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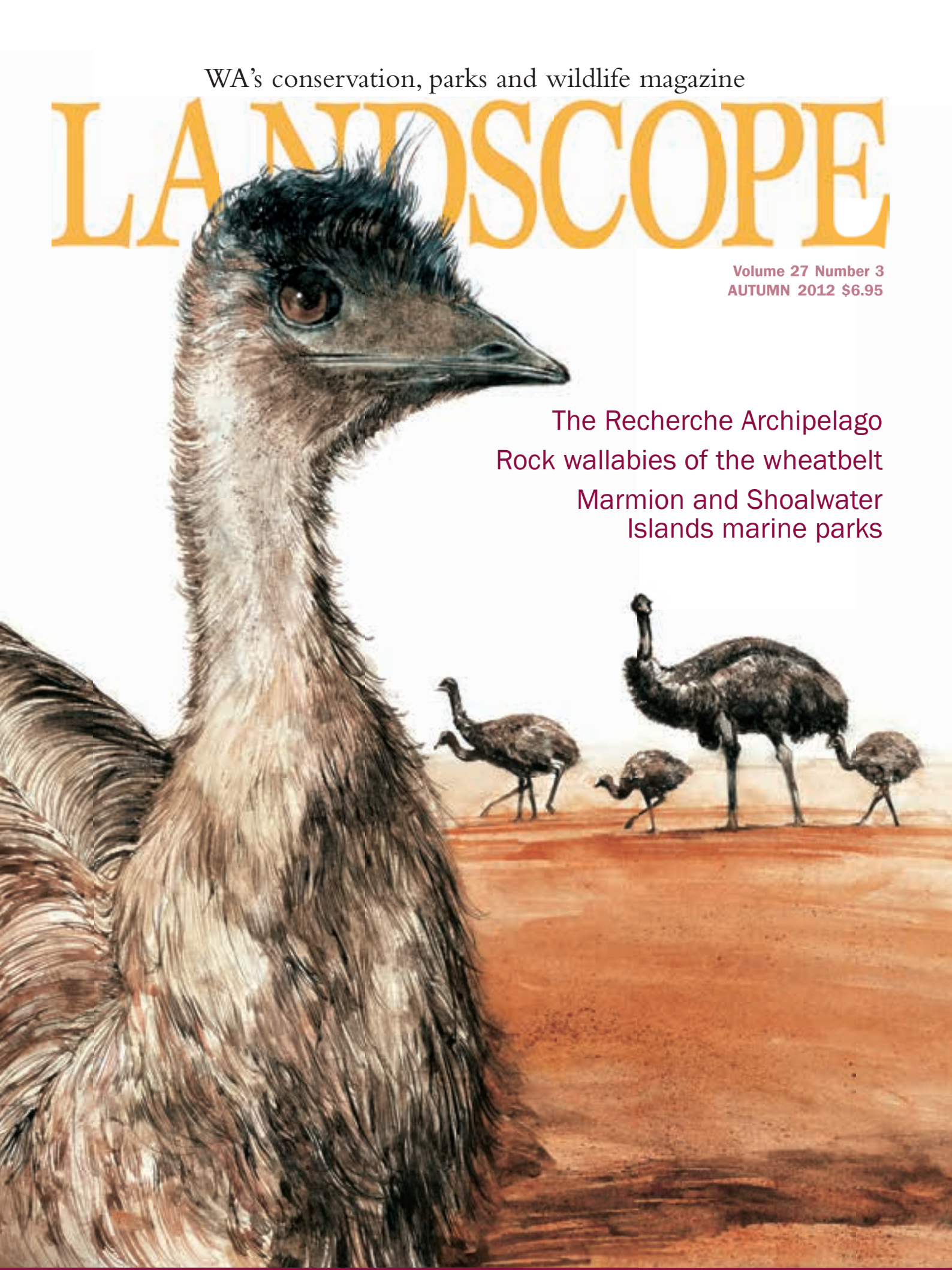


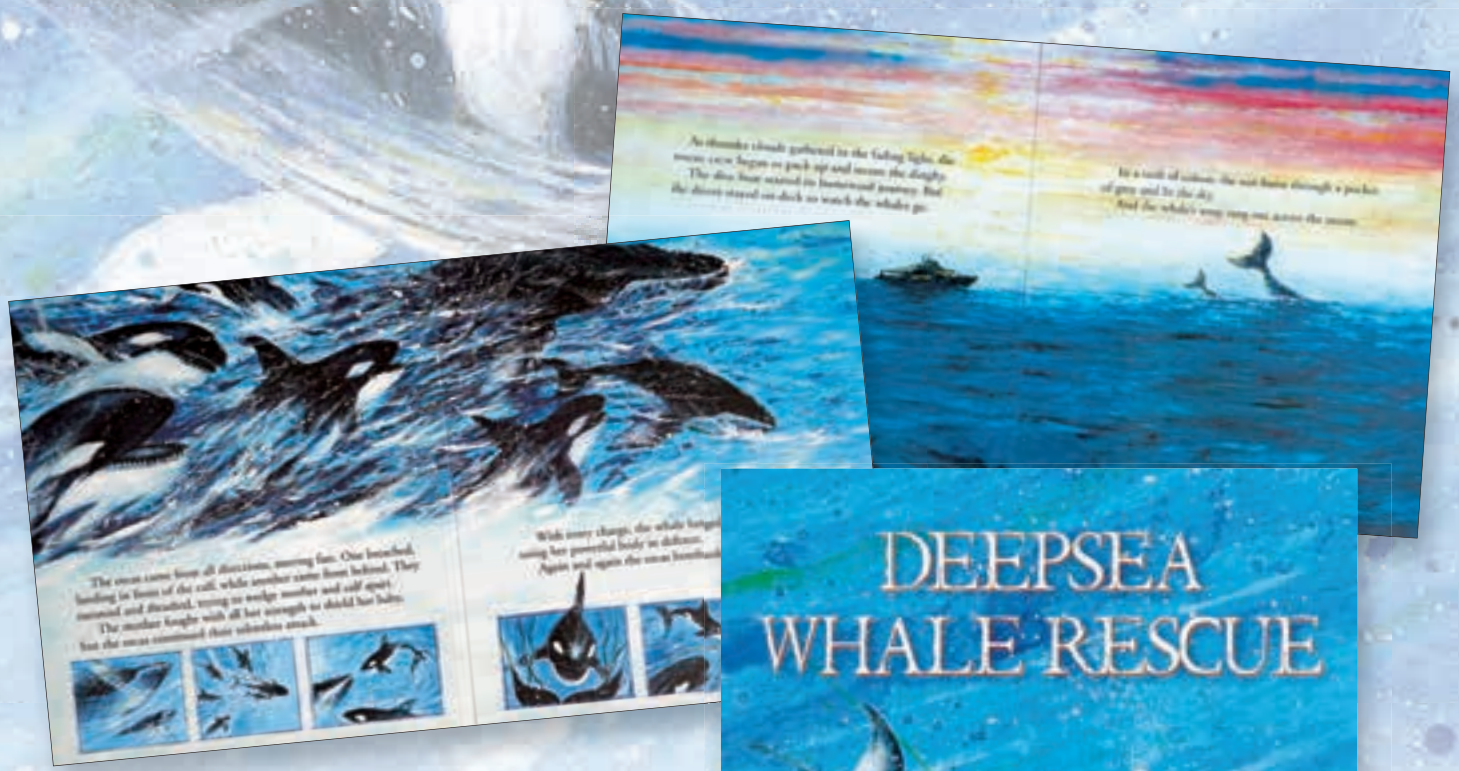
The Recherche Archipelago

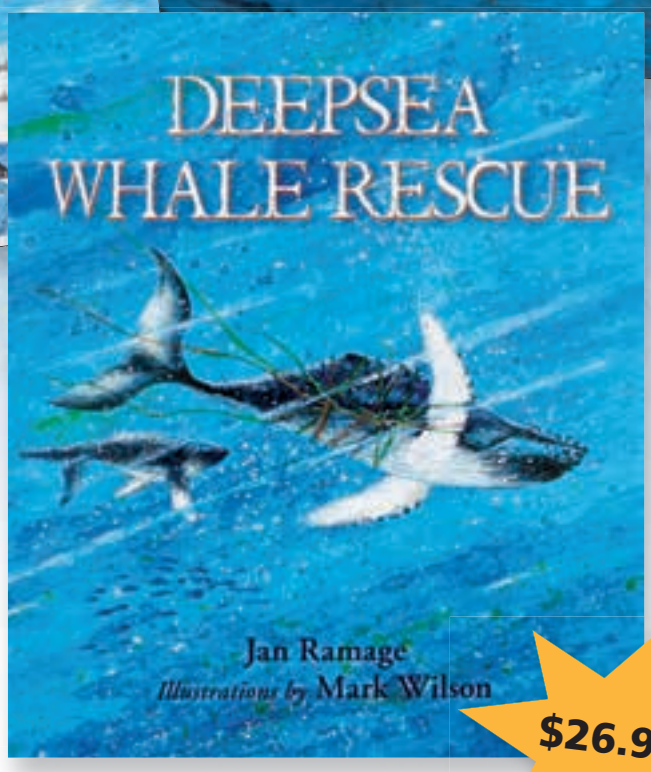
Rock wallabies of the wheatbelt

Marmion and Shoalwater Islands marine parks

New release!

Deepsea Whale Rescue





Written by award-winning author Jan Ramage and illustrated by internationally acclaimed author/ illustrator Mark Wilson, this stunning book is targeted at primary school-aged children but will engage and educate readers of all ages.

Deepsea Whale Rescue brings to life the true story of a mother whale's courageous defence of her calf against attack by a pod of killer whales and then of her life-threatening entanglement in nylon ropes.

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Department of
Environment and Conservation


Amanda Moncrieff


Peter Nicholas

contributors

Amanda Moncrieff is program coordinator for the Landscape Conservation Initiative, one of the programs being implemented as part of the Kimberley Science and Conservation Strategy. Based in the Department of Environment and Conservation's (DEC's) Kununurra office, she focuses on enhanced fire, weed and feral animal projects in the north and central Kimberley and works closely with pastoralists, non-government agencies and Aboriginal communities and organisations in the development and implementation of new projects. Amanda has worked in Kununurra since 2008 and, before that, was with the Environmental Management Branch in Kensington.

editor's letter

The coast: is it land or sea?

It's a question with many elements: geographical, biological, cultural, philosophical. Physically, the coast marks the edge of the continent; a visual reference point for the end of the road, a frontier. For many, it's a workplace, where busy ports and harbours provide a base for the fishing industry and a gateway for international trade. Culturally, the coast has a strong aesthetic and recreational pull—most of the state's towns and cities are located on or near it; the beaches and reefs around the state are prime places to explore and play. The importance of the seaside to our psyche features in this *LANDSCOPE*'s 'urban antics', where a childhood close encounter with a feathered denizen of the beach leaves a deep imprint (page 62).

As to the question of whether the coast is a terrestrial or marine environment, there is no simple answer—at the same time this 20,000-kilometre fringe around the seaward side of the state is both and neither. We tend to think of the coast as a boundary between two worlds, where one ends and the other begins. But it's really another world in itself. 'Life on the edge' (page 52), for example, relates the intriguing findings of survey work in the intertidal reefs in the Marmion and Shoalwater Islands marine parks. Subject to extreme and ever-shifting conditions—tidal fluctuations, unpredictable weather and wave action, battering winds and at times blistering heat—the reefs are colonised by unique and fascinating assemblages of robust life forms that have taken up residence in a sort of strata-title pattern of 'zonation', from the upper or 'supra-littoral' reaches down to the lowest-lying surfaces which are only exposed to the open air at the lowest of tides. It's a story of remarkable adaptation and diversity.

Meanwhile, Busselton Jetty ('Saving the jetty', page 39) is another example of a unique and distinctive place, in this case manufactured, that is neither land nor sea, but something very special in between with a character of its own. While the artificial structure has, over nearly 150 years, enabled natural forces to create and sustain a rich community of marine life, the jetty's cyclical history of near destruction and rescue is a testament to 'people power'. The jetty's survival is the result of decades of lobbying, fundraising and tireless effort from a determined public. Its triumphant re-opening just over a year ago, the biggest event in local history, has provided the final circuit-breaker, ensuring a bright future for the local landmark—or is it a seamark?—as a world-famous and much-loved living monument to biodiversity.

Madeleine Clews
Executive Editor

Peter Nicholas joined DEC in 2007 as a graphic designer. Bringing with him a love of all things marine and an outstanding underwater photography portfolio, Peter works on departmental publications such as books, brochures, newsletters, management plans and program branding. He has worked on *LANDSCOPE* magazine since 2010.

Jack Kinnear was born and raised in Edmonton, Alberta, Canada. He has attended four universities including The University of Western Australia, studying and working in endocrinology, fisheries and oceanography, nutritional physiology and desert adaptations of wallabies, microbiology and lately ecology. He joined the then Department of Fisheries and Wildlife in 1978 (later the Department of Conservation and Land Management) where he carried out pioneering research on the impact of the introduced fox on Western Australian marsupials. Now retired, he still maintains a keen interest in all matters involving native wildlife and the fox and feral cat.

Alan Kendrick has been a senior research scientist in DEC's Science Division at Kensington since 2008. Based in the Marine Science Program, he undertakes research that assists the management of WA's temperate marine parks and reserves and threatened marine fauna. In addition to surveying intertidal reef communities in the Marmion and Shoalwater Islands marine parks near Perth, he is also undertaking research in the Walpole and Nornalup Inlets and Shark Bay marine parks. Since joining the department in 2003 he has also worked as a marine planning officer, as the Shark Bay District marine park coordinator and as a marine and coastal ecologist in DEC's Pilbara Region.

also contributing ...

Ann Storrie, Anna Micha, Kevin Goss, Sarah Comer, Natasha Moore, Craig Pentland, Emma Adams, Michael Rule, John Huisman, Carolyn Thomson-Dans, John Hunter, Daryl Moncrieff, Nick Detchon, Leanne Robb, Kerstin Stender, Joanna Moore, Rhianna King and Monica Hunter.


Jack Kinnear


Alan Kendrick

Cover illustration by Gooitzen van der Meer
Known variously as wetj, wedji, kulya, kaya and yallibiri by Aboriginal people in Western Australia's south-west, the emu (*Dromaius novaehollandiae*) is Australia's largest native bird and the second largest flightless bird in the world. Emus are commonly found throughout the Australian mainland, including Nambung National Park, but are now mostly absent from built-up areas such as the suburbs of Perth. They live in a range of habitats including deserts, dense coastal shrublands, eucalypt woodlands and forests. Male emus do all the parenting, brooding five to 11 dark green eggs at a time in sparse nests of grass, bark and sticks built on the ground.
Illustration reference photo by Jiri Lochman

Back cover photo by Damon Annison
Nambung National Park is one of WA's most visited national parks and home to the spectacular Pinnacles Desert.

Features

Regulars

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Department of
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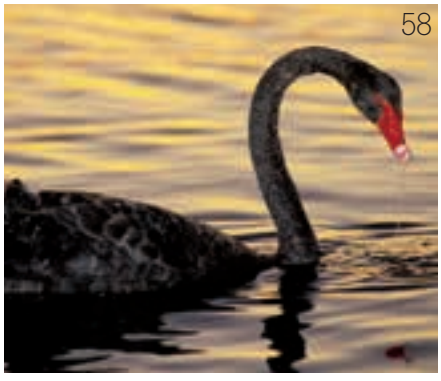


Protecting our precious wetland systems

A review of the Natural Diversity Recovery Catchment Program—a management initiative targeting six key catchments in the South West Land Division—has delivered some positive findings about the approaches used and achievements made in protecting these significant natural wetlands and their associated communities from the effects of altered hydrology in agricultural landscapes.

by Kevin Goss

It's rare to hear good news stories about concerted government and landholder action making headway against the dryland salinity threat to our precious Western Australian environment. Yet this is the case with the Natural Diversity Recovery Catchment Program managed by the Department of Environment and Conservation (DEC). A recent review of the program confirmed that despite decline in condition of some wetlands, threatened species and important ecological communities are persisting in six wetland systems within the program that are under pressure from altered hydrology in agriculture-dominated landscapes.

Tackling salinity and other changes in landscape hydrology is a challenging, ongoing task; even slowing and arresting biodiversity decline are significant achievements in an environment of broadscale landscape changes and a highly variable climate. The success of the recovery program owes much to the foresight and persistence of DEC and one of its predecessor departments, the Department of Conservation and Land Management (CALM), for maintaining funding for the program as national priorities shifted away from salinity. Through the program, ongoing partnerships among rural landholders, natural resource management boards, community groups and government officers have turned research into action.

Agriculture's legacy

It is less than 100 years since most of the Western Australian wheatbelt region was opened up to agricultural development. In that time, major technical advances in farming soils that are low in nutrients by global standards have resulted in reliably profitable crop production from variable rainfall. However, this economic and social success has come at a great cost to the environment. Of the 18 million hectares of farmed land in the South West Land Division, about one million hectares are salt-affected as a result of the clearing of native vegetation for agricultural land use.

From as early as the 1970s, the visible scar of salt-affected land in WA became an emblem of the dilemma faced by landholders, farming communities and governments—how to achieve profitable food and fibre production for domestic and export markets through sustainable use of natural resources. Within a decade there was a significant social and policy response in the form of new land conservation legislation, the rapid rise of land conservation districts and government-supported

Main Revegetation with mallee belts and other native plants to the north of Toolibin Lake (lake not pictured here) and associated nature reserves (far right). This vegetation helps to protect farmland and downstream wetlands from increasing salinity.
Photo – Wingsphotographics/DEC

Above top Toolibin Lake in 2006 when rainfall filled the lake, resulting in substantial bird breeding.
Photo – DEC

Above centre Fresh water being diverted into Toolibin Lake.

Above Recovery of sheoak (*Casuarina obesa*) on the floor of Toolibin Lake.
Photos – Sam MacWilliams/DEC

tree planting to address the salinity crisis on farms (see 'Greening the Wheatbelt', *LANDSCOPE*, Winter 1986).

However, a major turning point in the characterisation of the dryland salinity threat was the biological survey of the WA agricultural zone. This survey was a required action of the 1996 *State Salinity Action Plan* and involved field surveys from 1997 to 2001 by a large, multidisciplinary team of scientists drawn from CALM and the WA Museum. Its twin conclusions were compelling—450 plant species and 400 animal species (including aquatic invertebrates) were at risk of global or regional extinction due to salinity, and the biological richness of the wheatbelt was greater than previously thought. Concerted action, over and above changes in farm practices, was justified.

Integrated strategies to manage salinity

Before 1996, when the *State Salinity Action Plan* was released, the focus of salinity management actions was vegetation management. This focus was based on the assumption that by tackling the causal process of vegetation clearing leading to altered hydrology, salinity could be controlled. Clearing controls for agricultural land were introduced in 1986 and, by the 1990s, the criteria for regulation against clearing were dominated by salinity risk, to the point that, by 1998, the rate of clearing was at a very low level. However, in the already heavily cleared central wheatbelt, there was no longer scope for this to be an effective management strategy by itself.

The *State Salinity Action Plan* advocated diverse ways to manage water in the landscape. Its core management strategies included increased water use by crops, pastures and deep-rooted perennials; management of surface water and groundwater; and the protection of native vegetation remnants. Such an integrated approach to water management has proved very difficult to implement at catchment scales. However, it is the cornerstone of work in recovery catchments.

Left Landholder Jack Stone inspects surface water flow in the constructed grassed water-way immediately after the one-in-45-year rainfall event in the Buntine-Marchagee Recovery Catchment in December 2007. This helped give landholders confidence that actions on their land can improve water management.
Photo – Kathy Stone

Below left Successful on-farm revegetation in another part of Buntine-Marchagee Recovery Catchment, part of integrated water management.
Photo – Gavan Mullan

Between 2002 and 2006, the Salinity Investment Framework was developed to provide better analysis and decision-making on where public investment should be made. It recommended that public funds should be targeted where the highest-value assets were at risk, where the full range of salinity options were evaluated and where there was the greatest net benefit in applying the funds to their adoption. The Salinity Investment Framework principles have been applied in the Natural Diversity Recovery Catchment Program.

Six wetland systems chosen

Much of the agricultural region is a flat landscape with ancient drainage lines. Among these are wetland systems that may be fresh, saline or brackish, and permanent or ephemeral, in their natural condition. Although most of these wetlands are now severely degraded, some retain a good number of their natural biological assets. Including now-uncommon biological communities and threatened species, these areas are of high natural diversity value. They require careful management to avoid the fate of so many wetlands following land clearing and settlement.

The six wetland systems of the recovery program fall into this category and are at risk of altered hydrology. They include Toolibin Lake near Wickepin (known as the Toolibin Lake Natural Diversity Recovery Catchment, or NDRC); wetlands including and in the vicinity of lakes Muir and Unicup, east of Manjimup (the Muir-Unicup NDRC); and lakes in the Lake Warden wetland system immediately north of the Esperance town site (Lake Warden NDRC). The other systems are Lake Bryde, East Lake Bryde and other wetlands in the adjacent Lakelands Nature Reserve, north-east of Pingrup (the Lake Bryde NDRC); clay pans within Drummond Nature Reserve south-west of Bolgart in the Avon River basin (Drummond NDRC); and various wetlands and channels east of Marchagee and west of Buntine in the Northern Agricultural Region (Buntine-Marchagee NDRC).

The surface water catchment surrounding each of these wetland systems is used to define the boundaries of each 'recovery catchment'. Given that surface and groundwater catchments are broadly the same in these areas, this defines a useful area for assessing and managing hydrological threats, and provides the social boundary for bringing together government leadership, landholder support, science expertise and resources to plan and implement management (see map on page 9).

The basis of each recovery catchment's nomination was the value of the biodiversity at risk from altered hydrology, whether this is related to changed water quality—for example, increased salinity—or altered water quantity—for example, prolonged inundation. The three recovery catchments nominated in the original *State Salinity Action Plan* are listed as Wetlands of International Importance under the Ramsar Convention (Toolibin Lake, Lake Warden System and Muir-Unicup) based on conservation criteria that include importance to waterbirds. Three wetland systems were added based on information generated by the 2001 agricultural zone biological survey. These contain important plant and animal communities at risk from altered hydrology and include threatened flora, fish and aquatic invertebrate species. They also meet other important criteria for new natural diversity recovery catchments, including local community support.

Below right DEC officer Kimberley Oswald conducts a Chlorophyll A test on a water sample from Lake Warden as part of the water quality monitoring program. Excess nutrients entering the Lake Warden wetland system, along with excess inundation, threaten its natural diversity. *Photo – John Lizamore*

Management actions which occur through the program are comprehensive. For example, see 'Just add water: the Toolibin Lake inundation experiment' (*LANDSCOPE*, Summer 2011–12).

Catchment management at work

The 2010 review of the Natural Diversity Recovery Catchment Program made some important points. These included that the species and ecological communities threatened by altered hydrology persist in the recovery catchments. In at least one case—Toolibin Lake—the biodiversity values would have been lost without management, and in the case of the Lake Warden wetland system, areas of vegetation and habitat are currently recovering, largely as a result of management actions. Longer-term monitoring is needed to assess the impacts of other major management interventions including constructed waterways.

The review also found that revegetation, surface water management and other management works have improved the likelihood that many other biological communities threatened by altered hydrology will persist. It also noted that better understanding and management of landscape hydrology is essential, not only for biodiversity conservation, but also for continuing to deliver production and other public benefits from our agricultural systems. The review confirmed that recovery work is contributing to improved agricultural land management with respect to altered hydrology in the recovery catchments, which total some 700,000 hectares in area. Additionally, it found that the six recovery catchments, together with water resources recovery catchments managed by the Department of Water, provide the best examples of catchment-scale management in the state.

It was also possible to draw a general conclusion about work to protect natural resources, including land and water, in catchments; namely that success is dependent on long-term commitment by an organisation to the protection of catchment assets. The underlying reason is that, at catchment scales, success depends on long-term resource input over decades. This resource input needed to be focused on end-of-catchment outcomes such as biodiversity in wetlands, or the delivery of potable water.

Elements for success

The review of the Natural Diversity Recovery Catchment Program identified a range of requirements for achieving nature conservation aims

Above Hooded plover.
Photo – Dave Watts/Lochman Transparencies

Above right Epicormic shooting from swamp sheoak stems at Toolibin Lake. Together with recruitment of seedlings on the lake floor, this was the first sign of potential recovery in this ephemeral wetland. Groundwater pumping, surface water control and a succession of dry seasons all played a part.
Photo – Ken Wallace/DEC

in the face of the salinity threat. In addition to the long-term commitment of an organisation, four other elements identified are described below.

The first of these was the rigorous selection of priorities—strict and consistent processes were applied to designating natural diversity recovery catchments for single-minded attention and ongoing funding. Although the original *State Salinity Action Plan* set the number at an affordable six, only the three Ramsar-listed wetland systems started in that year, with the additional three added after further consideration, drawing on the work of the biological survey group in the department's Science Division.

The second element of success was the collection and analysis of sufficient data to develop a working model or hypothesis of catchment processes. Although our very general understanding of catchment processes is adequate, much more detailed information is required to implement effective management action within specific catchments. At least 10 years of trend data is required as a basis for management decisions. Research continues today and is advancing the scientific understanding of the processes at work in these wetland systems and their associated catchments.

A third element of success incorporated clear responsibility for management and a commitment to partnerships. The then CALM was assigned responsibility because it had the vested interest in achieving success under its legislative charter, backed by reporting and accountability requirements. Importantly, the department committed to partnering in an open and collaborative way with other agencies that had relevant expertise, with landholders to achieve complementary actions on private land, and with regional natural resource management groups that shared these objectives and had access to additional resources. Based on a review of expenditure between 1996 and 2006, about 35 per cent of the program's budget went to works on private land, including some land purchases.

Typically, work in each catchment is carried out over three broad phases. First, works such as revegetation or remnant vegetation protection are undertaken, which benefits biodiversity conservation without compromising longer-term goals. At the same time, investigations are carried out and landholders engaged. Second is surface water engineering works. This provides more immediate benefits but must be carefully assessed to avoid unintended consequences. Third, where justified by feasibility studies and environmental impact assessment, more intensive engineering works are completed, such as the pumping at Toolibin Lake and gravity pipeline at Lake Warden (see 'Triple test: recovering natural diversity at Toolibin Lake and Lake Bryde', *LANDSCOPE*, Winter 2010).

The fourth element of success was described as 'embracing integrated solutions'. In contrast to much earlier thinking on salinity management which tended to focus on single solutions—such as either revegetation or drainage alone—the Natural Diversity Recovery Catchment

Above Paperbarks in a small freshwater wetland to the east of Lake Unicup during a recent wet winter in the Muir-Unicup Recovery Catchment. This wetland complex supports more than 60 waterbird species, including 17 migratory species subject to international conventions; two threatened fish species; and a rich suite of aquatic invertebrates.
Photo – Ken Wallace/DEC

Program was pragmatic in embracing a range of practices and solutions that gave the best result or were important stepping stones to get there. Working with landholders and the broader community has been critical in this process. This is best exemplified by the department being prepared to provide incentives for commercial (blue gum) and potentially commercial (mallee) plantings in catchments where this contributed to catchment outcomes. DEC continues to support the nascent mallee biomass industry through research and development and through facilitating industry development. The broadscale revegetation that could result from such an industry would make an important contribution to achieving environmental outcomes.

These are important elements not only for the continued success of the Natural Diversity Recovery Catchment Program, but also for catchment management programs more broadly.

Setting a new standard

The Natural Diversity Recovery Catchment Program has implemented a relatively low-cost series of actions that, over 15 years, have ensured the persistence of important natural values in the agricultural zone of WA. These values range from increasingly uncommon biological communities—such as the valley floor melaleuca communities in the Lake Bryde NDRC and the threatened sheoak-melaleuca community at Toolibin Lake—to improving the habitat of species such as the hooded plover (*Charadrius rubricollis*) at Lake Warden. However, even these species and communities continue to be threatened—while actions to date have provided some respite, the need for ongoing management continues.

The program has been a quiet achievement for natural diversity in the highly cleared agricultural zone. In addition, it has set a standard for catchment management. Through the recovery program's contribution to understanding water in our agricultural landscape, it is also making a critical contribution to land use and management in general. However, much hard work remains to ensure ongoing success.

Kevin Goss recently retired as Chief Executive Officer of the Future Farm Industries Cooperative Research Centre which nationally is working on perennial plant-based technologies and farming systems to more effectively use water in the landscape. It partners with the Department of Environment and Conservation in a number of projects linked to the Natural Diversity Recovery Catchment Program. Before this, Kevin held senior management positions with the Murray-Darling Basin Commission, Department of Agriculture and Food WA and the then Department of Conservation and Land Management. Kevin can be contacted by email (kfgoss@me.com).

The Munda Biddi adventure grows

Two recent additions to the Munda Biddi Trail take the popular off-road cycle touring track through stunning karri forest near Nannup as well as past picturesque farmland and through bushland between Torbay and Elleker, near Albany.

by Nick Detchon, Leanne Robb, Kerstin Stender and Joanna Moore

In exciting news for cycling enthusiasts, Western Australia's premier off-road cycle touring track, the Munda Biddi Trail, now has two new sections open in the south-west. Agencies including the Department of Environment and Conservation (DEC), the Munda Biddi Trail Foundation and the Torbay Catchment Group have been working together to construct the new sections, progressing towards the final goal of a 1,000-kilometre trail extending from Mundaring near Perth to Albany on WA's south coast.

The Munda Biddi Trail is complete from Mundaring south to Manjimup, giving riders almost 600 kilometres of trail to explore, more than half the final distance planned. And the trail—which takes its name from Nyoongar for 'path through the forest'—is recognised as a world-class nature-based cycling experience.

Cycling through the tall trees

The newest section connects Jarrahwood to Manjimup and offers cyclists an additional 110 kilometres of trail, made up of nearly 10 kilometres of purpose-built single track linking a network of existing roads and trails through attractive natural environments. It can be split into four parts, providing for riders with different capabilities. Overnight accommodation options also vary, ranging from Munda Biddi Trail shelters, to camping and town site accommodation. The four parts are Nala Mia camp site, near Jarrahwood, to Nannup (27 kilometres); Nannup to Donnelly Mill (37 kilometres); Donnelly Mill to Karta Burnu camp site (23 kilometres); and Karta Burnu to Manjimup (23 kilometres).

For the first time, the trail passes through magnificent tall karri (*Eucalyptus diversicolor*) forest. The name of the most recent purpose-built hut, Karta Burnu, means 'hill of trees' in the Nyoongar language. This reflects its location within the Foresters Wood arboretum. Karta Burnu boasts stunning views over the Donnelly River Valley from its three-sided jarrah verandah.

A different experience on the South Coast

Located closer to Albany is the Torbay Rail Trail, between Torbay and Elleker on the south coast. While not currently connected to the rest of the Munda Biddi Trail, the eight-kilometre Torbay Rail Trail will form part of the Munda Biddi when it extends through to Albany in late 2012. The trail was a joint effort between DEC and the Torbay Catchment Group, which undertook extensive planning for this community trail before DEC joined the project.

Above Cyclists at Kartu Burnu camp site near Manjimup.

Opposite page
Left Keen cyclist Matt Moulten.
Photos – Kerstin Stender/DEC

Torbay Rail Trail enables cyclists, walkers and horse riders to share the trail. An attractive segment of the trail splits into two, divided by a line of melaleuca trees, with a flat section passing through adjoining farmland. Our four-footed users have the luxury of a soft sandy surface, while a firmer gravel surface caters for the two-wheeled and legged users.

The community trail component of Torbay Rail Trail was funded through Lotterywest and the Department of Sport and Recreation trails grant. Funding for this, and the other new section, also comes from the *Royalties for Regions* scheme, through the Great Southern and South West development commissions, Lotterywest/Department of Sport and Recreation and DEC, with assistance provided by prison work crews from the Department of Corrective Services.

Taking environmental and cultural concerns seriously

Minimising the adverse environmental, cultural and social impacts of trail development is vital. The majority of trail development time is spent in planning, and construction begins only once a wide range of tasks has been completed. The first stage involves scouting potential routes and identifying key constraints, such as big rivers, wilderness zones, dieback risk areas and private property. Once potential routes have been identified they are taken to the community for broad consultation and feedback.

Community feedback and extended time in the field applying the proposed alignment options are then used to work up the detailed alignment. Results from flora and ecosystem surveys and dieback assessments are collated, along with information about culture, water protection, and tenure and reserve status. Consideration is given to soil compatibility, erosion, conflict between different park user groups, other commercial uses, visual landscape management and fire and tree harvesting operations, among many other issues. Consultation with local Aboriginal groups also occurs, such as through the South West Aboriginal Land and Sea Council and local claimant groups. Once the final alignment has been identified, elders are taken out to inspect sections of new trail construction, including bridges and camp sites.

Above Cyclists exploring a new section of the Munda Biddi Trail take a breather among the karri trees at One Tree Bridge. *Photo – Leanne Robb/DEC*

Left The view towards Shelter Island from the mouth of the Torbay Inlet, near Albany. *Photo – Jay Sarson/Lochman Transparencies*

Below A Donnelly River bridge crossing. *Photo – Leanne Robb/DEC*

Planning and construction of the Munda Biddi Trail by DEC staff using minimal impact techniques ensures that the final trail is sustainable. The responsibility of the user then starts, with *Leave No Trace* principles providing a useful guide. To further reduce environmental impacts, fires are not permitted on the Munda Biddi Trail, with the use of fuel stoves recommended instead.

Towards the final goal

Work never stops for long on extending the Munda Biddi Trail, with construction carried out by four teams from DEC's Recreation and Trails Unit with assistance from Department of Corrective Services prison work crews. Through the project, members of these work crews are learning new skills in earthmoving, carpentry and general construction techniques. The Department of Corrective Services has been involved in the project from the beginning, providing a significant and valuable contribution.

With the trail now open to Manjimup, the focus for construction has shifted south of the town, with two teams focusing on developing the southward leg from Manjimup and two heading north from Albany. Great progress has already been made and the opening of the Albany to Denmark section is expected in mid-2012. Working towards Walpole, the four teams plan to meet there in late 2012—their work enabling riders to travel more than 1,000 kilometres on this unique cycle path through the forest.

Nick Detchon, Leanne Robb and Kerstin Stender are Department of Environment and Conservation (DEC) officers working on the Munda Biddi Trail project. Project coordinator Kerstin can be contacted on 0427 197 950 or by email (kerstin.stender@dec.wa.gov.au).

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

Munda Biddi Trail Map 5, covering the new Jarrahwood to Manjimup section, is now available and can be purchased from DEC, the Munda Biddi Trail Foundation (www.mundabiddi.org.au), or from bicycle, tourist and other retail outlets around the state. Visit www.dec.wa.gov.au/shop to order online or call DEC customer service staff on (08) 9334 0437 or (08) 9334 0481.

bookmarks by Rhianna King

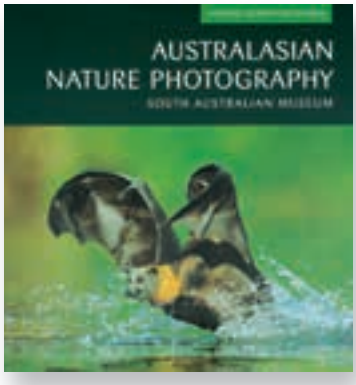
The Michael Morcombe eGuide to Australian Birds

Author: Michael Morcombe
Sound recordings: David Stewart
Publisher: PDA Solutions
Available from: itunes.apple.com/app and www.android.com/apps/
RRP: $31.99

This handy application provides information about the physical features, distribution and breeding patterns of nearly 800 Australian birds and includes more than 3,000 images. However, it's the 1,800 recordings of the birds' calls that are most impressive.

The application—available for Apple iPhone and iTouch and Android phones—enables users to enter observations such as location, colour, size and bill shape to generate a short-list or suggested species. This saves flicking through hundreds of book pages in the field. Another great feature is that it doesn't need internet access to function, which makes it handy for use in remote areas.

This is a comprehensive, easy-to-use application and inspired this iPhone user to stop playing *Angry birds* and head outdoors to identify a couple of 'mystery' bird species.



Australasian nature photography

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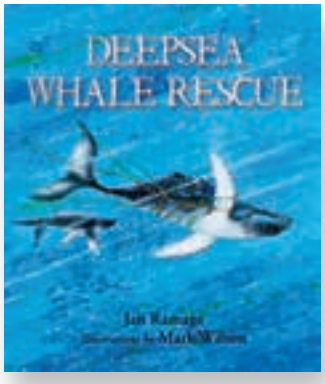
Now in its eighth year, the ANZANG Nature Photography competition was founded by Perth surgeon Dr Stuart Miller (see 'Nature's album', *LANDSCOPE*, Autumn 2006) and is now run by the South Australian Museum. In 2011, the competition attracted more than 1,600 entries and this book showcases the best. In fact, it can be difficult to turn the pages of *Australasian nature photography* without your mouth ajar and keep count of how many times one says "wow". Without exception, the photos are stunning and capture rare and/or spectacular moments. Each photo is accompanied by an anecdote about how it was captured, adding charm and interest to this beautiful book.



Deepsea Whale Rescue

Author: Jan Ramage
Illustrations: Mark Wilson
Publisher: Department of Environment and Conservation
www.dec.wa.gov.au
152 pages, soft cover, full-colour throughout
ISBN: 978 19 2170 320 1
RRP: $26.95

This beautifully illustrated book is based on a true story of a humpback whale that successfully defended its calf against a pod of killer whales. The plot thickens when it's discovered that the whale is entangled in nylon ropes. What happens next is an example of one of the many risky and complicated whale operations the Department of Environment and Conservation carries out each year.

There is an information section at the end of the book which describes whales and their behaviour and contains facts about threats to ocean life. This section complements the poignant account of the treacherous journey these magnificent creatures make along the west coast of Western Australia each year.

by Sarah Comer and Emma Adams

The Recherche Archipelago

a southern jewel

A recent terrestrial survey trip to this 250-kilometre-long collection of islands on the south coast uncovered some interesting finds.

Comprising 105 islands and more than 1,500 islets and 'obstacles to shipping', the Recherche Archipelago is a captivating feature of Western Australia's south coast marine environment. It stretches more than 250 kilometres from east to west and covers an area of about 9,700 hectares. The islands represent the eastern extent of the Albany Fraser Orogen—the granite-gneiss system of Archaean origin which extends along the south coast to the west of Albany—with some overlain by the younger Pleistocene calcareous eoliantie, or coastal limestone.

These islands have been isolated from the mainland for between 11,000 and 13,000 years, depending on their distance from the mainland and the characteristics of the surrounding ocean. As a result, each island is, in essence, its own natural laboratory, with the fauna and flora trapped as sea levels rose and then shaped by thousands of years of isolation.

Early exploration

Although first sighted by the Dutch explorer Pieter Nuyts in 1627, the Recherche Archipelago was not named by Europeans until 1792. It is named after *La Recherche*, one of the two

ships in the French expedition led by Rear-Admiral Bruny D'Entrecasteaux. Collections of plants made on this expedition by the botanist Jacques Julien Houton de Labillardière provided material for the first published descriptions of many Western Australian plants. In addition, the sighting of 'seals' by Labillardière was the first record of a mammal from the Recherche Archipelago, although the species of seal (or sea lion) and location of these records was not clear. In his journal, Labillardière also records several birds, thought to have been Cape Barren geese (*Cereopsis novaehollandiae grisea*), brush bronzewings (*Phaps elegans*), little penguins (*Eudyptula minor*) and Pacific gulls (*Larus pacificus*).

The islands were surveyed in more detail in 1802 by Captain Matthew Flinders in the *Investigator*, with botanist Robert Brown adding to the flora collections. Flinders also added to the records of mammals in the archipelago with his sightings of wallabies on Mondrain Island and Middle Island; the former are now known to be the endemic Recherche rock wallaby (*Petrogale lateralis hacketti*) and the latter tammar wallabies (*Macropus eugenii derbianus*).

In the ensuing years, the Recherche Archipelago attracted a large number of comprehensive surveys focused on documenting both terrestrial and marine species. These include the 1950 Australian Geographical Society survey which visited 20 of the islands and documented flora, fauna and invertebrates. Over the years, understanding of the outstanding biological and conservation values of the Recherche Archipelago has grown through the efforts of this and many other surveys (see 'Researching the Recherche', *LANDSCOPE*, Winter 2003).

Threatened species galore

The islands provide an important refuge for threatened species such as the Recherche rock wallaby, the black-flanked rock wallaby (*Petrogale lateralis lateralis*), the Recherche pygmy dugite (*Pseudonaja affinis tanneri*) and the Recherche Cape Barren goose. For the Cape Barren goose, the archipelago is the stronghold of the Western Australian subspecies. Island populations of species such as the quenda (*Isoodon obesulus fusciventer*), carpet python (*Morelia spilotes imbricata*), southern death adder (*Acanthopsis antarcticus*) and tammar wallaby are of enormous value for their genetic diversity, and the native rat (*Rattus fuscipes*) from Salisbury Island has been shown to be genetically distinct from individuals found elsewhere in the Recherche.

Previous page
Main Sheltered Bay on Wickham Island.

Left View of the archipelago islands from North Twin Peak.
Photos – Sarah Comer/DEC

Above Australian sea lions were one species monitored as part of the expeditions.
Photo – Sarah Comer/DEC

Above right DEC regional ecologist Sarah Comer with a little penguin.

Right The islands of the Recherche Archipelago are important habitats for the Recherche rock wallaby.
Photos – Emma Adams/DEC

Many of the islands provide important breeding grounds for nesting seabirds, with at least 12 species recorded breeding in the archipelago. This includes the little penguin, great-winged petrel (*Pterodroma macroptera*), fleshy-footed shearwater (*Puffinus carneipes*), short-tailed shearwater (*P. tenuirostris*), little shearwater (*P. assimilis*), white-faced storm petrel (*Pelagodroma marina*) and black-faced shag (*Phalacrocorax fuscescens*). Shorebirds are also frequently seen on the islands, including many of the species listed under migratory agreements such as the Japan–Australia Migratory Bird Agreement (JAMBA) and China–Australia Migratory Bird Agreement (CAMBA). With the exception of fire, usually the result of lightning strikes, many of the threats facing mainland populations of these species are not present on the islands (see 'Fire in the Arc', *LANDSCOPE*, Spring 2004).

Inviting opportunities

Despite the long history of biological survey and exploration, there are still many opportunities for new discoveries in the Recherche Archipelago, with inventories of flora and fauna not compiled for many of the islands. Opportunities to increase our knowledge are challenging, however; accessing islands from the water can be difficult, and the southern ocean often has hostile conditions.

In February 2011, a research expedition sailed from Esperance with the aim of continuing to document the biodiversity values of the islands in order to better understand their significance. This survey was made possible by a collaboration between the Department of Environment and Conservation (DEC) and Edith Cowan University, and included a terrestrial and marine (pinniped) survey team. The alliance therefore enabled further documentation of terrestrial flora and fauna, and provided an opportunity to monitor breeding success in colonies of New Zealand fur seals (*Arctocephalus forsteri*) and Australian sea lions (*Neophoca cinerea*) (see 'The long road to recovery', *LANDSCOPE*, Summer 2011–12). The terrestrial, or land-based, team comprised the authors, volunteer Andy Chapman, DEC threatened flora officer Sarah Barrett, DEC regional leader nature conservation Deon Utber and DEC threatened species conservation officer Cameron Tiller. The team's boat, the *Southern Conquest*, was skippered by Peter Hudson and his first mate Rayden Chambers.

The terrestrial team surveyed nine islands. One of the key projects was to compile flora inventories and collect and voucher specimens for the WA Herbarium, as most of the islands had few or no collections. Nearly 100 specimens from Daw, New Year, Cooper, Salisbury, Cranny, Taylor, Wickham, Glennie and North Twin Peak islands were collected, and these have been provided to the WA Herbarium to be included in the state's collection.

Daw Island, which covers 214 hectares, and New Year Island (21 hectares) were the first stops for the survey, with the team glad to have escaped the rolling seas for some harder ground. Daw Island is home to the only island population of the quenda, although only skeletons were seen on this trip. Cape Barren geese were found across the island and a number of invertebrates were collected including scorpions, spiders, pseudoscorpions

Top The Mart Island group consists of five islands up to 34 hectares in size.

Centre Recherche Cape Barren geese on Goose Island.
Photos – Emma Adams/DEC

Left Daw Island has the most significant island quenda population.
Photo – Jiri Lochman

Right South-western crevice skink.
Photo – Jiri Lochman

Below right Many islands in the Recherche Archipelago provide ideal breeding sites for the white-bellied sea eagle (*Haliaeetus leucogaster*).
Photo – Sarah Comer/DEC

and land snails. An oriental plover (*Charadrius veredus*) seen on New Year Island was an exciting find, and a new record for the island.

Despite being reasonably large, just less than 60 hectares, Cooper Island has no historical records of plants or vertebrates, except for being recognised as providing habitat for New Zealand fur seals and Australian sea lions. The terrestrial team was particularly excited by the opportunity to visit a previously unsurveyed island, and added a number of reptiles including the crowned snake (*Elapognathus coronatus*), the cream-striped fence skink (*Cryptoblepharus virgatus clarus*) and south-western crevice skink (*Egernia napoleonis*) and marbled gecko (*Christinus mamoratus*) to the inventory of reptiles for the islands. Large numbers of the migratory ruddy turnstone (*Arenaria interpres*) were seen, and Cape Barren geese were also observed in the low heath and herb fields that dominate the island.

Salisbury Island

To the south of Cooper Island lies Salisbury, a 350-hectare island lying more than 50 kilometres offshore, south of Cape Arid. While the vegetation communities on this island have been studied previously, no collections have been made from it. The island is home to large populations of New Zealand fur seals and black-flanked rock wallabies, and is an awe-inspiring site. Except for the northern peninsula and the southern peak, the island consists of a limestone plateau with steep cliffs. The remaining areas are composed of granitic rock, the southern peak reaching an elevation of 100 metres above sea level.

On limestone areas, the vegetation is low heath and dwarf scrub with dense mats of succulent plants occurring throughout. On granite areas, the vegetation is dense heath dominated by coastal wattle (*Acacia cyclops*), *Leucopogon obovatus*, *Pimelea clavata*, common fringe-myrtle (*Calytrix tetragona*) and stands of wind-pruned dwarf albizia (*Paraserianthes lophantha*).

The island was last burnt in 1992 as the result of a lightning strike, but the southernmost end is thought to have remained unburnt for more than 60 years. While no threatened flora species were recorded on Salisbury, information collected during the survey will provide important baseline data for monitoring the long-term recovery of flora cycles should another bushfire occur. The rock wallaby population counts on Salisbury from the recent trip are also important for monitoring, as this is the only island population of the mainland subspecies *Petrogale lateralis lateralis*. Recent work in the wheatbelt has found that mainland populations of this rock wallaby are suffering a significant decline, highlighting the importance of the Salisbury Island refuge (see 'A new threat posed by foxes' on page 26).

Smelling a rat

Middle Island is the largest island in the archipelago, covering some 1,000 hectares. It also has the most colourful history, having been the base for the rogue sealer 'Black Jack' Anderson in the 1800s. Largely due to its accessibility and size, there have been numerous surveys of the fauna and flora (see 'A visit to Middle Island', *LANDSCOPE*, Spring 2006) as well as studies of the vegetation and the effects of fire, but there are still grey areas in our knowledge.

For example, there are historical records of both the native rat and the introduced black rat (*Rattus rattus*) on

Above The pink and hypersaline Lake Hillier on Middle Island.
Photo – Col Roberts/Lochman Transparencies

Left Death adders blend into leaf litter and shelter under granite rocks so are often difficult to find.
Photo – Sarah Comer/DEC

the island. Clarifying which species is extant on the island has been an important question to resolve for management, with support for exotic rat eradication a focus for offshore island refuges. In 2008, a DEC *LANDSCOPE* Expeditions trip did not detect either native or black rats on Middle Island, despite extensive trapping. Interestingly, the native rat was recorded in high numbers on the adjacent Goose, Wickham and Glennie islands for the first time.

During the February 2011 survey, the terrestrial team set hair traps on transects running across Middle Island in an attempt to solve the mystery of which rat was present on the island. Analysis of hairs collected some months later confirmed that there are no rats of either species present on Middle Island, supporting the trapping and searching efforts of earlier trips. Searching back through the records, it was found that the record of native rats on the island was based on a single skull found in the 1970s and in a location frequented by birds of prey, and therefore there is a strong likelihood that this was carried from nearby Goose Island. Although the recent survey confirmed there are no rodents on the island, the reasons for their absence remains a mystery, especially given their presence on much smaller islands nearby.

Exciting finds

From Middle Island, the group headed west towards the small Taylor Island in Duke of Orléans Bay. This 22-hectare island also had previous records of the death adder, but the team was not fortunate enough to find one. They did observe two previously unrecorded reptiles, the crown snake and a skink, the common south-west

Above Spotted-thighed frog (*Litoria cyclorhyncha*) which is found in gnamma holes on Middle Island.
Photo – Sarah Comer/DEC

Above right Succulent steppe on Cooper Island.
Photo – Emma Adams/DEC

Right Common fringe-myrtle.
Photo – Jiri Lochman

ctenotus (*Ctenotus labillardieri*). Cape Barren geese were also seen on the western end of the island.

North Twin Peak Island is located about 10 kilometres offshore and is predominantly granite. Specimens had not been collected from the majority of the island since the 1970s except for a known population of a rare eucalypt which was the only known threatened species on the island before this trip. However, the poorly known *Acacia nitidula* was located on the southern end of the island. Known only from a few locations on the mainland and on one other island, this was a great find.

From North Twin Peak the group separated, pressured by deteriorating weather. Opportunities for the terrestrial group to access islands were diminishing and one half of the team elected to depart the expedition at Duke of Orléans Bay. This early end to the trip highlighted the challenges of surveying this unique area; challenges that have been experienced and noted by many before.

Building knowledge

The recent expedition to the Archipelago of the Recherche certainly increased our knowledge and understanding of some of the islands, adding to the valuable inventory started by French explorers some 300 years ago. Populations of conservation-dependent fauna such as the black-flanked rock wallaby and Recherche Cape Barren goose appeared healthy, and a number of new records of flora and vertebrate fauna were made. In addition, a number of short-range endemic invertebrates were collected for identification by WA Museum staff.

Every time an expedition such as this takes place we also increase our awareness of the importance of maintaining these island laboratories for future generations. Management can remain relatively simple, with biosecurity a key to ensuring island ecological processes are maintained. For the Recherche—where the terrestrial flora and fauna remain relatively intact—it is important to encourage hygiene protocols that minimise the chance of non-native flora and fauna being introduced, as these would most certainly damage the fragile habitats. Through these efforts, we can maintain this unique system of islands that is one of the outstanding nature reserves of the south coast.

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Nambung National Park

Famed for the thousands of limestone pillars that jut out of the shifting yellow sand, this national park looks more like a far away planet than an area of high conservation value that houses a range of native animals and stunning wildflowers.

Above The Pinnacles Desert, set against the night sky.
Photo – Damon Annison

Opposite page
Top left An emu.
Bottom left WA Christmas tree.
Photos – Sallyanne Cousans
Far right The Pinnacles Desert.
Photo – Alice Gillam/Sallyanne Cousans Photography

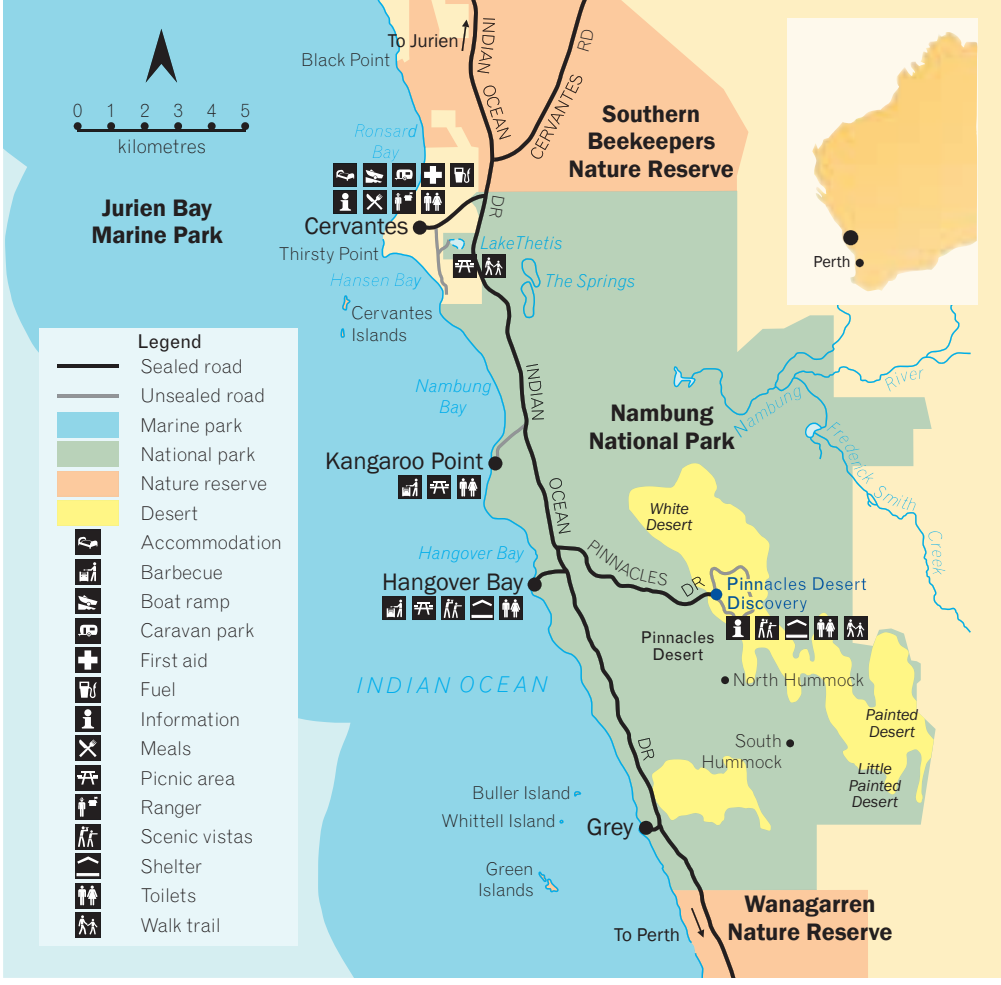
A comfortable day trip from Perth, Nambung National Park is one of the state's most visited parks. Its high visitation is not surprising, as the Pinnacles Desert and its remarkable limestone structures really have to be seen to be believed. The thousands of pillars that rise out of the yellow sand vary considerably in size and shape. Some are small, smooth domes while others, up to five metres high, are tall and jagged. The mood of the desert can change markedly depending on the colour of the sky, and more than one ghost story has been told of the area. The Yued Aboriginal people have a mythical explanation for the area which connects them to the land and carries the stories of their past.

Scientists have also looked for explanations about how the pinnacles were formed but have really only started to unravel the details of this ever-changing landscape. The pinnacles area is a classic karst landscape that was shaped mainly by water dissolving the marine limestone. This process typically leaves a maze of solution pipes, caves and pillars but, for some of the pinnacles, this was complicated by sediment deposits from a once-vigorous Nambung River. The sediment filled the solution pipes, which hardened and eventually became pinnacles. Other pinnacles appear to have formed around the roots of trees from forests that once grew on top of the limestone base. Many—perhaps the youngest ones—have a hard, stony dome on top; while the jagged, more eroded ones are thought to be older.

Viewing the pinnacles

Once in the park, visitors can view these amazing structures from the Pinnacles Lookout, afoot on the 1.5-kilometre Pinnacles Loop Trail or by following the Pinnacles Desert Drive.

Visitors can also learn about the park and its ancient formations in the Pinnacles Desert Discovery interpretive centre.The centre was designed to blend into the surrounding environment and was even set alight during construction to achieve a 'burnt look' which is so common in the Australian landscape. It was constructed in an environmentally



sensitive way and incorporates passive solar building design. The award-winning state-of-the-art display which includes soundscapes, video, panels and interpretive material dazzles in its ability to tell the story of the park's geological features and biodiversity. The gift shop houses a beautiful range of items for sale.

More than meets the eye

The pinnacles are not the only things of interest in Nambung National Park. The park features beautiful beaches, coastal dune systems, shady groves of tuart trees (*Eucalyptus gomphocephala*) and magnificent seasonal wildflowers. It is also an access point for Jurien Bay Marine Park—a temperate marine environment that provides breeding and rest areas for seabirds and Australian sea lions (*Neophoca cinerea*).

Lake Thetis, in the park's north, is a small saline lake that features marine stromatolites. These ancient formations look like lumpy rocks but are, in fact, made by cyanobacteria—similar to those that lived 3,500 million years ago. Fossil remains of cyanobacteria are the oldest record of life on Earth.

Kangaroo Point is popular for shore fishing and boating and also has a barbecue, toilet and picnic sites. Hangover Bay, a popular recreation site known for its beautiful beach, is undergoing a redevelopment program that will provide new barbecues, shaded picnic areas, toilets, increased parking and interpretive information. The works are due for completion in mid-2012 until which time the site is closed to facilitate construction works.

Wild draw

Wildlife is abundant in and around the park, including 103 bird species. Small birds of prey, such as kestrels, perch on the pinnacles while galahs nest in the hollows. The area is frequently visited by the threatened Carnaby's cockatoo (*Calyptorhynchus latirostris*) and emus (*Dromaius novaehollandiae*) are often seen wandering around.

As many as 30 species of reptile occur in the area, including the bobtail (*Tiliqua rugosa*), Gould's monitor (*Varanus gouldii*) and the carpet python (*Morelia spilota imbricata*).

The area is also home to the ash-grey mouse (*Pseudomys albocinereus*), western brush wallaby (*Macropus irma*), honey possum (*Tarsipes rostratus*), echidna (*Tachyglossus aculeatus*) and western grey kangaroo (*M. fuliginosus*). The quenda (*Isoodon obesulus*), tammar wallaby (*M. eugenii*) and woylie (*Bettongia penicillata*) have been reintroduced to the area through the Department of Environment and Conservation's *Western Shield* program.

In spring, the park erupts into colour from its wildflower displays. Then, come summer, the beautiful Western Australian Christmas tree (*Nuytsia floribunda*) punctuates the landscape with its brilliant orange flowers.

park facts

Where is it? 195 kilometres north of Perth.

Total area: 19,236 hectares.

What to do: Pinnacles exploration, photography, wildflower viewing, picnicking, swimming, fishing, snorkelling.

Facilities: Barbecues, information panels, tables and toilets. There are no camping areas in the national park but a full range of accommodation and other services are available in Cervantes. The Pinnacles Desert Discovery interpretive centre is open every day of the year from 9.30am to 4.30pm, except Christmas Day.

Park fees: $11 per vehicle (up to eight legally seated people).

Nearest DEC office: Cervantes Ranger Station, Bradley Loop, Cervantes, phone (08) 9652 7043.

A new threat posed by foxes

The introduced red fox is an efficient killer that has inflicted untold damage on much of Australia's marsupial fauna. Recent research on rock wallabies has shown that the mere presence of foxes can be equally as damaging as the act of predation itself. But solutions are at hand.

by Natasha Moore, Craig Pentland and Jack Kinnear

For more than 30 years, the wheatbelt black-flanked rock wallaby (*Petrogale lateralis lateralis*) has been the focus of a long-term ecological experiment. The originators of the conservation project (see 'A controversial experiment begins' below) have passed research to a new generation of scientists, but lessons continue to be learnt. For the most part, the project has been a spectacular success story, but it has also been the subject of controversy and scepticism, such as during times when the introduced red fox (*Vulpes vulpes*) was not yet accepted as a major wildlife conservation problem.

Through the early years of the project, and because of the resulting fox control through the then Department of Conservation and Land Management's *Western Shield* program, some rock wallaby population numbers irrupted. Indeed, some very small rock wallaby colonies, officially acknowledged as threatened with extinction, achieved pest status. Furthermore, these sites

became net exporters of wallabies in an effort to reduce their numbers, with batches periodically shipped off to fox-controlled sites where the species occurred before the arrival of the fox—a bonus for conservation efforts.

This was the scene for many years, but then the once too-good-to-be-true conservation story fell to Earth with a resounding crash. Some sites began showing signs of overgrazing. This had been predicted, but the severity of the consequent weed invasion was nevertheless alarming. No immediate remedial action was taken and in retrospect this was fortuitous, as the outcomes produced some new ecological insights.

Bad tidings

Signs of the recent rock wallaby population crash were first confirmed during site monitoring by the Department of Environment and Conservation (DEC) in 2010. Only a handful of animals was trapped on Nangeen Hill, a 160-hectare nature reserve in the wheatbelt. The trap success rate was extraordinarily low, sending a strong signal that something was wrong.

In response to this disturbing finding, further intensive trapping was organised, but, incredibly, only 14 wallabies were caught, compared with more than 100 wallabies trapped on the site during 2007, a figure comparable to the previous four census years (1986, 1990, 1994 and 1998). Moreover, statistical analysis suggested that the 2010 trapping had caught all the rock wallabies. Next, the outcrop at Mount Caroline Nature Reserve (351 hectares) was set with traps and again the results were jarring; the numbers had declined by 80 per cent from more than 300 to about 70 wallabies, and many were in poor condition. Both sites were heavily overgrazed. In terms of population, it was like 1978 all over again.

This posed the question: could the crash have been prevented? The provision of food supplements might have helped, but such an action would have resulted only in never-ending palliative measures. Moreover, such an intervention would have detracted attention from the fundamental issues that caused the crashes and, more importantly, any understanding of how to prevent them.

Opposite page
A female black-flanked rock wallaby warming itself in the early morning sunshine in the wheatbelt.
Photo – Hayden Cannon/DEC

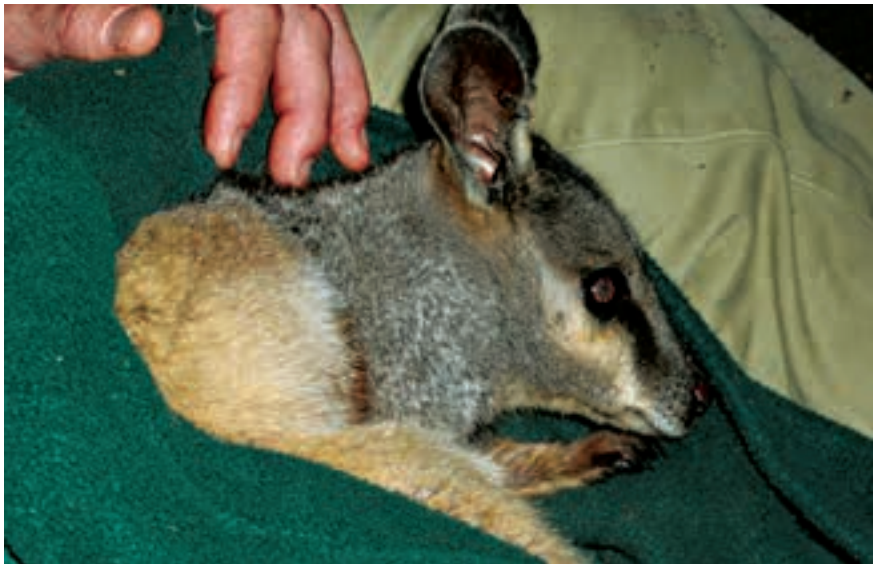
Below A rock wallaby in its habitat.
Photo – Jiri Lochman

A controversial experiment begins

In 1978, Jack Kinnear and Michael Onus, of the then Department of Fisheries and Wildlife, set out from the Wildlife Research Centre in Woodvale to investigate the status of some rare and endangered wheatbelt rock wallaby colonies living on three-billion-year-old granite outcrops south of Kellerberrin. Known locally as mounts, rocks or hills, they are collectively referred to as monadnocks by geologists; a name applied to prominent structures that stand alone in an otherwise flat or rolling landscape, such as Mount Augustus and Uluru.

The first task was to map the locations of the colonies and soon a pattern emerged; rock wallabies were invariably found wherever the rock was deeply fragmented, and associated with these fragmented areas were nearby grassy meadows. Months later, they estimated that there were about 75 wallabies spread across five sites with one population consisting of just six individuals. Twenty years later, when Jack and Michael folded up their traps and moved on, there were more than 500.

Left A good result for one rock wallaby population—Craig Pentland and DEC volunteer Sharon Lewis release a young male rock wallaby trapped during a population monitoring field trip in the wheatbelt.
Photo – Phil Lewis



Below left An adult rock wallaby ready for release after being measured and tagged during a population monitoring field trip.
Photo – Hayden Cannon/DEC

The instability problem

The fundamental problem that characterises the plight faced by the rock wallaby colonies is that they are inherently unstable, due to circumstances imposed on them by agriculture and predation by the introduced fox. When rock wallaby numbers are low, the fox, and probably the feral cat (*Felis catus*), pose an ongoing threat to their survival. Indeed, two local extinctions—in the absence of fox control—were recorded. Not only do unstable populations run a greater risk of extinction, they also lose genetic variability during a crash, which promotes inbreeding and increases the extinction risk even further.

All of these problems were supposed to disappear as the populations increased under fox control, and this was the case for about 25 years. But, as the years passed, other conditions transpired that created instabilities and set the colonies on a course heading for an inevitable crash. In other words, what seemed to be a simple win-win situation (that is, fox control) became a no-win situation. When small, the colonies are unstable because of the fox threat, and so the obvious remedy was to increase their numbers. This occurred with great success, but the colonies still ended up unstable—welcome to ecological complexity! Clearly, overgrazing was involved, but this was only a symptom; something more complex was going on.

Setting the scene

When the initial steps were taken in 1978 to assess the conservation status of wheatbelt rock wallabies, historical records revealed that the species was once widespread and abundant throughout the region. Development and agriculture took their toll on the habitat of many native marsupial species that once flourished in the wheatbelt, and for any species that managed to hang on, the coming of the fox sealed their fate. However, since no one has yet managed to grow crops on granite monadnocks, the habitat of rock wallabies survived to some extent.

The six-fold population increases—75 to 500—evident by 1998 were due to fox control achieved by monthly distribution of 1080 poison baits through *Western Shield*. Before the experiment began, between 1979 and 1982, numerous trials were conducted to assess the effectiveness of baiting, with the optimistic objective of making the reserves absolutely fox free. This turned out to be an unrealistic goal, in particular during the period when young foxes leave their birthplace seeking to establish their own territories, from November to May.

Fortunately, invading foxes do not always represent a direct threat to a rock wallaby population, as they normally take poisoned baits before they cause any damage. In addition, as populations increase, some depredations can be tolerated without causing a population decline—hence, despite some shortcomings, fox control works in the wheatbelt.

The role of fragmented rocky habitats

Rock wallabies live on fragmented rocky sites, known as 'breakaways'. These habitat features serve as safe havens from predators and also enable the species to avoid lengthy periods of

Above left Typical rock wallaby habitat among the tumbled and fractured rocks found within some wheatbelt nature reserves.
Photo – Hayden Cannon/DEC

Above The fox is a major threat to rock wallaby populations.
Photo – Jiri Lochman

Left Craig releases a tagged adult rock wallaby during a monitoring field trip.
Photo – Hayden Cannon/DEC

extreme heat and cold. Whenever the weather becomes extreme, the animals simply retreat into caves and crevices which serve as passive 'air-conditioned' niches or thermal refuges. By doing so, they do not need to drink—the moisture in the vegetation they eat suffices—and they also conserve energy through being insulated from extreme heat and cold.

The importance of these habitats—particularly when foxes are not controlled—cannot be overstated. Rock wallabies can only survive on deeply fragmented rocky sites and food must be nearby. Such sites are recognised as predation refuges or safe havens, and they were the places where the rock wallabies were invariably found during the first surveys made in 1978. No predator-proof safe havens, no rock wallabies; this rule explains why so many outcrops in the wheatbelt and elsewhere failed to sustain colonies.

Accordingly, logic suggests that when foxes are controlled, wallabies will occupy the less secure sections of an outcrop. And this is exactly what happened—with baiting, and therefore fewer foxes, the rock wallabies eventually spread out to occupy previously 'no-go' areas of the outcrops. In this way, fox control led to more wallabies because it reset the carrying capacity of all sites to a higher level. By 1998, the rock wallabies had responded accordingly—500 and climbing.

Applying further logic, suppose fox control was not working for some reason, and that was the reason for the decline: what would happen? Logic would predict that the declining population would contract to refuge sites. However, the trapping data showed that rock wallabies were caught at both refuge and at non-refuge sites (although the numbers were reduced)—this meant researchers could rule out fox predation as the cause of the decline.

A useful analogy is to liken the rocky sites to hotels with a fixed number of rooms, with this capacity setting a limit to the number of rock wallabies a site can support. One can also grade them accordingly: a 'five-star' refuge site is one which provides maximum security in the form of deeply fragmented breakaways, thus providing a safe haven from the four-footed marauding terrorist, the fox. Under fox control, the need for 'five-star' accommodation can be relaxed and more 'rooms' become available. When the 'hotel' becomes full, however, any rock wallabies that fail to secure a safe place to stay become homeless and either die or disperse. It's nature's way of limiting the population and preventing overgrazing, but currently it no longer works.

Above The impacts of overgrazing at Nangeen Hill Nature Reserve.
Photo – Hayden Cannon/DEC

Right A rock wallaby trapped for monitoring purposes.
Photo – Jiri Lochman

Marauding terrorists

Foxes not only kill rock wallabies, they also terrorise them. Researcher Craig Pentland has spent countless hours while collecting data for his PhD observing rock wallabies using night vision equipment. From time to time, a fox would appear and any wallabies foraging on the meadow would flee to the rock en masse—a mad scramble to safety. On one occasion, a fox was witnessed killing a wallaby. Gradually, it became evident that within the rock wallaby population, the mere presence of prowling foxes generates a fear of being killed, a phenomenon well documented in the predation literature. Indeed, it has been noted that the mere presence of predators can make prey so fearful that they elect to starve to death rather than risk predation.

In the case of the wheatbelt rock wallabies, the 'fear effect' only came into play as the numbers increased. Harking back to 1982 when fox control began, the populations were small, food was nearby and fear of predation was of little concern because they could safely graze close to their predator-proof five-star shelter—indeed, entirely on the rock itself. However, as the numbers increased, they exhausted the nearby food supply and therefore were obliged to venture away from shelter to graze and, as a consequence, the fear factor kicked in.

It is this fear factor that accounts for the inherent instability affecting the once-thriving Nangeen Hill Nature Reserve population: fear of prowling foxes has restricted the population's foraging range, a behavioural response that over the years has caused the outcrop and some surrounds (for example, the adjacent meadow) to become overgrazed and infested with weeds. What is particularly frustrating about this effect is that on the rock itself, the rock wallabies were limited to eating bark and ice plant (species of introduced annual herb which leach salt into the soil), and at 30 to 40 metres from the outcrop on the meadow the ground is bare or weed infested, but at 50 metres and beyond, perfectly good forage remains untouched.

In summary, Nangeen Hill Nature Reserve has enough food to support a population at carrying capacity, but the wallabies are just too scared to access it—all because it is not possible to totally exclude foxes by baiting. This outcome is somewhat paradoxical, because to control foxes in a wheatbelt setting we have to allow them to invade in order to expose them to bait, and hence they make their presence felt to the wallabies with fatal consequences—a near 'catch-22' situation. So, is there a solution? Prevent foxes from entering by erecting a predator-proof fence and rehabilitate the site. Importantly, the latter is already underway, organised by DEC district staff.

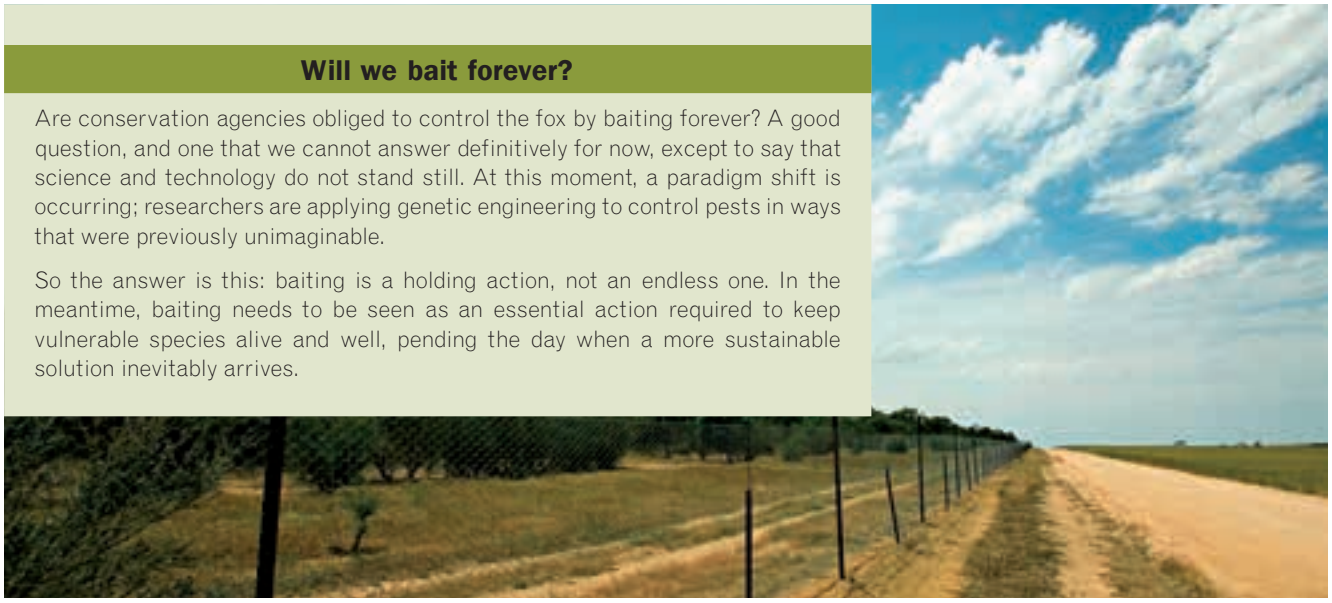
Mount Caroline

The situation at Mount Caroline Nature Reserve is similar in some ways. While larger than Nangeen, it has fewer 'five-star' sites: before fox control it supported less than 20 rock wallabies. By 1998 researchers were nearly overwhelmed as the population burst past the 300 mark, filling every available 'room' on the rock. This did not deter some of the homeless, who were observed happily occupying some 'one-star' sites around a nearby homestead, living under brush piles and abandoned buildings, enjoying scheme water and succulent food, while at night raiding the homestead's hanging baskets.

Will we bait forever?

Are conservation agencies obliged to control the fox by baiting forever? A good question, and one that we cannot answer definitively for now, except to say that science and technology do not stand still. At this moment, a paradigm shift is occurring; researchers are applying genetic engineering to control pests in ways that were previously unimaginable.

So the answer is this: baiting is a holding action, not an endless one. In the meantime, baiting needs to be seen as an essential action required to keep vulnerable species alive and well, pending the day when a more sustainable solution inevitably arrives.



Above Fencing of Mount Caroline Nature Reserve to protect crops from grazing.
Photo – Craig Pentland/DEC

Below Rock wallaby.
Photo – Jiri Lochman

Meanwhile, away from the homestead, the pillaging took on a more serious note: rock wallabies were leaving the reserve to forage as they had done for countless generations, but now the forage was a valuable crop. Not fussed about this exotic food, they fed on these cereal crops regularly, causing serious economic losses to farmers. DEC managers responded in the only way they could: a fence was erected which confined wallabies to the reserve, but this had unforeseen consequences—severe overgrazing within the reserve, making a population crash inevitable sooner rather than later.

While the Mount Caroline instability scenario appears to mimic the Nangeen situation due to overgrazing, the solution to the problem requires a different action. Nangeen Hill Nature Reserve has enough food to support a population at carrying capacity, while Mount Caroline does not. The solution to the overgrazing problem at Mount Caroline, brought on by extensive clearing of the surrounding landscape, is to buy some land back, in particular the land adjacent to the exclusion fence, and bait it for foxes.

The future

Does the rock wallaby have a future in its wheatbelt setting? Indeed it does—it is an adaptable, resilient species and, were it not for foxes, DEC would be faced with a pest species rather than a threatened one. Fundamentally, to conserve rock wallabies, all one needs to do is control foxes (see 'Will we bait forever?' above) and provide the colonies with sufficient food and, most importantly, enable them to access this food.

This lack of access to food is the root cause of the instabilities and the cause of the recent crashes. The remedies differ: at Nangeen Hill a predator-proof fence needs to be erected, at Mount Caroline some land needs to be added to the reserve.

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Craig Pentland is a part-time DEC assistant fauna conservation officer. His position is funded through the Special Nature Conservation Project program within DEC and he is finalising his PhD on the behavioural ecology of the rock wallabies of the central wheatbelt. Craig can be contacted on (08) 9041 6006.

Jack Kinnear was employed by the Department of Fisheries and Wildlife and then the Department of Conservation and Land Management, two of DEC's predecessor departments, from 1978 to 2001. He can be contacted on (08) 9245 3896 or by email (jakinn2@bigpond.com).

A project of this nature and longevity would not have been possible without the goodwill and cooperation of the rural community throughout the district and, in particular, the farming families whose properties contained or abutted the rock wallaby sites. And while there is much to be done, the collective skills of DEC, universities, local governments, World Wildlife Fund Australia, the Australian Wildlife Conservancy, regional natural resource management groups and individuals are being mobilised to restore the colonies to a more resilient and sustainable state.

People in profile

Story by Joanna Moore

Simon Cherriman is a young wildlife filmmaker and wedge-tailed eagle specialist with fresh perspectives on environmental education.

Environmental educator Simon Cherriman

He's only young—just 28 years old—but Simon Cherriman's achievements in the environmental education field are as impressive as he is tall—"I'm 6 foot 8," he rattles off by heart, obviously used to being asked, "All the better for climbing trees". A useful skill, one supposes, when researching birds and, in particular, his favourite, the wedge-tailed eagle (*Aquila audax*).

Simon has been passionate about the wedge-tailed eagle for as long as he can remember. And this specific interest is part of a broader environmental calling that started as a child and now helps Simon reach out to children and other audiences through education and wildlife filmmaking. Simon has worked as a field zoologist, as a field biologist, as a tour guide with the Australian Wildlife Conservancy, as a volunteer at Whiteman Park, and in several roles with the Department of Environment and Conservation (DEC) including as a threatened flora officer, threatened fauna officer and technical officer. He is also an expert tree climber, with a high level of skill and experience in finding, climbing to, photographing and filming nests of Australian birds.

Well known in the Perth environmental community as a wedge-tailed eagle specialist, Simon now runs an environmental consulting business. Adding to his qualifications as a biologist with first class Honours in wedge-tailed eagles, Simon recently completed his Masters in Natural History Filmmaking and co-produced the film *A Wedged Tale*, which contributed to his being awarded the Australian Geographic Young Conservationist of the Year in 2010. Simon also won the environmental category of the Western Australian Young Person of the Year Awards in 2008. But Simon is perhaps best known as an enthusiastic young speaker and educator, with a special ability to inspire environmental interest in adults and children alike.

Previous page
Main This massive nest in the Avon Valley boasts two large eaglets, almost ready to fly at 10 weeks old.
Photo – Simon Cherriman
Inset Simon Cherriman.
Photo – Joanna Moore/DEC

Opposite page
Left An adult wedge-tailed eagle prepares to take off after gorging itself on a kangaroo.
Photo – Simon Cherriman

Below Knee-deep in a Pinjarra swamp photographing an ibis breeding colony.
Photo – Gillian Basnett

A passion for eagles

Simon says it's hard to put a finger on the moment when it all began. Growing up in the Perth hills, there were plenty of inspiring moments, though he says there are a few that stand out. In one, the 15-year-old Simon spotted a huge structure of sticks high in a wandoo tree. He climbed up to the wedge-tailed eagle nest and marvelled at its size. "I was hooked!" he said. Simon's parents would often point out eagles and the family would

The wedge-tailed eagle story

"No one knows how many wedge-tailed eagles lived in Australia 250 years ago; certainly thousands, perhaps tens of thousands. Many of these birds lived in breeding pairs occupying permanent territories, while others were solo nomads wandering the landscape, as they do today. The breeders built massive nests in large, old eucalypts, with a commanding view over their kingdom—a perfect perspective on the pristine forests and woodlands which contained their prime food: mammals. Kangaroo, wallaby, bettong and possum, numbat, bilby and bandicoot—the diversity was as rich as anywhere else in the world, and it still is.

Today, the south-west bioregion is recognised as one of only 12 biodiversity hot spots in the world. We still don't really know how many eagles live here. There have probably been changes in eagle numbers, but it is uncertain whether these were increases or decreases. Whichever is the case, European settlement brought about two major changes to the environment which transformed the wedge-tail's life forever.

Drastic habitat alterations were perhaps the most significant. The ideal of acres of rolling green pasture, crops and livestock drove settlers to clear more than 90 per cent of the original vegetation in the south-west of WA (the area between Shark Bay and Hopetoun). Diverse eucalypt forests and woodlands were replaced with wheat stubble and sheep paddocks. And, with this disappearance of habitat, and the introduction of cats and foxes, came a wave of declines and extinctions in native mammal numbers. Eagles lost much of their food, but because of their versatility, managed to survive on what was available, including kangaroos, birds and reptiles. Did they decline, or remain constant? We will never know.

Another foreigner arrived: the European rabbit. This animal spread quickly across southern Australia, booming to plagues of millions. Eagles thrived on the abundance of this prime food, which spread into all habitats, was easy to hunt in the largely open landscape, and, except in very bad years, remained plentiful as a prey item. Wedgies feasted on rabbits as they took over the continent, often replacing the native species of yesteryear in the predator's diet. The once-diverse ecosystems over which the eagles ruled had in many areas been simplified, from numerous natives to one or two introduced species. Eagle numbers may well have increased during this time, but again we don't know for sure. But we do know that another introduced mammal became eagle food, and the settlers didn't like it—sheep.

Sheep were part of the grand scheme of agriculture envisioned by many pioneers in Australia. And, as the human population grew, so did the requirement for sheep. Small flocks soon became paddocks of hundreds, and the eagles undoubtedly took lambs when they needed to. But in many cases the eagles were feeding on dead lambs already killed by ravens or foxes.

Nevertheless, the farmers waged war on the eagles; hundreds of thousands were shot, until as recently as the 1980s. Governments endorsed this by declaring the birds 'pests of agriculture' and paying bounties on their scalps. Most shooting ended when scientific research exonerated the birds. As research scientists AS Leopold and TO Wolfe concluded in 1970, "[we cannot] justify the continued persecution of a native predator that eats mostly rabbits and has scarcely any adverse impact on the sheep industry". Luckily, wedge-tails didn't become extinct, probably because the birds killed were often immature non-breeders which were destined to die of natural causes. Culling by humans essentially replaced natural mortality, so the population remained largely stable.

Through all these changes, and despite persecution, wedge-tailed eagles have persisted. We are lucky to have them and while the number of eagles still isn't known, it is known that they aren't threatened on mainland Australia. This provides an opportunity for us to study and appreciate them. Wedge-tailed eagles represent one relationship between humans and the environment, and are a useful example for thinking about ecological systems and our place within them."

Contributed by Simon Cherriman

Left This black swan's nest was thrilling to find among an ibis colony. Weeks later, the cygnets were seen swimming on the lake with their parents, among hundreds of squabbling ibis chicks.

Below left Simon conducting a bone identification activity with school children. *Photos – Gillian Basnett*

share the excitement of seeing them around Western Australia during holiday trips.

Simon explains that as he grew up, he found he shared a connection with eagles—they too were tall and conspicuous. "Just as eagles are mobbed by other birds, I was often mobbed by other people when I went out, usually asking about my height," Simon says. "And I admired qualities that eagles possess: loyalty, cooperation, patience, dedication, caring for each other." Simon has also discovered that the striking and charismatic wedge-tailed eagle is a great topic with which to grab the attention, and stir the curiosity, of young people. He can talk for hours about eagles—what we know about them, what we don't know, and common misconceptions. He explains that the wedge-tailed eagle story (see box on page 35) is a useful educational tool.

Seeing the penny drop

Simon says engaging with children is one of the most rewarding aspects of his work. Whether through building eagle 'nests' and filling them with prey bones as part of a 'detective' workshop with Millennium Kids (a Western Australian not-for-profit youth environmental organisation), or running educational activities through DEC's *Nearer to Nature* program, creating fun, rewarding and exciting learning for children is his main aim. "I want them to feel that knowledge is useful," Simon explains, "And for them to go back to the classroom, or return home, knowing things about their environment and being excited about that. Science—which is merely seeking answers to questions about our world—is so often misinterpreted. It can actually be fun!"

How does Simon know a workshop has been successful? The kids are still talking about it after the session—on the bus ride back to school, in the playground, to their parents at dinner. Simon recalls a recent workshop in which the most distracted student at the start of the session was, by the end, "totally unrecognisable"—engaged, excited and really thinking about what he had learnt. "It's that moment the penny drops that I look for," he says.

Simon explains that education should not only be fun and engaging, but also challenging. "There's a lot to be said for incorporating a bit of adrenaline and risk—I think all people need it to some degree," he explains. Of course classroom educators need to keep their students safe, but Simon feels young people should be encouraged to find a 'rush' in positive ways, rather than just through going on a show ride, in simulated high-risk scenes such as those in some computer games or by engaging in dangerous and sometimes illegal behaviours such as drinking recklessly, taking illicit drugs or driving unsafely. "All activities need to be undertaken with an awareness of risk," Simon says, "I'm certainly quick to emphasise the 'don't try this at home' message when showing photos of me up massive trees! The risks I take climbing trees should certainly not be taken by most people—I have years of practice and training, special qualifications and good safety gear—but there's a certain beauty in the physical and mental challenge of many outdoor activities. To engage with your natural surroundings is to live!"

Right A 35-metre climb to a wedge-tailed eagle nest in the Perth hills.
Photo – Gillian Basnett

Simon's childhood playground of the Perth hills—where he spent time in national parks such as John Forrest, Mundaring (now Beelu), Kalamunda (now Mundy) and Walyunga—provided many opportunities for physical and mental challenge. These included the thrill of spotting a tiny tortoise hatchling washed past in a winter torrent of creek water, the challenge of climbing a tree with just-not-quite-enough lower branches, and the fascination of watching a trigger plant spring, as well as many others. These experiences set Simon's life on the positive and fulfilling journey he follows to this day.

A new perspective

From Simon's perspective, the dominant social view sees humans aiming to control and command the environment, and imagines nature as 'out there', as separate from us. This attitude that separates humans from the natural environment leads to us working against the natural system, or at least trying to find solutions without understanding the reason that problems arise in the first place. The former killing of eagles that occasionally took lambs is one example that Simon uses to illustrate this point. Of course this understanding is now implicit in many environmental management activities around the state, but it's a key lesson for young people to keep learning. Simon feels that change is constant, and we must adapt our knowledge to a changing world.

Through his educational activities, Simon aims to break down this disconnect people feel with the environment. "It all starts with nature in your own backyard," Simon explains, asserting that by providing just a few small bits of knowledge about the environment around them we can help children gain an appreciation of the natural systems that exist.

Sharing the view

Perhaps it was destiny that Simon Cherriman grew to be 203 centimetres tall. As a child, Simon felt he "just had" to climb trees. "We're all primates, aren't we?" he says. And that habit gave him a special perspective, one rarely gained by others—a bird nest, hatching chicks, views across the beautiful jarrah-marri bushland. "My eyes were the video camera," Simon explains, "And, more and more, I wanted to share the growing reel of footage in my mind with other people."

As a child, Simon was strongly influenced by Sir David Attenborough and the late Malcolm Douglas. He started imagining making the many things he saw in the bush into films—birds, nests, skinks, echidnas, 'roos, turtles—as well as showing the human side of his bush explorations—climbing, building hides, bushwalking and more. Simon says he wanted to share what he saw with other people, as well as share his environmental philosophy.

"I knew if you wanted something in life you just had to do it!" Simon says. So he got a video camera when he was about 20 and started filming what he was seeing. He collected hours of footage, with a particular focus on wedge-tailed eagles. This led to amateur and often frustrating attempts at filmmaking and eventually to a filmmaking course in New Zealand, where he learnt the professional approach.

Above Eagles have such good eyes that tree hides need to be entered in darkness to prevent the observer being seen.
Photo – Adam Hermans

Below These tiny eaglets are only a few days old.
Photo – Simon Cherriman

The premise of Simon's short film *A Wedged Tale*, co-produced with Adam Hermans, is the quest for the elusive predation shot, where a wedge-tailed eagle is filmed for the first time catching live prey. The film's hero, played by Simon, travels around WA to get this sought-after shot. While on his mission, he frequently gets distracted—watching shelduck ducklings jump from a lofty nest, for example, or observing the activities of numbats, echidnas and nesting honeyeaters. As well as creating a platform to generate appreciation for, and educate about, the wedge-tailed eagle, the film captures the rich diversity of the state's south-west.

One of the biggest challenges in environmental education—and in education broadly—is how to reach people with facts. There is so much information out there, how does one encourage people to relate what they see and are told to their own life, to their own surroundings? Simon's film is much more than a documentary. He explains that there's a strong aspect of storytelling to the film: "The narrative draws the viewer in and tells a bigger story—that biodiversity is important. My message is that there's so much out there, we just need to pay attention—even in our own backyards. Education as a child begins in the backyard and if you pay attention to the animals that are around you, you can learn a hell of a lot about the natural environment."

Simon is bashful when asked about winning the 2010 Australian Geographic Young Conservationist of the Year. "I'm just a big kid in love with my country," he says. "I believe the land connects all people, past and present, and we can all develop a connection to this land by spending time getting to know it." The other approach to this—which hopefully encourages people to one day get out there themselves—is to bring nature into the classroom and into people's lounge rooms—and this is what Simon's work aims to do each day. "Never stop learning," Simon says, "And keep the child in you alive."

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Simon can be contacted on 0422 916 747 or by email (aquila84@iinet.net.au)

Saving the jetty

One hundred and forty-seven years ago the first wooden piles of the Busselton Jetty were erected in Geographe Bay. Since then, thousands of people have been involved in building, saving, repairing and refurbishing this historic structure that protrudes nearly two kilometres into the ocean.

words by Ann Storrie and Anna Micha
photos by Ann Storrie

Under the jetty is a profusion of life. On a calm, clear day, pedestrians on the jetty can look down to see thousands of fish swirling around the piles. Snorkel, or dive, and you will be surrounded by enormous schools of yellowtail and Australian herring that dart past in feeding frenzies, mouths wide. These schools are often followed by equally large schools of predatory longfin pike and tailor. Juvenile globefish congregate in groups of a dozen or more, sometimes hiding among the branches of *Carijoa* sp. corals that protrude from the piles. Schools of old wives gently cruise around with western talma, leatherjackets and wrasse as they pick invertebrates from the structures. Young dusky morwong, bighead gurnard perch, wobbegong sharks, rays and the occasional seadragon shelter among the algae and seagrasses around the jetty. Descend into the Busselton Jetty Underwater Observatory and you can view much of this splendour in dry comfort.

Historical drama

The story of the Busselton Jetty can read a little like a soap opera. From its inception in 1865 until 1960, the jetty was extended further and further into deeper water to counteract the build-up of drift sand. It originally serviced the thriving timber export industry until it was officially closed to state shipping in 1973. Severe storms, including ex-tropical cyclone Alby in 1978, took a huge toll on the old piles, and the jetty was declared a hazard and marked for demolition. Luckily, hundreds of people raised funds and lobbied local and state governments to repair the jetty. Despite further degeneration from normal wave action, storms, marine worms and fire, the main structure survived. In 2001 an informative and interesting interpretive centre was built beside the jetty near shore. In 2003 the world-class underwater observatory was established close to the end of the jetty and a tourist train ferried passengers, including divers, to and from the facility.

However, this was not the happy ending many hoped it would be. In 2008, a structural examination of the jetty deemed many areas to be unsafe for the train. Public access became an issue and the jetty was closed in May 2009. During the jetty's refurbishment, many of the wooden piles with encrusting marine life had to be removed, the end of the jetty demolished and the decking of the whole structure (other than a small section surrounding the underwater observatory) dismantled. This resulted in direct sunlight beaming onto the surviving marine life, destroying some of the delicate corals and promoting the growth of algae that smother ascidians (sea squirts) and many sedentary invertebrates such as

Previous page
Main Open for business, the Busselton Jetty has been a feature of the area for nearly 150 years.
Inset The jetty after a fire in 1999.
Photo – Wayne Storrie

Above left Restoring the Busselton Jetty.

Left The 2011 Busselton Jetty swim.

Above Blue-throated ascidians (*Clavelina moluccensis*) live on the jetty piles.

Right Fish such as the moonlighter (*Tilodon sexfasciatum*) are common visitors to the jetty.
Photo – Shannon Conway

the sponges, bryozoans and *Carijoa* sp. corals (which are commonly wrongly referred to as telesto coral, derived from the previous classification of this species in the genus *Telesto*). If too much of this habitat is lost, mobile invertebrates such as crabs, shrimps and nudibranchs also disappear. Fish life is then affected; not only the direct inhabitants on and around the piles, but pelagic fish, such as tailor, no longer visit to feed. It was imperative that the restoration process be expedited before too much vital habitat was lost.

A grand re-opening

On Sunday 6 February 2011, the Shire of Busselton had its biggest-ever event. An estimated 10,000 residents and visitors gathered on the town's foreshore to witness the official re-opening of the Busselton Jetty. This was followed by a display of fireworks. The annual jetty swim the next morning attracted thousands of competitors and spectators were allowed free access onto the 1.7 kilometres of new decking. The underwater observatory opened later that day where the marine life put on an awesome show. Ironically, the enormous schools of yellowtail, herring and tailor seemed to have increased during the rebuild and most of the coral growth was intact on the old piles around the underwater observatory. This major event brought the community together as never before.

Along with essential replacement of piles and decking, many new features have been added to the jetty. These include interpretive signs, fish cleaning bays, swimming and diving platforms, rain shelters and heritage sculptures. The jetty train was soon running to capacity, carrying more than 40 passengers, nine times a day, to and from the underwater observatory. Together with pedestrians, more than 600 people have visited the underwater observatory in a single day.

Completing the jetty refurbishment by the deadline of February 2011 was not an easy task. Winter storms created dangerous conditions at times and work had to be suspended for three to four months of the year. A change in contractors extended the work period and the finishing touches to the jetty were only just completed before the official opening. The final 100 metres of decking, north of the observatory, will be completed in autumn 2012.

New piles of life

Many of the old wooden piles that were removed have been replaced

Left Admiring the view at the underwater observatory.

Below left The jetty train carries up to 40 passengers nine times a day to and from the underwater observatory.

with new treated wooden piles, while steel piles have been erected at the end of the jetty. The decking up to the underwater observatory was replaced before much of the marine life was destroyed on the remaining old piles. This will facilitate the regeneration of these invertebrates relatively quickly on both the new timber and steel piles. The area is now a living laboratory for some very exciting and unusual research, much of which can be carried out from the underwater observatory.

The jetty is managed by the Busselton Jetty Environment and Conservation Association (BJECA), a community group established to promote protection of the jetty and enhancement of the natural marine environment in its vicinity and the wider environs of Geographe Bay. BJECA has resolved to provide information, education, facilities and structures on the jetty and in Geographe Bay to assist organisations undertaking research that will promote the protection and enhancement of this natural environment. A long-term project is being planned to facilitate research into the health of the local marine life and monitoring of the overall marine environment. Re-colonisation of the new timber and steel piles by marine organisms will be monitored, with an emphasis on comparing differences between timber and steel piles. Surveys of fish life and water temperature monitoring that were originally undertaken from the underwater observatory are again in full swing.

The jetty attracts a variety of fish and other marine animals, offering a wonderful opportunity for observations of both residential and occasional visitor species. These visitors are usually tropical species brought down the Western Australian coast by the Leeuwin Current—a band of warm water that flows along the outer continental shelf from Exmouth. Tropical species of batfish, rabbitfish, butterflyfish and shrimps have been recorded around the observatory. Greatly reduced visibility during the stormy months precludes any useful observations between about May and October, and the variety of observed species around the jetty may not be truly representative of the coastal waters of southern Geographe Bay. However, these surveys are yielding an invaluable insight into the marine biodiversity of the area in summer and autumn each year. As there is a marine exclusion zone around the observatory, surveys may also contribute to a better understanding of the effect of exclusion zones on marine biodiversity in the area. Surveys are undertaken twice daily by trained guides using a 'tick sheet' of the well-known species as well as provision for the unexpected visitors. Results are collated and monthly summaries

of species are derived and compared against previous reports. Surveys often attract the attention of tourists and provide a good opportunity for public interaction and education.

Water temperatures have been recorded near the observatory using self-recording temperature loggers since February 2001. The 15-minute records are converted to hourly figures and then collated into annual files, with a running plot of the monthly average and extreme temperatures to show the seasonal temperature cycle and perhaps in the longer-term detect any rising trends in temperature. This project was initiated and run by former CSIRO oceanographer Alan Pearce and BJECA provided labour, loggers and diver support. This project is currently moving across to a live stream data set with the assistance of CSIRO. In the future, the program may extend to record water salinity, sea, swell and tide heights, strength of the Leeuwin Current and effect of wind on fish observations.

The Busselton Jetty has been a feature of Geographe Bay for nearly 150 years. It is famous around the world as an outstanding artificial reef containing more than 300 species of marine life growing within an ecosystem on its wooden piles or living underneath or adjacent to the jetty structure. It has been saved from demolition, restored from fire, patched, mended and fully refurbished and has become an emblem of marine biodiversity that has brought joy to thousands of visitors and locals who fish, swim, snorkel, scuba dive or simply walk and sightsee. The unique opportunity to catch a train to an underwater observatory to view thousands of fish and invertebrates that congregate, without barriers or feeding stations, has elevated the jetty to worldwide recognition and status. The Busselton Jetty is set to take its next step in a rich marine history.

Ann Storrie is an accomplished underwater photographer and marine enthusiast. She has contributed numerous articles to *LANDSCOPE* magazine and has co-authored and photographed Department of Environment and Conservation (DEC) books such as *Wonders of Western Waters* and *Beneath Busselton Jetty*. She can be contacted by email (naturescapes.au@hotmail.com).

Anna Micha is the Busselton Jetty Underwater Observatory manager.

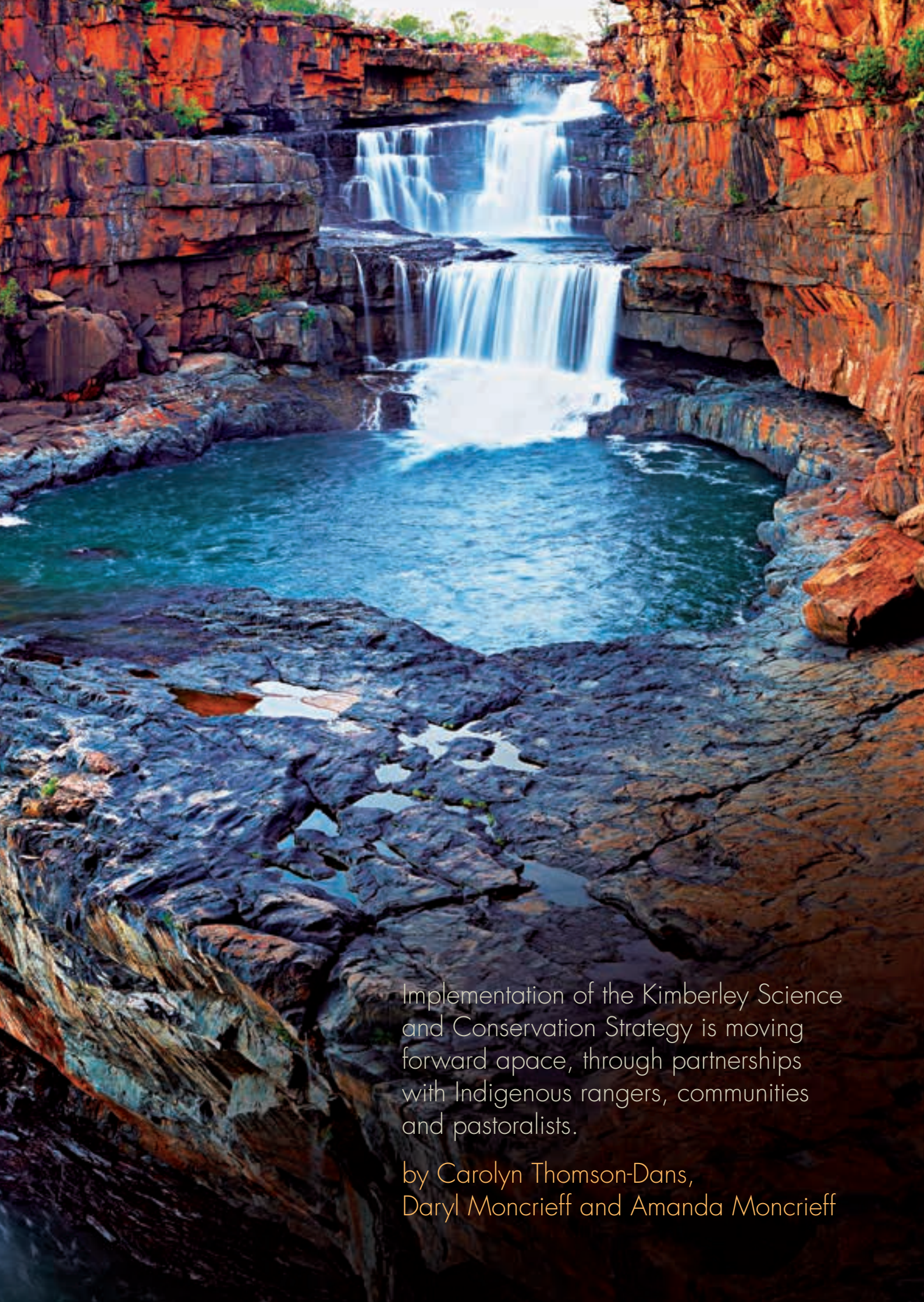
All results and data from the water temperature study are available to the public via the Busselton Jetty website at www.busseltonjetty.com.au.

For more information on the history and the wonderful marine life under the jetty, the DEC publication Beneath Busselton Jetty *describes most of the species of plants and animals that inhabit this unique underwater ecosystem. See the inside back cover for information about a special offer on* Beneath Busselton Jetty.

Above Nightfall at the Busselton Jetty.

Right A gurnard perch (*Neosebaste pandus*) under the jetty.
Photo – Shannon Conway

LOOKING AFTER COUNTRY



Implementation of the Kimberley Science and Conservation Strategy is moving forward apace, through partnerships with Indigenous rangers, communities and pastoralists.

by Carolyn Thomson-Dans, Daryl Moncrieff and Amanda Moncrieff

The Kimberley is a spectacular place, renowned for its natural and cultural significance as well as its raw beauty. It holds a special place for many people, locally, in Western Australia, Australia and across the world.

The state government's $63 million Kimberley Science and Conservation Strategy, released in June 2011, is a bold vision to ensure the region's long-term conservation (see 'Protecting the Kimberley wilderness', *LANDSCOPE*, Summer 2011–12). The strategy has four major themes: conserving the Kimberley's unique natural environment; working with and employing local Aboriginal people and maintaining the Kimberley's rich culture; increasing knowledge to support informed decision-making, planning and management; and providing opportunities for people to experience the Kimberley's natural and cultural wonders.

A key objective of the Kimberley strategy is to manage the north Kimberley at a landscape scale (known as the landscape-scale conservation initiative). This means managing threats—such as fire, feral animals and weeds—cooperatively across property boundaries and in partnership with traditional owners and key stakeholders including pastoralists and the Australian Wildlife Conservancy (AWC), to increase the resilience of ecosystems across the whole landscape.

From the outset, the state government has been determined to ensure that the Kimberley strategy engages and involves people who live and work in the central and north Kimberley. For Aboriginal people, this approach has the potential to create employment opportunities, helping to maintain the rich culture of the Kimberley. Numerous government agencies, non-government organisations and Aboriginal communities across the state are now working together to make the vision a reality, bringing about better on-ground management of country through control of weeds and feral animals and through enhanced prescribed burning programs.

Connection to country

The Kimberley has a diverse and living Aboriginal culture. Aboriginal people have inhabited the region for up to 60,000 years and today almost half of Kimberley residents are of Aboriginal descent. Traditional owners maintain a relationship to land in accordance with traditional laws and customs. Traditional ecological knowledge has been handed down from generation to generation and can be used in conjunction with modern science to inform land management practices and decisions.

Aboriginal people working on their own country, in the coordinated management of fire, feral animals and weeds as part of the landscape-scale conservation initiative, will deliver significant social and environmental outcomes. The Department of Environment and Conservation (DEC)

Previous page
Main Mitchell Falls in Mitchell River National Park is within Uunguu Country.
Photo – David Bettini

Above Kimberley scrub fire.
Photo – Jiri Lochman

Left Traditional owners controlling weeds on their country.
Photo – Bel Catcheside/DEC

Above The Bunuba traditional owners have been involved in constructing new visitor facilities at Geikie Gorge (pictured above) and Tunnel Creek national parks. *Photo – Jiri Lochman*

is working with a number of Indigenous ranger groups, including those managed by the Kimberley Land Council (KLC) and the Bunuba people, to implement the Kimberley strategy, and is hoping to establish similar arrangements with other traditional owner groups.

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

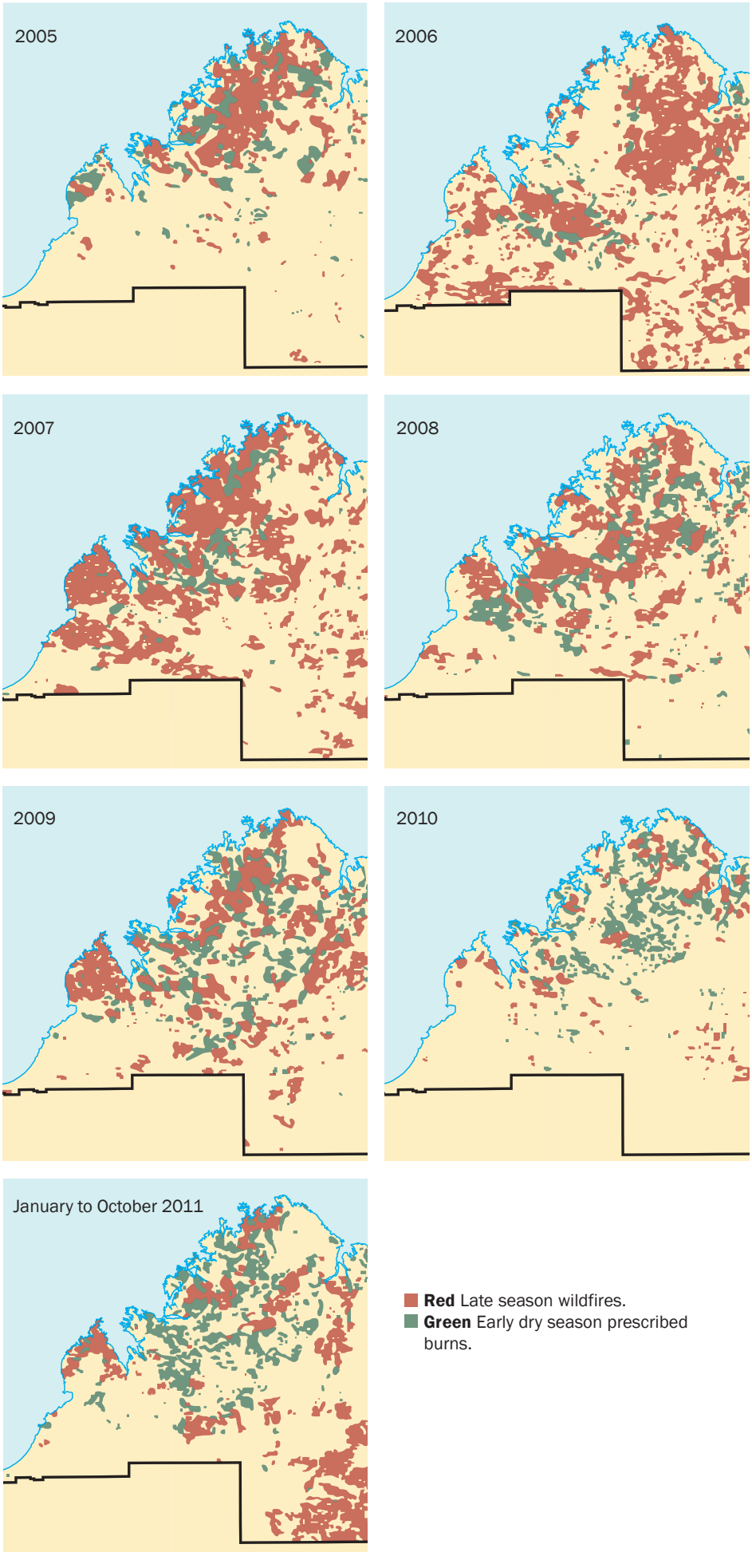
Managing fire

The Kimberley strategy is integrating contemporary science with traditional Aboriginal practices and knowledge by carrying out prescribed burning to create a mosaic of burnt and unburnt country in the late wet and early dry seasons. The resulting patchwork effect (see maps on page 48) reduces the amount of fuel available to burn and therefore reduces the risk of large, intense and damaging fires later in the dry season.

Changes in the vegetation structure are already evident as a result of burning programs such as *Ecofire*, a multi-stakeholder initiative coordinated by AWC. Originally funded through Rangelands Natural Resource Management as a short-term project, funding by DEC through the Kimberley strategy will enable *Ecofire* to continue in the future. Several years of managed prescribed burning by both AWC and DEC over multiple properties and land tenures has resulted in a range of vegetation of different ages across the Kimberley, which inhibits the occurrence of massive fires and improves biodiversity outcomes.

The Kimberley strategy is providing funding to expand these prescribed burning programs and to substantially increase the involvement of Aboriginal people in this work. In February and March each year, DEC staff meet with traditional owner groups to discuss which areas they would like to burn. Once an aerial burning program has been agreed upon, DEC conducts the prescribed burns and takes traditional owner representatives in the aircraft. In addition, Indigenous rangers are offered DEC's wildfire awareness training and some nominated rangers have already been trained to operate in more 'hands-on' roles. About 60 Aboriginal rangers, traditional owners and people from the four main claim groups in the north Kimberley took part in early dry season burning for 2011, which involved 300 hours of flight time in two aircraft.

In readiness for the 2012 burning season, DEC provided further basic and advanced firefighting courses (including training for incendiary operators and aerial navigators) for up to four representatives from each of the relevant claim groups across the Kimberley in February and March.



DEC has also begun discussions with traditional owners about the possibility of claim groups helping to undertake ground-based burning activities around cultural and fire-sensitive sites within the Wilinggin and Uunguu claim areas in advance of aerial burning.

DEC has installed multi-frequency radios in some KLC vehicles to improve on-ground communications between DEC and the KLC ranger groups. The Kimberley strategy has also funded the provision of a number of fire trailers, which are available for use by Aboriginal ranger groups.

Tackling feral animals

A program to eradicate feral pigs in the northern and central Kimberley is being developed by DEC and local Aboriginal ranger groups. Feral pigs are recognised as a significant threat to biodiversity conservation in the Kimberley due to habitat destruction, particularly along waterways. They can also transmit a range of endemic and exotic diseases. It is important for land managers to learn more about feral pig distribution and densities across the Kimberley and determine priorities for control actions.

A week-long feral pig training workshop held in Fitzroy Crossing in early August 2011 provided a great opportunity for Aboriginal rangers and land management organisations to exchange knowledge and plan the future management of feral pigs in the Kimberley. The workshop involved DEC staff, Miriuwung-Gajerrong rangers employed by DEC, Lake Argyle joint management rangers, KLC rangers and independent Aboriginal ranger groups from across the Kimberley. The training covered the impact of feral pigs and different control options, including trapping, shooting and baiting. This was followed by practical on-ground activities, such as building, setting and checking traps. The week concluded with a planning day in conjunction with KLC and the Department of Agriculture and Food WA, which focused on sharing knowledge and mapping areas where pigs were known to be present. This information will be used as a basis

Right Setting traps for feral pigs.
Photo – DEC

Below right Cathy Goonack from the Kandiwal community recording mammal measurements being taken by DEC's Ian Radford.
Photo – Richard Tunnicliffe/DEC

for developing joint works programs between DEC and Aboriginal ranger groups for feral pig control in the northern and central Kimberley.

Using additional resources made available through the Kimberley strategy, DEC has been able to expand the feral animal control program that has been in place for a number of years at Mitchell River National Park in the north Kimberley. Throughout the whole region, feral cattle, horses and donkeys create substantial grazing pressure on natural vegetation and impact on wetlands, streams and rivers, decreasing habitat values for native animals. In partnership with the Department of Agriculture and Food WA and neighbouring pastoralists, DEC has increased the duration and coverage of its operations to cull feral animals from strategic areas. DEC will continue to consult with pastoralists, non-government organisations and Aboriginal communities about future culling operations that may be feasible and about where other options such as fencing and/or mustering are warranted.

Joint weed control efforts

Collaborative weed control work is an important component of the Kimberley strategy. The strategy aims to facilitate the training and employment of Aboriginal rangers to undertake collaborative activities targeting weed invasion and biodiversity conservation.

DEC's West Kimberley District has developed an important partnership with the Wunggurr Aboriginal ranger group to work together; share knowledge, skills and training; and facilitate on-country land management activities. As part of this, DEC and the Wunggurr rangers recently began to eradicate an infestation of taro (*Colocasia esculenta* var. *aquatilis*) in King Leopold Ranges Conservation Park. The species, introduced in the 1980s, had been spreading along a tributary of the Barker River at the Mount Hart homestead. While taro is native to the east Kimberley, in the west Kimberley it is an invasive weed and has the potential to spread rapidly and choke river systems.

An expedition in August involved a trial program to survey the extent of the infestation and test different weed control methods. Spraying foliage with herbicide was found to be the most effective method, and almost two hectares of taro were sprayed twice in a follow-up expedition in September. DEC and Wunggurr rangers will continue to re-treat the affected area in the coming months and further survey work will be undertaken downstream to check for potential infested pockets.

Bunuba rangers have also been employed by DEC to conduct weed control activities in the southern half of King Leopold Ranges Conservation Park. Earlier this year DEC supported the rangers in completing courses within Certificate II and III in Conservation and Land Management that are applicable to controlling weeds and using chemicals. This was followed directly by employment for the rangers in several week-long blocks of work to control calotropis (*Calotropis procera*) along the Milliewindie Track.

Other partnerships

A number of Wunambal Gaambera traditional owners from the Kandiwal community near Mitchell River National Park worked with DEC staff in 2011 in monitoring a suite of sites in the Mitchell Plateau. These sites are being monitored to collect baseline data so that the impact of management actions on native vegetation and fauna can be measured over time. Such short-term employment opportunities

Left Setting a feral pig trap.
Photo – Richard Tunnicliffe/DEC

Below King Leopold Ranges Conservation Park.
Photo – David Bettini

provide a forum to exchange knowledge on plants and animals found in the area. DEC hopes to expand its involvement of traditional owners in the monitoring program in coming years.

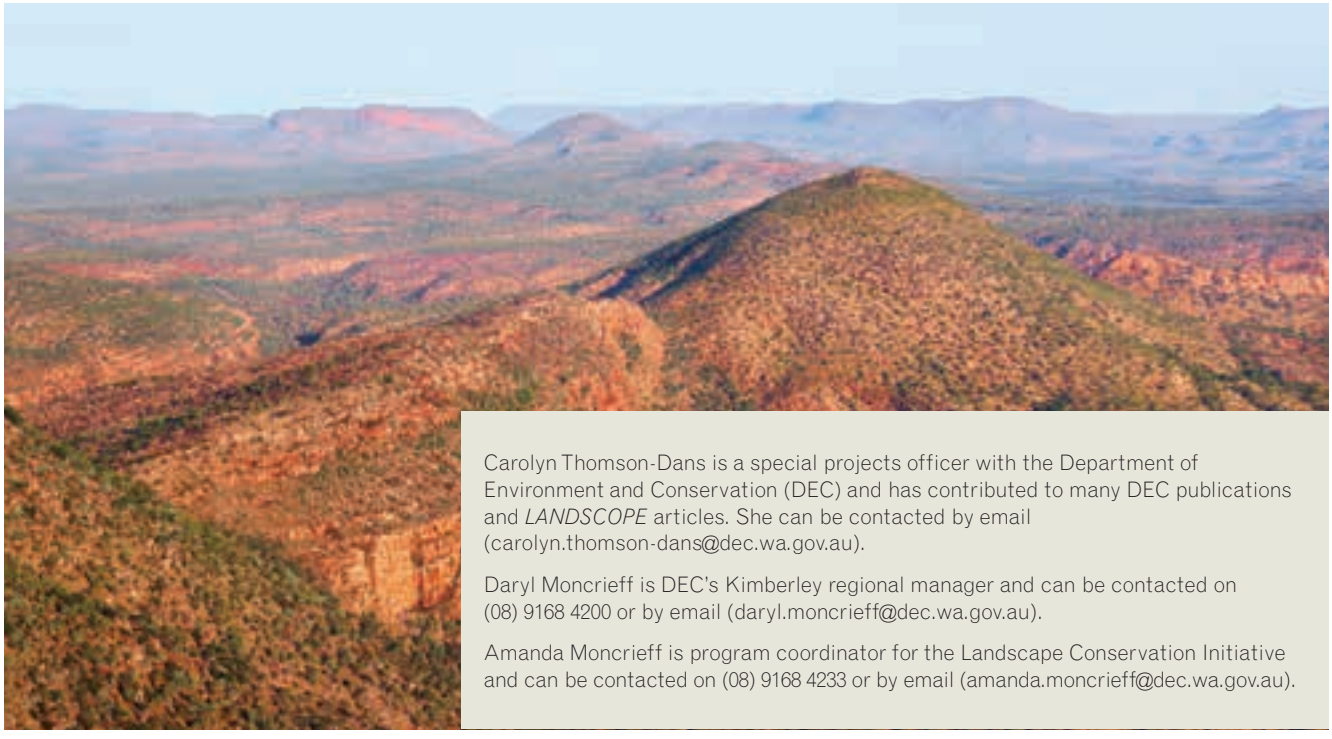
The aim is also for Aboriginal rangers to work with tour operators and visitors to promote positive visitor experiences while protecting cultural values.

The Kimberley strategy will offer support to Aboriginal communities to identify and develop culture- and nature-based tourism opportunities at key sites, including those along the Kimberley coast visited by cruise ships. This offer includes Tourism WA and other stakeholders working together to develop up to 10 existing Aboriginal tourism businesses and establish tourism products to service the cruise tourism market. There are also opportunities to further enhance the tourism experience at Mimbi Caves on Mount Pierre Station.

As part of the marketing and development of Kalumburu Road as a 'tourism corridor', DEC has collaborated with Drysdale River Station to address rubbish management issues along one section of the road.

Looking for partnership opportunities where sustainable land management outcomes can be achieved is at the heart of many of the programs and projects that sit under the Kimberley strategy.

Protecting the Kimberley is not just a government responsibility or imperative. It will not be possible to achieve long-term conservation of the Kimberley without partnerships between Aboriginal communities, the wider Kimberley community, pastoralists and agriculturalists, the resources sector, the tourism industry, non-government organisations, research institutions, and governments at the local, state and federal levels. Implementation of this strategy will involve different partners, playing different roles and carrying out different responsibilities, depending on their capacities and interests.



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endangered

by Monica Hunter

Rare banksia and eucalypt woodlands of the Swan Coastal Plain

Some of the most recognised tree species in bushland in and around Perth are banksias and eucalypts. A series of woodlands dominated by these trees, in particular types that only occur close to the Darling Scarp, are identified as threatened ecological communities because they have been extensively cleared. One such community is the species-rich '*Banksia attenuata* and/or *Eucalyptus marginata* woodlands of the eastern side of the Swan Coastal Plain'. Other conspicuous species that generally occur in this community include *Xylomelum occidentale* (woody pear), *Hakea stenocarpa* (narrow-fruited hakea), and the sedge *Mesomelaena pseudostygia*.

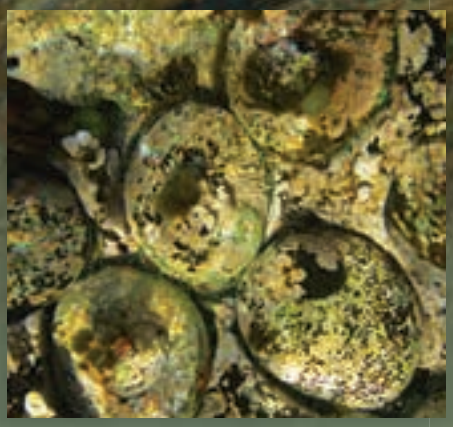
The significance of this species-rich woodland community was recognised after detailed surveys of the vegetation of the Swan Coastal Plain in the early 1990s. This was followed by the listing of the community as endangered in 1996. The woodland type is regionally rare and very restricted, with only about 220 hectares remaining. The community's habitat is the conspicuous orange sandy soils found at the base of the Darling Scarp from Chittering in the north to Yarloop in the south.

The most significant threat to the community is clearing for residential areas and related infrastructure such as roads. This vegetation type is also threatened by too-frequent fires, weed invasion and some impacts associated with recreational use. Many of the occurrences of the community are surrounded by urban areas. This leads to a high frequency of fires lit by arsonists, damage by off-road vehicles and illegal rubbish dumping, which all adversely affect the health and structure of the woodland. Climate change may present a particular threat to the community in the form of increased fires and drought impacts and possibly more weed invasion.

A recovery plan has been developed for the *Banksia attenuata* and/or *Eucalyptus marginata* woodlands with the aim of addressing the threats to the community. Recommended actions include monitoring of the woodland's health in response to specified management actions, active fire management and weed control. With only 85 hectares of the community recorded in nature reserves and other reserves specifically managed for conservation, protection of remaining areas from further clearing is a high priority. Of equal importance is raising awareness among landowners, managers and the general public of the importance of rare banksia and eucalypt woodlands and their special management needs.

Photos by Val English

Life on the edge:
intertidal reefs of the Marmion and Shoalwater Islands marine parks



Many people are familiar with the intertidal rocky reefs along Perth's beaches as places to fossick among tide pools during the calm low tides of summer, or watch powerful waves crash onto the shore during winter storms. Others may visit these reefs to collect abalone during the recreational fishing season, or to indulge in a spot of line fishing. Very few people, however, realise that these reefs also support complex assemblages of algae and animals, many of which are specially adapted to live in these characteristically harsh environments perilously positioned between land and sea.

by Alan Kendrick, John Huisman and Michael Rule

The Perth area has a magnificent coastline of white sandy beaches interspersed with limestone outcrops and headlands that extend offshore as a series of islands, emergent rocks and shallow reefs. This distinctive coast is geologically recent, having been formed in the past 10,000 years by sea level changes and the accretion, and subsequent erosion, of relictual dune systems that now form rocky features such as Cape Péron and Penguin, Garden and Carnac islands, and the complex offshore limestone reefs that lie roughly parallel with the coast.

Centuries of relentless wave action has sculptured many of these intertidal and shallow reef platforms into distinctive shapes. While isolated offshore patch reefs typically form a flat platform, those adjacent to rocky shores are commonly eroded into a flat reef platform backed by an undercut or 'notched' cliff on the landward side. The platform width varies markedly; those at Rottnest Island can be more than 50 metres wide and are typically larger than those on the adjacent mainland. The reef platforms vary in structure from being relatively level to very irregular due to the presence of gutters and rockpools. The seaward platform edge is frequently raised into a rim, beneath which the reef falls away in a vertical or undercut face to the seabed below.

Intertidal reefs are difficult places to live. In calm weather, falling tides can leave them exposed above the water level for several hours at a time, and they can be subjected to temperatures significantly above or below that of the receding water. On a hot summer day, desiccation and heat stress can kill many organisms, while during winter storms the same reefs can be pounded by large waves, which can strip away seaweeds and dislodge many animals. The typical seasonal build-up and erosion of sand along the coast can also periodically bury shoreline reefs and smother many of the organisms living on them. Despite such disturbances and destructive events, intertidal reefs are typically fertile environments crowded with algae and animals of various forms. For many years marine scientists have been studying these fascinating habitats.

The unique habitats and biological assemblages of these distinctive reef structures have been identified as key ecological values in the Marmion and Shoalwater Islands marine parks, which are located adjacent to Perth's busy metropolitan coast. Scientists from the Department of Environment and Conservation's (DEC's) Marine Science Program and WA Herbarium, together with marine park staff from DEC's Swan Coastal District, have been undertaking research since 2009 to better understand these communities.

Previous page
Main Cape Péron in Shoalwater Islands Marine Park.
Insets (left) Roe's abalone; (middle) a pair of sea anemones; (right) a sea hare.

Above An eleven-armed starfish.

Left An early morning reef survey in Marmion Marine Park.
Photos – John Huisman/DEC

Above Lightning storms at Marmion Marine Park.
Photo – Ann Storrie

In addition to documenting the composition of algal and invertebrate communities on shoreline and offshore intertidal reefs, this work will contribute to long-term monitoring and management of these habitats in both marine parks.

Life on the reef

The potential for organisms to dry out when receding tidal water levels expose them to the sun and air, combined with the effects of wave action, are major factors that influence what plants and animals can live on intertidal reefs, and exactly where on the reef platform they can occur. As anyone familiar with the coast will know, the ebb and flow of the tides can fluctuate considerably. Tides are caused by the gravitational pull of the moon and, to a lesser extent, the sun. When the sun and moon form a straight line with the Earth (at a new moon or full moon), this force is at its greatest and the tides will be at their largest range. These extreme tides are called 'spring' tides and they expose areas of the reef that usually remain submerged. Conversely, the smallest tides, known as 'neap' tides, occur when the moon is at right angles to the Earth–sun axis, as the gravitational pull of the sun dampens that of the moon. Overlaying these varying, but essentially predictable, patterns are the effects of local and regional weather. Onshore winds, a regular feature of the Perth coast, can often have a marked effect on the tidal level by pushing the water onto the shore.

A notable feature of nearly all intertidal reef communities is zonation, which is linked to tidal cycles and refers to the patterns by which organisms are vertically distributed on the shore. As the tide recedes, various parts of the reef platform are exposed to the air for longer or shorter periods. The upper intertidal is the first to be uncovered and remains exposed for the longest, as it is also the last to be inundated again by the incoming tide. Conversely, the lower intertidal is exposed for only a short period. Based on this degree of exposure, biologists divide the reef into several zones. The uppermost, known as the supra-littoral, barely qualifies as intertidal as it is typically only inundated by large waves and the highest of tides; its moisture is more usually derived from sea spray. This zone supports only a few hardy species of cyanobacteria, barnacles and molluscs. Common in this zone around Perth is the small blue periwinkle (*Austrolittorina unifasciata*). Animals living in this zone typically have a tough, desiccation-resistant shell and exhibit physiological and behavioural adaptations that further retard water loss, such as congregating in crevices and shady areas where a moist microclimate reduces the impact of exposure. The degree of tidal inundation then typically increases below this relatively dry zone, such that the lowest (or sublittoral) fringe of the reef is only occasionally exposed during the lowest of tides.

Being inundated for longer periods, the reef flat itself may support dense algae, such as *Sargassum*, and many small crustaceans, echinoderms and molluscs that live among this algal canopy and in the shelter provided by rock pools and crevices in the rock. However, just occasionally, when very low tides occur on a particularly hot and still summer day, these areas of the reef may experience massive mortalities as algae and invertebrates are exposed to intolerable drying and/or heat. While it is distressing to see such events occur, they are entirely natural and the reefs are soon recolonised by a suite of similar organisms.

The seaward crest of the intertidal reef is that part most subject to wave action, and is typically the realm of a relatively few species that can tolerate such high-energy conditions. Here, the cover of foliose seaweeds is often considerably reduced and the reef is covered with encrusting calcified algae, which appear as a light pink coating on the rock surface. The fauna is dominated by robust grazing molluscs, such as Roe's abalone (*Haliotis roei*), limpets and chitons that are able to cope with the rough conditions by adhering strongly to the rock surface. While the diversity of organisms on the seaward crest may be low, these molluscs happily live in very high densities and hundreds of individuals per square metre have been recorded.

Intertidal reefs

Surveys currently being carried out on intertidal reefs of the Marmion and Shoalwater Islands marine parks have so far recorded more than 100 species of algae, and more than 100 animal species. The most conspicuous algae

Top left The outer edge of an intertidal reef.
Photo – Michael Rule/DEC

Centre left A high density of red waratah anemones and coralline algae-covered limpets.
Photo – Alan Kendrick/DEC

Left A purple sea urchin.
Photo – John Huisman/DEC

Right A shoreline intertidal reef in Shoalwater Islands Marine Park.
Photo – John Huisman/DEC

is the large brown *Sargassum*, which can dominate the lower intertidal reef platforms, particularly during periods when plants are reproducing. Several algal species, such as the sea lettuce *Ulva*, occur on all of the reefs, but each reef also has a unique assemblage of species, possibly as a result of small variations in physical conditions such as the degree of exposure, or differences in the type and number of herbivores. The presence of rare species, such as the delicate feathery Struve's weed (*Struvea plumosa*), may be due to the entirely chance settlement of the alga's reproductive bodies on a piece of suitable habitat in the short period after they had been released from the parent. Most of the animals recorded have been molluscs and echinoderms with lesser numbers of crustaceans such as crabs and barnacles. The most prominent invertebrates inhabiting these metropolitan area reefs are large gastropods such as the turban shell (*Turbo torquatus*), Roe's abalone and the predatory cart-rut shell (*Dicathais orbita*), so named because of the distinct ridges in the shell. The most conspicuous echinoderms are the eleven-armed starfish (*Coscinasterias muricata*) and the purple sea urchin (*Heliocidaris erythrogramma*). Although also quite abundant, the six-armed starfish (*Meridiastra occidens*) typically remains well camouflaged within holes and crevices.

Despite the obvious nature of these larger animals, the most abundant molluscs on Perth's rocky shores tend to be much smaller and less obvious to the eye. The top shell (*Cantharidus pulcherrimus*) and dove shell (*Pyrene bidentata*) can live in very high densities among algae on the reef platform, while periwinkles such as *Austrolittorina unifasciata* and *Echinolittorina australis* can be abundant on rocks high on the shore. Several limpet species, including the ribbed limpet (*Patelloida alticostata*), can occur in very high densities towards the exposed seaward edge of the reef, although their shells are often well camouflaged under a covering of coralline algae. Another animal that can be found in extremely high numbers on Perth's intertidal reefs is the bright red waratah anemone (*Actinia tenebrosa*), which often occurs in the same exposed habitats as limpets and abalone.

Research by DEC has also found that particular species inhabit even the small pockets of sand that accumulate in hollows and rock pools on intertidal reefs. Here, burrowing molluscs such as the pontifical cone (*Conus doreensis*) and the western creeper (*Rhinoclavis biturberculata*) are found only by digging into the sand. Occasionally the lighthouse shell (*Campanile symbolicum*) can also be found in these pools. This relatively large shell is endemic to the south-west of Western Australia, and is the sole extant species of a group that was more diverse and widespread in the geological past.

Interestingly, this research has also found that intertidal reef communities in the Marmion and Shoalwater Islands marine parks are quite different. Reefs in Marmion Marine Park tend to support higher numbers of limpets and abalone, while those in Shoalwater Islands Marine Park tend to have more sea stars and sea urchins. This may be a consequence of the reefs being more exposed to wave action at Marmion than at Shoalwater Islands.

Top left Fishing for Roe's abalone on a Perth metropolitan reef.
Photo – Andrew Davoll/Lochman Transparencies

Top right DEC researchers at Cape Péron in Shoalwater Islands Marine Park.
Photo – John Huisman/DEC

Above Recreational fishing off a shoreline reef in Marmion Marine Park.
Photo – Andrew Davoll/Lochman Transparencies

Below A shore crab (*Leptograpsus variegatus*).
Photo – John Huisman/DEC

What's the future?

Perth enjoys the enviable position of having a relatively healthy coastal ecosystem in close proximity to a major population centre. However, the sheer number of people that live near and recreate on this coastline creates pressure on easily accessible intertidal reefs. These pressures may be direct, such as fishing, or indirect, such as the discharge or seepage of water contaminated with nutrients or other pollutants from the city into coastal waters. Among the most obvious of these impacts in the Perth area is recreational fishing for Roe's abalone, when many people wade onto the intertidal reefs during the short periods when the activity is permitted by the Department of Fisheries.

Perth is also fortunate in having well-developed systems to ensure the conservation and sustainable management of its coastal marine biodiversity. The Marmion and Shoalwater Islands marine parks are managed by DEC to protect this resource, while the Department of Fisheries ensures that the take of species such as Roe's abalone and other fisheries remain sustainable. By taking care when visiting Perth's intertidal reefs, everyone can assist in their protection. Step carefully to avoid crushing delicate animals and adopt a 'look but don't touch' approach to avoid disturbance where you can. Be particularly aware of what activities are permitted by fishing regulations and marine park zoning. The surveys described are part of DEC's statewide research and monitoring programs that assist in managing our marine parks and reserves and threatened marine fauna. Such work will help to ensure that Perth's biologically diverse intertidal reefs will remain a source of wonder for generations to come.

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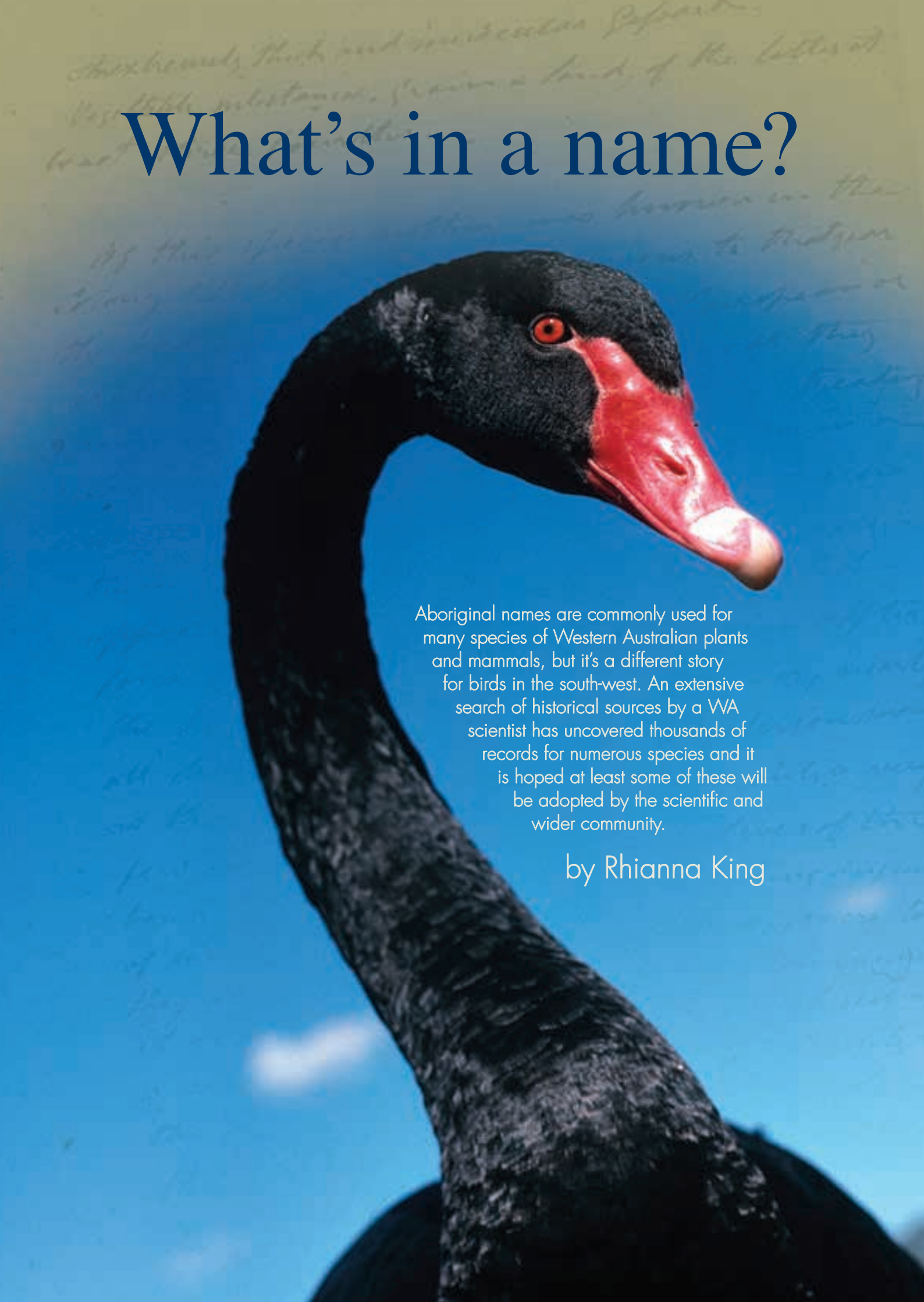
What's in a name?



Aboriginal names are commonly used for many species of Western Australian plants and mammals, but it's a different story for birds in the south-west. An extensive search of historical sources by a WA scientist has uncovered thousands of records for numerous species and it is hoped at least some of these will be adopted by the scientific and wider community.

by Rhianna King

As the original human inhabitants of the land, Aboriginal people have an affinity for Western Australia's plants and animals that spans at least 60,000 years. They knew the behaviours and habits of animals and relied on them for food and to predict seasonal changes and events. While mammals are thought to have been the primary source of protein for Aboriginal people, birds and their eggs were an important component of their diets. Men hunted cockatoos and emus and women collected small species and eggs. Birds also featured extensively in Dreaming stories and other Aboriginal lore, and some bird species have significant cultural value, particularly in the south-west where Nyoongar people identify themselves with the maniychmat (corella) or wordungmat (raven).

With more than 100 native languages spoken across WA there are numerous known, and probably many undocumented, Aboriginal names for birds. But, sadly, there are no Aboriginal names in use in the mainstream or scientific community for south-west WA species.

Name origins

Common names of most Australian birds were provided by early colonists and based on anglicised versions of Latin and Greek names. Or, as with the great brown kingfisher and the wattled bee-eater, they were likened, often incorrectly, to species found in Britain and given a common name containing an adjective to distinguish them from their namesakes. While there are some well-known species that have Aboriginal names—such as wonga pigeon, boobook owl, kookaburra, currawong, brolga, gang-gang cockatoo, galah, corella and budgerigar—these names mostly originate from areas near Sydney or inland New South Wales. Aboriginal names have, however, become commonplace for some south-west mammals—such as chuditch, dibbler, mardo, boodie, woylie, tammar wallaby, numbat, quenda, quokka and woylie (see 'Ancient Animals, Ancient Names', *LANDSCOPE*, Summer 2001–02).

An interest in Aboriginal languages and a desire to pay homage to traditional knowledge propelled Department of Environment and Conservation senior principal research scientist Ian Abbott to undertake the massive task of synthesising historical records to compile a list of Aboriginal south-west bird names. From 1996 to 2009, as time permitted, Ian trawled through books, letters, diaries, reports and other documents written by explorers, historians and anthropologists, looking for references to Aboriginal names. In total, he searched 91 sources and uncovered 3,200 records of Aboriginal names for 177 species. Ian used the records of nine ornithologists as the benchmark but opted to give primacy to the records of John Gilbert, who was instrumental in collecting WA species and who also had a keen interest in recording Aboriginal names.

Synthesising records

Gilbert collected birds during his two visits from March 1839 to March 1840 and July 1842 to December 1843 for John Gould's Birds of Australia project (see 'John Gilbert's Australian Collections', *LANDSCOPE*, Winter 1997). He had the opportunity to survey parts of WA before widespread colonisation had affected the abundance and distribution of Western Australian bird species. He was held in high regard by Gould and was a meticulous recorder of information. In fact, five documents detailing Aboriginal names for WA bird species, handwritten by Gilbert, still exist and detail 780 Aboriginal names for as many as 25 per cent of the birds known to exist in the south-west. In addition, he worked closely with Aboriginal people and was committed to collecting Aboriginal names, writing in 1839: "You will be pleased to hear that I have succeeded in getting Aboriginal names to nearly all my species" (John Gilbert 1839 in Whittell 1941: 127).

Previous page
Main Black swan—also known as koltjak, marli, wilar, wanar and wooroth—is one of the south-west's best-known species.
Photo – Jiri Lochman
Text detail John Gilbert's hand-written notes from his visit to south-west WA in 1840.

Above Australian magpie or koorbat, koorbardi or koorbardo.
Photo – Sallyanne Cousans

Left The emu or wetj, wedji, kulya, kaya or yallibiri.
Photo – Daniella Van/Sallyanne Cousans Photography

Opposite page
Carnaby's cockatoo or ngolak, ngolyenok or ngoolya.
Photo – Jiri Lochman

Names of conspicuous species

Scientific name	Common name	Aboriginal names [suggested pronunciation]
Leipoa ocellata	malleefowl	ngow [n'ow], ngowo [n'ow'awe]
Cygnus atratus	black swan	koltjak [call'jack], marli [mar'lee], wilar [wee'lar], wanar [war'nar], woorotho [woo'raw'thaw]
Platycercus zonarius	Australian ringneck	dowarn [dow'awn], doomolok [dorm'awe'lawk]
Dromaius novaehollandiae	emu	wetj [wetch], wedji [wet'chee], kulya [kool'ya], kaya [car'ya], yallibiri [yal'lee'bi'ree]
Anas superciliosa	Pacific black duck	yet [yet], ngoonana [n'oon'nar'nar], banji [ban'chee]
Corvus coronoides	Australian raven	wodang [wore'dang], kwokom [quor'corm], karlo [car'law]
Ardeotis australis	Australian bustard	bebilya [be'bill'ya], kooli [koo'lee], wabanga [wa'bang'a], bibilerak [bib'ill'e'rack], barado [bar'a'daw]
Aquila audax	wedge-tailed eagle	woldja [woll'cha], warlitj [woll'itch], warlike [woll'ick], warbako [war'bar'co], yelka [yell'car]
Cacatua pastinator	western long-billed corella	manyt [mar'night], manatj [mar'natch], nganarra [n'are'nar'ra], binadji [bee'nar'chee]
Cracticus tibicen	Australian magpie	koorbat [caw'bart], koorbardi [caw'bar'dee], koorbardo [caw, bar'daw]
Pelecanus conspicillatus	Australian pelican	nerimba [ne'rim'bar], boodelong [boo'de'lawng], ngooloomberri [n'ool'oom'berry]
Strepera versicolor	grey currawong	djilok [chee'lawk], bela [bell'are], bali [bar'lee], bil [beel], djabin [char-been]
Calyptorhynchus baudinii/ latirostris	Baudin's/Carnaby's cockatoo	ngolak [n'awe'lark], ngolyenok [n'ole'ye'nawk], ngoolya [n'ool'ya]
Calyptorhynchus banksii	red-tailed black cockatoo	karak [car'ark], dirandi [dee'ran'dee], yarbi [y'are'bee]

Names of rare and threatened species

Species name	Common name	Aboriginal names [suggested pronunciation]
Pezoporus flaviventris	western ground parrot	kyloring [ky'lore'ing], oorondodi [bore'awn'daw'dee], djardonkori [char'dawn'caw'ree], djoobada [chore'ba'dar]
Atrichornis clamosus	noisy scrub-bird	djimolok [chee'maw'lark]
Dasyornis longirostris	western bristlebird	booderitj [bore-de'rich], djidalya [chee'dal'ya]
Psophodes nigrogularis	western whipbird	dading [dar'ding]

Lost and found

Gilbert had the unique opportunity to collect Aboriginal names from Aboriginal people before widespread species extinction occurred and before European settlement disrupted Aboriginal society. As Aboriginal people then tended not to keep written records they relied on information being passed from generation to generation. Unfortunately, significant traditional knowledge has been lost due to population decline and displacement. In addition, the accuracy of some records is compromised because language boundaries were blurred by Aboriginal people moving around the country.

In working to capture and preserve this information, Ian uncovered reliable names for 132 of the 166 (80 per cent) terrestrial bird species that were breeding in the south-west at the time of European settlement, including more than 50 Aboriginal names for 14 of the region's most conspicuous species (see 'Names of conspicuous species' above). These also included names for now rare and threatened species (see 'Names of rare and threatened species' above).

Collating these names is, hopefully, the first step in facilitating their inclusion in the scientific and wider community. Future steps must also include government departments and other bodies integrating the names into popular publications and other documents to ensure they become familiar to the general community and part of popular vernacular. Director of the Australian National Dictionary Centre and author of *Speaking our language: The story of Australian English* and *What's their story* Bruce Moore writes: "In Western Australia there has been a strong move to replace European names for flora and fauna with Indigenous names, and this is certainly a trend that will continue". Ideally, one day, we will look to the sky and comment on the raucous ngolyenok flying overhead, just as the traditional owners have for millenia.

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This article was based on Ian Abbott's paper 'Aboriginal names of bird species in south-west Western Australia, with suggestions for their adoption into common usage' published in Conservation Science *(pages 213–278). This paper can be downloaded from DEC's website at www.dec.wa.gov.au.*

urban antics by John Hunter

Life's a beach

The summer and autumn beaches of the Perth metro area are second to none. And it could also be said of the Swan and Peel estuaries —rather more muddy and vegetated in places, but fun and places of learning ... to be shared with wild sea birds.

At the crucial learning age of five in the fabulous 1940s, visits to Scarborough beach for a swim and a picnic were a real treat. It was also a place to encounter gulls and terns.

On the footpath outside 'Peters by the Sea', a large silver gull (*Larus novaehollandiae*) hovered over an open-ended newspaper-wrapped fish-n-chips and harassed the living chips out of one poor little boy. Dad thought it hilarious, but the young-un was soon out of there, having dropped a couple of morsels in fright and then, like 'speedy Gonzales', challenged three Austin tourers and a Vauxhall van for rights to the roadway. That was not funny, and even today this old boy can still hear and see that 'pterodactyl' screaming 'kaaa – kaaa – kaaa' in my face ... very clever, but very frightening.

Gulls are naturally aggressive scavengers and are quite big birds with a wingspan of more than 60 centimetres. Hovering in squawking chaotic numbers, they are capable of harassing children to the point of danger. The birds have learned to congregate in areas where human organic refuse abounds, including sewage ponds, sporting arenas, ephemeral lakes and estuary mud flats. What is of real concern, is when unthinking humans handfeed begging groups of gulls which encourages familiarity, aggression and the build-up of unnatural numbers. This is when salmonella contamination in recreation areas and alfresco cafes is possible.

In times past, as it is today, from shoreline to city, silver gulls are high on the companion list of people, just hanging in there for a free handout. Away from human habitation, however, on offshore islands and remote localities, the birds feed naturally on dead or live marine and aquatic animals or are happy fossicking in fields for insects and worms.

In lesser numbers at our beaches are the terns. Best described as elegant in flight with long-pointed and rakish wings, they are usually solo aerial hunters of surface fish such as mullet, herring and pilchards. Over ocean or estuary, a bird will cruise at five to 10 metres, head down and eyes searching. When the quarry is spotted, the wings collapse and, like a feathered javelin, it plummets into the water. In a moment, it bursts back into the air, violently shaking its plumage, and, most times, with a fish firmly clasped in its long-pointed beak.

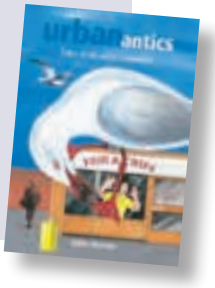
There are three main species of tern that can be seen around our local marine environs during the warmer months. The fairy tern (*Sterna nereis*) is the smallest visitor and can be seen around the Swan estuary nesting on sandspits or joining its larger cousin the crested tern (*S. bergii*) dive bombing the shallows. Occasionally joining them both is the Caspian tern (*S. caspia*), a very large species.

Today, the white sea birds still loaf together in their favourite beach dips between Trigg and Cottesloe. On passing, I nervously look sideways as this human beach-runner still feels somewhat intimidated. All beaks and eyes seem to be pointed my way.

I'm probably dreaming.

DID YOU KNOW?

- The WA Naturally book *Urban Antics* further describes gulls and other urban species. Check it out at your local book store or online at www.dec.wa.gov.au/shop.
- Fairy terns are currently under pressure as their summer metropolitan breeding coincides with human summer activity. Watch out on beaches and sandspits.
- The Caspian tern has a huge scarlet bill and a wingspan of about 1.4 metres. The crested tern with its distinguishing black-crested head and yellow bill is smaller.



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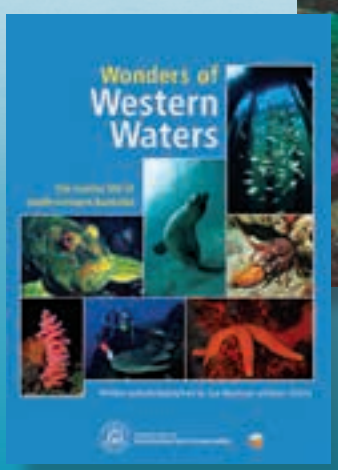

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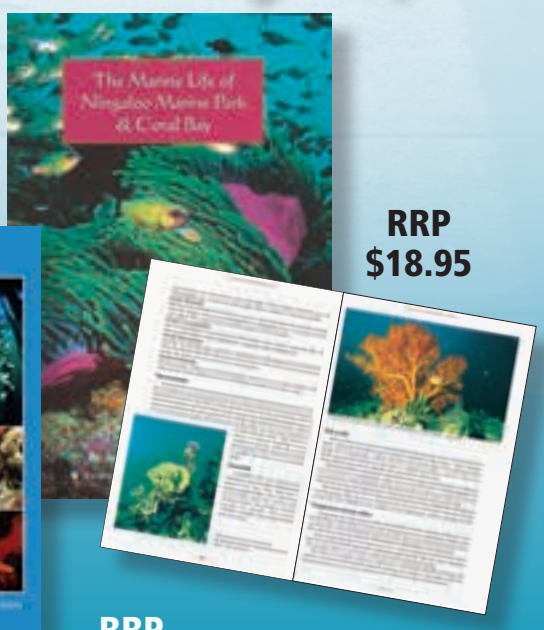

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