WA's conservation, parks and wildlife magazine

LANDSCOPE

Volume 21 Number 4 WINTER 2006 $6.95

Beyond Steep Point

Invasive marine pests

Burrowing bees

Julimar Conservation Park **Shark Bay Interpretive Centre** Cape Arid National Park

Take a journey of a different nature with LANDSCOPE Expeditions

Expeditioners in a drift of wildflowers on the former Doolgunna pastoral station in the Murchison in August 2005. Expeditioners took part in the first botanical survey carried out at Doolgunna, which has been purchased as an addition to the State's conservation reserve system. Photo – Bill Muir

Join our scientists for a trip that will leave a lasting impression on you and the environment

Protecting Eden — Biodiversity Conservation in Action
17–23 September 2006
Come and be part of one of the most exciting wildlife conservation projects anywhere in the world and help the vital process of measuring the success of Project Eden—a visionary conservation program set in the internationally renowned Shark Bay World Heritage Area. Participants will be involved in surveying for small native animals and will handle, identify and record data on captured animals, such as hopping mice and dunnarts. They will also assist with radiotracking and bird counting.

Conserving the Cape — Wildlife of Cape Arid
22–28 October 2006
The size and remoteness of Cape Arid National Park, 120 kilometres east of Esperance on Western Australia's south coast has meant very little fieldwork has been undertaken in the park. This expedition will explore the Mount Ragged area and focus on the study of plants and animals that exist in this pristine, isolated and spectacular region of Cape Arid National Park.

Magenta Magic — Exploring the Biodiversity of Great Southern Nature Reserves
20–30 November 2006
Lake Magenta Nature Reserve, one of the largest nature reserves in Western Australia's Wheatbelt, is an important habitat for a number of native animals and several endangered flora species. The success of the Department of Conservation and Land Management's world-class wildlife conservation program, *Western Shield,* has seen the area become home once again to chuditch, brushtail possums, Mitchell's hopping mice, heath mice, western mice, ash-grey mice and red-tailed phascogales as well as another 30 recorded species of reptiles and frogs. This expedition will focus on the trapping, identification and recording of animal species and monitoring the presence and impact of introduced predators within the reserve. Flora identification and surveying will also be carried out.

Loggerhead Turtles of Dirk Hartog Island, Shark Bay
Team A 8–15 January 2007; Team B 15–22 January 2007
This expedition will give participants a rare and memorable opportunity to view egg laying, hatchling emergence (depending on season) and help tag female loggerheads that nest on the beaches at the northern end of Dirk Hartog Island every night for six nights. Participants will be based on a research vessel at Turtle Bay, which has been shown to be the largest breeding colony of loggerhead turtles on the Western Australian coast and in the south coast Indian Ocean Basin. Some 700 female loggerheads are thought to nest there each year.

Send for your free LANDSCOPE Expeditions 2006 brochure now.

Brochures are now available for the expeditions planned for the second half of 2006. Get yours by calling (08) 6488 2433, faxing (08) 6488 1066 or emailing extension@uwa.edu.au. Or write to:

LANDSCOPE Expeditions
UWA Extension
The University of Western Australia
35 Stirling Highway, Crawley WA 6009
Or visit www.naturebase.net

Government of Western Australia
Department of Conservation and Land Management
Conserving the nature of WA
in association with
UWA Extension
The University of Western Australia


Cheryl Parker


John Alcock

contributors

Cheryl Parker has been a curator at the WA Herbarium since joining the Department of Conservation and Land Management (CALM) in 1985. Apart from the intellectual and physical care of the State's collection of flowering and non-flowering plants, her other major work interest is marine plants. She was appointed project manager for the NHT-funded On-line Marine Plant project which provides ready access, via CALM's FloraBase website, to names and other information on WA's marine flora and, where available, photos of around 20,000 specimens.

John Alcock is a professor in the School of Life Sciences at Arizona State University in Tempe, Arizona. His research interests focus on the evolution of insect mating systems. This interest has brought him to Western Australia a number of times to study bees and moths with colleagues from The University of Western Australia. His textbook on animal behaviour is now in its eighth edition and he has written a number of other books, including, most recently, *An Enthusiasm for Orchids*, which deals with the evolution of orchids and the behaviour of their pollinators, primarily those found in Western Australia.

Brent Johnson is a Principal Technical Officer with CALM's Science Division. Having worked at Woodvale Wildlife Research Centre since 1992 (after stints in Dwellingup and Karratha), he has been involved in many projects including evaluating the effects of fire on wildlife in a range of habitats and studying the impact of timber harvesting on forest animals. Brent spends most of his time working on endangered species, especially on the chuditch and heath mouse and has undertaken and monitored translocations of several threatened animals. He is now involved with research investigating relationships between introduced predators and native wildlife in the Wheatbelt.

John Huisman is a contract seaweed specialist at the WA Herbarium and a research fellow at Murdoch University. He has studied WA's marine plants for more than 20 years and has written four books plus one he's writing about the marine plants of north-western Australia. John has spent time in Hawaii, researching the marine plants of that tropical paradise. His book (coauthored with CALM's Ian Abbott) *Marine Green and Brown Algae of the Hawaiian Islands* recently won the prestigious Prescott Prize, awarded by the Phycological Society of America. John's lifelong aim is to change public perceptions of seaweeds, to show they are not just smelly flotsam on the beach, but unusual and attractive plants, deserving appreciation and admiration.


Brent Johnson


John Huisman

Also contributing ...

Glenn Shiell, Samille Mitchell, Joanna Moore, Liz Moore, Keith Morris, Val English, Carolyn Thomson-Dans, Caris Bailey, Martin Rayner, John Hunter, Verna Costello, Allan Rose, Klaus Tiedemann, Dave Rose, Paul Dickenson, Cathy Zwick, Ben Fitzpatrick and Alice Reaveley.

editor's letter

There's no doubt knowledge is dynamic.

Gathering the information on which management decisions are based is an open-ended process when you're managing natural environments. Even if research provided every detail about a particular species, there would continue to be changes to monitor, whether it was the impact of human usage, or an introduced disease, or global warming.

Of course, it's ambitious to think we will know everything about Western Australia's natural environment when the State covers 2.5 million square kilometres and has a coastline of more than 13,500 kilometres. We know there are unknown species of plants and animals—our best information about the number of invertebrate species, for example, is that there are hundreds of thousands of them.

While there's still plenty to do, the body of information amassed already is impressive. Once again, this issue of *LANDSCOPE* offers insights into some of what's been done to increase our understanding, with stories on topics as diverse as invasive seaweeds, the biodiversity of the Shark Bay region, native burrowing bees, and the marine life of Ningaloo Marine Park. When we talk about the configuration of the underground nests of Dawson's burrowing bee, for example, the painstaking work that went into collecting this information is not obvious.

'Putting dieback on the map' describes some of the effort that has gone into mapping this disease, including the hundreds of pairs of boots worn out while walking assessment lines over hundreds of thousands of hectares. The story also describes the achievements of one of the longest serving dieback interpreters, Abe van der Sande, who died suddenly last summer on his way back from another day's work in the bush. While many staff working for CALM and its predecessors have spent decades contributing to the accumulation of knowledge, I particularly want to acknowledge one of Abe's colleagues here.

John Webb worked in the southern forest and State-managed plantations for more than 36 years, most of that time as a forest assessor. He collected hundreds of thousands of measurements through some of the thickest vegetation in the State, to help regulate the yields of timber removed from the forest; design conservation reserves; map the extent of old-growth forest; and monitor the results of silvicultural trials. He also became one of CALM's aerial photography specialists, interpreting first black and white—and then colour—images to map selected features.

John also died suddenly last summer. He was on his way out to another day's work in the bush.

Caris Bailey

Caris Bailey
Executive Editor

Cover illustration by Philippa Nikulinski
A male Dawson's burrowing bee waits to pounce on a female bee as she emerges from her burrow in Kennedy Range National Park, which lies some 60 kilometres north of Gascoyne Junction. The nests of the bees are constructed in claypans which may be dotted with hundreds or thousands of little mounds, surrounding the burrows of the bees. When an adult female pops out of the ground from one of these burrows, after metamorphosing from the pupal stage, she almost always finds a male (or males) waiting right there.

Back cover photo Jiri Lochman
The eastern cliffs of Kennedy Range National Park.

Features

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Regulars

Publishing credits
Executive editor Caris Bailey.
Editors Carolyn Thomson-Dans, Rhianna King.
Scientific/technical advice Tony Start, Paul Jones, Chris Simpson, Keith Morris.
Design and production Tiffany Taylor, Maria Duthie, Natalie Jolakoski, Gooitzen van der Meer.
Illustration Gooitzen van der Meer.
Cartography Promaco Geodraft.
Marketing Estelle de San Miguel
Phone (08) 9334 0296 *Fax* (08) 9334 0432.
Subscription enquiries
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Visit NatureBase at www.naturebase.net

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A new state-of-the-art interpretive centre will help visitors to Shark Bay understand the immense historical and natural importance of the region.

by Carolyn Thomson-Dans

Showcasing

The new and imposing Shark Bay Interpretive Centre, built on the Denham foreshore at a cost of more than $8 million, is set to become one of Western Australia's cultural icons.

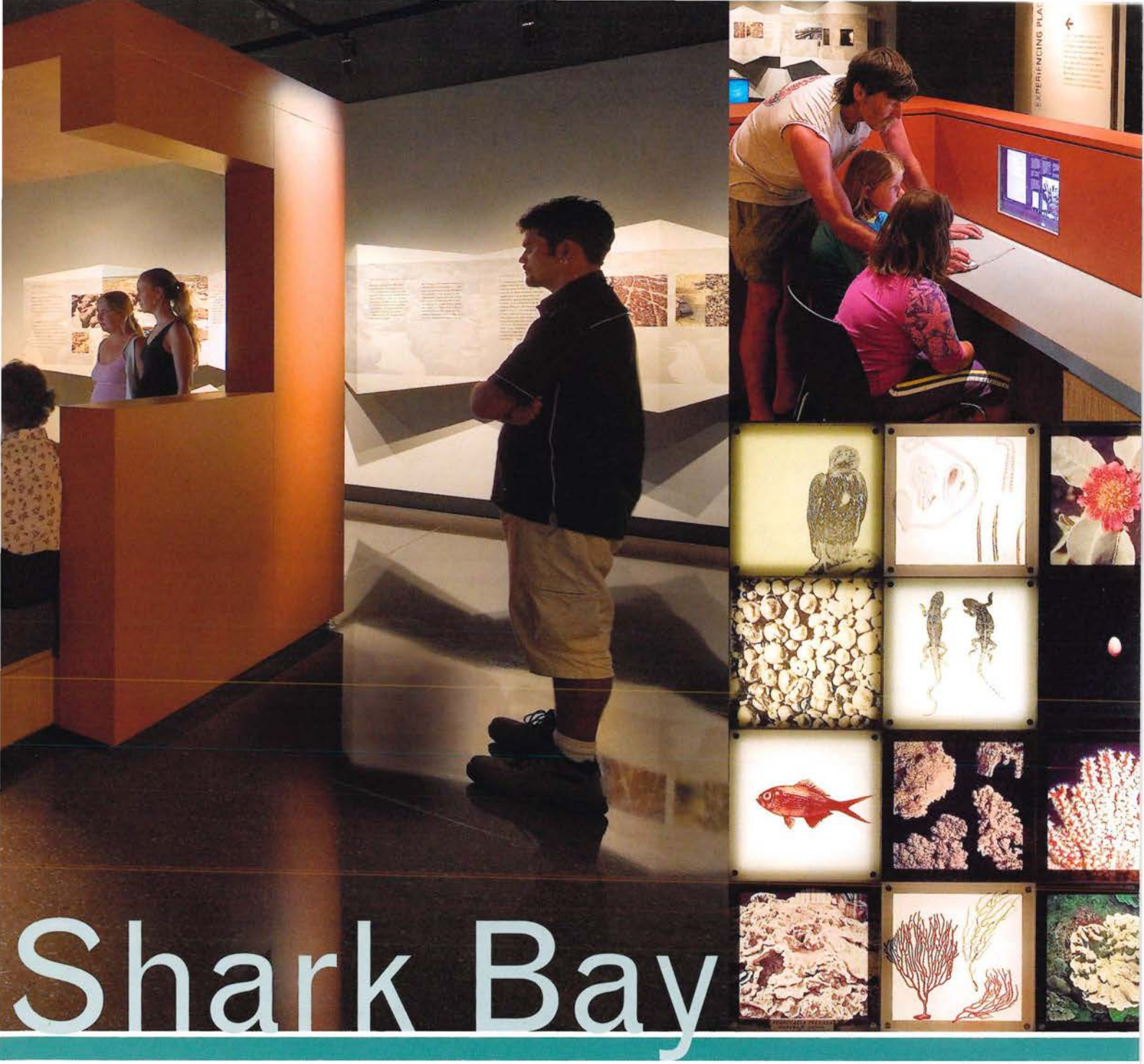
Shark Bay has long been known for its friendly dolphins and natural beauty. The area's World Heritage listing recognises its internationally significant natural values, but these values are not necessarily easily understood by the 150,000 visitors who descend on the area every year. As a result, the designers of the centre tried to relate World Heritage values in a meaningful way to human use of the unique and scientifically important region.

"It is a great place to totally immerse yourself in the history and natural heritage of the Shark Bay region," Kelvin Matthews of the Shire of Shark Bay said. "Every time I come in here I notice something different."

Upon entering the new centre, visitors will see an amazing map of the World Heritage Area on the floor, created by an etching in the concrete. Features of the topography give the impression of relief, and seasonal currents and their direction are marked in the ocean.

Astounding images and videos from some of Australia's best landscape and wildlife photographers illustrate the region's many and various World Heritage values. As you move through the centre, there are interactive computers on which you may search for information on Shark Bay, including some of the early maps of the region.

Features in the main room are



Shark Bay

organised in the same alignment as their geographical position in Shark Bay. Important historical relics from the early Dutch, English and French explorers are on display. For instance, you can see the figurehead of the *Gudrun*, wrecked in Shark Bay in 1901, and replicas of artefacts such as the pewter plate of Dirk Hartog, which marked the first recorded European landing in Australia.

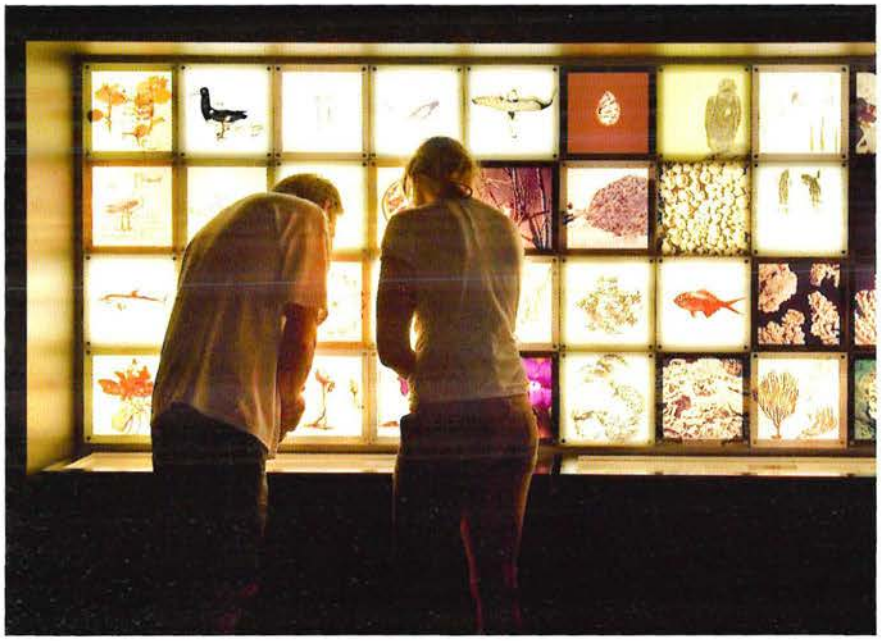
Two booths run continuous video footage of local characters and people who work in Shark Bay. This means that visitors can sit quietly and listen to interesting identities such as Darren Capewell, who runs Indigenous heritage tours at Monkey Mia, Hugh Edwards and Phillip Playford, who both had a hand in discovering the cultural and natural heritage of the area. There is also footage of renowned scientists, such as seagrass expert Di Walker, who expound the unique features of the region's natural plants and animals.

The Shark Bay Interpretive Centre was built with a $5 million State government grant from the Department of Local Government and Regional Development, $590,000 from the Commonwealth government's Midwest Gascoyne Area Consultative Committee, a contribution of around

Main This expansive view of part of the Shark Bay Interpretive Centre shows some of the display material and one of the audiovisual viewing areas.

Inset top Interactive computer screens enable visitors to search for information.

Inset above Wildflowers and native animals, both terrestrial and marine, are showcased at the centre.
Photos – John Gollings



Above A huge and detailed map that shows topography and oceanic currents is etched on the concrete floor near the entry point.

Left Some of the early collections and illustrations by naturalists make a striking display when backlit.

Below left The Shark Bay Interpretive Centre will enrich the experiences of visitors to Shark Bay.
Photos – John Gollings

$500,000 from the Shire of Shark Bay, $100,000 from the Department of Transport and Regional Services and about $27,000 from the Gascoyne Development Commission. A Commonwealth grant of $1 million from the Department of Environment and Heritage funded the development of interpretive material and the internal fit-out of interpretive displays. The Shire of Shark Bay will run the centre.

The final result is a tribute to the persistence of Shire of Shark Bay Council President Les Moss, who canvassed both the State and Commonwealth governments to secure such a substantial amount of funding for the centre.

Sydney-based company Freeman Ryan Design—also responsible for the Canberra Museum, the Canberra War Museum and Powerhouse Museum in Sydney—were responsible for the interpretive design and content of the centre, while architect John Nichols of Woodhead International designed the building.

The building also incorporates a temporary exhibition space funded by a $475,000 grant from Lotterywest.

The Shark Bay Interpretive Centre is an ideal place to visit when you first arrive in Shark Bay and perhaps to revisit again before you leave, once you have spent time in the area and gained a deeper appreciation of it. It will enrich your experience of this amazing place.

Carolyn Thomson-Dans is a long time editor and writer for *LANDSCOPE* and CALM's other saleable publications. She can be contacted on (08) 9389 8644 or via email (carolynt@calm.wa.gov.au).

bookmarks by Verna Costello

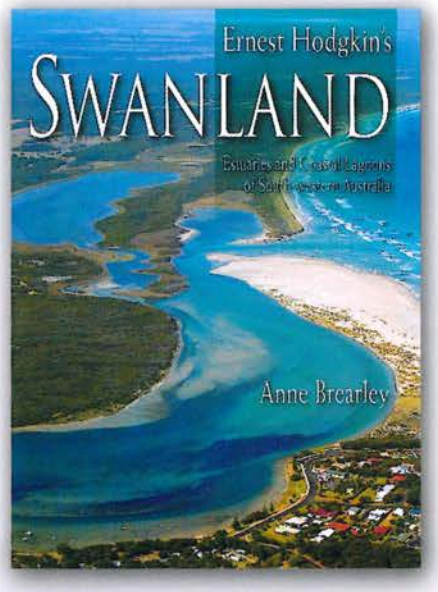
Ernest Hodgkin's Swanland

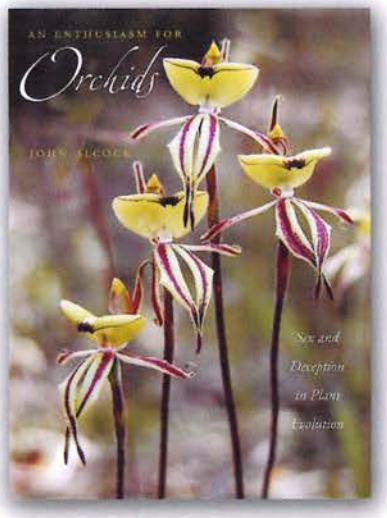
Author: Anne Brearley
Publisher: UWA Press
550 pages, hard cover, full colour
ISBN: 1 920694 38 2
RRP: $75.00

The author's recent and widely sourced research has been grafted onto Ernest Hodgkin's extensive body of work, and provides an up-to-date and extensive guide for the conservationist, scientist, student, observer and visitor to the estuaries and coastal lagoons of south-western Australia.

Focusing on the individual estuaries, it gives a history of their formation, geography, geology, water flows, plants and animals, and how these have changed since European settlement, with its increasing pressures of nutrient enrichment, urban development, fisheries, and the opening of sandbars.

This book is available from most good bookshops or direct from UWA Press.





An Enthusiasm for Orchids

Author: John Alcock
Publisher: Oxford University Press
302 pages, hard cover, full colour
ISBN: 019518274X (Indent from USA/UK)
RRP: $62.95 (plus postage)

A subtitle to this book promises to show how 'sex and deception in plant evolution' is cunningly employed by orchids to attract insects that unwittingly pollinate them. It is all in the name of orchid procreation, while resulting in a complete waste of time for, say, a visiting male thynnine wasp, duped into behaving as if he is mating with a female of his kind.

The orchids selected for discussion in John's book are almost entirely species found in Western Australia.

This book is available from Oxford University Press via email (cs.au@oup.com).

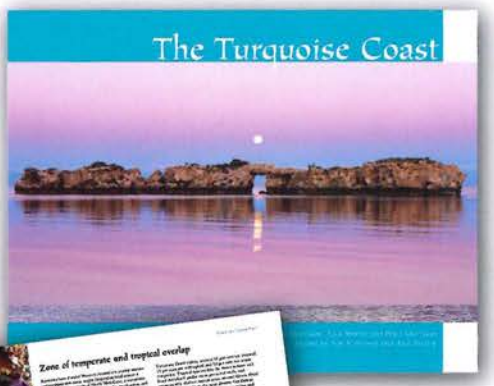
The Turquoise Coast

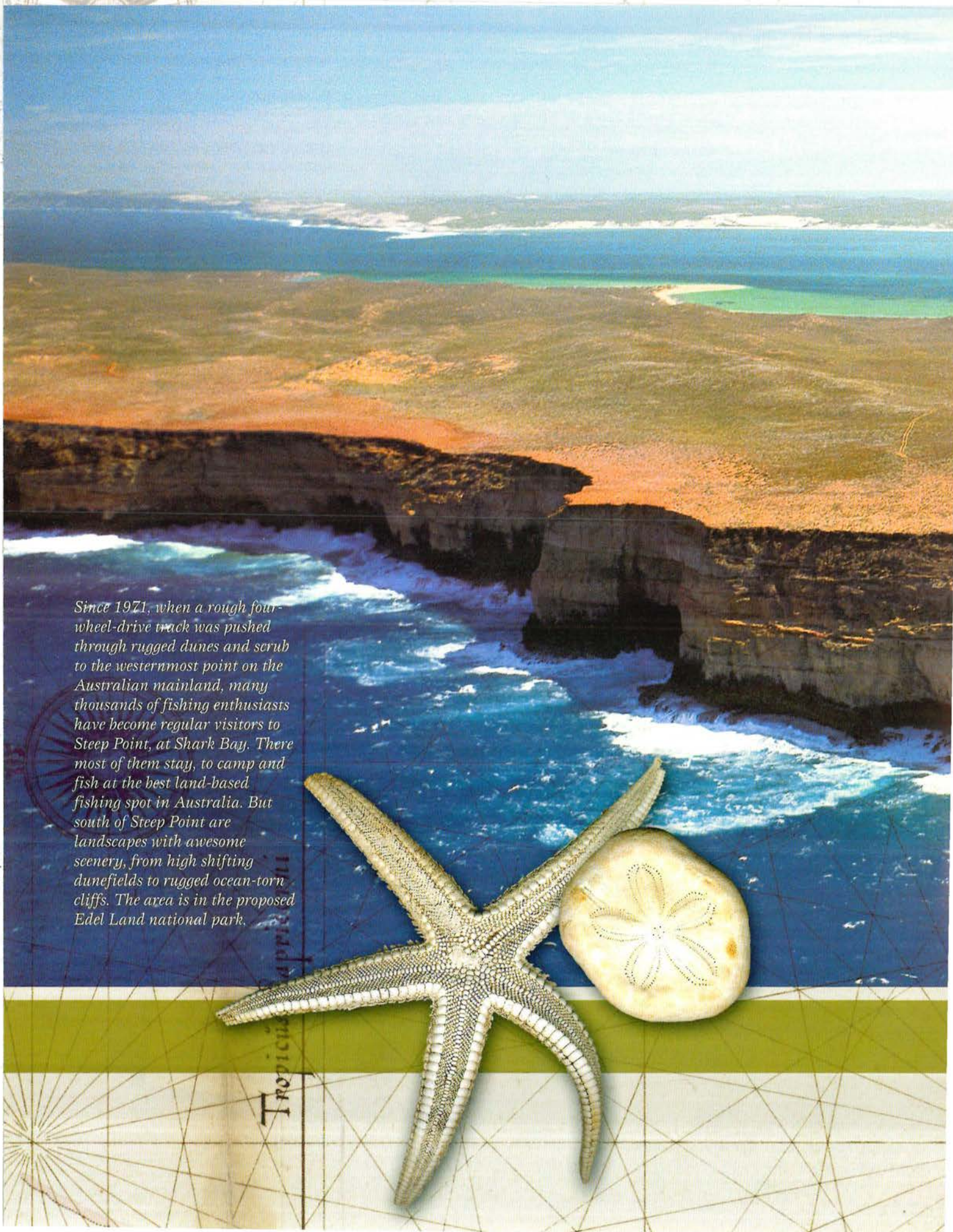
Authors: Sue Morrison, Ann Storrie and Peter Morrison
Publisher: WA Naturally Publications, CALM
128 pages, soft cover, full colour
ISBN: 0 7307 5561 4
RRP: $29.95

One of the most biologically diverse areas in Western Australia is The Turquoise Coast, which stretches from Lancelin to Leeman. It includes Jurien Bay Marine Park, dozens of islands and the astonishing wildlife living on them, the remarkable Pinnacles in Nambung National Park, a wealth of wildflowers and caves, and the towns and other landforms of the region.

The detailed information in this book is well supported by many colourful, beautifully composed photographs by Ann Storrie and Sue Morrison. This truly is a book that will both inform and endlessly delight its readers.

This book is available from bookshops or CALM offices or you can contact WA Naturally Publications on (08) 9334 0333, fax (08) 9334 0498 or order online at CALM's NatureBase website (www.naturebase.net).

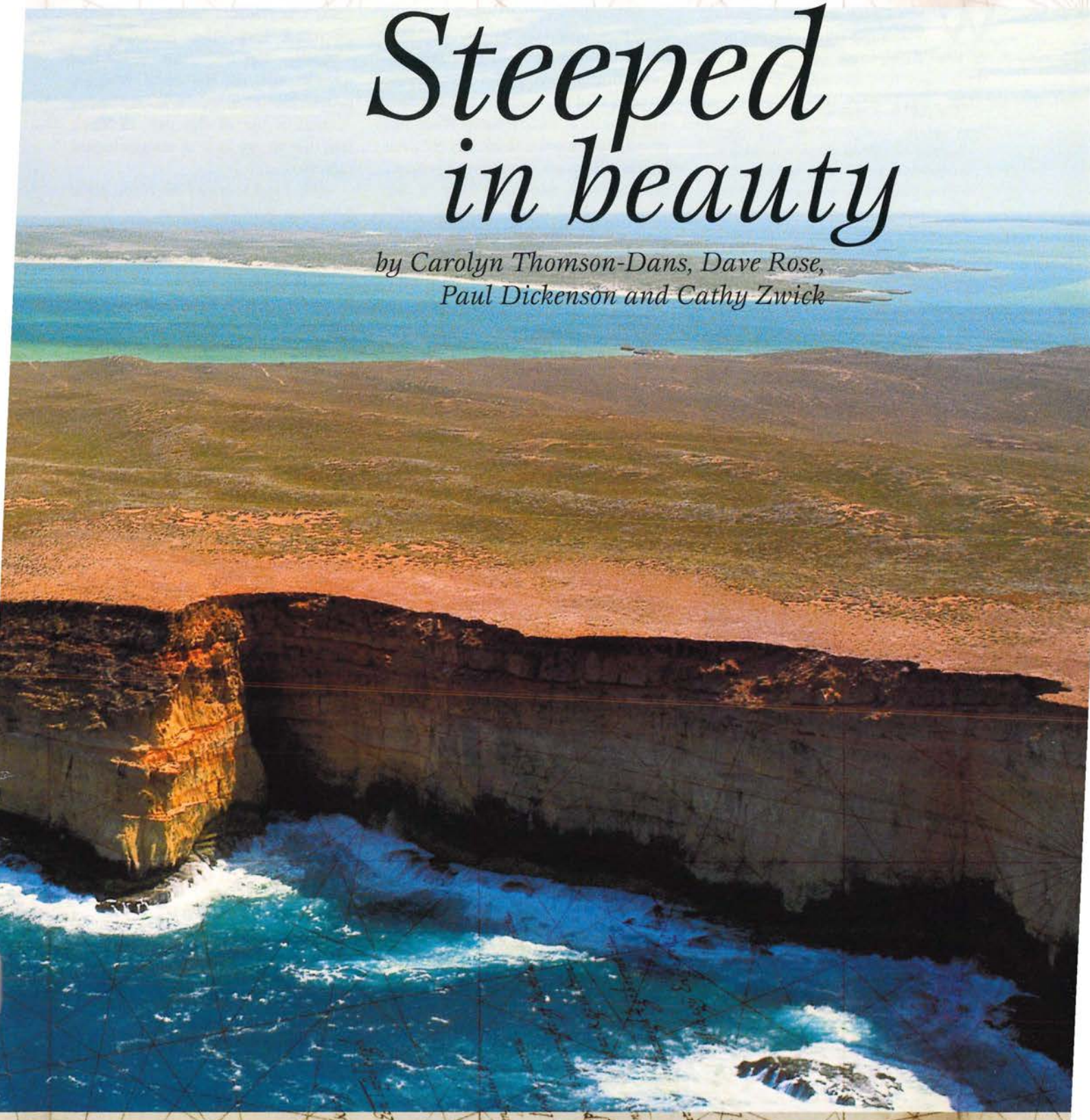




Since 1971, when a rough four-wheel-drive track was pushed through rugged dunes and scrub to the westernmost point on the Australian mainland, many thousands of fishing enthusiasts have become regular visitors to Steep Point, at Shark Bay. There most of them stay, to camp and fish at the best land-based fishing spot in Australia. But south of Steep Point are landscapes with awesome scenery, from high shifting dunefields to rugged ocean-torn cliffs. The area is in the proposed Edel Land national park.

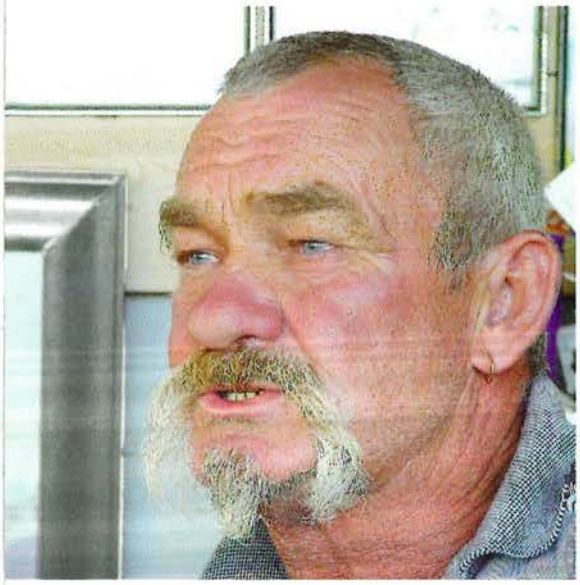
Steeped in beauty

by Carolyn Thomson-Dans, Dave Rose, Paul Dickenson and Cathy Zwick



When Dutch mariner Willem de Vlamingh sailed past the coast of Edel Land, south of Shark Bay, on 29 January 1697 he commented that:

> "The land here appears very bleak, and so abrupt as if the coast had been chopped off with an axe, which makes it impossible to land. The waves break here with so great a fury that one should say that everything around must shake and become dismembered, which appears to us a truly terrible sight. Nevertheless, we found it rather difficult to drag ourselves away from this evil place."



When de Vlamingh's quote is read to him, Paul Dickenson laughs. "Yes, they found it **difficult** to **drag** themselves away from this evil place." For the last 10 years Paul has managed the camping and recreation areas at Steep Point and its surroundings for Shark Bay Salt, the leaseholders of Carrarang Station, the northern part of which is the proposed Edel Land national park. Paul can attest to the area's popularity, which, despite its remoteness, draws about 5500 visitors a year. Camping at Steep Point is carefully managed through a booking system (www.steeppoint.com.au) to ensure that the fragile nature of the coast can sustain visitation at peak times. With the recent sale of both the salt operation and station, management of the northern part of Carrarang Station will soon be transferred to the Department of Conservation and Land Management (CALM), to allow the establishment of the proposed Edel Land national park.

Early history

When Europeans arrived in the Shark Bay area, the largest Aboriginal camp they noted was in the proposed park at False Entrance, where fresh water was available. Another site in the proposed park—the Blowholes at Thunder Bay—was an important spiritual site for the local Malgana people. However, little is known about Aboriginal use of this part of Shark Bay, due to the lack of archaeological surveys.

Edel Land is one of the oldest place names in Australia still in use today. Dutch explorer Frederick de Houtman sailed north along the WA coast in 1618 and named 'd'Edels' Land' after Jacob d'Edel, a Member of the Council of the Indies and Supercargo (officer in charge of the cargo) on the *Amsterdam* that was accompanying Houtman's vessel, *Dordrecht*. The name, marked on a sea chart from 1619 by Joannes Van Keulen, originally referred to the mainland adjacent to the Houtman Abrolhos Islands. Today, however, the name is generally used to refer to the mainland between Geraldton and Shark Bay. However, the proposed Edel Land national park will only cover the northern part of the Edel Land peninsula at Shark Bay.

In 1699, English explorer William Dampier sailed into Shark Bay and named the region 'Sharks Bay' due to the large numbers of sharks he saw. The Frenchmen de Freycinet, Hamelin and Baudin passed through the area over the period from 1801 to 1818, naming many geographical features, including Bellefin Prong (named by Louis de Freycinet in 1801 after the surgeon

Previous page
Main Zuytdorp Cliffs near Steep Point. *Photo – Bill Bachman*
Insets top and base Detail of Volkersen's map of the 'Lant van Eendracht' (Shark Bay) 1658 made by Dutch sea captain Samuel Volkersen. *Image courtesy Algemeen Rijksarchief, The Hague.*
Bottom left Remains of a starfish and sand dollar.

Above left Paul Dickenson has managed camping and recreation areas at Steep Point for the last 10 years.

Left Large blowhole at Thunder Bay. *Photos – Carolyn Thomson-Dans/CALM*

Below right The site of an old pearling camp on the west coast of Heirisson Prong.
Photo – Jiri Lochman

aboard the *Naturaliste*) and Heirisson Prong (after de Freycinet's sub-lieutenant). The aridity of the landscape and the lack of obvious water sources did little to create any real French enthusiasm for the region.

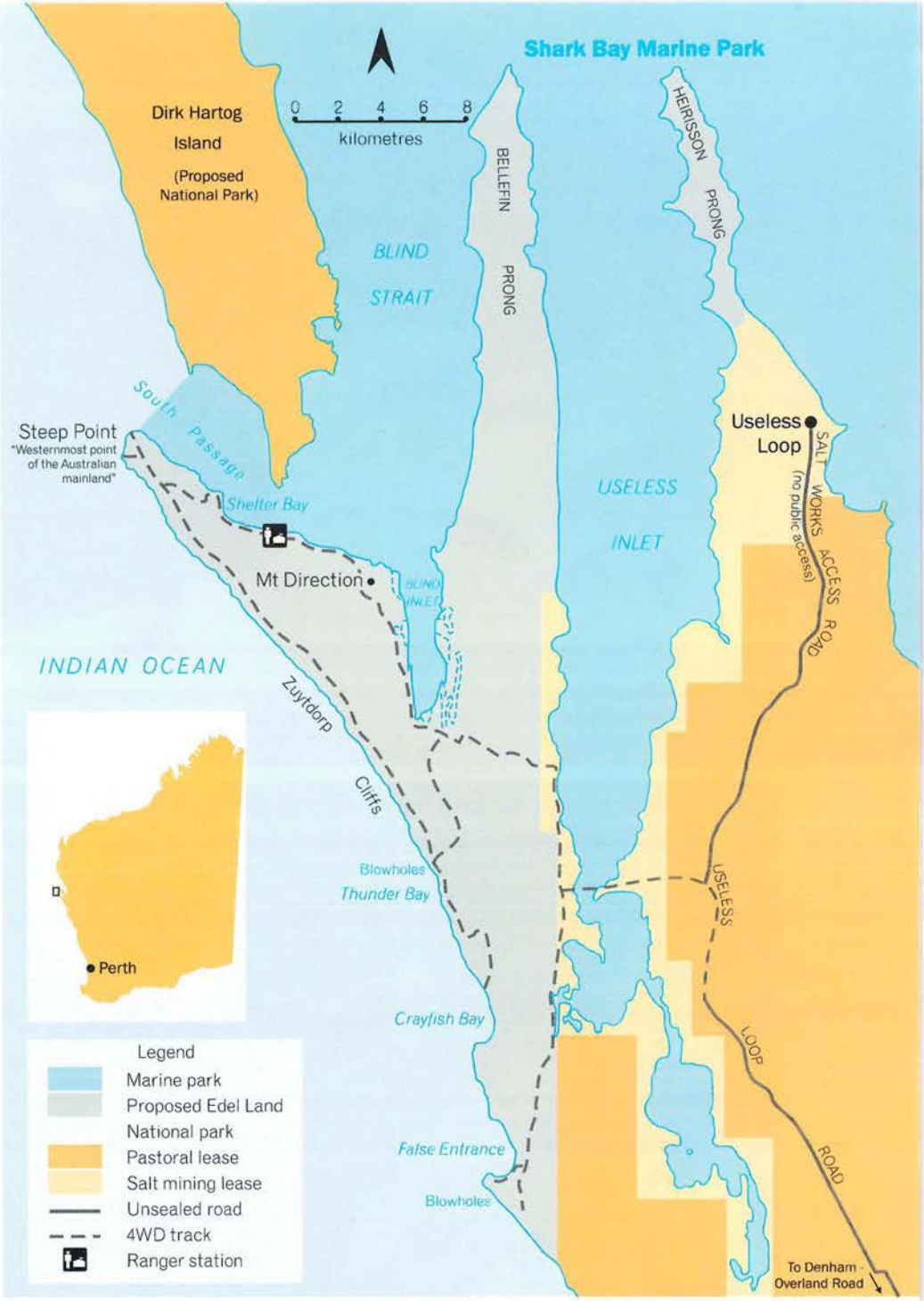
The next seafarer of note to arrive was Captain Henry Mangles Denham, aboard the HMS *Herald*, in 1858. While sailing along the coast of Edel Land, he named Epineux Bay (today known as Crayfish Bay). Around this time, American, English and French whalers plied the coastal waters. In the 1870s, Charles Broadhurst imported dozens of Asian men to collect the lucrative pearlshells at Shark Bay, together with enforced Aboriginal labour. Wilya Mia (which means 'shell camp'), on Heirisson Prong, was once part of the busiest pearling areas in Shark Bay, with hundreds of people working there.

"A wonder to see"

Today, Edel Land still offers a remote, nature-based experience that is all the more rewarding because the area is difficult to get to.

Shelter Bay, which fringes the Shark Bay Marine Park, is an idyllic spot that provides respite from the relentless strong summer winds. Across South Passage, there are views to Dirk Hartog Island, another proposed national park that is also steeped in history, being the first place in Western Australia that Europeans were known to come ashore. Parts of Shelter Bay are closed to driving every year between November and May, when loggerhead turtles nest and hatch on the beach around the full moon, and visitors are given guidelines to minimise their impact on turtles. Shorebirds that use the beach include Pacific gulls and oystercatchers. Hermit crabs are numerous along the water's edge.

Steep Point (translated into English from Steyl Hoeck, the name given to it by de Vlamingh) has become a



Above Looking north along the Zuytdorp Cliffs.
Photo – Cathy Zwick/CALM

Left A migrating humpback whale alongside Steep Point.
Photo – Stax Stevens

Below left Fishing at Steep Point.
Photo – Layton Cooper

drawcard for those who want to stand at the westernmost point of mainland Australia, a great place to watch the sun set through a window in the rock and contemplate the crashing surf that will sometimes wash over the high cliffs. A rock cairn was built here by the Leyland brothers in 1966 after an arduous overland trek through the then-roadless area to reach it.

People fish from the cliff top for Spanish mackerel, tuna, tailor, sea kingfish, sailfish, big sharks and other species. The most popular form of fishing here is ballooning, where big baits are carried several hundred metres offshore by gas-filled balloons. At least 320 species of fish, including occasional whale sharks and huge tiger sharks, have been recorded in South Passage. Other large marine animals include humpback whales, killer whales and dugong. There has even been an elephant seal—normally only seen in the sub-Antarctic—born on a beach

near Steep Point in 1996, one of only two such births ever recorded in Western Australia.

Steep Point is at the northern end of the Zuytdorp Cliffs, which provide breathtaking views from high vantage points, while surf crashes far below with such force that spray constantly showers over the cliff tops, a scene described in the log of de Vlamingh's vessel, the *Geelvink*, as:

> "High steep land and very precipitous... altogether high and bare, without any green thing on it and very steep at the top... without any beach at its foot, with heavy surf that is a wonder to see."

Euros can be seen in and around rocks along the top of the sea cliffs—a seemingly incongruous sight silhouetted against the ocean on these high vantage points—while green turtles, sharks and other kinds of marine animals may sometimes be spotted in the water below.

Differing features along the length of the cliffs are accessed via a rough sandy track that is constantly being gouged out by the wind. At Thunder Bay—so named because immense waves thunder into this rocky bay in rough weather—surf is forced through fissures in the cliffs to produce the eerie sound of the Blowholes, sometimes shooting spray up to 10 metres in the air. On a clear day, Dicko's Lookout provides sweeping views over Shark Bay's birrida system if you look inland. Crayfish Bay testifies to the bountiful marine life that lives offshore, with colourful shells of all shapes and sizes crowding the sandy beach and excellent fishing.

Seafarers and smugglers

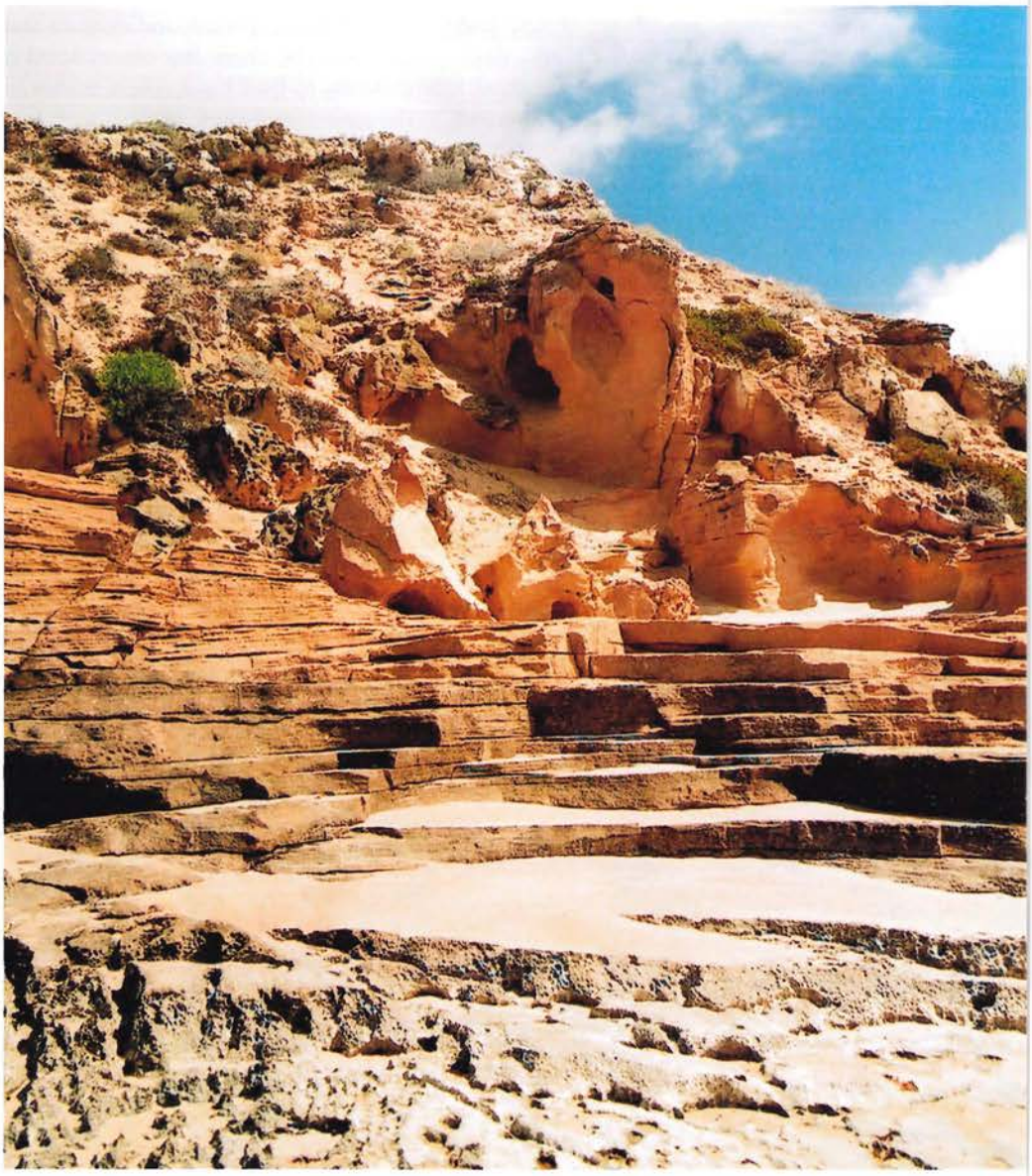
The next bay to the south is known as False Entrance because mariners have sometimes confused it with South Passage (the 'true' entrance to Shark Bay). To reach False Entrance from Crayfish Bay you must traverse large undulating white dunefields that are constantly being moved and reshaped by the winds, smothering vegetation in their path. These extensive bare, moving sand dunes are starkly beautiful, especially on a windy day when the wind constantly whips the sand over the leading edges of the dunes.

In April 1963 the prawn trawler *Nor 6* sank near False Entrance on her maiden voyage. The skipper, Jack Drinan, managed to survive by clinging to the vessel's ice box but strong easterly winds took him out to sea for 16 days, before he was eventually blown back towards shore and rescued. The bodies of the three other crew members were never found.

In 2002, smugglers attempted to use the remote coastline near False Entrance as a landing point for a cocaine shipment worth about $250 million. They made it all the way from South America in a 50-foot fishing boat, then ferried the drugs to the beach in the dead of night before scuttling the boat. However, it seems that the remoteness of False Entrance gave them a false sense of security—the Tactical Response Group, Customs and Fisheries officers arrested them once they had brought all the drugs ashore.

Wildflowers and wildlife

Although the wind-pruned and salt-pruned plants may not appear to be very interesting at first glance, Edel Land has some rather special flora.



Right Natural Steps at False Entrance beach.
Photo – Cathy Zwick/CALM

Left The rotund sandhill frog lives in the dunes of the proposed national park.
Photo – Jiri Lochman

Below left Large mobile dunes are a feature of the Edel Land landscape.
Photo – Cathy Zwick/CALM

Below Four-wheel-drive tracks soon become deeply eroded in this fragile and wind-buffeted area.
Photo – Tracy Churchill/CALM

The heaths on Edel Land are a blend of arid and south-western species. There are unusual speargrass (*Stipa*) communities (the only place where such a vegetation community grows), low shrublands of succulents, such as pigface and samphires, and heaths on the Zuytdorp Cliffs. Grey cottonhead, coastal fanflower, coastal spinifex, acacias and blue-flowered hibiscus are common here. A variety of spider orchids appear 3–11 days after the first winter rains. Though the vegetation appears fairly uniform for most of the year, it is a different story in the wildflower season, when it bursts forth in a colourful display. The small circular saltpans, known as birridas, have their own unique spring-flowering annuals, especially samphires, while the saline creeks and estuaries are lined with white mangroves.

Reptiles live here in large numbers, including at least 12 species of snakes, such as the southern blind snake which reaches the northern limit of its range in Edel Land, spotted sand dragons and goannas. The Shark Bay worm lizard is endemic to Edel Land, where it lives in the pale coastal sands studded with low heath, sheltering beneath leaf litter, limestone slabs, in moist sand under logs and in rotten stumps. Edel Land is the only place where the unusual sandhill frog is common. This rotund but diminutive creature is one of very few frogs that goes through its entire life without ever inhabiting water. Its eggs are laid in the sand and the tadpole stage occurs within the egg.

Emus are relatively uncommon in the area but are sometimes seen. Birds of prey such as ospreys and wedge-tailed eagles are often seen. Ferals include goats, rabbits, cats and low numbers of foxes.

Management

When CALM assumes management of the proposed park, the area's tenure will change from pastoral lease to unallocated Crown land, but regular visitors will see little change in access. People will still be welcome to fish and camp at Steep Point, with camping fees and conditions similar to those at present. Visitor infrastructure and signage along the less-visited Zuytdorp Cliffs should improve, and the area's new status as a park will undoubtedly

draw more people interested in nature-based tourism to the area.

Visitor risk will be a major issue. The high cliffs, potentially slippery rocks and treacherous ocean have claimed relatively few lives, given their dangerous nature, but it will be important for CALM to erect signage warning of the dangers.

Access on Edel Land is a significant management problem. The large sand dunes and extensive sand drifts are highly unstable and prone to erosion. In the past, tracks have become impassable within a relatively short time, with a sequence of new ones being established. In recent years, many of the resulting spider webs of tracks have been closed to allow regeneration. The process of stabilising and rationalising tracks and regenerating old tracks will be a priority for park managers.

Ideally, the new park will remain a wilderness-style destination, offering a sense of adventure and solitude to people who wish to enjoy a relatively untouched part of Australia, steeped in a special beauty all of its own.

Above Hardy survivor, Thunder Bay.
Photo – Michael Pelusey

Above right Steep Point.
Photo – Eva Boogaard/Lochman Transparencies

Carolyn Thomson-Dans is a long-time writer and editor for *LANDSCOPE*. She can be contacted on (08) 9389 8644 or by email (carolynt@calm.wa.gov.au).

Dave Rose is Shark Bay District Manager for CALM, based in Denham. He can be contacted on (08) 9948 1208 or by email (daver@calm.wa.gov.au).

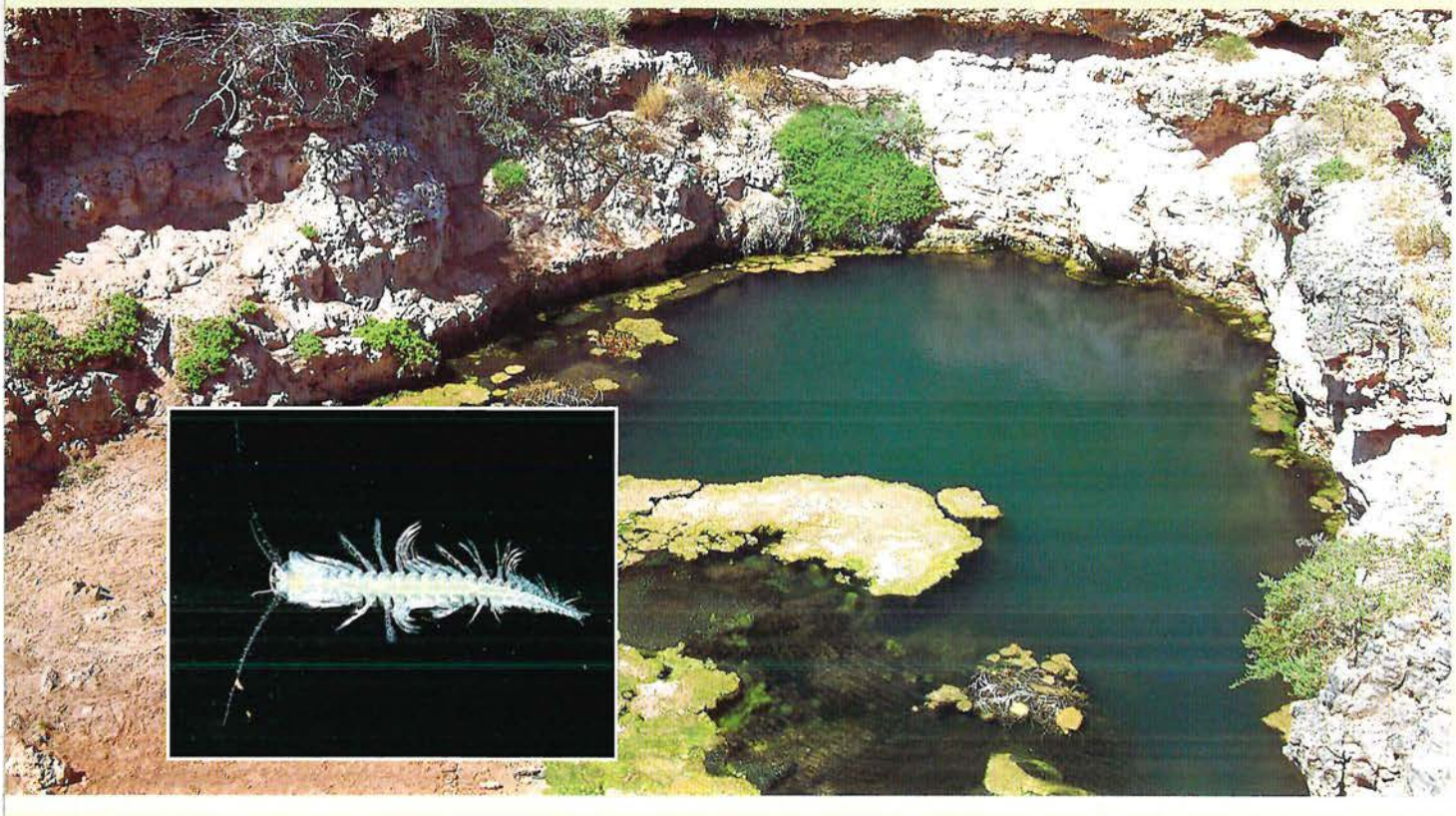
Paul Dickenson, the ranger at Steep Point, can be contacted on (08) 9948 3993 or by email (ranger@steeppoint.com.au).

Cathy Zwick is Acting Senior Ranger based at CALM's Shark Bay district office in Denham. She can be contacted on (08) 9948 1208 or by email (cathyz@calm.wa.gov.au).

The authors thank Graham Hoare of CALM for research on the history of geographical names and Paul McClusky and Jock Clough for their input. More information about camping at Steep Point can be found at www.steeppoint.com.au.

endangered

by Val English



Cape Range remipede community

Some extremely significant groups of miniature animals occur in 'threatened ecological communities' in caves and groundwater on the Cape Range peninsula. Some of these animals are protected as threatened species under State and Commonwealth laws.

The community that occurs in 'Bundera Sinkhole' (a water-filled cave) was originally described by scientists from the WA Museum. They discovered that this sinkhole contains the only known example in the southern hemisphere of an ancient and scientifically interesting community mainly made up of small animals without backbones (invertebrates) that completely rely on the sinkhole habitat for survival. Most of the species that make up this critically endangered community are known from nowhere else in the world.

The community is a unique assemblage of groundwater-dwelling ('stygobitic') animals and is composed primarily of crustaceans, but also includes blind fish and probably an elusive blind eel. These animals are mainly relicts from the times of the ancient Tethyan Sea, which separated southern continents between 65 and 225 million years ago (the Mesozoic era). The community is known as the 'Cape Range remipede community'. The community name is derived from the fact that the assemblage includes the only representative of the crustacean class 'Remipedia' in the southern hemisphere.

Bundera Sinkhole contains very sharply defined layers of water that differ vastly in oxygen levels, salinity, levels of various nitrogen and sulphur compounds, and temperature. This layering is thought to be vital to the survival of the animals that live in the sinkhole and is the only Australian example of this layering of water in a cave system.

Major threats to the community include dumping of waste, disturbance of the layering of the water (by diving, for example), introduction of feral fish, nutrient enrichment (from droppings from high numbers of feral goats), and other impacts to the water quality or level.

Actions recommended in the recovery plan for the community include protecting the site from dumping of rubbish and/or the introduction of feral fish, prohibiting unauthorised diving and reducing numbers of feral goats in the area. The North West Cape Karst Management Advisory Committee is overseeing the implementation of the plan. The group includes stakeholders from the WA Museum, Department of Conservation and Land Management, Shire of Exmouth, Department of Environment, Defence Estates Organisation and the WA Speleological Group (Exmouth). The recovery actions are designed to help ensure the survival of this miniature ecosystem for another few million years.

Photos by Peter Kendrick/CALM (main) and by Douglas Elford/WA Museum (inset)

Putting dieback on the map

by **Caris Bailey** and **Martin Rayner**

Dieback disease is one of the worst environmental threats facing Western Australia.

The first essential step in managing this threat has been to detect and map infected areas. That's been no small task, since the disease has been recorded over an area that stretches for millions of hectares, from Eneabba to east of Esperance.

Previous page
Main and inset Different views of a jarrah 'graveyard' showing the stark impact of dieback.

Left A recently-killed jarrah tree stands out from its healthy neighbour.
Photos – Jiri Lochman/CALM

The root rot disease commonly known as dieback is caused by several species of *Phytophthora*, water moulds named using two Greek words meaning 'plant destroyer'. The effects of the disease were recorded in Western Australia from the 1920s, and dieback was unwittingly spread across the south-west for decades before it was identified here in 1964. While it is now known to affect hundreds of native and exotic species growing in WA, its impact in the jarrah forest was most alarming at that time, and there were fears that the forest could be wiped out.

Initially, the priority for those managing the forest was to identify bare patches in the jarrah forest where stands of trees had been killed by dieback, so that the areas could be scheduled for timber harvesting before the trees degraded—a process that was then thought to be inevitable. As research revealed more about the disease, management focused on preventing the spread of dieback and protecting threatened species at greatest risk. This required mapping the distribution of the disease across the landscape.

Mapping challenge

Disease distribution was mapped from the mid-1960s using existing black and white aerial photographs that covered more than 2.5 million hectares of land. However, there were problems with accuracy, largely because of the small scale of the images (up to 1:50,000) and their variable quality due to age and the time that had elapsed (and hence vegetation change) since the photographs were taken.

In 1971, trials with colour aerial photographs taken under shadowless conditions began in the hope of finding a more accurate mapping technique, but the program was hindered by the lack of a reliable navigation system for aircraft until new equipment was introduced in 1977.

The challenge was to be able to navigate the planes along set flight paths so that the sea of trees below could be photographed systematically, and so that the location of the thousands of images collected could then be identified. At the time, field staff still relied on reference trees to find their way through a landscape with few roads. Adopted after the First World War, reference trees were specially marked trees on a surveyed grid one mile by one mile throughout the forest—the white-painted shields cut into selected trunks can still be seen if you look out for them.

The new navigation equipment meant forest officers had to work their way through the bush to set up transponders on vantage points to guide the planes. Though the technology has changed dramatically since the 1970s, working in difficult terrain, in the heat and in the rain, with March flies and ticks, remains part of the job of mapping dieback.

Interpreting dieback

Two generations of staff working for the then Forests Department and now for the Department of Conservation and Land Management (CALM) have worked in the field to detect and map dieback. These staff are called dieback

Towering achievement

There have been about 100 dieback interpreters since 1979, but Abe van der Sande's story illustrates their commitment particularly well.

Abe first worked for the Forests Department as a tower man in 1968 in the fire lookout tower at Mount Solus, east of Perth. He continued as a tower man over subsequent summers and in various roles outside the fire season, including starting the seed collection program that contributed to the rehabilitation of the areas around Jarrahdale mined for bauxite.

In 1980, he was selected as a dieback interpreter, a role in which he excelled. Recognising the enormous job to be done, Abe worked tirelessly, including many weekends. His wife Carol became a registered CALM volunteer, and often accompanied him. Abe's comprehensive knowledge of the vegetation patterns in the forests led to his discovery of a new species of dryandra in 1998, later named *Dryandra insulanemorecincta*. Further survey work identified five more populations in the area.

His work improved management practices for forests, coastal plains and wetlands, and he ultimately became responsible for CALM's interpretation program across more than three quarters of a million hectares of land in the northern region, including the training of new interpreters.

Last December, Abe and Carol were returning from another day's work in the bush when Abe died suddenly.

interpreters because they need to interpret a range of symptoms. As well, other diseases, insect attack, fire, waterlogging, drought, competition, salinity, frost, mechanical damage and herbicides can all produce similar symptoms to dieback.

Interpreters look for commonly found plant species within the particular vegetation type that are susceptible to dieback—known as indicator species—and assess the influence of their position in the landscape, local soils and drainage, all of which are factors in the spread of the disease. The absence of indicator species and dominance of dieback-resistant species can indicate long-term changes caused by dieback.

Dieback interpreters also take samples from recently-killed plants and the surrounding soil to analyse them for the presence of dieback. It is estimated that more than 22,000 samples have been tested in the Kensington laboratory of CALM's Vegetation Health Service since it was set up in 1979.

In the same year, an interpretation system using new aerial photographs—1:4500 colour images on 70-millimetre transparencies—was introduced by the Forests Department, a huge advance on the old, small-scale black and white images. With the creation of CALM in 1985, dieback mapping began to extend from the forest to national parks and nature reserves in the affected region. In 1986, the system was further improved with the introduction of 230-millimetre transparencies.

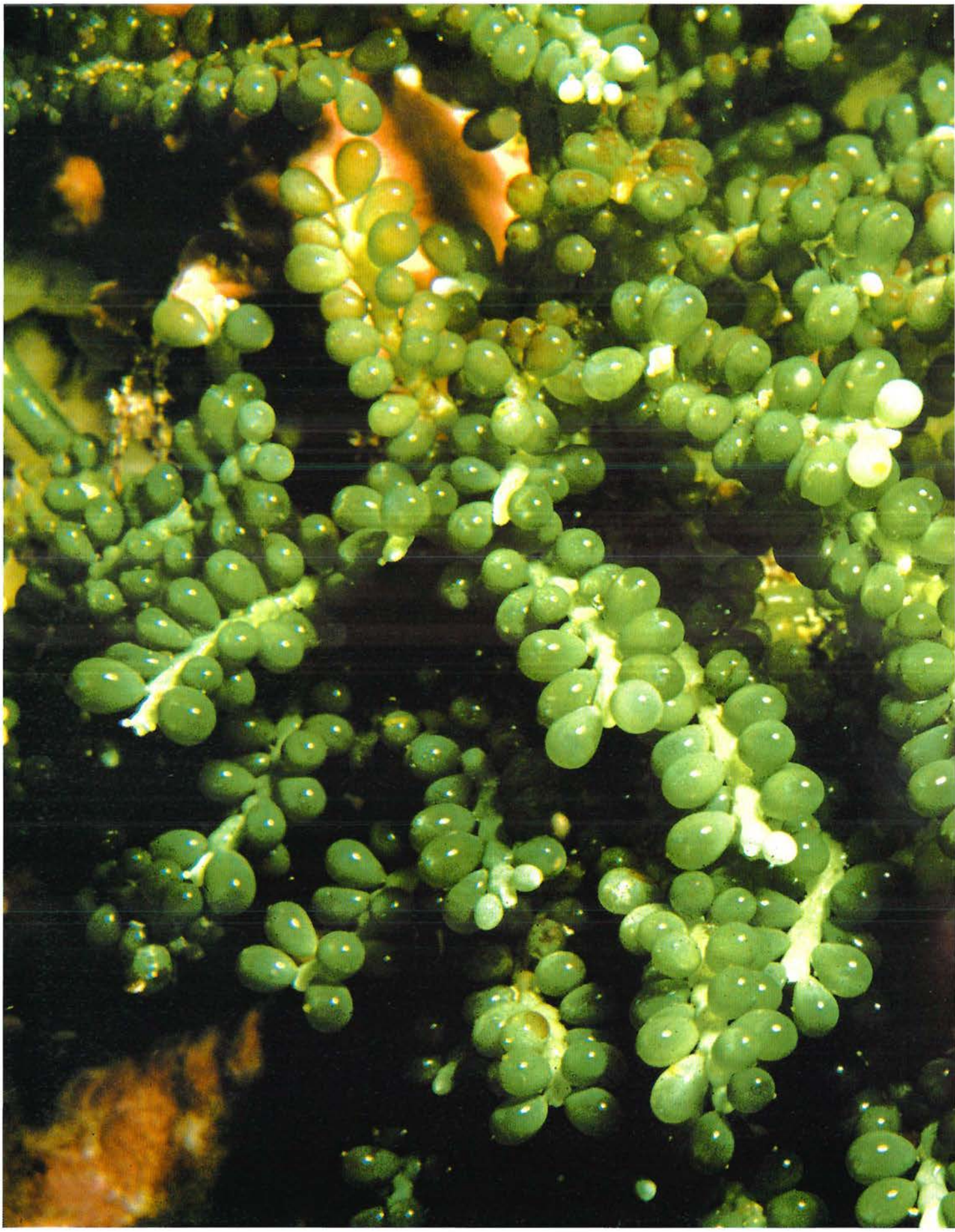
The next major advance came during the 1990s, when hand-held navigation devices operating on the satellite global positioning system (GPS) became affordable for field staff, making it possible to determine their location with far greater accuracy. Today, advances in computer technology enable staff to enter map information on palmtops in the bush and produce maps showing the expected spread of dieback decades into the future.

Despite enormous advances in technology and trial of satellite imagery and other remote sensed data, skilful interpretation and ground survey remain essential in mapping the extent and impact of dieback. It is estimated that dieback interpreters have walked assessment lines over 700,000 hectares, excluding areas mapped more than once, demarcating sites with around 85,000 rolls of tape and wearing through about 540 pairs of boots.

The information collected is used to manage access and operations in these landscapes, to project future spread and impact of the disease in the vegetation and wildlife it supports, and to contribute to a variety of research and educational projects. CALM is currently developing a dieback atlas, a project that will make the latest dieback mapping available to everyone in the community involved in managing dieback across the landscape.

Caris Bailey is Executive Editor of *LANDSCOPE* and has worked in a variety of roles in CALM. She can be contacted on (08) 9389 8644.

Martin Rayner is Manager of CALM's Forest Management Branch, which is responsible for the dieback interpretation program, and can be contacted on (08) 9725 5927.



The menace below
invasive seaweeds

Many dangers lurk beneath the ocean waves, but not all of them have sharp teeth.

by John Huisman and Cheryl Parker

The value of the marine environment to Western Australians is difficult to quantify. It is probably our favoured playground, whether for swimming, surfing, diving or other recreational activities. In addition, our marine industries generate around $5 billion per year, and employ more than 14,000 people.

On a less positive note, it receives much of our waste, which it mostly absorbs very efficiently. Thankfully, we no longer hold the perception that the marine environment can supply an inexhaustible harvest, and that it can be treated as a bottomless dumping ground. If we take care of our marine environment and treat it with respect, we should be able to maintain a healthy and productive system.

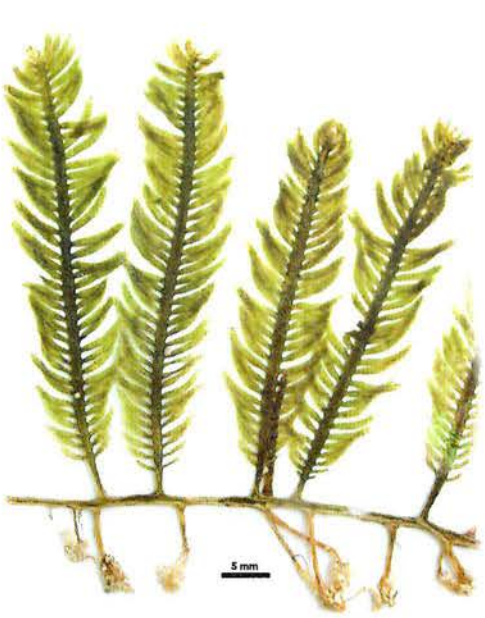
But our oceans are under threat. Pollution, global warming and overexploitation of the marine environment are major problems in many places already, potentially leading to the total collapse of the delicate balance of the marine ecosystem. In Western Australia, excessive nutrient pollution often leads to algal blooms visible from the surface. Now an additional menace looms, capable of reducing diverse and productive ecosystems to virtual monocultures, dominated by a single, all-pervasive species. The menace comes in many guises, but is collectively known as 'invasive marine pests'.

Feathery caulerpa

Caulerpa is a widespread genus of green algae that grows by sending out horizontal creeping stems, from which upright branches can arise. The uprights come in all manner of shapes. Some look like bunches of small grapes, some are flattened and almost fern-like, while others resemble thick blades of grass.

Some years ago, a particularly vigorous form of a common tropical species, feathery caulerpa (*Caulerpa taxifolia*), became a popular decoration in marine aquaria. Plants grew very rapidly, nothing ate or attacked them, they tolerated a wide variety of environmental conditions and new plants could be created from the smallest cuttings. Unfortunately, all of these characteristics also meant feathery caulerpa was an ideal weed, potentially able to colonise large areas of the world's shallow seafloor. And there were no constraints on transporting *Caulerpa* around the world; it could be ordered by mail from aquarium suppliers and delivered to your door!

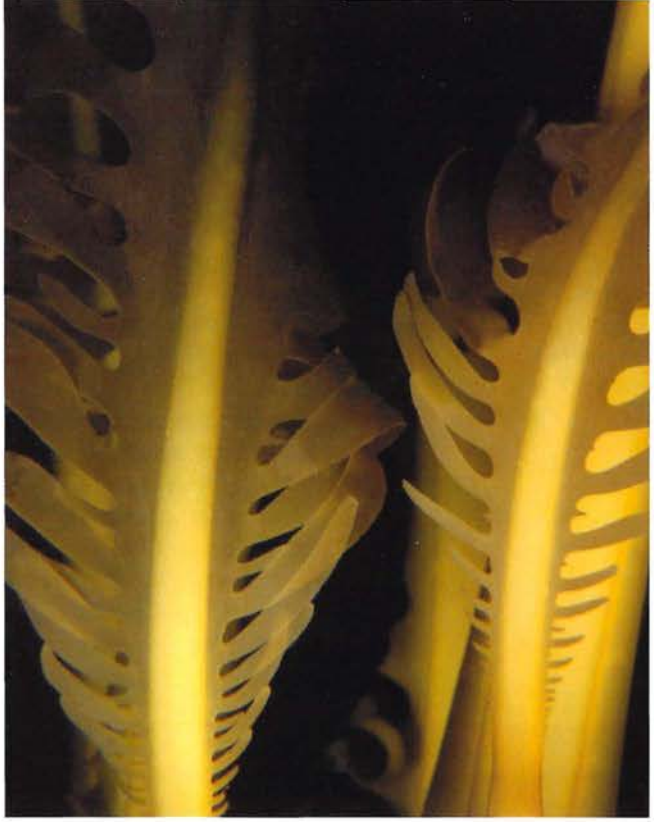
It is widely believed that this 'aquarium strain' of feathery caulerpa is a genetically modified mutant of recent origin, as there are clear genetic



Previous page
Main Sea berries (*Caulerpa sedoides*), a local green seaweed growing at Rottnest Island.
Inset Sea grapes (*Caulerpa racemosa* var. *cylindracea*), a green seaweed native to the Perth region, is now an invasive weed in many parts of the world.

Above The local green seaweed *Caulerpa distichophylla* looks similar to feathery caulerpa (*Caulerpa taxifolia*).

Left Two dried plants of feathery caulerpa (*Caulerpa taxifolia*)—the regular strain from Broome (far left) and the invasive strain from Adelaide (left)—are almost identical in appearance and hence difficult to distinguish from one another.
Photos – John Huisman



differences between the invasive plants and the tropical, non-invasive plants also known as feathery caulerpa. Recently published observations on a cold-tolerant variant of feathery caulerpa, which has been found in Moreton Bay (Queensland) since at least the 1870s, might indicate an alternative source of this pest.

In 1984, French marine biologist Alexandre Meinesz noticed an unusual green alga in the Mediterranean, which in his many years of experience he had never seen growing locally. The plants were adjacent to the Monaco Oceanographic Institute, where many display aquaria were in use. Meinesz identified them as feathery caulerpa, and attempted to raise the alarm that an introduced and potentially invasive species was growing in the Mediterranean. Unfortunately his concerns were largely ignored, as the prevailing feeling at the time was that it was a natural part of the Mediterranean ecosystem. How wrong this proved to be! In subsequent years, feathery caulerpa ran rampant throughout large tracts of the Mediterranean, displacing native seagrasses and radically altering the entire marine ecosystem. There now appears to be no means of containment. Mechanical removal is not viable, because the plant has spread so far and so rapidly.

Subsequent outbreaks also occurred in California, and in New South Wales and South Australia, but due to the experience gained from the Mediterranean, eradication was attempted before the species was able to gain a large foothold. The success of

Above left A close view of the blade of the invasive wakame (*Undaria pinnatifida*) shows the midrib distinctive to this species. Compare this to the local kelp.

Above The stem of wakame has distinctive ruffled reproductive branches. These do not occur in *Ecklonia*.
Photos – CSIRO

Left The common kelp (*Ecklonia radiata*) found in local waters.
Photo – John Huisman

Recognition of WA's marine flora

Unlike the terrestrial flora, the vast majority of marine plants are virtually unknown to all but a handful of biologists. The problem of introduced and invasive species is compounded by this general lack of awareness; if you didn't know that the plant you were looking at was introduced, you wouldn't think to be concerned. CALM's WA Herbarium is undertaking a project to increase awareness about our marine plants, by providing online information, including descriptions, photographs and distribution data of the marine flora. This will eventually be a major resource, accessible via CALM's FloraBase information system.

The first phase of this project included databasing the State's scientific collections of marine plants and was a joint venture between CALM's WA Herbarium and its Marine Conservation Branch. Coastwest/Coastcare provided funds for the initial stage and CALM received a Natural Heritage Trust grant to continue the project into 2006. Additional funding is being sought to support the project beyond this.

The WA Herbarium already had an extensive marine plant collection but only data on seagrasses were available through FloraBase. In collaboration with CSIRO, Murdoch University and The University of Western Australia, existing specimens collected by these agencies will be permanently housed at the Herbarium. A combined specimen database will provide information on more than 20,000 specimens.

The resulting database will be supported by an authoritative census of WA's marine plants, including around 1000 macroalgae and seagrass species, together with references to other sources of information about them. The comprehensive work carried out by Roberta Cowan from Murdoch University in compiling the Australian Marine Algal Name Index (AMANI) has provided a sound basis for the WA Marine Plant Census.

This project will provide extensive support to agencies and researchers contributing to conservation of WA's marine biodiversity. Scientists, community groups and volunteers will have ready access to up-to-date information on marine plants.

FloraBase is available on CALM's website at http://florabase.calm.wa.gov.au/.

eradication is subject to ongoing monitoring. Eradicating even small outbreaks is very expensive, costing $US 6 million (up to 2004) in southern California and $AUS 6–8 million in South Australia.

Is WA at risk? Most certainly. In the Mediterranean, water temperatures drop to 13°C over winter, and feathery caulerpa survives. It could certainly survive WA's winter sea temperatures, which are around 16–23°C in the vicinity of Perth. In New South Wales, feathery caulerpa survives in temperatures from 12–25°C, and elsewhere is reported to tolerate temperatures from 7–32°C. There seems no question that it could survive along most parts of WA's coastline.

But it has to get here first, and with proper management we might remain free of this pest. The invasive feathery caulerpa is apparently all male and does not reproduce sexually, so can only spread (other than by human means) by fragmentation and by growing laterally. Unfortunately, it can survive from the smallest fragments, and can also survive out of water for many days in humid conditions. The best means of control is to stop it getting here in the first place, so we need vigilant policing of quarantine procedures of living marine plants. Greater community awareness is also important, to stop people dumping aquarium contents into waterways. The species is now banned from import and sale, but remnant populations probably survive in many home aquaria.

Community awareness is also important for other reasons. An outbreak of feathery caulerpa might go unnoticed for years if no-one recognises it. Divers, snorkellers, fishers and others must be made aware of the problem so any suspect outbreaks can be immediately reported to the Department of Conservation and Land Management (CALM) or WA Fisheries.

Above left A diver collects seaweeds at the Houtman Abrolhos Islands, as part of ongoing surveys of Western Australia's marine plant biodiversity. *Photo – John Huisman*

Right After storms, the accumulation of drift seaweed on Perth beaches can be substantial.
Photo – John Huisman

Sea grapes

In the early 1990s, a second invasive species of *Caulerpa* was observed in the Mediterranean. This species appeared to be even more vigorous than feathery caulerpa, outgrowing it in head-to-head encounters. It was not identified until a study published in 2004 showed the invasive species was in fact sea grapes (*Caulerpa racemosa* var. *cylindracea*), a species with a natural distribution centred on the Perth region. The spread of this species in Europe has been described as a blitzkrieg, and it is proving to be as problematic as feathery caulerpa. Parts of South Australia are also now becoming inundated by this species, illustrating that pest species do not have to travel far to be problematic. As the Western Australian ecosystem has evolved to accommodate sea grapes, the species is unlikely to become a pest in our waters.

Wakame

Wakame (*Undaria pinnatifida*) is a largish (to three metres tall) brown kelp that is widely eaten in Asian and other cuisine. It is native to Japan, China and Korea and has been collected and eaten in Asia for centuries. Wakame has been accidentally introduced to New Zealand, California and the Mediterranean Sea (France, Italy). It was also deliberately introduced into the North Atlantic, to Brittany, for commercial exploitation, then was recorded in natural communities in France, Britain, Spain and Argentina. In 1988, populations were observed in Tasmania, and wakame now grows over a large area of Tasmania's east coast. It has also spread to Port Phillip Bay in Victoria.

Unlike *Caulerpa*, wakame grows upright from a single holdfast. This might lead one to think that it could not spread rapidly, but wakame has other means of getting around. Each plant produces many thousands of spores—from specialised branches called sporophylls that arise laterally on the stem—that can drift in the water and settle some distance away, eventually producing new plants. Wakame looks very similar to a Western Australian species, common kelp (*Ecklonia radiata*), and could possibly supplant that species if it took hold. Wakame generally inhabits only cold temperate coastal areas and grows best in waters below 12°C, but can survive in temperatures from 3–20°C, and the microscopic gametophyte stage can survive up to 25°C, so many parts of WA's coastline are probably at risk from an invasion.

As with *Caulerpa*, vigilance is important to keep this pest at bay. Sightings should be reported immediately. Wakame has a distinct midrib running through at least part of the blade and, when mature, produces specialised spore-bearing branches known as 'sporophylls'. These are convoluted and easily distinguished from the main frond. Common kelp has a flat blade with no distinct midrib and lacks specialised spore-bearing branches.

Fragile fingers

Fragile fingers (*Codium fragile* var. *tomentosoides*) is a large (sometimes more than 20 centimetres tall), dark green plant, regularly divided into paired branches. The branches, up to a centimetre in diameter, are spongy with tufts of whitish hairs just below the tips. The species is probably native to Japan, but is now one of the most

invasive seaweeds in the world, having found its way to New Zealand and then to south-eastern Australia, where it is forming dense populations. It generally grows on hard surfaces and attaches itself to shellfish, which makes it particularly unwelcome to aquaculturists.

It seems likely that this species will eventually spread across southern Australia to WA, probably by drifting or as a fouling organism. It looks similar to several WA species, and scientists need to examine its internal structure to identify this species. It survives in a broad temperature range and could easily invade WA waters.

Other seaweed invaders

The four species mentioned above have become invasive in Australia and many other parts of the world. But many more marine plant species are now regarded as pests. It is difficult to predict if a species is likely to become a pest in a new environment, as many introduced species remain relatively innocuous and do not dominate their new homes.

Some introductions of otherwise sedate species, however, have had disastrous consequences. In the 1970s, a well-meaning researcher at the University of Hawaii introduced several species of red seaweed to Hawaiian waters, to test their suitability for aquaculture. These studies resulted in major seaweed aquaculture industries in several tropical Pacific countries, including the Philippines and Indonesia.

Unfortunately, the test sites did not fare as well. The plants were left to their own devices and began to dominate

Above *Caulerpa racemosa* var. *laetevirens* at Dampier Archipelago, a variety very similar in appearance to the local *Caulerpa racemosa*.

Left Duthie's fingers (*Codium duthiae*), one of many native species of dead man's fingers (*Codium*) found in the Perth region. *Photos – John Huisman*

Below right Sea grapes is native to south-western Australia but a major pest elsewhere.
Photo – John Huisman

the ecosystem in parts of Hawaii. After southerly storms, Waikiki Beach (one of the world's most famous beaches and a major tourist destination) is inundated with large piles of beaded gracilaria (*Gracilaria salicornia*) derived from that first introduction. Kaneohe Bay now supports huge tracts of jellyweeds (*Eucheuma denticulatum* and *Kappaphycus alvarezii*), also introduced intentionally. On Maui, blooms of another red seaweed, hookweed (*Hypnea musciformis*), result in massive beach drift that eventually rots and becomes foul smelling. Once-pristine beaches have become intolerably tainted. The costs of cleaning the beaches are huge and ongoing, adjacent land values have dropped dramatically, and the local tourist industry has suffered. Manual eradication has been trialled, but is presently not feasible and there seems no way to halt the spread of these species.

What to do?

It is often impossible to predict how one species might fare in new environments, but it is painfully obvious that we should ban the intentional movement of living marine plants and do our utmost to prevent accidental introductions. Accidental introductions can occur by hull fouling and ballast water, and new regulations addressing at least some of those sources will soon come into force. Community awareness is vital, to prevent introductions and to alert the appropriate authorities if any invasive species are sighted. If only one or two people in WA can actually recognise a pest species, it is likely that any infestations will go unnoticed, but, if we all familiarise ourselves with at least the major pest species, then the chance of recognition is vastly improved. If you are regularly involved in marine activities, make a note of what you normally see. That way, you will be able to recognise any major changes, and notify the appropriate agency.

Once marine pests gain a foothold, it is very difficult—if not impossible—to eradicate them. By being vigilant and keeping a watchful eye over our marine environment, we can hopefully keep WA free of these unwanted aliens.

Introduced, cryptogenic, invasive or pest?

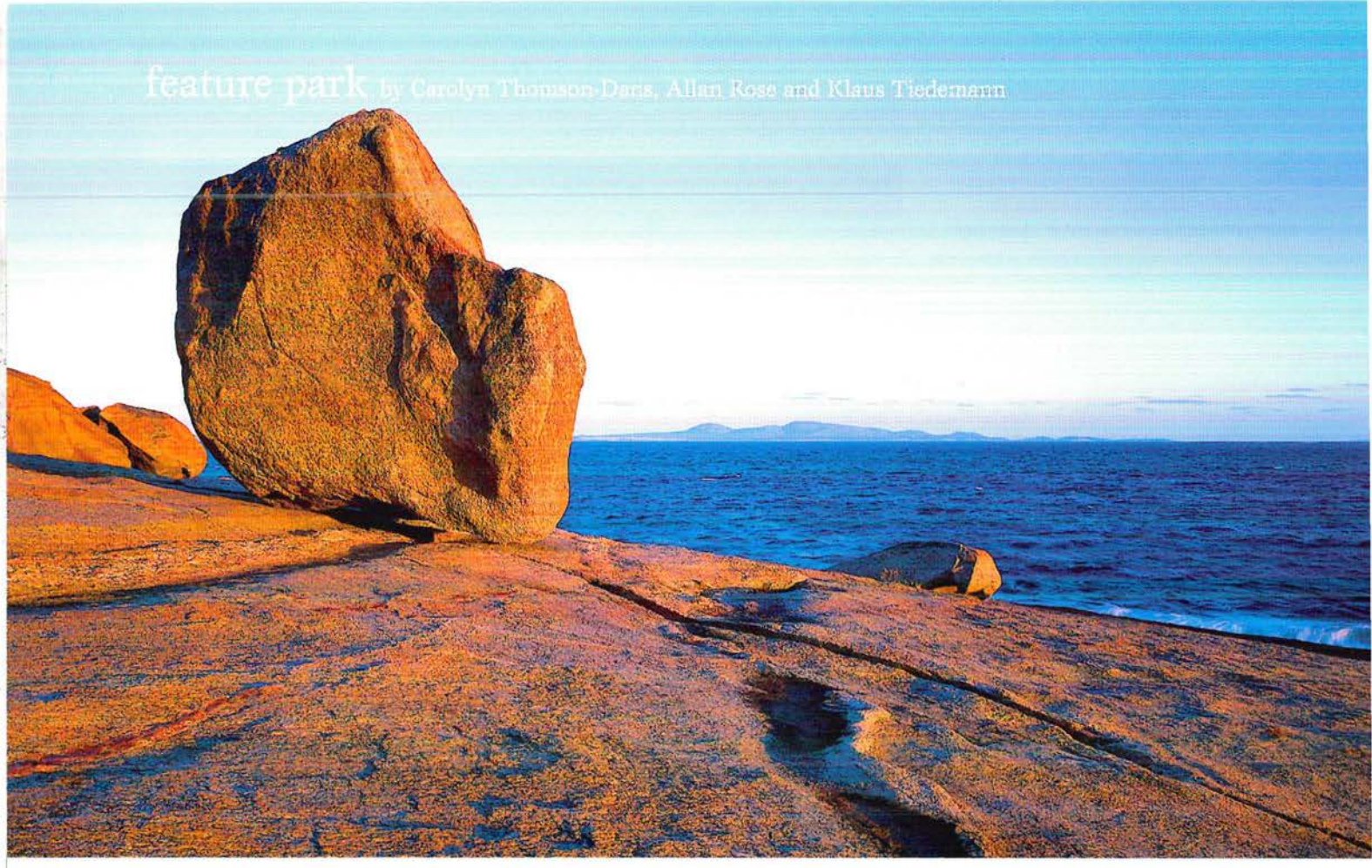
Many marine species have found their way around the world's oceans, either by natural means, such as currents, or unnatural pathways such as hitching a ride on a ship or yacht, or being imported for aquaculture or the aquarium trade. Most of these species are fairly innocuous and unlikely to have a major impact on the environment. In the past, these species were often described as 'cosmopolitan', indicating their widespread distribution. Nowadays they are also known as 'cryptogenic', which essentially means that their original source is unknown, obscured by their now-ubiquitous presence. They may, or may not, be introduced. 'Introduced' species are those that have clearly established a new population outside their natural distribution. They tend to be initially encountered in the vicinity of ports and harbours, and have not previously been recorded from local waters. Nowadays, further proof that a species is introduced comes from comparing DNA sequences between the newly established population and any possible source populations. Introductions do not necessarily have to come from a different country. Australia is a big place, and introduced species can also be translocated from elsewhere in the country.

Occasionally, some imports flourish in their new home, displacing native species and seriously affecting the marine environment. At this point, the species are described as 'invasive' or 'pest'.

John Huisman, author of *Marine Plants of Australia*, is a contract seaweed specialist at the WA Herbarium, and also research fellow at Murdoch University. He can be contacted by email (johnhui@calm.wa.gov.au).

Cheryl Parker is a curator at the WA Herbarium and manages the State's marine plant collection.

A forthcoming bush book, *Marine Plants of the Perth Region*, will be published by CALM in late 2006.



Cape Arid National Park

French Admiral D'Entrecasteaux named 'Cap Arride' in 1792, and the name was anglicised by Matthew Flinders in 1802. The Cape Arid National Park was subsequently named after this feature.

Above A boulder at Tagon Bay, looking towards Mount Arid.
Photo – David Bettini

Facing page
Top far right Flora on Mount Ragged.
Photo – Jiri Lochman
Above right Stilts.
Photo – Tim Brett
Right Cape Arid National Park.
Photo – Tim Brett

Although, due to its far south coastal position far from any large population centres, Cape Arid is one of the least known national parks in Western Australia, it is nevertheless an exceptionally beautiful and biodiverse area.

Cape Arid National Park is renowned for its sweeping beaches, clear blue seas and rocky headlands. Low granite hills extend inland, and in the northern part of the park the Russell Range rises to its highest point at Tower Peak (around 600 metres). Like the Barrens of the Fitzgerald River National Park, Tower Peak and the Russell Range were islands when sea levels rose about 40 million years ago. Wave-cut platforms can be seen on their lower slopes.

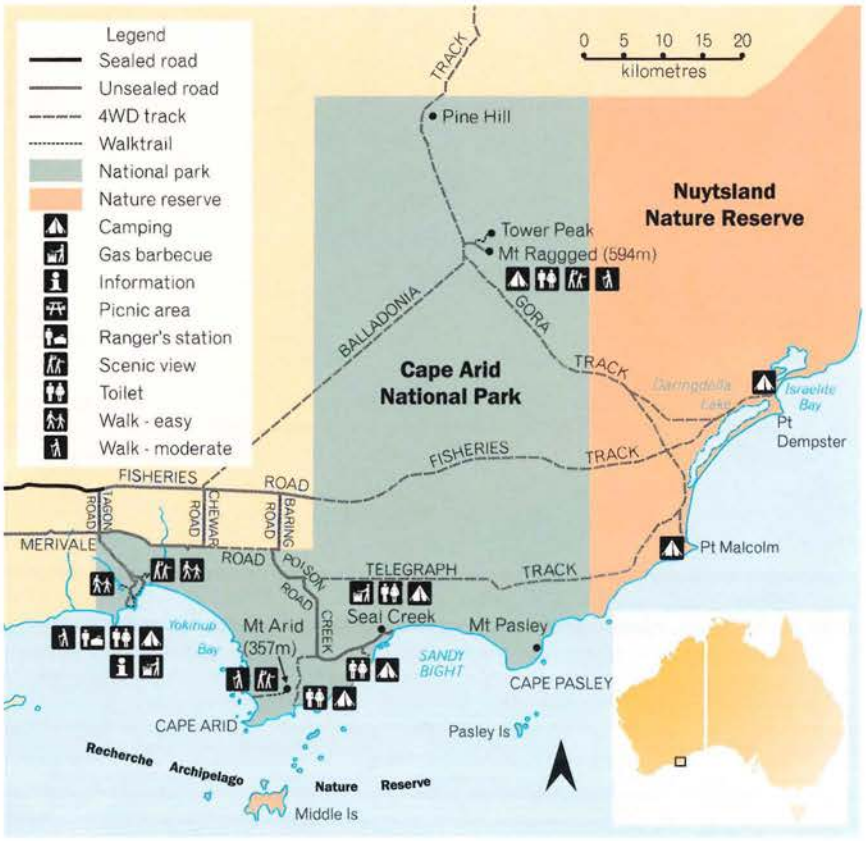
Together with the Nuytsland Nature Reserve and Eucla National Park to the east, Cape Arid National Park forms an almost continuous nature conservation area to the South Australian border.

Cape Arid itself consists of granite rock jutting out into the Southern Ocean and very low heath nearby. The remainder of the park has a huge diversity of flora, with 1100 species of plants recorded so far. The park's coastal heathlands have abundant wildflowers in spring. The park also has extensive woodland in the northern sections.

In 1870, Campbell Taylor arrived to take up land around the Thomas River for grazing. William Ponton and John Sharp settled the area around Pine Hill five years later. A dam and the graves of some travellers can be seen near the waterhole at Pine Hill. Brumbies also frequent this waterhole. In a deep valley east of Mount Arid, the grave of Ponton and the remains of 'Hill Springs', the homestead of the Baesjou family, can be found.

Birds and other life

Birds found in the area include the purple-gaped honeyeater, western spinebill, red-eared firetail, mulga parrot and pied butcherbird. Sixteen of the 18 species of honeyeater found in WA south of Dongara are known from the park, a good indication of the



richness of species. One endangered bird, the western ground parrot, lives in the park, and several threatened species, including the vulnerable Australasian bittern, the endangered Carnaby's black-cockatoo and the vulnerable Cape Barren goose, visit the park on occasion. Recherche Cape Barren geese breed only in the Recherche Archipelago, and occasionally visit nearby parts of the mainland. This subspecies is naturally rare, and total numbers are estimated to be only about 650 birds.

In 1998, a number of threatened chuditch were reintroduced to Cape Arid National Park as part of the Department of Conservation and Land Management's *Western Shield* project. Aerial fox baiting is carried out at Cape Arid, and other parks and coastal reserves around Esperance, to keep down the numbers of these introduced predators and give native wildlife a chance of recovering.

Whales are regularly spotted off the coast, especially during late winter and spring. An excellent location to see whales from winter to mid-spring is the Thomas River area, where they come close to the granite headlands. Seals sometimes visit the beaches. Western brush wallabies live in the park. In 1930, a 'living fossil' was discovered in Cape Arid National Park. The world's most primitive species of ant, more primitive than known fossil ants, was found alive and thriving near Mount Ragged.

Attractions

There are three main areas of attraction to visitors. In the Thomas River area, where the park headquarters are situated, there are excellent camping facilities, including several walks. This area is accessible by conventional vehicle and has good unsealed roads.

The Seal Creek–Poison Creek area is popular for camping and fishing, and is accessible to conventional vehicles from Fisheries Road via Baring Road.

The Mount Ragged area requires a four-wheel-drive vehicle. It has a quiet camping area and a footpath to the summit of Tower Peak. Many species of orchid and several ferns grow on and near Mount Ragged, together with several plants which are more typical of coastal locations, such as showy banksia (*Banksia speciosa*) and a small population of sticky tailflower (*Anthocercis viscosa*).

A management plan for the Esperance District Coastal Reserves, which includes Cape Arid National Park, is currently being prepared and, as part of this process, part of the park is likely to be considered as a possible wilderness area.

park facts

Where is it? One hour and 30 minutes drive (120 km) east of Esperance.

Total area 279,832 hectares.

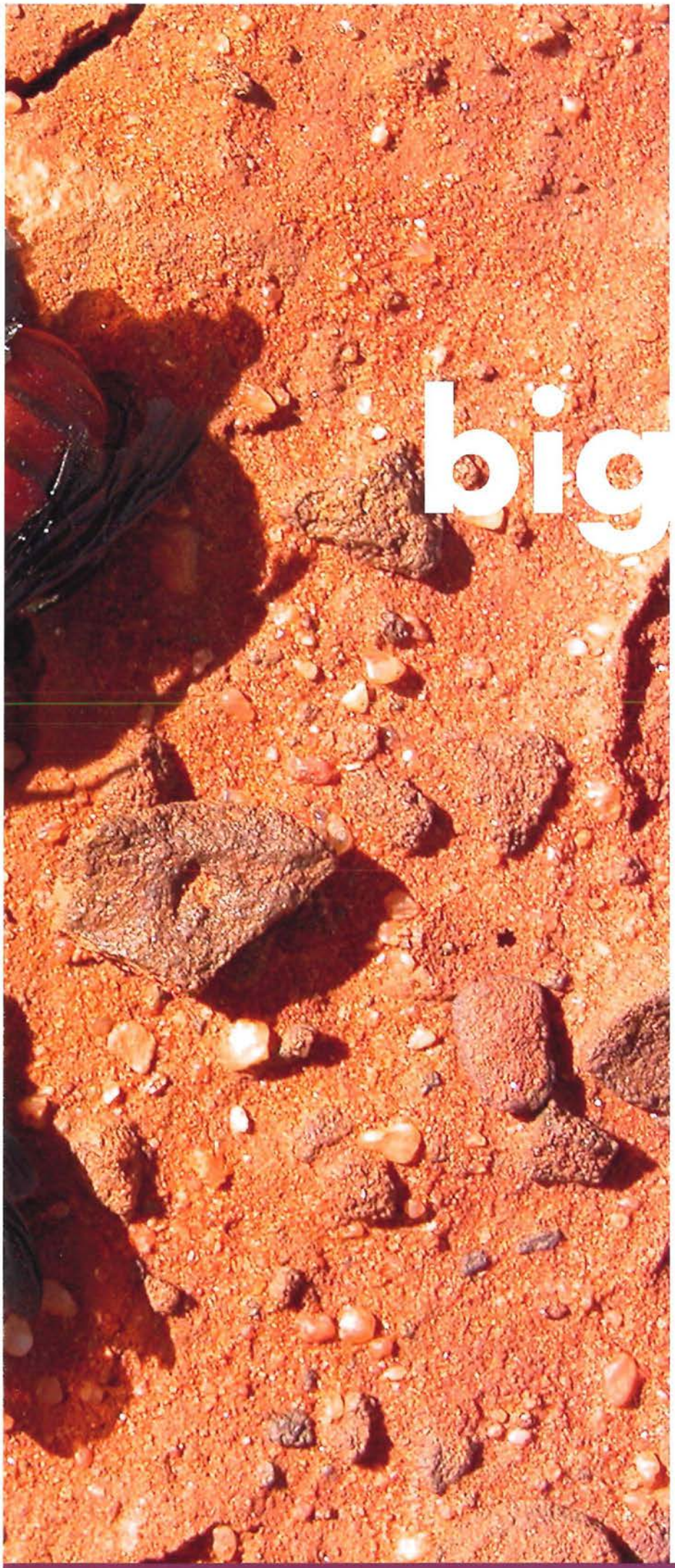
Naming 'Cap Arride' was named by French Admiral D'Entrecasteaux in 1792.

What to do Bushwalking, camping, birdwatching, whale watching, picnicking, photography, four-wheel-driving, fishing.

Facilities Barbecues, tables, toilets, campsites, walktrails.

Must see sites The beaches of the Thomas River area including the long, sweeping beach of Yokinup Bay.

Nearest CALM office Esperance district office, 92 Dempster Street, Esperance, phone (08) 9083 2100. A resident ranger is based within Cape Arid National Park, phone (08) 9075 0055.



The wrestling, mating, nesting, buzzing, big bees

of Kennedy Range National Park

Tucked away in claypans in the less visited eastern plains of the far flung Kennedy Range National Park is a natural phenomenon that leaves US professor John Alcock abuzz with excitement!

by John Alcock

The vast arid plain on the eastern side of Kennedy Range National Park lacks the obvious drama of the deeply-cut canyons and massive sandstone cliffs to the west. Not surprisingly, therefore, visitors to the park, which lies some 60 kilometres north of Gascoyne Junction, are drawn primarily to the attractive canyons near the camping area. A few bushwalkers even manage to scramble cautiously to the top of the cliffs, where they find themselves on a strange and wonderful plateau covered in pale green spinifex accented by brilliant red sand dunes.

Given the appeal of the ranges themselves, only a handful of visitors choose to explore the eastern plain. This tiny minority wanders through a shrubby woodland of acacias, hakeas and eremophilas. There is no trail here but the walking is easy, offering none of the obstacles provided by the jumbled rocks in the canyons nearby. Thornbills, redthroats and spiny-cheeked honeyeaters slip from bowgada to mulga and back again.

Claypans

In the course of a stroll across the eastern plain, you will come sooner or later to one or another of the claypans scattered through this part of the park and beyond. These depressions sometimes fill to overflowing, but only on those rare occasions when remnants of cyclones surge into the arid interior of Western Australia. Most of the time the park's claypans are bone dry and hard as concrete. A line of emu or kangaroo footprints, all but fossilised in brick-hard clay, may reveal that once upon a time the pan's surface was wet and muddy—but not now.

Anyone who finds one claypan is likely to want to see others. Some pans are beautifully symmetrical, a circle of red clay rimmed by pale red sand dunes; others have an irregular outline, all curves and indentations, with an isolated white-barked eucalypt or two growing on a bend in the shoreline. Some cover several hectares; others are much smaller. Some have smooth, flat surfaces that would be the envy of a tennis club; in others the clay is deeply cracked and flaked, or blotched with patches of black pebbles. On the borders of some pans, stone flakes lie in the sand where they were left by Aboriginal people long ago.

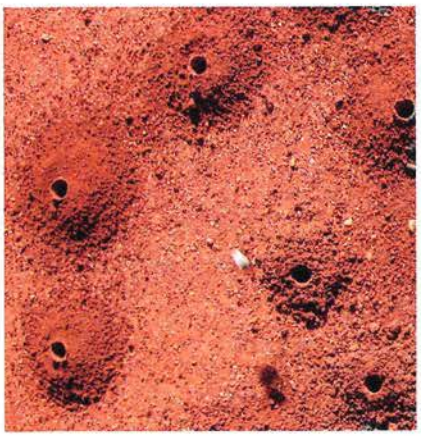
The pans are largely barren and apparently devoid of life, although some have a little island of scrub where a red kangaroo or two may lay up during the heat of midday. Most pans, however, are empty, and suffused in a profound silence broken only when a breeze rustles the acacias on the nearby dunes. Nevertheless, in a small number of pans, the rule of silent lifelessness is overruled for a small part of each year. As you walk out onto the edge of one of these special sites in August or September, you will be greeted by a swirling mass of very large and noisy bees, an intimidating encounter that sends most people into retreat. These are Dawson's burrowing bees, one of the largest and most handsome of Australia's native bees, and they have gathered here in great numbers to build their nests in the clay soil of the pan. Once you have backed away from the bees (which are all buzz and no bite), you will notice that the surface of the pan is dotted with hundreds or thousands of miniature pyramids, little mounds consisting of dirt excavated during the construction of the burrows of the bees.

Gnawing problem

Each mound of dirt surrounds the entrance to a nest built and maintained by an elegant black and pale grey female bee. To make her nest, the

Previous page
Main Dawson's burrowing bees compete fiercely for mates. Here, a group of males has assembled around an emerging female. A free-for-all will ensue when the virgin female does venture out of the exit tunnel. As the males all seek to hold the female, a ball of bees forms from which the winning male will emerge with his mate to race for cover away from the losing males.

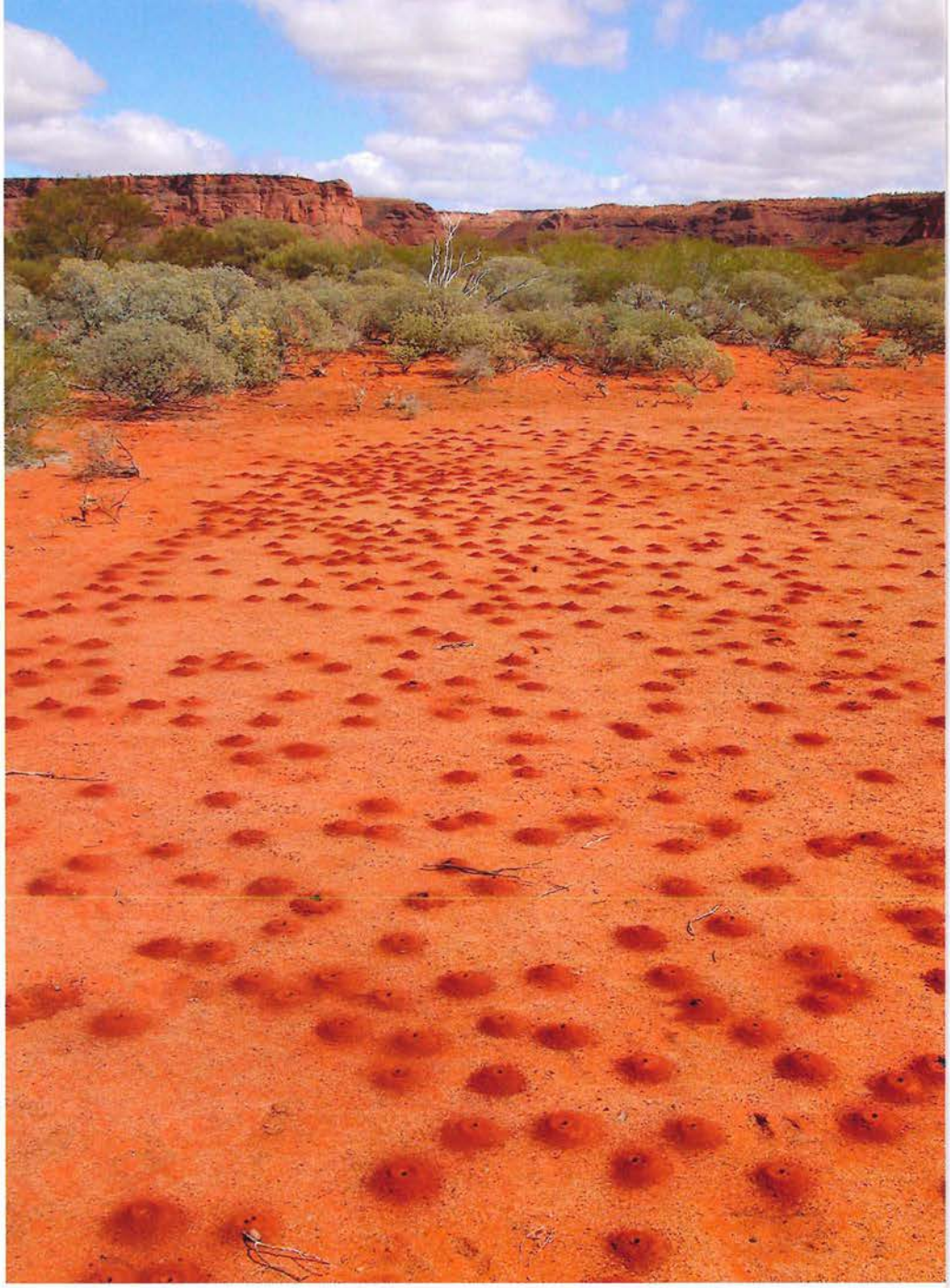
Left A claypan in the Kennedy Range National Park.
Photos – John Alcock



Above Although female Dawson's burrowing bees build their nest entrances very close together, they easily relocate their nest when returning from their pollen and nectar-collecting trips.

Right A nesting aggregation photographed late in the nesting season after many hundreds of females had chosen to dig their nests in this area. The eastern cliffs of the Kennedy Range are visible in the background.
Photos – John Alcock

Below right A female Dawson's burrowing bee builds her nest in the hard clay favoured by this species. Note that the female has built a circular turret that retains the loose soil pushed out of the nest burrow during the construction phase.
Photo – Jiri Lochman



female had to dig down into the rock hard clay of the pan. For Dawson's burrowing bees, 'digging' might be more accurately described as chewing, because the females do most nest construction with their jaws. Although the bees have powerful mandibles, they would be stymied by the location they have chosen, were it not for the fact that they regurgitate fluid onto the clay, which softens it. The identity of the liquid is not known for sure, but is suspected to be flower nectar, which the bees collect and store in a honey crop linked to their digestive tract. Whether nectar or ordinary water, the fluid makes it possible for the bee to gnaw a vertical shaft into the ground in stages, each step requiring a trip out to collect more liquid to moisten the bottom of the lengthening nest tunnel.

Females spend the better part of a day digging straight down, some 20 centimetres or so, before tunnelling in

Above A female emerges from her exit tunnel after having recently become an adult. The male will grasp her as soon as possible.

Left A male mounts a female Dawson's burrowing bee immediately upon her emergence.
Photos – John Alcock

a path roughly parallel to the surface for a short distance. The bee then heads down again, as she excavates a terminal upright cavity perhaps five centimetres long. This chamber is lined with wax produced by special glands in the female's head. The female subsequently fills the now-waterproofed container with a soupy mix of nectar and pollen gathered over a long series of trips to and from flowering plants in her neighbourhood. In the Kennedy Range, the bees harvest these materials from eremophilas and northern bluebells.

At the height of the nesting season, battalions of females come and go all day long from the aggregated nests. Given the number of nest entrances and their close proximity to one another, you might think that the bees would sometimes get confused about which nest was whose, but Dawson's burrowing bees are professionals. They never make mistakes. Instead, each pollen-carrying female rockets directly back to her nest entrance where she hovers for a fraction of a second before plunging head-first into her burrow. Females almost certainly manage this trick by learning the visual landmarks en route to and from their burrows, including those cues available right around the burrow entrance, such as the position of some local pebbles or the pattern made by a set of neighbouring nest mounds.

Because of their navigational skills, females efficiently deposit pollen and nectar in their own brood cells (and never help other females at their nests). Once a pot is about two-thirds full, the bee lays an egg on this moist mass of food. She then closes off the cell with a mud cap. When this dries, it seals off the brood pot, preventing desiccation of its contents and keeping parasites away from her offspring. Inside the safely sealed brood pot, the egg hatches into a grub that feasts on the supplies left for it by its mother. Meanwhile, the female extends her nest burrow, adds another brood cell, and goes to work all over again for her next offspring, a cycle that she usually repeats for her entire adult life, which only lasts a month or so. During this period, the nest burrow is steadily extended until such time as the female dies or moves to a new location.

As a larva polishes off the provisions left by its mother, it grows rapidly until it metamorphoses into the so-called prepupal stage. At this time, the baby bee becomes a dormant grub bloated with fat, which helps to keep it alive for the better part of a year. Then, after a new winter has come around, the prepupa becomes a pupa, which changes into an adult and gnaws its way

out of the brood pot and up through the soil until it reaches the surface. In a place where dozens, hundreds or thousands of Dawson's burrowing bees nested shoulder-to-shoulder in the previous winter, many dozens, hundreds or thousands of bees make this transition over a couple of months.

Greeting committee

Once out of the ground, the bees embark on the busy program of activities that they must accomplish in order to reproduce. Adult females spend the bulk of their lives building a nest or two and, in the process, will fill a dozen or so brood pots with food for their progeny. But, before they can start nesting, female bees must mate to secure sperm with which to fertilise their eggs. This is where the adult males come into their own. After a male emerges, he fuels up with nectar from some local flowering plants before returning (probably) to the place where he emerged. Odds are that many females will also be coming to the surface here in the days and weeks ahead. These are the females that males attempt to find, and they are so good at this task that when a female pops out of the ground, she almost always finds a male (or males) waiting right there.

The female's greeting committee has assembled because males can detect the odour of the female, which wafts out of the exit tunnel soon after her jaws break the surface of the ground. As the female continues to nibble away at this little opening, making it larger, her scents attract the attention of one or more males sailing low over the area. A patroller that smells an emerging female is quick to drop to the ground by the incipient exit hole, because when the virgin female comes out, she is sexually receptive. A male that is able to scramble onto her back will accompany his partner as she races to the edge of the pan, where the pair can hide under a little shrub or by some debris. There they can copulate without interference from other male bees or from predators like butcherbirds, which can kill Dawson's burrowing bees with a snap of the beak.

Bee-to-bee combat

The way for a male to leave many descendants is to find and mate with many freshly emerged females. In their eagerness to do so, males regularly get in each other's way. So, when several males independently smell a female before she has fully come to the surface, they may encircle the exit hole shoulder to shoulder. When the female does come out, a free-for-all ensues in which Marquis of Queensbury rules are forgotten. The males violently attempt to interpose themselves between the female and their rivals. Occasionally, the battle for control of a potential mate becomes so fierce that the virgin female is literally pulled to pieces by her out-of-control suitors. Usually, however, the battle is resolved in a minute or two, when one male somehow forces his way out of the tumbling melee with the

Above right On the left, a male that had been guarding an emerging female wrestles a rival male while a third male waits at the emergence hole, which he discovered while the other two males were fighting. Neither of the two wrestlers mated with the female when she emerged because their fight lasted too long. Instead, the third male won the honours.

Right One of the pollen and nectar sources for Dawson's burrowing bee, a species of *Eremophila*.
Photos – John Alcock

female safely beneath him. The pair then moves as quickly as possible away from their harassers.

To avoid having to struggle with large numbers of competitors after a female's emergence, males that have managed to find a potential mate generally try to repel newcomers as quickly as they can. When a waiting male senses a male approaching from behind, he flies up and back into the other male, bumping him away as forcefully as possible. If this manoeuvre is successful, the Johnny-come-lately will not be able to land by the emergence hole, and so cannot position himself to scramble onto the female's back when the bee decides to leave her exit burrow. Instead, the guarding male will secure the prize.

If, however, a rival somehow manages to land near the emergence hole, the guarding male may attack, leading to an all-out wrestling match on the ground. In these bouts, the two males tumble about trying to bite one another or tear at each other's wings with their powerful mandibles. If an opponent can be convinced to leave, the winner hurries back to be there when the female emerges. Two evenly matched contestants, however, may spend several minutes grappling with one another, during which time a third male sometimes slips down to wait for the female to emerge. Not infrequently, this latecomer wins the chance to copulate, when the female comes out before a winner of the wrestling match has been determined.

August attraction

During my occasional visits to the Kennedy Range over the years, I have come to spend more time in Dawson's burrowing bee habitat than in the park's canyons and plateau, at least during the month of August. I imagine that if more park visitors knew of the mate guarding, bee-to-bee combat and sexual intrigue that occur in the eastern plain, some would set out to find claypans rather than spend all their time exploring the imposing canyons and cliffs of the range.

Even if a trip to the range is not in the offing, I encourage winter travellers to the arid central parts of Western Australia to keep their eyes open for Dawson's burrowing bees, which often nest and emerge in roadside verges scraped clean by graders working the back roads of the Murchison and Gascoyne districts. These bees, although big and noisy, are essentially harmless (the females can sting but will do so only if picked up, not something most people are likely to attempt); they readily tolerate human observers and will reveal much of their lives to anyone willing to spend even an hour or two in their company. Although the marvellous geological features, birds, mammals and flowering plants rightfully attract the attention of most visitors to parks and reserves managed by the Department of Conservation and Land Management, the insects of Western Australia also warrant a look. Some, like Dawson's burrowing bees, positively demand our attention. Those of us willing to invest some time getting acquainted with these creatures know that a good return on our investment awaits us.

Above Looking east over Kennedy Range National Park. Several claypans can be seen on the left hand side of the photograph.
Photo – David Bettini

Below A nesting female.
Photo – John Alcock

John Alcock is a professor at Arizona State University and a frequent visitor to Western Australia. He studies the behaviour of the native bees in both Arizona and Australia and has great enthusiasm for the natural environments of both places. He can be reached at j.alcock@asu.edu.

Be a nature conservation officer for a weekend

The Department of Conservation and Land Management's successful **EcoEducation** program has now been extended to **Shark Bay**.

by Joanna Moore and Liz Moore

Have you ever imagined that one of the earliest forms of life on Earth—diverse microbial communities called stromatolites—could still exist, and in Western Australia's own Shark Bay World Heritage Area? Did you know that Gould's sand monitors (*Varanus gouldii*) have two penises? Did you realise that a captive-breeding program in Francois Peron National Park, part of *Western Shield's* Project Eden, has led to some 300 threatened or locally extinct native animals being released back into the wild? This knowledge and so much more, along with teaching resources and ways to encourage environmental studies in schools, were gains for a diverse and enthusiastic group of Western Australian teachers.

Adventure in science

It was the beginning of National Science Week, in August 2005, and the teachers had driven or flown from all over WA to stunning Shark Bay for a weekend science adventure based at a former station homestead in Francois Peron National Park. Teachers were given the chance to be students again, to experience the fascination and excitement of hands-on learning, just as students across the State had been doing through EcoEducation programs for more than 13 years.

The two-day camp—which invites teachers to 'Be a Nature Conservation Officer for a Weekend'—was a professional learning opportunity for teachers at its most involved and rewarding, providing them with an escape from the concrete of classrooms to one defined by nature.

The weekend aimed to raise awareness about Shark Bay's World Heritage status, exploring why the area is regarded as globally outstanding, and thus its heightened need for careful management and protection. Teachers met and helped several Department of Conservation and Land Management (CALM) scientists and nature conservation officers, whose job is to protect and rejuvenate this fragile natural landscape and the many threatened species that live in it.

CALM's EcoEducation section takes a strategic approach to involving schools and their communities in biodiversity conservation. Its programs provide classroom resources, professional learning for teachers and a wide range of engaging excursions and camps. The success of initial programs at the Perth Hills National Park Centre (formerly known as The Hills Forest Discovery Centre) near Perth led to their expansion to Wellington Discovery Forest Centre near Collie (see 'Classroom in the Forest', *LANDSCOPE*, Spring 2005), the Margaret River Eco Discovery Centre,

Previous page
Main Science teacher Steve Covich being a nature conservation officer.
Photo – Joanna Moore

Above Teachers help to clear along a pitfall trap fenceline.
Photo – Liz Moore

Left A carpet of everlasting daisies in the Shark Bay World Heritage Area.
Photo – Joanna Moore

Right Down to a birrida to monitor animals using pitfall and Elliot traps.

Below right Geraldton teacher Angela Britton and Murdoch University lecturer Catherine Baudains check the contents of an Elliot trap.
Photos – Joanna Moore

Dryandra Woodland and the Henderson Environmental Centre. These camps are affordable, practical and supported by curriculum-linked resources. The Shark Bay weekend was part of a plan for CALM's EcoEducation to reach school communities beyond WA's south-west.

Fragile beauty

Just like students, teachers can be inspired by the bush. They too love the chance to be really close to native animals and plants and to find out about the once-vibrant ecosystem found on Peron Peninsula, which is now recovering from the effects of pastoralism. Learning in the fragile beauty of regions such as Shark Bay reinforces the importance of the conservation lessons they teach.

The weekend gave teachers the opportunity to meet CALM scientists and other staff in an active setting, where they could share some of their enthusiasm and knowledge. The weekend was organised by CALM staff based at Denham and CALM Senior EcoEducation Officer Liz Moore, who facilitated the weekend's activities. The camp program balanced information sessions with hands-on activities and plenty of time for interaction with rangers, scientists, nature conservation officers and local representatives in education and tourism. CALM staff—including Ranger-in-Charge and reptile enthusiast Mark True, Manager of the Project Eden Captive Breeding Centre Nicole Noakes, Project Officer for the World Heritage Area Cheryl Cowell and Project Eden Manager Colleen Sims—provided close engagement with their diverse roles.

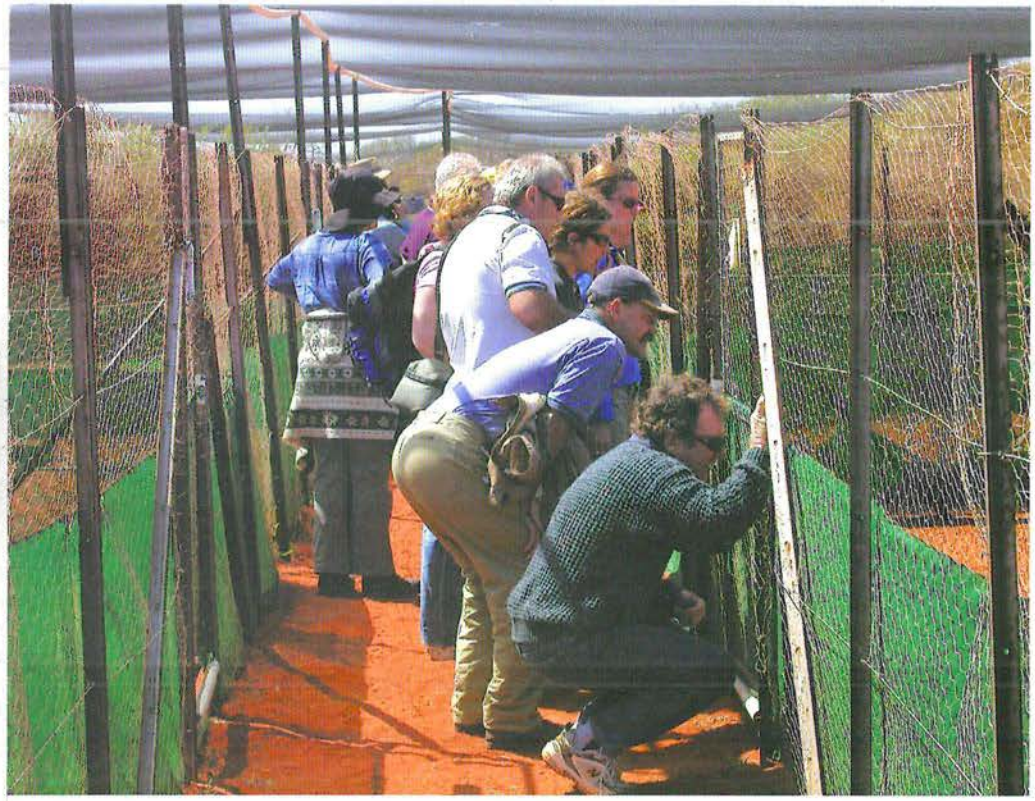
After a get-to-know-you game of 'Threatened Species Animal Bingo', Aboriginal Elder Rodney Drummond, from the Yadgalah Corporation, welcomed teachers to the country. Rodney provided a valuable insight into the Indigenous heritage of the region.

With the help of Colleen and Nature Conservation Officer Kathy Himbeck, the teachers set pitfall, Elliott and cage traps. Shark Bay hopping mice and other local animal inhabitants were captured, measured and released—all part of the hands-on experience in research methods used to investigate and protect them.

Path of discovery

With guidance from botanist Rob Davis, from CALM's WA Herbarium, teachers discovered the remarkable diversity of Shark Bay's flora, and its central role in supporting fragile wildlife populations. Rob demonstrated how to collect, label and press plant samples for a regional herbarium, and suggested practical ways to create budding botanists from naturally curious children. Sometimes, just teaching a young person how to use a magnifying glass correctly and providing a few plant samples can set them on a self-motivated path of discovery.

Many teachers commented that establishing a regional herbarium was a



particularly suitable and rewarding school project, perhaps for a local block of native bush. Activities like this foster a sense of environmental responsibility in youth, a personal investment central to instilling conservation values, attitudes and behaviours.

Western Shield

This action-packed weekend was part of the *Western Shield* Schools Program, now in its tenth year. Some 75,000 students, teachers and other adults have gained an understanding of the *Western Shield* native fauna recovery program through excursions, classroom resources and professional learning opportunities such as this camp.

Western Shield is CALM's initiative to control introduced animals, such as foxes, rabbits, feral cats and goats, as a means of protecting native animal species from predation and habitat loss. Its projects and achievements were a significant part of the weekend, in particular that of Project Eden, CALM's conservation program covering the entire 1050-square-kilometre Peron Peninsula.

The Peron Captive Breeding Centre was established by CALM in 1996. Since then, some 300 animals from four locally threatened or extinct species—the bilby, banded hare-wallaby, mala (or rufous hare-wallaby) and western barred bandicoot—have been bred at the centre, many of which have been included in Project Eden's reintroduction programs. In addition, woylies have been translocated to Peron Peninsula as part of Project Eden and malleefowl have been hatched and raised at the centre from eggs collected elsewhere. The centre also provides a rare opportunity to study these animals and to gain a greater understanding about how such creatures feed, breed and behave in arid environments. Such research will increase the chances of conserving threatened

Above left Teachers undertake a guided tour of the Peron Captive Breeding Centre.
Photo – Liz Moore

Left A banded hare-wallaby at the breeding centre.
Photo – Jana Sie

Above Nicole Noakes, manager of the breeding centre, with a bilby.
Photo – Joanna Moore

Above right Project Eden manager Colleen Sims shows off a bobtail lizard.

Right Nature Conservation Officer, Kathy Himbeck, displays a spinifex hopping mouse.
Photos – Liz Moore

species in the Shark Bay World Heritage Area and across Australia.

Animal magnetism

The weekend gave this group of educators time to encounter threatened animal species whose causes they will be championing. Normally, the Peron Captive Breeding Centre can be visited only by volunteers, but Nicole's guided tour gave the teachers special insights into wildlife that will make it even easier for them to interest their students.

Nearby Monkey Mia is a hub of research, not only on its iconic species, the bottlenose dolphin, but on dugongs, several species of turtles and even seagrasses—complex plants that are the basis of the bay's food chain and environmental balance. Massive seagrass meadows, including the world's largest at 1030 square kilometres, provide food sources and shelter for small crustaceans and fish, right through to Shark Bay's 10,000 resident dugongs, approximately one eighth of the world's dugong population. Monkey Mia Visitor Centre provides visitors with a worthwhile insight into the complex interrelations between the park's various ecosystems and native populations and, on this weekend, also enlightened our group of teachers.

World Heritage values

The Shark Bay World Heritage Area, approximately 850 kilometres north of Perth, covers about 22,000 square kilometres. Roughly 70 per cent of this area is water. Two large peninsulas create a 'W'-shaped shoreline of 1500 kilometres, which varies from rugged sea cliffs to sheltered bays of white sand and shells.

Shark Bay is one of only 16 World Heritage Areas that meet all four of the criteria that define World Heritage status. These criteria are: outstanding examples representing the major stages of the Earth's evolutionary history; outstanding examples of significant ongoing geological processes; extraordinary natural phenomena such as areas of exceptional beauty or where significant natural and cultural elements combine; and significant natural habitats where threatened species of outstanding universal value still survive. The professional learning weekend could provide only a taste of what the Shark Bay region has to offer.

A study of the Shark Bay World Heritage Area is useful for exploring the complexities involved in managing natural resources alongside the economic demands of commercial

Left The Peron Homestead.
Photo – Joanna Moore

The setting

The hum of the generator kicks in about 6.30 am but it's no chore to rise, despite yesterday's full schedule and today's ahead. The distinct call of the chiming wedge-bill (*Psophodes occidentalis*) has recently started its musical accompaniment to the soft tin-scrape of the homestead windmill. The sounds seem a perfect background to the clear morning air which rejuvenates and inspires, and to the dew-freshened vegetation all about the homestead. Time to make the dream of a dawn soak in the artesian-fed hot tub a reality.

The experience of staying in the 1950s-built Peron Homestead is a rare one—tourists in general are not permitted to stay and neither are students, as it usually only accommodates CALM staff and volunteers. Homestead hosts during the camp, Tani and Frank, took care of the property and were a further source of information about the peninsula landscape.

The chiming wedge-bill.
Photo – Babs and Bert Wells/ CALM

fishing, tourism, pastoralism and salt mining industries. With the guidance of CALM staff, the teachers gained an understanding of the complicated issues and competing interests which must be considered in management decisions. The region, and in particular Francois Peron National Park, is an excellent case study which demonstrates the centrality of rigorous scientific research to good management decisions.

The Shark Bay World Heritage Area offers a range of possibilities for school groups on camp. They come from the Midwest, Geraldton and Exmouth, the Goldfields and as far afield as Perth. Discovering what it means for a region to be internationally recognised for protection enables young people to understand, for example, the reasons for careful management of tourism and recreational activities. Along with a better understanding of the area's once-vibrant and now steadily recovering ecosystems, comes an investment for its future protection and a will to cherish what it has to offer.

Learning areas

The capacity of EcoEducation to benefit a wide range of students was indicated by the diversity of teachers who attended the camp. The 22 educators were from independent and government schools in metropolitan, regional and remote locations, and from primary, secondary and tertiary learning levels. Most taught in the learning areas of Society and Environment, and Science (including Biology), while the university staff were involved in training pre-service teachers.

Speaking on behalf of local CALM staff, Mark True described the weekend as "a chance to showcase the park"; to expose teachers to the many opportunities that Francois Peron and the World Heritage Area as a whole offer for observation and involvement in conservation activities.

Teachers enjoy and need the opportunity to get together and support one another and to exchange stories and ideas, experiences and goals. While the camp was certainly about appreciating the natural environment and spreading the messages of conservation and environmental management, it was also about providing topical and relevant case studies for outcomes-based education and encouraging supportive teacher networks.

The participants talked about how they could integrate this experience with their work as educators; while wading through the glassy water at Monkey Mia; while socialising and networking at Saturday night's informal barbecue; and even while soaking in the artesian-fed hot tub under the stars each night. For many, their newfound passion for this special part of the natural world will have a lasting impact on their approach to teaching.

Joanna Moore is a freelance writer who has written several articles for *LANDSCOPE* and currently has a position with CALM's graduate recruit program. She can be contacted on 0401 523 184 or by email (josyphine@hotmail.com).

Liz Moore is CALM's Senior EcoEducation Officer. She can be contacted on (08) 9334 0333 or via email (lizm@calm.wa.gov.au).

Teachers interested in attending the 2006 Shark Bay weekend camp on August 19–20, or other *Western Shield* camps to be held in WA's south-west, may contact Liz Moore.

Understanding the reef

What is known about the marine life of the Ningaloo Marine Park might only be the tip of the iceberg. Knowledge gained from future research can be passed on to visitors and tourism operators to help them conserve the reef, which is one of the world's most biologically diverse coral reef ecosystems.

by Glenn Shiell and Ben Fitzpatrick

Stretching for 290 kilometres, Ningaloo Reef is the world's largest fringing coral reef ecosystem. It is the only major tropical coral reef occurring on the western seaboard of any continental landmass. Its presence is due to the strongly flowing Leeuwin Current, which carries warm tropical water south. The Leeuwin Current results in some of the most southerly coral reefs in the world and even the presence of some tropical marine organisms in the Great Australian Bight.

Ningaloo Reef is widely acknowledged as a globally significant biological hotspot. It is a major feeding ground for the whale shark, the world's largest fish; provides habitat for marine turtles, manta rays and dugongs; and supports at least 500 species of fish and 200 species of coral. However, there is much more to be learnt about the area. Ningaloo Reef is believed to contain countless new species, and its biological significance is thought to be much greater than current knowledge suggests. To discover more about this spectacular environment, the State

government, through the Department of Conservation and Land Management (CALM) and the Department of Fisheries, has committed $5 million over four years for research in the waters of Ningaloo Marine Park.

Conserving for the future

The relatively pristine nature of Ningaloo Reef contrasts starkly with the often degraded and threatened nature of coral reefs worldwide. Twenty per cent of coral reefs have been lost entirely, and scientists predict that up to 50 per cent of reefs will succumb to the effects of global warming and other forms of degradation over the next 20 years. The distance of Ningaloo Reef from large cities, combined with its relative lack of land-based impacts, such as nutrient-laden freshwater run-off, has protected it from much of the damage being inflicted upon other reefs worldwide. Nevertheless, Ningaloo Reef's close proximity to the shore renders it highly vulnerable to recreational impacts, including damage from boating, fishing, diving and snorkelling. Ningaloo is also now one of Western Australia's premier nature-based tourism destinations. These pressures on the area have increased steadily in recent years

Ningaloo Reef is one of the world's most pristine large coral reef structures and, given Australia's economic position and quality scientific resources, the WA community has an opportunity to conserve the pristine qualities of the reef indefinitely. However, this will require careful planning and a greater emphasis on the benefits of education. The preservation of Ningaloo Reef also requires collaboration between scientists, government bodies, managers and local communities. This will lead to environmentally and socially responsible conservation outcomes.

Information isolation

Despite the ecological significance of Ningaloo Reef, our understanding of the many processes that drive and sustain it is surprisingly limited. The reef's distance from Perth makes research expensive and logistically difficult. Nevertheless, much excellent research has been conducted but, unfortunately, few of the research outcomes are communicated to local interest groups or members of the public. Instead, scientific research findings are often published in specialist journals with limited distribution, or communicated at international conferences, often held thousands of kilometres from the actual site.

Previous page
Main Cabbage coral.

Left Racoon butterflyfish are generally found in pairs and may even stay together for life.
Photos – Steven Thorne

Above All 15 families of hard coral found in Australia have been recorded in Ningaloo Marine Park.
Photo – CALM

This is of concern, as the transfer of information directly to local communities can be a highly effective conservation tool, particularly if the information is then passed on to the many thousands of tourists who visit Ningaloo each year, ultimately increasing global awareness of potential threats to the reef. As the number of visitors to Ningaloo increases, it will be important to place more emphasis on education, so users of the resource become more aware of the potential impacts of their actions. The open communication of research findings may also have other benefits, including collaboration between local communities, scientists and government management authorities. This would, in turn, greatly extend the scope of research, and significantly expand potential research infrastructure.

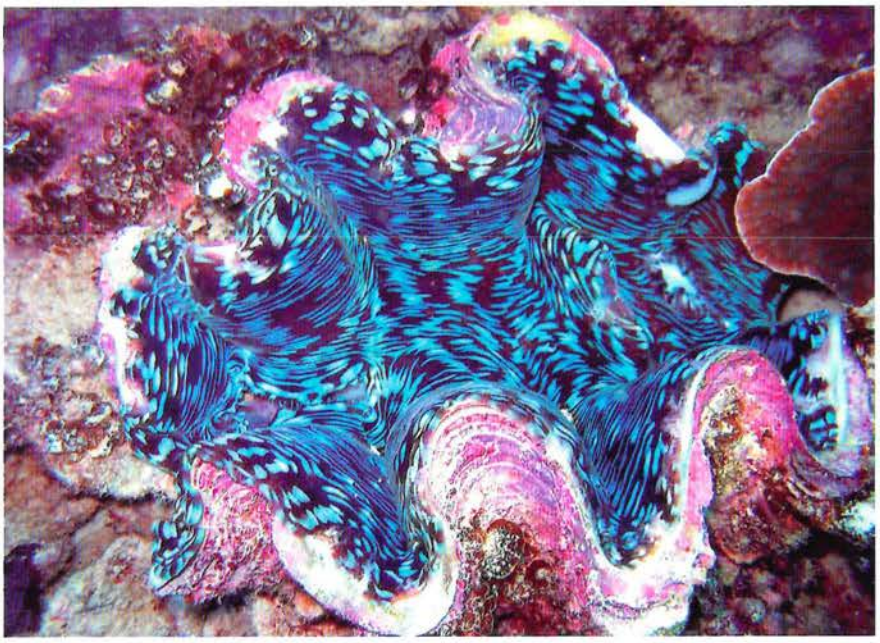
Marine science seminar

In 2003, The University of Western Australia (UWA), in collaboration with researchers and coral reef managers, held the first of what is hoped to be a series of community-based marine science information seminars. Held in Coral Bay, the seminar aimed to foster communication between scientists, managers and the local community, by presenting the results of research into a number of ecological issues affecting both local residents and the overall health of the reef. In particular, the seminar sought to emphasise the importance of facilitated education as a potential conservation tool.

One of the feature topics was the presentation of information about the natural coral die-off events that have repeatedly occurred in Coral Bay. CALM Exmouth District Manager Jennie Cary (previously Senior Marine Ecologist at CALM) explained how coral spawn—consisting of sperm and eggs—could become trapped within embayments during periods of low wind, where it subsequently died. This process, in certain environmental conditions, removes most of the oxygen from the water and effectively suffocates the marine life. This entirely natural phenomenon has impacted parts of Coral Bay at least three times in the last 20 years, resulting in the death of numerous corals (particularly in the nearshore zone) and the death of an estimated one million fish.

Recovery of corals following these events is painfully slow, likely to take place over years or decades. James Gilmour, a UWA PhD candidate and Australian Institute of Marine Science (AIMS) researcher, explained that knowledge of where and why coral larvae settled was important for conservation and management of reefs, because areas that received high levels of recruitment may recover faster than areas with a low supply of larvae. James Gilmour and his AIMS colleagues have measured differences in coral recruitment at various spatial scales and determined that some parts of the reef have consistently high recruitment, while others, such as Bills Bay (the central Coral Bay lagoon) do not. Consequently, Bills Bay corals have recovered only marginally from the catastrophic mortality following a coral spawning event in 1989.

Several other aspects of the reef's ecology were also outlined: Josie Dean from CALM summarised the success of CALM's *Western Shield* program, which aims to bring threatened animals back from the brink of extinction through baiting for feral animals. Predation by foxes on turtle hatchlings and destruction of nests by recreational vehicles are major threats to Ningaloo's turtle species. The baiting program, which uses the naturally occurring poison 1080, has so far been effective in reducing the number of foxes and has decreased the threat posed by feral animals to the hatchlings and their nests.



UWA's Glenn Shiell presented the findings of his investigation into the ecology and reproduction biology of sea cucumbers. Although they are often incorrectly referred to as 'sea slugs', these creatures are more closely related to sea stars, sea urchins and feather stars. The growing popularity of sea cucumber as a delicacy in China has led to the near extinction of some species in many parts of the world, including Ashmore and Cartier reefs in the far north-west of WA. Science is now striving to better understand the significance of these interesting animals, which have clear benefits for the functioning of coral reef ecosystems. Sea cucumbers ingest sand and other small particles on the seafloor and digest any organic matter, thereby fulfilling an essential role in the recycling of nutrients within coral reef ecosystems.

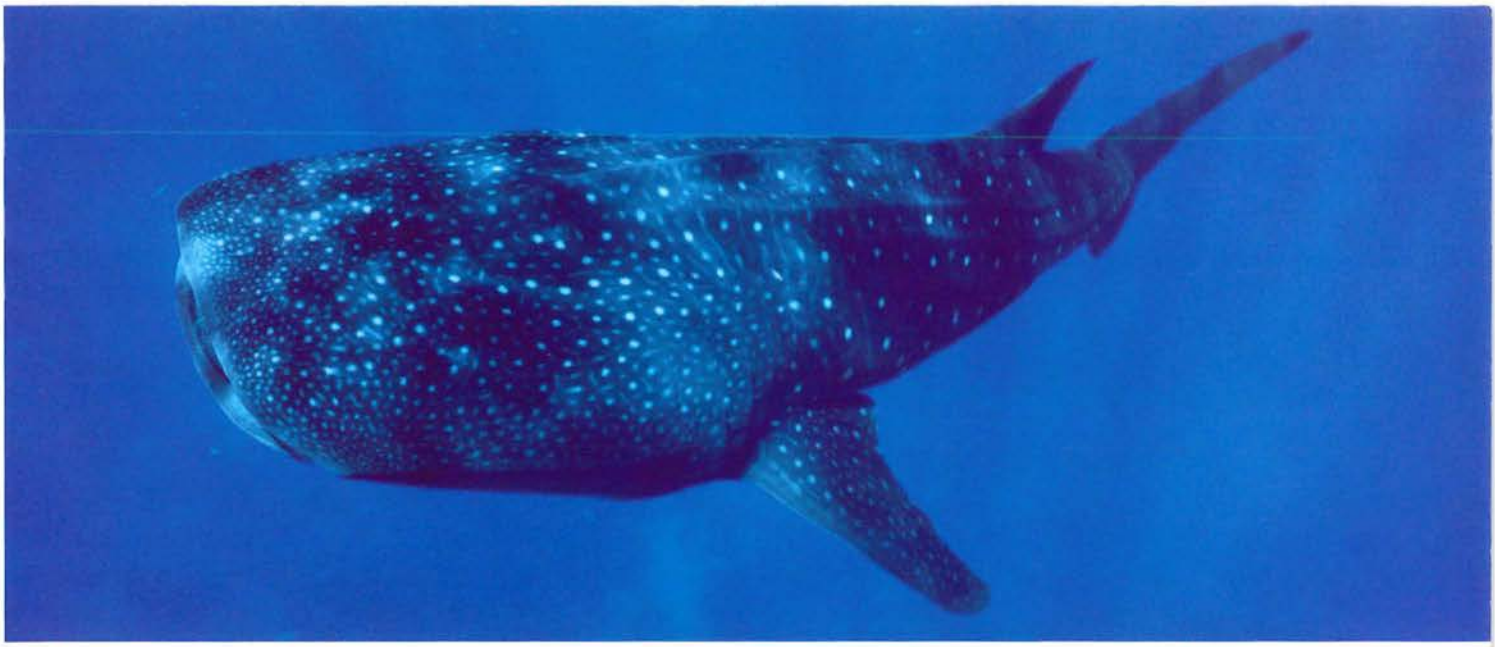
Diverse ecosystem

Ben Fitzpatrick presented the results of a collaborative survey with Murdoch University into the marine ecology of Bateman Bay (just north of Coral Bay). Ben explained that Bateman Bay was an ecologically diverse ecosystem. Bateman Bay, including its under-appreciated sandy habitats, provides important habitat for many marine creatures, including the spectacular manta rays, humpback whales, Indo-Pacific humpback dolphins and dugongs. Incidental observations and anecdotal evidence provided by charter operators indicate that the bay is a nursing or feeding area for these animals. Fifty five species of juvenile fish are known to inhabit the nearshore reef and seagrass habitats of the bay, including the recreationally

Top left At Coral Bay, Ningaloo Reef lies in very close proximity to the shore.

Centre left Green turtles are quite common in and around Coral Bay.

Left Giant clams are very common in Ningaloo Marine Park and can be seen in shallow water.
Photos – Steven Thorne



Above Whale sharks are an iconic megafauna species of Ningaloo, and draw thousands of tourists each year.
Photo – Jeremy Colman

Right Frog fish.
Photo – Steven Thorne

targeted spangled and red emperor species. Bateman Bay also provides nesting and feeding habitat for loggerhead, green and hawksbill turtles. This survey provided an ecological context of the potential effects of a proposed development of a marina and resort complex just north of Coral Bay.

Finally, UWA PhD candidate Sarah Gardner outlined her proposed research into the manta ray aggregations on Ningaloo Reef. The interesting and gentle nature of manta rays has led to a lucrative tourist industry that provides people with an opportunity to swim with these creatures. As this industry continues to expand, there is a clear need for baseline information on the biology and behaviour of manta rays. Sarah aims to research the variability of manta ray populations, their behaviour and habitat use, and the potential impacts of interaction with people.

The seminar was attended by an enthusiastic crowd of more than 100 people, including tour guides, local residents and visitors from outside the region. It was abundantly clear that the local community were extremely appreciative of the delivery of up-to-date information on topics of direct relevance to their local environment and ecology-based businesses. It was clear from the positive feedback that information presented on the night would be passed on to visitors.

One thing is certain. Careful planning, active communication between governments, the local community and research scientists, and a greater emphasis on community education are crucial to efforts to conserve Ningaloo Marine Park. Only such coordination, combined with greater educational resources, can lead to environmentally and socially responsible conservation outcomes.

Glenn Shiell is in the School of Animal Biology at The University of Western Australia and can be contacted on (08) 6488 3970 or by email (cucumber@cyllene.uwa.edu.au).

Ben Fitzpatrick is in the School of Plant Biology at The University of Western Australia and can be contacted on (08) 6488 4733 or by email (oceanwise@bigpond.com).

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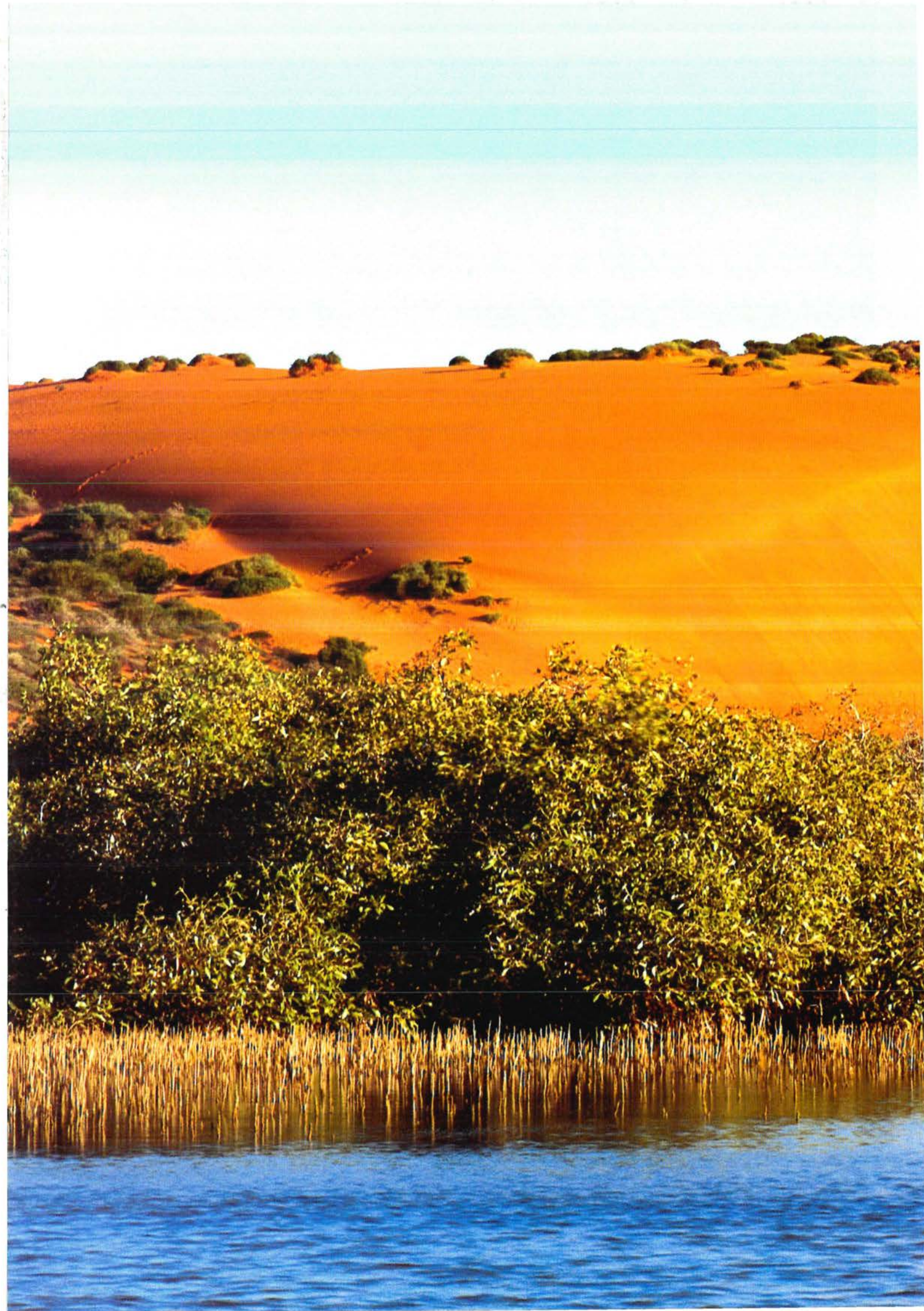


The **Geraldton** to **Shark Bay** sandplain

A strikingly beautiful biodiversity hotspot

A biologically significant area, the Geraldton to Shark Bay sandplain is home to rich and diverse plant and animal life. A number of acquisition and rehabilitation projects are working to restore the area to its former state and protect it from threats.

by Samille Mitchell and Maria Lee

Take the time to wander through an expanse of native bush in the Geraldton sandplains bioregion (which includes Shark Bay) and you'll discover a natural wonderland rich in strikingly beautiful landscapes and plant and animal life. Tiny reptiles scurry through the undergrowth, birds soar on the winds above and rare marsupials hide in the undergrowth. The flora is especially impressive in spring, when the true nature of this incredibly biodiverse region is revealed. For, in spring, the earthy colour of the soils and the greens and browns of the bush erupt into seas of dazzling colour. Brilliant yellows, pinks and whites carpet the landscape as everlastings burst into bloom. The bushland explodes with the colour of thryptomenes, grevilleas, eremophilas and a kaleidoscope of other flowers—all with their own unique design.

However, many of these animals and much of this spectacular annual wildflower display are confined to roadsides and conservation reserves. You see, large tracts of this flora-rich landscape have succumbed to pressures such as land clearing, stock grazing and weeds. The biodiverse nature of the region and the fact that it is threatened has earned the Geraldton to Shark Bay sandplain its position as a national biodiversity hotspot.

The Geraldton to Shark Bay sandplain hotspot also falls within the confines of the south-west of Australia—an area listed as an international biodiversity hotspot. This listing also recognises the region's biodiverse nature, endemic species and the fact that it is under immediate threat.

What's a hotspot?

Biological diversity—these days more commonly known as biodiversity—has arisen as a result of millions of years of evolution. Each species has evolved and adapted to result in today's incredible selection of life. This myriad of living diversity is forever dynamic, increasing with the onset of a new genetic variation, a new species or a new ecosystem and decreasing when species become extinct, when genetic variation decreases or when an ecosystem dies.

Hotspots are areas that are rich in plant and animal species, particularly endemic species, that is, species that live nowhere else in the world. If the world were to lose any of these areas, it would also lose the plants and animals that inhabit them. In the case of endemic plants and animals, these species would be lost forever.

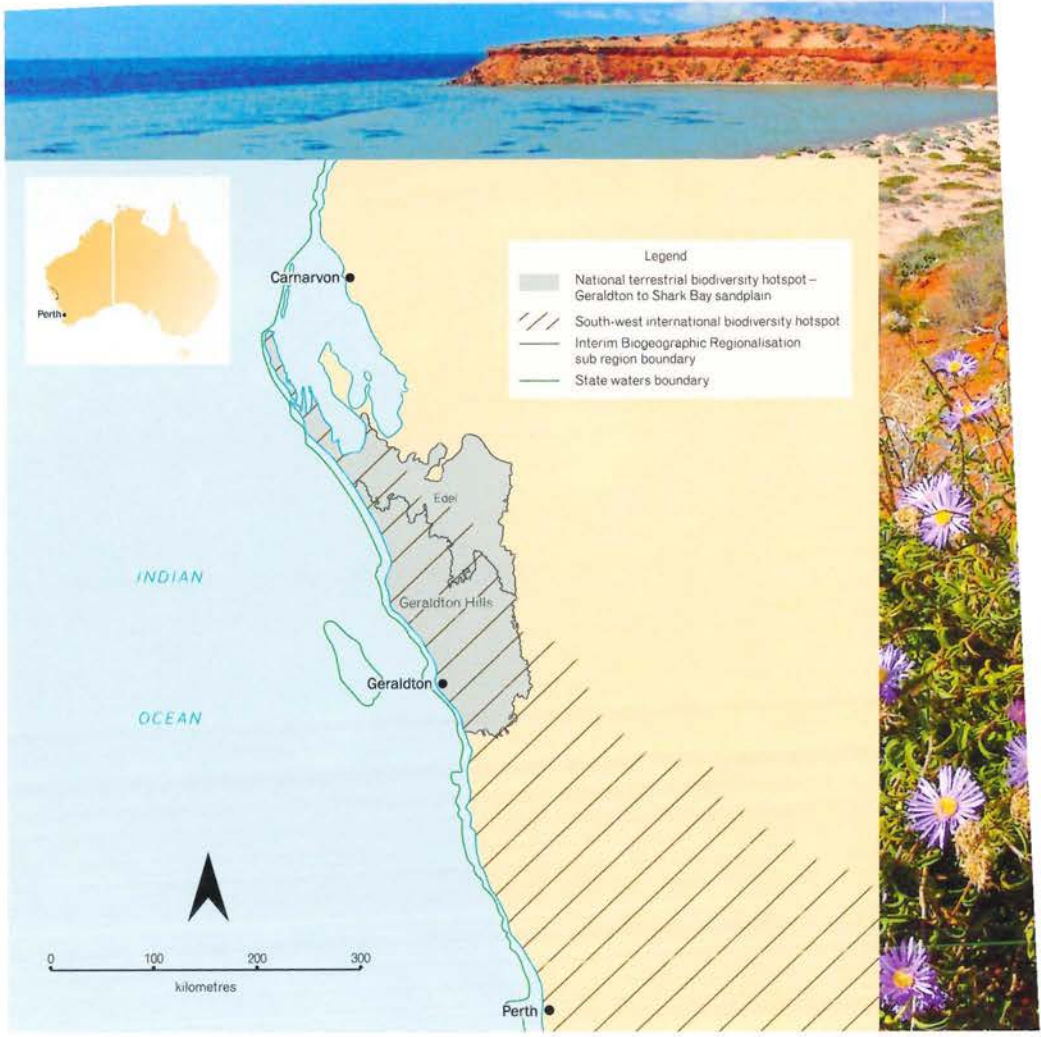
While this is an abhorrent thought, it is a possibility. To be classified as a hotspot, a region must also be under immediate threat. This means the region's plants and animals could succumb to impacts such as land clearing, development pressures, salinity, weeds and feral animals. Classifying these special areas as biodiversity hotspots is designed to raise public awareness of our environmental heritage at risk and to support strategic actions to conserve it.

There are two levels of hotspot rating—international and national. Conservation International, a non-profit international organisation working to conserve the Earth's biodiversity, identified 34 international

Previous page
Main Sand dunes at Cape Lesueur, in Francois Peron National Park.
Photo – Jiri Lochman
Inset Thorny devil.
Photo – Cliff Winfield

Above A sea of wildflowers south of the Overlander Roadhouse.

Left Everlastings.
Photos – Samille Mitchell



Above The Murchison River in Kalbarri National Park.
Photo – Samille Mitchell

biodiversity hotspots across the globe, of which one lies in Australia—the south-west of Western Australia. This region stretches from the southern shores of the State, north to Shark Bay. Conservation International selected these special areas because of their plant diversity.

To qualify as a hotspot, a region must support 1500 endemic plant species—0.5 per cent of the global total. As well as this unusually high species number, to be classed as a hotspot the region should also have lost at least 70 per cent of its primary vegetation.

Following the lead of Conservation International, the Australian government's Threatened Species Scientific Committee, and recognised experts in the field, identified 15 national biodiversity hotspots in Australia in 2003—the first government in the world to do so. The guidelines for selection were not as exacting as for international hotspot classification, but the results are the same—recognition of areas of high biological diversity that are under threat. By classifying these areas, the government has earmarked them for special protection and funding.

Biological importance

The Geraldton to Shark Bay sandplain biodiversity hotspot sweeps from the Shark Bay peninsulas, at the westernmost tip of Australia, to the patchwork of rolling hills around Geraldton and Dongara. It includes landscapes as varied as the sand dunes of Shark Bay's Francois Peron National Park to the plummeting river gorges at Kalbarri National Park and the flat-topped slopes of the Moresby Range near Geraldton.

The region is the meeting place of the South-West and the Eremaean botanical provinces. This makes for an unusually diverse selection of flora. Here, you'll find the cooler climate plant varieties of the south-west, such as banksias, growing side by side with desert plants of the semi-arid north and interior, like eremophilas. What's more, this region has also recently become known for its examples of gigantism, that is, species growing in forms much larger than normal.

However, many of these flora species have suffered the consequences of threats such as grazing and land clearing. Some 25 plant species have been declared critically endangered, 23 are endangered and 17 are vulnerable.

Animals in the Geraldton to Shark Bay sandplain are just as important to biodiversity. This region is so diverse in reptiles, particularly in the north, that some nine reptile species in the Shark Bay area are found nowhere else in the world. However, more than 40 per cent of the region's original mammal fauna is now regionally extinct. Three mammal, three turtle and two bird species have been declared endangered and five mammal, seven bird and two reptile species are vulnerable. These include the malleefowl, bilby, Baudin Island spiny-tailed skink, woma python, black-footed rock-wallaby and tammar wallaby.

Threats

While the Geraldton to Shark Bay sandplain boasts an incredible selection of plant and animal life, these seemingly hardy life forms are

Left Skipjack Point, Francois Peron National Park.
Photo – Samille Mitchell

Peron Peninsula – a haven for threatened wildlife

Peron Peninsula is home to one of the most successful captive breeding and reintroduction projects in the State—Project Eden (see 'Approaching Eden', *LANDSCOPE*, Autumn 1998). Here, on the rust red sand dunes among the desert shrubs, some of the State's most threatened mammal species have been given another chance to become reestablished.

These mammals once roamed the peninsula naturally. In 1801, when François Peron visited on the Nicolas Baudin expedition, some 23 species of mammals were present. However, by 1990, less than half of these species remained. Predation by ferals such as cats and foxes, habitat destruction, and competition for food by stock and rabbits had taken a deadly toll.

After the State government purchased the former Peron Station, CALM removed all the station's sheep and cattle in 1994 and more than 12,500 goats, prior to making part of the area a national park. The following year, CALM erected a 3.4-kilometre, two-metre-high fence across the peninsula to control reinvasion from the south and embarked on extensive baiting of feral animals, through its massive *Western Shield* program. This proved highly successful at eradicating foxes and cut the cat population by 50 to 70 per cent.

Next, CALM reintroduced locally extinct animals such as the woylie, bilby, malleefowl, banded hare-wallaby and rufous hare-wallaby. The banded hare-wallaby and rufous hare-wallaby introductions floundered because of cat predation and starvation during drought but the malleefowl, woylie and bilby populations flourished. Indeed, the bilbies bred to the extent that the Peron reintroductions are regarded as the most successful yet.

During this time, CALM established a captive breeding centre to provide animals for reintroductions. The centre has since bred more than 450 animals.

Today, CALM continues to control feral animals through baiting and trapping programs and plans further releases of native animals. With continued work, one day Peron Peninsula's animal population may approach something akin to that which François Peron himself enjoyed more than 200 years ago.

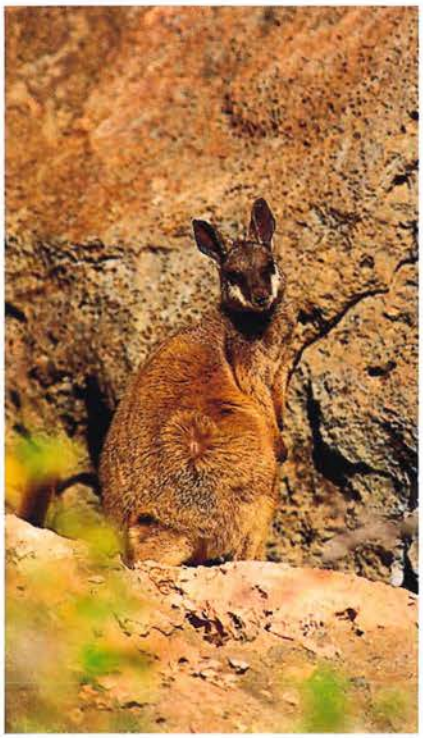
threatened by a range of impacts—largely caused by people.

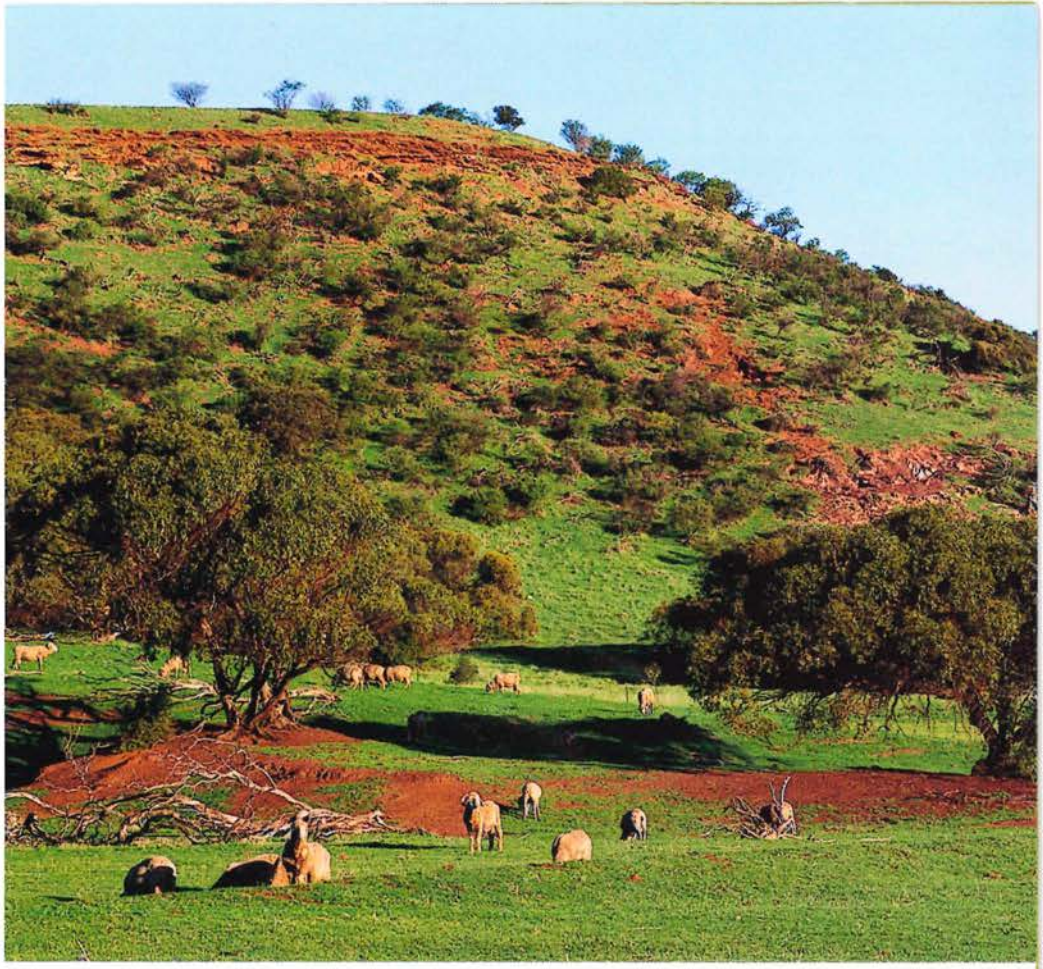
Land clearing, livestock grazing, weed introduction, and feral animal predation and competition for food have brought about the demise of several mammal species and put many endemic flora species under threat. Just 14 per cent of the Geraldton Hills subregion is protected in conservation reserves, while 64 per cent is used for dry land agriculture. Of the conserved area, 68 per cent lies within the Kalbarri National Park. In Edel subregion a large proportion of the land is used for pastoral purposes.

While land clearing is not as much of a problem that it is in southern regions of WA, it has had some effect throughout the region, particularly around Geraldton. Here, large tracts of land have been cleared for agricultural purposes. In many areas only land unsuitable for farming, such as the Moresby Range and breakaway country, remains. This reduces the amount of native flora in a region and results in destruction of habitats for native wildlife. In severe cases, it can also contribute to serious widespread environmental problems throughout the agricultural landscapes.

Although the Geraldton to Shark Bay sandplain has escaped much of the perils of land clearing, livestock has taken a heavy toll. The hooves of countless sheep and cattle have roamed the region's pastoral plains during the past 100 years, trampling native flora in the process. This has contributed to erosion, lack of feed for native animals and destruction of habitats. While pastoralists today are much more environmentally aware than in previous times, their work to remedy the effects of overgrazing will take years. In many areas, the effects of overgrazing are clear—landscapes once covered with vegetation are degraded.

Introduced species have also taken a toll on the region's natural environment.





Above Black-footed rock-wallaby.
Photo – Jiri Lochman

Above right The Moresby Range.
Photo – Bill Belson/Lochman Transparencies

These weeds strangle native vegetation and take over entire ecosystems, wiping out habitats and food sources for native animals in the process. Over time, these weeds can also transform landscapes from areas of shrubland to open communities that are more prone to fire. Weed growth is generally greatest in areas of disturbance.

The spread of feral animals into the Geraldton to Shark Bay sandplain is a key reason for the alarming extinction rate of native mammals in the region. Foxes in particular, and probably cats, have decimated small mammal populations. Native species like the Shark Bay mouse, boodie, rufous hare-wallaby, banded hare-wallaby and western barred bandicoot are now restricted to islands such as Bernier and Dorre, 50 kilometres from Carnarvon. These islands have remained free of cats and foxes and are tiny remnants of these species' former range.

While foxes and cats prey on the native mammal and reptile species, rabbits, goats and pigs compete for food, trample native vegetation and soil and erode landscapes by grazing the native growth. Together, these species are also responsible for native plant and animal decline.

Protecting wildlife habitats

The Department of Conservation and Land Management (CALM) has embarked on a host of initiatives to protect the wildflowers, wildlife and ecosystems of the Geraldton to Shark Bay sandplain. Key to this protection is the *Western Shield* program—CALM's Statewide battle to combat introduced predators and reintroduce native animals into their former habitats. The program has three main focuses: baiting foxes on an unprecedented scale, controlling feral cats and reintroducing native animals. In the Geraldton to Shark Bay sandplain area, the program has been most used in Francois Peron and Kalbarri national parks.

CALM has also embarked on a major land acquisition program, selectively purchasing pastoral leases from owners looking to sell. In the Geraldton to Shark Bay sandplain region, CALM manages Francois Peron National Park (part of what was once Peron Station and now the site of Project Eden—see box opposite) and has purchased Nanga Station. The State government recently agreed to purchase the historic and biologically important Dirk Hartog Island from the current owners of the island's pastoral lease. It is also negotiating to take on the northern portion of Carrarang Station (see 'Steeped in beauty' on pages 10-17). By managing these areas, CALM hopes to dramatically increase the relatively small proportion of land protected in conservation reserves. The removal of stock will allow the land to rejuvenate and encourage native plants and animals to return.

Samille Mitchell is a Perth-based freelance journalist and photographer who specialises in travel and environmental topics. She can be contacted on 0407 998 721 or by email (samille@wn.com.au).

Maria Lee worked on the NHT2-funded and Northern Agricultural Catchment Council-administered Biodiversity Hotspots Project. She is the Crown Reserves Officer for CALM's Midwest region and can be contacted on (08) 9964 0910 or by email (mariaL@calm.wa.gov.au).

Julimar
turning full circle

Just 100 kilometres north-east of Perth is an 'island' of woodland with an interesting past and an important future. Surrounded by farmland, **Julimar Conservation Park**, as it is now known, was used by early pastoralists. Later, it was partly cleared for farming and harvested for timber, and has also been used for beekeeping and armed forces training. Today it fulfills an ongoing and significant conservation role.

by Brent Johnson,
Alice Reaveley and
Keith Morris

At nearly 28,000 hectares, Julimar Conservation Park is a sizeable, very attractive area of mixed jarrah (*Eucalyptus marginata*) and marri (*Corymbia calophylla*) upland woodland with often thick parrotbush (*Dryandra sessilis*) understorey, valleys with open wandoo (*Eucalyptus wandoo*) woodland and outcrops of powderbark (*E. accedens*) on the lateritic breakaways. Nyoongar people would have been attracted to the area for hunting and gathering, as it contained a high diversity of plants and animals. The abundant grasstrees (balga), with their multiple uses and reliable bardi grub supply, along with honey drinks from the dryandra flowers, would have been among the attractions. There were also several freshwater springs within or near Julimar, however, many of those are now saline.

It was the valleys with their creeks, loamy soils and open wandoo woodlands that first attracted European settlers. These valleys proved easiest to clear and supported good pasture. Nearly half the area was taken up for farming under conditional purchase

leases. Only about half of these properties were cleared but, by the 1930s and the onset of the Great Depression, most farmers were forced to abandon the land. The leases reverted to Crown land and the area eventually became State forest in 1956.

By this time, Julimar had been subjected to years of unrestricted timber cutting and firewood collecting. On the other hand, it had been well protected from high intensity bushfires, the result of regular burning by beekeepers seeking to protect the wandoo trees and dryandra shrubs, their main source of honey. When the land was vested with the Forests Department in 1956, all timber harvesting and other activities in the area came under strict controls. Thereafter, several licensed contractors operated in the area, supplying jarrah and wandoo logs to sawmills at Bindoon, Bolgart, Northam and in the Swan Valley. Additional industries—such as charcoal manufacture, at Wundowie, and tannin extraction, utilising wandoo trees, based in Toodyay—thrived during the late 1950s and through much of the next decade. A small Forests Department settlement was established and a succession of young, eager foresters, assisted and guided by bushwise forest workmen, forged their early careers controlling the timbercutters, improving the road network and regenerating harvested areas. The burning programs carried out by the beekeepers were continued, wildfires were suppressed and a fire lookout tower was erected.

Over the years, Julimar woodland has attracted interest on many fronts. Beekeeping for honey production has long been associated with Julimar, no doubt due to the flavours imparted by the abundant dryandra species and wandoo trees. Beekeepers are still very active in the area. Licensed wildflower pickers have also operated there. Nature lovers have regularly visited the area since the 1960s.

In 1966, with the impending closure of the Avon Valley Army Training Area (now the Avon Valley National Park), the Department of Defence sought a land swap and the Commonwealth government assumed management of the northern third of Julimar State forest to establish a new defence training facility. This facility is now an integral and important part of the Australian Army's training capabilities. The area remains mostly uncleared and retains the intrinsic values of the adjoining conservation park.

Previous page
Main Grasstrees in Julimar Conservation Park.
Photo – Sallyanne Cousans

Left Apiary site in wandoo woodland at Julimar.
Photo – Brent Johnson

Right Keighery's spikerush, a threatened plant, grows in a seasonally inundated area at Julimar.
Photo – Alice Reaveley

Below right CALM volunteer Megan Dilly with a goanna.

Below far right Past logging activity has created ideal habitat for chuditch.
Photos – Brent Johnson

The Water Corporation also showed interest in that area's potential as a water catchment at one time, describing Julimar Brook as 'one of the few remaining examples of a watercourse flowing through undisturbed wandoo'. Mining and agricultural interests have also given rise to many requests for access to the forest. Over the years, however, departmental officers have successfully defended Julimar from further fragmentation or tenure change. It was clear that the woodland had very high conservation value, a fact highlighted in the Conservation Through Reserves (System 6) report for the Darling Range in 1981.

Wildlife

As the sounds of the farming and timber industries faded into history, the woodlands which had been regenerated in their wake slowly but surely recovered. Early foresters and naturalists who worked at Julimar in the 1950s and 1960s noted the abundant wildlife, but a biological survey by the Forests Department in the 1980s failed to find any medium-sized mammals. Undoubtedly, a major factor was predation and competition from the introduced European fox, which began to flourish in the area in the mid to late 1960s as more of the surrounding land was cleared for agriculture. Feral cats were also present, and this predator is also believed to have played a role in the decline of many mammal species.

Prior to the implementation of widespread fox control under the Department of Conservation and Land Management's (CALM's) *Western Shield* wildlife recovery program, Julimar was selected as a suitable site to reintroduce the threatened chuditch (*Dasyurus geoffroii*). A recovery plan for this species had identified reintroduction to parts of its former range as a key strategy. The last record of these attractive marsupial carnivores from Julimar had been a roadkill in 1973. Fox baiting was commenced and individuals were selected for release from the breeding colony at Perth Zoo. The reintroduction began in spring 1992. Monitoring by CALM staff and numerous sightings by visitors and locals since then indicates that a relatively abundant population now exists.

Following the success of this program, woylies (*Bettongia penicillata*) and tammar wallabies (*Macropus eugenii*) have also been reintroduced to the area. Displaced brushtail possums (*Trichosurus vulpecula*) and quenda (*Isoodon obesulus*) from urban developments, such as new roads and subdivisions around Perth, have also been relocated to Julimar. Other species to benefit from fox control in Julimar include the western brush wallaby (*Macropus irma*), echidna (*Tachyglossus aculeatus*), goannas (*Varanus* spp.), carpet python (*Morelia spilota*) and smaller animals such as skinks and dunnarts.

Annual wildlife monitoring by CALM is conducted with the financial and logistical assistance of the Department of Defence. This monitoring includes parts of the

Left CALM carries out annual wildlife monitoring at Julimar Conservation Park.

Below left Carpet pythons have benefited from fox control at Julimar. This particular animal ate a radiocollared chuditch.
Photos – Brent Johnson

northern 'army land', where a flourishing chuditch population has reestablished. The Department of Defence funds the fox baiting of much of the training area. This assists with native wildlife recovery and also provides a substantial buffer for the conservation park by preventing foxes from reinvading from the north. CALM has also recently completed a study at Julimar investigating the possible impact of an alternative fox bait on chuditch.

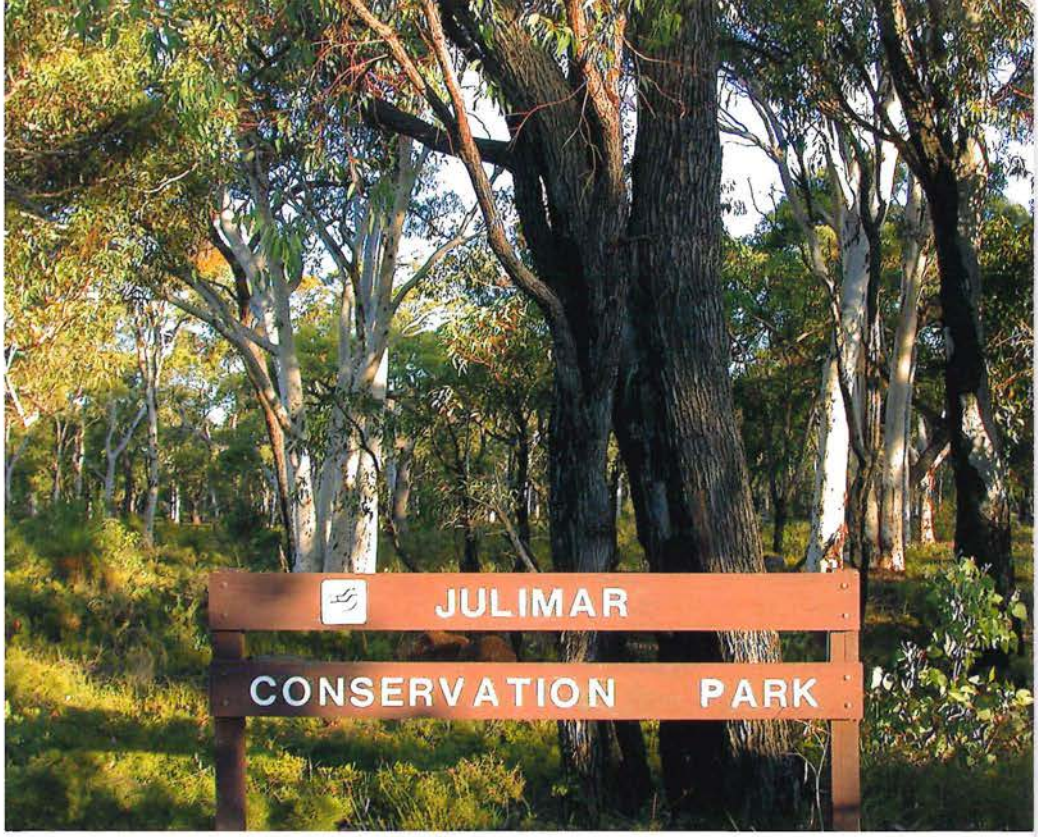
Birds and invertebrates are also abundant, with many species attracted to the prolific dryandra, banksia and eucalypt flowers. More than 50 bird species have been recorded and many have breeding sites within Julimar.

Wildflowers

Julimar consists of lateritic uplands and dissected lateritic slopes supporting open jarrah and marri forest, with moderately incised valleys clothed in open wandoo woodland, with some jarrah and powderbark. Extensive stands of many-headed dryandra (*Dryandra polycephala*), pingle (*Dryandra squarrosa*) and many-headed smokebush (*Conospermum polycephalum*) grow throughout the reserve. There are smaller areas of banksia woodlands, granite outcrops, creeklines and swampy areas.

Because of this habitat diversity, and the fact that Julimar lies at the boundary of two major biogeographic regions, the reserve has a rich flora of more than 500 flowering plants. Particularly noticeable are the banksia family, with 43 species, and there are more than 30 orchids and 28 triggerplant species. This gives an amazingly colourful spring display. Two species of declared rare flora are known from Julimar. One is an aquatic species, Keighery's spikerush (*Eleocharis keigheryi*), which grows in a seasonally inundated claypan in the north-west corner of Julimar. This wetland of open mohan (*Melaleuca viminea*) scrub over open low sedges of black bristlerush (*Chorizandra enodis*) is an unusual vegetation community within Julimar and also contains a suite of priority species, including white-tip myriocephalus (*Myriocephalus appendiculatus*), aquatic pennywort (*Hydrocotyle lemnoides*), floating bog-rush (*Schoenus natans*) and jumping jacks (*Stylidium longitubum*).

The other species of rare flora at Julimar is Bindoon starbush (*Asterolasia nivea*), a small shrub up to 50 centimetres high with small white star-shaped flowers, inconspicuous sepals and aromatic leaves when crushed. The main populations of this species grow in Flat Rock Gully Nature Reserve, to the east of Julimar. However, one population occurs in Gallagher Forest Block, which is separated from the main block of Julimar by private property but proposed for inclusion in the conservation park.



Right Mixed woodland is typical of Julimar Conservation Park.
Photo – Brent Johnson

Recreation

As most management effort has been aimed at protecting and restoring the nature conservation values, especially the wildlife, there are no camping areas, picnic sites or toilets at Julimar. However, due to the decades of logging and other commercial activities, a network of tracks weave through the conservation park. These can be used by bushwalkers and four-wheel-drive enthusiasts for camping, birdwatching and nature appreciation activities. The low level of visitation, compared to better known parks and reserves closer to Perth, provides a unique experience, with minimal disturbance away from the hustle and bustle of the city.

Management

Because of its proximity to the metropolitan area and other large towns such as Toodyay, illegal firewood collecting has been a management problem at Julimar. However, increased public awareness and enforcement has reduced this activity over the last few years. Random patrols are undertaken by CALM wildlife officers and there is a heavy penalty for illegal firewood collection. Hollow logs and standing dead trees are particularly important in Julimar as refuge sites for wildlife.

Commercial beekeeping is still undertaken at Julimar, although commercial wildflower pickers no longer harvest many-headed dryandra (*Dryandra polycephala*) for dried floral arrangements following the proposal for this land to become a conservation park.

Trail biking and off-road driving are not allowed at Julimar, as this activity is inconsistent with its purpose as a conservation park. So far, Julimar has managed to avoid excessive impact from these activities, with trail bike and off-road users opting for more hilly terrain closer to Perth. Similarly, horse-riding is discouraged at Julimar, particularly as horses can potentially introduce weeds in their dung.

CALM's Perth Hills District recently completed an overhaul of the tracks throughout Julimar. Strategic boundary and internal tracks required for management operations were cleared to their original width and graded to an appropriate standard, while old minor logging tracks were left ungraded and will be allowed to overgrow. *Phytophthora cinnamomi*, the plant pathogen that causes the disease known as dieback, occurs in isolated pockets of jarrah forest at Julimar. Consequently, management operations are only undertaken in dry soil conditions and recreational four-wheel-drives should always remain on designated tracks to avoid spreading *Phytophthora*.

The various woodland blocks that make up Julimar are burnt under prescribed conditions every 10 to 15 years, depending on the amount of plant litter. The resulting mosaic of fuel ages throughout the entire forest enables an optimal range of biodiversity values to be maintained and also prevents a large wildfire from consuming the whole park. One section of Julimar has been designated as a 'no-burn' area and fire has been excluded by burning off from around its edge. This area is used as the release site for woylies, tammar wallabies, possums and quenda, providing a dense understorey in which the animals can shelter before their initial foray to explore their new home.

The Julimar Conservation Park stands today as an excellent example of a mixed age, multi-species woodland. It has survived the many battles waged for its attributes and uses. It now offers nature lovers a relaxing and interesting forest experience, yet is relatively close to the Perth metropolitan area. With a diversity of habitats, interesting wildflowers and abundant refuges, the native animals that were once so common have returned to inhabit this unique 'island'.

Brent Johnson is a Principal Technical Officer with CALM's Science Division based at Woodvale. He can be contacted on (08) 9405 5100 or by email (brentj@calm.wa.gov.au).

Alice Reaveley is a Nature Conservation Officer with CALM's Perth Hills District. She can be contacted on (08) 9295 1955 or by email (alicer@calm.wa.gov.au).

Keith Morris is a Senior Principal Research Scientist with CALM's Science Division based at Woodvale. He can be contacted on (08) 9405 5100 or by email (keithm@calm.wa.gov.au).

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urban antics by John Hunter

Moving poles

About a year ago, it occurred to me that I could no longer drive to work—or anywhere else for that matter—in the same time or carefree manner that I had been accustomed to over the last 40 years. I'm feeling the squeeze, the rush and the uncomfortable need to share scarce resources with a burgeoning population. Perhaps I now know how the quendas in new outer suburbs are feeling, as the creep of human development also encroaches on their habitat.

It is strange how some human 'improvements' to our urban environments have changed things for the better and yet at the same time... for the not so good.

Take the recent changes to underground power in some suburbs. For decades, the grey jarrah power poles, bedecked with a finery of crossbars, insulators and wire, covered our streets like rampant bramble bush. On the other hand, this high flat perch, level with my sitting room window, although a blot on the view, provided a keyhole scene of wildlife interaction. The post top often resembled a butcher's chopping block, as nomadic birds of prey went about their meals. Not to mention the spreader bars, where gangs of galahs, cuckoos and twenty-eight parrots squabbled and wobbled precariously between wires that could have conceivably turned them into shish kebabs.

The spring rush by brooding honeyeaters for insects and spiders always saw the sagging feeder wire to a house become a sway bridge of 'pedestrian' traffic, as these feisty gluttons paraded, then attacked, the new season's webs under eaves and shrubs. Multicoloured hairy caterpillars could be seen climbing the fissured timber to cocoon for their next stage of life, as millions of termites poured out of some pole crowns like living molasses to seemingly evaporate in search of a new queen.

High summer around the poles rewarded observers with the spectacle of reflective sunlight shimmering iridescent green and bronze. Here, aerobatic bee-eaters chased dragonflies through, over and around the maze of wood and wire on which they later perched in pairs to consume their prey and preen.

The removal of the poles and their adornments had an immediate effect on all. Homeowners immediately felt a euphoric exposure to the rest of the world. It was as though there was no longer a protective canopy, no extraterrestrial dreamcatcher. Then there was that feeling of utter crapulence as people realised the value of property had increased by 20 grand. Strange reactions also occurred among local fauna.

Territorial kookaburras that always had a set routine patrolling boundaries were seen to falter in mid-flight, do two 'panic circles', then head towards a newfangled light standard 50 metres away on the opposite verge. Here, they crash-landed and toppled in frantic disarray to the ground. I've never seen one stare upwards before.

Then there was the shih tzu cross, a terrier dog of great pride that raced down the drive onto the verge, cocked a leg into the breeze and peed on himself as he toppled into a vacant 'space'.

The new British Racing Green painted steel poles were also playing havoc with other species. Fence skinks tried to claw their way skywards, only to find it was two steps up and one step back, as the hot glossy surface took its toll. On the other hand, white bush snails have discovered a wonderful smooth dark surface on which to park for the day, a disaster if discovered by small children on the way home from school. Such is life.

DID YOU KNOW?

- Pelicans are the masters of light pole landings. They can be seen from time to time roosting comfortably along the Kwinana Freeway between the zoo and the river.
- Some high-tension wires crossing the flight paths of night flying swans and ducks on the coastal plain have had reflective indicators attached to help prevent collisions.

North, south and somewhere in between ...

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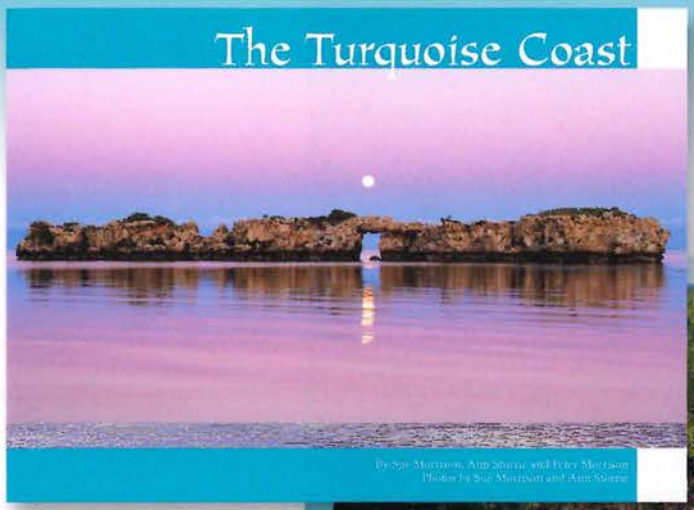

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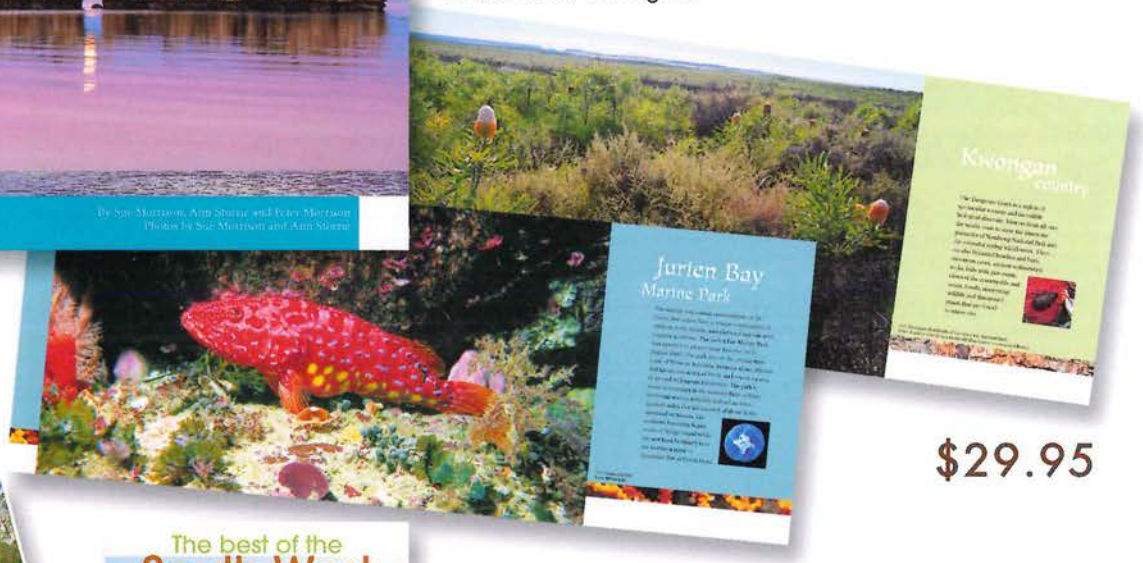

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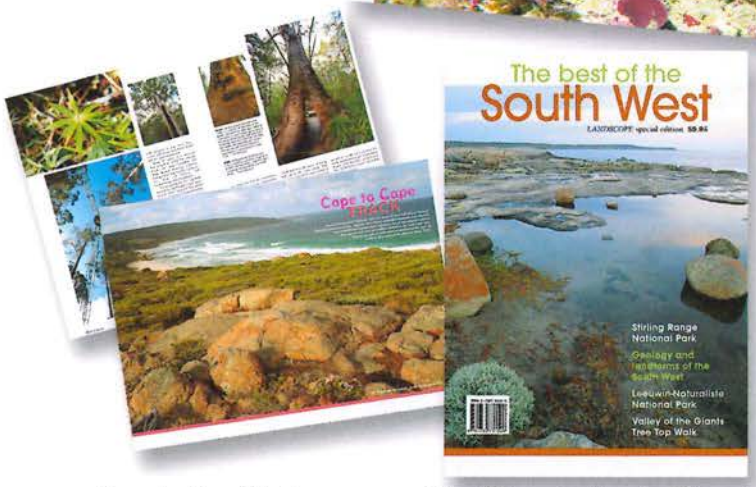

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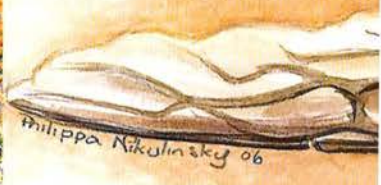

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