

How to bring Karijini National Park into your home for a whole month.

The new LANDSCOPE 1996 calendar.

It's here again — an exquisitely photographed calendar from LANDSCOPE. Thirteen beautiful pictures that capture this captivating State from top to toe. At only \$15.95, this new calendar is a visual knockout!

- Breathtaking photograph for every month
- Geographical descriptions of the areas photographed
- Location maps
- Historical notes by key dates
- School and public holidays clearly shown

Get your copy now \$15.95 (+ \$3.05 postage and handling)

Phone (09) 334 0333 [or TTY (09) 334 0546] and use your credit card or post your order (see tear-out order form between pages 8–9) with a cheque or money order to: *LANDSCOPE* Calendar, PO Box 104, Como, Western Australia 6152 or visit our main office at 50 Hayman Road, Como. Also available at major bookshops, newsagents or card shops throughout WA.

A CALM publication DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT



The threatened Wyalkatchem foxglove is being given a helping hand by scientists from CALM and Kings Park and Botanic Garden (see page 17).



A new CALM book, Dive & Snorkel Sites in Western Australia, will encourage novice divers and snorkellers to explore the rich and diverse coastline of WA. See 'Secrets of the Sea' on page 10.

LANDSCOPE

VOLUME ELEVEN NO. 1 SPRING ISSUE 1995



This nesting pair of splendid fairy-wrens is one of the many 'Birds of the Stirling Range' (see page 36).



WA Goldfields timbers are fast becoming recognised as prime materials for producing world-class musical instruments. See 'Musical Timbers' on page 48.



The common rock-rat, photographed here in the Kimberley, has recently been recorded in the Kennedy Range National Park. See page 28 for a profile of this wonderful wilderness area.

	F	E	A	1	U	H	E	S	
SEC	CRETS	OF 1 Homs	THE S	EA					10
WIL	LTHE	WYA	LKAT	CHE	M FOX	GLO	VE SU	RVIVE	-?
MIKE	O'DON	IOGHL	JE & K	EN AT	KINS				. 17
AFT	ER TH	IE BL	JRN						
MAN	DY CLE	WS &	NEILE	BURRC	WS				. 21
KEN	INEDY	RAN	IGE N	IATIO	NAL	PARK			
DAVI	d gou	GH & I	RON S	HEPHE	ERD				. 28
BIRI	DS OF	THE	STIR	LING	RAN	GE			
ALLA	N BUR	BIDGE	& ALL	AN RO)SE				36
CUT	TING	OUT	THE	LEAF	MINE	R			
IAN	ABBOT	T, PAL	JL VAI	N HEU	RCK,	том в	URBID	GE &	
ALLA	N WILL	.S							. 43
MUS	SICAL	ТІМВ	ERS						
FELD	X SKOV	VRONE	K & 14	N KEA	LIEV				48

	R	E	G	U	L	А	R	S	
IN PE	ERSP	PECTI	VE						4
BUS	H TE	LEGR	APH.						5
END	ANG	ERED) THEV	ENAR	d Isla	ND MO	OUSE .		20
URB	AN A	NTIC	S						54



Managing Editor: Ron Kawalilak Editor: David Gough Contributing Editors: Mandy Clews, Vera Costello, Kate Hooper, Carolyn Thomson, Penny Walsh Scientific and technical advice: Andrew Burbidge, Ian Abbott, Paul Jones, staff at CALM Science & Information Division (Woodvale) Design and production: Maria Duthie, Sue Marais Finished art: Gooitzen van der Meer Illustrations: Gooilzen van der Meer, Philippa Nikulinsky Cartography: Promaco Geodraft Marketing: Estelle de San Miguel = (09) 334 0296 Fax: 334 0489 Subscription enquiries: = (09) 334 0481 Colour Separation by Prepress Services Printed in Western Australia by Lamb Print © ISSN 0815-4465. All material copyright. No part of the contents of the publication may be reproduced without the consent of the publishers. Pubished by Dr s Shea, Executive Director Department of Conservation and Land Management, 50 Hayman Road, Como, Western Australia 6152.

N P E R S P E C T I V E

TIMBER WITH TIMBRE

One of the consequences of the over exploitation of the world's rainforests is that the unique woods required to give special tonal qualities to musical instruments are becoming increasingly difficult to obtain. In this issue of LANDSCOPE, lan Kealley and Felix Skowronek describe how timbers from Western Australia's amazing desert forest have the required timbre.

These desert forest timbers are also incredibly beautiful (see LANDSCOPE, Winter 1995). They have already been used to produce fine wood craft products, but recent research has demonstrated that these timbers have the potential to be used for high quality parquetry and fine furniture.

Western Australia already has a well-established fine furniture industry, based on one of the finest hardwoods in the world—jarrah—and one of the major features of WA's 1987 Timber Strategy was the incentives it provided for value adding within this industry. This value added strategy has worked.

Before 1987, less than 10 per cent of sawn jarrah timber was seasoned. (Wood has to be carefully dried before it can be used for high value products such as furniture.) Currently, more than half of jarrah sawn timber is kiln-dried, with major saw mills kiln-drying almost three-quarters of their output.

The research and investment in new plant and equipment that has now been carried out is allowing karri and marri sawn timber to be kiln dried, with the result that WA furniture manufacturers are now capitalising on the unique ornamental properties of these two timbers (see 'Bush Telegraph').

Western Australia's fine wood and furniture industry which is already significant—has the potential to become a major export earner and job creator for this State. There are few places in the world that have a large sustainable source of high-quality, ornamental timbers. But here in Western Australia, we have a wide range of highly ornamental woods, the skills necessary to manage the forests and an outstanding and creative group of artisans.

The fine wood and furniture industry is made for small business, and there is sufficient wood to sustain an industry employing 25 000 people. But even though there is a huge and increasing market for fine wood and furniture products, we, as a nation, are not good at marketing. This is one reason why LANDSCOPE will continue to 'do its bit' by featuring stories on Western Australia's fine wood and furniture products, and industry developments.

Byd Alea

The Publisher

MORE MAPS, PLEASE

I have been a subscriber to LANDSCOPE since I discovered the magazine in 1993, and just want to express my appreciation to you for such a splendid publication. It is interesting, diverse, well written and well illustrated.

The only negative that I can see is the lack of maps. You have a tiny location map at the beginning of most articles, but very rarely is there a more detailed map of anything. For example, in the current issue [Autumn 1995], the article 'Return to Eden' cries out for a map that would show such things as the location of Cape Peron, Monkey Mia, Heirisson Prong, the proposed position of the barrier fence, etc. TOM MCKNIGHT

LOS ANGELES, CA

Unfortunately, we sometimes forget that our overseas readers don't have easy access to maps of Western Australia, and are unable to pinpoint some of the places we mention in articles. We do try to get at least one map in each issue, but it's not always possible. An annotated satellite image of the Shark Bay area is found in our Shark Bay Special issue (Summer 1991–92), now reprinted. – Editor

MEMORIES OF YALGORUP

Congratulations on your wonderful article on the Yalgorup National Park. I visited the area many times as a lad in the late thirties and early forties.

Wildlife was prolific. Kangaroos, brush-tailed wallabies, tammar and numerous other small wallabies were plentiful, and wild figs were numerous also.

Birdlife was likewise prolific. All sorts of ducks, swans, wading birds, parrots, cockatoos and lorikeets were present.

I remember one old abandoned farm named 'Sunny Flat', with an enormous fig tree in the yard. I wonder if any part of it exists today. Standing in the yard and thinking about the early pioneers who lived there and what they must have gone through trying to develop it—the trauma and headache and hard work—all came back to me when I read your story.

My father, whose family were pioneers of the Bunbury and Australind districts, knew the area very well and worked as a guide for the surveyors and geologists, when they first visited the area to set up the lime kiln. In later time, my grandfather worked there, probably as an engine driver or similar capacity.

It is imperative that places like the lakes [of Yalgorup] are protected for the future by being made into national parks. All too often, we see beautiful parts of our State disappear in the name of development.

One only has to look at what development is doing to some of our northern coastal areas to realise how important areas such as Yalgorup National Park are. BRUCE TEEDE CARNARVON

I'm glad the article brought back fond memories for you. We've had difficulty finding out about 'Sunny Flat', but local residents Morgan and Maidee Smith remember a farm, like the one you describe, which was once at the head of Clifton Lake and owned by the McLartys. – Editor

EDITOR'S NOTE:

In the last issue of *LANDSCOPE*, in the article 'Fighting Wildfires', we stated in a caption that no CALM firefighters had been killed during fire control operations in the last 40 years. This statement was in error, and we apologise to the families of those CALM firefighters who died in the Nannup fire of January 1958 and the Shannon River fire of January 1963.

B U S H T E L E G R A P H

DRYANDRA TAKES TO THE AIRWAVES

High technology and environmental sensitivity are hallmarks of Western Australia's first radio drive trail at Dryandra Woodland, 20 kilometres north-west of Narrogin.

By simply turning on their car radios at designated stops along the trail, visitors can listen to six unique commentaries on Dryandra's past and present, as seen through the eyes of people who have lived and worked in the area. At each stop, the stories reveal the relationship between people and that particular location. They also provide insight into how the woodland can be sustainably managed.

Dryandra's rich history of human interaction includes that of Aboriginal people, foresters, farmers, researchers and tourists. As visitors tune in, they'll eavesdrop on a fire spotter's conversations, listen to the boom of the mallee fowl and hear about the lives and culture of the Nyoongar Aboriginal people. Narrators, including some CALM staff, bring the sounds of the past to life.

Solar and radio technology were chosen as an efficient and compelling way to share bush stories compiled from oral histories and other primary sources. Each story on the 25kilometre drive trail is carried by an individual short-range solar-powered transmitter, which broadcasts on 100 FM (100 MHz in the VHF band). Digitally recorded sound is played in a continuous loop so visitors can hear the full story no matter when they tune in.

This remarkably simple system includes a solar panel, a length of cable, a short whip antenna and the transmitter itself, which is housed in a waterproof box about the size of a toaster. Each system is mounted several metres above the ground and out of the visitor's line of sight to minimise environmental and visual impact.

To encourage visitors to take their time driving around the radio trail and enjoy the tranquillity of the woodland environment, picnic areas are located at the start and at the fourth stop. In addition, there are several other trails to enjoy on foot, on a bicycle, or on horseback.

Dryandra Woodland is a beautiful and peaceful place to spend a day or a week, and it's only two hours from Perth by car, making it an ideal day-trip. If you want to stay longer, accommodation is available in the old forestry settlement (managed by The Lions Dryandra Forest Village) or you can camp at the Congelin Camp Ground.

Below: Close-up of transmitter and solar panel installation.

Bottom left: *Transmitters are located off the ground and out of sight of visitors.*

Bottom right: Visitors stop at marker posts to hear the commentaries on their car radios. Photos – Daryl Moncrieff





BUSH TELEGRAPH

GOGO FOSSIL FISHING

The search for a fossil emblem for Western Australia began after schoolchildren from the Sutherland District Primary School, in Dianella, suggested the idea of having a fossil fish from Gogo Station in the Kimberley district of Western Australia, and forwarded detailed a submission to Premier Richard Court last year.

John Long, Curator of Fossil Vertebrates at the Western Australian Museum, was then given the task of heading up a team of scientists and representatives from industry to make a recommendation to the Minister for Arts, Hon. Peter Foss. Submissions closed on 30 June 1995 and included fossil stromatolites from the Pilbara, ancient lamp shells and sea lilies from the Gascoyne region, and sea scorpion trackways and marine reptiles from near Kalbarri. (Regular readers might recall articles on stromatolites in LANDSCOPE, Summer 1991-92, and sea scorpion track-ways in LANDSCOPE, Winter 1993.) The Gogo fish (Monamaraspis kaprios) was suggested by the children after they had voted on a number of different fossil fishes.

So, what is so special about the Gogo fish? The fascinating history of this fossil spans 370 million years, which makes it imperative that it and its contemporaries be jealously guarded from damage or loss. John Long has had a long association with the Gogo fish, having studied it for many years. His new book, The Rise of Fishes-500 million years of evolution, has just been published by the University of New South Wales Press, Sydney. It features the Gogo fish skull on its cover, and John remembers the excitement he experienced at the time he found the skull:

"The hammer struck another limestone nodule, and after hours of searching in the hot Kimberley sun, I spotted a glint of shining bone. It was a fossil fish, but not just any ordinary fossil. The fish entombed by the calcareous rock was soon freed to reveal its delicate bones in perfect three-dimensional form."

Such marvellous preservation makes the Gogo Formation, in the north of Western Australia, one of the world's most important fossil localities.

These ancient fishes lived around a great barrier reef system fringing the southern part of what is now the Kimberley region. Today, the fossil remains of these fishes and other reef-dwelling creatures are to be found, preserved inside the orange limestone nodules of the Gogo Formation. The great diversity of fishes found in these deposits are preserved in such exquisite detail because of the lack of later geological activity such as large movements of the Earth's crust, which usually deform and compress fossils of this age.

JOHN A. LONG

Gogo is significant, not only because the superb state of the fossils tells us much about the anatomy and structure of these early fishes, but also because of the great diversity of species found so far-more than on any other site of this age in the world. At the same time as the Gogo fishes were swimming around the Kimberley, the oldestknown amphibians were taking their first tentative steps on land in eastern Australia, and they provide valuable

The fossilised skull of the Gogo fish (above) also features on

the cover of John Long's new

Photo - Kristine Brimmell

book (left).

scientific information about this great leap in evolution.

John found the first complete skull of one of these rare fishes in 1986 and a second specimen was found in 1990. In all, about 40 new species of fossil fish have been identified from the Gogo deposits.

It is significant that the Gogo fish was found near Mimbi Caves, an important area of the Kimberley that is being proposed for classification as a nature reserve. To date, Mimbi Caves have been a well-kept secret by many people concerned that



the ecologically fragile area could be irrevocably damaged by too many visitors. But even the best-kept secret will out, and more and more people are seeking information on how to gain access to the caves.

In response, and with a view to protecting important fossil deposits and Aboriginal cultural sites, the Department of Conservation and Land Management (CALM) is helping the Mimbi Aboriginal Corporation (MAC) to secure land tenure over the area.

West Kimberley District Manager Allen Grosse says that when this matter is resolved, it is intended that CALM and MAC will enter into an agreement to manage the area as the Mimbi Caves Conservation Park.

Apart from the important fossil fish deposits in this part of the Kimberley, the most predominant physical feature of the area is the extensive labyrinth of caves, tunnels and narrow gorges that pass through the Lawford Range.

"Many of these features are easily accessible. Several caves have permanent, freshwater pools. The cave system is believed to be among the largest in Australia," Allen said.

Obviously, the fossil history and geological importance of this area demands that the area be managed with with a high degree of sensitivity, so the management plan will include steps to be taken to minimise any negative visitorimpact on the area.

Above right: John Long searching for Gogo fish fossils east of Fitzroy Crossing, near Mimbi Caves.

Right: Volunteer helpers searching for fish fossils in the valleys around the ancient Devonian Reef. Photos – John Long.



THE MALLEE MUNCHER

A prototype mallee harvester, developed by CALM senior technical officer Tim Birmingham, is attracting keen interest among farmers interested in oil mallees as a viable cash crop for the lucrative eucalyptus oil industry.

Tim developed the harvester, known as "the mallee muncher", by modifying an old wheat harvester in CALM's Dwellingup workshop.

This, in conjunction with a still developed by Phil Scott from the Department of Agriculture, has been used at oil mallee field days to demonstrate how more than 200 litres of eucalyptus oil can be extracted from about 10 tonnes of mallee leaf material. Batches of this oil have been given to several large international companies for early market development.

In 1993, CALM's Vegetation and Tree Planting Advisory Service (VATPAS), in association with interested farmers and the Department of Agriculture, embarked on largescale plantings as a beginning to the establishment of 5 000 hectares in each of six centres (or planting cells) at Canna, Woodanilling, Narembeen, Kalannie, Wickepin, and Esperance.

Also in 1993, more than 200 000 oil mallee seedlings were planted, increasing to more than a million seedlings in 1994, with nearly three million seedlings expected to be planted by the end of the 1995 planting season.

The seedlings are offered



to the farmers in the planting cells as part of a share-farming contract with CALM.

All plantings are integrated into the farming system, where they will provide the maximum landcare benefit as well as a possible income from the sale of eucalyptus oil, should the industry develop.

As well as the large-scale

Photo – John Bartle

plantings, more than 30 oil mallee species trials and 12 genetic improvement trials have been established throughout the Wheatbelt to further our knowledge on species selection and planting layouts. These plantings will also provide a workbase for further tree breeding to increase vigour and oil content.

B U S H T E L E G R A P H

RECORD PLANTINGS AND VALUE ADDING

A record 24 million tree seedlings will be planted by the Department of Conservation and Land Management (CALM) over 16 500 hectares of private cleared farmland, native forests and State-owned plantations throughout the south-west of Western Australia this winter. Seven thousand hectares of this will be planted under partnership agreements with farmers.

CALM's 1995 planting program is the biggest to be carried out by a single organisation in Australia, and the Department continues to set new planting records for itself each year.

Farm forestry is one of Western Australia's fastestgrowing primary industries, and the response from landowners to CALM's sharefarming scheme has been very strong, especially around Albany where bluegum is proving to be a popular commercial tree species. More than 2 500 hectares will be planted in the district this year. Farmers on the sandplains north of Perth are planting pines to meet the growing demand for softwoods. This year's plantings result from a CALM initiative that will see 5 000 hectares of pines established under partnership agreements over the next three years.

In the Wheatbelt, where low rainfall makes short-rotation timber crops unsuitable, native oil-producing mallees are thriving, and CALM is evaluating their farm forestry potential in a series of commercial-scale plantings. The mallees not only provide landcare benefits, but with further development of harvesting and oil-extraction techniques, they may become a viable crop that could help offset the cost of landcare programs.

Another CALM initiative to explore potential new markets is in the processing of karri and marri wood for the production of fine quality furniture.

The department's Wood Utilisation Research Centre at Harvey has dried marri and



karri timber and supplied it to two local manufacturers—BVR Furniture of O'Connor and Jensen Jarrah of Busselton—to craft into fine furniture. The resulting pieces were unveiled at a recent furniture trade fair and met with rave reviews. On show were dining room tables and chairs, coffee tables, Welsh dressers and outdoor settings.

Until recently, it was thought that the problems involved in seasoning, machining and gluing karri, and the gum vein imperfections typical of marri, would make them unsuitable for furniture manufacture. However, the irregularities in the marri may become selling points; used as aesthetic features to create unique and highly valued products.

The research that has produced marri and karri timber suitable for furniture making represents a significant step towards increasing the value of WA's native hardwoods and opening up important new markets for value-added products. Use of the local native and plantation-grown wood could replace timbers such as cherry wood and oak; which are currently imported, and create more local jobs in timber-processing industries.

CALM is establishing a special karri and marri network, with timber and furniture industry input, to help develop further market opportunities.

Top: Just a few of the 24 million tree seedlings to be planted this year by CALM. Photo – John Bartle

Left: This marri dining room furniture was manufactured by WA company BVR Furniture. The gum vein feature can be clearly seen in the doors of the dresser and the table top. Photo – Ross Swanborough



B U S H T E L E G R A P H

EYE TO EYE WITH A WHALE

Visitors to Albany have the chance to enjoy an unforgettable experience coming eyeball-to-eyeball with huge marine mammals about the size of a bus.

Southern right whales (Balaena australis) weighing up to 80 tonnes and reaching 18 metres long, migrate into Albany waters from late-July to mid-October.

Right whales are baleen whales, which means they have horny plates hanging from their upper jaws. They feed on swarms of plankton, found in near-surface waters, and which they sieve through the fibrous inner hairs of the baleen plates.

During summer, right whales prefer the open ocean, away from the coast, but during late winter and spring the cows come in close to shore. There, near the surf line in sheltered bays, they give birth, before returning to deeper waters as summer approaches.

For many years, whalers caught southern right whales and rendered their bodies down for oil and whale bone. In fact, they were called right whales because in the days of open-boat whaling with hand harpoons they were the "right" ones to catch. They were slowswimming, floated when dead, and yielded large amounts of valuable products - particularly oil for lighting and lubrication.

The populations declined to dangerously low levels before whaling of southern right whales ceased in 1959. Now, after nearly 30 years, they are recovering and forming the basis of a flourishing whalewatching industry. One of the most successful is Southern Ocean Charters, operated by Les Bail, whose magnificent photographs can be seen here.

Whales often come right

into Albany's Princess Royal Harbour. Lice resembling tiny white crabs can be seen on the photograph of the whale's eye shown on this page and Les says that he is often able to locate whales in fresh water, which may be an attempt by the whales to kill the tiny parasites.

"Although southern right whales are huge, bulky creatures, they are also agile and active animals, and their acrobatic antics can keep whale watchers amazed and entranced for hours," Les said.

"It is estimated the entire world population of southern right whales is only about 3 000, compared with an original population before whaling of 100 000, so it is really a privilege to watch these whales and observe their comeback from the brink of extinction on the Albany coast."

Southern right whales: breaching (top), feeding (centre) and taking a closer look at its human observers (below). Photos – Dorothy and Les Bail











From the incredible whale sharks of Ningaloo Marine Park to the second-largest divable wreck in the world, Western Australia has a diversity of experiences to offer even the most discerning diver. However, these may seem somewhat daunting to the beginner. Snorkellers and novice divers may be less sure about where to go to explore the marine environment. A new book now makes it easy for them.



BY CAROLYN THOMSON

estern Australia is rimmed by 12 500 kilometres of coastline. Beyond the shore, the waters seem to stretch from horizon to horizon in an endlessly flat surface. Only occasionally, where the reef line intrudes above the water, is there some hint of the fascinating seascape that lies below. Once you take the plunge, waving fronds of kelp, colourful soft corals, anemones, reef fish in bizarre shapes and enchanting colours, and the yawning entrances of caverns and swimthroughs invite you to discover their secrets.

More and more people are wanting to discover Western Australia's underwater wonders. However, it is estimated that three or four out of every 10 people that complete a SCUBA diving course may never go diving again, probably because they don't have a boat or are unsure where to find the best shore dives. As a result, a new book has been released by the Department of Conservation and Land Management (CALM) entitled Dive and Snorkel Sites in Western Australia. The book is designed primarily for snorkellers and novice divers and has a strong emphasis on shore dives and dive sites within marine parks. The dives are all relatively easy (none is deeper than 18 metres) and accessible, as well as being fun and interesting. However, there are also many boat dives that experienced divers would find challenging and enjoyable, and some moderately difficult

Previous page:

Main: Port Jackson sharks are commonly seen by people diving in the south-west. They are usually harmless. Inset: Invertebrates such as starfish and sea squirts often form a blaze of colour, coating a variety of underwater structures. Photos – Eva Boogaard/Lochman

Transparencies

Above right: Yellow anemones are common in Marmion Marine Park. These animals use stinging tentacles to catch their prey and are closely related to jellyfish.

Photo – Dick Beilby/Lochman Transparencies

Right: Bullseyes form large schools that often inhabit underwater caves. Photo – Gerhardt Saueracker/Lochman Transparencies

shore dives. Simple mud maps and descriptions are provided for each site.

The book strongly emphasises low impact diving. The message is to look at marine life without disturbing it. Conservation-minded divers and snorkellers will always leave marine plants and animals where they belong for others to enjoy.

DIVING NEAR PERTH

The diving and snorkelling sites near Perth are populated with a mixture of temperate and tropical fish species. A band of warm water, known as the Leeuwin Current, carries the larvae of many tropical fish species from coral reefs further north and allows them to thrive by providing the warmth they require in otherwise cooler waters.

The eroded limestone reefs around Marmion Marine Park are a diver's paradise, forming ledges, caves and swimthroughs. They are inhabited by a wonderful array of fish species and colourful invertebrates. One of its jewels is undoubtedly Bovinaboat Reef, which lies at the southern end of a chain of inshore reefs. It is just 75 metres from the sea wall of Hillarys Boat Harbour and its accessibility and beauty has made it one of the most popular dive sites in Perth. Caverns in the reef provide homes for many fish, including western blue devils, old wives, banded sweep, crested morwong, horseshoe leatherjackets,





Right: Anemonefish inhabit coral reefs in tropical and sub-tropical areas such as Ningaloo. They produce a mucous that prevents the anemone's stinging tentacles from triggering, and gain protection from predators by retreating into the tentacles. Photo – Eva Boogaard/Lochman Transparencies

Below right: Stunning Pocillopora Reef, at Rottnest Island, is easy to reach from shore. Photo – Gerhardt Saueracker/ Lochman Transparencies

dusky morwong, truncate coralfish, bullseyes, wrasse and red-striped cardinalfish. The reef top often comes alive with the frantic feeding of large schools of buffalo bream. Blue and orange nudibranchs are common and add to the colour.

Little Island, Cow Rocks, Wreck Rock and North Lump are also among the nine dive sites from Marmion Marine Park described in the new book. Little Island is particularly rich in invertebrate species. Sponges, gorgonians, hydroids, sea urchins and sea squirts can all be found in large numbers beneath ledges and in caves. The seagrass meadows that grow in sandy areas around the island support a huge range of animals such as bailer shells, and sea lions laze on the beach nearby. North Lump is an entirely submerged reef that offers a rewarding dive within a small area. It has interesting arches, caves and tunnels and excellent invertebrate life.

Rottnest Island, only a half hour boat trip from Fremantle, also has surprisingly beautiful underwater landscapes. Go snorkelling at Pocillopora Reef and you could be forgiven for thinking you were in the tropics. The reef is named after the species of beautiful pink coral, Pocillopora damicornis, that grows there in profusion. The coral reef community is completely different from any you will see elsewhere near Perth, and the variety of fish and invertebrate life is astounding for such a small area. Only a short swim from shore, the clumps of Pocillopora are so densely packed together that they lie virtually on top of one another.





Rottnest Island is the southernmost location where this species is known to grow. In fact, it is quite remarkable that these animals are able to grow here so far south of their normal tropical or subtropical habitat.

Beneath the water, the limestone that also forms the island itself has eroded to form spectacular cave formations, swimthroughs, ledges and grottos. Roe Reef, for instance, is among the most spectacular diving locations near Perth. Its numerous underwater grottos and caverns are inhabited by marine life, ranging from the large and impressive to the minute but colourful, such as tiny juvenile scalyfin. One of the highlights of this delightful reef is a large cave inhabited by large-snouted boarfish, some large zebra fish, mosaic leatherjackets and other colourful fish species. Such is the variety of underwater formations around the island that virtually its entire coastline is divable.

The maritime history of Rottnest dates back to the seventeenth century and the remains of 14 wrecks lie around the island. Shipwrecks include the *Macedon*, the *Denton Holme* and the *Lady Elizabeth*, to name but a few, and most of these can be dived.

LEEUWIN-NATURALISTE COAST

Lying between three and four hours drive south of Perth are the coastal towns of Busselton, Dunsborough, Yallingup, Margaret River and Augusta. They are



nestled in picturesque farmland surrounded by wineries, caves, tall karri forest and national park. This area is the southern escape for many holidaymakers from Perth and it offers some tremendous diving. Busselton has the second-longest jetty in the southern hemisphere—1.8 kilometres long. Marine life of all shapes and colours has grown over and around the pylons. The last 50 metres or so offers the best diving, and here, due to the shade provided by the jetty and its distance from shore, you can see many deep water species.

The beauty of it all can be appreciated in only eight metres of water (the reason for the jetty's extraordinary length is that it was repeatedly extended because of silting). Piles near the end of the

Above left: West Kingston Reef, near Rottnest, is the site of three shipwrecks, including the Denton Holme and the Macedon. Photo – John & Val Butler/Lochman Transparencies

Above right: The Busselton Jetty provides one of the most rewarding dives in the south-west. Colourful invertebrates vie for space on the pylons and fallen timber. Photo – Eva Boogaard/Lochman Transparencies

Right: White-barred boxfish are easily recognised by their striking shape and colouring. Photo – Dick Beilby/Lochman Transparencies structure are covered with masses of telesto coral, which is coated with brilliantly coloured sponges. During the day, they look like colourful tree branches without leaves, but at night they display a profusion of brilliant white coral polyps, the density of which has to be seen to be believed. Amid this mass of waving fronds live hundreds of leatherjackets, boxfish, truncate coralfish (western talma), old wives, false Tasmanian blennies, blackthroated threefins, globefish, clingfish and even many of the unusual knight fish or pineapple fish. Gurnard perch cleverly disguise themselves as bits of wood, only their watchful eyes betraying they are living things. In recent months, an enormous Queensland groper has also taken up residence around the pylons. The Busselton jetty is a dive site that should not be missed. It also makes a wonderful night dive.

Between Busselton and Augusta there are innumerable diving and snorkelling sites, either just off the shore or accessible by small boat. The pick of these sites are the most southerly-those nearest to Augusta. This is wild and rugged coastline, however, and you have to pick your time. If the conditions are suitable, the best dive sites are at Hamelin Bay, Cosy Corner and Flinders Bay. There are magnificent limestone reefs riddled with caves, swimthroughs, ledges and dropoffs. Bombies (discrete reefs) are crammed with marine life such as blue groper, Port Jackson sharks, harlequin fish, schooling fish, colourful reef fish and much more, plus the wealth of colourful invertebrates. Local identity



Ted Wright even gave up one of his 'secret' sites for the book—a bombie in Flinders Bay that offers one of the best 45-minute dives you will ever complete in temperate waters.

CORAL COAST

The marine embayments of Shark Bay Marine Park also offer many shallow, but highly recommended, diving and snorkelling sites. The Broadhurst coral patch is around 500 metres in diameter, and swarms with colourful sea life. Many species of staghorn, brain and plate corals vie for attention, and there are numerous soft corals. A bright purple sponge growing throughout the area is notable.

The coral and fish communities of Sandy Point lie on the eastern side of Dirk Hartog Island. There are numerous species of blue, purple, green and brown staghorn corals growing in a great diversity of forms. In one area, there is a virtual garden of beautiful blue staghorn coral. Brain corals and plate corals can also be seen. There is such a large diversity of corals, in a kaleidoscope of colours and forms, that this is a good place to see how many different varieties and growth forms you can distinguish. Dugongs and marine turtles inhabit both areas and are frequently seen.

To the north, Ningaloo Marine Park offers a vastly different diving experience. It protects a 260-kilometre-long barrier reef, which is one of only two large coral reef systems to occur on the western edge of a continent. It is also the only large reef found so close to a continental land mass, being about 100 metres offshore at its closest point.



Above: Knight fish are among the more unusual fauna that can be seen at the farthest end of Busselton Jetty. Photo – John & Val Butler/Lochman Transparencies

Right: When they feel threatened, globefish swallow air until their entire bodies inflate and their yellow spines become erect.

Photo – John Butler/Lochman Transparencies

Below: Corals grow in a variety of colours and forms in the shallows around Dirk Hartog Island. Photo- Eva Boogaard/ Lochman Transparencies

Divers flock to Ningaloo, despite it being one of the most isolated coastal locations in the world. Whale sharks regularly appear for an eight-week period between March and May each year—a phenomenon that is not known to occur anywhere else (see LANDSCOPE,





Summer 1994–95). As a result, a thriving charter industry has been established from the coastal town of Exmouth. But divers are not drawn to Ningaloo Marine Park only for the whale sharks. Ningaloo Reef run along some of the most beautiful and unspoilt coastline in the world. It rivals the famed Great Barrier Reef in terms of the numbers of coral and fish species (few people who are not marine scientists could tell the difference), but unlike the Great Barrier Reef, the delightful coral gardens of Ningaloo and their resident tropical fish are accessible from the shore.

Turquoise Bay, 65 kilometres south of Exmouth, is an excellent dive site for the family because of its ease in most conditions, the rich diversity of coral, fish and other marine life very close to shore and the exceptional beauty of the beach and Turquoise Bay itself. Not far from shore, there are several large coral bombies as well as numerous smaller coral colonies, particularly brain coral and the slow-growing massive coral. Many species of colourful reef fish live in and around the colonies of massive coral. The myriad of angelfish, wrasse and parrotfish in different shapes, sizes and colours are a delight to watch. Parrotfish are closely related to wrasse, but have dental plates which give them beak-like mouths. Like wrasse, they change sex from female to male.

At Pilgramunna Ledges, snorkellers can discover a surprising diversity of marine life, some beautiful coral formations, multitudes of colourful reef fish and occasional oceanic fish species, as well as rays, sharks and diverse invertebrates. All this is within only 10

Below: Despite their bright colours and attractive markings, harlequinfish are well-camouflaged. Photo – Gerhardt Saueracker/Lochman Transparencies metres of the shore. These, together with two sites from Coral Bay, make up some of the eight diving and snorkelling sites from Ningaloo Marine Park described in the new book.

NOT SO SECRET

Throughout *Dive and Snorkel Sites in Western Australia* there are features on marine life that reveal details of their enigmatic life histories. For instance, many mosaic leatherjackets actually spend the first few weeks of their lives within the bells of some types of jellyfish, where they gain protection from predators by staying within the jellyfish's stinging cells. Starfish can regrow their

Bottom: Nudibranchs, or sea slugs, are carnivorous. Many brightly-coloured species store distasteful and noxious chemicals in glands in their skin. Photo – John Butler/Lochman Transparencies

bodies from a single severed arm, if it is attached to a portion of the central disc. Even the tiniest sea squirts may filter 170 litres of sea water each day, and sea cucumbers can eject their respiratory organ and gut, to distract predators, and then regrow their missing parts. The information provided about marine life will hopefully stimulate interest in the marine environment and encourage divers to adopt a conservation ethic.

Compiling this book was an enormously enjoyable experience. It is hoped that readers will derive just as much pleasure in discovering the sites for themselves. The secrets of the sea won't be secret for much longer!

Below: Delicate staghorn and plate corals inhabit many of the inshore areas of Ningaloo Marine Park. Photo – John & Val Butler/Lochman Transparencies



Carolyn Thomson researched and compiled *Dive and Snorkel Sites in Western Australia*, in conjunction with CALM staff, dive shops and volunteers. She can be contacted on (09) 389 8644.

Dive and Snorkel Sites in Western Australia can be purchased from a variety of bookshops, dive shops and other outlets for \$14.95.



16 LANDSCOPE

Will the Wyalkatchem Foxglove Survive?

Staff from the Department of Conservation and Land Management and Kings Park and Botanic Garden have joined forces to save one of Western Australia's rarest wildflowers, the Wyalkatchem foxglove.

by Mike O'Donoghue and Ken Atkins

.........

...............................

he Wyalkatchem foxglove (Piturodia scabra) is on the brink of extinction in the wild. Since its first collection in 1959, it has only been known from a single population scattered along the Koorda-Wyalkatchem Road verge. By 1987, only eleven plants were present at the site; six on the degraded road verge, and the other five on an area that had been excavated for railway ballast. This latter site was extremely inhospitable to the plants, as the vegetation and upper soil had been removed. The plants had probably regenerated after the site disturbance, but all were suffering from stress, particularly during the dry summer months.

Following the 1987 assessment, recommendations were made for the management of the species. In spite of this, six of the plants were dead by 1990. Their deaths were probably due to the naturally short life of the species, the exposed nature of the sites and the impact of road maintenance activities. Only one of the roadside plants and four in the excavated site were still alive, and the latter plants were obviously stressed. There had been one small success, however: a survey had located a new plant in an area of degraded private bush adjacent to the original site.



The species had become critically endangered. The Department of Conservation and Land Management (CALM) asked the Minister for the Environment to declare it as rare flora, and it was so declared in 1990. Such declaration provides the species with special protection under the Wildlife Conservation Act and highlights the need for management of the species.

After the summer of 1991–92, all 11 of the original plants had died, either from natural causes or because of the hostile



One of the last Wyalkatchem foxglove plants left growing in the wild on private property. Protection from grazing and site disturbance is the highest priority for these remaining plants. Photo – Andrew Brown The Wyalkatchem foxglove (*Pityrodia* scabra) is a shrub approximately one metre in height, with a single main stem when young. The white mint-like flowers are arranged along the tips of the branches, contrasting with the small, rough, dark-green leaves. It appears to be naturally short-lived, relying on regeneration from seed. As it ages, many branches develop, radiating out to a width similar to the height. With age, the structure breaks down and it appears to collapse, the lateral branches dying over several seasons.

A number of people have been involved in attempts to rescue the plant. The CALM group is led by Senior Botanist, Dr Ken Atkins, and includes Wildlife Branch staff Brenda Moran and Mike O'Donoghue; Merredin District Manager Mike Fitzgerald and Operations Officer Nick Woolfrey; and Andrew Brown, botanist with CALM's Threatened Species and Communities Unit. Kings Park and Botanic Garden staff include Curator Roger Fryer, propagator Sophie Juszkiewicz, and horticulturalists Dave Blumer and Tim Parker. environment of the excavation site. For a time, the plant found in 1990 was the only representative of the species growing in the wild. Further intensive surveys to find more plants were undertaken by CALM staff and consultants, through funding provided by the Australian Nature Conservation Agency (ANCA). These surveys were successful: two young plants were located, bringing the current number of plants in the wild to three. But the older plant is collapsing, as this species does with age, and is unlikely to survive the summer of 1995–96.

INTERVENTION

The status of this short-lived species had become precarious in the wild. In 1993, the sites where the plants had been known to occur were scarified, in an attempt to stimulate seed germination. But no foxglove seedlings appeared after this treatment.

A second method was needed. Kings Park and Botanic Garden had been developing a new propagation technique aimed at germinating native seed by applying smoke direct to the seed, or direct to an area thought to contain a native seed source, and at first this method seemed promising. Although it was still in an early stage of development, impressive results had already been achieved, and some of Western Australia's native plant species had been stimulated into life following the smoke treatment. A major advantage of the method is that it can be undertaken in the field without any site disturbance.

With great expectations, smoke trials were begun at the site of the foxglove where, it was hoped, a viable seed store had accumulated in the soil. Scientists waited anxiously for early results, and systematicallymonitored the treated areas. However, much to the disappointment of all those involved, the trials proved unfruitful and the status of the species in the wild remained unchanged.

CALM scientists looked for another method. Where germination had failed, perhaps translocation would succeed.

Previous page

The spectacular flowers of the threatened Wyalkatchem foxglove. Photo – Steve Hopper

Top: Close-up of a Wyalkatchem foxglove flower. It is believed this species is insect-pollinated—possibly by native bees. Photo – Andrew Brown

If plants could be moved into the field, plant numbers in the wild would increase and thus provide the species with some insurance against extinction. Management guidelines and a translocation proposal were prepared and approved.

The BankWest *LANDSCOPE* Conservation Visa Card provided some financial resources for the re-establishment trials. Kings Park and Botanic Garden staff got to work to produce the plants.

GRAFTING, CUTTING, MOVING

Kings Park and Botanic Garden had begun work on propagating the Wyalkatchem foxglove in 1990, as part of its program to research propagation methods for Declared Rare Flora. Their attempts to use tissue culture were frustrated by the difficulty of sterilising the material, and early attempts to strike cuttings were also unsuccessful. However, material was successfully grafted onto other host rootstock from the related species *Dicrastylis fulva* and *D. corymbosa*.

These plants grew well and provided clean, healthy material for further work in propagating the species by cuttings. The success of this work enabled plant numbers in cultivation to increase. Some collections were made from the wild as new plants were found, ensuring that all the available genetic diversity was captured. Each clone was propagated separately by both grafting and cuttings.

Early trials at pollination indicated that the plants may be unable to produce viable seed using their own pollen, so they were cross-pollinated by hand. Seed from this method proved difficult to germinate normally, but seedlings were produced by the embryo excision method, whereby the seed embryo is removed from the rest of the seed and grown on special media. A mix of seedlings and cuttings from the parent plants made up the 119 plants prepared for the translocation.

The obvious area to reintroduce the Wyalkatchem foxglove was the private land on which the species was known to occur in the wild. Even if the plants could be successfully established, however, the species would still only be present at one site, and would be susceptible to local perturbations. A second population was needed. Surveys were undertaken to find a secure site within the general vicinity, one which had suitable habitat for the species.



Such an area was located. It is a Crown reserve 14 kilometres north-west of the original population, and CALM staff found it to have similar habitat to that in which the Wyalkatchem foxglove grows. No plants of this species were located in the vicinity, nor were any species taxonomically similar to the rare plant; it is therefore likely that the foxglove will not interfere genetically with other native flora species in the area. It is also likely that the two populations, once established, will be genetically isolated; scientists believe that the plant is probably insect-pollinated and the second site is separated from the first by a salt-lake system. At CALM's request, the reserve has been set aside specifically to establish a population of the Wyalkatchem foxglove.

WAIT AND SEE

A planting strategy was prepared for the two sites, aimed at maximising the interaction between the plants. This should enhance their ability to crosspollinate and produce fertile seed-highly necessary if the population is to be viable in the future. With the permission of the property owner, 50 plants have been carefully planted into the fenced area on private property that contained two of the last remaining wild plants. The property owner has kindly agreed to maintain a fence around the site to protect the rare plants from accidental damage. Sixty-nine plants have also been planted into the Crown reserve, with assistance from adjacent property owners John and Llewyn Green and Beth Booth.



Above: CALM and Kings Park and Botanic Garden staff planting the first plants on private property along the Koorda–Wyalkatchem Road. Photo – Ken Atkins

Left: Plant propagator Sophie Juszkiewicz tends a young plant in the Kings Park laboratory. Photo – Steve Hopper

After planting, each plant was watered and tagged, and site details were recorded for future reference. Llewyn Green kindly agreed to monitor the progress of the new plants and provide regular reports. If a normal winter rainfall is received, the introduced plants should establish quickly before the onset of the dry summer period. Such is the enthusiasm of the local farmers, however, that they offered to hand-water the seedlings during the critical weeks following transplant, if the winter rains are delayed.

The monitoring will also report on other problems. Grassy weeds, if causing competition problems, will be controlled using a selective herbicide. Rabbit netting has already been installed around each plant after reports of rabbits eating and pulling out some of the new plantings. CALM will also monitor the new populations to determine if crosspollination produces viable seed, and if natural regeneration of the species occurs at these sites. More plantings may take place next year, if necessary.

The Wyalkatchem foxglove has, at least for the time being, been brought back from the brink of extinction. Only time will tell if its long-term future in the wild has been secured.

Ken Atkins is CALM's Senior Botanist and Mike O'Donoghue is an administrative officer in CALM's Wildlife Branch. Both can be contacted on (09) 334 0455.



ENDANGERED



THEVENARD ISLAND MOUSE

The Thevenard Island mouse is found only on one Pilbara island near Onslow, where it shares its environment with a tourist resort and an oil processing and storage facility.

Hiding behind the name of Leggadina forresti, a native mouse sparsely scattered throughout the deserts of arid and semi-arid Australia, the Thevenard, Island mouse remained incognito until 1987, when its larger body size led to its taxonomic status being questioned by Department of Conservation and Land Management (CALM) scientists. Subsequent genetic research showed that it is actually more closely related to another short-tailed mouse, Leggadina lakedownensis, a species originally described from Cape York, Queensland. At present, the Thevenard Island mouse is thought to be a new subspecies found only on one island!

Species of short-tailed mice, as their common name suggests, are easily distinguished from other native mice by having a tail that is shorter than the head and body. Little is known about the biology or ecology of these seldom-seen mice. They are usually found on sandy soils vegetated with desert scrub and grasses. Like other arid-adapted rodents, the Thevenard Island mouse avoids the hot daytime temperatures by being nocturnal and by sheltering in burrows, where temperatures are significantly lower than above ground. Preliminary research on its water-conserving abilities suggests the mouse can extract sufficient moisture from its food and does not require free water.

Why is this native mouse threatened? Until recently, it lived on Thevenard Island without other mammalian competitors. When house mice were accidentally introduced in 1986, concern for the native mice became an issue, especially when the house mice began their characteristic plague

By Dorian Moro Photos by Jiri Lochman & Dorian Moro

cycle following summer rainfall. The perceived biological similarities of both species, and the known success of house mice in colonising many types of habitat, suggest that a poison-baiting program would not be a feasible option for control. With the assistance of CALM, the Australian Nature Conservation Agency, West Australian Petroleum, and the University of Western Australia, a PhD study is now under way to examine the requirements of both the Thevenard Island mouse and the house mouse on Thevenard Island, and to develop a means of selectively controlling or eradicating the house mouse. Interim Wildlife Management Guidelines have been prepared by CALM to guide the native mouse's conservation. Actions to be carried out under the Guidelines include a translocation to another island to secure the subspecies against any catastrophic event.

The future of the Thevenard Island mouse now rests with selective control of house mice and a successful translocation.



Fire is an ancient natural force. In partnership with climate, it has shaped the vegetation of forests, woodlands and shrublands of Western Australia for thousands of years. The endless process of fiery destruction and resurrection is a source of great fascination. This story explores the cycle of bushfire and regeneration as an artistic and a scientific experience. The Mt Adams area, in the heathland south of Geraldton, has been an inspiration to wildlife artist Philippa Nikulinsky, while farther south, the jarrah forest's response to fire has been the focus of the research of CALM scientist Neil Burrows. Common to both their accounts is an enduring sense of wonder.

he place is Mt Adams, south-east of Dongara. The time is late in the summer of 1991-92. It is not a hospitable place, particularly at this time of the year. It is shadeless and beset with scorching heat, flies and a relentless, furnace-like easterly wind. From the relative shelter of a car, the dusty grey heathland that stretches to the horizon in every direction looks unremarkable. Where a bushfire has recently swept through, the landscape appears even more desolate: charred and lifeless. And vet. on a closer look, this seemingly bleak and barren expanse of burnt scrub is bristling with life, and is an inspiration to wildlife artist Philippa Nikulinsky. In

her words, it's 'a glorious display of life', a pageant of botanical splendour. The flames that raged across this heathland in December 1991 fuelled the crucible from which a unique artistic project was born.

It was a large, intense bushfire. Farmers in the area counted as many as 80 lightning strikes. It took three weeks for firefighters to bring the blaze under control. But what elsewhere seems such a destructive element is, in fact, the opposite here. For the hundreds of species of plants in these parts, fire is a midwife, a life-giving force that coaxes seed from plants and vigorous new growth from lignotubers. From the



ashes and charcoal and soot, a triumphant display emerges, as species after species regenerates in a defiant parade of colour.

A few days after the fire, Philippa visited Mt Adams on a routine field trip and found a charred, ashen landscape with little sign of life. Then, within a few weeks, she returned to find the first green shoots reaching out from the blackened trunks and stems. Although the phenomenon of regeneration was well known to her, she still found herself suffused with a sense of awe. 'You just wonder how they can do it,' she says. 'There you are, in the hot, dry conditions, whipped by soot and sand in the scorching wind, no water in sight, no shelter, and there's all this life around you, all this new growth. It's like magic.'

The following spring, Philippa was acting as a consultant to a photographer, who was working on a feature on Western Australian wildflowers for National Geographic magazine. Knowing there would, by now, be interesting displays to be found, she brought him to Mt Adams and went for a walk with her notebook, while her client took photographs of the thousands of grasstree spikes that had emerged. 'I noticed that so much of the burnt matter seemed to form cages over the new growth,' Philippa recalls, 'and I wondered if it was a natural mechanism for protecting it.'

From there, ideas about the visual potential of capturing the depth and complexity of the theatre of regeneration began to take shape. Starting with a description of zamia fruit, her notebook reads, '...yellow-green, like lights inside the burnt leaves...amazing contrasts. Every tone of black, brown, mahogany, Indian red, even purple...how do I fit it on the page?' Reviewing her notes later, she added, 'Do I have to?' The seeds of *After the Burn* were sown.

Previous page

The contrasts between soft and harsh (or hard), bright and dark, colour and black make flower arrangements or paintings wherever one looks.

Left: Twisted, gnarled shapes of burnt seed cases make stark contraists with catspaws glowing bright orange—so many, they are called fire weeds.

ART FROM THE ASHES

Over the following year, Philippa returned to the location a dozen times, keeping a carefully selective record of the botanical talent show that was taking the stage in response to the fire. 'I feel that the burn makes a sort of a level playing-field,' Philippa explains. 'It gives every plant a fresh chance at its own glory. And each one more or less bounces out and says "Hey! Look at me!"

Eventually, *After the Burn* developed into two five-metre-long scrolls of rice paper—story rolls—depicting the remarkable regeneration story through an artist's eye. One scroll represents the spring following the burn, the other twelve months later. 'The story rolls are meant to capture a sense of the rolling out of time,' Philippa says, 'the opening up of life, in endless sequence, a continuous story with no beginning, no end. 'And I wanted to convey the sustained sense of wonder, at life and all its forms, and the vitality and diversity of growth, death and regeneration in the natural world.'

Accompanying the scrolls are a series of individually framed pieces, which Philippa says represent frozen moments from the continuum.

'I wanted to show every plant in its individual space; not just a picked piece on a page, but *how* it grows, and what grows with it, its interaction with its surroundings,' she explains.

Philippa stresses that, although her botanical knowledge is thorough and her technical detail is correct, *After the Burn* is not in any way a scientific exercise. 'This is not a methodical inventory of species,' she says. 'It is a representation of what caught my eye as an artist.

'There is no exact measure of time here, either. For example, the elegant banksia (*B. elegans*) and yellow kangaroo paw (*Anigozanthos pulcherrimus*) do not flower at exactly the same time.

'But they grow together, and I know

Top (to page 26): Story roll featuring plants from the first spring flowering after the burn.

Right (to page 26): Story roll featuring plants from the second spring flowering after the burn.



this. They are like partners. So they are pictured flowering together here.'

Likewise, artistic vision overrides scientific fact in the depiction of something that was not springing to life. Philippa was asked by a scientist looking at the work whether a particular zamia really had not produced any leaves, because it is the first species to do so after a fire. 'As it happened, there were other zamias around that had sprouted; this particular specimen, for some reason, had not,' Philippa says. 'But it was this one that caught my eye, because it was so dramatic. Whether it is scientifically representative of the region or not is of no consequence.

'I did not approach this as an objective observer. Sometimes, when I took to the field for this project, I was looking for things I wanted to see, because I knew they would be there.'





This selective vision is precisely what Philippa believes to be the key to the preference botanists are continuing to show for professional drawings over photographs to illustrate their work.

'A botanical artist can highlight features, leave out unnecessary detail and still make things absolutely correct without the distraction of background elements,' she says. 'A camera cannot do that. A camera cannot show how a plant grows, because a camera cannot *know* how a plant grows.'

Philippa continues to visit the Mt Adams area as part of her regular work. But she says the *After the Burn* site will soon lose its unique fascination.

'Five or six years after a fire, it's hard to walk through this bush,' Philippa says. 'It's thick and prickly, and it's difficult to find a lot of things, because they have retreated from their "moment". It's almost as though the bush is hibernating, waiting for the next event.

'Fire is not devastation. It's a new beginning; like a new canvas, where every plant has its moment of glory before everything else takes over. The regeneration is climactic. The colours of these plants will never again be so dramatic, or the flowers so profuse. This is life at its peak.'





A SCIENTIST'S VIEW

Measured against the human understanding of time, the tall forests appear eternal, quiescent, unchanging. But even over the four-hundred-year lifespan of a jarrah tree, bushfires are paramount among events that initiate the cycle of regeneration, growth and senescence. The forest is ever-changing.

The dynamic cycle of plant life and growth in a jarrah forest is most apparent

in the first few years after a bushfire. Adaptive traits, evolved over thousands of years to ensure the persistence of each species, are on display within weeks. About three quarters of the plants resprout from buds buried beneath the soil or beneath protective bark—these are called 'resprouters'. The remainder will regenerate from seed stored in woody capsules or in the soil—these are the 'seeders'. Fire re-sets the time clock, and the variety and vigour of regenerating plants are staggering. The forest community demonstrates that, in the face of fire, it is not delicate and fragile, but robust and resilient.

CALM scientists and field officers have recorded the fire response of about 500 plant species in South West forests, including a number that are declared rare. The time it takes for plants to reach flowering age varies with each species





and with rainfall. At two study sites on high rainfall, upland jarrah forests (average annual rainfall 1 000 to 1 200 mm),92 per cent of all understorey plants had flowered within two years of fire, and all understorey species had flowered within three years. Pineapple bush (*Dasypogon hookeri*) and grasstree or pulonok (*Kingia australis*) flowered within three months of the fire, and another ten shrub species had flowered within eight months. Orchids and other geophytes, herbs and fire ephemerals had flowered within 12 months. Wattles and grevilleas flowered within one to two years, depending on the species. At another site, in low rainfall jarrah forest (average annual rainfall about 750 mm), plants took some 12 to 18 months longer to reach flowering age after fire, but all understorey plants had flowered within four years.

Mature trees such as jarrah (Eucalyptus



marginata), marri (*E. calophylla*) and bullich (*E. megacarpa*) can take as long as four or five years to reach flowering age after having their crowns scorched or burnt by an intense wildfire. Small trees, such as bull banksia (*B. grandis*), take two to three years to flower.

TIMING IS EVERYTHING

Plants do not always set viable seed in the first flowering period after fire. Some plants take many years before seed production is sufficient to re-establish the population after fire. Plants most vulnerable to frequent fire are the seeders, especially those that depend on seed stored in capsules on the bush. If these plants are not able to flower and produce adequate stores of seed before the next fire, they will not survive.

Some seeders growing on sites such as creek lines and around granite outcrops, which are usually too damp to burn in spring and are normally only dry enough to burn in summer or autumn, require longer fire-free periods. For example, a mohan (Melaleuca viminea), which grows along valleys in the eastern part of the jarrah forest, can take up to six years before flowering after fire, and river banksia (B. seminuda), which in the jarrah forest is confined to rivers and creeks, can take up to seven years to flower after regenerating from seed. The swamp banksia or pungura (B. littoralis), is similar in appearance to the river banksia and is also found along creeks, rivers and swampy areas in the forest. But unlike the river banksia, it is able to resprout after fire and usually flowers within three to four years.

To ensure the survival of the seeder species, it is essential that the interval between fires is sufficient to enable an adequate build-up of seed, either in the soil or on the plant. The time it takes for this to occur is not known for every species in the jarrah forest, but based on a number of species that have been studied around Australia, adequate seed can be expected to exist for a particular species when more than 50 per cent of the plants have flowered, or when the time elapsed is twice the time taken for the plant to first flower after fire.

For high rainfall and low rainfall jarrah forests, fire interval of six to seven years and eight to nine years respectively are likely to maintain plant diversity. For moist sites, such as around granite





outcrops, valley floors and creek lines, fire interval of less than about 10 to 12 years could cause a gradual decline in some seed species. Frequent summer bushfires or regular autumn prescribed burns (at six- to eight-year intervals), which burn creeks and valley floors, could threaten those species that take a relatively long time to reach flowering age. On the other hand, infrequent summer or autumn fires (every 20 to 30 years) stimulate regeneration and pose no threat to these species.

Prescribed burning is an important management technique for reducing the threat posed by forest wildfires. The rate of accumulation of dead leaves and twigs (fuel) on the jarrah forest floor, is such that these forests are normally burnt to reduce fuel loads on a six- to eight-year cycle, depending on fuel build-up. When fuel-reduction burns are implemented under cool, moist, spring conditions, it is mainly the drier mid-slopes and ridges that burn. Damp sites (such as creek lines and valley floors) normally do not burn in spring, so those plants that take longer to reach flowering age are protected. The interval between fuel-reduction burns in jarrah forests is determined by the fuel accumulation and is sufficient to allow all understorey species to regenerate and build up seed stores.

Above: The startling blue splashes of the leschenaultia with the amazing colours of new leaves appearing from a hakea lignotuber, have to be seen to be believed.

CALM scientists and field officers are compiling an extensive computer database of the response of plants to fire. This information, together with the findings from other fire ecology research, is being used to refine and further develop fire management in South West forests, where the aim is to minimise the threat of wildfire, while conserving the forest ecosystem. In this way, our use of fire will ensure it fulfils its natural ecological function.

POSTSCRIPT

Fire is the ultimate leveller to artists and scientists alike. While it can be a tool wielded under our control, it will always remain an outside, primal and overpowering force, and its breathtaking aftermath of regeneration is a constant reminder of how far beyond us the natural world extends. Recognition of this superhuman scale and power is where, in nature, science and art meet and find a common purpose. Above: Sundews (Drosera spp.) appear in vast numbers. As the sun glints on the sticky leaves, they appear to light up, especially during early morning and late evening.

Below: Spilling seeds and leaves from the charred remains of eucalypts and banksias.



Mandy Clews is a contributing editor for *LANDSCOPE* and can be contacted on (09) 430 7032.

Neil Burrows is a principal research scientist with CALM's Science and Information Division, based at Como Research. He can be contacted on (09) 334 0299.

Philippa Nikulinsky is an artist specialising in wildlife. Her work is regularly featured on the cover of *LANDSCOPE* magazine.

KENNEDY RANGE



NATIONAL PARK

JUST NORTH OF GASCOYNE JUNCTION, IN THE HARSH AND UNFORGIVING INTERIOR OF THE STATE'S NORTH-WEST, LIE THE SPECTACULAR SANDSTONE BATTLEMENTS OF THE KENNEDY RANGE. THIS HUGE MESA, PUSHED UP FROM AN ANCIENT SEABED, HAS DOMINATED THE SURROUNDING PLAINS FOR MILLIONS OF YEARS. ITS COMPLEX GEOLOGY MAKES IT ONE OF THE MOST SCENIC ATTRACTIONS OF THE REGION, AND SINCE IT WAS MADE A NATIONAL PARK, MORE PEOPLE HAVE BEEN FINDING OUT WHAT IT HAS TO OFFER.

BY DAVID GOUGH AND RON SHEPHERD

he Kennedy Range is an eroded plateau situated about 800 kilometres north of Perth and 150 kilometres east of Carnaryon on the rim of the Gascovne River catchment. It is between 10 and 25 kilometres wide and extends for roughly 195 kilometres in a northerly direction from near Gascoyne Junction. The Kennedy Range National Park, which covers an area of 141 660 hectares, was gazetted on 8 January 1993 and is in one of the fastest growing tourist areas in the Gascoyne. It offers spectacular scenery of gorges and precipitous faces, with a vast plateau of ancient dunefields on top of the range. The area still retains a wilderness feeling, and camping beneath the stark sandstone cliffs is an experience not to be missed.

The general area is classified as hot arid desert, with warm winters and hot summers. The average annual rainfall recorded at nearby Lyons River Station is 210 mm, with the highest monthly average of 34 mm in February and the lowest in September. January is the hottest month, with an average maximum temperature of 40.6°C recorded at Gascoyne Junction, so the area is best visited between April and November.



NATURAL HISTORY

In Permian times, some 250 million years ago, the Gascoyne region was a shallow ocean basin off the edge of the ancient Australian continent. It filled with sediment, which later became compressed to form layers of sandstone and shale. Movements in the Earth's crust brought these layers above the sea level, where erosion has stripped away much of the rock. Today, marine fossils can be found in the range's sandstone strata.

The Kennedy Range is a remnant of the land surface that elsewhere has been worn away, but here forms a huge mesa. The southern and eastern sides of the range have eroded to form spectacular cliffs rising up 100 metres or so above the Lyons River valley. The cliffs are dissected by a maze of steep-sided canyons, which have running streams after rain. A few small pools remain for several months after rain, and the deepest may be permanent. Along the western side of the range is a strong fault system, and springs are common here along the base of the range.

Seemingly endless rows of waterless red sand dunes, dominated by spinifex with scattered wattle, mallee and other small shrubs, are found on the mesa. Sand forming the dunefield has been weathered from the underlying sandstone, and the dunes themselves may have been formed about 15 000 years ago, during the last major arid period in Western Australia. Swales are 100 to 500 metres wide, occasionally up to a kilometre, and are stabilised by the vegetation. In places, the dunes rise up to 18 metres above the

Previous page Main: The eastern scarp of the Kennedy Range rises majestically from the mulga plain. Inset: Sandstone. Photos – Bill Bachman

Below: Aerial view of the range showing the gorges and access roads to the visitor sites. Photo – Marie Lochman



swale and have slopes up to 20 degrees. Most of the upper parts of the dunes are unstabilised, but sand movement by wind appears to be confined to swirling around perennial woody shrubs.

This huge mesa remains much the same today as it would have been when Aborigines first crossed it, thousands of years ago.

ABORIGINAL HISTORY

Like Mount Augustus (see *LANDSCOPE*, Winter 1995), the Kennedy Range appeared to separate the traditional lands of two Aboriginal tribes. According to Tindale (*Aboriginal Tribes of Australia*, 1965, 1974), the range formed the boundary between the Maia tribe to the west of the range and the Malgaru tribe to the east.

The Maia people occupied an area of about 12 000 square kilometres from just north of Carnarvon to the western slopes of the Kennedy Range. The freshwater springs on this side of the range support abundant wildlife and would have been a source of food and water for the Maia people.

The Malgaru's tribal lands covered a similarly large area, stretching from the eastern escarpment of the range, across the Lyons River (known to Aborigines as *Mithering*) and east to the boundary with the Wadjari tribe—near the Gascoyne River, around Mooloo Downs and Yinnetharra.

The Aboriginal history of the range itself is largely unrecorded, but occupation sites exist around and within the range. Outcrops of chert found in the area are ideal for stone tool making, and a large number of artefact scatters near the freshwater springs on the western side provide additional evidence of occupation by Aboriginal people in the 20 000 or so years before European settlement.

The Aboriginal Affairs Department has recorded almost 100 sites on and around the range. Most are archaeological sites, but a number of them are of ceremonial or mythological importance.

Such sites include a march fly *talu* site—a site where special ceremonies are conducted to increase the numbers of a particular species—and a mythological site in a most inaccessible part of the dunefield in the centre of the range. Engravings in the southernmost gorge of the visitor area are heavily weathered, and it is difficult to decipher them.



STATION HISTORY

The freshwater springs and permanent pools that were so important to the local Aboriginal tribes also attracted pastoralists in the late 1800s.

In 1858, an expedition into the Gascoyne Region, led by Francis Thomas Gregory, reached the Kennedy Range on 12 May. The range was subsequently named in honour of the then Governor of Western Australia, Arthur Edward Kennedy, and the Lyons River, which runs along much of the eastern side of the range, presumably in honour of the British admiral and diplomat Lord Edmond Lyons. Gregory's expedition continued to Mt Augustus before returning to Perth via Mt Gould, the Murchison and Irwin rivers, Dandaragan and Toodyay.

In his report of the expedition to the Surveyor General, Gregory stated:

"With regard to the quantity and distribution of the available lands, it will only be necessary to observe that, with the exception of 30,000 or 40,000 acres at the mouth of the Gascoyne, there is no land worth occupying for many years to come west of the Lyons River; the amount of land on this river has already been estimated at nearly 300 square miles, while on the Upper Gascoyne and its tributaries there is probably double that quantity; this, with the lands on the Murchison near Mount Hale, would make a total of about a million acres.

"A very important circumstance in connection with this district is the total absence, so far as we were able to observe, of any of the varieties of *Gastrolobium* or *Euphorbia*, which constitute the poisonous plants so fatal to cattle and sheep in other parts of the colony."

Perhaps it was this last point, rather than his earlier comments, that led to the fact that within 20 years of Gregory's expedition, pastoral leases were taken up along both the Gascoyne and Lyons rivers, and the region rapidly developed into a prosperous wool-producing area.



Gregory also suggested in his report that another expedition be mounted to the area at a different time of year, but this was not immediately undertaken. Author Rhonda McDonald, in her book *Winning the Gascoyne*, takes up this point:

"In 1872 Charles Brockman had just returned from an exploratory trip to the Mount Magnet area, when he met Mr J. B. Ridley. Mr Ridley expressed surprise that no one had followed up Gregory's report of the Gascoyne River."

Four years later, Brockman set off for the West Gascoyne with Mr Charles Fane. In 1877, he established Boolathana Station, just north of the mouth of the Gascoyne River. Jimba Jimba Station, at the junction of the Gascoyne and Lyons Rivers south of the Kennedy Range, was taken up in 1878 and from then on, as people ventured further inland, stations sprang up throughout the area along the Lyons River.

Lyons River Station was first taken up in the 1880s by George Hammersley and Thomas Simms, but little development was done. However, when William Hatch purchased the lease in 1906, he and his family began developing the property and obtained additional land. During the intervening years, the station experienced good times with sheep numbers increasing, and by 1911 it had a new shearing shed with the most upto-date machinery available. The owners continued to lead the technological revolution in the area when they purchased a motor vehicle in 1916 and had the region's first telephone line installed in 1919. But communication was often severed for many weeks during the rainy season, when the Lyons and Gascoyne rivers swelled and swept away the line and poles in many places.

The only other station on the eastern edge of the range is Mt Sandiman. This is currently being run as a tourist venture offering a range of station-stay accommodation and tours. It is owned and by the Fraser family, who also own Minnie Creek Station farther north.

Above left: Calytrix brevifolia is one of the shrubland plants found on the dune ridges. Photo – Jiri Lochman

Left: A little red kaluta pauses as it feeds on nectar from an Ashby's banksia flower. Photo – Jiri Lochman High numbers of sheep grazed the area around the Kennedy Range until the late 1930s, when drought, depression and overgrazing caused many businesses to crash. Even now, much of the land surrounding the range has not recovered from some of the worst degradation in the State to be caused by early pastoral activity. Fortunately, because the top of the range is virtually waterless, it was only lightly grazed and, even though there has been mineral exploration, it remains relatively unscathed.

MINERAL EXPLORATION

The Kennedy Range was explored for its mineral potential as early as 1861 by an expedition led by Augustus Charles Gregory, brother of Francis Thomas Gregory. Subsequent expeditions, in 1883 by W H Huddleston and 1901 by A G Maitland, also looked at the area's potential for mining.

Interest in the hydrocarbon potential of the Carnarvon Basin began in the 1920s, but exploratory drilling for oil and oil shale since the 1960s has been unsuccessful. West Australian Petroleum (WAPET) drilled five holes in the Kennedy Range in the 1950s, and two shallow wells were drilled outside what is now the park's north-east boundary by Hartogen Exploration in 1972. In the early 1980s, Esso took out tenements over the range and conducted limited seismic exploration, which included the drilling of two exploration wells.

Since the mid 1960s, the area has been explored for uranium, diamonds, coal and base metals. But in 1992 a geological report, prepared for the then Department of Minerals and Energy, indicated the mineral potential of the Kennedy Range National Park was low.

But despite this history of exploration, little was known about the vegetation, plants and animals that inhabit the range until fairly recently. A few surveys of selected areas were conducted in 1975, 1987 and 1991, but a full-scale survey had not been carried out until early this year,

Above right: The endemic sand-swimming lizard Lerista kennedyensis has only been recorded in the Kennedy Range. Photo – Ron Johnstone

Right: Sand dunes on top of range are reminiscent of those on the Cape Range near Exmouth. Photo – Marie Lochman



when zoologists and botanists from the Department of Conservation and Land Management (CALM) and the WAMuseum conducted the Carnarvon Basin Survey.

ANIMALS

Twenty-six species of reptile, nine species of mammal and around 70 bird species were recorded on the dunes and swales of the mesa during the recent survey. These ranged from the endemic sandswimming skink *Lerista kennedyensis* to the death adder (*Acanthophis pyrrhus*), and included the mulgara (*Dasycercus cristicauda*), the little red kaluta (*Dasykaluta rosamondae*, formerly *Antechinus rosamondae*) and the northern mastiff bat (Chaerephon jobensis).

The scree-slopes of the range yielded seven species of reptile and 10 native mammals, including the euro (*Macropus robustus erubescens*), the common rockrat (*Zyzomys argurus*), Finlayson's cavebat, the skink *Ctenotus uber* and the long-tailed dunnart (*Sminthopsis longicaudata*).

The outwash plains and watercourses below the range support quite a different fauna. Seven species of lizard and eight mammals were recorded in these mulga-dominated communities. They included the dragon lizard *Ctenophorus reticulatus* and the perentie (*Varanus giganteus*), and





Above: Mooka Springs: one of several springs on the west of the range. Photo – Greg Keighery

Right: The rufous-crowned emu-wren was recorded in the range during a recent biological survey. Photo – M & I Morcombe

native mammals such as the yellowbellied sheath-tailed bat and stripe-faced dunnart (*Sminthopsis macroura*).

Of the birds, the most significant find was the rufous-crowned emu-wren (*Stipiturus ruficeps*) in the spinifex dunes on top of the range—the only recorded site in the Gascoyne. This bird is often found on the Cape Range in the Pilbara, a habitat almost identical to that on the top of the Kennedy Range. Small flocks of painted finches were recorded close to their southern limit, and western gerygone and grey fantails were also present as migrants from south-west of the State.

As would be expected, the regular suites of birds found in mulga country and spinifex plains are to be found on and around the range. Common bronzewings and spinifex pigeons are common around water holes on the west side, and wedge-tailed eagles are known to breed in the range and nest in the high cliffs on the eastern side.

FOSSILS & PLANTS

The Merlinleigh Sandstone of the range is of the Eocene period and contains many fossils of marine animals as well as fossil plants. In the 1960s and 1970s, archaeologists collected a small number of fossilised plant specimens, two of which were fruiting bodies of the family Proteaceae that turned out to be banksias. In 1979, palaeontologist Ken McNamara of the WA Museum collected two further fossilised specimens of *Banksia* in the range. From these collections, two new species were described, but only one— *Banksia archaeocarpa*—has been formally named. The existence of these fossils in the



range represents the earliest known occurrence of *Banksia* in Australia.

Of the 295 other plant species recorded on the range, about 82 are annual wildflowers, with the remaining being the small, medium and large shrubs.

The outwash plains support open woodlands of mulga (Acacia aneura) over shrubs including dandjin (Hakea preissii), poverty bushes (Eremophila spp.), and cassias (Senna spp.). They are particularly rich in bunch grasses such as wanderrie (Eriachne and Eragrostis spp.) and spear grass (Stipa spp.). After rain, mulla mullas, everlastings and rich herbfields of native cornflower (Brunonia australis) appear. Creeklines flowing out of the range are lined with coolibah (Eucalyptus coolabah var. rhodoclada) and the wattle Acacia citrinoviridis.

The scree slopes of the range have open low wattle woodlands of snakewood (*A. xiphophylla*) and bramble wattle (*A. victoriae*), with scattered kopi mallees (*Eucalyptus striaticalyx*) over a speciesrich but sparse layer of woody shrubs and herbs, including an undescribed species of native lily (*Wurmbea* sp.). Exposed pavements along the top edge of the mesa support low shrublands of native cassias.

The dune ridges on top of the range support a shrubland of prickly plume grevillea (*G. annulifera*), Ashby's banksia (*B. ashbyi*), *Calytrix brevifolia*, and an undescribed, endemic single-sided bottlebrush (*Calothamnus* aff.borealis). The interdune plains have hummock grasslands of lobed spinifex (*Triodia* basedowii) and soft spinifex (*Plectrachne* schinzii), with scattered clumps of the narrow-leaved bloodwood (*E. lenziana*), each standing on its own mound of trapped sand.

Springs under the cliffs on the western side of the range support a diversity of tropical aquatic plants including Indian sundew (*Drosera indica*), sedges and bulrushes.

TOURISM

One of the best times to visit the range is in the months following winter rain, when the usually dusty red landscape changes to rich verdant hues and wildflowers flourish and carpet large areas of the surrounding plains.

Kennedy Range National Park is a semideveloped park attracting the more adventurous visitor seeking a wildernessstyle of experience. But being within an hour's drive of Gascoyne Junction, it is also attracting those visitors who want to sample the outback experience, but still feel a little unsure about leaving 'civilisation'.

Most visitors travel by road from Carnarvon—a distance of about 210 kilometres. However, you might choose to combine your visit to the Kennedy Range with a visit to Mount Augustus. This can be done as a round trip from Perth to Carnarvon, then inland to Gascoyne Junction, Kennedy Range and Mount Augustus, returning to Perth via Meekatharra, or vice versa. Either way, you should carry ample fuel, food and water. Remember, this is the outback.

Other options include flights and safari tours from Carnarvon and Denham, and coach tours and packaged



charter flights from Perth. Details of accommodation and tours can be obtained from the Shire of Upper Gascoyne or from the WA Tourist Centre in Perth.

Although unsurfaced, the roads are easily negotiable by the average family car, but may be closed or hazardous after heavy rain (telephone the local Shires for up-to-date information). An access road off the Lyons River Road runs into the park to the main visitor sites. Vehicle access to other parts of the park is not recommended, as tracks are extremely hazardous and it is easy to become lost.

An information shelter on the access road into the park gives details of the campgrounds and walktrails, and describes the mulga country surrounding the range. Bush camping is permitted at the base of the eastern escarpment. The sites are undeveloped and have no facilities other than a bush toilet.

WALKTRAILS

Walktrails run from each site into the nearby gorges and, although the trails are largely unmarked, they are easy to follow.

The trail from the northern visitor site runs into the gorge a short distance before encountering a sheer wall of honeycomb-like rock formations. You can sit below the wall and examine the strange shapes carved out of the sandstone by the combined action of wind and water or look for animal tracks beside the semi-permanent pool at the base of this usually dry waterfall.

From the middle site, a track runs along a creek bed for a few hundred metres before dividing beneath an enormous block of sandstone. The left fork of the creek follows a narrow winding gorge, where occasional pools provide sanctuary for frogs. The right fork continues much farther and you can see where rushing waters have scoured out the creekbed and lower slopes of the gorge.

The trail from the southern site runs part-way up the side of the gorge to a waterfall, which flows after rain. Looking back there are good views east across the mulga plain. From the waterfall, it is possible to scramble down to the creekbed for a different perspective. Look for a large boulder that has tumbled down into the creek bed. On its flat rock face are very old and faint Aboriginal petroglyphs (rock engravings), the meanings of which have long since been lost.

MANAGEMENT

Management guidelines have been prepared for the park in consultation with pastoralists and Aboriginal people.



Above: The trails from the southern visitor site runs part-way up the side of the gorge to a seasonal waterfall. Photo – David Gough

Left: Weird, honeycomb-like rock formations carved out of sandstone by wind and water. Photo – Jiri Lochman

Long-term management for the Kennedy Range National Park includes the conservation of its biological, physical, cultural and landscape values; the provision of visitor recreational opportunities and facilities that will not compromise the natural values of the range; and the promotion of a better understanding of these and the cultural values through interpretation panels, park brochures and other information.

From a recreational perspective, the visitor sites on the eastern side of the escarpment are being developed to provide a quality wilderness experience for park visitors.

Though the Kennedy Range National Park is still in its infancy, it is becoming well known for its wilderness value. And as you stand at the foot of its sandstone battlements, the Kennedy Range beckons you to explore and discover its natural attractions.

David Gough is Editor of *LANDSCOPE* and a communications officer with CALM's Corporate Relations Division. He can be contacted on (09) 389 8644.

Ron Shepherd is District Manager of CALM's Gascoyne Region and can be contacted on (099) 48 1208.

The authors gratefully acknowledge the assistance of Gil Field of CALM's Planning and Visitor Services Branch; Norm McKenzie, Greg Keighery and staff at CALM's Wildlife Research Centre in Woodvale; Ron Johnstone, Laurie Smith, Peter Bindon and Ken McNamara of the WA Museum; staff at the Department of Aboriginal Affairs; author Rhonda McDonald; and Peter Bridge of Heperian Press, in preparing and researching this article.







STIRLING RANGE

The Stirling Range is a wild, mountainous place—just the scene for the intriguing or unusual bird species that make their home there.

by Allan Burbidge and Allan Rose

everal early colonists visited the Stirling Range before 1840, but probably did not collect bird specimens. The first collections were most likely made by Johnston Drummond, who made a brief visit to the range in the summer of 1843-44 with his father, the well-known botanical collector James Drummond, Johnston Drummond collected birds and mammals for John Gilbert, who sent them to the famous English 'bird-man', John Gould. Unfortunately, Drummond's collections are simply labelled 'Swan River Colony', so it is impossible to tell whether any of them came from the range.

Serious work on birds of the Stirling Range began in 1902 with a visit by Alex Milligan and Charles Conigrave of the Western Australian Museum. With several companions, they walked from the railway line at Tenterden, through the range as far as Toolbrunup, which was then thought to be the highest peak in the range. They battled dense vegetation, strong winds and drenching rain to draw up the first comprehensive bird list for the range. Their list included a number of species of interest, such as an unusual form of the striated field-wren, which Milligan named Calamanthus montanellus.

Previous page

The red-eared firetail, found only in south-western WA, usually inhabits dense vegetation, but they are regularly found along the walk trail to Toolbrunup Peak. Photo – Babs & Bert Wells/CALM F. Lawson Whitlock, a highly experienced field ornithologist, was commissioned to collect birds and their eggs for Mr H. L. White of Belltrees, New South Wales. Whitlock worked in and near the western end of the Stirling Range during the spring of 1910. Otto Lipfert, of the WA Museum, and Frederick Bradshaw, of nearby Tambellup, made observations and collections in the Stirling Range during 1920. Since 1950, there have been a number of visits by contemporary field workers, beginning with Lindsay Sedgwick.

Today, many people enjoy studying or simply watching birds in the Stirling Range, in considerably more comfort than was available to those hardy early visitors.

THE BIRDS

As a result of these endeavours, together with continuing observations, some 140 bird species have been recorded in what is now the Stirling Range National Park. Ninety species have been recorded breeding. Ducks and other aquatic species have been recorded on the lakes in the south-eastern sector of the park. There are 11 bird of prey species (at least six of which breed in the park), three pigeons, 11 parrots and cockatoos (seven

Below left: Usually a resident of mallee woodlands further inland, the southern scrub-robin lives in drier parts of the Stirling Range, but is not found in wetter areas near the coast. Photo – Babs & Bert Wells/CALM



Elevated rocky outcrops with a panoramic view, such as here on Mount Trio, are favoured perching sites for the peregrine falcon. Photo – Marie Lochman/Lochman Transparencies

breeding), four cuckoos and many smaller bush birds, including robins, whistlers, fairy-wrens, thornbills and 14 species of the honeyeater family.

Why are there so many species here? Part of the answer lies in the diversity of plant species and vegetation communities, and part in the topography and geographical position of the range. The high number of flowering plant species (about 1 500) provides a good, year-round source of nectar for honeyeaters, and a varied food source for flower and seed-eating birds such as cockatoos and parrots. Presumably, these plants also help support a varied invertebrate fauna, which would in turn support populations of insectivorous birds in the Stirling Range. These plant species combine to produce a range of

Below: Brilliantly coloured male splendid fairy-wrens can be seen in shrubby vegetation in a number of places in the range, such as Moingup Springs and Red Gum Springs picnic areas. Photo – Kim Howe





bird habitats, from wetland vegetation through heath and thickets to several kinds of mallee-heaths and woodlands.

The array of bird species is also augmented by the topography and geographic position of the range. The locally high rainfall, resulting from the relatively contrasting topography, contributes directly to habitat diversity, and allows a number of wet area birds to occur here. In other parts of the range, species more characteristic of drier regions may be found.

The geographic position of the range also contributes to this effect. Birds at the inland limits of their range in this part of the State include Baudin's blackcockatoo, the white-breasted robin, western thornbill, red-winged fairy-wren, spotted pardalote (as a breeding species) and red-eared firetail. About 20 bird species occur no nearer to the coast than the Stirling Range in this part of the State. These include the jacky winter, crested bellbird, southern scrub-robin, shy heath-wren, blue-breasted fairywren, mistletoe bird, yellow-rumped pardalote, brown-headed honeyeater and black-faced woodswallow. The masked owl and barking owl have been recorded here at the eastern limits of their distribution in south-western Australia.

Below: Endemic to south-western Western Australia, the western thornbill is at the inland limit of its distribution in the range. Photo – Babs & Bert Wells/CALM and the range supports the most westerly population of the purple-gaped honeyeater. A few species, including the crested pigeon, galah and yellowthroated miner, are more common in the surrounding open farmland and usually only enter the edges of the park.

In the Porongurup Range, about 30 kilometres to the south, a study in the 1970s by principal research scientist Ian Abbott, of the Department of Conservation and Land Management (CALM), revealed the presence of only about 56 bird species, 30 of which were thought to breed in the area. The Porongurup Range covers a smaller area than the Stirling Range and contains fewer plant species and vegetation types.

There are few introduced birds in the Stirling Range: the kookaburra is present and the laughing turtle-dove is known from one road-kill specimen on Chester Pass Road. The turtle-dove is normally associated with human habitation and is usually found nearer to towns to the north, including Borden and Ongerup.

HISTORICAL CHANGES

The brief visits by Milligan and Whitlock were confined to early or midspring, and it is therefore difficult to analyse the changes in the status of bird

Below right: The masked owl is rarely recorded in the Stirling Range National Park, where it is at the eastern limit of its distribution in Western Australia. Photo – Jiri Lochman/Lochman Transparencies species over time. However, some useful comparisons can be made.

The bush thick-knee (stone-curlew) was plentiful in Milligan's time, and his party flushed them on many occasions. However, this species was not recorded by Sedgwick in the 1950s and 1960s, and there are no recent records. The bird has declined through much of the Wheatbelt, probably due to clearing of native vegetation and predation by foxes.

The malleefowl may also have been lost from the park, although it was probably always rare in the area, since it provides marginal habitat for the species. Malleefowl were recorded breeding in the park in the 1960s, but have not been seen there since 1980.

A few species seem to have increased in abundance in the park. Milligan and Whitlock did not see any crows or ravens in or near the Stirling Range. Fifty years later, Sedgwick found them in small numbers. Now, Australian ravens are frequently seen in small numbers. Their arrival was probably tied to clearing of the surrounding land for agriculture, and to increased human use of the park.

Milligan did not record Port Lincoln ('twenty-eight') parrots in the area, but Whitlock found them to be rare in 1910 and Bradshaw described them as uncommon in the 1920s. Thirty to 40 years later, Sedgwick described them as being common, as they are today.

Maned ducks and shelducks were not recorded by early observers, but both species now breed in small numbers in





the park. This probably ties in with a trend throughout the south-west in which these two species have increased in abundance as a result of the provision of farm dams and 'improved' pastures.

The little eagle has moved into the area since Whitlock's time. During the same period, the galah and crested pigeon moved further into the south-west, and now occur in the Stirling Range in small numbers as visitors (galahs) or at the margins (crested pigeons). Elegant parrots have also become more common in south-western Australia, and now breed in the park.

The laughing kookaburra was introduced to Western Australia around the turn of the century and was not recorded in the Stirling Range until Sedgwick found a number of them at Moingup Springs and the east face of Bluff Knoll in the 1950s and 1960s. They are now common in wooded areas.

BIRD-PLANT RELATIONSHIPS

A great many plant species of the Stirling Range are believed to be pollinated by birds. Individual bird species may visit the flowers of a broad range of plant species including the spectacular mountain bells. The data from the Stirling Range, together with data gathered elsewhere in south-western Australia, show that the only exception to this rule is the purple-crowned lorikeet. In southwestern Australia this species is only known to visit eucalypts, usually smallflowered species. Purple-crowned lorikeets harvest both pollen and nectar, but presumably are also effective pollinators.

Individual plant species may be visited (and presumably pollinated) by more than one bird species. Generally speaking, there is little specialisation between plant and pollinator, although each is important to the other.

An extensive survey of Stirling Range plants by CALM scientist Ray Wills has shown that a number of plant species listed here are highly susceptible to dieback disease, caused by the organism *Phytophthora cinnamomi*. These include feather-leaved banksia (*Banksia* brownii), scarlet banksia (*B. coccinea*), bull banksia (*B. grandis*), chittick (*Lambertia inermis*), single-flowered honeysuckle (*L. uniflora*) and, to a variable extent, heath-leaved honeysuckle

> Left: Carnaby's blackcockatoo, which is declining in the Wheatbelt, nests in small numbers in wandoo trees within the Stirling Range National Park. Photo– Babs & Bert Wells/CALM

> Below: The diet of the purple-crowned lorikeet consists of pollen and nectar from small flowering eucalypts, and when these are flowering, the lorikeets are a common sight within the park.

Photo – Babs & Bert Wells/CALM

(*L. ericifolia*). If these species were lost from the park, or drastically declined, there could be a corresponding decline in the numbers of nectar-feeding birds. This might result in less efficient pollination of the plants that remain, producing even further declines.

There is a high incidence of natural hybrids in the eucalypts and mountain bells in the Stirling Range. This phenomenon may be partly a consequence of the relatively high numbers of both honeyeater and plant species in the park, and the lack of marked foraging preferences on the part of the honeyeaters. This, together with the mobile nature of many honeyeaters, may lead to unusually high rates of pollen movement between plant species.

Marri (*Eucalyptus calophylla*) is an important tree for birds, providing nectar and pollen for a number of honeyeater species and the silvereye. It is also an important food source for seed-eaters, especially red-capped parrots and blackcockatoos, which probe the fruits with their elongated bills. Marri also provides nesting hollows for birds such as redcapped parrots.

RARE SPECIES

Two species found in the Stirling Range, the western whipbird and crested shrike-tit, are declared rare fauna. Four species, the peregrine falcon, Baudin's black-cockatoo, Carnaby's blackcockatoo and the red-eared firetail, are given special protection.

The western whipbird is known from long unburnt mallee-heath in several localities in the Stirling Range, including Mount Trio and Talyuberlup. The crested shrike-tit is difficult to detect, but may be found in wandoo or yate woodland.





40 LANDSCOPE





The Bluff Knoll turn-off is a good place to start looking for them.

The peregrine falcon can be seen around the taller peaks, including Toolbrunup and Talyuberlup. Baudin's black-cockatoos visit the Stirling Range, and are most often seen in marri woodlands. Carnaby's black-cockatoos, on the other hand, breed in the range and can be seen there at any time of year. They can be seen in a variety of places, but the woodlands in the Moingup Springs-Toolbrunup area, or near the Bluff Knoll turn-off are likely places. The red-eared firetail prefers wetter gullies with dense vegetation. They are sometimes difficult to detect, but can be found along the path through the gully on the way up Toolbrunup.

WHERE TO SEE BIRDS IN THE RANGE

The Toolbrunup path is also the best area to see birds of the wetter gullies. Apart from the red-eared firetails, you can observe white-breasted robins and, possibly, red-winged fairy-wrens, as well as more widespread species such as western rosellas, white-browed scrubwrens and shining bronze-cuckoos. Higher up, near the craggy tops, you may be lucky enough to see a peregrine falcon.

The Bluff Knoll turn-off is a good place to see birds of the wandoo woodlands. Here, yellow-plumed honeyeaters are often heard calling noisily to each other. However, other species also take note of their 'hawk' alarm calls. At such times it is worth watching for birds of prey—the Australian hobby (a small falcon) may appear, chasing a tree martin or a purplecrowned lorikeet.

Another interesting bird of these woodlands is the rufous treecreeper. Studies by Allan Rose have shown that treecreepers in this area are found only in wandoo, where they have territories of about five hectares. They normally have two broods of young each year, with the young from the first brood helping to feed the young from the second brood. The young birds attain adult plumage after six to eight months, and can breed at the end of their first year.

It is also worth looking for birds near



Above left: Colourful red-capped parrots, found only in south-western Australia, can often be seen in the woodlands of the range. Photo – Babs & BertWells/CALM

Above: Rufous treecreepers feed on the trunks and, unusually for treecreepers, also on the ground. The best place to see them in the range is near the Bluff Knoll turn-off.

Photo - Bill Belson/Lochman Transparencies

Left: Australian owlet-nightjars are nocturnal, but occasionally sit at the entrance to their hollows during the day, when the alert observer could see one in the woodland areas in the park. Photo – M & I Morcombe

the Moingup Springs campsite, especially in springtime. Here you can see many of the birds of the marri and yate woodlands: red wattlebirds, red-capped parrots and Carnaby's black-cockatoos can be found breeding or roosting. Owlet-nightjars can sometimes be seen or heard in this area. In nearby heath, you may see splendid fairy-wrens and, if you are lucky or persistent, southern emu-wrens.

From the Mount Trio carpark, crested bellbirds and western whipbirds can be heard calling. Patient observers may see the whipbirds raking through the leaf litter with their bills. This is also a good area to see honeyeaters. A number of plants—heath-leaved honeysuckle, chittick, mountain pea (*Nemcia luteiflorum*) and bell-fruited mallee (*Eucalyptus preissiana*)—attract nectareating birds while they are flowering.

Within a short walk of Red Gum Springs picnic site are woodlands of marri, yate, banksia and wandoo. A broad range of woodland birds, including wattlebirds, common bronzewings, kookaburras, gerygones, thornbills and honeyeaters, can be found here.

Thornbills, scrub-wrens, currawongs

and spinebills can be found near the Bluff Knoll carpark. A walk into the gullies on the Bluff Knoll path may also reveal a variety of birds, including cuckooshrikes, cuckoos and honeyeaters. Spectacular wedge-tailed eagles may be seen soaring around this and other peaks in the range.

BREEDING

Some breeding can occur at almost any time of year in the Stirling Range. although most birds breed in spring, with the peak being October-November. Allan Rose has been studying bird breeding in the Stirling Range, principally in the wandoo woodlands near the Bluff Knoll turn-off. Thirty-two species have been recorded breeding here. For example, yellow-rumped thornbills have been recorded building nests as early as May, laying in July (or even as early as June), and continuing breeding through winter, spring and into early summer. They can therefore rear several broods in a season. This thornbill is a frequent host for the shining bronzecuckoo. On one occasion in the Stirling Range, a shining bronze-cuckoo, which was being chased away from a thornbill nest, flew into a window and killed itself. A post-mortem showed that it was about to lay an egg, and presumably had been attempting to do so in the thornbill's nest.

Other species have a more restricted breeding season and apparently only raise a single brood each season. Sacred kingfishers seem to have a short breeding season, while square-tailed kites have only been known to lay in November in the Stirling Range. Being a predator of small birds, the kite nests relatively late, when many smaller birds have started to produce young. As in many other areas, predation rates on nests in the Stirling Range are high. Likely predators include grey currawongs, kookaburras, ravens and, especially for nests near the ground, foxes, goannas and snakes.

Wandoo trees provide good quality nest hollows of various sizes for a number of bird species. These range from quite small species, such as the tree martin, through intermediate-sized birds, such as PortLincoln parrots, to the large Carnaby's black-cockatoo. It probably takes several hundred years for a hollow to become large enough for the black-cockatoos, so it





Top: Bronze-cuckoos breed in the park. This young bird would have been raised in the nest of a small songbird. Photo – Babs & Bert Wells/CALM

is important to ensure that such trees, and potential replacements, receive long-term protection.

ARE BIRDS OF THE STIRLING RANGE UNIQUE?

Some of the early ornithologists, especially Milligan, went to the Stirling Range in search of new or unusual forms of birds. Indeed, many of the specimens collected differed from those obtained elsewhere. In the first quarter of this century, Gregory Mathews and Alex Milligan named 16 species and subspecies of birds based on specimens collected in the Stirling Range. Subsequent study has shown that these forms are best considered part of more widespread species and subspecies that may vary slightly from place to place or between Above: South-western Australia is a stronghold of the uncommon squaretailed kite. It regularly nests in wandoo trees in the park. Photo – Simon Nevill

individuals. It is now believed that no bird species or subspecies is unique to the Stirling Range. Nevertheless, the bird community of the Stirling Range is unique.

Allan Burbidge is a senior research scientist with CALM with a particular interest in terrestrial birds. He can be contacted on (09) 405 5100. Allan Rose was a ranger at Stirling Range National Park for many years and is a keen birdwatcher and photographer. His phone number is (090) 759 027. This article is based on a chapter in *Mountains of Mystery: A Natural History of the Stirling Range*, available from CALM offices and bookstores for \$19.95.

Cutting Out the Leafminer

by Ian Abbott, Paul Van Heurck, Tom Burbidge and Allan Wills

> Unlike most forested parts of the world, the hardwood forests of Western Australia did not experience insect outbreaks until 30 years ago. One concern is that forest management practices may aid the spread of insect pests, but in the case of one, the jarrah leafminer, detailed studies have shown that timber harvesting and spring burning are unlikely to have caused the outbreaks. This research has also thrown up possibilities for control of the jarrah leafminer.

> > DAN

he jarrah leafminer (Perthida gluphopa) became a pest in jarrah forest east of Manjimup around 1960, when feeding by the larvae caused extensive damage to the crowns of jarrah trees. This infestation has gradually extended west, south and north, and at present occurs as far north as Collie. At the peak of an outbreak of jarrah leafminer in 1980, more than half a million hectares of State forest were moderately to severely affected. In 1992, 196 000 hectares were affected, as the outbreak around Manjimup had receded. What has caused this outbreak, and what can we do to control it?

LIFE CYCLE

The female jarrah leafminer moth deposits her eggs into the lower surface of jarrah leaves in April or May, preferring leaves that are about six months old. A tiny caterpillar (or larva) hatches out of each egg and feeds for about five months during the winter. The process is rather like mining coal underground in that the caterpillar in its 'mine' consumes leaf tissue from within the leaf. The rate at which it grows is largely dependent on the temperature; during a mild winter,

Previous page

Top left: New seasons's growth of jarrah leaves, not yet infested by jarrah leafminer. Photo – Dennis Sarson/Lochman Transparencies *Top right:* Magnified detail of a jarrah leaf showing several completed mines (evidenced by cutouts). Photo – Steve Curry



the caterpillars grow more quickly. When the caterpillar is mature, around September or October, it cuts a neat circular hole (cutout) in the leaf and falls to the ground within a protective capsule of leaf tissue. It then burrows a couple of centimetres into the soil, where it remains inactive until about the end of February, when pupation begins. The pupal stage, during which the caterpillar metamorphoses into an adult moth, lasts for about another month. When the adults emerge, they probably have only a few

Previous page

Bottom left: Flower buds, fruits and flowers of jarrah. Bottom right: Close-up of jarrah bark. Photos – Babs & Bert Wells/CALM days to mate successfully and and for the females to lay their eggs (adult moths live for only about 10 days in the laboratory).

If you walked through a forest infested with jarrah leafminer, you might notice the crowns of the jarrah trees appear brownish, where the feeding caterpillars are destroying the leaves. In severely affected stands, so-called 'outbreak zones', 60 per cent or more of all foliage turns brown and is unable to photosynthesise. Consequently, the foliage becomes less dense and dies back

Above: Crowns of jarrah infested (brown) and uninfested (green), seen from Kepal fire tower in 1966. Photo – Steve Curry

Below: Progressive deterioration (1967, 1975, 1987) in the condition of a jarrah tree crown due to jarrah leafminer infestation. Photos-Zan Mazanec and Ian Abbott









from the branch tips, permanently damaging the crown of the tree. Although this does not usually kill the tree, it affects the overall health and vigour of the forest. As a result, the balance of the forest could change as marri (Eucalyptus calophylla), which is not affected by the jarrah leafminer, thrives. It could also affect other organisms that depend on jarrah foliage, such as leaf-eating beetles. The loss of leaves will mean that affected trees use less water, which could have an effect on the levels of water tables locally. Also, in places where jarrah is harvested for timber, the sparsely leaved jarrah crowns will have an economic effect. It is estimated that jarrah leafminer currently causes a reduction in the growth of approximately 50 000 cubic metres of wood per year, because infested trees grow more slowly.

Above: Comparison of leaves from jarrah susceptible (left) or resistant to infestation by jarrah leafminer. Note that although many eggs are laid within the resistant leaf, none develop to any notable extent. Photo – Babs & Bert Wells/CALM

Below: By December, the flush of new jarrah foliage constrasts markedly in colour with foliage damaged a few months earlier by jarrah leafminer. Photo – Ian Abbott

Many people believe the emergence of the jarrah leafminer in pest proportions in State forests over the past 30 years might be partly due to forest management methods, such as timber harvesting and spring burning. Because both of these result in regeneration of the forest and a burst of new leaf growth, burned or thinned stands of jarrah should provide ideal egg-laying sites for the female leafminer moths. It was, therefore, Above: In leaves from jarrah susceptible to infestation, much of the tissue is consumed and the individual mines appear to coalesce. Note cutouts and capsules (left) containing jarrah leafminer larvae. Photo – Steve Curry



thought these areas might be infested with leafminer caterpillars the following winter, from where the moths would disperse into the surrounding forest the next autumn. For the Department of Conservation and Land Management (CALM) to control the spread of this pest, it was important to establish whether timber harvesting and spring burning have any effect on the distribution or abundance of the leafminer.

COUNTING CUTOUTS

It was decided to use the number of larval cutouts at sites throughout the affected areas as a measure of the abundance of the leafminer. Once the abundance and distribution of the pest had been established, this could be correlated with the logging and burning records for the areas. The number of cutouts per leaf indicates how many larvae have gained maturity; it is therefore a useful measure of the severity of infestation. (Note that it is not a measure of the total number of larvae as some die before the cutout stage, but these generally do less damage to the foliage than the larvae that grow to maturity.)

In 1984 and 1987, 40 experimental plots were established by CALM scientists in State forest in the Manjimup and Collie

EXTENT OF JARRAH LEAFMINER OUTBREAKS 1987-92



Leafminer Outbreaks

Cutout Boundary

1992

1991

46 LANDSCOPE

districts. These were carefully chosen to cover a representative range of rainfall, fire history, logging history and vegetation type. In each plot, six young jarrah saplings were randomly selected for detailed study and each spring, for between four and seven years, several new leaves on each plant were tagged. The following spring, the number of larval cutouts on each of the 600 leaves tagged in each district was counted. The total area burnt in the previous spring in each district, and the total area logged in the previous year in each district, were extracted from CALM records and compared with these figures for the average number of leafminer cutouts (i.e. mature larvae) per leaf.

The area of forest logged or burned in the Manjimup and Collie districts varies markedly from year to year, sometimes by a factor as great as five. If these practices contributed to the spread of the leafminer, you would expect that the greater the area of forest logged or burned in any year, the more abundant would be the leafminer larval cutouts in the following spring. In fact, although the abundance of the leafminer in the experimental plots went up and down from year to year by as much as a factor of three, the increases in abundance did not necessarily follow years in which the areas logged or burned had increased.

Further investigations, directly comparing experimental plots that were either burned or not burned, showed no significant difference between the burned and unburned plots in the number of larval cutouts per leaf the following spring.

MONITORING THE SPREAD

To keep tabs on the spread of the jarrah leafminer, 300 000 hectares of jarrah forest, north of the main outbreak zone near Collie, were inspected annually for the presence of leafminer mines and cutouts. When the annual results are plotted on a map, there is a clear boundary in the distribution, termed the 'cutout boundary'. To the north of the cutout boundary, no leafminer larvae successfully complete the feeding part of their life cycle in the jarrah leaf; all larvae die in their mines-perhaps because of cold or lack of nutrients. To the south of the cutout boundary, larvae are able to finish feeding and then drop from the leaf to complete the next stage



of their life cycle in the soil.

The cutout boundary is not fixed; it shows quite marked fluctuations in position from year to year. If logging and/or burning aid the spread of the leafminer, the cutout boundary should follow closely the location of recently burned or logged stands of jarrah. In fact, the detailed set of maps over six consecutive years from 1987 until 1992 show that the annual fluctuations in the position of the cutout boundary do not relate to the location of spring fires or logging in the previous year (see opposite). Substantial areas of forest burned in spring were not colonised successfully by jarrah leafminer in the following year. For example, Hakea forest block was burned in spring 1985, but remained to the north of the cutout boundary until 1989. A notable retreat of the boundary southwards occurred in 1988, even though extensive tracts of forest to the north had been burned in springs of preceding years.

CONTROL OPTIONS

So how can we control outbreaks of jarrah leafminer? One possibility is to disrupt the life cycle of the leafminer. An experiment and a survey carried out in Collie district show that burning forest in autumn under hot dry conditions scorches all or part of the forest canopy and reduces the density of leafminer for 18 months. The scorched leaves are quickly shed, but are not replaced until spring. This means that female leafminer moths find fewer suitable leaves in which A stand of jarrah trees burnt in autumn. Note the green foliage and lack of infestation by jarrah leafminer. Photo – Dennis Sarson/Lochman Transparencies

to lay their eggs. In addition, if done early enough in autumn, fire can kill leafminer pupae in the topsoil, so that fewer moths emerge.

At present, less than five per cent of State forest in Collie district is burned in autumn; most is burned in spring under cool damp conditions. Spring fires rarely result in leaf scorch exceeding six metres above the ground and tend to burn the ground vegetation in patches. Some judicious autumn burning, to scorch crowns of affected jarrah forest, could be an effective way of subduing outbreaks of the jarrah leafminer.

Interestingly, about 10 per cent of all jarrah trees seem to be resistant to attack by the larvae of the jarrah leafminer. Although the leaves of these resistant trees carry similar numbers of larvae to the susceptible trees, most of the larvae die in their mines before they have damaged a significant part of the leaf. Although the chemical basis for this resistance has not yet been discovered, criteria for detecting resistant trees have been established. Increasing the proportion of resistant trees in the jarrah forest would effectively limit the spread of the jarrah leafminer. This could be achieved by ensuring resistant trees are left behind when timber is harvested from affected jarrah stands, so that in time the forest will naturally contain a greater proportion of resistant trees. A simple change such as this could have a dramatic effect on the vigour and growth of the jarrah forest around Collie and Manjimup, as well as protecting against future outbreaks.

> Ian Abbott is Science Adviser and Head. of CALM's Science Services Group. He can be contacted on (09) 442 0300.

Paul Van Heurck, Tom Burbidge and Allan Wills are technical officers with CALM's Science and Information Division. Tom and Allan are based at

 Como Research Centre and can be contacted on (09) 334 0305. Paul is based at Woodvale Research Centre and can be contacted on (09) 405 5100.

nusical

Makers of woodwind instruments are on the lookout for a new source of search has concentrated on the tropical species of Latin America, Africa Washington, had the visionary idea of looking to Australia for this new believes he may have found what he is looking for in the unique timbers



T I M B E R S

timber to supply a significant international market. So far, much of the and Asia. But Felix Skowronek, Professor of Flute at the University of source. After nearly ten years of research with flute head-joints, he of the Western Australian Goldfields. BY FELIX SKOWRONEK AND IAN KEALLEY







he sweet, melodious tones of the flute are popularly associated with idyllic outdoor settings. Perhaps this is because, in Greek mythology, the flute was the favoured instrument of Pan, the god of Nature. The thin, whispery quality of the reed flute that Pan played is a long way from the bright, intense, and versatile range of sounds we now associate with the concert flute. But the bucolic origins are still there, echoing faintly behind the trills and flourishes of our modern-day virtuosos.

For the uninitiated, it often comes as a surprise to learn that the modern flute, clad in its armour of silver, gold, or platinum, is a member of the woodwind family of instruments. But until this

Previous page

An array of Goldfields timber head-joints illustrates an attractive range of colours and grains.

Photo - Felix Skowronek

Insets: Barks from Goldfields species gimlet, merrit, mulga, Webster's mallee.

Below: From the raw materials to the finished product: an elegant gimlet head-joint against gimlet bark.

century, all flutes were made of wood, with the metal version becoming the norm only since about 1920. In Great Britain, wood flutes continue to be made to this day, but only by the handful compared with the numbers turned out up to about 1950.

The wooden tradition, however, is not disappearing. Far from it. There is still an abiding respect among flautists for the sonoric capabilities and the overall aesthetics of wood as a medium, and in recent years there has been a resurgence in demand for the wooden product. There has been some experimentation with synthetic materials, but precious woods will always have a fascination and value as a natural and time-honoured source

Below right: A typical Goldfields woodland scene: a 90-year-old regrowth thicket of mixed species that could provide materials for world-class musical instruments.

Bottom: Although its range extends across Australia, the mulga of the Goldfields has harder, heavier and finer grain than its Eastern states counterparts.

of beauty and function.

Not many timbers around the world have the density and mass necessary to produce the brilliant tone we have come to expect from the modern instrument. Supplies of the traditional flute-making timbers—the African blackwood and the West Indian ebony—are nowadays in doubt. African blackwood is still available commercially, but it is harder to obtain now than it was in the hey-day of the wooden flute, and it is of poorer quality. West Indian ebony is simply not available. Around the world, the search is on for materials to replace these classic woods.

Many of the slow-growing timbers of the Goldfields are showing great potential for the fashioning of 'head-joints' (i.e., mouthpieces) which can be fitted onto the metal body of the flute, creating a hybrid instrument capable of whole new dimensions of sound quality. With the support of the Goldfields Specialty Timber Industry Group—through the Goldfields regional office of the Department of Conservation and Land Management (CALM)—researchers based at the University of Washington,







Left: The woodlands of the Goldfields are taller, denser and more extensive than many people realise.

Below (from left to right): Potential musical instrument timbers in their natural settings—salmon gum, Goldfields blackbutt, boree.



Seattle, have sampled a range of species to this purpose, yielding some very interesting possibilities for certain timbers to create the flutes of the future.

WHAT'S IN A HEAD-JOINT?

The head-joint is the tone-generating element for the flute. Its special importance as part of the entire instrument was long recognised, but has only recently been separated from the construction of the entire instrument. But the head-joint is the key to instrument's sound qualities.

Its manufacture is relatively simple: a tapered-bore length of tube of definite dimensions, with an 'embouchure-hole' (i.e. blow-hole) carved into the tube at a certain point. Unlike the rest of the flute, there are no moving mechanical parts involved.

The rest of the instrument, in contrast, consists of a sophisticated and



delicate system of keys, rods and springs by which the various tone holes in the body and foot are stopped in order to determine the different notes to be played. The dimensions of the body and foot joints of the flute remain much as they were more than a hundred years ago, and the mechanics are standard to manufacturers the world over.

The head-joint, however, carries one feature that has resisted standardisation and thus has remained at the last frontier of flute making: namely, the dimensions and carving of the all-important embouchure-hole. While a set of basic dimensions and wall-angles has been loosely adhered to for the last century or so, details have varied widely, from almost-round holes to oval or rectangular, in the quest for the ideal balance between maximum tone and volume, as well as ease of articulation.

In the last 10-15 years, the



manufacture of head-joints has become so specialised that a growing industry has emerged in the custom-making of flute head-joints. It is not at all unusual nowadays for a performer to be playing a flute with a head-joint made by someone other than the original manufacturer of the instrument.

But head-joint-making, for all its recent successes, is still an inexact science. Every flautist's facial muscular structure is different, and indeed, different flautists can sound vastly different using the same head-joint. And the embouchure-hole is not the only factor. The material of which the headjoint is made also makes a considerable difference to the sound of the instrument. And here again, there is a degree of inexactitude that could drive the technicians mad, if it were not for the beautiful music which can result.



One of the Goldfields' most memorable landscapes: gimlet trees with an understorey of pearl bluebush (*Maireana sedifolia*) and saltbush (*Atriplex* sp.).

Below left: Merritt is well suited for producing a baroque sound quality.

Below right: Giant mallee is one of several red heartwood species that have provided the hardest materials for head-joint making.

MAKING THE DIFFERENCE

Although the average listener may not discern them all, the flute is capable of an astonishing range of tone qualities to suit different musical styles. For example, a professional musician might describe 'modern' sounds as hard, firm, brilliant, projecting: 'romantic' as broad, mellow, full; 'baroque' as soft, dulcet, open; 'jazz' as hard, loud, airy; or 'folk' as thin, airy, hollow or haunting. A skilled player can achieve most of these qualities on a single 'modern' metal or wooden head-joint, but to do so requires adjustments to the embouchure (mouth position)-making it artificial to the player's natural styleand the head-joint design.

In the sampling of Goldfields timbers, the intriguing possibility is emerging that certain tonal characteristics might be 'built-in' to particular species, regardless of the measurements and cut of the embouchure-hole. This is contradictory to a popular scientific theory that an instrument's tone is not affected by the material from which it is made. But this is an area where subjectivity must reign, for what a performer 'feels' in the response of his or her instrument presides over any judgement, and it remains a tantalising idea that flautists of the future may be able to change head-joints every time they change musical styles.

THE SCIENCE OF SOUND

Over the years, a number of scientific experiments have failed to convince performers that the materials from which flutes are made have less effect on the

tone of the instrument than factors such as measurements and vibrations. Scientific fact in this instance carries little meaning. Performers are, after all, the ones actually playing the instruments, and what they feel determines their attitudes about materials. Among the metals of choice for the flute, silver is thought of as bright and projecting; gold, mellow and full; and platinum, hard and brilliant. Wood, thought of as being mellow or soft in quality, perhaps akin somewhat to gold, actually tends to combine elements of all the others, though is generally more resistant and harder to blow.

So what does this all mean as far as wood and flute tone is concerned? Generally, it is assumed that the harder



and denser the material, the brighter and fuller the tone. The 'inventor' of the modern flute, Theolbald Boehm, observed in the mid-19th century that very hard wood produced a more brilliant, ringing sound. If any attempt is to be made to use wood to make a modern flute, the heaviest and densest specimens are likely to be most successful.

WHAT THE GOLDFIELDS OFFERS

Regular *LANDSCOPE* readers will know about the remarkable density of Goldfields timbers (see 'Western Australia's Desert Forest', *LANDSCOPE*, Winter 1995). Most species from this arid region sink in water. These are obviously not the best timbers for making floats. But



for flutes, they could well be ideal.

An amazing array of hard, heavy, fine-grained timbers grow here, which compare favourably against similar species elsewhere in Australia. Of the three eucalypt heartwood-colour groups of red, brown, and green, the reds have provided the hardest materials for head joint making, notably giant mallee (Eucalyptus oleosa), red morrel longicornis), salmon (E.gum (E. salmonophloia), and redwood (E. transcontinentalis). The latter three are endemic to the Goldfields and adjacent Wheatbelt.

The mulga (Acacia aneura) of the Goldfields appears to be harder, heavier and finer-grained than anywhere else in Australia, and has so far stood out as prime head-joint material. Also among the acacias, western myall (A. papyrocarpa) differs markedly in hardness and density from the lighter weight eastern myall (A. pendula), found in Queensland and New South Wales. Likewise, the closely related black oak (Casuarina pauper) of the Goldfields and Queensland's C. cristata appear to be one and the same tree from outward appearance. However, the heartwood of the Queensland tree is beige, while the Goldfields species is a dark chocolate brown, and is an almost uncanny lookalike for the prized West Indian ebony it seeks to replace.

To describe this field of research as exciting would be an understatement. Experimenting with these little-known hardwood species, on the edge of new developments with flute head-joint design and woodwind instrument manufacture, is a constant process of discovery and joy. Thanks to the good folks in Kalgoorlie-Boulder who have made all this possible, and under whose watchful eye the precious resource will be carefully managed, we may well be listening to and enjoying a lot of music in the future whose origins can be traced back to the Goldfields. And the Goldfields may take the credit for bringing the flute back closer to nature once again.

A KEY TO THE BAROQUE QUANDARY

Today's flautists face a dilemma when they undertake to play Baroque-era music. It has been a subject of intense debate since baroque music began enjoying a resurgence in popularity, some 25 years ago.

This historic period, roughly coincident with the life of the great composer Johann Sebastian Bach (1685–1750), saw an enormous amount of music written for the flute. The flute of that time, however, was an almost completely different instrument from the 'modern' or Boehm-system flute, invented in the 19th century. The baroque flute had only six open finger holes and one mechanical key. It had a much thinner, smaller sound than today's instrument and, as a limitation of its crude design, was extremely difficult to play in tune.

Many purists insist that the baroque flute, or a modern replica of it, is the only suitable instrument for performance of this music. This places the modern flautist in an awkward position, with only a few options available: first, to disregard completely the 'radical' attitude of those who would insist on historical correctness; second, to adopt some, but not all, of the baroque performance elements on the modern instrument; or third, to take up the baroque flute, in essence learning the new techniques and demands of an obsolete instrument.

Fortunately, Goldfields timber head-joints offer another option that goes a long way towards a fulfilling compromise on this thorny issue. Many of the less dense or lighter-weight Goldfields species seem to be well suited for producing a baroque sound quality on a flute head-joint of relatively modern design, placed on the metal body of a modern flute; essentially a composite instrument. The more fibrous eucalypts, such as Dundas mahogany (*E. brockwayi*), Dundas blackbutt (*E. dundasii*) and merrit (*E. flocktoniae*), for example, have given consistent results along these lines. Other species worth exploring further because of light-weight yet fine texture are white cypress pine (*Callitris glaucophylla*), boree (*Melaleuca pauperiflora*), and perhaps even the sapwood of the black oak.

A particularly interesting case can be made for Strickland's gum (*E. stricklandi*), which exhibits a mellow and full yet mild tone with a wonderfully 'cushiony' and reliable articulation. Heads made from this species have done remarkably well in the performance of Bach sonatas and arias on both metal and wooden flutes.



The Strickland's gum headjoint blends beautifully with the soprano voice.

Felix Skowronek is Professor of Flute at the University of Washington, Seattle. An accomplished flautist, Felix was a founding member of the Soni Ventorum Wind Quartet in 1962, and has made more than 24 recordings with them. He also performs with his jazz combo, the FS Jazz Trio, which debuted at the 20th Annual National Flute Convention held in Los Angeles in August 1992.

Felix has been a leading promoter of the revival of the wooden Boehm-system flute in the USA, and through his research has become an authority on the use of new hardwood species for flute and woodwind instrument manufacture. He can be contacted on (USA) +1 206 543 9260, or e-mail: fesaushw@u.washington.edu. Ian Kealley is CALM's Goldfields Regional Manager and has been actively involved in helping Prof. Skowronek in his search for specialist timber on the WA Goldfields. Ian can be contacted on (090) 21 7831.

Unless otherwise indicated, all photos are by Jiri Lochman

URBAN ANTICS!

GALLOPING GECKOS

'DONTOUCHTHEDAMN

THINGITLLBITEYER!!!'...a common phrase used in the past to teach youngsters that all you see in the world of bugs and other bities is bad, or at best, dodgy.

Many of us, therefore, have grown up thinking that all reptiles are cold, slimy, poisonous and snappy little devils that should be avoided or simply disposed of what a shame! They are, in fact, fascinating creatures that deserve a fair go.

The gecko lizards have loose skins, very large round eyes with vertical pupils, no eyelids and, in some species, a voice—a rarity among lizards. The hunting 'call' of these species is onomatopoeic with their name— 'gecko, gecko', repetitively. They are amiable house prowlers, searching at night for insect delicacies.

A most haunting feature of these creatures is that, from a position high on a wall or branch, their slim arms, delicate feet and the slender neck, with a somewhat rounded skull, make them a little reminiscent of the aliens from TV's 'X Files' or Speilberg's 'Close Encounters'. And remember, in many indigenous cultures around the world, it was the 'lizard men' who brought the law.

In Perth suburbs we are likely to

come across two main species (see 'Reptiles in the Garden', LANDSCOPE, Autumn 1994). The marbled gecko (Phyllodactylus marmoratus) is the lizard that we see from time to time inside our houses, garages or cupboards. They can often be seen ducking for cover behind a picture frame or dart board on a verandah wall. With patience, the creature will re-appear and you can watch it checking out the nooks and crannies for prey.

The marbled gecko is a brownish grey on the upper surface. Its back is usually crossed by thick blackish 'W' shaped lines, each followed by a pale grey blotch. Quite often, this animal is found horribly squeezed between furniture or stacked wood, but to our amazement, quietly slithers away uninjured into another restriction.

The western spiny-tailed gecko (Diplodactylus spinigerus) is a real outdoors type. Found around undisturbed corridors of urban bush, it lives in shrubs and low trees on sandy soils, especially over coastal limestone. If you have a garden of native vegetation, the species can be found, with reasonable difficulty, clinging in a camouflage mode to the branches of bottlebrush shrubs. Here, particularly when the plant is in flower, it is but a hop, step and a jump to the many insects attracted by the nectarproducing blooms.

This gecko is generally grey on the upper and lateral surfaces, except for a

broad, white dotted black stripe, which is straight-edged on the tail and wavyedged on the back to the head. Two rows of dark, long spines run along the top of the tail, usually with two short spines above the eye. The most striking feature of this animal is its eye, which is very large, golden with a chestnut centre and sometimes having angular greyish spots, a fascinating arrangement of colours.

The western spiny-tailed gecko has one novel habit that is not found in the marbled variety. If molested, it will squirt a sticky fluid from glands in the tail, which would almost certainly deter a would-be predator.

Like most geckos, these two beasts show an elaborate refinement for light control. During daylight, their vertical pupils have notched edges that can be bought together to form a series of pin-holes. The separate images are then superimposed at the back of the eyeball, giving them super-sharp vision. After dark, their pupils relax to form large black orbs to watch you, even in the dead of night.

BY JOHN HUNTER

DID YOU KNOW?

- There are 720 species of gecko arranged in 84 genera in the world, with 58 species and 11 genera found in Western Australia.
- Some geckos have toe pad scales which, with the aid of hair-like filaments, enable them to walk on vertical surfaces as smooth as glass.
- The marbled and western spinytailed geckos have backwardscurved claws that are able to be sheathed like a cat's.
- A large wide tongue enables them to lick and clean their lidless eyes, and if they are grabbed by the tail, it comes free to be gobbled up by a predator as the animal escapes.

Discover the treasures of WA's coastline

Whether you're a treasure-seeker or a pleasure-seeker, there's a new book just out that will take you down under.

Dive & Snorkel sites in Western Australia is CALM's latest nature-based recreation guide. It is packed with fascinating shore dives and boat dives from Cape Leeuwin to North West Cape. The 43 sites range from easy snorkelling that are suitable for the whole family, to more challenging boat dives that would appeal to experienced SCUBA divers. This 168-page guide follows the same delightfully descriptive, easy-toread style as the popular Family Walks in Perth Outdoors and More

Family Walks in Perth Outdoors, with mud maps, site descriptions, fascinating features, colour plates, and illustrations.

Dive & Snorkel sites in Western Australia is set to become this summer's bestselling recreation guide. Dive into it and head down under...the waves.

Dive & Snorkel sites in Western Australia is available from all good bookshops, newsagents, dive shops and CALM offices, or by mail order from CALM at the address below (postal charges will apply).

A CALM publication Department of Conservation and Land Management PO Box 104 COMO WA 6152

Tel: (09) 334 0333 TTY: (09) 334 0546

\$14.95



Reef fish, including the brilliant blue neon damselfish, dance among the staghorn corals in the Ningaloo Marine Park near Coral Bay.

Photo - Clay Bryce/Lochman Transparencies



PRINT POST APPROVED PP665002/00004