history has now begun. Adjoining 'Perup – Nature's Guesthouse', a 420-hectare predator-free enclosure has been constructed to support about 400 wild woylies. The Perup Sanctuary is based on the proven success and importance of the Karakamia Wildlife Sanctuary, managed by AWC, in supporting a healthy woylie population free from predators. It will be monitored and managed as insurance from local extinction for the indigenous woylie populations of Kingston and Perup. The sanctuary will also enable scientists to conduct research on the impact of predators and disease in the conservation and recovery of the woylie. The same project will also see another complementary captive insurance population established at Perth Zoo that will try to capture the genetic diversity of the entire species. Woylie releases into the two insurance colonies began in late 2010.





Adrian Wayne is the Department of Environment and Conservation's (DEC's) forest fauna ecology research scientist. Based in Manjimup, he researches the ecology of forest vertebrate fauna (frogs, reptiles and mammals), focusing on work relevant to the conservation and management of threatened species and fauna responses to timber harvesting and prescribed burning. He can be contacted on (08) 9771 7985 or by email (adrian.wayne@dec.wa.gov.au).

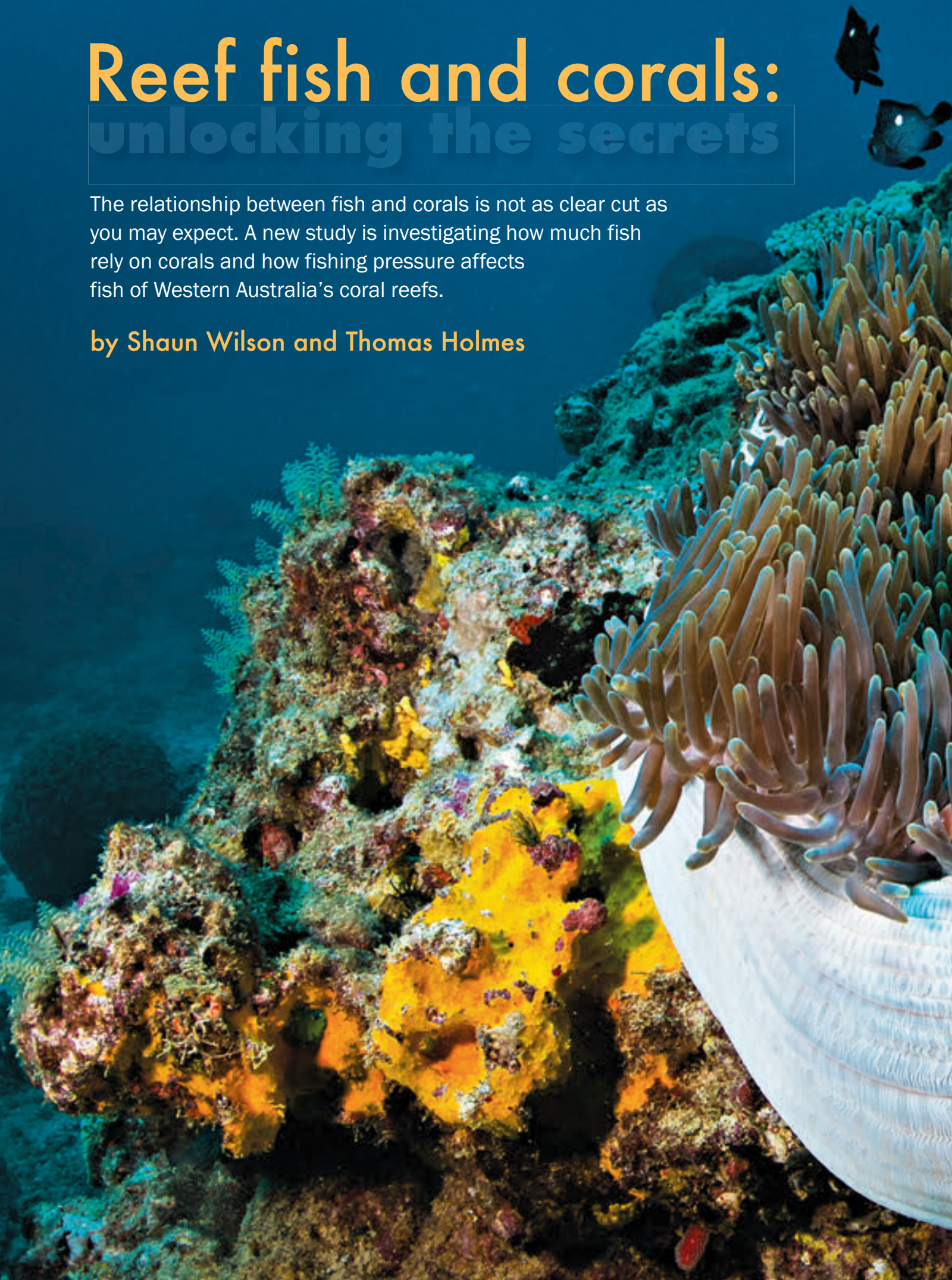
Joanna Moore is a DEC publications officer and *LANDSCOPE* editor. She can be contacted on (08) 9389 4009 or by email (joanna.moore@dec.wa.gov.au).

For more information about staying at 'Perup – Nature's Guesthouse' contact DEC's Donnelly District Office on (08) 9776 1207.

Reef fish and corals:
unlocking the secrets

The relationship between fish and corals is not as clear cut as you may expect. A new study is investigating how much fish rely on corals and how fishing pressure affects fish of Western Australia's coral reefs.

by Shaun Wilson and Thomas Holmes





Coral reefs, which line extensive areas of the state's tropical and island coastlines, are an integral component of Western Australia's natural environment. While most of us are aware of the famous fringing reefs at Ningaloo, corals reefs are also a prominent feature of the Kimberley coast, the remote Rowley Shoals and the Montebello Islands. Many of these areas are either existing or proposed marine parks, managed by the Department of Environment and Conservation (DEC). Warm waters, pushed down the coast by the Leeuwin Current, also enable coral reefs to thrive in southern waters around the Abrolhos Islands, creating a unique combination of warm and cool-water habitats (see 'Slaughter, seabirds and ocean life at the Abrolhos', *LANDSCOPE*, Winter 2010). These reefs and many others are among the most diverse of all ecosystems, providing homes for thousands of species of fish, plants and invertebrates.

Coral homes

Hard corals, also known as scleractinian corals, create the foundation of most reefs. These corals can form massive colonies, in many cases living up to hundreds of years old, and come in a multitude of shapes and sizes, creating a network of nooks and crannies for animals to feed and shelter on the reef surface. Unfortunately for these animals, corals are coming under growing levels of stress from climate change pressures such as increasing sea temperatures, severe tropical storms, disease, rising sea levels and ocean acidification. The influence of such pressures could lead to changes in the type of corals that we see on tropical reefs and, in some locations, the possible loss of corals.

Fish are one group of animals that benefit greatly from the presence of corals. Many fish species are recognised as playing critical roles in the functioning of reef ecosystems, increasing these systems' ability to recover from disturbances. In addition, through fisheries and tourism, fish on reefs provide food and livelihoods for millions of people living on tropical coastlines around the world. Consequently, fish are among the most well-studied group of species on reefs and, in comparison to other reef inhabitants, we have a relatively good idea of how they respond to changes in coral abundance.





Different responses to coral loss

So what exactly do changes in the reef environment mean for the thousands of fish species that call coral reefs home? Fish that rely on live coral as a source of food are among the most vulnerable to disturbances that reduce the overall cover of hard corals. This includes many members of the brightly coloured butterflyfish family (Chaetodontidae), which snorkellers often spy nibbling on coral branches. Not surprisingly, the abundance of many of these types of fish declines after significant coral loss. However, this is only a general pattern, with the response of butterflyfish to coral loss varying considerably among different species. Some, such as the chevron butterflyfish (*Chaetodon trifascialis*), feed on only a few types of coral and these fish are the most likely to suffer when coral death occurs. Others, such as the melon butterflyfish (*C. trifasciatus*), may feed from more than 50 different

Previous page
Main Ningaloo Reef.
Photo – Ross Gudgeon

Above The chevron butterflyfish is a highly specialised coral feeder.
Photo – Shaun Wilson/DEC

Left Hard and soft coral.
Photo – Clay Bryce/Lochman Transparencies



species of coral and an overall loss of live coral cover often has little impact on their abundance.

The differing responses between fish species to coral loss occurs because disturbances to the reef tend to have their greatest effect on a handful of coral types. Unfortunately, these are often the corals that highly specialised species such as the chevron butterflyfish feed upon. Melon butterflyfish also feed on these corals but, as they are able to shift the focus of their feeding to other less affected corals, they tend to be more resilient to disturbances on coral reefs.

Coral settlers suffer

Habitat disturbance and a loss of coral can also have a detrimental effect on many of the small-bodied fish that live on reefs, such as the damselfish (family Pomacentridae) and some of the gobies (family Gobiidae) that shelter among the branches of coral colonies. Some of these fish are closely associated with corals for their entire lives, but some live in close proximity to corals only early in their life, sheltering among corals when they are just a few millimetres long. For these 'coral settlers', reliance on corals may not be apparent when they are adults, but it is still critical to their long-term survival on reefs. A recent study on Ningaloo Reef found that about 40 per cent of fish species rely on live corals for food and shelter when they are juveniles, much more than the 10 per cent of species that closely associate with corals as adults. As a result, any effect of coral loss is expected to be particularly pronounced during the early stages of a fish's life.

Coral as shelter—dead or alive

For some fish the colour present in coral tissues provides an ideal backdrop, allowing them to blend into their surroundings and help them avoid detection by predators. But for most reef fish it is the myriad of small holes and passages created by coral branches that is essential for their survival. For these fish, extensive coral mortality will have no immediate effect, as coral skeletons will continue to provide the shelter they require, even after the coral has died. Indeed, studies on the Great Barrier Reef have shown the number of fish species present on a reef may be unchanged after extensive coral loss, providing the structural framework of the reef remains intact. And that is the critical factor. If the coral skeletons remain upright, then highly specialised, coral-dependent species will be gradually replaced by fish that feed on algae or invertebrates and the overall diversity of the fish community will be unchanged. In fact, an influx of algal-feeding fish is critical to the recovery process of the reef, as their feeding prevents algae overgrowth and maintains space for corals to grow.

However, if the reef structure breaks down, then diversity of the fish community will decline. This will be particularly important for the small-bodied fish that rely heavily on



Top Abrolhos Islands corals.
Photo – Gunther Schmida/Lochman Transparencies

Above Damselfish and basslets on a coral reef.
Photo – Ann Storrie



Left Aerial view of the Abrolhos Islands.
Photo – Cliff Winfield

Below left Coral trout are prized by fishers on coral reefs.
Photo – Thomas Holmes/DEC

coral shelters to avoid predators. These small-bodied fish are an important component of diversity; species with maximum body lengths less than 10 centimetres typically account for 30 to 50 per cent of all fish species on reefs. Loss of these fish may therefore have a serious impact on overall diversity.

Fishing pressure

Climate change effects are not the only significant pressures affecting coral reef fish communities. One of the most prominent threats on a global scale comes from commercial and recreational fishing. Fishing is a favourite pastime of many Western Australians, contributing $570 million dollars to the state's economy annually and providing a livelihood for thousands of people. Fishing is permitted within designated areas of the state's marine parks and is a popular recreational activity for many visitors.

However, the types of fish targeted by WA fishers represent only a small fraction of the thousands of species found on coral reefs. Fishers typically target large-bodied predatory species that feed on other fish or invertebrates. Reduced presence of live coral is unlikely to directly affect these fish. However, it may affect the availability of their prey, especially if they target coral-dependent species. A breakdown of coral skeletons may also affect juveniles of target species that shelter within the protective reef matrix, which may have long-term consequences for the abundance of adults. Alternatively, removal of fisheries-targeted species may reduce predation pressure or result in an increase in the abundance of small-bodied predators.

Providing answers

Clearly the effects of habitat disturbance and changes in coral cover frequently occur in areas subjected to fishing pressure. It is therefore essential to understand how the effects of habitat disturbances interact with changes instigated by fishing pressure. To date, WA's tropical reef ecosystems remain relatively unaffected by severe climate change impacts. However, given global climate predictions, this may change in the future.

In addition, fishing pressure is likely to continue increasing as population growth continues along WA's tropical and sub-tropical coast. Will excluding fishing effectively reduce stress on the environment and help maintain a healthy reef and diverse fish community in WA's tropical reefs? Or is some level of fishing required to reduce predation pressure and encourage survival of smaller-bodied coral-dependent fish?

These questions and others are the focus of a research program being undertaken by DEC's Marine Science Program. Together with researchers from the Department of Fisheries, Australian Institute of Marine Science and CSIRO, the program will investigate which fish require live coral and at what stage in their life coral is an important habitat requirement. The program will also look at which fish are the major predators of reef-associated fish and what may happen to fish communities and the reef environment if these predators are removed by fishing.

Climate change and fishing are undoubtedly the two greatest threats to reef fish. This research, combined with ongoing monitoring from DEC's West Australian Marine Monitoring Program, will improve our understanding of how both these factors influence reef communities, thereby improving our management of coral reefs.



Shaun Wilson is a senior research scientist with the Department of Environment and Conservation's (DEC's) Marine Science Program. His research focuses on the ecology of coral reef fish, particularly the effects of disturbance. He can be contacted by email (shaun.wilson@dec.wa.gov.au).

Thomas Holmes is a research scientist with DEC's Marine Science Program. His research has examined predation and recruitment of reef fish. He can be contacted by email (thomas.holmes@dec.wa.gov.au).



The great teaching event: memories of the 1961 bushfires

It has been 50 years since the Dwellingup, Karridale and Crowea fires swept through the south-west, devastating townships and teaching profound lessons to forest and bushfire managers. A new book recalls the horrors of the fires from the people who experienced them firsthand.

by Roger Underwood

"The roaring sound. What I remember most is the tremendous roar and crackling, as the flames raced through the trees and into the town. What I remember next is the faces, especially of those gathered at the pub whose loved ones were missing and feared lost."

So begins a memoir of the 1961 Dwellingup fire written by retired forester Jim Williamson, who was there the night the town burned. It is one of 47 dramatic and emotionally charged stories collected in a new book commemorating the 50th anniversary of Western Australia's blackest summer.

In that summer, bushfires burned perhaps a million hectares across the southern half of the state. Four towns were consumed. Bridges, roads, railways, schools, hospitals, churches, homesteads and business premises were lost or damaged. Hundreds of thousands of hectares of farm and bushland were incinerated. Untold millions of native animals were wiped out. The losses and the costs of the fires were incalculable. And, although no human lives were lost, the psychological scars on those who survived them have, in many cases, never healed.



Early signs

By late spring of 1960 it was clear a bad fire season was looming. Winter rains had been above average, but conditions soon dried up and the first heatwaves began to roll through. By Christmas a number of serious fires had occurred. What followed, however, was beyond expectations: a summer punctuated by extreme heatwaves and severe atmospheric instability, as anticyclones in the south interacted with tropical cyclones in the north, and lightning storms swept the south-west forest country.

To make things worse, much of this forest carried heavy, long-unburnt fuels. The then Forests Department had introduced a policy of broad-acre fuel reduction burning in 1954 but, by 1961, the new burning program had scarcely made a dent in the fuel accumulations of the previous 30 years.

Lightning strikes twice

"I was the DFO [district manager] at Dwellingup," recalls retired bushfire specialist Frank Campbell. "We knew we were in trouble on the afternoon of the 19th January when a big thunderstorm moved in and the lookout towers started to report lightning strikes. By 6.30pm we had plotted six separate fires. Four new fires were located the next morning and by afternoon the number of fires, and their extent, exceeded our capacity to control them."

The problem for the fire controllers at Dwellingup was that the same lightning storm that dealt them such a





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Main Nanga Brook, 25 January 1961.
Photo – The West Australian

Above left The Dwellingup forestry office, before the fire.

Left Nanga townsite before the fire.
Photos – DEC



heavy blow had also moved right across the Mundaring, Jarrahdale, Harvey and Collie forest districts, and then extended down into the karri forest. Every man and machine the department possessed was now firefighting. The job they did was remarkable, and almost every fire was caught and suppressed in the first 24 hours.

But the lightning came again

On the evening of 20 January, under conditions of high winds and searing temperatures, a second massive lightning storm flickered down the forest country, starting numerous new fires. These added another layer of complexity to the harassed firefighters, who were still dealing with the fires started the day before and not yet made safe. Despite the mobilisation of every firefighter, and the call-up of practically every able-bodied man in the south-west (including hundreds of timber workers, the Army, farmers and waterside workers), two massive fires developed over subsequent days, one to the north and one to the east of Dwellingup. Under extreme heatwave conditions and gale-force winds, these fires eventually coalesced and, on the evening of 24 January, they took on a life of their own. The townships of Dwellingup, Holyoake and Nanga Brook all burned. Banksiadale, a few kilometres north of Dwellingup, was miraculously unharmed, as the fire veered away at the last moment.



Top A Forests Department vehicle, caught by fire in the forestry yard.
Photo – The West Australian

Above Frank Campbell—the officer in charge at Dwellingup in 1961, then aged 27—recalls the fire 45 years later.
Photo – DEC



Right Signalman Ed Renton operating an Army A510 radio at the Dwellingup fire, January 1961.
Photo courtesy of Ed Renton

Frank recalls the fateful night: "It was now about 7pm. I remember Bruce [Beggs] taking a small group of men down into the yard to try to save some vehicles and then I didn't see him again. The others had left the office. There was nothing they could do. The ember storm had arrived and burning brands were falling thickly all around. Houses and buildings started to catch alight, including my own house that was next door to the office. I ripped the front out of my shirt, wet it in a pack spray and wrapped it around my face so that I could breathe and went to try to save my house. It was hopeless. I ran back to the office. It was by then well alight. My car was parked







Above Aerial view of the devastated Dwellingup town site.

Left Forestry firefighter at the Crowea fire.

Below left Boranup Forest in the wake of the Karridale fire.
Photos – The West Australian

at the front and just as I was running to it, Sonny Cave (a forest ranger from Mundaring) appeared from nowhere at my side and ran with me. Sonny stood by me for the rest of the night.

"The front seat of my car was alight, but we put that out and climbed in. It wouldn't start—the petrol in the carburettor must have vaporised in the heat—but at last it fired and we tore off. I was heading for Alan Hatch's house, where I hoped my wife and kids might be. As we drove headlong down the main street, a powerline dropped across the bonnet of the car and then swept over the roof. I instinctively ducked, sat up, found I was headed for a shopfront, swerved back onto the road and kept going. At this moment I spotted the Hatch car on the football oval. There, being minded by Nan Hatch like an old mother hen with her chicks, I found my wife and kids."

It was a time for heroes, and there were many of them. It was also a time for terrible anxieties and stress. Wives were separated from their husbands, parents from their children, men from their families. Gloria Wilmott is the daughter of the legendary forestry overseer Jim Warren, who was away

with his gang firefighting. Gloria, aged 17 at the time, remembers that when the fire hit town her mother was responsible not just for her six children, but also for her elderly parents and the family dog. Mrs Warren never lost her cool: "Mum assembled everyone on the front verandah, and armed us with wet blankets that she had been soaking in the bath. Her idea was to head for the football oval or the hotel, but we had left our run too late. The fire caught us before we even reached the railway line. There was a hollow in the ground in front of Jim Carroll's house, some sort of drain, and we took shelter in it. Mum huddled us together and covered us with the wet blankets, but these dried out as soon as the heat struck them, so she got me up and she and I ran across to Carroll's to re-wet them, carry them back and get in under until they dried out again. We made three or four trips before the tap stopped running. As I ran back and forth I could see that the houses, hedges and parked cars down Banksiadale Road and the forestry office were all burning."

All communications had broken down, and for many hours communities were isolated from the outside world. Josephine Holland, who became separated from her husband Arthur, went looking for him at the Pinjarra Hospital the next day. "There were rows of men lying on the lawn of the hospital," she recalled, "and I walked up and down looking for Arthur. Eventually I found him, and at first I thought he was dead. But he was just blinded by smoke and ash, and utterly exhausted."

But the long hot summer was not yet over

In mid-February 1961, before the authorities had even started to recover from the Dwellingup catastrophe, a new and vicious lightning storm struck, this time deep in the karri forest. One of these became the Crowea fire, south of Pemberton, and another the Dog Road Fire, south of Shannon River. Although these fires did not affect towns or farmland, they devastated thousands of hectares of beautiful and valuable karri and jarrah forest.

And even then it was not over. In early March yet another searing heatwave struck the south-west. A number of fires broke out near Margaret River and Augusta. One of these developed into an unstoppable crown fire within Boranup Forest (which had not been burned for more than 40 years), and eventually destroyed the historic township of Karridale. Lee Walker was a young policeman at the time, and had the job of investigating these fires. He recalls: "Friday, March 3 was the day Karridale bore the brunt of the main fire. During the day, residents had fearfully watched the huge clouds of smoke to the north, and as it came closer they could hear the roar of the fire, see the flames and the many spot fires starting up ahead of the main front. White ash would fall, quickly followed by red hot cinders.

"Reaching Karridale, the fire burnt to the ground: Millars Trading Store (also the post office and liquor shop), the fuel depot, six mill houses, the CWA Hall, the Karridale Hall, the hospital, the Anglican Church, and two privately owned houses. Due to timely evacuation, there was no loss of life. Eventually, the fire reached Hamelin Bay, where people sheltered on the beach, after which it turned towards



Right The explosion of the fuel dump at Karridale.

Below Overseer Jimmy Warren and forest guard John Patterson arriving back at headquarters from firefighting.
Photos – The West Australian





Left All that remained of a farm homestead after the Karridale fire. *Photo – The West Australian*

Below Dwellingup town today. *Photo – Elisa Skillen/DEC*

Augusta. Luckily Augusta township was protected by an area of light fuels which had been burned not long before."

Lessons learned

The fires of 1961 were investigated by a Royal Commission. Although the commissioner praised the skill and courage of the firefighters, and acknowledged the unprecedented conditions they faced, he also made numerous recommendations. Among the most important outcomes were improved coordination between government and volunteer firefighters, the use of modern radios and equipment and, most importantly, a new emphasis on fuels management. The Royal Commission was a driving force in stimulating the development of fire behaviour research and the fuel reduction burning program that later took WA to the forefront of world bushfire management.

And what of the fact that not one life was lost while four townships burned and firefighters confronted ferocious crown fires? There are two explanations: first, the forest firefighters of the time were tough, practical and fire-wise. They knew how to look after themselves and their mates and they were well led by experienced overseers and officers. Second, the people in the small forestry and timber towns of the south-west in those days were people who lived in, worked, and understood the Australian bush. They knew about fire. When the threat reached a certain point, they simply moved out, seeking safe places where they waited out the fire storm. Saving lives took priority over saving possessions. Furthermore, although towns such as Dwellingup were surrounded by forest, the forest did not dominate within the town. In Victoria on Black Saturday in 2009, on the contrary, people were caught in townsites where houses nestled beneath the dense canopy of heavy forest.

To the firefighters and survivors of the fires of 1961 two lessons remain indelible. The first is that attempts to fight a crown fire burning in heavy fuels under bad weather conditions will always fail—the intensity and spot fires generated make firefighting hopeless. For this reason, the maintenance of an effective fuel reduction burning program is absolutely vital. In the words of Gordon Styles, one of WA's finest firefighters, and a survivor of the Dwellingup fire: "We were trying to defeat fast-moving fires under hot, windy conditions in heavy fuels. Even with modern equipment this simply cannot be done. If there is a single lesson from the Dwellingup fire I hope will never be forgotten, this is it."

There is a second lesson: communities in bushfire-prone areas must have a 'Plan B'—the capacity to move quickly and calmly to safe places well in advance of intense, fast-moving fires. This is especially critical these days as so many people who live in bushfire-prone areas have little bushfire experience.

Will there be another summer to equal that of 1960–61? Hopefully not, but the authorities should never forget the lessons learned that year. One 'great teaching event' is enough.



Roger Underwood is a former district and regional manager with the then Western Australian Forests Department, and was a firefighter during the 1960–61 fires.

This article is based on Roger's new book *Tempered by Fire— stories from the firefighters and survivors of the 1961 Western Australian bushfires*. The book is available from The Bushfire Front by email to yorkgum@westnet.com.au.

See the next edition of *LANDSCOPE* for an overview of how fire management has changed in the 50 years since the Dwellingup fires.

bookmarks by Joanna Moore

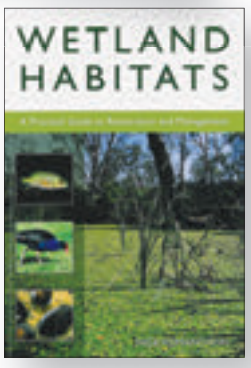




Field guide to sea stingers and other venomous and poisonous marine invertebrates of Western Australia

Authors: Loisette M Marsh and Shirley M Slack-Smith
Publisher: WA Museum
www.museum.wa.gov.au
246 pages, paperback, illustrations and colour photographs throughout
ISBN: 978 192 084 3953
RRP: $35

One of the unavoidable drawbacks of Western Australia's remarkable marine environments is the number of sea creatures capable of injuring people who enjoy exploring, relaxing or researching in the ocean. This useful book from the WA Museum will help swimmers, fishers, divers, beachcombers and marine naturalists learn about and take care to avoid a range of venomous and poisonous marine animals. It also provides up-to-date information on appropriate first aid when bites, stings or poisoning does occur. Photographs throughout illustrate these fascinating marine creatures—from sponges, hydroids, jellyfish, anemones and corals, to worms, molluscs, echinoderms, sea squirts and crustaceans.



Wetland habitats: a practical guide to restoration and management

Author/photographer: Nick Romanowski
Publisher: CSIRO Publishing
www.publish.csir o.au
216 pages, paperback, colour photographs
ISBN: 978 064 309 6462
RRP: $49.95

This detailed manual provides a wealth of information for landowners and other wetland managers. Find out about wetland animals' diverse needs, the many types of wetlands and how they change, as well as the nature of the water which characterises them. One chapter details human impacts, weeds and alien animals. Another explores management and restoration, including discussion of a range of problems often encountered and potential solutions. A section of coloured photographs provides illustrative examples of diverse wetland habitats.



Remote and wild: seeking the unknown Australia

Authors: Richard and Carolyn Green
Photographer: Richard Green
Publisher: Fine Focus Press
www.richardgreen.net.au
208 pages, hard cover, colour photographs throughout
ISBN: 978 064 652 2937
RRP: $165

If you're looking for a book to astound you with the beauty and diversity of Australian landscapes, *Remote and wild* will do the trick. This visually stunning coffee-table book features some 70 colour photographs, including extra large panoramas of Australian landscapes—taken from Windjana Gorge National Park in WA to Southwest National Park in Tasmania—some of which fold out to almost a metre long. The photographs were mostly taken when 'heli-camping': a novel mode of transport which has enabled authors Richard and Carolyn Green to access many rich and magical places. While the focus of the book is its photographs, several chapters at the beginning—written by Carolyn—provide an interesting insight into the adventure that is heli-camping. A closing chapter by Richard explains his photography equipment and techniques. Take your time to fully appreciate this beautiful book.





Avon Valley National Park

Just 80 kilometres north-east of Perth, Avon Valley National Park is a popular getaway for campers looking to escape the city.

Above Darling Scarp flowering understorey.
Photo – Bill Belson/Lochman Transparencies

Opposite page
Top right Spreading coneflower.

Above right Zamia.

Right Bobtail lizard.

Far right Avon River.
Photos – Jiri Lochman

Avon Valley National Park protects nearly 4,800 hectares of rolling countryside to the north-east of Perth. The Avon River charges through the park after winter rains, and reduces in summertime. Wildflowers adorn the landscape with lashings of brilliant colour in springtime and forests of jarrah (*Eucalyptus marginata*), marri (*Corymbia calophylla*) and powderbark (*E. accedens*) cloak the park's uplands with growth. Other than the campgrounds, infrastructure is minimal, meaning the park is characterised by a feeling of wilderness.

History

The Nyoongar people call the Avon River Golguler, which means 'happy water running over rocks'. Some say you can sit beside the river in contemplation and you may well hear the waters whispering stories of their happiness. The park marks the border of the Ballardong and Yued Aboriginal people. It was an important area for Aboriginal people who would travel through it on their journeys from the York area to what is now known as Walyunga National Park. Avon Valley National Park is also known as the hideaway of the infamous bushranger Joseph Bolitho Johns, better known as Moondyne Joe. Moondyne Joe was a former convict who was deported to the Swan River Colony in 1853, aged 22, for stealing food and a kettle. His continued escapes from prison and recaptures raised the ire of the colonial government and won him the hearts of the public.

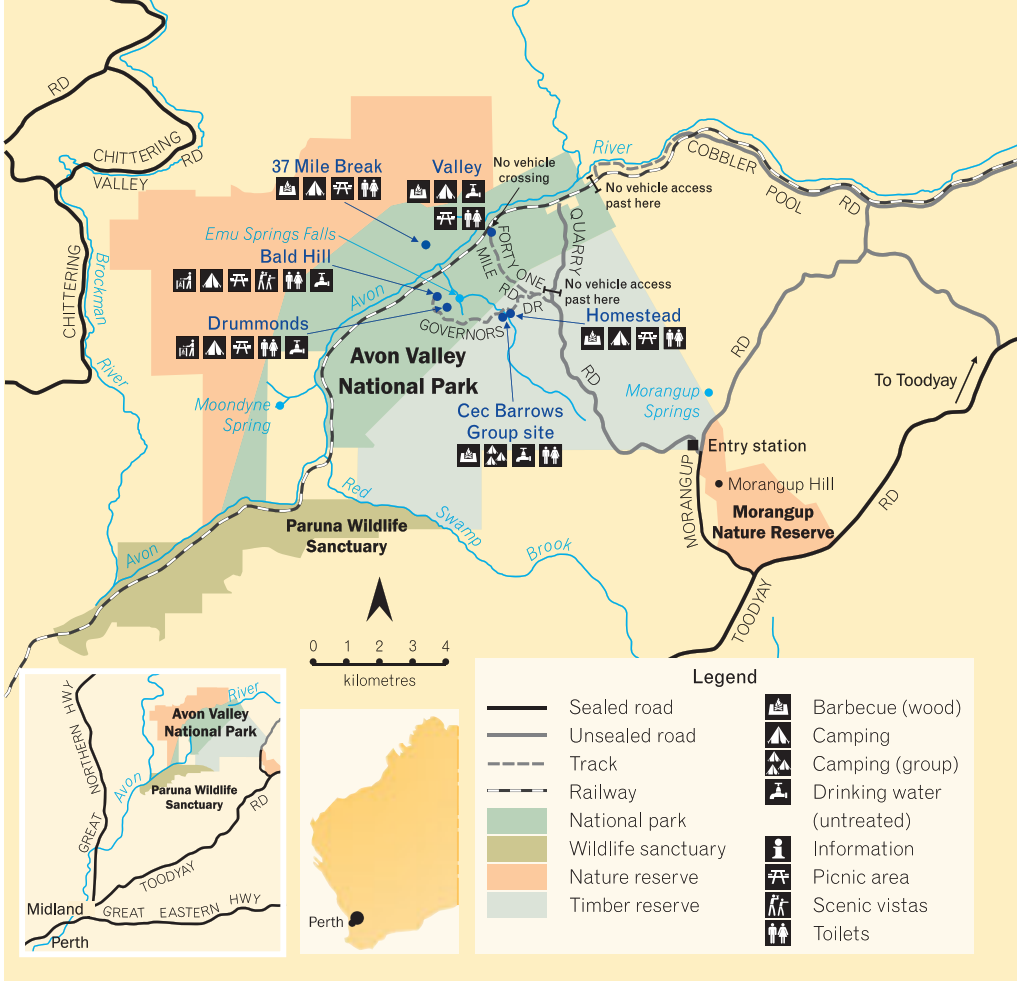
Natural attractions

The sides of the Avon Valley sweep down to the waters of the Avon River. Undulating hills roll through the park and wandoo (*Eucalyptus wandoo*) and jarrah woodlands dominate.

The undergrowth is particularly pretty in spring when species such as fuschia grevillea (*Grevillea bipinnatifida*), coneflowers (*Isopogon* sp.) and balgas (*Xanthorrhoea preissii*) explode into bloom. The park is also home to a fringed lily, *Thysanotus anceps*, a rare species found only in a few localities in







the Darling Range north-east of Perth.

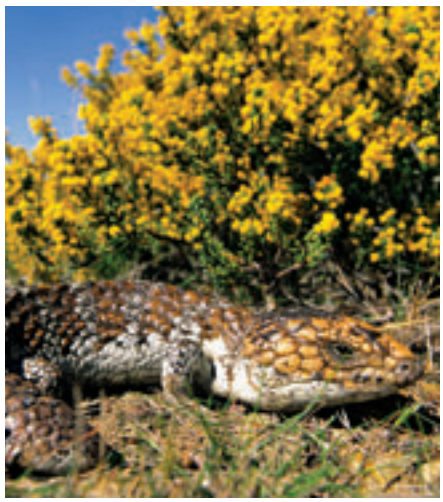
Flooded gums (*Eucalyptus rudis*) crowd the banks of the river, and are home to many bird species, and granite outcrops adorn the landscape with their stark beauty. Those with a keener eye can also admire low shrubs and small lichens and mosses clinging to the rocks.

You will find many smaller birds moving down the slopes in summer to take advantage of the greater number of insects and the continued growth of the plants where the soil is deeper. Bobtail lizards (*Tiliqua rugosa*) are also common here, and are frequently seen from spring through to autumn, sunning themselves on the roads and tracks. Care should be taken to avoid these lizards on the roads.

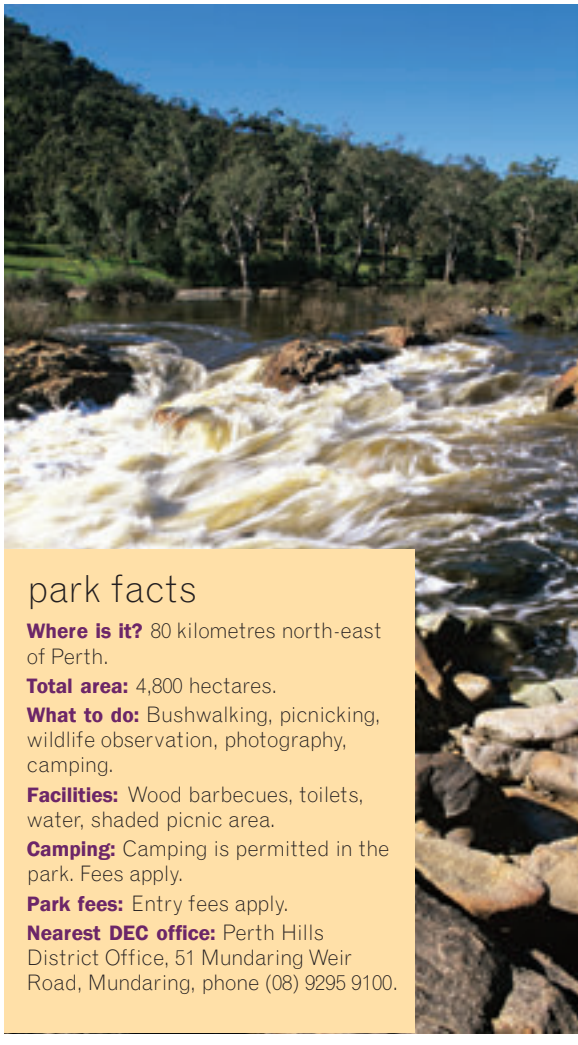
Black-footed rock-wallabies (*Petrogale lateralis lateralis*) have recently been reintroduced to the park and you may be lucky enough to see one around granite outcrops.

Exploring the park

The park features camp sites as well as picnic sites. All camp sites in Avon Valley National Park feature toilets and fire rings in winter when fires are allowed. All except 37 Mile Break and Homestead have water tanks. 37 Mile Break is positioned on the top of the



Darling Scarp on the northern side of the river, providing views over the surrounding plain. Homestead camp site provides a large, flat camping area in the centre of the park suitable for caravans and camper trailers. Cec Barrow's is a group site only and can cater for up to 50 campers. Bookings with the ranger are required. Bald Hill campground is perched atop Bald Hill, providing views of the whole park and Drummonds campground is the start of a three-kilometre-return walk trail to Emu Springs Falls. Walkers can also set out on unofficial tracks along firebreaks.



park facts

Where is it? 80 kilometres north-east of Perth.

Total area: 4,800 hectares.

What to do: Bushwalking, picnicking, wildlife observation, photography, camping.

Facilities: Wood barbecues, toilets, water, shaded picnic area.

Camping: Camping is permitted in the park. Fees apply.

Park fees: Entry fees apply.

Nearest DEC office: Perth Hills District Office, 51 Mundaring Weir Road, Mundaring, phone (08) 9295 9100.

Wetland wonders

Sprawled across 115,000 hectares of the remote east Kimberley are the spectacular wetlands of Parry Lagoons and Ord River nature reserves. The reserves teem with a breathtaking array of birdlife and are now subject to a draft management plan designed to protect and enhance the area well into the future.

BY CORRIN EVERITT AND TROY SINCLAIR





in the far north:

protecting Parry Lagoons and Ord River nature reserves

The Kimberley is renowned as being one of the wildest and most remote places in Australia. Its isolation has helped protect it from disturbances that have led to the decline of native species elsewhere—in fact, the north Kimberley is the only place on mainland Australia that retains a largely intact mammal fauna. That's not to say, however, that the area is not fragile and sensitive to disturbance. Changes caused by altered fire regimes, increasing visitor use, grazing by feral animals and, especially in the case of the Ord River, hydrological changes, mean that management intervention is required if the unique wildlife of the Kimberley is to be maintained.

Located on the lower Ord River are the Parry Lagoons and Ord River nature reserves—two examples of the special but sensitive places found throughout this remote corner of the state. The wetlands here provide important feeding and breeding grounds for an outstanding array of migratory waders and waterbirds. Ord River Nature Reserve also provides important nesting habitat for estuarine crocodiles (*Crocodylus porosus*). Such is the area's value as an important wetland habitat that it was listed as a wetland of international significance under the Ramsar Convention in 1990. Visitors to the reserves enjoy the opportunity to observe a diverse range of fauna in some of the most breathtaking scenery in the east Kimberley.

The habitat

Parry Lagoons and Ord River nature reserves cover more than 115,000 hectares and are representative of the full spectrum of Kimberley habitats, including mangroves, estuarine mudflats, permanent billabongs, shallow ephemeral lagoons and sandstone ranges. The reserves also contain attributes such as basalt outcrops and freshwater springs.

The boundaries of Parry Lagoons Nature Reserve, initially listed as 'Palm Springs' in 1971, have grown over the years to include wetland grasslands which represent the most extensive vegetation community of this type in Western Australia. The reserve's most prominent lagoon, Marglu, is known for its amazing array of waterbirds, making it a hot spot for birdwatchers the world over. Parry Lagoons Nature Reserve is also recognised for its historical significance to the region for here, perched atop Telegraph Hill, is the old Telegraph Station, which overlooks vast grassland floodplains and unique woodlands bordering stunning lagoons and freshwater springs.

Ord River Nature Reserve, located on the eastern side of Cambridge Gulf, has some of the best areas of mangroves in the Kimberley in terms of species diversity, structural complexity and size. The reserve includes the 'False Mouths of the Ord'—the most extensive mudflat and tidal waterway complex in WA. The False Mouths are home to more than 12,000 hectares of contiguous mangrove forest and contain 16 of the 18 species of mangrove found in WA.

Bountiful birds

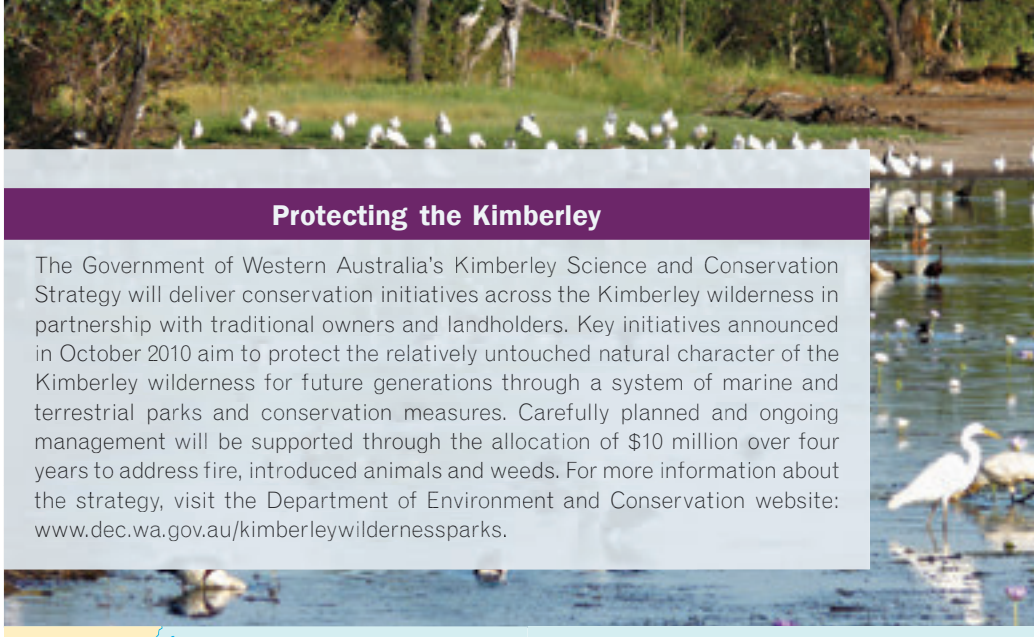
The two nature reserves support a diverse range of birds with more than 190 species recorded from the area, including significant numbers of waterbirds, migratory birds and numerous species of finches. It also contains an array of bats, with nine species recorded.



Previous page
Main Parry Lagoons at sunrise.
Photo – Marie Lochman

Inset Bar-breasted honeyeater.

Left Ord River.
Photos – David Bettini



Right background Birds become more concentrated as waterholes shrink or dry up.
Photo – Jan Lewis

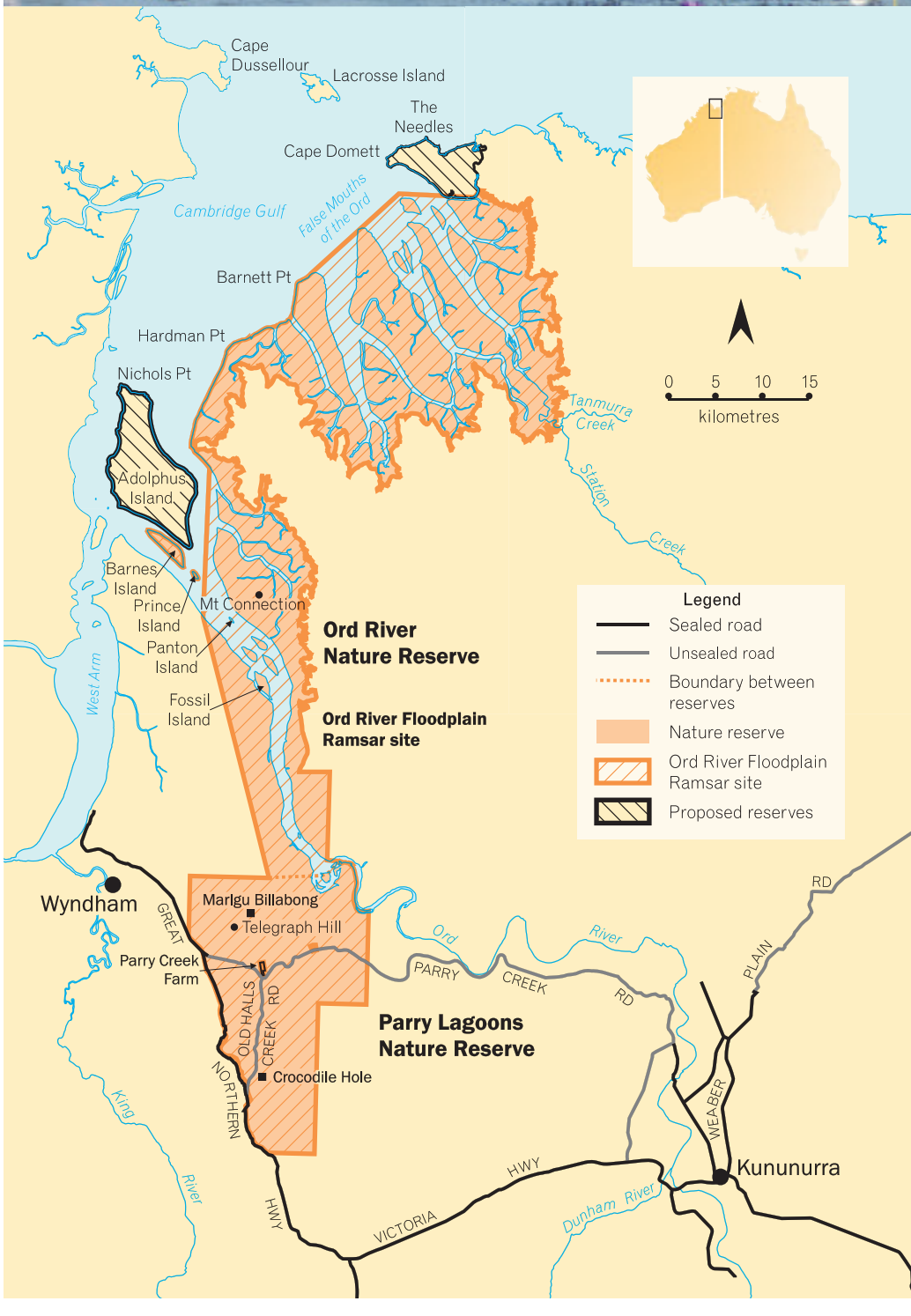
Protecting the Kimberley

The Government of Western Australia's Kimberley Science and Conservation Strategy will deliver conservation initiatives across the Kimberley wilderness in partnership with traditional owners and landholders. Key initiatives announced in October 2010 aim to protect the relatively untouched natural character of the Kimberley wilderness for future generations through a system of marine and terrestrial parks and conservation measures. Carefully planned and ongoing management will be supported through the allocation of $10 million over four years to address fire, introduced animals and weeds. For more information about the strategy, visit the Department of Environment and Conservation website: www.dec.wa.gov.au/kimberleywildernessparks.

While the famed gouldian finch (*Erythrura gouldiae*) is rarely seen in the area, the species is believed to use southern parts of Parry Lagoons Nature Reserve for foraging and possibly breeding among the sandstone hills. Dr Sarah Pryke of the Save the Gouldian Finch Foundation has been studying gouldian populations to the west of Parry Lagoons Nature Reserve, at the upper Grotto Creek system, for more than three years. This area supports a large breeding population from which most juveniles have been banded for identification over the past three years. Significant numbers of star finches (*Neochmia ruficauda*), crimson finches (*N. phaeton*) and chestnut-breasted mannikins (*Lonchura castaneothorax*) also use the reserves for feeding and breeding grounds. These finches are best seen in the early morning and late afternoon during the dry season, drinking at the remaining waterholes dotted throughout the reserves (see 'Fire and finches' on page 36).

Additionally, the area contains 21 of the 22 forest birds which are confined to mangroves in WA. These include the collared kingfisher (*Halcyon chloris*) (rare in the rest of the Kimberley but common here), shining flycatcher (*Myiagra alecto*) and chestnut rail (*Eulabeornis castaneoventris*). A population of black butcherbirds (*Cracticus quoyi spaldingi*) also breeds in the area and is the only known population in WA.

The area is also significant for seasonally supporting large numbers of migratory wader birds such as black-tailed godwits (*Limosa limosa*), marsh sandpipers (*Tringa stagnatilis*), wood sandpipers (*T. glareola*), little curlews (*Numenius minutus*), oriental pratincoles (*Glareola maldivarum*), black-winged stilts (*Himantopus himantopus*) and sharp-tailed sandpipers (*Calidris acuminata*). Any area that supports populations of wader birds is important and needs to be protected to sustain the estimated 850,000 birds that move to





Left Gouldian finch.
Photo – David Bettini

Fire and finches

Historically, large populations of finches and mannikins occurred in areas around Wyndham, including Ord River Nature Reserve. However, species such as gouldian finches are now confined to small populations scattered throughout the east Kimberley. Other species of finches that use the reserves include double bars (*Taeniopygia bichenovii*), crimson finches (*Neochmia phaeton*), long-tail finches (*Poephila acuticauda*), chestnut-breasted mannikins (*Lonchura castaneothorax*), star finches (*N. ruficauda*) and zebra finches (*T. guttata*).

Finches in the reserve area would normally feed on late-seeding perennial grasses such as spinifex. Spinifex needs to be at least three years old to produce viable seed, and it is spinifex that is three years old or older that burns best. Due to fires and increasingly abundant annual sorghum (locally known as 'cane grass'), sandstone escarpment spinifex communities are unable to produce enough seed to reliably support finches late in the season when other seed sources are lacking.

However, cane grass outcompetes other grasses due to its vigor, and thrives under the disturbance of fire and grazing. Finches in the reserve are now overly reliant on cane grass for food. This is problematic because, unlike the regular-seeding spinifex, cane grass seeds in a 'boom or bust' cycle whereby it seeds prolifically all at once and then doesn't seed at all for the rest of the year. Critical to the long-term survival of these finch populations in the reserves is the management of cane grass through altered fire management. This change in fire regime will increase the diversity of aged spinifex so that an ongoing supply of seed can be maintained once more. Also critical to the birds' survival is the control of hot late season fires which destroy nesting hollows.

The Department of Environment and Conservation (DEC) is working with stakeholders to improve the management of fire in the Kimberley, including within Parry Lagoons and Ord River nature reserves, to reduce the total area of reserve burnt by late season fires. DEC's objective in gouldian finch habitat is to introduce a mosaic of differing aged vegetation while maintaining some areas of longer unburnt country which will benefit seed production and assist in the maintenance of species diversity. The Save the Gouldian Finch Foundation has already reported a rise in the number of gouldian finches in areas where late season fire is controlled, a suite of grasses is able to produce seed all year and there is adequate nesting ground.

Conservation efforts including fire management, supplementary nest boxes and education programs promoting the species aim to restore populations of gouldians to their once-common status throughout the east Kimberley.

the north-west coastal strip of Australia every year in preparation for their long flight to the northern hemisphere.

The numbers of birds that the Ord River floodplain and Parry Lagoons support in relation to surrounding areas was highlighted in recent aerial and ground surveys undertaken by the state government for the Ord River Irrigation Area Weaber Plain Development Project. Surveys took place in March and August 2010 along the Ord River below the Diversion Dam adjacent to Kununurra, as well as along the lower Keep River. Results from the March survey indicated approximately 27,000 birds were using the Ord River floodplain and Parry Lagoons, compared to approximately 1,000 for the lower Keep River. These numbers help ensure the area maintains its Ramsar listing, which requires a minimum of 20,000 birds.

Croc country

Parry Lagoons Nature Reserve includes large tracts of habitat suitable for nesting estuarine crocodiles. Increased protection from threats such as hunting and trampling of nests by cattle has led to a significant increase in the estuarine crocodile population in the Ord River. A 2008 spotlight survey on the Ord River adjacent to the reserve revealed that there had been a two-fold increase in the number of non-hatchling crocodiles since the survey was last conducted in 1992. The estuarine crocodile population in this area has therefore been recovering from the extensive commercial hunting of the 1970s quicker than any other population in the east Kimberley.

Reserve extension

Species such as the northern quoll (*Dasyurus hallucatus*) have probably become locally extinct from the reserves but a large population is located nearby at Adolphus Island, which is situated in the mouth of the Ord River and surrounded by tidal mudflats and mangroves. It is the largest island in the east Kimberley and supports the only known island population of northern quolls in the region. Adolphus also supports the only known Kimberley island population of the yellow spotted monitor (*Varanus panoptes*). In light of these unique attributes, the 2009 Ord River and Parry Lagoons draft management plan has recommended that Adolphus Island be included in Ord River Nature Reserve.

Seasons of change

Over the years, the reserves have been subject to significant changes in use. They have long been important to the Aboriginal people of the area for food and cultural activities. The





traditional owners recognise three seasons: Mawan (build up to the wet season) when the grasses are brown, the clay soils and lagoon bed are cracked and dusty and birdlife is least noticeable; Maiyurr (the wet) characterised by heavy rainfall, an abundance of new growth and increased birdlife; and Bandenyirrin (the start of the dry season) when the area receives dry cool easterly winds and floodwaters recede to pools.

There are also marked variations from year to year depending on rainfall and flood events. Historically, the Ord River would have played a greater role in the flooding of the vast grassland plains but, since the massive Lake Argyle was created in 1973, the wetlands are now recharged from local runoff from hillsides and the flooding of Parry Creek.

Between 1919 and 1962, it is estimated that at least two million cattle were driven through the area *en route* to the Wyndham meatworks for slaughter. However, with the change to trucking of stock in the 1970s, the area was no longer heavily used for cattle watering and resting.

Due to their abundant birdlife and fragile habitats, the reserves are now managed by the Department of Environment and Conservation (DEC) and have become increasingly popular with tourists.

Filling gaps in knowledge

In 2008 the Australian Government developed an 'ecological character description' of the area which worked to determine limits for acceptable levels of change in key areas, including the mangroves and associated wetlands, species diversity and the area's ability to support critical life-stage development of numerous species of migratory animals. However, there are a number of key knowledge gaps that restrict the setting of such thresholds, namely limited understanding of the hydrology of Parry Lagoons and associated floodplain (particularly the role of Parry Creek in inundation of the floodplain), the connectivity between the floodplain and estuarine areas of the Ramsar-listed site and the hydrology of the False Mouths of the Ord and other tidal creeks that influence the area.

To help overcome these gaps in knowledge, in 2009 Geoscience Australia, on behalf of the Ord Irrigation Cooperative and Rangelands Natural Resource Management, included the Ramsar area in helicopter surveys to assess the hydrology and geology of the Ord floodplains using 'airborne electromagnetic models' and 'digital elevation models'. Information gleaned from the survey is helping determine



Above Walkway at Marglu Lagoon in Parry Lagoons Nature Reserve.
Photo – Marie Lochman

Above right Estuarine crocodile.
Photo – John Kleczkowski/Lochman Transparencies

Right Comb-crested jacana or lotus bird.
Photo – Jiri Lochman



Above Wet season view from Telegraph Hill, in Parry Lagoons Nature Reserve.
Photo – Jan Lewis

limits of acceptable change within the reserves and is paving the way for management actions to be prioritised. In particular, the information will serve as a benchmark for assessing changes in the wetlands and identifying areas that may be at risk of increased salinity and hydrological changes as a long-term result of the damming of the Ord River in 1972 and consequent changes in its flood patterns.

Such information has helped to guide DEC's newly developed draft management plan, which is designed to provide guidance and consistency to the management of the reserves for the next 10 years and beyond with a focus on balancing the need to manage the reserves to maintain biodiversity while also enhancing the area for visitors.

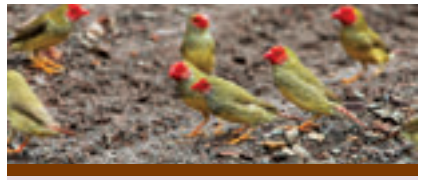
Into the future

While reserves are declared to protect the unique species assemblages and landscape they contain, it is also important to allow access to the general public to appreciate these values. However, increases in usage provide mechanisms for weed intrusion, introduced animal abundance, disturbance to birds, arson and degradation of the landscape due to vehicle tracks off designated roadways. DEC is working to improve the management of these threats to minimise their impact on the fragile areas.

DEC is also working to enhance the experience for visitors to the reserves. The department has recently upgraded the bird hide and walkway at Marglu Lagoon in Parry Lagoons Nature Reserve to enable visitors to better witness the spectacular birdlife without disturbing it. DEC has also improved designated roadways and rehabilitated areas that had become degraded and provided interpretive material to offer visitors a better understanding of the area's history.

DEC has plans to improve weed management within the reserves with a focus on control of parkinsonia (*Parkinsonia aculeata*), rubber bush (*Calotropis procera*), noogoora burr (*Xanthium strumarium*) and belly ache bush (*Jatropha gossypifolia*). These weeds can significantly alter the wetland and surrounding grassland habitats, which in turn threatens the biodiversity that they support. Management of weeds is one of many threats to biodiversity that relies on good relationships with neighbouring users—something that DEC is continually working to improve through liaison with traditional owners and pastoralists. DEC is also working with neighbouring pastoralists to reduce cattle numbers in the reserves to protect important crocodile nesting habitat, grasslands, riparian habitats and waterways. By working together, these important habitats can be protected well into the future.

Below Star finches.
Photo – Jan van de Kam



Corrin Everitt is the Department of Environment and Conservation's (DEC's) state Cane Toad Initiative program leader. As part of her role, she assists with media and editorial articles to increase awareness of the east Kimberley's unique natural diversity and landscape. She can be contacted on (08) 9168 4219 or by email (corrin.everitt@dec.wa.gov.au).

Troy Sinclair is DEC's regional leader of nature conservation for the Kimberley Region. He helps manage threatening processes to the area's biodiversity. He can be contacted by email (troy.sinclair@dec.wa.gov.au).

New national park to be cat free

The opportunity to reconstruct the native fauna of Dirk Hartog Island will rely on the eradication of feral cats. An upcoming project to achieve this will be the largest feral cat eradication campaign attempted on an island in the world, and will include some unique challenges and interesting tools.



by Dave Algar, Steffi Hilmer, Mike Onus, Neil Hamilton and Joanna Moore



Dirk Hartog Island, within the Shark Bay World Heritage Area, became a national park in November 2009. With some 200 kilometres of coastline and an area of 620 square kilometres, it is the largest island off the Western Australian coast and could potentially support one of Australia's most diverse arrays of mammals.

This means that WA's newest national park could contribute significantly to the long-term conservation of several threatened species, such as the woylie (*Bettongia penicillata*), boodie (*Bettongia lesueur*) and chuditch (*Dasyurus geoffroii*). However, making the most of this opportunity to reconstruct the native mammal fauna of the island relies on the successful eradication of feral cats (*Felis catus*).

The cat problem

There is extensive evidence that the introduction of domestic cats to both offshore and oceanic islands around the world can seriously affect endemic land vertebrates and breeding bird populations. Insular faunas that have evolved for long periods in the absence of predators are particularly susceptible to cat predation.

Dirk Hartog Island is no exception, with 10 of 13 native terrestrial mammal species that previously occurred on the island now locally extinct. Predation by cats was a major factor in these extinctions. The 10 species are mainly medium-sized mammals and include the boodie, woylie, western barred bandicoot (*Perameles bougainville*), chuditch, crest-tailed mulgara (*Dasycercus cristicauda*), dibbler (*Parantechinus apicalis*), greater stick-nest rat (*Leporillus conditor*), desert mouse (*Pseudomys desertor*), Shark Bay mouse (*P. fieldi*) and heath mouse (*P. shortridgei*). Only three smaller-sized species—the ash-grey mouse (*P. albocinereus*), sandy inland mouse (*P. hermannsburgensis*) and the little long-tailed dunnart (*Sminthopsis dolichura*)—still occur on the island. It is possible that the banded hare-wallaby (*Lagostrophus fasciatus*) and rufous hare-wallaby (*L. hirsutus*) also occurred on the island, as they both occur on nearby Bernier and Dorre islands, and at one time occurred on adjacent mainland areas.

The island is also home to three threatened bird species—the Dirk Hartog Island white-winged fairy wren (*Malurus leucopterus leucopterus*), Dirk Hartog Island southern emu-wren (*Stipiturus malachurus hartogi*) and the Dirk Hartog Island rufous fieldwren (*Calamanthus campestris hartogi*). A population of the western spiny-tailed skink (*Egernia stokesii badia*) found on the island is also listed as threatened.

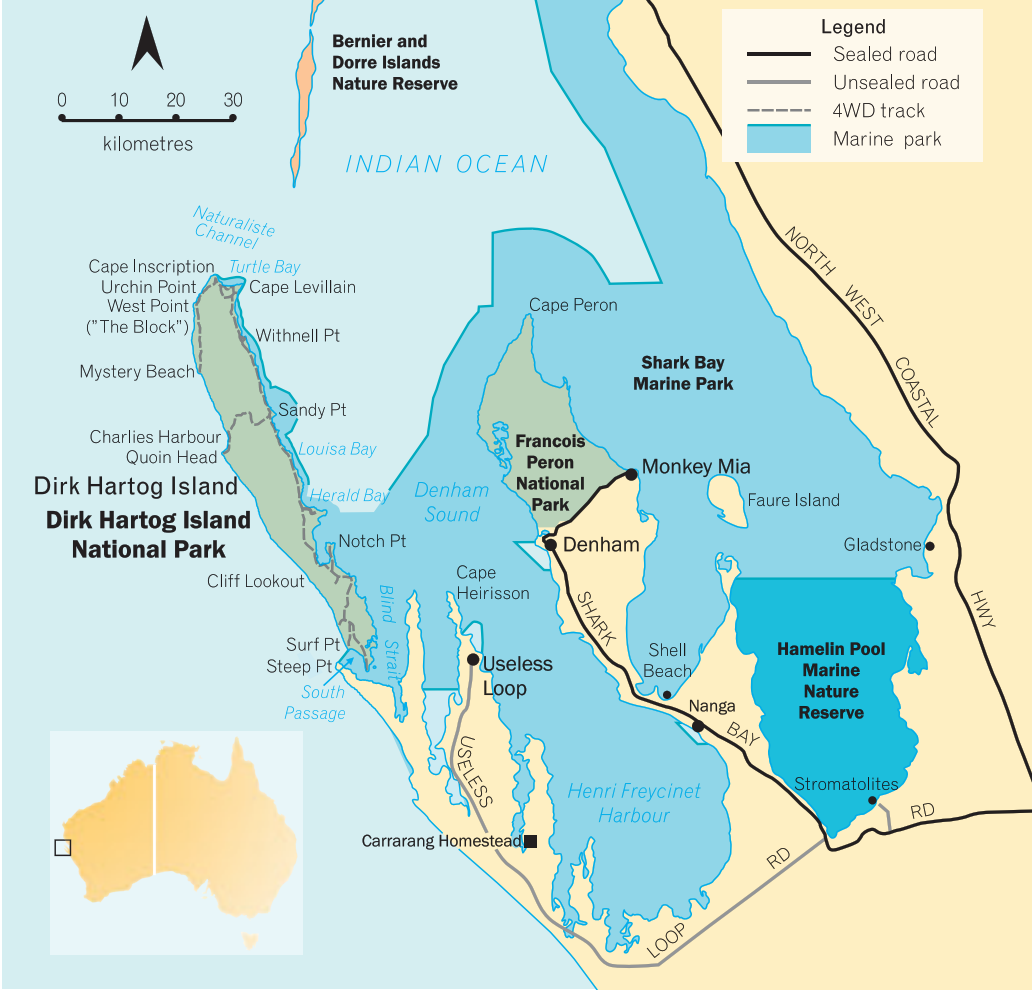
Dirk Hartog Island has a rich and multi-layered history. Shell middens



Previous page
Main Cat paw prints on sand track.
Photo – Neil Hamilton/DEC
Inset Feral cat with transmitter collar.
Photo – Steffi Hilmer/DEC

Above Coastal vegetation and bays.
Photo – Mike Johnston/DSE Victoria

Left Dunnarts are vulnerable to feral cat predation.
Photo – Jiri Lochman







Below right Lighthouse on Dirk Hartog Island.
Photo – Eva Boogaard/Lochman Transparencies

Bottom right A feral cat with kittens—successful eradication requires cats to be killed more quickly than they can breed.
Photo – Jiri Lochman

and stone artefacts dated at between 6,000 and 3,500 years old suggest that Aboriginal people lived on the island at times of lower sea levels. The island is also arguably one of the most significant places for early European contact in WA (see 'Dirk Hartog Island: inscribed in history', *LANDSCOPE*, Summer 2007–08). Since the 1860s, Dirk Hartog Island has been managed as a pastoral lease and grazed by sheep and goats. More recently, tourism has been the main commercial activity to occur on the island. Feral cats became established on the island during the late 19th century and were probably introduced by early pastoralists.

A major challenge

It is estimated that eradicating feral cats from Dirk Hartog Island National Park and confirming the program's success will cost some $2,300,000 over a three-year period. Globally, the Dirk Hartog project will become the largest feral cat eradication campaign attempted on an island.

Control of feral cats is recognised as one of the most important fauna conservation issues in Australia today and, as a result, the national *Threat abatement plan for predation by feral cats* has been developed. Under the plan, the goal is to protect affected native species and ecological communities, and to prevent further species and ecological communities from becoming threatened. The plan's first objective is to prevent feral cats from occupying new areas in Australia and eradicate feral cats from high conservation value islands.

The successful eradication of cats from an island relies on a number of requirements including that all cats are at risk from the baiting, that the population can be killed faster than it can be replaced, that the feral cats can be detected at relatively low densities to target residual pockets of individuals, and that reinvasion can be prevented. It is also important to have community support for the program and to make sure funding continues until a successful outcome is reached.

Planning logistics

There is a range of challenges in conducting an eradication campaign on Dirk Hartog Island, including the island's size, in particular its length. The island is 76 kilometres long and

between three and 11 kilometres wide, covering 62,000 hectares. As it is not practical to monitor cat activity over such a large area all at once, the eradication campaign will be conducted in two stages. A 10-kilometre-long cat-proof fence will be constructed east–west across the island at Herald Bay, effectively dividing the island into two, with a gate at the intersection of the main track across the island to allow vehicle movement.

The program will be carried out over three years, from July 2011 to July 2014. The first stage will be dedicated to putting the infrastructure in place for accommodation and equipment storage, installing monitoring transects and constructing the barrier fence. Baiting will then begin in the southern section in autumn 2012 with a follow-up monitoring and trapping program to eradicate feral cats through to autumn 2013.The following year the same process will be followed in the northern section.

Techniques and trials

Baiting is recognised as the most effective method for controlling feral cats on mainland Australia, and has been used as the primary technique for eradicating cats on some islands. Worldwide, cat eradications on islands have tended to be successful when poisoning with toxic baits was the main element. The bait designed and developed by Department of Environment and Conservation (DEC) researchers for the successful control of feral cats is known as *Eradicat*®. The baits, manufactured at the DEC bait factory at Harvey, contain 4.5 milligrams of directly injected toxin 1080, or sodium monofluoroacetate, the same toxin that occurs naturally in native poison pea plants.

For the baits to be effective, it is essential that campaigns are conducted prior to the onset of late autumn or winter rainfall. For the Shark Bay area, this seasonal period usually begins in May. A 25,000-hectare pilot study was conducted on Dirk Hartog Island



Left Setting a cat trap.
Photo – Steffi Hilmer/DEC



Below left Bait preparation.
Photo – Katrin Koch



Below A released cat with transmitter collar on Dirk Hartog Island.
Photo – Steffi Hilmer/DEC





Monitoring techniques

A key component of the eradication program will be monitoring to quantify the results. Monitoring techniques must be capable of detecting animals at low densities. To provide a measure of effectiveness, cat activity will be surveyed on track transects at both monitoring plots and along the length of transects before and after control programs.

Track survey transects, each 10 kilometres in length, will provide a broad coverage of the entire area. Twenty marked one-metre-wide sand plots, positioned across the width of the transect and located at half-kilometre intervals along each transect, will be used to survey feral cat activity, with each plot observed for the presence or absence of tracks. An audio and scent lure will be used to attract cats to the sand plots during the pre and post-bait survey periods.

A hair snag device will be located at each plot to capture hair for DNA analysis to identify individual cats. Through DNA analysis of hair samples collected at monitoring plots, researchers can assess changes in population abundance, and this has the potential to greatly improve understanding of the effectiveness of control strategies (see 'Controlling introduced predators in the rangelands: the conclusion', *LANDSCOPE*, Winter 2010).

between March and May 2009 to assess the effectiveness of the current aerial baiting strategy, which will be the main technique in the proposed eradication campaign. Prior to the baiting program, a number of cats were fitted with GPS data-logger radio-collars, in part to assess baiting efficacy and also to provide detailed information on cat activity.

The information gained from this pilot study has been used in the planning of flight transects for bait delivery across the island. The proposed modifications to the current baiting regime will maximise the likelihood of the entire cat population encountering a bait within the shortest possible time. This will make baiting more efficient and cost-effective. Unlike baiting campaigns on mainland sites—where baits are required to be laid annually to control cat numbers because of reinvasion—it is expected that single-site baiting will prove extremely effective on Dirk Hartog Island. However, a baiting program alone is unlikely to result in eradication, so an intensive monitoring and trapping campaign will also be conducted to remove the cats that survive baiting.

Monitoring, tagging and 'sentinel cats'

In conjunction with the monitoring surveys conducted pre and post-baiting, radio-collared cats will be used to determine the effectiveness of baiting. Three to four months before the start of the two baiting programs, a number of cats will be trapped and fitted with GPS data-logger radio-collars with a mortality signal. Feral cats will be trapped in padded leg-hold traps, using a mixture of cat faeces and urine as the lure. Sex and bodyweight of the captured animals will be recorded and a sample of hair and tissue taken for DNA profiling. Data collected on movement patterns of these animals during the monitoring programs will be used to help calculate occupancy and abundance estimates, and provide a measure of baiting efficacy.



Top left Radio tracking feral cats.
Photo – Steffi Hilmer/DEC

Top right background Dirk Hartog Island coastline.
Photo – Eva Boogaard/Lochman Transparencies

Left Shark Bay mouse.
Photo – Jiri Lochman





Above Coastal dunes.

Left A banded hare-wallaby.
Photos – Jiri Lochman

Cats are social animals and when at low numbers are likely to actively seek other cats in the area, particularly during the breeding season. Researchers are considering the use of 'sentinel cats'—animals brought in from outside the control area and sterilised, not de-sexed. (De-sexing through removal of the ovaries and fallopian tubes or castration changes hormonal activity, whereas sterilisation through tubular ligation or vasectomy means the animals maintain normal hormonal activity and so will interact with other cats as they would normally.) These cats would also be fitted with radio-collars to enable their locations to be plotted and their subsequent removal. Information collected from the animals will, firstly, give further confidence in cat detectability, especially at low population densities. Secondly, once the sentinel cats have been removed, intensive searching of the area for subsequent signs of cats will indicate whether the sentinel cats had found other cats in the area or had been living alone.

Rapid detection of cats surviving the initial application of baits is critical to successfully eradicating cats from the island. The detection of any cat

Guaranteeing the achievement

The significant expenditure and effort associated with the attempted eradication of exotic species on islands can be very quickly wasted if the target species are able to readily re-establish from other locations. Dirk Hartog Island is sufficiently isolated to preclude the arrival of cats swimming or drifting independently from the mainland. DNA samples will be taken from feral cat populations on Dirk Hartog Island, at Denham and Steep Point and stored as reference samples. These genetic profiles can then be compared with DNA samples from any cats that may be found on the island following the confirmation of eradication. Thus, in the event of cats getting onto the island post-eradication, this information will help determine where quarantine measures need to be improved.







sign during the monitoring programs will instigate an intensive ground baiting of the general location and the implementation of a trapping program at the site of the sign and surrounding area so any remaining cats can be removed.

Cats that survive the baiting programs will be removed by trapping. There are a number of different trap sets and lure types suitable for use on Dirk Hartog Island depending on the situation and location. Following the completion of the monitoring and trapping programs, detector dogs and their handlers will be contracted to further verify the absence of cats. At the conclusion of the program, an independent team of experts will be invited to the island to corroborate that eradication has been successfully achieved.

DEC will implement an ongoing cat monitoring program and a strict quarantine program to ensure that cats and others introduced species will not be reintroduced to Dirk Hartog Island.

Top left The knob-tailed gecko is a common island species.
Photo – S Wright/DEC

Top Sandy inland mouse.
Photo – Jiri Lochman

Above A white-winged fairy wren.
Photo – Babs and Bert Wells/DEC

Below Feral cat.
Photo – Jiri Lochman

Dave Algar is a senior research scientist at the Department of Environment and Conservation's (DEC's) Science Division at Woodvale. He has worked throughout Western Australia conducting research on feral cat control for the past 20 years. He can be contacted by email (dave.algar@dec.wa.gov.au).

Steffi Hilmer has recently completed her PhD titled 'Ecophysiology of feral cats in Australia'. Part of her work was conducted on Dirk Hartog Island, investigating the home range and movement patterns of cats on the island. Steffi is now working with DEC. She can be contacted by email (stefanie.hilmer@dec.wa.gov.au).

Mike Onus is a senior technical officer at DEC's Science Division at Woodvale. He has worked on feral cat research under the fauna conservation program for the past 20 years. He can be contacted by email (mike.onus@dec.wa.gov.au).

Neil Hamilton is a senior technical officer at DEC's Science Division at Woodvale. He has worked on feral cat research under the fauna conservation program for the past nine years. He can be contacted by email (neil.hamilton@dec.wa.gov.au).

Joanna Moore is a DEC publications officer and *LANDSCOPE* editor. She can be contacted on (08) 9389 4009 or by email (joanna.moore@dec.wa.gov.au).





People in profile

Story by Samille Mitchell
Photographs by Jiri Lochman



When now-renowned Western Australian wildlife photographer Jiri Lochman submitted an image for possible publication in *LANDSCOPE* 25 years ago, he sparked a long relationship with the magazine that has seen his photographs published in all but three of the *LANDSCOPE* magazines ever to be produced. Along the way, Jiri has built a reputation as one of the country's foremost wildlife photographers. The beginnings for his distinguished career were formed as a child in Czechoslovakia from a love of animals and a strong conviction to fight for what he believes in.

Wildlife photographer

Jiri Lochman



Wildlife photographer Jiri Lochman is not one to gush; he says it straight, to the point. But talk to him about Australian wildlife and you may just note a sparkle in his eyes that belies his depth of feeling for the subject. For Jiri is a conservationist first and foremost. Photography is simply a way to spend time with animals and enlighten others about their beauty and need to be conserved. He'll reject photographic assignments if he feels they could harm an animal. He'll wait for hours, days, even weeks for an animal to show itself rather than scare it out to be photographed. For Jiri, the animals always come first.

Jiri's strong sense of right and wrong was apparent even as a kid growing up in communist Czechoslovakia. At 12 years of age, he staged his first environmental protest by insisting the family do away with Christmas trees—he had calculated how many trees were killed each year simply to adorn households for a few days. His parents complied with his wish, much to the chagrin of his older sister. This early passion for the environment and wildlife led to his first job as a zookeeper in Liberec Zoo.

As a young adult, Jiri had one other passion—song writing. However, the Czechoslovakian communist regime punished him for writing humorous protest songs by banning him from working in anything but a communist-dictated job. His career at the zoo was over, his passport taken, his future dim. So, in 1977, Jiri and his partner Marie fled their homeland and took up refuge in Austria. They were wed in an Austrian refugee camp near Vienna in the 11 months they waited to be accepted by Australia. They requested Australia for their future home, firstly, because they knew no-one here and could establish themselves independently and, secondly, because Jiri was enamoured of the Australian wildlife.

"The North American fauna was similar to the European fauna and in all of the Czech zoos there were only four or five species of Australian mammals—I wanted to see more," Jiri says.

New beginnings

So it was that the young duo first set foot on Australian shores in Sydney. With virtually no English language ability, they embarked on an intensive English course before finding jobs—Jiri at a turkey breeding farm and Marie at a caravan park. Whenever they could wangle a day off together they'd set out into the bush. So taken were they with what they saw that within six months the Lochmans had saved enough money to buy their very first camera to capture the sights on film—a Nikon FM, and they continue to use Nikons today. While Jiri describes his first photographic efforts as "terrible",



Previous page
Main The beach stone curlew (*Esacus neglectus*) is a rare inhabitant of remote beaches.

Above Jiri spotted this red-bellied black snake (*Pseudechis porphyriacus*) curled on a little track in north-eastern Queensland and laid himself beside it with his close-up lens on ready.

Left Jiri followed this short-beaked echidna (*Tachyglossus aculeatus*) through wandoo woodland until it climbed into a tree stump hollowed by termites to have a little nap. Jiri waited nearby, and it paid off; he took this image as the echidna checked for signs of danger before leaving its temporary domicile.



Above When feeding is good parrots can be quite blasé about their safety. This male red-winged parrot (*Aprosmictus erythropterus*) definitely liked this native hopbush, as he allowed Jiri to photograph him from a very close distance.



Right Aerial antics of dragonflies are easier to watch than photograph. The graphic flutterer (*Rhyothemis graphiptera*) is one of the most vividly coloured Western Australian dragonflies.

it wasn't long before the photos began to improve.

Another six months later and the couple had scratched together enough cash to buy a car—and freedom. They quit their jobs and set off around the country. They travelled south from Sydney, then via the Birdsville Track to Queensland and to Cape York where they spent four months photographing and exploring the great wilderness. Next they journeyed across the top of the country to Kakadu and then on to the Kimberley, working occasionally to fund their travels. They marvelled at vast wetland plains, hiked among ancient cathedrals of rock and gazed in wonder at Australia's unique plants, insects, mammals and birds. It was a grand time—when few people ventured to these then relatively untouched corners of the country—and the Lochmans revelled in the richness of the natural surrounds.

A home in Perth

Some two-and-a-half years after they set off, the Lochmans arranged to meet a friend in Perth. They reached the outskirts of the city around Bullsbrook at about 2am and decided to pitch a tent for the night before entering the city the next day. With uncharacteristic effusiveness, Jiri recalls: "When we woke up the next morning we looked out of the tent and there were kangaroo paws all around us, dew on all the plants and everything was in bloom. We felt like we were waking in a paradise." With that first impression of Perth, the Lochmans knew they had found a place to call home.

Keen to establish themselves and continue to indulge their passion for animals, Jiri approached Perth Zoo for a job and it wasn't long before he was working as a zookeeper with the carnivores. But Jiri had his sights set on another part of the zoo—the nocturnal house which housed the Australian mammals he so adored. He eventually fulfilled his ambition but by then photography had become more than a hobby and Jiri and Marie took the plunge by quitting their jobs once again and forging a career from photography. It wasn't long before their stock library, Lochman Transparencies, was born.

Passion for photography

While Jiri and Marie had already been selling photos during Jiri's time at the zoo, Jiri's first paid photographic assignment was for one of the Department of Environment and Conservation's predecessors, the Department of Conservation and Land Management. He was asked to photograph Perth lakes for a *LANDSCOPE* article. Jiri and Marie also photographed their first book for the department—the original publication of *Wild Places, Quiet Places* about the south-west's parks and reserves.

He notes a photographic assignment for *Australian Geographic* in Western Australia's Karlamilyi National Park, formerly Rudall River National Park, as a particularly memorable one. "It's all about having the opportunity to be there with the animals, in their environment, and with the people who care," he says.

Not that it's all plain sailing. In fact much of the job is about waiting, waiting and waiting. Jiri refuses to interfere with his subjects, so, rather than flush a creature out of its burrow, he will simply wait—sometimes days—for it to appear. Given the nocturnal habits of many Australian creatures, much of this waiting is at night, with some shift changes in which Marie takes over while Jiri catches some sleep. He remembers photographing southern bush rats (*Rattus fuscipes*) in New South Wales from a hide.





Above Jiri was originally photographing one yellow-footed rock-wallaby (*Petrogale xanthopus*) when the second one appeared and, for the briefest moment, posed allowing Jiri to take this amazing shot.

Left Some Australian jewel beetles, such as this *Stigmodera gratiosa*, have such gem-like qualities that in the past they were sought by jewellers.

Below right Freshwater crocodiles (*Crocodylus johnsoni*) are usually very shy, but this one stayed on the surface allowing Jiri to take a couple of successful images.

However, on this occasion he had already taken lots of photos so decided to leave Marie sleeping and the camera gear unattended while he dozed for a couple of hours. Upon awakening, he returned to his hide, waited for the bush rat to reappear and began to photograph but the flashes didn't fire. He checked the equipment, waited and waited for the bush rat again, and attempted to photograph it once more. Again, nothing. It turned out the bush rat had chewed through the cables while Jiri dozed nearby.

Despite the trials of his profession, Jiri says it's aglow with highlights. He marks being the first person to photograph a live monjon (*Petrogale burbidgei*) as a memorable moment in his career. The recent publication of his book *Wildlife of Australia* and winning an *Australian Geographic* award for excellence in photography, together with Marie, also rate a mention. But for Jiri the best part is simply being in the bush: "Every time I'm out there with some animal—that's the highlight," he says.

Passion for conservation

While Jiri has no regrets about his career, he is saddened by a decline in wildlife across the country. He remembers visiting the north-west Kimberley in the 1980s and early 1990s and photographing abundant mammal life in many places. However, return trips in the late 1990s and 2000s yielded dramatically different results. He observed that many places where wildlife once abounded now seemed all but deserted. He remembers a sad visit to one of his favourite rainforest patches where he once photographed the northern quoll (*Dasyurus hallucatus*), scaly-tailed possum (*Wyulda squamicaudata*), golden-backed tree-rat (*Mesembriomys macurus*), Kimberley rock-rat (*Zyzomys woodwardi*), common rock-rat (*Z. argurus*) and sugar glider (*Petaurus breviceps*). However, by 1999 all but the northern quolls had disappeared. "We returned again in 2001 and spent four nights there," Jiri says. "I barely slept, as I was incredibly eager to disprove the sad observation from our previous visit. This time even the northern quolls were gone, we did not see a single one. The nights were eerily silent, no rustling in dry leaves, no movements in the trees, nothing but dead silence."

Rather than deter him from his job, the animals' plight makes Jiri all the more determined. Armed with his cameras, he is doing his bit to help stem the decline. As he wrote in a *LANDSCOPE* article about being a wildlife photographer (see 'Animals in my lens', *LANDSCOPE*, Summer 1990-91): "The biggest task of any wildlife photographer is to open this sometimes unfamiliar world to those who are interested, and who, for various reasons, may not be able to experience it firsthand. Wildlife photography plays a major role in the conservation of endangered species. For example, few people have seen the giant panda but, thanks to photography, most of us know what it looks like. Without this change of the unknown into the familiar, motivating sufficient interest to save threatened animals would be difficult, if not impossible."

With this belief in mind, Jiri plans to continue his mission to show animals in their most beautiful light. In doing so, he will be playing his part in preserving the Australian animals that first captured his heart in a Czech zoo more than 40 years ago.



Samille Mitchell is a DEC editor and features writer. She can be contacted by email (samille.mitchell@dec.wa.gov.au).

endangered

by Val English



Coastal sedgelands

An important suite of wetlands that contains the threatened ecological community known as 'sedgelands in Holocene dune swales' occurs in the Rockingham area, with a few small outliers near Bunbury and Wanneroo. These special wetlands occur within linear dips (swales) between sand dunes mainly in regional parks, local government reserves and private land.

The Rockingham-Becher Plain on which these wetlands mainly occur was formed through the deposition of beach sands by the ocean during the past 10,000 years—known as the Holocene period. These dunes and swales are of great interest in the study of landforms and the processes that shape them. They provide a record of how the wetlands have developed, from the older dunes further inland, to the younger soils closer to the coast that were deposited more recently along the shoreline. The wetlands also provide an insight into the evolutionary record of sea level history, shoreline and climatic changes.

The typical wetland where this community occurs is a dampland—in winter it becomes waterlogged, and in summer it remains quite wet near the soil surface. Some of the wetlands contain surface water during the winter months and are known as sumplands.

Typical flora in the community include the shrubs climbing lignum (*Muehlenbeckia adpressa*), orange wattle (*Acacia saligna*) and balga (*Xanthorrhoea preissii*); the sedges bare twig-rush (*Baumea juncea*) and knotted club-rush (*Ficinia nodosa*), and the grass *Poa porphyroclados*. One sub-set of this community includes trees such as swamp banksia (*Banksia littoralis*), melaleucas and tuart (*Eucalyptus gomphocephala*).

This sedgeland is only known from a total of about 180 hectares, of which a small area is in protected reserves. The community is under threat from clearing and a decline in water levels and quality resulting from the drying climate and adjacent land uses such as residential developments, golf courses, heavy industry and grassed sporting grounds. While this community is relatively resilient, too frequent hot fires have a big impact and encourage weed invasion. One of the worst weeds in the community is Geraldton carnation weed (*Euphorbia terracina*)—a very invasive, toxic species. Fortunately, recent research indicates that this weed can be controlled with special herbicides that have minimal impact on the sedgelands.

The Department of Environment and Conservation has developed a recovery plan and set up a recovery team for the community that includes local stakeholders. Actions include managing groundwater levels and quality, managing fire, controlling weeds and fencing. Together, such work will help ensure the future protection of these very special wetlands.

Photos by Val English



Western Australia's Ramsar wetlands

by Michael Coote

Australia has 64 wetlands listed under the Ramsar Convention—an intergovernmental treaty whose member countries cover all geographic regions of the planet—and 12 of these are within Western Australia. Complex conceptual, mapping and management tools are required to understand and protect these multifaceted systems.





Wetlands—once seen as swampy places of little aesthetic or conservation value—are now recognised as some of the most biologically diverse of all ecosystems. Wetlands can indeed be swamps (and there is a diverse range of these) as well as marshes, ponds, lakes, saltmarshes, fens, creeks and rivers. These areas provide habitats for a wide range of animals, from the waterbirds which are probably the most well recognised and studied wetland species, to equally important but perhaps less charismatic animals including species of amphibians, reptiles, insects and mammals. As well as creating habitat for fauna, our wetlands provide a range of important ecosystem services including storing and naturally purifying water and absorbing carbon. They are worthy of our protection and conservation.

Australia is one of 160 countries that is party to the Ramsar Convention on Wetlands, which was signed in Ramsar, Iran in 1971. This treaty, officially known as *The Convention on Wetlands of International Importance, especially as Waterfowl Habitat*, currently lists more than 1,906 wetlands worldwide covering some 186.5 million hectares. The Ramsar Convention aims to provide the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources.

Australia has a great tradition of identifying important wetlands across the breadth of the continent. It was the first to nominate a site in 1974—Cobourg Peninsula in the Northern Territory—and now has 64 wetlands listed under the Ramsar Convention. Twelve of these sites occur in Western Australia, covering a total area of 514.8 thousand hectares.

Previous page

Main Lesser crested terns.
Insert Mudskippers, Roebuck Bay.

Above right Waders in Roebuck Bay.
Photos – David Bettini

Ramsar wetlands in WA

The 12 WA wetlands included on the Ramsar list are spread across the state. Four are in the Kimberley region: the Ord River Floodplain, near Wyndham (see 'Wetland wonders in the far north: protecting Parry Lagoons and Ord River nature reserves' on

What makes a wetland internationally important?

The Ramsar Convention recognises wetlands under nine conditions. Listed wetlands can meet any one of these, however, in practice, they normally have to meet one other criterion besides Criterion 1 (known as group A—'Sites containing representative, rare or unique wetland types'). Criterion 1 is: A wetland should be considered internationally important if it contains a representative, rare, or unique example of a natural or near-natural wetland type found within the appropriate biogeographic region.

Group B—'Sites of international importance for conserving biological diversity'—includes three criteria based on species and ecological communities. These are: Criterion 2—A wetland should be considered internationally important if it supports vulnerable, endangered, or critically endangered species or threatened ecological communities; Criterion 3—A wetland should be considered internationally important if it supports populations of plant and/or animal species important for maintaining the biological diversity of a particular biogeographic region; and Criterion 4—A wetland should be considered internationally important if it supports plant and/or animal species at a critical stage in their life cycles, or provides refuge during adverse conditions.

There are also two specific criteria based on waterbirds: Criterion 5—A wetland should be considered internationally important if it regularly supports 20,000 or more waterbirds; and Criterion 6—A wetland should be considered internationally important if it regularly supports one per cent of the individuals in a population of one species or subspecies of waterbird. The specific criteria based on fish are Criterion 7—A wetland should be considered internationally important if it supports a significant proportion of indigenous fish subspecies, species or families, life-history stages, species interactions and/or populations that are representative of wetland benefits and/or values and thereby contributes to global biological diversity; and Criterion 8—A wetland should be considered internationally important if it is an important source of food for fishes, spawning ground, nursery and/or migration path on which fish stocks, either within the wetland or elsewhere, depend. Criterion 9, which is based on other taxa, is: A wetland should be considered internationally important if it regularly supports one per cent of the individuals in a population of one species or subspecies of wetland-dependent non-avian animal species.



1. Ord River floodplain, Wyndham
2. Lakes Argyle and Kununurra, Kununurra
3. Roebuck Bay, Broome
4. Eighty Mile Beach, south of Broome
5. Forrestdale and Thomsons lakes, Perth
6. Becher Point, Rockingham
7. Peel-Yalgorup system, Mandurah
8. Lake Toolibin, Wickepin
9. Vasse-Wonnerup system, Busselton
10. Lake Warden system, Esperance
11. Lake Gore, Esperance
12. Muir-Byenup system, Manjimup



page 32); lakes Argyle and Kununurra, near Kununurra; Roebuck Bay, near Broome; and—the largest in the state at 175,487 hectares—Eighty Mile Beach, south of Broome. Each of these wetland sites is listed for at least five of the nine Ramsar criteria, with lakes Argyle and Kununurra and Roebuck Bay listed for eight—every criterion except the last.

There is one Ramsar site in the Perth metropolitan area—Forrestdale and Thomsons lakes, with an area of 784 hectares—while nearby Becher Point, at Rockingham, is 677 hectares. The state has two Ramsar-listed wetlands in the South Coast Region—the Lake Warden system and Lake Gore—both near Esperance, and one in the Warren Region, the Muir-Byenup system, near Manjimup. There is also the Peel-Yalgorup system, near Mandurah, the Vasse-Wonnerup system near Busselton and Lake Toolibin near Wickepin.

These important wetlands are recognised internationally as having particular biodiversity significance. Roebuck Bay and Eighty Mile Beach in the West Kimberley have international recognition because of the migratory wader birds that fly many thousands of kilometres to take advantage of the rich feeding grounds of the mudflats of these near-shore tropical embayments.

Other Ramsar sites are important for resident waterbirds that use the habitat in part of their life cycle. The Peel-Yalgorup system and the Vasse-Wonnerup system support high numbers of many resident waterbirds including black swans (*Cygnus atratus*) and pelicans (*Pelecanus conspicillatus*) that rely on the permanent estuarine conditions with highly productive sediments (see 'Wetland wonders', *LANDSCOPE*, Winter 2010).

Many of these systems are also vestiges of threatened ecological communities such as Toolibin Lake in the southern wheatbelt—the last, large, sheoak (*Casuarina obesa*) dominated wetland in the inland agricultural area of south-western Australia. Wetlands of this type were formerly widespread; however, most have now become severely degraded by secondary salinisation. Toolibin Lake is listed as a threatened ecological community under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The listing is recorded as 'Perched wetlands of the Wheatbelt region with extensive stands of living sheoak and paperbark across the lake floor—Toolibin Lake' (see 'Triple test: recovering natural biodiversity at Toolibin Lake and Lake Bryde', *LANDSCOPE*, Winter 2010).



Above right The location of Ramsar-listed wetlands in Western Australia.

Right Magpie geese are a migratory species found in the northern Ramsar wetlands.
Photo – David Bettini

Ecological character

Designating a wetland as a Ramsar site carries with it certain obligations, including managing the site to retain its 'ecological character' and having monitoring and evaluation in place to detect if any threatening processes are likely to, or have altered, that character. Thus, understanding and describing the ecological character of a Ramsar site is a fundamental management tool which should form the baseline or benchmark for management planning and action, including site monitoring to detect negative impacts.

Australia has been a leader in developing policy to identify the ecological importance of wetlands in the landscape and many of the initiatives in wetland conservation policy have been developed by a collaborative team of state agency-based aquatic ecologists and the federal Department of Sustainability, Environment, Water, Population and Communities. One of these initiatives has been the development of technical descriptions of the ecological character of listed sites.

Below A wetland near Perth.
Photo – Marie Lochman

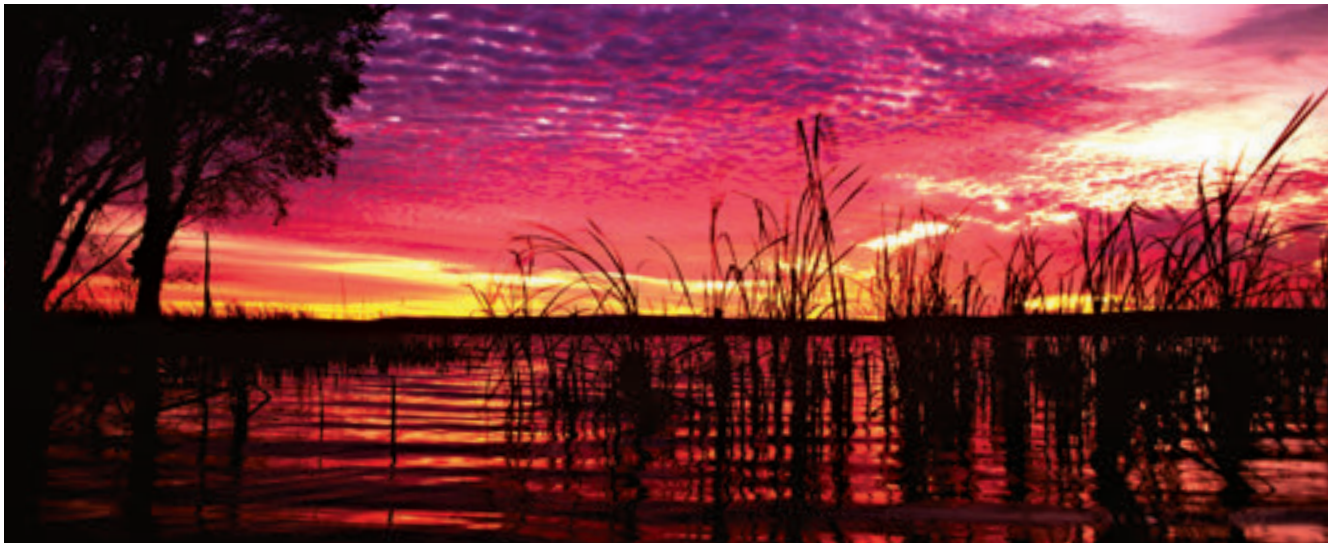
Bottom Forrestdale Lake.
Photo – Jiri Lochman



The core of an ecological character description, or ECD, is the description of the components, processes, benefits and services of the wetland and how they are linked at the time of listing. The components and processes of the wetland influence and determine the habitats, ecological communities and species that are found at a site and the criteria for which it was listed. These, in turn, influence the benefits and services provided by the wetland site. Mapping out and understanding ecological character can be challenging. One tool to assist in this process is the use of conceptual models. Each ecological character description has a conceptual diagram indicating the broad relationships that exist between components and processes and how they interact to provide the critical supporting services of the site.

Threats to ecological character

Wetlands are complex systems and an understanding of their components and processes and the interactions or linkages between them is necessary to describe ecological character. Similarly, threats to ecological character need to be described not just in terms of their potential effects, but the interactions between them. One mechanism for exploring these relationships is the use of stressor models. Stressors are defined as 'physical, chemical, or biological perturbations to a system that are either foreign to that system or natural to the system but applied at an excessive (or deficient) level'.



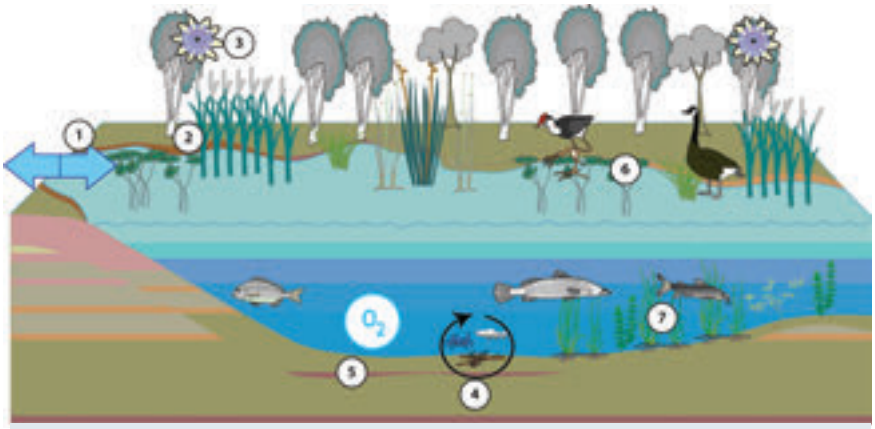




Above Frogs are an important indicator of a heathy wetland system.
Photo – David Bettini

Above right Mangrove on tidal flats in the Kimberley.
Photo – Dennis Sarson/Lochman Transparencies

Right A simple conceptual model of Lake Kununurra showing the major interactions between components, processes and services, both positive and negative.



1. Controlled, sustained releases from Lake Argyle keep water levels constant.
2. Constant water levels enable the establishment of riparian and submerged vegetation.
3. Riparian vegetation has a high density of weeds.
4. Stable water levels and temperature year round result in high primary and secondary productivity.
5. Constant flow-through mixes the water column which remains oxygenated.
6. Diversity and density of vegetation provides feeding, roosting and nesting habitat for waterbirds.
7. Diversity of vegetation and density of submerged vegetation provides habitat for native fish.

In evaluating threats it is useful (in terms of management) to separate the driver or threatening activity from the stressor, as this helps to clearly determine the causes of impacts to natural assets. This provides clarity for the management of natural resources by focusing management actions on threatening activities that cause the stressors. For example, increased turbidity may be identified as a threat for seagrasses in Roebuck Bay. However, management actions cannot be targeted at increased turbidity without some understanding of why the increase is taking place. By identifying the threatening activities that could contribute to increased nutrients (for example, stormwater inflows or dredging), management actions can be targeted at these threatening activities and reduce their impact.

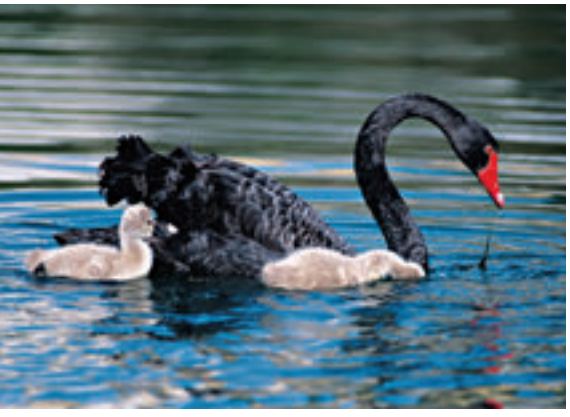
The Ramsar Convention has defined a 'change in ecological character' as the human-induced adverse alteration of any ecosystem component, process and or ecosystem benefit or service. To detect change, it is necessary to establish a benchmark for management and planning purposes. Ecological character descriptions form the foundation for a site management plan and associated monitoring and evaluation activities.

Limits of acceptable change

The description of the ecological character of Ramsar sites includes guidance for managers on the extent to which changes in a particular measure or feature are considered acceptable. This could be changes in the population of certain species, changes in the number of hectares covered by a particular wetland type or the range of a certain water quality parameter. The inference is that if the particular measure or parameter moves outside the 'limits of acceptable change', this may indicate a change in ecological character that could lead to a reduction in or loss of the values for which the site was Ramsar listed.







Top right Yellow-spotted goanna.
Photo – David Bettini

Top left Lake Kununurra.
Photo – Col Roberts/Lochman Transparencies

Above Black swan and cygnets.
Photo – Stuart Millar/Lochman Transparencies

Below Roebuck Bay.
Photo – David Bettini

Managing these limits requires a monitoring and evaluation system for detecting a trend that, if left unchecked, may move beyond natural variability. This may mean accounting for changes in the frequency and magnitude of extreme events such as cyclones, changes in the temporal or seasonal patterns of rainfall and changes in spatial variability of habitat condition, as well as changes in the mean or median conditions of, for instance, the salinity of a wetland.

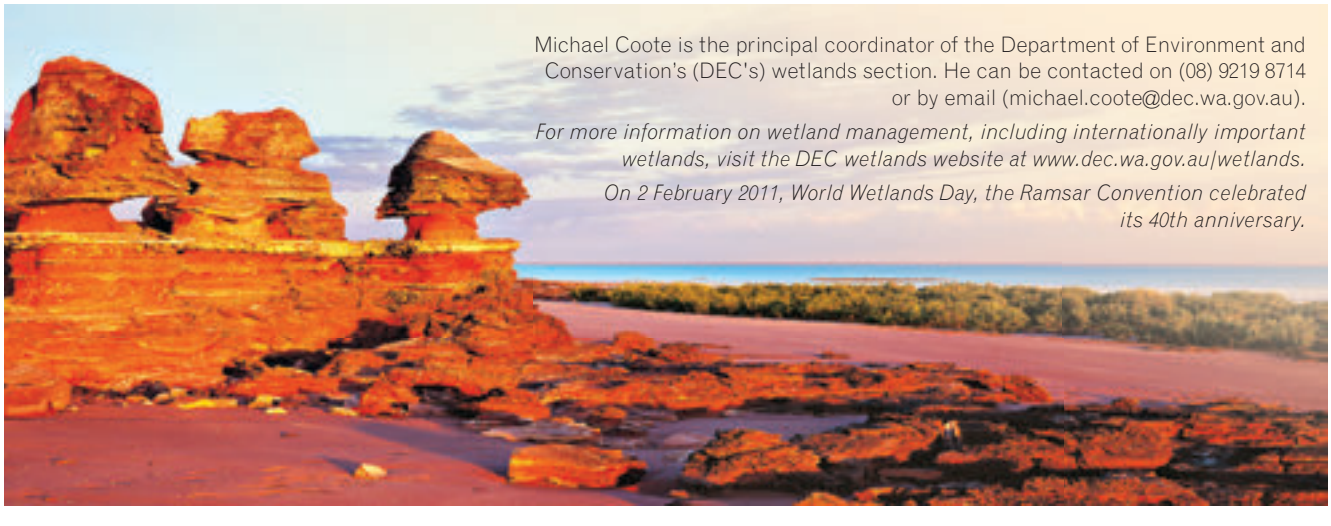
In a perfect world with complete scientific and ecological knowledge, limits of acceptable change could be set to match the tolerances or optimum conditions for the key biological components and processes for which the wetland site was listed. In this manner, limits could be set to guarantee that ecological character is maintained. However, this information is rarely available for the most well-studied species, let alone the more cryptic organisms. In the absence of this complete knowledge, a conservative approach is most often adopted.

The role of wetland management is to detect change with sufficient time to plan and take management actions before an irreversible change in the ecological character happens. The management plan for a site must develop and implement a set of management triggers that sends a clear message to site managers that management has to be adapted in order to mitigate the early warning trends. It is hoped that by adopting adaptive management styles, the WA sites listed under the Ramsar Convention will retain their biodiversity values for future generations to appreciate as much as we can today.

Michael Coote is the principal coordinator of the Department of Environment and Conservation's (DEC's) wetlands section. He can be contacted on (08) 9219 8714 or by email (michael.coote@dec.wa.gov.au).

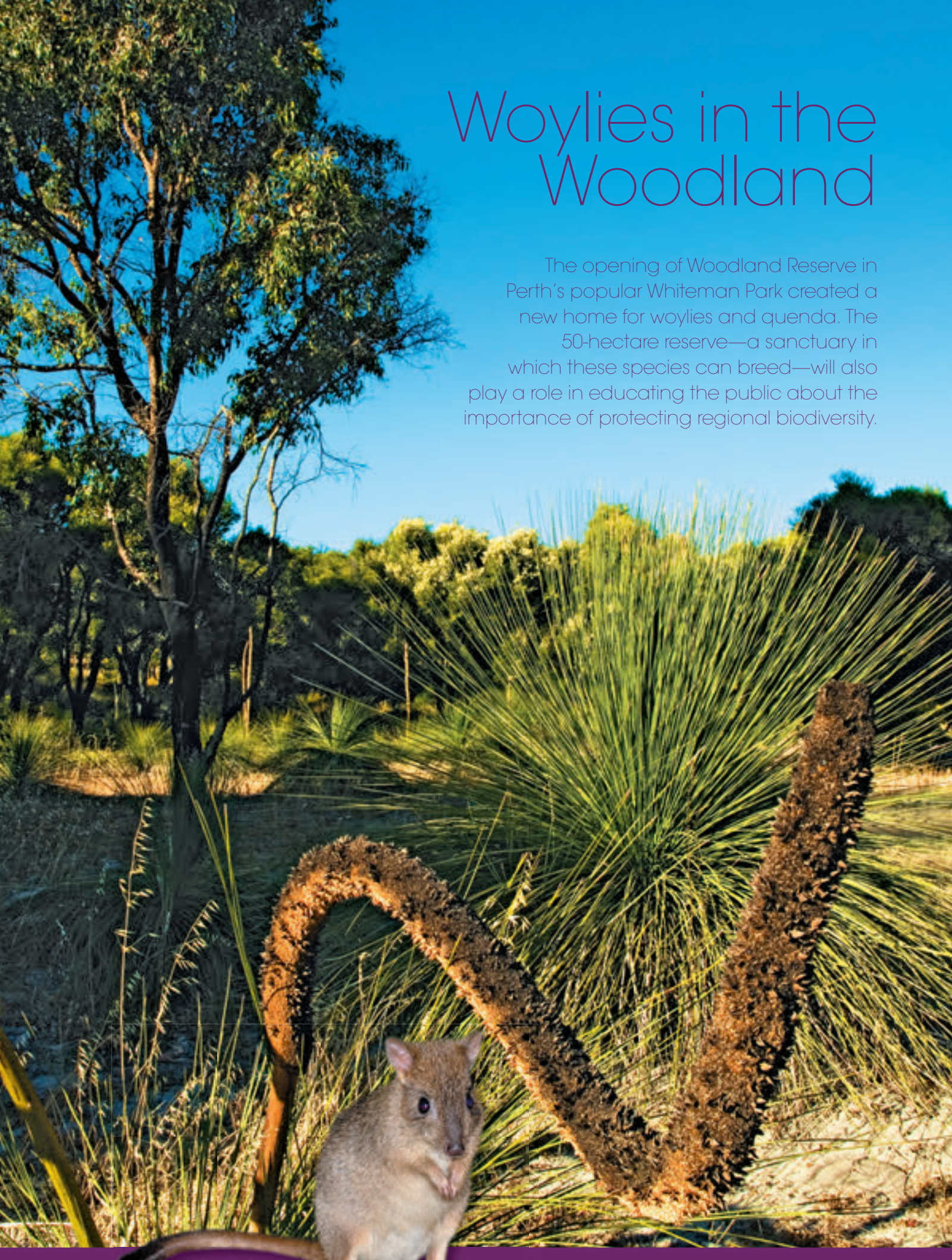
For more information on wetland management, including internationally important wetlands, visit the DEC wetlands website at www.dec.wa.gov.au/wetlands.

On 2 February 2011, World Wetlands Day, the Ramsar Convention celebrated its 40th anniversary.



Woylies in the Woodland

The opening of Woodland Reserve in Perth's popular Whiteman Park created a new home for woylies and quenda. The 50-hectare reserve—a sanctuary in which these species can breed—will also play a role in educating the public about the importance of protecting regional biodiversity.



by Karla Forrest



The 50-hectare Woodland Reserve has been specially designed as a breeding site for Western Australia's threatened fauna, including the critically endangered woylie or brush-tailed bettong (*Bettongia penicillata*). It is enclosed by electric fencing to keep out predators and features guided walks and other initiatives to provide the community with insights into threatened fauna and flora, and the importance of their conservation.

Renewed hope for resilient woylies

The woylie has been the focus of a number of conservation efforts over the past 20 years. The nocturnal herbivore was once widespread across southern Australia west of the Great Dividing Range, but numbers steadily fell due to a combination of factors. Populations then began to recover in response to fox control and translocations beginning in the 1970s, prompting its removal from state and federal threatened species lists in 1996 (see 'It's back: the return of the woylie', *LANDSCOPE*, Autumn 1996).

However, optimism from this success was short-lived. Research in the early 2000s showed another severe population decline and woylies were listed as critically endangered in 2008. But thanks to the new reserve at Whiteman Park and other conservation projects, such as the woylie enclosure at Perup (see 'The jewel in the crown: Perup and the Upper Warren' on page 10) and Karakamia Wildlife Sanctuary near Chidlow (see 'Bringing back the animals', *LANDSCOPE*, Autumn 2009), woylie populations may rise once more.

Four breeding pairs of woylies, along with a number of quenda or southern brown bandicoots (*Isoodon obesulus*), were released into Woodland Reserve in 2010. Within just six months, numbers had increased with the birth of at least six woylie joeys and four quenda joeys. The breeding habits of both woylies and quenda allow them to reproduce swiftly. Encouraged by these early successes, staff at the reserve now plan to reintroduce other species such as the tammar wallaby (*Macropus eugenii*).

Designing the safe haven

Woodland Reserve is the result of more than three years' planning. Funded by the Western Australian Planning Commission, the construction of the reserve was based on the vision of returning the area to a condition imitative of pre-settlement—before human disturbance. The two-metre-tall electrified fence is specially designed for local conditions such as the sandy soils of the Swan Coastal Plain. The state-of-the-art fence makes it near-impossible for predators such as foxes (*Vulpes vulpes*) and feral cats (*Felis catus*) to get inside and prey on the vulnerable animals, and also prevents the native animals escaping into the unprotected surroundings. Baits containing the 1080 toxin have also been used as a safeguard against introduced predators.

There is also the ever-present threat of bushfires around the fringes of the metropolitan area. A fire suppression



Previous page
Main Whiteman Park bushland.
Photo – Dennis Sarson/Lochman Transparencies
Inset Woylie.
Photo – Sallyanne Cousans

Above A visitor watches a woylie in the soft-release enclosure in Woodland Reserve.

Left A woylie and a quenda at a feed station within the soft-release enclosure.
Photos – Sarah Stevenson/Whiteman Park

reticulation system has therefore been installed, consisting of a powerful sprinkler system which drenches vegetation in a fire emergency. If the threat is extreme, there are also remotely operated gates that will be opened to provide an escape route for the animals.

The reserve also contains a smaller internal soft-release enclosure. Used for the release of new arrivals, the one-hectare enclosure acts as a transitional habitat so staff can monitor the animals' behaviour and supplement their diet.

Engaging the public

As Woodland Reserve is located in the popular Whiteman Park in Perth's northern suburbs, it is easily accessible to visitors. Staff here hope the reserve will not only stimulate population growth of endangered animals, but also help to educate the public about the importance of protecting regional biodiversity. There are plans to provide an interpretive facility for the public and opportunities for people to learn about the ecology of the reserve while seeing conservation management in action.

Tours play an important role in educating visitors, with nocturnal tours running during the summer and autumn and day tours in the cooler months. The 'Nocturnal Woylie Walk' on Friday nights includes a guided tour of the greater reserve as well as the soft-release enclosure, which provides the opportunity to spot animals up close. Special lighting has been installed for this tour, which gives off a red glow to enable visitors to see the animals without disrupting them.

Day visitors can enjoy walks in the greater reserve along a graded walking track suitable for prams and wheelchairs. The walk trail showcases banksia woodland and melaleuca damplands scattered with majestic jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*) trees. Large grasstrees (*Xanthorrhoea*) remain from pre-settlement times and provide perfect cover for the woylies, quenda and other small animals.

There is something interesting to look at all year round, with signage highlighting specific features applicable to every month of the year. In December, the reserve is coloured by the vibrant orange blossoms of the Christmas tree (*Nuytsia floribunda*). Of the five species of banksia in the reserve, at least one is always in flower. You might spot a threatened Carnaby's black cockatoo (*Calyptorhynchus latirostris*) or, in autumn and spring, the white-cheeked honeyeater (*Phylidonyris nigra*), when these distinctive birds are busy building their nests.

Woodland Reserve provides an opportunity to look back in time and get a sense of what the bush and its animals were like in and around Perth before it was settled by non-Aboriginal people. The reserve is also an important conservation effort in the breeding and protection of some of the state's rarest and most threatened flora and fauna species, in particular, the embattled woylie.



Right Feral-proof fence.
Photo – K Morley



Below right Visitors on the 'Nocturnal Woylie Walk' at Woodland Reserve.



Bottom right Woylie.
Photos – Sarah Stevenson/Whiteman Park

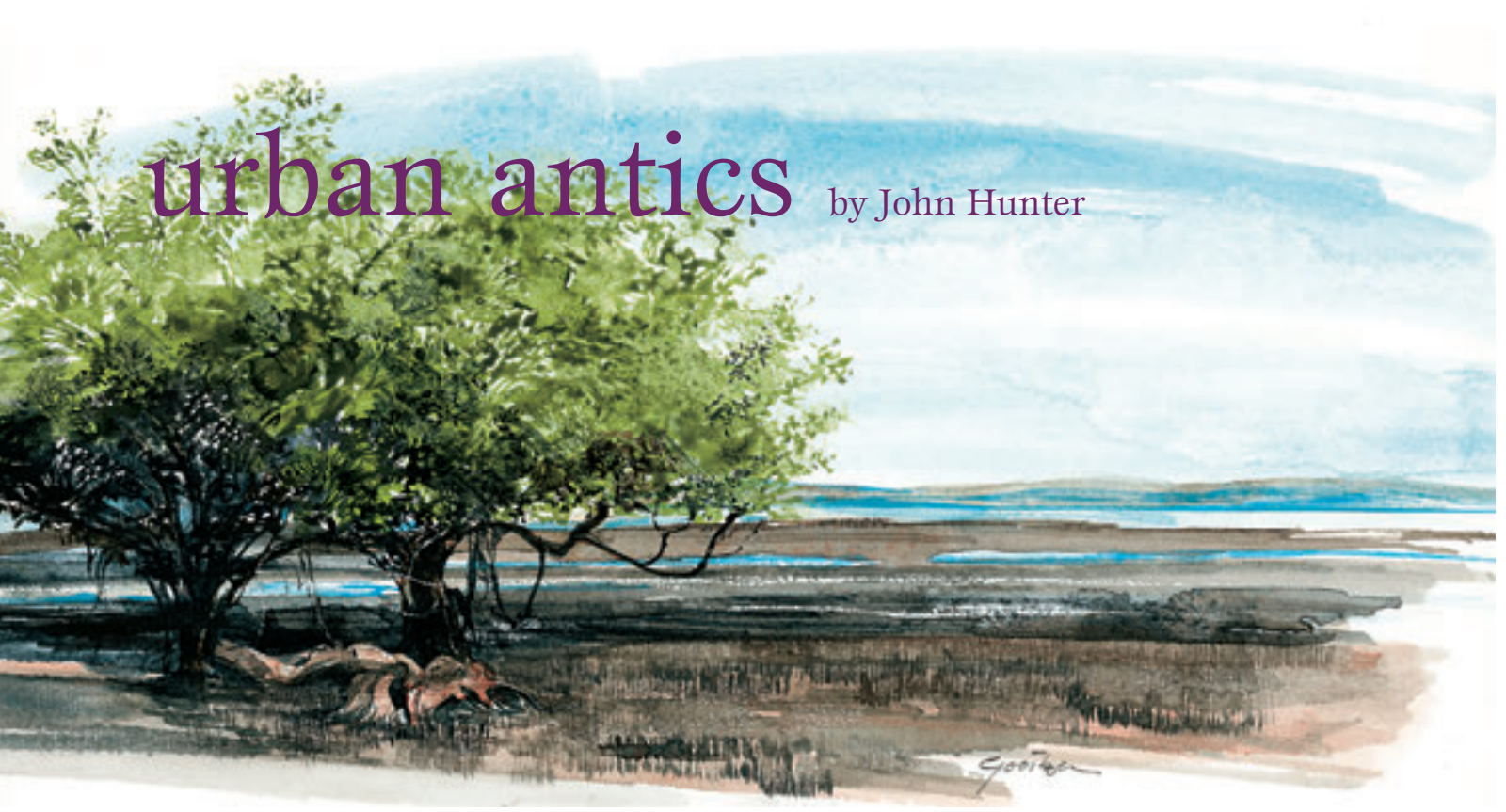
Karla Forrest is a final year Communication and Cultural Studies student majoring in Professional Writing and Publishing at Curtin University. She can be contacted on (08) 9355 5005 or by email (karlaforrest@hotmail.com).

The author wishes to thank Whiteman Park staff land and environment manager Dr Chris Rafferty and marketing and events officer Sarah Stevenson for their assistance.

To find out more about Whiteman Park's guided tours of Woodland Reserve, visit www.whitemanpark.com. Bookings are essential and can be made on (08) 9209 6000 or bookings@whitemanpark.com. There is no cost for these tours, but donations are appreciated.

urban antics

by John Hunter



Mangroves ...

"A rose by any other name would smell as sweet," said Juliet.

Ahh ... but not so every forest, says I. For example, as peppermint and eucalypt may be the very essence of addictive fragrance, a mangrove forest at low tide was once viewed, and still is by some, as a stinking place, a mosquito-ridden swampy wasteland.

How times have changed. Thank goodness science has unravelled the importance of mangroves to the coastal ecosystem and we now hold in high regard these forested areas as nurseries of rich biodiversity arguably like no other. They are real 'salt of the Earth' places for aquatic and terrestrial life to live and breed.

Mangroves are trees and shrubs that grow in the intertidal coastal areas and are most common in the tropical and sub-tropical areas of our north.

One species, however, the white mangrove (*Avicennia marina*), is found in the urban area of Bunbury city about 180 kilometres south of Perth. This rare southern colony is thought to have arrived as floating seedlings from northern climes to the Leschenault Estuary and tidal lagoons some several thousands of years ago on a then much stronger Leeuwin Current.

My first introduction to the Bunbury mangrove forest was during the early 1960s when, after weekend music engagements at a nearby hotel, the Perth 'ivy league uni set' would retire to the Koombana Bay campground for some serious partying. Many's the time we sat in complete darkness behind the mangroves, quaffing ale and whispering sweet nothings to friends while listening to the late-late shows on radio 6BY. Next morning it would be crabbing from old clinker rowboats in the backwater mangrove lagoons until the drinks esky was emptied and refilled with angry blue mannas, or we all went overboard for a swim in a frenzy of naked joy. Ahh ... those were the days.

Since those times, reclamation for urban and industry expansion has changed the original lay of the Preston River delta and lagoons in the southern part of the estuary, but the mangrove-fringed shoreline has persisted and is now enhanced with an interpretive walkway. Young seedlings, saplings and mature trees are evident in the colony but it will be interesting to see if, in the future, the ecosystem remains unaffected by modern urbanisation and pollution.

Meanwhile, the special thick-leaved canopy and strange systems of tangled arboreal, underground, and vertical air-filled roots called pneumatophores that typify mangroves will continue to grace the environment of the Leschenault Estuary and lagoons.

Like times past—when Aborigines camped and speared cobbler, mulloway, mullet, black bream and taylor and collected many species of mollusc and crustacean in these waters—it is hoped the Bunbury mangrove forest will continue to thrive and protect its diverse community of marine life.

DID YOU KNOW?

- The United Nations has declared 2011 as the International Year of Forests, themed *Celebrating forests for people*.
- Forests cover only 31 per cent of the Earth's terrestrial area but it is estimated that they provide habitats for about two-thirds of all species on the planet.
- Mangroves are adapted to cope with salt and waterlogging. Their leaves have epidermal cells that secrete salt.

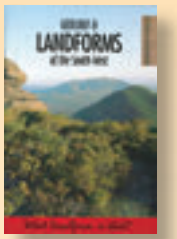
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Orchids of the South-West



Geology and Landforms of the South-West



Waterbirds of the South-West Wetlands



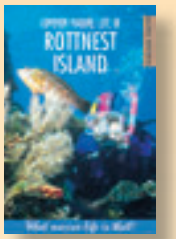
Bush Tucker Plants of the South-West



Beachcombing Perth and South-West beaches



Marine Plants of the Perth Region



Common Marine Life of Rottnest Island



Common Trees of the South-West Forests



Common Wildflowers of the South-West Forests



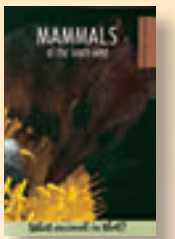
Wildflowers of the South Coast



Wildflowers of the Stirling Range



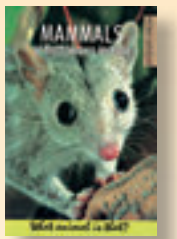
Fungi of the South-West Forests



Mammals of the South-West



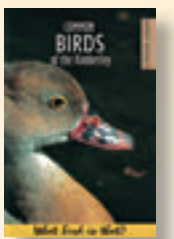
Common Birds of the South-West Forests



Mammals of North-Western Australia



Hazardous Animals of North-Western Australia



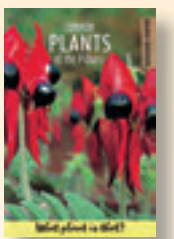
Common Birds of the Kimberley



Geology and Landforms of the Kimberley



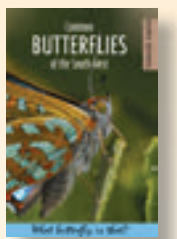
Common Plants of the Kimberley



Common Plants of the Pilbara



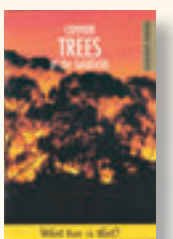
Geology and Landforms of the Pilbara



Common Butterflies of the South-West



Wildflowers of Shark Bay



Common Trees of the Goldfields



Common Wildflowers of the Mid-West



Threatened Wildflowers of the Mid-West



Wildflowers of Dryandra Woodland



Whales and Dolphins of Western Australia



Threatened and Rare Birds of Western Australia



Australian Birds of Prey



Common Birds in the Backyard



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Animals of Shark Bay

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