

WA's conservation, parks and wildlife magazine

LANDSCOPE

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Marine cleaners

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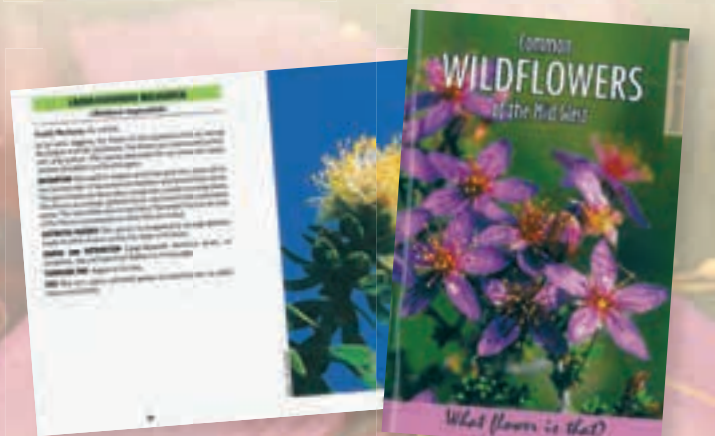
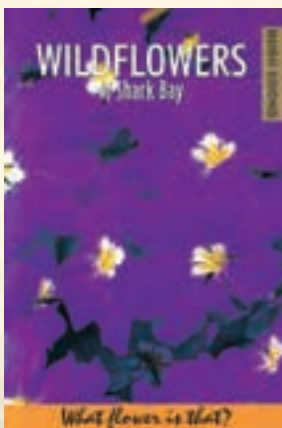


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Cheryl Lohr



Simon Cherriman

contributors

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Cheryl has worked on several projects related to the management of introduced vertebrates including baiting technologies, wildlife contraceptives, cost-benefit analysis of wildlife management practices, and human attitudes towards introduced animals. Currently, Cheryl is working on identifying efficient biosecurity actions for Western Australia's islands.

Simon Cherriman is an environmental biologist, consultant, educator and wildlife filmmaker. He currently manages the consulting business Insight Ornithology, which he established in 2008, with the aim to educate and inspire others about the importance of engaging with and preserving the natural environment. He has also worked for DPaW as a fauna conservation officer and particularly enjoyed being part of the south coast threatened bird team, working on noisy scrub-birds in 2006. Simon has researched wedge-tailed eagles for nearly 15 years and recently conducted an Australian first by capturing two adult birds and fitting them with solar-powered, GPS satellite transmitters which will track their movements over the coming years.

guest columnist

This issue is the first under the new Department of Parks and Wildlife, and it fittingly showcases our core business of conserving Western Australia's plants and animals and managing natural areas for people to experience and enjoy.

As part of this focus I am pleased to announce that in the coming months *LANDSCOPE* will be undergoing some exciting new changes. You can still expect the same hard science, informative tone and spectacular images you would be familiar with, but it will be sporting a new look, front cover photography and a spotlight on how you can experience the incredible nature our great state has on offer.

This issue highlights some of the diversity of work being done throughout our department by our dedicated, talented, knowledgeable and innovative staff. In the desert environs at Lorna Glen we're working to return rangeland ecosystems to their natural state with the reintroduction of mammals to their former range. 'Desert eagles: wedge-tailed eagles at Lorna Glen' (page 32) provides an insight into how native predators are affecting these translocation programs.

It's also fascinating to learn how we're uncovering species that are new to science. In a single collecting trip in south-west nature reserves, WA Herbarium staff uncovered seven species of plant which are believed to have never before been recorded, not to mention new populations of threatened species ('Botanical blitz', page 9). It's a reminder of the importance of protecting natural areas, not only for the species these areas are known to contain but also for those we're yet to discover.

Of course much of our work is also conducted behind a desk. '100 years of biodiversity data put to work' (page 6) reminds us of the importance of office-based study by revealing a project that is pulling together 100 years of disparate information on the diversity of the Pilbara islands into a single database.

This edition also offers an insight into the state's natural beauty through the eyes of our writers and photographers. It's delightful to view the form of the eucalypt species yate with the admiration in which a retired staff member regards them ('The elegant yate', page 27). We also have images of wildflowers submitted by photographers from across the state—a breathtaking reminder of why WA is world renowned for its amazing floral diversity. Readers keen to get out and see the spring display can find inspiration in this edition's feature park—Coalseam Conservation Park (page 40).

WA is indeed a natural environment well worth working to conserve for people to enjoy. So, while our new department is in its infancy, it is drawing on a long tradition of work in every corner of our state to conserve our natural spaces. We will continue this work well into the future to ensure our natural areas are accessible for you to enjoy.

Jim Sharp
Acting Director General
Department of Parks and Wildlife

Robert Powell worked for DPaW and its predecessors for 34 years, involved chiefly in acquiring land for conservation. He is particularly interested in trees and vegetation and in revegetating land with local plant species to increase wildlife habitat. He has given many talks on those subjects and is the author of *Leaf and branch: Trees and tall shrubs of Perth*, published by the department. Robert retired in 2009 and is now living in Devon, United Kingdom, where he is enjoying a wildlife garden and the surrounding countryside.

Melita Penniford is a research scientist with DPaW's Science Division, based at the Wildlife Research Centre in Woodvale. Since joining the department in 1999, Melita has been involved in aquatic fauna surveys of the south-west agricultural zone and Avon River pools. Her recent project investigated the effects of fire and timber harvesting on stream biodiversity in the south-west of WA. She is currently analysing data from that project to investigate the biogeographic patterning of forest stream invertebrates and how climate change may influence these aquatic systems.



Robert Powell

also contributing . . .

Dorian Moro, Pat Cullen, Roger Underwood, Annette Cook, Julia Lees, Kevin Thiele, Ann Storrie, Samille Mitchell, Wendy Chow, Catherine Jack and John Hunter.



Melita Penniford



Cover illustration by Gooitzen van der Meer

The spreading coneflower (*Isopogon divergens*) occurs from north of Geraldton to just south of Perth and into the southern Wheatbelt. The small spreading shrub grows from 0.3 metres to two metres high in gravelly or granitic soils. The red to pink-purple flowers bloom from August to October. *Illustration reference photo by Sallyanne Cousans.*

Back cover photo by Sallyanne Cousans

Rica Erickson Nature Reserve, Calingiri.

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100 years of biodiversity data put to work



Protecting the fragile biodiversity of Western Australia's islands isn't all about being out in the field. A new project will compile 100 years of existing but disparate biodiversity data on the Pilbara islands into a single computer database to help guide future management of these precious refuges for threatened and endemic plants and animals.

by Cheryl Lohr

More than 3,700 islands line the Western Australian coast, ranging in size from small rocky outcrops to Dirk Hartog Island, the largest at 58,640 hectares. Many of these islands are the last refuge for threatened and endemic species such as the Shark Bay mouse (*Pseudomys fieldi*) and the rufous hare-wallaby or mala (*Lagorchestes hirsutus*), which have become extinct on the mainland from the effects of introduced predators such as cats and foxes. Many islands also have relatively undisturbed communities of plants and habitat types, including mangroves and sandplains, that are



spared the frequent bushfires or increasing pressure from development seen on the mainland. Such habitats can provide critical breeding sites for seabirds and sea turtles that usually only come on land to breed.

Humans are a major source of dispersal for invasive species. Insects and seeds get in our luggage, rodents hide in cargo containers, and cane toads (*Rhinella marina*) hitch rides in vehicles. Some of WA's islands have been colonised by invasive species such as buffel grass (*Cenchrus ciliaris*), mice (*Mus musculus*), and black rats (*Rattus rattus*) (see 'The mysterious case of the black rat on Sunday Island', *LANDSCOPE*, Winter 2013).

100 years of data

Along the Pilbara coastline, between Exmouth and Eighty Mile



Beach, there are more than 550 islands including the Dampier Archipelago, the Mary Anne Passage islands and the Barrow–Montebello islands group. Scientists have been visiting these islands for nearly 100 years to record the species of animals and plants living on them. The first detailed biological descriptions of islands came from Hermite Island in 1912, one of the Montebello Islands approximately 75 kilometres from the WA coast. Since then, dozens of scientists and field naturalists from government agencies, universities and private companies have visited the Pilbara islands to

record data. Today, global biodiversity databases contain tens of thousands of records of plants and animals for the Pilbara islands alone. And that is not all of it. A lot of data has not been entered into electronic databases and is instead printed in books or reports and filed away in overflowing filing cabinets left behind when a biologist retires.

Managing islands

With the huge number of islands in the Pilbara alone, it is essential for the Department of Parks and Wildlife to have a system that helps managers prioritise management and protection

Main Montebello Islands.
Inset Flatback turtle hatchlings.
Photos – David Bettini

of the islands. Many management actions, such as the Montebello Renewal rodent eradication project in the 1990s, cost hundreds of thousands of dollars (see ‘Montebello Renewal’, *LANDSCOPE*, Summer 1996–97). As such, the department needs to ensure that management actions are prioritised so the most conservation benefit is gained for the least cost.

Over the next five years, a team of scientists from the department’s



Top Nesting pelicans.
Photo – David Bettini



Above Rufous hare-wallaby.
Photo – Jiri Lochman

Right Northern quoll habitat on Dolphin Island, Dampier Archipelago.
Photo – Keith Morris/DPaW



Science Division and James Cook University (Townsville, Queensland) will compile 100 years of existing data into a single resource. They will then build a software package that will enable land managers to maximise the number of conservation goals they can achieve. The biodiversity data will tell us where the high priority species are, and whether they are threatened by invasive species. It will enable us to compare islands and management tasks objectively, and work to conserve our native species efficiently. Expert knowledge regarding the cost of implementing management tasks and the social acceptability and the effectiveness of each management option will also contribute, as will new data designed to fill the gaps in our knowledge that remain after 100 years of data collection.

By compiling the knowledge in such a way, the department will be in a position to best conserve the islands and their fragile biodiversity in a way that maximises conservation at the least cost.

Five-year collaboration—what will it achieve?

This research project will influence conservation management actions on islands in Western Australia by developing:

- 1) A single comprehensive database on WA island characteristics, fauna, flora, and threats.
- 2) Operational decision-making software for island management.
- 3) Training to develop the ability of Department of Parks and Wildlife staff to apply the software in managing islands.
- 4) Accountable and cost-effective decisions that aid the conservation of WA's native species.
- 5) A strong partnership with Queensland island researchers and managers.

Cheryl Lohr is a research scientist with the Department of Parks and Wildlife's Science Division and can be contacted on (08) 9405 5150 or by email (cheryl.lohr@dpaw.wa.gov.au).

A photograph of several bright orange flowers with dark centers growing in a rocky, sandy environment. The flowers are scattered across the frame, with some in sharp focus and others blurred in the background. The ground is composed of small, reddish-brown rocks and patches of dry, greyish vegetation.

Botanical *blitz*

New species revealed, rare species rediscovered, mysteries solved; it's amazing what can happen when you let loose a group of keen-eyed, well-trained botanists into a small patch of bush with a simple remit: go forth and collect plants.

by Kevin Thiele

The plant life of Western Australia is justifiably famous worldwide. Our state boasts more than 12,300 native vascular plants—an incredible biodiversity which has helped the south-west corner become listed among the world’s 34 biodiversity hotspots. Knowing this, one might expect the state’s flora to be well documented, with all species described, their ranges mapped, and nothing new to be discovered. It might come as a surprise to some, but this is far from the truth. While what we do know far exceeds what we don’t, there remains a substantial component of our flora that is either undescribed, or yet to be discovered.

With this in mind, the Western Australian Herbarium has embarked on a series of ‘botanical bush blitzes’, where a team from the herbarium visits a bush location, with the express purpose of documenting, photographing, and gathering specimens to supplement the



herbarium’s collection. Localities are not chosen randomly, but are selected based on the known gaps in the herbarium’s holdings, plus where there is a strong likelihood of unusual or rare species. The first of these expeditions was mounted last year.

In the field

In spring 2012, we conducted a plant collecting blitz in a group of small but important nature reserves and patches of bush west of Woodanilling in the south-west of the state. The aim was to target a number of reserves

Previous page

Main *Drosera barbiger*.

Photo – Adrienne Markey

Below left Kenmare Community Hall in Woodanilling.

Photo – Alex Chapman

in the area that were poorly known botanically. Some of these had only a handful of specimens previously collected from them, some had none at all. Some were nature reserves managed by the Department of Parks and Wildlife (DPaW), others were local council reserves. All of them were known to be rich, biodiverse, and were expected to hold treasures that, perhaps, the keen eyes and assembled expertise of the WA Herbarium staff could uncover.

A hall in the bush

One of the most important things when planning a field trip is to have a good place to stay, if at all possible. Botanists often have simple needs—the ideal for a collecting trip such as this is a good roof, shelter from wind, and plenty of room to process and press the myriad specimens that a team can collect in a good working day. A bonus is a good patch of bush close by, to camp in and explore. In this case we hit gold when we discovered the Kenmare Community Hall.

Kenmare is a small, close-knit community of farms to the west of Woodanilling. Like many such communities, the community hall and school were a focal point for Woodanilling residents in the early days. Built of local stone with a high ceiling and wooden floor, this was where dances were held, marriages were celebrated, and everyone gathered on grand final day to listen to, or later to watch, the footy. Unlike many such communities, though, Kenmare has been fortunate to keep its hall when others were being demolished in the face of years of disuse, or misuse. In fact, the local community has renovated the hall, patching up the stonework and roof, and equipping it with a good kitchen, an enormous outside fireplace made





Above *Verticordia insignis* subsp. *compta*.
Photo – Kevin Thiele/DPaW

Right Flagstaff Reserve.
Photo – Julia Percy-Bower

from a tractor split rim, and plenty of trestle tables, chairs, and coffee mugs. And, Kenmare Hall sits in a patch of bush. Kindly made available to us by the local community complete with an enormous pile of firewood and a loaned generator, it was ideal for our purposes.

Botanical field work

Spring was in full swing when the group assembled in mid-October 2012, and the season had been good, so there were plenty of plants to collect. We set our target on five Parks and Wildlife nature reserves: Martinup, Strathmore Hill, King Rock, Flagstaff and Wingedyne, plus a small, local council reserve with some very high-quality and interesting bush. The first three of the nature reserves are very small, Wingedyne substantially larger. Over two days, teams of collectors and botanists fanned out into the reserves, aiming to sample each main habitat in each reserve, and to collect all species that had not previously been collected there.



The results show the reserves were indeed interesting. More than 500 specimens were collected, representing more than 350 species. Before these collections, only 50 specimens representing 37 species had been collected from these reserves: the collecting thus provided a 10-fold increase in our knowledge of these parts of DPaW-managed lands.

New and noteworthy

As expected, a number of specimens were interesting and noteworthy. New populations were discovered of several species listed as threatened or 'priority' (these need further study before an accurate assessment of their conservation

status can be made). This is always welcome as it expands our knowledge of the status of species considered at risk; new populations discovered in nature reserves help with conservation planning; and it's encouraging for the long-term prospects of the species. In addition, range extensions were recorded for a number of widespread species, helping increase our understanding of species' geographic ranges and spread.

Ten specimens collected were of undescribed species, represented in the herbarium collection under phrase names, such as *Hibbertia* sp. Kojonup and *Leucopogon* sp. Great Southern. Phrase-named species are ones that herbarium botanists believe represent



Above left *Lambertia ilicifolia*.

Above *Drosera dichrosepala*.
Photos – Kevin Thiele/DPaW



Left Terry Macfarlane and Louise Biggs recording and collecting specimens west of Woodanilling.
Photo – Alex Chapman

distinct taxa, but which have not yet undergone the rigorous assessment and study needed to formally name them as new. Specimens of phrase-named taxa are particularly valuable, as they help in our understanding of the variability in the species, and hence provide critical information when a formal taxonomic assessment is made.

There are currently more than 1,400 phrase-named flowering plants represented in the census of WA plants, an indication of the vast amount of research still needed to provide a complete picture of our flora. Importantly, species that are phrase-named are afforded the same conservation protection as formally named species, an important piece of conservation policy in a state that has such a rich, but still under-explored, flora.

New species

Seven specimens collected during the expedition may represent entirely new species, ones that have never before been collected and hence, with further study, could be phrase-named or named as new. An example is an interesting grass, *Puccinellia stricta*, collected around the edge of a salt lake in Martinup Nature Reserve. This species is found at scattered localities fringing salt lakes throughout the south-west. At this site, two different forms of the grass were observed—one with very narrow flowering spikes with branches held close together and erect, the other with more open inflorescences with the branches wide-spreading at flowering time. Such variation in the species has been noted previously, but at this site both forms were growing together with no intermediates—just the type

of evidence that can sometimes point to an unrecognised species. Trials are being conducted with seeds collected from these plants to see if they remain different when grown together in a greenhouse.

Clearing confusion

Two particularly welcome and interesting records were specimens collected of *Hemigenia rigida* and *Drosera dichrosepala*, both of which help enormously in our understanding of these species. Before this collecting trip, *Hemigenia rigida* was known from only two specimens, the original one collected by colonial botanist James Drummond in the early 19th century, and a single specimen collected 150 years later (and more than 20 years ago) from a small patch of remnant bush some 40 kilometres north of our collecting localities. Despite its rarity, it wasn't recognised as being threatened, as from the time of its first collection it had been confused with a similar, but distinct and relatively widespread species, *H. pritzelii*. The collection made by the herbarium team had several effects. Firstly, it has

What's a herbarium?

The Western Australian Herbarium, part of the Science Division of the Department of Parks and Wildlife, is the main research facility in WA for taxonomic and systematic studies of the state's plants, algae and fungi. Centred on a collection of more than three-quarters of a million specimens, it's a core repository of knowledge and research on the botanical biodiversity of the state. Without the herbarium and its collection, we wouldn't know what species occur here and where they occur, how common or rare they are, or in what habitats, landforms and bioregions they all grow. A great deal of biodiversity and conservation research would grind to a halt (or never be able to start at all) without the foundational knowledge represented by the herbarium.

Staff at the herbarium study, and care for, the collection of pressed, dried specimens, discovering and naming new species, keeping our knowledge of the state's flora up to date, and providing taxonomic and identification expertise to the department, government and community.

Sometimes, though, they need to get out, into the sunshine and open air, and into the bush where fresh, live, glorious plants grow. And when they do, all sorts of mysteries are solved and discoveries made.



Above right Ryonen Butcher working on specimens at the WA Herbarium.

Photo – Peter Nicholas/DPaW

Below right Michael Hislop shares his botanical knowledge with (from left to right) Evelyn McGough, Meriel Falconer and Sue Carroll.

Photo – Adrienne Markey

helped clear up the confusion between these two species and highlighted the critical conservation status of *H. rigida*. Secondly, it has provided a new locality for the species in a well-protected nature reserve, and thirdly, in so doing, it has brought the species to the attention of conservation officers, who will now have a better chance of protecting it from possible extinction.

The second species, *Drosera dichrosepala*, likewise illustrates the difficulties sometimes faced in understanding and protecting rare and potentially threatened species. Originally described in 1854 by Russian botanist Nikolai Turczaninow (again from a specimen collected by the redoubtable James Drummond), this was a species we thought we knew well—the herbarium had many specimens believed to be *D. dichrosepala* from the Albany area. All that changed when a small, white-flowered sundew collected on this trip was examined closely after our return. At first, we believed that it represented a new species, as it matched no other species in the herbarium's collection. However, when it was shown to Western

Australian *Drosera* expert Allan Lowrie, a research associate at the herbarium, it was immediately recognised as the true *D. dichrosepala*, and only the second recent collection of an obviously rare species. It turns out the species previously called by this name from around Albany is not *D. dichrosepala* at all and needs a new name. So the specimen has highlighted both a misunderstood, rare species and an unnamed common one.

Importance of study


These cases exemplify the importance of careful and rigorous

scrutiny of plant specimens collected on expeditions such as these, and the significance of botanical collecting in a region like WA, with its rich and often threatened flora. Woodanilling is not a remote part of the state; in fact it's in a part of WA that's better known than most. Nevertheless, a couple of days spent by the herbarium team unearthed some treasures, helped solve some mysteries, added significantly to our knowledge of parts of DPaW-managed lands and, hopefully, has helped ensure that some more species are protected for future generations to enjoy just as much as we did.



Kevin Thiele is the curator of the Department of Parks and Wildlife's Western Australian Herbarium and a scientific advisor to *LANDSCOPE*. He can be contacted on (08) 9219 9128 or by email (kevin.thiele@dpaw.wa.gov.au).





Western Australia is world renowned for its mind-boggling floral diversity and dazzlingly beautiful wildflowers. The state—which spans three broad climatic regions and offers a diverse range of habitat types—is home to more than 12,300 native plant taxa (species, subspecies and varieties), many of which grow nowhere else in the world. Knowledge of our flora continues to grow, with new species frequently unearthed and important populations of poorly understood species continuing to be discovered (see ‘Botanical blitz’ on page 9). While our unique botanical treasures can be enjoyed throughout the year, several areas stand out for their wildflower displays. Depending on winter rains, the Gascoyne and Murchison regions often erupt into vibrant oceans of spring colour, as everlasting daisies and a kaleidoscope of different species burst into bloom. The sandplain heaths and mallee shrublands in the south-west corner of the state, including areas such as the botanically significant Fitzgerald River and Lesueur national parks, are breathtaking in their species diversity, while the majestic Stirling Range National Park is a similarly impressive botanical drawcard. But WA’s floral diversity is so extraordinary that even the smallest fragment of bush, an individual granite outcrop, or even an ephemeral swamp, can reveal a wonder world of species. Here we celebrate WA’s wonderful wildflowers in a photographic essay.

Wildflowers: a visual celebration





Previous page

A spectacular blue-flowered species of *Andersonia* from Mount Roe National Park in the Walpole Wilderness area.
Photo – Marie Lochman

Opposite page

Pink woolly (*Verticordia monadelpha*) at moonrise in Reynoldson Reserve, Wongan Hills.
Photo – Sallyanne Cousans

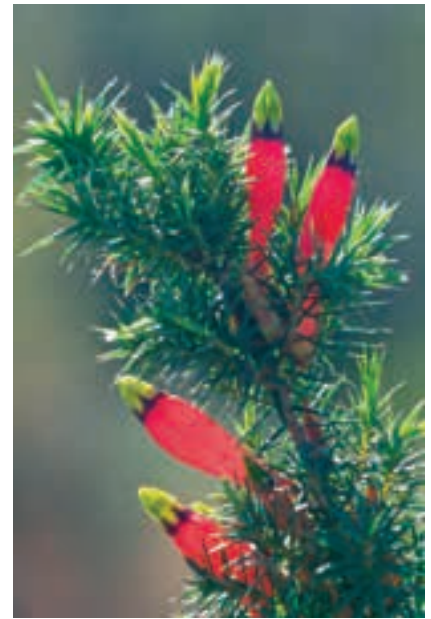
Top left A member of the fan flower family, *Scaevola calliptera*, Quindalup.
Photo – Sue Morrison

Top right Black kangaroo paw (*Macropidia fuliginosa*), which occurs between Geraldton and Perth.
Photo – Janine Gunther

Centre left Granite clawflower (*Calothamnus graniticus*), Meelup Regional Park, Cape Naturaliste.

Above Common cats paw (*Anigozanthos humilis*), Badgingarra.
Photos – Sue Morrison

Left Coastal banjine (*Pimelea ferruginea*), Leeuwin-Naturaliste National Park.
Photo – Ann Storrie



Top left Kunzea (*Kunzea ciliata*),
Quindalup.
Photo – Sue Morrison

Top right Candle cranberry (*Astroloma foliosum*), Mundy Regional Park, Perth.
Photo – Marie Lochman

Above Sundew wattle (*Acacia anasilla*),
Purnululu National Park, Kimberley.
Photo – Jiri Lochman

Left An island of everlastings
(*Cephalopteris drummondii*) at
Thundelarra former pastoral lease in the
Murchison.
Photo – Cliff Winfield

Opposite page

Top right A typical rural scene at Paynes
Find during the wildflower season.
Photo – Sallyanne Cousans

Right Rock thryptomene (*Thryptomene saxicola*) in Leeuwin-Naturaliste National Park.
Photo – Ann Storrie





Spotting quolls in the Pilbara

Threatened by cane toads, habitat loss, predation and more, northern quoll populations are declining across much of their range. In the Pilbara, little is known about populations of these medium-sized marsupials. New studies seek to shed light on the Pilbara quolls so plans can be put in place to protect them.

by Annette Cook and Julia Lees



Quolls are the largest of the carnivorous marsupials to occur on the Australian mainland (the Tasmanian devil is larger) and four species occur in Australia. The northern quoll (*Dasyurus hallucatus*) is the smallest of these, weighing between 300 and 1,000 grams. They once occurred in a broad band across northern Australia but their distribution has become fragmented into several disjunct populations in north-east Queensland, the Top End of the Northern Territory, and the Kimberley and Pilbara regions in Western Australia. In the Northern Territory it appears that northern quolls have been declining for at least several decades, where introduced predators, cane toads (*Rhinella marina*), habitat degradation, disease, changed fire regimes and increased predation following fire are considered to be the probable causes.

Victims

In the past, northern quolls, along with the three other Australian quoll

Previous page

Main A northern quoll ready for release.

Photo – Annette Cook

Below Northern quolls are the smallest of the quoll species.

Photo – Jiri Lochman

species, were shot for their night raids on domestic chickens. In recent years the rapid spread of cane toads has posed the greatest threat to northern quolls. Widespread decline across their mainland range has been exacerbated due to their susceptibility to poisoning by the toads' toxins when they prey on the exotic pest. In the Northern Territory, quoll populations were devastated by the arrival of cane toads. With the current spread of toads into the wetlands of the Kimberley region, heavy losses and localised extinctions are expected there too. This impact has tipped the balance for northern quolls and is the reason they have joined their larger relatives, the chuditch (*Dasyurus geoffroii*) and the spotted-tail quoll (*D. maculatus*), on the list of species threatened with extinction. The northern quoll was listed by the federal government in 2004 as a threatened taxon and is specially protected under both state and federal legislation.

Adding to their plight, northern quolls only breed once a year and have an extremely short lifespan compared with similarly sized mammals. Females rarely breed for more than two breeding seasons, most only breed for one year. They can rear up to eight young but only a small percentage survives to weaning age. In Northern Territory



populations, all male quolls die after mating. However, while males from Kimberley and Pilbara populations undergo a major post-mating decline, a proportion survive the breeding season and may breed in a second year. In association with other impacts, these life history traits make this species more susceptible to local extinction.

Little-studied Pilbara quolls

Northern quolls are still considered common in the Pilbara by many who are familiar with their antics. They have a tendency to inhabit the roofs of buildings, occupy vehicle engine compartments and scavenge in rubbish bins. However, surprisingly little is known about northern quolls in the Pilbara region. Most of what is known about the species comes from studies on populations in the Kimberley, the Northern Territory and Queensland.

Although many surveys are conducted on behalf of the mining industry and other developers to detect the presence or absence of quolls, these studies do not address the gaps in our knowledge of the





ecology of the Pilbara northern quoll populations, their population trends, and the impacts that mining and other development may have on them. What's more, information that has been collected is not readily available and, therefore, assessments of the trends and condition of Pilbara northern quoll populations cannot be made. Of particular concern is the possibility the cane toad could establish in the Pilbara once it has spread to the west Kimberley in the next five years or so. This, combined with other potential pressures from introduced predators and loss of habitat through mining and other developments, could lead to a significant decline in the Pilbara's northern quoll population.

Recent increased interest to learn more about Pilbara quoll populations stems from state, national and international obligations to ensure the species persists in the region and is guided by the objectives of the *National Recovery Plan for the Northern Quoll*. Specifically, the objective to halt northern quoll declines in areas not yet colonised by cane toads prompted the

federal Department of Sustainability, Environment, Water, Population and Communities and the Department of Environment and Conservation (DEC)—now the Department of Parks and Wildlife (DPaW)—to bring together managers, researchers, mining company representatives, and environmental consultants to plan future conservation actions for the northern quoll in the Pilbara. A workshop involving representatives of these groups identified the need for a regional monitoring program and ecological study of the northern quoll, and this was documented in a project plan for the species.

The Pilbara's current rapid development and some apparent ecological differences between the Pilbara northern quoll populations and other populations further highlighted the importance of learning more about this threatened species.

Protection plans underway

In 2010 the then DEC took on the responsibility of developing and implementing the regional monitoring

Above Granite outcrops around Turner River provide suitable quoll habitat.
Photo – Annette Cook

program, which is currently funded through offset funding from mining projects. The first priority in developing the program was to work out where to establish sites for long-term monitoring. A search for old records and assistance from the department's Pilbara region staff helped to identify focus areas for landholder consultation and a distribution study using motion sensor cameras.

Consultation with local landholders provides valuable historical and current information about changes in abundance and distribution of quoll populations, and will add to our knowledge of the northern quolls' ecology. Additional information has been gathered through consultation with park rangers, tourism operators, environmental staff from mining companies, and, perhaps surprisingly at first, a very knowledgeable grader driver: when you travel bush roads at such a slow pace you gain a valuable insight into the local wildlife.



Left A quoll fitted with a radio transmitter.

Below left Researcher Annette Cook weighing a quoll.
Photos – John Kelly

Bottom left Technical officer Fiona Carpenter releasing a quoll.
Photo – Annette Cook

Up to 100 sites will be surveyed with motion sensor cameras to record the presence or absence of northern quolls and their pattern of distribution across the Pilbara. This survey will also help to locate populations that are of a suitable size to detect whether the population is increasing, decreasing or is stable over time. At least 10 long-term monitoring sites will be chosen to represent a wide geographical spread across the Pilbara region. They will be surveyed twice a year using a method known as ‘capture, mark, recapture’ to record demographic and ecological data.

Examining habitat

Another aspect of the camera study is to record the habitat characteristics at all the survey sites. Using habitat modelling, environmental factors recorded for sites where quolls are relatively abundant can be compared with those where they appear to be absent or low in numbers. This will provide a better understanding of quolls’ habitat requirements and preferences, and help identify other areas where they are likely to occur.

In the Pilbara region, quolls are known to inhabit many different types of geological features such as mesas and ridges, breakaways, rocky gorges, isolated granite outcrops and ranges. Suitable quoll habitat is not continuous across the landscape and is often separated by vast distances, typically of stony plains dominated by spinifex (*Triodia*) hummock grasses and ephemeral tussock grasses with scattered shrubs and sparse trees. Therefore, the ability for individuals to disperse and the connectivity of populations is a puzzling aspect of the ecology of quolls in the Pilbara.

Radio telemetry is being used to see just how far these small mammals move. Radio tracking quolls during



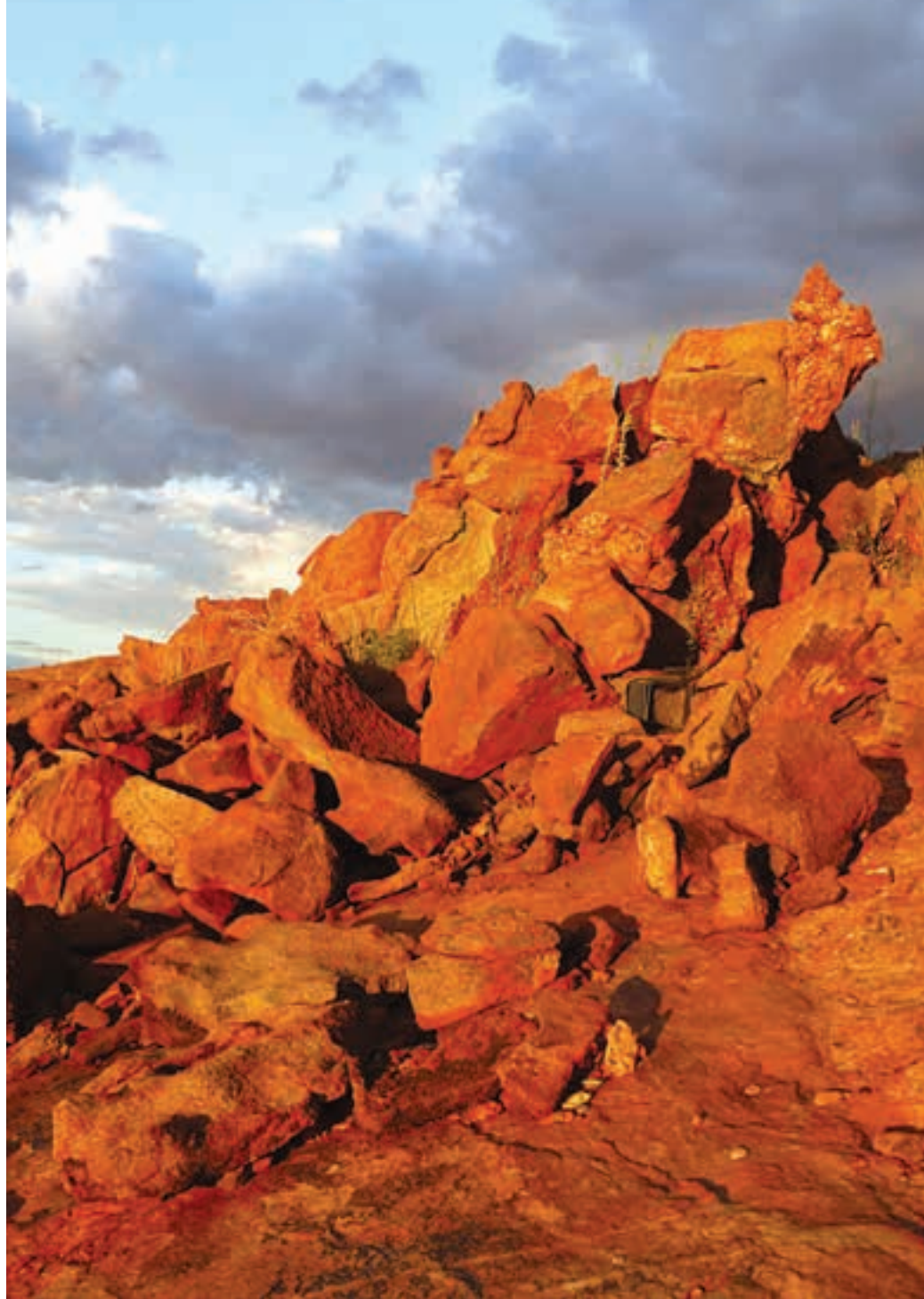
Right A quoll monitoring site on a weathered granite outcrop.
Photo – Annette Cook

the day has revealed the use of multiple dens, and movements of more than 1.5 kilometres between individual ‘denning’ sites. Dens in granite outcrops were located up to 1.5 kilometres from the site where the quolls were initially trapped and radio collared. Accurate night-time locations are difficult to obtain using standard VHF radio transmitters because of the rocky terrain. GPS technology is being trialled to record where quolls go and how far they travel during nocturnal foraging forays. Tissue samples are being collected from each individual quoll captured to determine if subpopulations across the landscape are genetically related. Scats are being collected from all the survey sites for dietary analysis in an attempt to identify any connections between food resources and habitat requirements.

Quolls are more commonly encountered within 150 kilometres of the coast, which coincides with higher rainfall. There have been a few recent records as far inland as Karlamilyi (formerly Rudall River) National Park, and Nifty and Kintyre mines in the western Great Sandy Desert. It is uncertain whether these individuals indicate the presence of a breeding population at these remote sites or if they were males dispersing. They may even be hitchhikers—individual animals transported in a vehicle and inadvertently relocated. Proposed collaboration between DPaW staff and Western Desert Indigenous groups, who conduct annual monitoring at Karlamilyi National Park, will shed some light on the surprise quoll sighting in the park in late 2012.

Industry pitches in

As they have done in the past for other threatened fauna, mining companies are providing support for the Pilbara quoll monitoring program



and other research. Consistent with the Commonwealth Environment Protection and Biodiversity Conservation Act’s Policy Statement 3.25—Referral Guidelines for the Endangered Northern Quoll—mining companies are required to provide information on Pilbara quoll populations relevant to impacts identified in the guidelines. These impacts include adversely affecting habitat critical to the survival of the species, reducing the area of occupancy of the species, and modifying, destroying, removing, isolating or decreasing the availability or quality of habitat to the extent that the species is likely to decline.

Resultant offset funding has enabled DPaW to start the northern quoll research and monitoring program in the Pilbara. This is a long-term project so it is hoped that ongoing cooperation and funding from mining companies and input from other non-government stakeholders and land managers such as Rangelands Natural Resource Management group will ensure the future security and persistence of quolls in the Pilbara.

BHP Billiton Iron Ore (BHPBIO) has also contracted the department to conduct research with the aim of providing information about northern quoll ecology and demographics to mining companies and environmental

regulators. This information will enable mine sites to be appropriately managed to ensure the persistence of resident northern quoll populations. A trapping program to monitor populations at a number of sites identified by BHPBIO started in May 2011 and will be conducted twice annually over three to four years. Disused quarries and mines have been matched with reference areas located in undisturbed similar habitat for comparison. Reference areas at distances of more than five kilometres were chosen to reduce the likelihood of quolls moving between sites. With the support of BHPBIO, it is possible that some of these sites will be incorporated into the regional monitoring program.

Monitoring for BHPBIO has already provided some interesting results. It appears the Pilbara northern quolls are breeding later in the year and over a longer period than elsewhere in their range. They are, on average, larger than their northern counterparts, and, unlike those in the Northern Territory, some males survive after mating. Radio tracking has also

provided some insight into habitat use and scale of movement in the landscape.

Building up our knowledge of the Pilbara's northern quoll populations through this monitoring is the first step towards ensuring their populations are protected. In this way we may be able to help them survive the host of threats afflicting their northern cousins.

Right Six-week-old young nestled in their mother's pouch.
Photo - Kelsey Malony

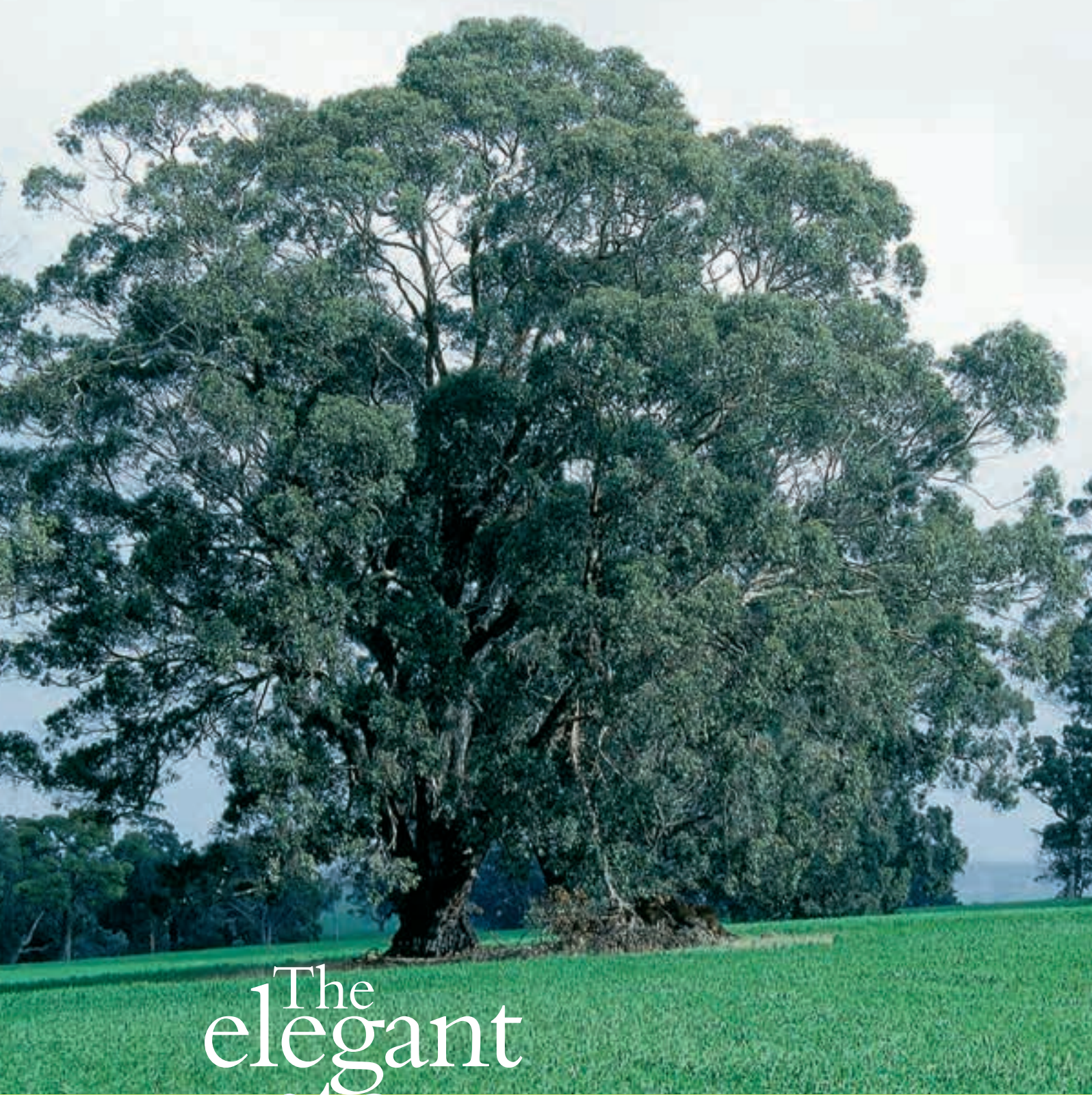


Below A northern quoll.
Photo - David Bettini



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The elegant yate

While many Western Australians will have heard of karri, jarrah, tuart or wandoo trees, perhaps few will have heard of yate. This lesser-known species was, however, the first Western Australian eucalypt to be named. It is a tree of great beauty, with other notable features, and deserves to be better known.



by Robert Powell

Yate (*Eucalyptus cornuta*) is a tree of the far south of Western Australia, extending from Geographe Bay to Rossiter Bay, east of Esperance. It is found mostly near the coast, but in the Albany region also extends further inland. It also occurs in the Manjimup area, where it extends into the inland valleys of the Perup and Tone rivers, about 100 kilometres from the coast. Yate does not form continuous populations over wide expanses, like jarrah (*E. marginata*) or wandoo (*E. wandoo*), but is typically found in smaller stands, in scattered spots, often in moist valleys or near granite outcrops.

In the Esperance area, yate occurs on some of the islands of the Recherche Archipelago, where, in 1792, it was originally collected from Observatory Island. The collector was the French botanist Jacques de Labillardière, on an expedition commanded by Admiral Bruni d'Entrecasteaux, in search of the ill-fated expedition of the *La Pérouse*, lost in 1788. Yate was botanically described in 1800 in Labillardière's



Relation du Voyage à la Recherche de la Pérouse. Other islands of the archipelago on which yate occurs include Middle, Mondrain and Woody islands. On the Esperance mainland, yate can be found at Rossiter Bay, in Cape Le Grand National Park.

At the other end of its occurrence, in Geographe Bay, yate grows in a few spots in Tuart Forest National Park and particularly just west of there, near where the Sabina River enters the Vasse Estuary. There are also some occurrences towards Cape Naturaliste, along Cape Naturaliste Road.

In the Albany region, yate can be found in parts of Albany itself, and in many spots near Mount Barker, including Porongurup Range National Park and its surrounds. There is also a small occurrence in Stirling Range National Park, at the camping area near Mount Toolbrunup. From there west to Lake Muir, individual yate trees and small stands of yate can be found along roadsides and on farms, particularly in places where the soil is comparatively fertile.

It is in this area that many Perth people will have encountered yate, as they travel on the Albany Highway approaching Mount Barker from the north. Here the yate trees in paddocks stand out from the marri (*Corymbia calophylla*) and jarrah trees by their glossy foliage and smooth brownish-white bark on their upper branches, and by their purposeful spreading-erect habit.

Notable features

Yate is renowned for its timber, which is light in colour and very hard and dense. It is also exceptionally strong, one of the strongest in the world, with a strength reputed to be close to that of wrought iron. In the early years of last century, it was used for wheelwright work. Today it is used for making small timber poles and for woodturning, but its supply is extremely limited. Yate is also prized for its honey, light to mid-amber in colour, with a beautiful flavour. It is produced in early to mid-summer, but only in some years is there a good flow of nectar.

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Main This yate tree, growing with plenty of room, has developed a broad dome shape and a wealth of exquisite detail.

Photo – Robert Powell

Inset Yate fruits.

Above Yate buds, opening into flowers.

Photos – Malcolm French

Left These coastal yate trees near Bremer Bay have developed a compact form and an abundance of foliage, for protection against salt winds.

Photo – Robert Powell





Above Yate on the shores of Table Island, Duke of Orleans Bay, Recherche Archipelago.

Right An old, complex yate tree, showing the rough, dark-grey, fibrous bark of the trunk and lower branches.

Photos – Malcolm French



Yate is one of the hardier eucalypts in tolerating salty or waterlogged soils, and is planted on farms to help control salinity. An adaptable, fast-growing tree, yate is also one of a number of eucalypts planted overseas, in countries such as Spain, Portugal, South Africa and the United States of America. In California, it grows particularly well along the coast, and is one of the most popular eucalypts. It is sometimes planted to help reclaim land with alkaline soils.

Yate's biological value has been little studied. Eucalypt trees growing in their areas of natural occurrence are ecologically important in supporting many associated insects. Insects comprise a large part of an ecosystem's biodiversity, and provide essential services such as pollination and the recycling of nutrients. They are also the main food of many birds and reptiles. As a fast-growing eucalypt of relatively fertile soils, yate is likely to support a particularly wide range of insect species. Yate flowers are attractive to

honey-eating birds, large numbers of which visit, for instance, the grove of trees at Rossiter Bay in early summer, when they are in flower.

Yate and its relatives

The buds and fruits of yate are fairly distinctive. The bud-caps (opercula) are long, slender and reminiscent of horns (hence the scientific name *cornuta*, which means 'horned' in Latin), while the fruits have protruding valves, which remain fused together at the tips rather than completely separating when the fruit opens. Horn-shaped bud-caps and fruits with projecting valves are also found in close relatives of yate. These include the long-flowered marlock or river yate (*E. macrandra*), warted yate (*E. megacornuta*), and bushy yate (*E. lehmannii*). However, not all close relatives have 'yate' in their name (for example, the Bald Island marlock, *E. conferruminata*) and, conversely, not all eucalypt species with 'yate' in their name are considered among the closest relatives of yate (for example, flat-topped or swamp yate, *E. occidentalis*).

Yate and its relatives all have yellow or yellowish-green flowers and are endemic to southern regions of WA. Some have very restricted distributions, particularly Burdett's mallee (*E. burdettiana*), McQuoid's mallee (*E. mcquoidii*) and the Beaufort Inlet mallee (*E. newbeyi*). Others are more widespread, or are well known in cultivation, such as the Bald Island marlock and bushy yate. Yate occasionally hybridises with Bald Island marlock and river yate, and with less closely related species such as tuart (*E. gomphocephala*).

Beauty

Yate produces displays of colourful flowers. But we can appreciate trees best if we see them as whole objects; that is how they normally appear, unless we are standing very close to them. As whole objects, trees have shape, structure, patterns and detail. 'Structure' includes the number of main stems and the hierarchy of the branches. Patterns include repeated features, such as angles of branching,



Above Like many yate trees, this specimen has developed several main stems.
 Photo – Malcolm French

and shapes of clumps of foliage; and more general features, such as the distribution of foliage through the tree. Variations in the overall patterns stand out as interesting details.

Some species of tree are very consistent in their shape and structure. The introduced Norfolk Island pine (*Araucaria heterophylla*) is a good example: virtually all specimens have a single, straight main stem, with short, parallel side-branches, producing a narrow conical shape. They look very much alike.

By contrast, many eucalypt species, including yate, are wonderfully varied, with different specimens varying enormously in shape, structure and detail. While this is partly due to genetic differences between the individual trees, a very important influence is the environment. Over yate's range, the rainfall varies from about 1,300 millimetres a year on the south coast near Walpole, to only about 500 millimetres a year in some of yate's inland and eastern occurrences. At a single site, conditions vary greatly too. Near the coast, salt winds are very

damaging to foliage, so yate trees in exposed spots are reduced in height and much more asymmetrical in shape than specimens in slightly less exposed spots nearby. And soils over granite vary in depth, often quite suddenly; yate specimens growing where the soil is shallow can be much reduced in size.

Another influence on a tree is its neighbours. Yate trees with plenty of room will spread, whereas those confined or overshadowed by neighbours will adapt their growth to seek what light and space they can find.

For trees growing in their natural range, the activities of their associated insects cause irregularities in their growth. Different individual trees are affected in different ways or to different degrees. Where the associated vegetation has been preserved, an additional influence is damage by fire.

Most individual trees do nonetheless tend to display growth characteristics typical of their species—the woodiness of jarrah, the wiggly branches of marri, the weeping habit of pricklybark (*Eucalyptus todtiana*), for example, which give them their particular forms of beauty. Yate is an uncommonly elegant tree. Its foliage, at the ends of very slender branchlets, is nicely organised into small, dense clumps, which often join up into layers or larger masses. Between the concentrated areas of

foliage are often large gaps, giving many of the trees a light, airy look. The spreading branches have a strong tendency to sweep upwards, resulting in the trees' 'purposeful' appearance, referred to earlier.

A big little tree

Another characteristic of yate is its readiness to grow more than one trunk, or main stem. Many small species of eucalypt grow as shrubs, and have a well-developed underground woody swelling, known as a 'rootstock' or 'lignotuber'. When burnt in a fire, all the above-ground parts of the shrub are killed, and it recovers by sprouting two or more stems from the lignotuber. Eucalypts with this habit of growth, common in areas of low rainfall, are known as mallees.

Many larger species of eucalypt have lignotubers too, but develop with a single stem that is protected from fire by well-insulating bark. They normally have a single trunk, and it is only after a very severe fire or injury that they may regrow with more than one stem.

Some smallish eucalypt species are in between these two categories. Perth's limestone marlock (*E. decipiens*), for example, often grows as a small tree, with a single stem. If burnt in even a moderate fire, it is killed above ground, and regrows from its lignotuber, with several stems. Even if unburnt,



Above In this regeneration of yate and wandoo, the yate trees, through their faster growth, have greatly suppressed the wandoos, most of which are hardly visible.
Photo – Robert Powell

Below A yate specimen from the Western Australian Herbarium.
Photo – Julia Percy-Bower

however, some specimens will develop one or two new strong stems from near the base or from the lignotuber, which grow strongly and develop to become a substantial part of the tree.

Yate is a largish tree, growing to 25 metres tall in the Albany region, where conditions are good—yet it has the same tendency as limestone marlock to send up additional stems from its lignotuber. It is thus a large tree with a growth characteristic more typical of smaller eucalypts: a ‘big little tree’.

The present and future

Near the coast, some of the occurrences of yate are within national parks. Many of these specimens do not develop very fully, as a result of salt winds, shallow soils or recurrent fires. There are also some healthy stands of mature yate on land managed by the Department of Parks and Wildlife in State forest and Perup Nature Reserve.

Many of the best developed yate trees occur in the Albany region. Here yate grows chiefly on good agricultural soils, and many of its occurrences have been destroyed by clearing. Those that remain are mostly on farms, where cultivation of the soil, or grazing by livestock or feral animals, prevents them from regenerating. Agricultural weeds can often smother small seedlings. There may thus be few offspring to replace the present trees when they die.

As the climate of south-western Australia continues to become drier, trees of many species are dying or declining in health, and yate will be increasingly affected.

Thought should be given to preserving this distinctive and very elegant tree. On farms it would be helpful to fence off stands of yate trees to encourage them to regenerate, or, if they do not, to plant yate seedlings. In towns and cities within yate’s natural range, yate (and other naturally occurring species) should be grown wherever space permits, including in irrigated parks, where they would be

protected from the drying climate. And, as with all our wonderful and fascinating eucalypt species in WA, we should aim to make them better known and more highly valued by coming generations.



Robert Powell’s interest in trees began with the local species he discovered during his childhood. He has written about Perth’s species in *Leaf and branch: Trees and tall shrubs of Perth*. Robert worked for 34 years for the Department of Parks and Wildlife’s predecessor departments: Environment and Conservation, and Conservation and Land Management. He is now retired and living in Devon, United Kingdom. He can be contacted by email (robert.powell@graduate.uwa.edu.au).

The author would like to thank Peter White and Jane Emberson for their comments on a draft of this article.

Desert eagles: wedge-tailed eagles at Lorna Glen

Introduced predators are not the only threat to native mammals being reintroduced into their former habitats as part of conservation efforts: native predators such as wedge-tailed eagles also prey on the newly released animals. Studies in the arid rangelands region are examining the relationship between these majestic birds of prey and reintroduced species.



by Simon Cherriman



In 2010 the then Department of Environment and Conservation began reintroducing several species of threatened mammal into a 1,100-hectare fenced enclosure at Lorna Glen proposed conservation park. The aim was to provide a safe haven, free from wild dogs and feral cats, for threatened wildlife so they could build up sufficient numbers to help recolonise the broader landscape of the rangelands region. But introduced mammals are not the only predators which pose a threat to their survival. Our largest avian predator, the wedge-tailed eagle (*Aquila audax*), is also known to feed on medium-sized mammals. An investigation into eagle ecology has provided some interesting findings on this species at Lorna Glen.

Restoring mammal fauna

Lorna Glen is a 240,000-hectare former pastoral lease property situated across the boundary of Western Australia's Gascoyne and Murchison



biogeographic regions. The property was purchased by the state government in 2000 for conservation and is jointly managed by its traditional owners the Martu people, and the Department of Parks and Wildlife (see 'Into the wild: restoring rangelands fauna', *LANDSCOPE*, Winter 2009). Initially, the project focused on fauna reintroductions following intensive control of introduced predators, particularly cats (*Felis catus*). The reintroductions were largely successful for the common brushtail possum (*Trichosurus vulpecula*) and bilby (*Macrotis lagotis*), which have now established at Lorna Glen. However, predator-

vulnerable species such as rufous hare-wallaby, or mala (*Lagorchestes hirsutus*) did not survive trial translocations in 2008, and the decision was made to construct the fenced enclosure, intended as a 'soft-release' pen—a breeding enclosure for animals before they are released into the wider Lorna Glen habitat. Golden bandicoots (*Isodon auratus*) and boodies (*Bettongia lesueur*) were released into the enclosure in 2010, followed by rufous hare-wallaby and Shark Bay mice (*Pseudomys fieldi*) in 2011, and these have been breeding successfully since.

Some of the initial reintroductions were threatened or failed for a number of reasons, including predation by feral cats and wild dogs, failure to find sufficient food, exposure following wet and cold periods, and predation by birds of prey. The initial translocation of rufous hare-wallaby in 2008 was not successful, primarily due to cat predation and starvation, and early observations of a second release inside the enclosure in 2011 indicated raptors may have had some impact on the survival of founder animals. Even though rufous hare-wallaby were translocated from Trimouille Island where they were known to be predated by white-bellied sea eagles (*Haliaeetus leucogaster*), they were still observed to rest during the day in locations with limited cover, making them easy pickings for local raptors. Department staff had recovered rufous hare-wallaby and boodie carcasses with fur meticulously plucked and entrails removed, suggesting raptors were responsible. But which species were the culprits?



Previous page

Main Wedge-tailed eagles make their nests from a high vantage point to survey the surrounding landscape.

Photo – Simon Cherriman

Inset Simon Cherriman fitting a GPS backpack to a wedge-tailed eagle chick.

Left Lorna Glen is a former pastoral lease now managed for conservation.

Photos – Judy Dunlop



Wedge-tailed eagles

Although wedge-tailed eagles had often been observed at Lorna Glen, especially in the vicinity of the fenced enclosure, and a couple of old nests had been found, little was known of the species' ecology. Were they permanent residents or just occasional visitors? How many eagles were present? Did they prey on reintroduced mammals? What other animals might they eat in this arid landscape?

Given their size, wedge-tails were certainly capable of taking medium to large reintroduced mammals, and had been documented doing so at other conservation reserves including Dryandra Woodland near Narrogin and Karakamia Wildlife Sanctuary in the Perth hills. But the extent to which this occurred at Lorna Glen was unknown. Given that eagles are an important native component of rangelands ecosystems, any information on their biology would be very useful in the context of the mammal reintroductions. Therefore, research into their ecology began in late 2011, with the aim of answering such questions and painting a more detailed picture of eagles at Lorna Glen.

The search begins

Like many birds of prey, eagles are known to form long-term breeding pairs which occupy permanent territories. As long as the environment provides enough food and contains trees suitable as nest sites, eagles can establish these territories in a variety of habitats. While pairs may be observed perched in tall trees early in the morning, they spend much of their day soaring high on thermals and are not easy to locate or observe. Therefore, the best place to start a landscape-scale study is by searching for their nests.

Although locating a nest among a quarter of a million hectares of mulga scrub may seem like a needle-in-a-haystack task, wedge-tails build very large stick structures, usually placed in sturdy forks of tall trees, making them quite conspicuous, even from several kilometres away. Nest searching is best conducted by finding a prominent viewing point from which to survey the surrounding plains, and scanning with binoculars. This can be done from the top of hills or breakaways, the roof of a vehicle (being sure to

Above left Tall gidgee trees are the preferred nest site for wedge-tailed eagles at Lorna Glen.

Above These eaglets are only a few days old and have a great view over the mulga plains.

Photos – Simon Cherriman

remain safe), or sometimes from tall trees. In this way, large tracts of land can be surveyed systematically.

Once an eagle nest has been spotted, a GPS unit can be used to record a compass bearing and project an approximate site location of the nest, provided the observer can estimate its distance. Then, using a vehicle to access the nearest point via road, the nest is approached on foot and its exact location recorded. Other information is also gathered, including the nest tree species, nest height and whether the nest is being used. Additionally, the area in close proximity to the nest site is searched for prey remains such as bones, fur and feathers left by eagles after feeding. Prey remains and pellets (indigestible material regurgitated by eagles) are collected and placed into bags for later identification and analysis in the laboratory.



Left An adult wedge-tailed eagle launches from its massive nest at Lorna Glen.
 Photo – Simon Cherriman

Below left DPaW’s Neil Hamilton with a captured wedge-tailed eagle.
 Photo – Gill Basnett

Bottom left A track cuts through the scrub at Lorna Glen.
 Photo – Simon Cherriman

Many nests

Surveys for eagle nests have been conducted during several field trips to Lorna Glen since October 2011, the most comprehensive of which occurred in August 2012 during the breeding season. As we became more familiar with the landscape, we were able to predict new sites to focus our searches, with some confidence that nests would be found. It was very exciting to visit a previously unsearched area, and shortly after, spot a new nest and watch a huge female wedge-tail launch into the air, confirming the nest’s occupancy.

Fifty-eight nests were located around Lorna Glen, and a strong pattern emerged regarding their locations. It is known that eagles show preference for a prominent nest site, enabling them to see prey from a long distance and remain vigilant to any would-be predators. All but two nests found were built in gidgee (*Acacia pruinocarpa*) trees, a species which prefers stony soil and often occurs on higher ground. Gidgee trees are much taller than nearby trees and shrubs and, due to their preference for rocky slopes, they are the most abundant suitable tree that offers a view over the surrounding landscape. Interestingly, no eagle nests were located in river red gums (*Eucalyptus camaldulensis*), which form tall belts lining drainage lines in the low-lying areas. Also, despite significant searching, no nests were found in areas composed of spinifex with taller marble gums (*E. gongylocarpa*). The absence of eagle territories in these two habitats suggests that abundance of suitably sized prey is too low here, as the tall trees would provide ample nest sites. Perhaps the presence of several other raptors in these areas, such





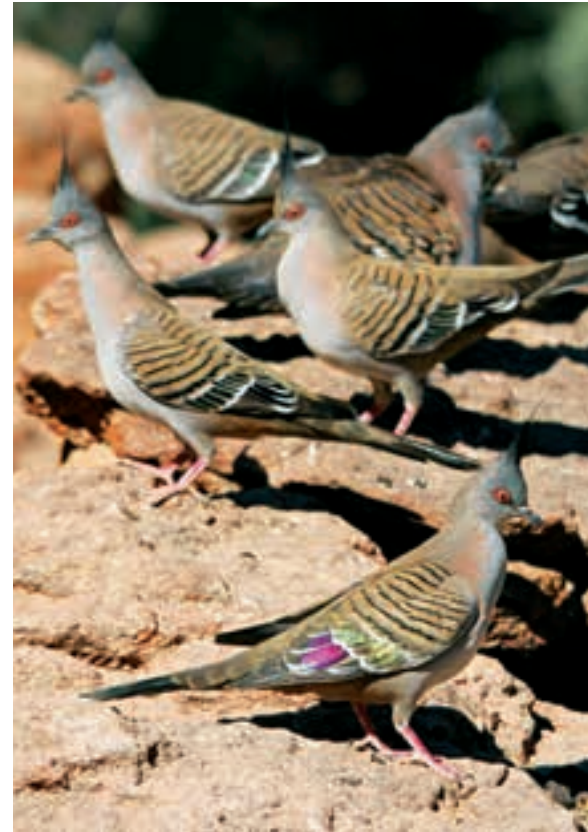
Above Simon and DPaW's Neil Hamilton collecting prey remains.
 Photo - Gill Basnett

as black-breasted buzzards (*Hamirostra melanosternon*) and whistling kites (*Haliastur sphenurus*), whose nests are especially common along drainage lines, also acts as a deterrent.

Finding such a large number of eagle nests at Lorna Glen was a pleasing result. This confirmed that wedge-tailed eagles were breeding residents. In addition, the age of many nests indicated the population had been present for many years; some nests were almost certainly decades old. Nests were usually found to occur in clusters, with each cluster representing one territory belonging to an adult pair of eagles. During the breeding season, most territories were found to be occupied. This was confirmed by the presence of one active nest in each territory, lined with fresh leaves, or containing eggs or chicks, together with the observation of adult birds nearby.

The spacing of many territories was surprisingly uniform in some parts of the property, with simultaneous active nests occurring about five kilometres apart. This pattern became clearer when approximate territory boundaries were plotted on a map. Such spacing might

Above right Crested pigeons are often eaten by wedge-tailed eagles in arid Australia.
 Photo - Simon Cherriman



Right Inspecting a wedge-tailed eagle nest.
 Photo - Gill Basnett



be explained by eagle territoriality. In a fairly flat landscape, neighbouring pairs will tolerate each other as long as they remain a certain distance from each other's nests.

Varied diet

Large quantities of prey remains, mostly in the form of bones, were collected from nests across the landscape. More than 900 individual prey fragments were analysed. These were compared with skeletal material from a reference collection in order to identify which animals the wedge-tailed eagles had preyed upon. The most frequently eaten animals at Lorna Glen were the pouch young of macropods

(either red kangaroos, *Macropus rufus*, or euros, *M. robustus*), and large goannas such as the yellow-spotted monitor (*Varanus panoptes*). Many birds occurred in the eagles' diet too, including the Australian bustard (*Ardeotis australis*), emu (*Dromaius novaehollandiae*) chicks, crested pigeon (*Ocyphaps lophotes*) and galah (*Eolophus roseicapillus*). Smaller reptiles such as the centralian bluetongue (*Tiliqua multifasciata*) and thorny devil (*Moloch horridus*) were also eaten.

Several threatened mammals were recorded in the diet of one eagle pair.



Above left Euros provide a reliable food source for wedge-tailed eagles.

Above Eagle nests can be located by scanning the mulga plains with binoculars from a prominent location.

Left An assortment of prey fragments collected from a wedge-tailed eagle nest in the breeding season.

Photos – Simon Cherriman



This was not surprising, as their nest was situated only a kilometre from the fenced enclosure. Remains from this nest suggested the birds had eaten one boodie, one rufous hare-wallaby and at least four golden bandicoots. The exact identity of the rufous hare-wallaby was able to be confirmed because this animal had been marked with a microchip which, amazingly, was extracted from within a regurgitated eagle pellet. The eagle must have swallowed the microchip while tearing flesh from the wallaby's body. This example demonstrates how wildlife forensics can be used to form clear pictures of ecological relationships. We can imagine an adult grasping this mammal with iron-gripping talons,

carrying it to its nest and feeding it to a developing nestling.

The only other record of a reintroduced mammal came in the form of a bilby skull, recovered from an eagle nest relatively near the centre of the property. Bilbies have successfully spread throughout the landscape at Lorna Glen and their diggings were frequently observed during eagle nest surveys. While the presence of threatened mammal remains at nests does not prove beyond doubt they were killed by eagles, preference for 'portable' live prey during nesting suggests this is most likely the case.

As well as threatened mammals, wedge-tail eagles were found to prey upon introduced animals

including numerous European rabbits (*Oryctolagus cuniculus*), both near the pen and across the broader landscape. The bones and fur of two feral cats were also identified from two separate nests, showing the eagles are performing useful tasks by helping control these pests.

Relating food to nesting

One of the most interesting finds of the study so far is that only one pair of wedge-tails at Lorna Glen successfully reared young. This was the same pair whose territory largely overlaps with the fenced enclosure where native mammals such as boodies and golden bandicoots are increasing in abundance. Such an abundant native food source, complemented by other vertebrates from outside the pen such as birds and reptiles, enabled the eagles to catch enough prey to supply their chick with plenty of food, and therefore fledge successfully.



Above Surveying an eagle's nest at Lorna Glen.

Photo – Simon Cherriman

All other nesting pairs, despite their breeding attempts, occurred in areas where the landscape is not yet productive enough to support successful eagle breeding. When Lorna Glen was managed as a pastoral lease, numerous bores throughout the property supplied permanent water and probably enabled macropods and rabbits to breed continuously. This provided eagles with a reliable food source but, together with other landscape changes, meant that their diet became simplified and relied heavily on rabbits and on kangaroos, a native species but one whose population had increased well beyond natural levels.

When management shifted to conservation, the bores were turned off in order to re-establish natural conditions. The declines in rabbits and kangaroos which followed probably reduced the eagles' capacity to breed in the short term, but the shift in eagle diet observed at the pen is a

good indicator that eagles can readapt to consume native food and breed successfully.

We know from previous research by CSIRO in the 1970s that adult wedge-tail pairs demonstrate a strong attachment to their territory, and will remain there permanently, either not attempting to breed in years of drought, or nesting unsuccessfully in marginal years. This information comes from a study conducted in an area where the eagles' diet consisted almost entirely of one prey animal, the rabbit, whose abundance was linked directly to annual rainfall. In such a simplified ecosystem (where native mammals are largely extinct), the eagles' breeding success is strongly linked to introduced rabbits. Lorna Glen was probably once very similar to this; however, the gradual shift in ecosystem composition from one or two introduced mammals to several natives has the potential to provide eagles with a varied food source, and perhaps help them breed more successfully. Time will tell and ongoing research is needed to detect any trends.

After the first year of this study, a great deal of information has been

gathered on wedge-tailed eagles at Lorna Glen. Known nest sites can now be visited during the breeding season to monitor their use, and the eagles' breeding success and diet over time. It will be fascinating to determine whether, as reintroduced mammals recolonise Lorna Glen, they are taken as food more commonly, restoring native predator-prey relationships in this arid landscape.

Simon Cherriman has researched, filmed and photographed wedge-tailed eagles for nearly 15 years. His small business, Insight Ornithology, specialises in bird research, photography and education, and aims to inform and inspire others about the Australian natural environment. Simon can be contacted by email (aquila84@inet.net.au).

The author would like to thank those who helped with the nest-searching component of the research at Lorna Glen, often in very hot conditions: Gill Basnett, Jeff Turpin, Michael McDonnell and Daniel Hunter. Keith and Rhonda Skelly, Tony Woods and Rowena Connolly provided logistical support, and Judy Dunlop provided useful comments on the article.



Coalseam Conservation Park

Renowned for its spectacular spring wildflowers, Coalseam Conservation Park lures visitors from across the state.

Coalseam Conservation Park is treasured for its annual wildflower display, when pink, white and yellow everlasting daisies burst into brilliant bloom. After good winter rains, whole landscapes become carpeted in the vibrant colours of these delicate, papery flowers. The park is also rich in history and geology, and is a popular camping place during late winter and spring.

History

Indigenous history in the area is evident in artefacts such as stone flakes, scar trees and grinding stones. Coalseam earned its modern-day place on the map in 1846 after brothers Augustus, Francis and Henry Gregory set out from Perth to find suitable grazing and agricultural lands. They came across the Irwin River on their journey and noted two exposed seams of coal—the first significant discovery of coal in Western Australia. As a result, the government of the day declared a 4,000-hectare coal reserve in the area. Despite the excitement over the find, the coal deposit here never became

a profitable venture due to the coal's poor quality and the distance to Perth. However, the protection afforded to the area, combined with its hilly landscape, meant Coalseam was spared from the clearing which surrounded it. As a result, Coalseam Conservation Park remains an island of native vegetation amid a sea of cleared agricultural lands in the northern Wheatbelt.

Natural attractions

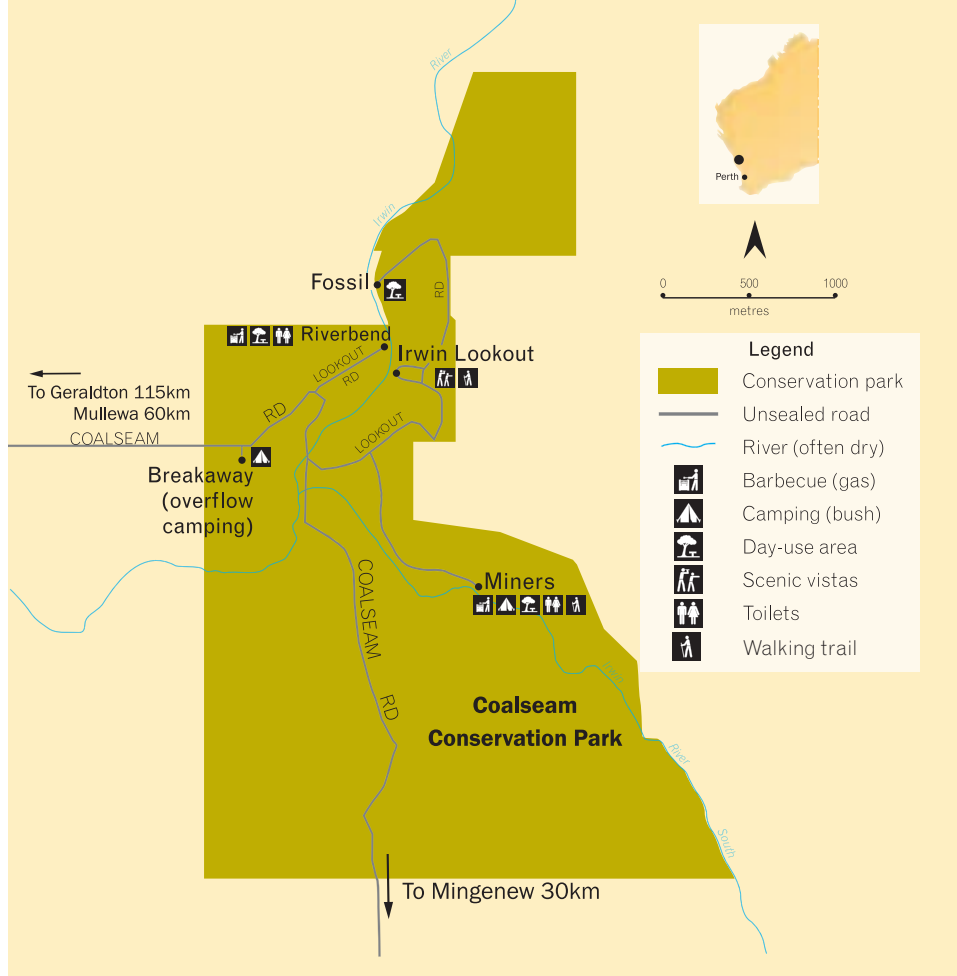
Some of the park's geological history can be seen in the exposed bands of coal seams, siltstones, claystone and sandstones in eroded sections of the banks of the Irwin River. Different coloured stripes in the cliff face reveal different layers from 200 million years of geological history.

Evidence of an earlier epoch rich in marine life can also be seen in fossils embedded in the banks of the river. The cliff face upstream from the Riverbend day-use area has beautifully preserved specimens of small marine creatures—evidence of a Permian sea which once covered the area.

Above Coalseam Conservation Park.
*Photo – Dennis Sarson/Lochman
Transparencies*

Above right from top A red-capped robin, and everlastings carpet the ground.
Photos – Sallyanne Cousans

Far right Climbing fringed lily (*Thysanotus manglesianus*).
Photo – Jiri Lochman



However, if there is one thing the park is renowned for, it is wildflowers. Its position between the northern sandplain country and arid lands of the Murchison, as well as a range of different habitat types, results in a big range of flowering annuals and perennials.

On the sandplain you will find a diverse kwongan heath community, while the floodplain supports a wattle-dominated scrub and, during spring, everlasting daisies transform the wattle understorey with colour. They include pompom heads (*Cephalopterum drummondii*), as well as pink lawrencellas (*Lawrencella rosea*) and rhodanthes (*Rhodanthe* sp.). Other pretty annuals include parakeelya (*Calandrinia* sp.) and fringed lily (*Thysanotus* sp.).

While the wildflowers are strikingly obvious, the mostly nocturnal mammals are seldom seen. However, echidnas, euros and red kangaroos are common. Bird life includes singing and spiny checked honeyeaters, wedge-tailed eagles and peregrine falcons. Galahs nest in tree hollows near Miners campground and red-capped robins flit around the shrubs.

Exploring the park

The park features two short walk trails and three day-use areas which are suitable for picnics. The 700-metre-return Miners walk trail starts from the Miners picnic area and traverses the usually dry bed of the Irwin River to a viewing platform over the disused Johnson coal shaft. Signs explain the history of the shaft, which was sunk in 1917.

Riverbend day-use area has picnic tables, barbecues, toilets and an information shelter with signs interpreting the area's geology, flora and fauna. Nearby, a section of the Irwin River has carved a striking cliff face into the Victoria Plateau. A cross-section of the underlying rock layers is exposed, offering an insight into the park's interesting geology. The layers of rock span five evolutionary periods and provide valuable visual evidence of how the local landscape was formed.

Camping

The park's main camp site is Miners campground where there are non-powered sites for tents and caravans. Picnic tables, gas barbecues and toilets are also provided. When the campground is full, overflow camping

is permitted at the Breakaway site. All other sites are open for day-use only.

Camping is restricted to a maximum of three consecutive nights during the peak season from late July to October. Volunteer campground hosts are located at Miners campground during this time.

park facts

Where is it? 30 kilometres north of Mingenev and 115 kilometres east of Geraldton.

Total area: 754 hectares.

What to do: Wildflower viewing, hiking, camping, picnicking.

Facilities: Campground, walk trails, gas barbecues, toilets.

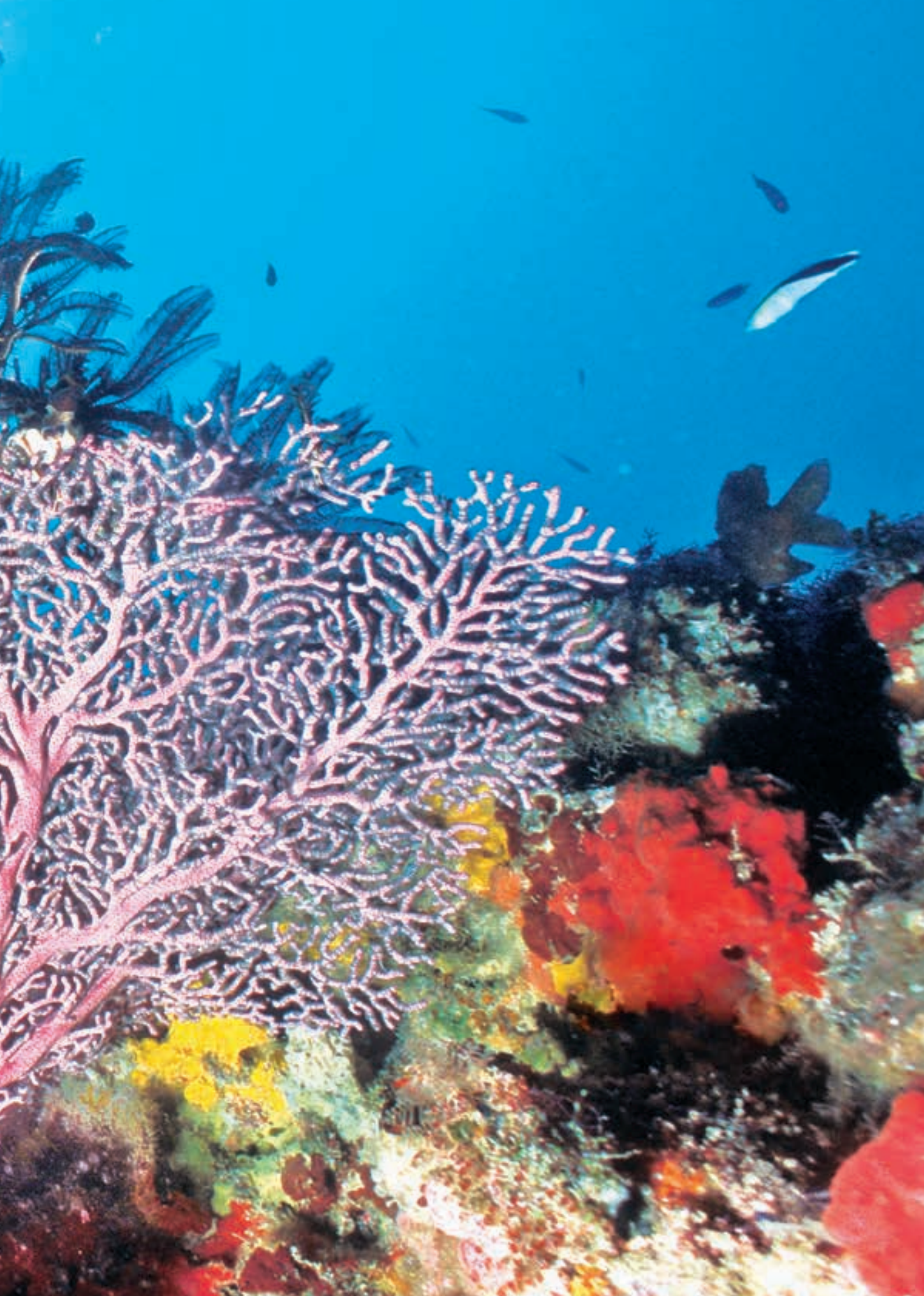
Nearest Parks and Wildlife office: Midwest Regional Office, 201 Foreshore Drive, Geraldton, phone (08) 9921 5955.

Cleaning. for a living

One of the most fascinating symbiotic relationships in the marine world is of cleaners and their 'clients'. More than 56 species of fish have been observed cleaning other fish. These cleaners include species of wrasse, butterflyfish, angelfish, perch, gobies and clingfish. Many species of crustacean also clean. It is a vitally important service for the health of many fish, both on tropical coral reefs and in temperate waters.

by Ann Storrie





Most people are familiar with the cleaner wrasse of the tropics. These fish are known as obligate cleaners as their main diet consists of parasites that live on other fish; hence they clean for a living. There are several species of cleaner wrasse. They choose areas on the reef known as 'cleaning stations' where they perform 'dances' to attract customers. The wrasses swim in a distinctive, jerky manner that indicates their presence and attracts both resident fish and visitors to their station. When 'clients' arrive, the cleaners swim to them and enthusiastically pick parasites, damaged scales, dead skin and mucus from their bodies. The cleaners often move inside the gills and mouths of large fish, picking up food particles as well as parasites and dead cells.

This symbiotic relationship is a very obvious example of animals benefiting from each other's actions, with the cleaners obtaining their food while the clients are cleaned. It is now also thought that this service has more far-reaching effects, especially on coral reefs. For example, resident fish that are



deprived of the cleaning service are generally smaller in size than average and more prone to disease. Also, if cleaners are removed from an area of reef the numbers of resident fish decline and less fish visit.

To eat or not to eat

Hundreds of species of fish have been observed being cleaned. These include very large predatory fish such as groupers, emperors, eels and even sharks, yet very few cleaners are ever

eaten, either by design or mistake. These tiny fish cleaners are quickly recognised by potential clients by their contrasting colours and jerky swimming motions. They also vibrate their fins continuously while inside the mouths of large fish to remind the fish to avoid swallowing while having their teeth cleaned. Large moray eels often share their lairs with cleaner shrimps that move over the eel's face, mouth and nostrils with impunity while cleaning.

Most clients also send specific messages to the cleaners when they wish to be cleaned. Many fish float, almost motionless, in a nearly vertical position. Some spread their fins and gills and open their mouths wide with anticipation. More than a dozen snapper have been observed resting on the sea bed while cleaner wrasse flit from fish to fish. It is interesting that several different species of fish may be present at cleaning stations without becoming territorial and aggressive towards one another as would be



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Main Fan coral in Ningaloo Marine Park with a few tiny fish, including cleanerfish, in the background.

Inset A giant moray eel (*Gymnothorax javanicus*) being cleaned by a common cleanerfish.

Above A pregnant common cleanerfish. These tiny fish grow to just 11.5 centimetres.

Left Blueband glidergobies (*Valenciennesa strigata*) being cleaned by a common cleanerfish.

Photos – Ann Storrie



Above An estuary cod (*Epinephelus coioides*) opens its mouth to enable cleaner wrasse to clean inside.
 Photo – Ross Gudgeon

Right A bluegirdle angelfish (*Pomacanthus navarchus*) is cleaned by a common cleanerfish.
 Photo – Sue Morrison



expected on ‘their’ patch of reef. They seem oblivious to anything but the prospect of being cleaned.

Cunning, clandestine copyists

One of the most common cleaners on tropical reefs is the common cleanerfish (*Labroides dimidiatus*). These small, energetic wrasse, up to 11.5 centimetres in size, are usually seen alone or in pairs and have a distinct dark stripe that begins at the snout and becomes progressively wider as it approaches the tail. Like all cleaner wrasse, the common cleanerfish has a small, narrow snout for picking parasites from its hosts. But like so many oddities of nature, there are others that take advantage of this trusting relationship. A sabretooth blenny by the name of

Aspidontus taeniatus has mimicked the common cleanerfish. It is the same size and colour as the wrasse and it swims in a similar jerky motion to attract clients. It even has the common name false cleanerfish. One of the differences in its physical appearance is its snout, which is slightly larger than that of

the cleaner wrasse. More importantly, especially to its clients, is that the blenny has two large canine teeth in its lower jaw that it uses to bite pieces out of the clients’ fins!

The best way for divers to tell the fish is apart is to observe their behaviour at a cleaning station.



Above The white tip reef shark (*Triaenodon obesus*) will remain motionless while being cleaned.
Photo – Ross Gudgeon

Left Many shrimp also clean, and banded coral shrimps (*Stenopus hispidus*) are sometimes referred to as cleaner shrimps.

Below left It would not take long for these common cleanerfish to thoroughly clean a small neon fusilier (*Pterocaesio tile*).
Photos – Ann Storrie



Cleaner wrasse methodically swim over the fish's body, delicately picking off the parasites, usually with little reaction from their clients. Blennies may also appear delicate, but when they take a bite of flesh, they usually have to make a 'run' for it. Some blennies zoom in very quickly, bite, and then duck away. The client sometimes swims away just as quickly, although many do try to make a blenny breakfast. False cleanerfish also eat fish eggs and the tentacles of tubeworms. Although these fish are generally associated with tropical waters, the false cleanerfish is found as far south as the Turquoise Coast, while the common cleanerfish has been sighted around Rottneest, and in Marmion Marine Park.



Above A bluespotted maskray (*Neotrygon kuhlii*) lies motionless on the sand as it is cleaned.

Photo – Ann Storrie

Left The colourful yet diminutive western cleaner clingfish only grows to about four centimetres in length.

Photo – Sue Morrison



Charismatic cleaner clingfish

Although our warming waters may be responsible for the progressive migration of tropical species further south, there are some cleaners that are genuine temperate water inhabitants. Juvenile western king wrasse (*Coris auricularis*) particularly enjoy a supplementary meal of parasites from larger fish. Even adult king wrasse are sometimes inclined to clean compliant clients. Unlike their tropical counterparts, most temperate water cleaners do not set up cleaning stations and are more opportunistic. Unlike obligate (or dedicated) cleaners, they spend relatively little feeding time cleaning other fish as most of their food is found on the reef or in seagrass

beds. However, there are exceptions to every rule.

A tiny clingfish, the western cleaner clingfish (*Cochleocephalus bicolor*), lives in southern Australian waters from Port Phillip Bay in Victoria to Lancelin in Western Australia. It grows to a maximum of four centimetres long and can be very well camouflaged on the reef. Like all clingfish, its ventral fin is modified into a muscular suction disc on its breast that enables the fish to cling to many different surfaces including rocky reef, sponges and other fish. Its base colour is yellowish to pinkish-red, covered with closely packed red spots. The spots on the posterior portion are normally darker, producing a distinctly bicoloured appearance. There are also

12 to 15 narrow, iridescent blue bands that run across the fish's back. The fish can also reduce or enlarge the colour cells in its skin to either blend into its surroundings on the reef, or to emphasise its presence on a pale background. It is indeed very striking if sitting on a white sponge, which is where many set up their cleaning stations.

Given the size of these cleaners and their ability to camouflage themselves on many different surfaces, divers could be forgiven for never having seen a cleaner clingfish. Occasionally, the fish has been discovered after it has hopped onto a diver's hand that was resting on the reef! And once you have seen one, you will see many. A close look at a harlequinfish (*Othos dentex*), or a southern blue devil (*Paraplesiops meleagris*) may reveal one, or even several, tiny western cleaner clingfish hopping over their bodies.



Above Ribbon sweetlips (*Plectorhinchus polytaenia*) line up on the sea bed to be cleaned. There are two common cleanerfish on the sweetlip second from the left.

Photo – Ann Storrie

Left Spot the three western cleaner clingfish on this harlequinfish (*Othos dentex*).

Photo – Sue Morrison



Unlike the ‘dance’ of the tropical cleaner wrasse, the western cleaner clingfish advertises its presence by sitting on a rock, sponge, ascidian (sea squirt), or other sedentary animal that usually elevates it above the substrate and emphasises its colours. The clingfish will then swim over to any fish that arrives and exhibit submissive behaviour similar to that of tropical species at cleaning stations. Other clients such as the harlequinfish, banded seaperch (*Hypoplectrodes nigroruber*), or dusky morwong (*Dactylophora nigricans*) simply sit motionless on the bottom near the clingfish’s station. In the blink of an eye, the little clingfish appears

to hop over to the client where it commences cleaning the fish’s body. Interestingly, it is not usually observed cleaning inside a fish’s mouth or gills.

Conservation of cleaners

The unique symbiotic relationship between cleaners and their hosts at cleaning stations plays a significant role in the health of reef ecosystems. Unfortunately, many tropical cleaners are collected for the aquarium trade. The removal of these cleaners leaves resident fish more vulnerable to disease, while transient fish are not so inclined to visit. Divers can help keep the balance of the ecosystem by

observing the natural behaviour of these animals within our marine parks rather than collecting or buying them for aquariums. Keeping cleaners in aquariums is rarely successful as their specialised diets cannot usually be met. Enjoy watching fish at cleaning stations and, if you are diving in our temperate waters, remember to look for colourful, tiny, blue-banded clingfish. If you see one on a sponge or rock, rest your hand nearby and, if you are very lucky, the cleaner may hop on and start cleaning. You can feel the tickle of the delicate suction of their modified ventral fin on the palm of your hand. And don’t worry, as far as we know nothing has yet evolved that looks like a western cleaner clingfish with fangs!

Ann Storrie is a frequent contributor to *LANDSCOPE* magazine and an accomplished underwater photographer. She can be contacted by email (naturescapes.au@hotmail.com).



Saving streams of the south-west forests

The streams of the south-west forests harbour a whole host of aquatic species and provide many environmental benefits. Yet these rivers are under threat from a drying climate. An eight-year study examined just what shape these waterways are in, and paved the way for their future protection.

by Melita Pennifold



People often hold a fascination for rivers and streams. These natural features offer somewhere to recreate, to seek solitude and to admire nature's beauty. They promote biodiversity, offer a whole array of environmental benefits, and aid agriculture, tourism and forestry. The rivers and streams of Western Australia's south-west forests are especially important, offering refuges for plants and animals in our dry state, particularly during the drier summer months. Further, forest streams usually have better water quality than streams in cleared areas, as the surrounding vegetation plays a vital role in preventing the rise of saline groundwater.

Yet these forest waterways and their inhabitants may be at risk from human-related pressures such as agriculture, tourism, forestry, water storage and recreation. Some of these activities may create disturbances in the catchment which change the hydrology and sediment processes. This in turn can affect conditions within a stream and therefore the animals that live in them.

To add to this pressure, over the past couple of decades the south-west has been experiencing a drier climate, which increases competition for water resources. Since the mid-1970s there has been a significant decrease in annual rainfall—about 10 to 15 per cent—and an associated, even larger drop in stream flow—up to 40 per cent. In some cases,

streams which used to flow year round are now dry for several months. This has further increased concern over what may become of the rivers and streams in the south-west forests and their aquatic inhabitants.

The project

In 2005, the South-West Forest Stream Biodiversity Monitoring project was initiated to determine the health of aquatic invertebrate communities in forest streams. The ecological condition of the rivers and streams was assessed using the Australian River Assessment Scheme. The scheme focused on aquatic macroinvertebrates—creatures that can be seen with the naked eye—and includes all aquatic insects, worms, snails and crustaceans. Some of these animals spend only part of their life cycle in the water and have terrestrial adult stages—for example dragonflies, midges and

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Main Blackwood River.

Photo – Alicia Dyson

Insets from left to right A diving beetle (*Necterosoma penicillatus*), mayfly (*Tasmanocoenis tillyardi*) and stonefly (*Newmanoperla exigua*).

Photos – DPaW Science Division

Above DPaW technical officer Kirsty Quinlan collecting samples.

Below left Lefroy Brook.

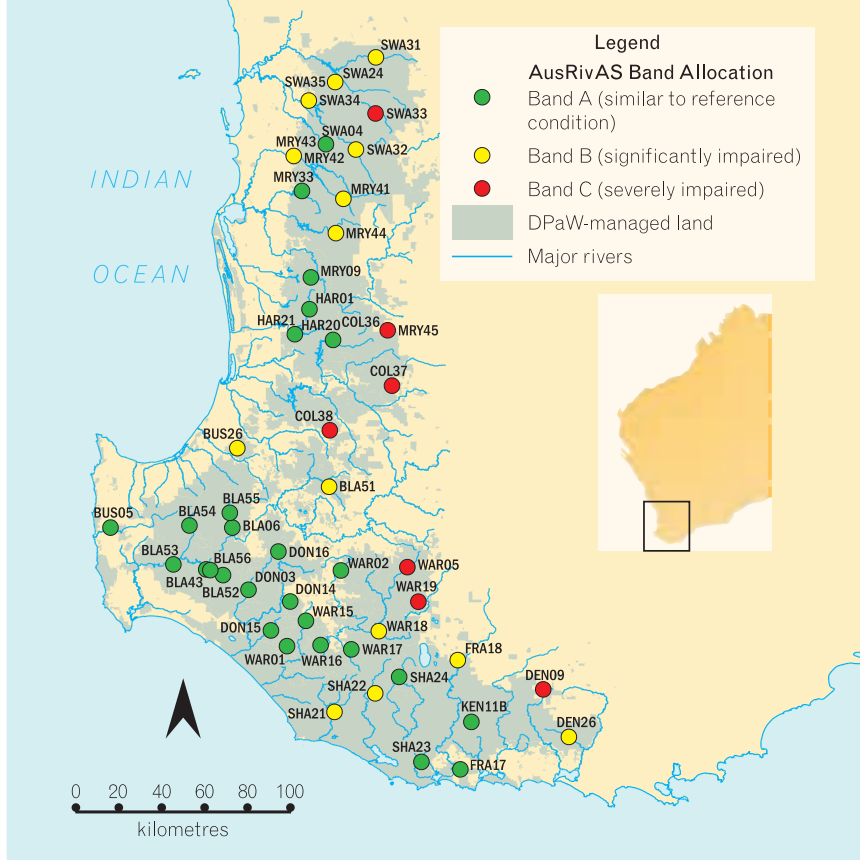
Photos – Melita Pennifold/DPaW

mosquitoes—while others rely on the stream for their entire life cycle.

Macroinvertebrates are often used for biomonitoring in rivers as they are common, widespread and provide a good measure of a river's health. These animals respond to water conditions over a period of time, and a single period of adverse water quality during their life cycle may result in death and the absence of a species from a site. Some macroinvertebrates cannot tolerate polluted or disturbed streams while others thrive in degraded conditions. Therefore, the condition of a river or stream greatly affects the macroinvertebrate community.

Macroinvertebrates were sampled annually in spring at 51 sites located over a wide geographic area in the south-west of WA, including streams in catchments subject to a range of management activities such as timber harvesting, prescribed burns and maintenance of roads and tracks. Generally, sites were downstream of, rather than within, areas subject to timber harvesting and prescribed burns. This is because the aim was to monitor the broader effectiveness of forest management rather than local impacts. Sampling was conducted from 2005 to 2011 and spanned a





Above Monitoring resulted in waterways being assigned Australian River Assessment Scheme (AusRivAS) bands, which reflected their state of health.

Above right Nile Creek during a dry winter in 2010.
Photo – Melita Penniford/DPaW

wide variety of seasonal stream-flow conditions, including several very dry years. Findings were then compared to data obtained from minimally disturbed reference streams and assigned to ‘bands’ that reflect different ranges of biological condition, ranging from ‘richer than reference’ to ‘extremely impaired’, that is containing very few of the expected families.

Dry findings

This is the first study to monitor stream aquatic fauna over a long time period in such an expansive area of the south-west. The aquatic fauna in the streams was very diverse, with more than 295 species recorded from 116 families. Insects such as water beetles, dragonflies, caddisflies and midges were the most common and widespread fauna collected. The number of species collected for any particular site varied each year and was usually lower after a dry winter. Low rainfall over the study period resulted in some streams drying more frequently or having a shorter hydroperiod (the length of time water is retained). This reduces the chance

of survival for some species, as they may not have time to breed. In 2010, a particularly dry year, a third of the sites were dry and in the following year the number of species recorded for most sites was reduced. In 2011, only three sites received an ecological band rating similar to reference condition. If the incidence of dry years continues to increase, streams will become more seasonal and there may be a change in fauna from river-type fauna, which like flowing water, to wetland-type fauna.

When averaged over the eight years, 27 sites were classed as ‘similar to reference’, 16 were ‘significantly impaired’ and eight were ‘severely impaired’. No sites were classed as ‘richer than reference’ or ‘extremely impaired’. While almost half of the sites appeared to be impaired, the level of impairment was not directly related to forest management activities. In most cases impairment could be attributed to low rainfall, naturally high salinity or acidity, or some other kind of local disturbance. Timber harvesting and prescribed burning generally had small and transient effects on stream biodiversity. Most of these impaired sites were in the northern jarrah forest north of Dwellingup or in the drier eastern forests.

Bushfires which occurred at two sampling sites did reduce the diversity and abundance of the stream fauna, but the fauna at these streams recovered

after several years. However, the intensity of the bushfire seemed to determine how long recovery took—the more intense the fire, the longer the recovery. How dry the streambed is when a fire occurs may also determine how much the stream fauna is affected by the fire and how quickly it recovers.

Where to now?

This study shows that many streams and freshwater communities are under greater stress and risk of decline from a drying climate rather than current forest management activities. This places greater importance on managing catchments and groundwater to ensure the streams keep flowing. It is important to determine areas where aquatic communities are similar (bioregions) and areas where rare and endemic species occur. These data can then be used to assess if aquatic fauna are protected through the current conservation reserves. It is also important to identify and protect those habitats, streams and regions that can act as long-term refuges from drying to ensure future survival of aquatic communities.

Melita Penniford is a research scientist with the Department of Parks and Wildlife’s Science Division. She can be contacted on (08) 9405 5184 or by email (melita.penniford@dpaw.wa.gov.au).

bookmarks by Catherine Jack



Australian lizards: a natural history

Author: Steve Wilson
Publisher: CSIRO Publishing
www.publish.csiro.au
196 pages, soft cover, colour photographs
ISBN: 978 06 4310 640 6
RRP: \$49.95

While not the most glamorous residents of the animal kingdom, when captured in detail lizards can prove fascinating and visually stunning subjects. Author Steve Wilson's passion and enthusiasm for lizards is evident as he describes his childhood dismay at finding that not everyone shared his obsession.

In this book he aims to ignite interest in the species with a glimpse into their remarkable lives, providing information to satisfy both novice and specialist.

More than 400 colour photographs, many with excellent macro detail, will hold your attention as you discover interesting facts on the secret life of our nation's lizards; how they fight, mate and procreate, all while carefully regulating their temperatures and struggling to survive in a complex world of predators.

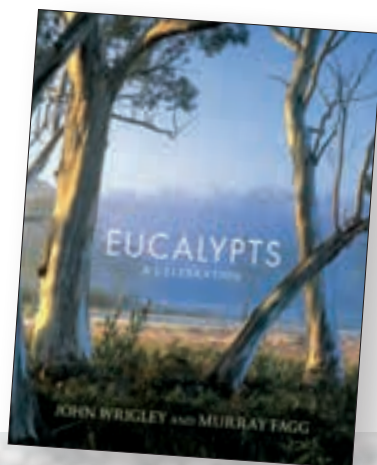
Eucalypts: a celebration

Authors: John Wrigley and Murray Fagg
Publisher: Allen and Unwin
www.allenandunwin.com
352 pages, soft cover, colour photographs and illustrations
ISBN: 978 17 4175 924 2
RRP: \$65.00

Give me a home among the gum trees ... *Eucalypts: A Celebration* draws the reader into the romantic Australian image of the bush, bringing forth scenes of billy tea around a campfire, mists of eucalypt oil rising off the Blue Mountains, Cuddlepoot and Snugglepole, and the poems and songs that form part of Australia's recent history.

Eucalypts have influenced modern Australia, from the creation of our homes, to work, art and culture, and this book celebrates their diversity, history and management.

Rich in detail and cultural references, coupled with beautiful imagery of Australian country scenes, *Eucalypts: A Celebration* explores a piece of Australia's history that many of us have shared.



Common birds in the backyard

Authors: Carolyn Thomson-Dans and John Dell
Publisher: Department of Parks and Wildlife
shop.dpaw.wa.gov.au
64 pages, soft cover, colour photographs
ISBN: 978 07 3096 996 9
RRP: \$6.95

One of the nicer aspects of living in a city like Perth is hearing the tinkering, musing calls of local birdlife. The bright colours of galahs, lorikeets and parrots brighten up our backyards and urban spaces, while the familiar 'aah-ahh-aahaah' call of the raven often provides an unceremonious wake-up call in lieu of our morning alarms.

This handy pocket-sized field guide from the Department of Parks and Wildlife's Bush Book series has been updated. The revised reprint provides fascinating facts about our local species including details on how to identify different bird species by sight and sound, and a 'how to' on building a bird-friendly garden. A great little book for kids or adults.



Lucky escapes in Torndirrup National Park

A personal account of the sometimes treacherous southern coastline.

by Roger Underwood



On a recent exploration of well-loved spots along the coast east and west of Albany, my wife Ellen and I were reminded of two escapades in Torndirrup National Park many years ago. Both resulted in near disaster. Revisiting the scenes reminded us that this coast is not just one of the most beautiful in the world, but also one of the most treacherous.

The first incident occurred in 1964 when Ellen was a young school teacher and I was a young forestry officer, both living in Pemberton. We were courting at the time, and on weekends would set out on explorations of the karri forest and the little-known inlets, cliffs and beaches along the south coast. Our invariable companion was Cassius, my blue heeler cattle dog. Cassius had initially been a one-man dog and for a while he was suspicious of Ellen entering my life, but she had won him over, and the three of us had enjoyed many lovely times bushwalking and beachcombing.

Previous page

Top The Gap in Torndirrup National Park.

Bottom Huge swell crashing on the coast in the park.

Below A rock fisherman takes a risk fishing off Cable Beach, a sandy bay on the southern side of Torndirrup National Park. Photos – Andrew Halsall

Lucky escape

One 1964 trip took us to Torndirrup National Park, the dramatic peninsula of granite, limestone and heathland that forms the southern backdrop to King George Sound, across from the historic town of Albany. This was in the days before Western Australia's park managers had begun to disallow people taking their dogs into the national parks, so there was no problem in having Cassius along with us. We had planned to walk across the isthmus from Salmon Holes to Bald Head, and I was carrying a small haversack with a bottle of water and a couple of apples.

It was an excursion that was never completed.

Setting off from the Salmon Holes we first walked around the beach to where a massive granite outcrop shelves into the sea, and from which we could climb up to a rough fishermen's track that led out along the peninsula. It was one of those glorious south coast days, with a gentle south-easterly breeze, a sparkling sea, whirling gulls and gentle rollers cruising in to the beach or surging up onto the rock faces. Climbing steadily, Ellen and I had reached a point perhaps 150 metres above the shoreline, when we stopped for a breather and a



look around. Cassius was way below us, fossicking about in little clumps of scrub or snuffling among the rocks, probably looking for an abandoned fish carcass, and generally enjoying himself as a dog does.

We watched the scene below with pleasure ... and then suddenly with alarm. Out of nowhere, a giant wave swept in and surged up the rocks, at least 50 metres beyond the point at which any previous wave had reached. It caught Cassius, upended him and sucked him straight out to sea. He disappeared underwater momentarily, then reappeared and then disappeared again. In a moment or two we could see his head bobbing about among the rollers. He was well off shore and drifting further out.

Ellen gave a cry of fear and I gasped with anxiety. No dog could swim ashore in this situation. I knew immediately that Cassius was lost.

Just then a second huge wave appeared out of nowhere. It was not as big as the first one, but it surged powerfully. It caught Cassius up and swirled and tumbled him all the way inshore, depositing him way up on the

Improving rock fishing safety on the south coast

Salmon Holes has been the location of several rock fishing-related drownings over recent years. Since 2007, there have been 13 rock fishing deaths in Western Australia.

To enhance safety for rock fishers and promote a greater understanding of the potential dangers of ocean swells, the state government has provided \$300,000 over three years to the recreational fishing body Recfishwest.

Priority areas identified by the government, in consultation with Recfishwest, for new safety measures include Twilight Cove and Hellfire Bay at Esperance, Salmon Holes and Lowlands at Albany, and Kingie Rock and Long Pont in the Denmark-Walpole region.

At Salmon Holes, the Department of Parks and Wildlife has worked with Recfishwest to identify the location for rock fishing safety devices. Installation will occur later this year, when the dangerous winter swells typical of the Southern Ocean have passed, and in readiness for the coming summer.



rock face. Emerging from the froth and bubble, and steady on four legs, he shook himself vigorously, trotted off and resumed his snuffling in and around the rocks, looking for anything of interest. I whistled, and he lifted his head, erected his ears and came trotting up the rock to join us, wagging his tail, seemingly oblivious to recent events.

I have often wondered what went through his mind during his brief and life-threatening adventure. Probably not much. He was an intelligent dog, but was still only a dog; his emotional range was narrow and he had no sense of his own mortality.

What was going through our minds, on the other hand, was amazement and relief. I don't think either of us would have ever fully got over carrying a memory of his little head bobbing about in the waves, had he been swept out rather than swept in.

It doesn't pay to dwell on things like this, so we soon got over it, although it did dampen our enthusiasm for the walk to Bald Head. This was abandoned for something less stressful that day.

Nature strikes again

The second incident occurred nearby several years later. In 1973 Ellen and I (now married, and again living in Pemberton) were holidaying in Albany with our three children; Tim aged six, Jane aged four and Peter two. Cassius, I regret to say, was no longer with us.

Again it was a glorious south coast morning. The air was soft, and it was clear and sunny. A mild, briny breeze puffed in off the Southern Ocean, but the sea was almost calm, just the steady swell of the deep sea rollers. Eclipse Island, a mile or two offshore, stood out sharply, and figures could be seen walking around near the lighthouse keepers' cottages. We walked out to look at the little mainland lighthouse on its rocky headland just near Natural Bridge, and then climbed down to do some beachcombing on Cable Beach, a sandy bay on the southern side of Torndirrup National Park. Tim scampered ahead, Jane struggled after him and Peter slid down the dunes or perched on my shoulders, steering me with my ears, as was his wont.

Cable Beach is not all sand. At its western end there is a rocky bar

Above Salmon Holes in Torndirrup National Park.

Photo – Andrew Halsall

running parallel with the shoreline, set back about 50 metres from the spot where the spent waves fade and reverse themselves across the reef into the ocean. The rocks stand about two metres above the beach. It was an inviting spot for an adventurous family, so we all scrambled up to poke around for treasures among the boulders and rock pools.

Suddenly Ellen gave a shout of warning. Coming at us out of the sea was an enormous wave, reminiscent of the one that had captured Cassius all those years before. I just had time to grab Tim and Jane, one under each arm, and plant my feet, while Ellen grabbed little Peter and clutched him to her.

The wave crossed the beach above the height of the rocks and took us about waist high, before ending up at the foot of the far dunes. It was foaming and swirling powerfully. I just managed to stay upright, but Ellen was knocked off her feet and she and Peter went briefly under before scrambling up. Almost the second it passed, the



wave's energy subsided and the water dissipated and retreated. I put Tim and Jane down and went to see to Ellen and Peter. They were both okay, but cut and bruised.

In fact, we were all okay, but we beat a retreat back to the car and to our holiday home, needing (in Ellen and Peter's case) first aid, and (in mine) a stiff drink.

King wave menace

The two great waves we had experienced are known to south coast locals as 'king waves'. They are a well-known phenomenon on the south coast of Western Australia, and over the years many fishermen and tourists have been surprised by them, and swept out and drowned. In many cases these were people who knowingly placed themselves in danger under that other well-known phenomenon, the 'it can never happen to me' philosophy.

I knew nothing much about king waves in 1964 when the wave grabbed Cassius, but I was well-enough informed by 1973 to have made sure my family never got too close to the edge when clambering around south coast rocks. But even then, I had no idea that a wave of such massive proportions could just emerge from a relatively calm sea. In our situation there was, perhaps, only a small risk that we could have been swept out to sea, but we could easily have been

badly injured, and it was sheer luck that all of the kids were within reach when the wave bore down on us. There was no second wave to have washed one or more of them ashore.

Nevertheless, two lucky escapes is at least one too many. Thirty years later I am still super-cautious, knowing how an appreciation of the beauty of this area must be tempered with respect.

It is a lesson many others are yet to learn. On our recent visit we observed numerous occasions where people were taking enormous risks along the rocky shores of Torndirrup National Park, yet another example of the failure of the human species to learn from the experience of others.

Dogs in national parks

The exclusion of dogs from national parks is necessary to prevent them consuming 1080 baits which these days are often distributed to help eradicate introduced species. Some species of dogs may also pose a threat to native wildlife.

Above Natural Bridge in Torndirrup National Park. Note the tourists on the left.

Below Often people are unaware of the risks while visiting the Blowholes. Photos – Andrew Halsall



Roger Underwood was the department's district manager at Pemberton from 1968 to 1975.



Termite mounds: more than just termites

Termite mounds are home to much more than termites. New studies on Barrow Island Nature Reserve reveal a remarkable suite of creatures who inhabit these towering mounds of earth.

by Dorian Moro and Pat Cullen

Termite mounds are common pinnacles of the northern Australian landscape. These mounds, also referred to as termitaria or ‘terrestrial icebergs’, are built over time by large colonies of social insects—termites—that act as important miners of the soils. Yet surprisingly little is known about the other wildlife that share mounds with these insects. A recent survey on Barrow Island Nature Reserve provided an insight into the many other—and larger—inhabitants that use these impressive structures.

Termite mounds provide nutrient-rich islands across arid landscapes and support nutrient flow to vegetation. Additionally, they serve as habitat to many species of vertebrate fauna who have adapted to use them for shelter, perches or other needs. However, while most of us only think of termites when we see these large mounds, many different types of invertebrate and vertebrate wildlife species may co-habit these structures. On Barrow Island, recent surveys found that mound-sharing was a common feature for many vertebrate species.



Islands within an island

At 23,400 hectares, Barrow Island is Western Australia’s second largest island, and is located off the state’s Pilbara coast. It is one of Australia’s most important mammal and marine turtle conservation areas. Given its natural significance, the Department of Parks and Wildlife maintains a significant presence on the island, with an office, laboratory and team of fly-in fly-out staff. The island occurs in an arid landscape that reflects what mainland Australia looked like before the island’s separation during the last ice age about 8,000 to 10,000 years ago. It supports diverse terrestrial habitats primarily comprising spinifex and coastal vegetation. Termite mounds are a common feature of this island

ecosystem and act as natural island-arks for the species that make use of them. Invertebrate surveys by Curtin University and Chevron Australia found 31 species or morphospecies of Isoptera (termites) from two families and eight genera on Barrow Island. However, the large termite mounds are primarily built by the one species, *Nasutitermes triodiae*. The mounds measure up to 2.5 metres high and two metres across.

During approved land clearing operations to facilitate the development of the Chevron-operated Gorgon Gas Project on Barrow Island, dedicated fauna handlers were required to carefully dismantle termite mounds that were to be destroyed and to survey and record the vertebrates living within them.

Species diversity

More than 400 termite mounds were surveyed. However, not all mounds contained vertebrates: fauna were recorded from 66 mounds (16 per cent) of those found in the cleared area. Reptiles were the most common vertebrate fauna sheltering within termite mounds, with 26 species recorded, although four small mammal species were also found.

Species common in termite mounds included the Stimson’s python (*Antaresia stimsoni stimsoni*), Pilbara dtella (*Gehyra pilbara*), Bynoe’s gecko (*Heteronotia binoei*), rock ctenotus (*Ctenotus saxatilis*) and exquisite fire-tail skink (*Morethia ruficauda exquisita*). Although the Pilbara dtella is a known specialist of termite mounds and seldom found away from them, Bynoe’s gecko was the most abundant species



Previous page

Main Obe’s Beach, Barrow Island.

Photo – Marie Lochman

Left inset A euro bounds past a termite mound on Barrow Island.

Photo – Dorian Moro

Right inset Excavating a termite mound on the island.

Photo – Pat Cullen

Left Termite mounds on Barrow Island.

Photo – Dorian Moro



found to occupy termite mounds on Barrow Island. Interestingly, captures of Bynoe's gecko were higher in mounds on Barrow Island than have been observed from surveys elsewhere in the Pilbara.

Another reptile of interest that was found within the mounds was the perentie (*Varanus giganteus*). This species is a top-level predator on the island and, during the summer months, is often seen patrolling the beaches in search of turtle eggs and hatchlings. Past records from the well-known conservationist and naturalist Dr Harry Butler report that this species uses termite mounds for nesting.

Termite mounds were also favoured by some reptiles more than the surrounding vegetation. For example, four reptile species (the Stimson's python, Pilbara dtella, Bynoe's gecko and exquisite fire-tail skink) were found to occur predominantly in termite mounds, rather than in the

surrounding vegetation. In contrast, the rock ctenotus, northern slender blue-tongue (*Cyclodomorphus melanops melanops*), grand ctenotus (*Ctenotus grandis titan*) and sharp-snouted delma (*Delma nasuta*) were better represented in the surrounding vegetation than in termite mounds.

Mammal diversity was limited to some of the smaller mammals known from Barrow Island; the dasyurids Rory's pseudantechinus (*Pseudantechinus roryi*) and common planigale (*Planigale* sp.), Barrow Island golden bandicoot (*Isoodon auratus barrowensis*), and western chestnut mouse (*Pseudomys nanus ferculinus*).

More than shelter

Termite mounds offer large animals more than just shelter; they also provide opportunities for feeding, nesting, perching, sunning, or seeking shade. Reptiles such as the perentie and ring-tail dragon (*Ctenophorus caudicinctus*)

Top left Stimson's pythons were found to occupy the termite mounds on Barrow Island.

Above Surveying a termite mound on the island.

Photos – Pat Cullen

Above left A termite mound makes a convenient perch for an osprey.

Photo – Jiri Lochman

caudicinctus) can often be observed warming themselves in the morning sun as they spread themselves on the tips of one of these pinnacles. Reptiles will eat a range of invertebrates that termite mounds harbour, such as termites, cockroaches, beetles, or spiders. Termite mounds can also act as incubators for reptile eggs, protecting them from extreme temperature fluctuations that are present outside the shelter of the mound. Finally, termite mounds offer shade opportunities; the Barrow Island



Above Termite mounds on Barrow Island.
Photo – Dorian Moro

Below Turtle Bay on the island.
Photo – Marie Lochman

euro (*Macropus robustus isabellinus*) often uses the shade of termite mounds to rest during the day.

While no birds were found sheltering inside mounds during this survey, birds may also use these structures. Historical records of red-backed kingfisher (*Todiramphus pyrrophygius*) nesting inside termite mounds are known from the island. Like they do for reptile eggs, termite mounds can also act as incubators for bird eggs. Furthermore, the mounds offer important perching and observation platforms for many raptors and other terrestrial birds in a landscape otherwise devoid of tall vegetation. Birds perching will glean insects, and mound perching is typically observed by the nankeen kestrel (*Falco cenchroides*), osprey (*Pandion cristatus*), brahminy kite (*Haliastur indus*), white-breasted woodswallow (*Artamus leucorhynchus*), bar-shouldered dove (*Geopelia humeralis*), spotted harrier (*Circus assimilis*), and white-bellied sea eagle (*Haliaeetus leucogaster*).

Landscape value

Termite mounds are particularly useful as habitat for almost half of the known reptile species occurring on Barrow Island, and they also offer shelter for small mammals in a

landscape with limited vegetated cover. Information on which vertebrates live within termite mounds offers environmental managers an insight into the value these mounds have as habitat to wildlife, and the usefulness of these structures as refuges to large fauna during fires or floods.

Large termite mounds act as functionally important habitats to many vertebrate species. The results from this survey highlight the value of retaining termite mounds in other landscapes where fauna, for

example rare species, have restricted distributions. Importantly, the high species diversity observed within the mounds on Barrow Island provides an insight into the diversity of habitats that many vertebrates occupy on this island and likely elsewhere across the arid zones of Australia. The potential refuge these mounds offer during flood or following land clearing disturbances such as fire, and the potential opportunities they offer for future local re-colonisation, feeding and nesting, should be acknowledged.



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The Gorgon Project is operated by an Australian subsidiary of Chevron, in joint venture with the Australian subsidiaries of ExxonMobil, Shell, Osaka Gas, Tokyo Gas and Chubu Electric Power.

endangered

by Wendy Chow



Bentonite lakes

A series of seasonal freshwater, winter-filled lakes in the Watheroo-Marchagee area, about 200 kilometres north of Perth, contain a very absorbent clay called bentonite. The plant community on these lake beds is very distinctive and mainly consists of herbs such as daisies that grow across the lakes after rain, then die off. Although many of the herb species that inhabit the bentonite lake beds are known from other areas, the combination of species that makes up the plant community on these lake beds is rare, and differs from those on other types of lakes, probably due to the presence of the bentonite. These lakes therefore contain a listed threatened ecological community called 'Herbaceous plant assemblages on bentonite lakes', ranked endangered. All occurrences of this community are located in the Watheroo-Marchagee area immediately south and east of Lake Pinjarregga, including some areas on private property. The community is known only from a total of about 118 hectares.

The lakes are dominated by a combination of prickly arrowgrass (*Triglochin mucronata*), the daisies *Trichanthodium exile* and *Asteridea athrixioides*, and marsh grass (*Puccinellia stricta*) on the beds, and a combination of wiry podolepis (*Podolepis capillaris*), camel-grass (*Angianthus tomentosus*) and the daisy *Pogonolepis stricta* on the margins. In 2008, a priority one species of purslane, *Calandrinia aperta*, was discovered growing on one of the lakes. This species is known only from two areas—the other being in salt pans near Shark Bay. While most bentonite lakes are covered by herbs, there are a number that have swamp sheoak (*Casuarina obesa*) trees, and shrubs of gorada (*Melaleuca lateriflora* subsp. *lateriflora*) and a wattle, *Acacia ligustrina*.

The annual flowering herbs are dependent on fresh water in the lakes followed by drying of the clay bed, sealing moisture within the pores of the clay. This promotes germination of the herbs and usually occurs a few weeks after rain. The requirements for the seeds to germinate are not

fully understood, however, and monitoring is being undertaken to help determine links between water levels and quality and the germination of the lake-bed plants. Water monitoring is also being carried out around the lake fringes to determine groundwater levels and salinity trends as areas close by are becoming saline.

Threats to this community type include mining for bentonite, drying climate, salinisation and grazing. Bentonite is used in several commercial industries, in horticulture as a soil-wetting agent, and in beauty products, cement, adhesives, ceramics, and kitty litter. Some occurrences have been previously mined and some lakes have mineral tenements over them.

The Department of Parks and Wildlife is seeking to conserve this threatened ecological community, mainly with further monitoring to guide future management and by investigating the purchase of lands that contain this threatened community for conservation.

Photos by Wendy Chow

urban antics

by John Hunter



Ladybirds

Perhaps the greatest enigma of the insect world is the ladybird. One minute a shiny exquisite dollop of lollypop in a hemispherical clown suit, the next a ruthless predator and outrageous cannibal.

This tiny beetle from the family Coccinellidae is the perfect public relations logo for most other insects which, in human terms, are less than attractive. With its appealing colours, shape and size, and having the movements of an over-enthusiastic robotic vacuum cleaner, it is no wonder there have been so many children's stories, songs and movies made about this little beast. Its demeanor and external morphology have inspired many ancient religions, cultures, artists, and a famous German automobile maker's dream.

Being part of the order Coleoptera (beetles) which accounts for about 40 per cent of all insects, the Coccinellids are themselves the third largest beetle family (that we know of) on Earth. Often misnamed as 'ladybugs', the animals have very efficient biting mandibles, whereas true bugs have feeding-tube mouth parts.

During winter and spring, as with most other insects, local ladybirds are probably in their lowest numbers. It is a time when the availability of food, fecundity, and well-being is generally lacking. At this moment, ladybirds are either aestivating in trees and

various natural nooks and crannies or, depending on the particular species, are quietly gathering a scarce seasonal selection of pollen, honeydew, plant material, nectar or fungi, and the odd unlucky little grub.

Ladybird beetles are mostly observed in our local suburban gardens during the warmer months, particularly in autumn, as they dart about on vegetation, especially roses and citrus, where there is usually a seasonal population explosion of their favourite prey.

Starting in spring and culminating in autumn, well-watered gardens of luscious new-growth vegetation attract squillions of tiny sap-sucking aphids and scale insects, mites, butterflies, moths, lacewings and a horde of other insects. This is where the pantomime gives way to the brutal euphoria of a Flavian colosseum with plunder, pillage, feeding and breeding in concert.

Predatory Coccinellids lay their eggs on plants near their adult prey and their broods, the numbers of prey determining the number of eggs laid. The beetles are holometabolous insects, undergoing a complete metamorphosis with four discrete life stages: egg, larva, pupa and adult.

After about a week-long gestation, ladybird larvae, complete with efficient mandibles, break from their eggs and immediately seek out the nymphs and eggs of aphids and any other insect larvae, as well as cannibalising eggs and grubs of their own kind. They pass through four instars, each time shedding their skin and growing larger. The fourth instar is able to hold their prey in its jaws like the adult beetle, and sometimes lifts it from the substrate while it chews, eats and, in some species, sucks the bodies dry. After the pupa stage of seven to 10 days, an adult beetle emerges, wings extending from under the pale shiny dome of its wing covers.

Within several hours, the cuticle hardens and the species develops its characteristic colour pattern. It is not long before the voracious little beetle, with a twitch of its tiny clubbed antennae and the blur of six little legs, is busy hunting the soft juicy flesh of a victim, just like the rest of its cousins—up one branch and down the next.

There is no rest for the wicked, so the saying goes. Within a few days a ladybird will mate, the copulation lasting around an hour, but sometimes extending to hours or days—wow! Longevity then depends on length of aestivation, climate and brood numbers. They may live from two months to two years. And so the cycle continues—eat or be eaten.

DID YOU KNOW?

- Some 6,000 species of ladybird are found throughout the world with about 500 in Australia.
- Ranging from one to 10 millimetres across, ladybirds were first described by Carl Linnaeus in 1758.
- Many species are introduced around the world as biological control species in crops and orchards.



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