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A CALM publication DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT



Cooperation between 4WD clubs and CALM is helping to protect WA's special recreation spots through a program of education. See 'Go Lightly' on page 17.

LANDSCOPE

VOLUME TEN NO. 4 WINTER ISSUE 1995



The noisy scrub-bird is one species that is responding well to its recovery plan. 'Recovering from the Brink' (page 10) discusses how such plans are drawn up.

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RECOVERING FROM THE BRINK

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There is a great deal written and talked about our forests. But what are the facts? 'Looking Beyond the Obvious' (page 22) dispells some of the myths.



Mt Augustus is the biggest rock in the world; yet few people know it exists. Find out more about this natural wonder on page 28.



Specially developed computer software is helping speed the identification of plant species in 'The Smart Collection' (page 49).

COVER The rainbow bee-eater is a common bird found throughout most parts of the State, including Mt Augustus National Park. Illustration by Philippa Nikulinsky.

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Published 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

DISCOVERING WESTERN AUSTRALIA

There are few places in the world where travellers consistently experience the pleasure of a 'new discovery'. But Western Australia constantly produces such surprises. It is only recently that most Western Australians have become aware of the existence of Ningaloo Reef—a coral reef matching the Great Barrier Reef. It is only a few years ago that the phenomenon of whale sharks visits off the Ningaloo coast were observed, and this is only the second year that the whale shark phenomenon has been readily available to tourists.

How many Western Australians know that we have a rock twice the size the one in the centre of Australia that is only 850 km due north of Perth? The history, beauty, biology and geology of Mt Augustus, which is the biggest rock in the world, are described in this issue of LANDSCOPE by David Gough and ranger Terry Bloomer. Mt Augustus only became a national park in 1989, and is increasingly becoming a magnet to tourists.

CALM's advocacy of nature-based tourism and description of out-of-the-way, unique places in Western Australia, through this journal and other media, occasionally draws criticism. We have been accused of spoiling some natural places because we have contributed to them becoming 'too popular'. But we believe it is our responsibility to ensure that all Western Australians have the opportunity of knowing about the natural wonders of their State and, if possible, having the opportunity of visiting them. Apart from the equity argument, CALM does not believe a 'King Canute' strategy is realistic; people are going to find these unique places anyway.

Unfortunately, there are many places around Western Australia that have been 'found' by a relatively small number of people, who have then proceeded to savagely degrade them. Paradoxically, there is a greater chance of our precious natural wonders being preserved if they are visited by more people; because then it becomes possible to manage visitor pressure. In 'Go Lightly: minimising the impact', Wayne Schmidt and Mandy Clews describe how it is possible to manage both sites and people, so we can all enjoy our natural environment without destroying it.

This issue of LANDSCOPE also describes another of Western Australia's unique 'surprises'; our Desert Forest. I believe there are few things more beautiful than the sun setting on a stand of Goldfields eucalypts. I am sure most Western Australians would be surprised to learn that more than three million hectares of this 'forest' was clear-felled to support the gold mining industry. This extensive forest has regrown and has the potential to provide the raw materials for an exciting, high-value, labour-intensive, new industry in the Goldfields.

Ind Alea

The Publisher

LUCKY FRIENDS

I am a recent subscriber to this magazine and am writing to say that I have found it to be exceptional in its high standards across all facets of publication—photography, writing style, appropriateness of articles etc. It gives an excellent view of the flora and fauna of our State. I'm sufficiently impressed to be immediately sending subscriptions to two of my overseas friends.

Well done! to all associated with the magazine.

GREGORY PETERSON BASSENDEAN

Thank you for your comments. Many subscribers send aift subscriptions of LANDSCOPE to friends and overseas—often relations because the magazine concentrates solely on Western Australian plants, animals and places. It helps provide those not living here with a glimpse of the natural wonders of our wonderful State. Other readers who would like to send gift subscriptions, either overseas or interstate, please see the subscription form in this issue. -Editor

BUSH POETRY

I have just purchased the latest LANDSCOPE and have now done what I should have done years ago-become a subscriber. I have always been interested in the environment and conserving what we have here in Western Australia, even more so since I joined the Go Bush! program some time ago. I have attended sixteen different activities, and can say without a doubt that I have enjoyed every one. The instructors are so interesting, and the CALM Staff so pleasant and helpful. This year, I decided to apply for a position as a volunteer, and hope I will be accepted.

One of the sessions 'Discover Nyoongar Way' seemed extra special, and prompted me to write a poem which I enclose. I hope you enjoy it.

WENDY GILMOUR NORTHAM

I am sure that all the people involved with CALM's Go Bush! program will be delighted to hear you have had such a good time at the many events you have so far attended. Unfortunately, we don't have space to publish your poem here, but perhaps readers might hear it for themselves at one of the Go Bush! poetry and song evenings held in The Hills Forest. – Editor

DISAPPOINTED READER

As a regular subscriber to natural science magazines such as LANDSCOPE, Australian Geographic and National Geographic Iwas disappointed with the 21 page article on 'Wildflowers of Western Australia' in the January 1995 issue of National Geographic.

As National Geographic magazine has about 10 million copies printed and distributed worldwide on a monthly basis, it represented a great opportunity to publicise Western Australia as the 'Wildflower Capital of the World'. Instead, the article seemed to concentrate on the landscape, people and fauna, but not the numerous, diverse, unique and spectacular flora we possess.

I have written to encourage the Editor of National Geographic, if there is another article on the flora of Western Australia, to contact relevant organisations in this State for assistance. As an additional

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

incentive, I enclosed the Spring 1991 issue of *LANDSCOPE* and the offer of a free gift one year subscription of *LANDSCOPE* to both the Editor and the article's contributor, Cary Wolinsky.

JOHN R. FELDMAN MANNING

The Illustrations Editor of National Geographic has since replied to Mr Feldman's letter stating that the intention of the article was to concentrate not on the flowers of WA, but on the natural environments in which they could be found. The magazine's staff did refer to previous issues of LANDSCOPE and used many consultants to help with the selection of photographs. – Editor

HUNTING THE HUNTER

It is disappointing to find even small errors in a favourite publication. In the Spring 1994 issue, in the article on vegetation of the Stirling Ranges, a salmon-bellied skink (Egernia napoleonis) was named as a King's skink (Egernia kingii) in a photograph of Bluff Knoll. Similarly, the feral cat photographed in the act of eating a bird in the Summer 1994-95 issue was eating a painted button-quail, not a stubble quail as suggested in the caption.

In the same piece on feral cats of the desert ['Hunting the Hunter'], the conclusion that feral cats contributed to the decline of native mammals in the region conflicts with information presented in the article. It is stated that feral cats have been present in the desert for perhaps several hundred years; and yet the catastrophic decline of native fauna occurred from early to mid this century! Feral cats are clearly a problem for the

Painted button-quail Photo—Babs & Bert Wells/CALM

reintroduction of mammalian fauna and their impact may be exacerbated by the removal of foxes, as the abundance of feral cats has been known to increase upon the control of foxes. The importance of feral cats at the reintroduction stage should not be allowed to cloud our understanding of the original causes of decline, however. Those original causes, which may include cats, need to be understood for the long-term management which will be needed after successful reintroductions are achieved.

MICHAEL J BAMFORD KINGSLEY

The LANDSCOPE article states that cats have been present in the arid zone for at least 100 years, not several hundred as stated by Dr Bamford. Mammal declines in the arid zone probably commenced soon after the arrival of the feral cat, but were not really noticed until around the middle of this century, when some species became extinct. This was probably exacerbated by the deliberate introduction of thousands of cats into parts of the arid zone to control rabbits earlier this century, and by the arrival of the fox. It is our [the authors'] view that the establishment and expansion of feral cats in the arid zone had a dramatic and devastating impact on medium size mammals and will be a major impediment to mammal reintroduction programs. We believe that in the absence of



predation by feral cats and foxes, rare native mammals can be successfully re-established in the arid zone. Unlike foxes, for which there is an effective control measure, there is no proven broad-area control measure for feral cats, although CALM scientists are making considerable progress in this area. – Dr Neil Burrows, Principal Research Scientist and co-author of 'Hunting the Hunter'

LANDSCOPE VISA CARD

My wife and I recently transferred our ordinary Visa card to the LANDSCOPE Visa. We have done this willingly to support its purpose, even though we lost some advantage with interest rates.

However, there are not many groups to which we give money that do not at least give an annual report when not giving actual receipts. Do you plan to publish some sort of account of the funds generated by the scheme?

DONALD B REID DUNCRAIG

Thank you for your support towards endangered species conservation by transferring to the LANDSCOPE Conservation Visa Card.

CALM will produce, every year, a leaflet which will introduce the projects on which the funds raised by the LANDSCOPE Conservation Visa Card are spent. The leaflet will be mailed to cardholders with one of their monthly statements.

> We are always pleased to receive letters about articles that appear in *LANDSCOPE*. Letters should be addressed to the Editor, *LANDSCOPE* magazine at the address on page 3.

Although the insert will not generally include details of revenue and expenditure, more detailed information will be included in the department's annual report in the section dealing with external funding.

Projects which gain support from the card will also be reported on from time to time in LANDSCOPE, as they were in the Spring 1994 issue. – Dr Syd Shea, Executive Director, CALM

FOND MEMORIES

I was very excited to see pictures of the 'Whicher your Brachysemas' in interesting article in LANDSCOPE [Summer 1994-95 issue] because the species photographed looks exactly like a species of Epigaea found here in the Laurentians of Quebec in early spring. This flower, E. repens, is sometimes called Mayflower, but mostly called trailing arbutus. It flowers in May-one of our earliest flowers-and can be located both by its beautiful perfume and by looking under its large glossy green leaves.

Last January, Andy and I enjoyed a fantastic trip with Bob and Ann of Coates Wildlife Tours exploring some of the beautiful country and wildlife in the Cape Range and at Ningaloo, Coral Bay and Shark Bay, with the highlight of the tour being the tagging of green and loggerhead turtles under the supervision of CALM's Bob Prince.

JANE K HUGESSEN KIRKLAND, QC, CANADA

The turtle-tagging program at Ningaloo benefits in two ways from the tour you enjoyed. First from the physical help of extra pairs of hands, and second from the financial assistance provided by the tour operator, who donates part of the tour cost to the program. – Editor



FOXES ON THE RUN

One morning, early in April, Department of Conservation and Land Management (CALM) officers began collecting dead foxes and cats after the first night of a threenight baiting program to determine the density of the feral predator population on Peron Peninsula.

Little did they know that by mid-afternoon on the third day they would have evidence that the fox density on Peron Peninsula was twice that known anywhere else in the State.

Fox-baiting at Peron Peninsula is part of Project Eden (see LANDSCOPE, Autumn 1995), a program to eradicate feral animals from the peninsula and reintroduce native animals.

Over a three-night period, 146 foxes and three cats were killed, which project officer Ray Smith saidwas anextraordinarily high density of foxes.

"Seventy-nine foxes died the first night, with 37 and 30 on the following two nights, respectively," Ray said.

"The unusually high density of foxes could probably be attributed to the large numbers of rabbits, on which foxes prey."





With the initial density trials completed, aerial baiting with 1080 poison baits began. About 10000 baits were dropped on an area covering the entire peninsula, with baitfree buffers being retained around Denham township, the Monkey Mia facilities and main camping areas to protect family pets from inadvertently picking up a bait.

Before the aerial baiting began, signs were erected to let people know which areas were being baited. Brochures were mailed to all homes and businesses in the area to inform residents and visitors about the project and details of the baiting program. Brochures are still available at all local tourist resorts, caravan parks, information offices and the CALM office in Denham.

Some four weeks after aerial baiting began, the density survey was repeated. This time no foxes were killed.

Extensive track inspections and spotlight surveys by the Special Air Services Regiment, have confirmed that foxes have been almost eradicated in the baited zone, with only one fox being sighted.

Some foxes still persist in the bait exclusion zones, although their numbers have been reduced. Follow-up baiting is planned for areas next to the zones to help stop those remaining foxes from reinvading the nearby Francois Peron National Park.

As expected, the fox baiting has had little impact on feral cats, which are

Above left: Before aerial baiting began, Peron Peninsula had a very high fox density. Photo – Ray Smith

Left: Fewer fox tracks indicate a successful baiting program. Photo – Babs & Bert Wells/CALM widespread on the peninsula, but in relatively low numbers. However, a broad area baiting of the peninsula, planned for September, will use a special cat bait developed by CALM scientists, and it is expected that this will reduce the number of cats as well as further reduce the number of remaining foxes.

Research by CALM and other agencies has shown that, when fox and feral cat numbers are controlled, populations of some native animals increase dramatically. Species that may have become extinct locally may be reintroduced once feral predator numbers have been reduced.

Some species that are now extinct on Peron Peninsula still survive on islands such as Bernier and Dorre, near Shark Bay; they include the boodie, rufous hare-wallaby, westernbarred bandicoot and the Shark Bay mouse.

Other species that once inhabited the region are the chuditch, woylie, red-tailed phascogale, stick-nest rat and the mulgara (a marsupial carnivore).

Later this year, a fence will be erected across the threekilometre-wide Taillefer Isthmus, just south of Shell Beach, as a further barrier to minimise reinvasion by foxes, cats, goats and rabbits. The fence design will enable vehicles on the main road to pass without stopping, but feral animals will not be able to get through at that point.

Project Eden is creating interest across Australia. Scientists from the Australian Nature Conservation Agency (ANCA), who are planning a similar but smaller-scale project on the east coast, spent several days with CALM scientists to gain an insight into the fox and feral cat control techniques CALM employs.

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

PLEASE DON'T FEED THE DOLPHINS

Dolphins at Monkey Mia will soon have better protection, thanks to a new utility boat acquired recently by CALM's Gascoyne District office at Denham.

The *Sirenia*, which takes its name from the taxonomic group to which dugong

belong, has a top speed of 30 knots and is being used initially to patrol the waters around Monkey Mia, where staff are monitoring the feeding of dolphins from boats.

National and international research has shown that uncontrolled hand-feeding



has resulted in the disappearance or death of dolphins, primarily due to their loss of natural instincts and development of abnormal behaviour.

The dolphin experience at Monkey Mia has survived because of careful supervision of the interaction between humans and dolphins, and control of feeding at one location—namely, the beach area at Monkey Mia.

Not only is it important to protect the dolphins from a nature conservation aspect, it

CALM's Gascoyne District staff inspect the Sirenia before launching. Photo – David Gough is also important for the local tourist industry, as the dolphins' continued presence at the beach is still the prime attraction for most visitors.

Deaths of juvenile dolphins have been high over the past few years, and hand feeding may well have been a contributory factor.

CALM officers will patrol the area and hand out information brochures to people seen fishing.

The initial phase of this operation will be to educate people about the problems associated with hand feeding dolphins, but anyone caught persistently feeding the animals after having been informed about the problems could face prosecution and be fined under the Wildlife Conservation Act.

SPRING COMES EARLY AT YALGORUP

If winter is not your favourite season, Steve Dutton, the ranger-in-charge of Yalgorup National Park, would like you to know that spring arrives early there.

Yalgorup National Park, which featured in the Autumn 1995 issue of *LANDSCOPE*, is a scenic place to explore on invigorating winter days, and offers a pre-spring glimpse of wildflowers.

It is an area of diverse habitats, lakes, ocean, heath and forest, where the spring flowering pattern is basically the same as the inland forests

Right: Yellow buttercups reflect the colour of winter sunshine at Yalgorup National Park. Photo – Babs & Bert Wells/CALM

Far right: The vivid red cockie's tongues provide a splash of winter colour. Photo – David Gough on the scarp (beginning with wattles then progressing to hoveas and peas), but the sequence seems to begin a month or two earlier.

The cockies' tongues (Templetonia retusa) provide a vivid red splash of winter colour to the under storey, and if you look carefully you might see the delicate and rare Conostylis pauciflora, with its bright yellow flowers, among the fallen banksia leaves. This is one of a number of prioritylisted species that are now secure within Yalgorup National Park.

The heath areas also provide an eye-arresting colour show, with many species such as the yellow buttercups (*Hibbertia hypericoides*) flowering in winter.

It seems that winter weather at Yalgorup is milder,

with clear days and a little drizzle—wonderful for walking along bush trails admiring the first flowers of the season.

Luckily for walkers, much of the rain comes from southwesterly storms, and can be reliably predicted. But, walking along the beach, togged up against the elements, and with a storm brewing, can add a crisp note to the winter charm of Yalgorup National Park.





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

THE ELUSIVE NIGHT PARROT

Few birds excite more interest among professional ornithologists and amateur birdwatchers alike than the highly elusive night parrot.

The night parrot (*Pezoporus occidentalis*), is listed as a threatened species in Western Australia under the Wildlife Conservation Act. A recently developed procedure for ranking threatened species suggests that the night parrot should be ranked as 'critically endangered' and

probably given the highest priority for recovery action of any Western Australian bird if only we knew enough about its distribution, movements and ecology to produce such a plan!

Though less bulky, the budgerigar has similar colouring to the night parrot.

Before the turn of the century, many reports—but only 23 specimens—came from a vast arid area of Australia, with records from every mainland State. There seems little doubt that the bird has undergone a considerable decline in numbers and/or range since then. Nevertheless, there have been a number of reported sightings this century, of varying credibility, including 38 from Western Australia.

Historically, collected specimens and most sight

The night parrot. Based on W. T. Cooper's illustration of the Night Parrot on p.125 of Derrick Ovington's Australian Endangered Species (Cassell Australia, 1978).

records have come from four large but widely separated areas, including central Western Australia, especially the north eastern Gascoyne and along the Canning Stock Route. The late Dr Glenn Storr, a former WA Museum curator of birds, also recorded several unconfirmed sightings from arid parts of the Kimberley.

The first definite record for 80 years was a roadkilled

specimen collected near Boulia in northwestern Queensland in 1990. Coincidentally, there

had been a growing number of unconfirmed reports over the last fifteen years or so mainly from people driving at night—from the Mount Isa-Cloncurry region inland of the Gulf of Carpentaria, about 150 km north of Boulia.

A recent paper in the journal*Emu* describes seven separate sightings of night parrots in a relatively small area of the Mount Isa uplands south of Cloncurry, between March 1992 and June 1993. Most observations were at sites which had combinations of gravelly surfaces, dense, mature spinifex (*Triodia* spp.)

nearby, and water, accessible within a kilometre or so.

It has been assumed that the night parrot is a highly nomadic species, moving widely about the arid zone to find suitable habitat. It has also been suggested that there may be a more or less seasonal movement from spinifex grasslands, once the seed resource is depleted, to the samphire flats of salt lakes. Because of the assumption of nomadism, it has also been assumed that it would be extremely difficult to develop management plans for the species.

The types of habitats in which night parrots have been recorded appear to be widespread across arid Australia. Nevertheless, in the light of the comparative concentration of historical sightings, and the many recent reports over several years from a quite restricted area of northwestern Queensland, it seems possible that the night parrot may have key areas (or refuges in dry periods) on which its populations depend. It is on such key areas that any necessary management, such as predator control, should be concentrated.

A reading of both very old and very new literature on the night parrot suggests that one cannot rely solely on being in the right place at the right time for a chance sighting of the species. This is a small, secretive bird, coloured for concealment, which appears to be genuinely nocturnal, hiding almost totally in either dense spinifex or samphire

Like the night parrot, the elegant parrot feeds on the ground, but does so during the day.

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

during the daylight hours. Thus, deliberate searching, especially by spotlight at night, is likely to be needed if attempting to determine whether or not the night parrot occurs in a particular area. Daytime sightings have almost always involved birds flushed from spinifex or samphire, by chance or deliberately, through a beating process.

A logical first step towards developing a recovery plan for the night parrot in Western Australia would be to concentrate our enquiries and search efforts on those areas which appear to have the right combination of habitat features and which are in the same general area as historical sightings. A good starting point would be the north-east Gascoyne and adjacent areas, inland to the proposed Carnaryon Range National Park and areas south and south-west of it, down to Lakes Nabberu, King and Gregory.

The Department of Conservation and Land Management (CALM) is about to take preliminary steps towards finding out whether, and if so where, populations of night parrots exist in Western Australia. Full-colour posters and brochures, showing the difference between the night parrot and the similarly-sized Bourke's parrot, which is also fairly active at night, are to be produced for distribution at truck stopsespecially along the Great Northern Highway-and circulated to pastoralists in the Gascoyne region, four-wheel drive clubs, kangaroo shooters, and anyone else likely to be moving around in the rangelands at night.

Sightings reported as a

result of this publicity will be assessed and discussed with the people involved. If a significant number of apparently reliable reports come from the same or adjacent localities, and if the country meets the habitat needs of night parrots, the next step would be an expedition to search systematically for them.

Given the special mystique of the night parrot, it should be easy to assemble a team of keen and experienced birdwatchers to help in the search!

Bourke's parrot is fairly active at night but has totally different colouring.

Illustrations by Judith Blyth

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CONTRACTOR OF A DECK OF A DECK

ALEX



What happens when a plant, animal or ecological 'community becomes threatened with extinction?

Recovering from the brink

In this article members of CALM's Western Australian Threatened Species and Communities Unit describe the 'recovery process,' a method of addressing priorities and actions, and of bringing together everyone who can help pull threatened species and communities back from the brink.

by Andrew Burbidge Andrew Brown and John Blyth n Western Australia, there are many threatened species and ecological communities—unfortunately, far too many for all to be managed immediately with the scarce funding that is available for conservation work. So, as is the case with any campaign, conservation becomes a matter of good planning and efficient resource management.

The increasing importance of threatened species and ecological community conservation led the Department of Conservation and Land Management (CALM) to set up, in 1992, the Western Australian Threatened Species and Communities Unit (WATSCU). The unit's task is to coordinate and promote the conservation of all threatened species and communities in the State, and to help find the necessary resources.

In an earlier article ('Threatened with Extinction', *LANDSCOPE*, Spring 1993), we looked at the reasons for conserving threatened species and ecological communities, and outlined the threatening processes that are driving extinctions in Australia. But this is just one stage in understanding and combating species, habitat and community decline. To understand which species and communities are most threatened and to ensure their conservation, we in Western Australia, like many other places in the world, are using the 'recovery process': a logical sequence that aids research, planning and operations work. First, the conservation status of species and communities is reviewed, priority lists

Previous page

Main: Many of the people who have worked on the recovery of the western swamp tortoise were present at the first release of captive-bred tortoises back into the wild.

Inset: With only about 30 animals of breeding age in existence, methods to ensure successful hatching of eggs in captivity was a major thrust of the recovery plan for the tortoise. Photos – Jiri Lochman

Below left: Pioneering techniques for obtaining and incubating eggs from captive tortoises were developed by Dr Gerald Kuchling. This is a key element in recovering the critically endangered western swamp tortoise. Photo – Jiri Lochman

Below right: Western swamp tortoises released back into the wild carry small radio transmitters to monitor their movements. Photo – Jiri Lochman are prepared and the necessary research is conducted. Then, recovery plans are costed and produced. And finally, funding is obtained to enable the plans to be implemented, monitored and reviewed.

CONSERVATION STATUS

Information about the conservation status of species comes from many sources, including museum and herbarium collections, biogeographic surveys, scientific research and searches for particular species. This information is collected by a variety of government agencies, natural history clubs and private naturalists.

On an official level, taxa (species, subspecies and varieties) that are deemed in danger of extinction are listed in notices published in the State Government Gazette, according to definitions provided in the Wildlife Conservation Act. These taxa are generally known as threatened flora (also known as declared rare flora) and threatened fauna. CALM has set up two committees, one dealing with plants and the other with animals, to regularly review nominations of taxa as threatened. For a taxon to be listed, its threatened status must be clearly proved, and it must meet criteria dealing with the







thoroughness of survey and its acceptance as a distinct taxon. The committees recommend changes to the lists, which are then forwarded to the Minister for the Environment for final approval.

Information about the status of ecological communities, is at present, less easy to come by, mainly because their identification and conservation is a relatively new initiative. To help overcome this, CALM is developing procedures for identification that will result in a database of threatened ecological communities, initially for the South West Botanical Province, which extends inland from the coast to a line running from Shark Bay to Israelite Bay.

DEGREES OF THREAT

Ideally, all species and communities listed would be intensively studied by scientists so that the reasons for their decline were understood, and all species and communities would be managed to prevent their extinction. However, because there are more species listed than there are resources available for conservation work, the species on the lists must be ranked to ensure that the most threatened are allocated resources first. Priorities are set by allocating threatened species to the threat categories laid down by the World Conservation Union, namely, critically endangered, endangered, vulnerable, and conservation dependent (see box). These are the most recent categories adopted by the World Conservation Union (in November 1994), following a review of criteria which took place over a period of several years. The term 'threatened'

Above: The recovery plan for the western swamp tortoise has many elements. These include the management of two Class 'A' nature reserves, including fencing them to protect the tortoises from foxes, detailed ecological research and captive breeding. Photo – Babs & Bert Wells/CALM

Right: The Ellen Brook Nature Reserve. This was the last place on Earth to harbour a population of the western swamp tortoise until its recent re-establishment at Twin Swamps Nature Reserve. Photo – Marie Lochman

covers the categories critically endangered, endangered and vulnerable.

CALM has set up a scientific panel to allocate all declared threatened taxa to the World Conservation Union categories. To aid the panel's work, WATSCU developed a scoring system in which questions are asked and numerical scores allocated according to the taxon's geographic distribution, abundance, occurrence in conservation reserves, response to environmental threats, status in living collections (zoos, botanic gardens, etc.) and so on. No scoring system can be absolutely definitive for all species, and the scores are used only as a guide. However, they do, to a large degree, allow a dispassionate evaluation of a species' status. A similar scoring system has been developed for ecological communities and is currently being trialled.

SCIENTIFIC RESEARCH

Listing a species or community and allocating it a conservation priority are vital steps in the recovery process. But



the species or community must then be conserved. So what needs doing? It could be a waste of time and money controlling foxes or weeds, for example, if they are not the actual cause of a species' impending extinction. This is where scientific research may be necessary. Sometimes, a great deal of intensive research over several years is needed to develop new techniques that managers can apply to the problem.

In CALM, a world-class group of scientists and support staff is studying nature conservation issues, and many threatened species and ecological communities are receiving attention. Scientists in other organisations, such as universities, the Commonwealth Scientific and Industrial Research Organisation (CSIRO), industry, botanic gardens and non-government groups, are also contributing. However, scientific research is never cheap (although it is usually much cheaper than correcting actions taken in the absence of adequate knowledge), and the amount of research conducted is often limited by the amount of funding available. This has been the case with conservation work, and, increasingly, research has had to be funded from outside sources.

RECOVERY PLANS

Once the causes of a species' or community's decline are understood, and once techniques are available to increase its abundance and geographic range, a recovery plan is prepared.

A recovery plan is like a land management plan or a business plan, but is directed at the conservation of a threatened species or community. It is a document that examines one or more species or communities, describing their history, conservation status and the reasons for them being threatened, and then prescribes and costs actions that will be undertaken to 'recover' them, in terms of numbers and/or distribution. An important aspect of the recovery plan is that the monetary value of every action is carefully calculated-there are no hidden costs. This allows the necessary funds to be raised, either from government or other sources.

Typically, funds for implementing a a recovery plan come from a variety of sources. For example, the recovery plan for the western swamp tortoise (*Pseudemydura umbrina*) is being funded by the Western Australian Government via CALM, Perth Zoo and the Western Australian Water Authority; by the Commonwealth Government via the Australian Nature Conservation Agency (ANCA); and by non-government societies including the World Wide Fund for Nature Australia, the British Chelonia Society and a German herpetological society. Support has also come from several Perth companies including Midland Brick, East West Veterinary Supplies and Unidata.

Not all recovery plans are adequately funded. As is the case for scientific research, funding of recovery work is insufficient to cover all necessary work.

Below left: The varnish bush (Eremophila viscida) is a rare species with scattered occurrence between Mullewa and Lake Hope. Photo – Steve Hopper

Below right: Wongan cactus (Daviesia euphorbioides). A recovery plan has been written for this unusual and attractive pea. Funding is being sought this year to implement the plan. Photo – Steve Hopper

THE TEAM APPROACH

The key to developing and implementing a recovery plan is the recovery team. Recovery teams comprise representatives of all those who have a stake in, or are affected by, the conservation of the species or community. Usually, team members include people who have responsibility for the implementation of the plan, such as local CALM operations staff; people who have conducted, or are conducting, research, such as scientists from CALM or another institution; people on whose land the species or community occurs; people who are providing money or other resources; and people who are contributing their labour.

A recovery team can bring together scientists, land managers, landowners, local government councillors, financiers, conservation society members and volunteers. Recovery team meetings are often the only time that all the people who can influence a species' status will ever meet each other! Recovery teams have been operating in Western Australia for only a few years, but are already being hailed a success.

The western swamp tortoise recovery team has been in existence longer than any other in WA, having first met (as the







Western Swamp Tortoise Captive Breeding Management Committee) in 1987. Today, its members come from the University of Western Australia, Curtin University of Technology, ANCA, Perth Zoo, the World Wide Fund for Nature Australia, the Shire of Swan and CALM. Soon, a 'Friends of the Western Swamp Tortoise' group may be started; if this happens, a volunteer representing the group will be invited to join the team.

Recovery plans are proving most effective and practical when the recovery team is appointed first and then asked to oversee the writing of the recovery plan. This gives the team an ownership of the plan that it would not otherwise have if the plan was written without its input.

MANY SPECIES, FEW TEAMS

Currently, there are about 370 taxa of Western Australian plants and animals listed as threatened flora or fauna. In addition, there is inadequate information about the conservation status of many other species, and they have been placed on 'priority' lists. This means that additional searching for, or monitoring of, these species is urgently required. CALM scientists have estimated that, within a decade, there may be as many as 500 or more listed threatened species! Above: The recovery plan for the woylie has been an outstanding success. Numbers have been greatly increased and several new populations established. Photo – Jiri Lochman

Right: Sandpaper wattle (*Acacia denticulosa*) is confined to a few rocky areas north of Beacon and is being looked after by the Merredin District Threatened Flora Recovery Team. Photo – Steve Hopper

As well, there may be up to 100 threatened ecological communities.

Having 500 recovery teams and 500 recovery plans would not be efficient. So, particularly for plants, more and more threatened species are being addressed on a district-by-district basis. Here, a recovery team is set up to deal with all threatened and priority taxa in a geographical area, usually a CALM region or district. Their operation is guided by a district threatened flora management plan, which is constantly updated as more information about species comes in.

One district team that is well established is the Merredin District Threatened Flora Recovery Team. In 1991, with the aid of funds from ANCA, surveys of plants thought to be threatened



began in CALM's Merredin District, which encompasses 16 shires. (The plan actually covers 15 shires; the Shire of Wongan-Ballidu still has to be surveyed.) This culminated in the publication, in 1993, of Declared Rare Flora and Other Plants in Need of Special Protection in the Merredin District. The district has a small number of staff, so in 1993, CALM sought and obtained financial assistance from ANCA to help implement the plan. In 1994, Clare Welbon, a Murdoch University graduate who studied the diet of the noisy scrub-bird (Atrichornis clamosus) for her Honours thesis, started work at Merredin as the district's threatened flora coordinator. Clare's work is guided by the recovery team, which is chaired by CALM's District

Manager, Mike Fitzgerald, and includes representatives of local government authorities.

MORE TO COME

There are now 21 recovery teams operating in Western Australia. Of these, 10 are dealing with threatened animals, five with threatened plants; five are region or district teams; and one is dealing with a threatened ecological community-Toolibin Lake (see 'Recovering Lake Toolibin', LANDSCOPE, Spring 1994, and 'The Last Lake', LANDSCOPE, Winter 1988). In the years ahead, more recovery teams will be appointed and some will disappear, with their work completed. The recovery team for the woylie (Bettongia penicillata) is planning to be the first to achieve this distinctionthe current woylie recovery plan anticipates that woylies will no longer need to be listed as threatened by the end of 1995.

Each recovery team looks forward to the time when its target species or community is secure and its own existence as a group is redundant.

Recovery plans for different species have different key actions. The noisy scrub-bird has responded well to fire management and translocation, and is becoming increasingly less threatened. Photo – Babs & Bert Wells/CALM



Andrew Burbidge, Andrew Brown and John Blyth all work in CALM's Western Australian Threatened Species and Communities Unit (WATSCU). Andrew Burbidge, the unit's Director, deals primarily with threatened animals, Andrew Brown with threatened plants and John Blyth with threatened ecological communities. They can be contacted at CALM's Wildlife Research Centre at Woodvale, on (09) 405 5128.

DEFINING THE LEVEL OF THREAT

As outlined in 'Coming to Terms with Conservation' (*LANDSCOPE*, Spring 1993, p. 22), the World Conservation Union has been reviewing the categories to which threatened species are allocated, and trying to make the allocation of taxa to categories subject to clear and easily applied criteria. New categories and criteria were adopted by the World Conservation Union on 30 November 1994. The new categories are:

- Extinct: there is no reasonable doubt that the taxon's last individual has died.
- **Extinct in the wild:** a taxon that is known to survive in cultivation, in captivity or as a naturalised population well outside the original range, but exhaustive surveys in known and/or expected habitat, at appropriate times throughout its historic range, have failed to record an individual.
- **Critically endangered:** a taxon that is facing extremely high probability of extinction in the wild in the immediate future. **Endangered:** a taxon that is not critically endangered, but is facing a very high probability of extinction in the near future. **Vulnerable:** a taxon that is not critically endangered or endangered, but is facing a high risk of extinction in the wild in the medium-term future.
- **Conservation dependent:** a taxon that is not critically endangered, endangered or vulnerable, but which is the focus of a continuing conservation program, the cessation of which would result in the taxon qualifying for one of the threatened categories above.
- Threatened: an umbrella term embracing the terms critically endangered, endangered and vulnerable.
- **Data deficient:** a taxon that has been tested against the above criteria, but for which there is inadequate information to make an assessment of risk of extinction.
- Low risk: a taxon that has been evaluated, but does not qualify for the categories critically endangered, endangered, vulnerable, conservation dependent or data deficient.

The next stage will be to develop guidelines for the application of the new categories at the national level.

GO LIGHTLY: minimising the impact

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People visit the bush for all kinds of reasons: escape, adventure, challenge, discovery, rest. But as our population grows and becomes more mobile, the sheer pressure of numbers can turn a beauty spot into a rubbish tip. Today's land managers must find a balance between enabling us to enjoy the natural environment and conserving the very values for which we go there.

Wayne Schmidt & Mandy Clews

by

he place: a secluded forest block in the South West. The time: the early 1970s. Twenty or so tents have been pitched along the picturesque riverside. A handful of campers have come seeking a weekend of bushwalking, swimming and fishing in the peaceful forest. At dusk, the low murmur of voices rises intermittently to happy chatter as families prepare meals and get ready for nightfall. As darkness falls, silence descends. The activities of the day are given over to the occasional thumping of foraging kangaroos and the rustling of possums in the trees.

The same place, twenty years later. A 50-car capacity carpark is overflowing with 100 vehicles. A tent city has spread back in concentric semicircles from the eroded riverbank. First-in-best-dressed waterfront campsites have become walk-through thoroughfares for many other campers. No one is catching any fish.

This sounds like an extreme example, but in the space of two decades, the number of visitors to many of Western Australia's beauty spots has risen dramatically. At Dwellingup, for example, the estimated number of visitors to Lane Poole Reserve rose nearly tenfold, from 25 000 in 1973 to just under 220 000 in 1990. There are many such places around the State, idyllic forest retreats, wild stretches of coast, rugged inland hills



Previous page Four-wheel-drive vehicles are often the only way that some remote and beautiful parts of WA can be explored. Photo – Bill Bachman

and valleys, that are under pressure from high visitor numbers.

Such a rapid increase in impact on the environment can be difficult to foresee. The Department of Conservation and Land Management (CALM) is charged with conserving WA's national parks and other conservation reserves for future Above: Western Australia's native flora is world-renowned and represents one of the State's most important naturebased recreation and tourism attractions.

Below: Recreation vehicle access to beach areas has been one of the most controversial management issues confronting State and local government authorities. Photos – Robert Garvey

generations. But short of shutting people out, how is this sort of impact to be managed?

There are no instant fixes, but there is a long-term solution. Environmental management does not have to mean locking nature away from people. On the contrary, there is a place for human





Above: Campers vie with one another for a 'front row' riverside site. Left unmanaged, such use can cause significant environment degradation and visitor conflict. Photo – Maxine Cooper-Copeman

Above right: Many of the State's coastal landforms are very sensitive to human disturbance and can be easily damaged by uncontrolled vehicle access. Photo – Wayne Schmdt

presence in most natural areas. The goal is to make that presence a caring, appreciative one. Encouraged to behave responsibly, to observe, and to learn as they enjoy the outdoors, visitors are being invited to become partners in the conservation process.

A GIANT PLAYGROUND

CALM manages a total of nearly 200 000 square kilometres of land and water, a huge area, almost the size of the State of Victoria, which received more than four million visits last year. On the basis of these staggering numbers alone, the chief responsibility for behaving sensitively in natural areas has to rest with the visitors themselves.

Environmental management is often a delicate partnership with the public. While it is necessary to have some restrictions in management schemes, such as for public safety, no one wants to arrive at a recreation area only to be faced with a barrage of signs indicating that 'you can't do this' or 'you shouldn't do that'. Some people see such signs as a challenge and rebel, whereas others may be offended by them and leave the area feeling their visit had been spoilt. By far the most effective tool in managing people pressure is to offer information, education and enrichment to those seeking outdoor recreation. After all, the natural environment is theirs to enjoy.

One way to address the needs of visitors is to offer high-quality recreational experiences. A sealed track that runs three-and-a-half kilometres around Big Brook Dam gives wheelchairconfined people an opportunity to experience the karri forest at close quarters. A guided boat ride takes visitors into little-known reaches of the spectacular Geikie Gorge. Visitor centres at Milyering in Cape Range National Park, Millstream and Northcliffe provide a popular range of interpretive activities. National parks around the State offer ranger-led programs such as walks, slide presentations, night-time spotlighting tours and more, all examples of how CALM is adding value to nature-based recreation.

But perhaps the most important and long-lasting strategy in balancing protection and public enjoyment of nature is to involve visitors.

FORGING PARTNERSHIPS

Under the CALM Act, any area vested as a national park must have a management plan. CALM has already prepared a large number of these, always in consultation with the community. Such a plan will include ways of managing the impact of visitors on areas-for example, by providing greatest access to areas most capable of carrying visitors, offering a range of high-quality recreational opportunities, constructing tourist facilities, designing interpretive and instructive signs and providing literature. Local government, community interest groups, nearby landowners, farmers and pastoralists, are all

encouraged to take part in drawing up the plan. Comment is invited from the wider public when the draft management plan is completed.

Once public comments have been taken into consideration and the formal management plan is in place, the spirit of partnership with the public continues. In addition to facilities, recreational opportunities and a constantly updated supply of interpretive literature, CALM offers courses through Bob Cooper Outdoor Education in outback safety, bushcraft and minimum impact camping and bushwalking. In conjunction with four-wheel-drive clubs, CALM has supported education programs in fourwheel-driving. Evidence, so far, supports what managers have long thought to be the case: little environmental damage is caused wilfully. People simply have not been aware of the collective consequences of their actions in the bush. All that is changing.

An unusual success story to emerge from transferring responsibility to the public has been the removal of rubbish bins from selected national parks. Some years ago, as a trial, bins in several parks were replaced with signs advising visitors they were to be responsible for their own rubbish. When it was first proposed, this experiment met with some scepticism and doubt from staff, who were concerned that the rubbish problem would proliferate beyond recovery. But surprisingly, volumes of rubbish have since been greatly reduced in most areas, and, in many places, litter has ceased to be a problem altogether. These results are building confidence in the process of sharing responsibility. If people see a

TREAD LIGHTLY!

Originally launched in the United States in 1989, the *Tread Lightly!* program was a ground-breaking experiment in making the bush-going public self-regulating. The need arose with the staggering increase in sales of what Americans call 'recreational vehicles'. All around the country, forest managers were unable to cope with the increased numbers of liberated people. Visitors had to be educated and relied upon to take responsibility for themselves.

Although born out of trends in the vehicle market, *Tread Lightly!*'s message ranges far beyond four-wheel-driving to include all manner of outdoor activities. The two governing principles of *Tread Lightly!* are virtually the same as those underlying CALM's strategies: almost all damage to the environment is caused through lack of knowledge, and teaching people how to prevent it is better than shutting them out. Sponsoring bodies from the public and private sector are able to use the *Tread Lightly!* logo and promotional materials in fashioning an environmentally friendly image. Meanwhile, bumper stickers, brochures and other publicity urges trail-bikers, mountain cyclists, rock-climbers and bushwalkers to follow the acronym:

- Travelling only where permitted
- Respecting others' rights
- Educating oneself
- Avoiding animals and easily damaged areas
- Driving responsibly

The Australian National Four-Wheel-Drive Council immediately recognised the program's advantages and bought a licence from the American organisation. Realising that to be accepted by the general public, *Tread Lightly!* should not be seen as a hostage of any so-called 'lobby group' (no matter how well-intentioned they might be), the Council stepped back in favour of a totally independent company being set up to run the program.

The result: Australia's own fully independent *Tread Lightly! on Public and Private Land — A National Land Use Ethics Program* officially came into being in 1993. It now has the formal support of a number of State conservation agencies around Australia, including CALM, as well as sponsorship from the private sector.

Public membership is also welcome and information can be obtained by writing to: *Tread Lightly! on Public and Private Land*, Box 123, Coorparoo, QLD 4151, or by telephoning 1 800 650 881 (toll free).



bin, even an overflowing bin, they get the impression that someone else is looking after the problem. Acting in good faith, they will lay their bag of rubbish next to all the others, where it will be torn apart by scavenging animals and strewn across the ground. If, on the other hand, they know they are being depended upon and trusted, they will carry their waste away with them.

WHEELS WITHIN WHEELS

In developing its public partnership strategies, CALM owes a great deal to its successful relationship with the WA Association of Four-Wheel-Drive Clubs. The two organisations were first brought together ten years ago in the process of management planning for the Shannon-D'Entrecasteaux National Park. When four-wheel-drive enthusiasts became concerned that access to traditional recreation spots along the coast would be cut off, they formed an interest group called 'Keep Our Coast Open'. Obviously, there was a need to communicate more effectively with the growing number of four-wheel-drive owners in WA, so an informal partnership was formed to exchange information and assist each other in planning the conservation and management of recreation areas.

Largely through the efforts of key Association member Steve Wilke, the two agencies have established a lasting and effective line of communication. Most four-wheel-drive clubs now inform CALM staff of their plans when organising an excursion into a CALM-managed area. Staff are then able to support the excursion with maps and advice.

But more exciting are the positive initiatives that have been undertaken jointly by the two agencies. For example, last year at CALM's Gnangara pine plantation, members of four-wheel-drive clubs donated their vehicles, tow-ropes, trailers and skill during a massive cleanup of old car-bodies. More recently, club members helped in a major weed-control operation at John Forrest National Park. In return, a ranger later led the vehicles along some restricted tracks normally closed to the public. And in March this

Left: Western Australia's expansive outback areas are a mecca for a growing armada of 4WD-equipped adventurers. Photo – Bill Bachman





Above: The thoughtless actions of just one irresponsible visitor can leave an impact that can take years or even decades to heal. Photo – Wayne Schmidt

Above right: The promotion of 'minimal impact' or 'no-trace' camping is an important initiative in the management and protection of back country areas and wilderness values. Photo – Cliff Winfield

Right: Resource protection and management programs, which place a major emphasis on visitor information and education, are preferable to locking areas up and shutting people out. Photo – Marie Lochman

year, clubs rallied to help in a major weekend clean-up of badly littered areas near Pemberton.

Steve Wilke has been instrumental in developing the environmental ethics of the four-wheel-drive clubs in WA. He created the position of Environmental Officer in all clubs and helped transform the culture of four-wheel-drive recreation from the bush-bashing of the 1970s to today's aim of maximising enjoyment while minimising impact on the environment.

In fact, four-wheel-drive clubs have become so environmentally conscious that their peak organisation, the Australian National Four-Wheel-Drive Council, was the driving force in setting up a nationwide education campaign to minimise recreational impact on the environment. Called *Tread Lightly!*, the campaign is making steady progress in reforming our ideas of how to behave in the bush.



WEALTH FOR EVERYONE

Turning to nature for recreation is spiritually enriching, but it also offers another kind of wealth. Nature-based tourism is on the increase in WA, as it is the world over. In business terms, it is one of the world's fastest-growing industries. With its unique flora and fauna, WA stands to reap rich rewards from the world's increasing environmental consciousness. Tourism is already one of our biggest income and employment generators, and visitor surveys have shown natural features to be the number one attraction to overseas visitors.

But the ethics of caring for the environment must still abide. Local appreciation of our natural wonders is still very strong—statistics show that by far the highest proportion of visits to natural areas in WA are by Western Australians. If 'people pressure' is the right way to describe the undesirable impact of a high number of users, the growth in the nature-based tourism industry might be expected to aggravate the problem. At the same time, the provision of highquality nature-based recreation, educational experiences and a sense of partnership should help diminish it.

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Looking Beyond the Obvious

by Ian Abbott and Per Christensen

Majestic giants, leafy canopies, teeming wildlife, dappled sunlight ... karri and jarrah forests tend to evoke an emotional response in most people, and our natural instinct is to reject the claim that logging and burning do not harm the forests. But things aren't always what they seem. In this article we examine a few common misconceptions about Western Australia's forests.

A few centuries ago, sailors refused to venture too far west or south, for fear of their ships falling off the edge of the Earth. After all, anyone could see for themselves that the Earth was flat. It took the brave voyage of Christopher Columbus to demonstrate the fallacy of what was apparently obvious to everyone.

Most of us now scoff at the 'ignorance' of our forebears—but are we any better? Humans rely heavily on visual clues; seeing, after all, is believing. And in many ways, we are at a greater disadvantage than our ancestors; they, at least, lived a rural lifestyle and were in touch with nature. People today have become urbanised; they gain information about the natural world second-hand and in simplified form through the news media.

The current debate about what is the most desirable human use of native forests is a good example of this. How many of those claiming that Western Australia's forests are doomed have visited the forests and taken an objective look at them? How many have taken the time to look beyond media statements to check the facts for themselves?

Many critics of logging and burning in the native forests of Western Australia look no further than the obvious immediate aftermath of timber removal or fire: apparently incinerated trees and devastated forests. However, a frequent outcome of scientific study is that what seems to be the commonsense point of view is wrong. In this article, we look beyond the 'obvious' and demonstrate that things aren't always what they seem.

DO WE KNOW ENOUGH?

Some people believe that WA's forests are being logged and burned without adequate knowledge of the forests themselves, the environmental consequences of logging and burning, and the biological processes and composition of forest communities. This is not the case.

More than 50 years of study of jarrah and karri trees and forest ecosystems has resulted in hundreds of published scientific papers. For example, in 1986, there were more than 180 papers on karri forests alone. Comprehensive reviews of knowledge have also been produced for jarrah (1986), the northern jarrah forest (1989), the karri forest (1992) and karri (1995). These are good places to start for anyone wishing to find out what is known about a particular aspect of forest ecology.

Recently, Mike Lyons and Neil Gibson, of the Department of Conservation and Land Management's (CALM) Science and Information Division, put together a bibliography of papers dealing with the biology and natural history of Western Australia. A 1994 paper by these writers (published in CALMScience Supplement 1) shows that there are more than four times as many studies for the South West Forest Region as for any other region of WA. Of the 2 333 studies listed, approximately 15 per cent relate to the jarrah or karri forest in State forest, an area of less than one per cent of the State.

Forest research has also included

environmental impact studiesinvestigations of the effect of human disturbance (logging, thinning, fire, dieback, damming of rivers, mining) on the ecology of species or communities. Although forests in Western Australia, Victoria and New South Wales have been subject to similar numbers of impact studies (51, 59 and 54, respectively), Victoria has nearly twice, and New South Wales six times, the forested area of Western Australia. In relation to their area, our forests in WA have had more environmental impact studies than those of any other State. This information has been taken from Report No. 9 (1993) of the Resource Assessment Commission.

Biological surveys in State forest have been intensive. For example, in the 10year period between 1972 and 1982, surveys of the southern forests included 75 771 trap nights (a measure of the effort spent in trapping animals—10 trap nights may equal 10 traps set for one night or one trap set for 10 nights), 1 340 hours of organised searching for animals and signs

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Karri tree with old growth characteristics (hollows in its trunk and dead hollow branches) surrounded by regenerating karri. Photo – Len Stewart/Lochman Transparencies

Below left: 100-year-old regrowth karri at Boranup, in the Leeuwin-Naturaliste National Park, near Pemberton. Photo – Graeme Liddelow

Below: A recently clearfelled and burnt coupe showing extensive ashbeds and retained seed trees.

Photo – Dennis Sarson/Lochman Transparencies





of animals, 2 047 hours of spotlight transects (a measure of the effort spent in searching for nocturnal animals at night, with spotlights), and 795 hours of bird surveys. Not surprisingly, the knowledge base for forest-dwelling plant and vertebrate species is broad. There is also a sound understanding of vegetation types in the northern and southern forests, as well as in the karri forest.

This regional or strategic approach to biological surveying is far more effective than section-by-section surveys, which produce a poor return for the effort expended.

ARE OLD GROWTH FORESTS SACRED?

The term 'old growth forest' inspires a certain awe. In recent years, it has been marketed to conjure up an image of untouched, primeval stands; a place where gnarled and stately trees festooned with lichen and vines reach for the sky through a tangled undergrowth of strange and unknown species. A consequence of this fairytale image has been to hinder rational debate on the use and reservation of old growth forest.

The term 'old growth' may be defined in several ways. For example, 'forests that are both negligibly disturbed and ecologically mature and have high conservation and intangible value' (Resource Assessment Commission, 1992) or 'forest that is ecologically mature and has been subjected to negligible unnatural disturbance such as logging, roading and clearing. The definition focuses on forest in which the upper stratum or overstorey is in the late mature to over mature growth phases' (National Forest Policy Statement, 1992). Old growth karri and jarrah forests do not, in themselves, have any special biological significance. The species living in them and the processes that take place there may be present in a selectively logged forest, as well as in forests that have regenerated following clearfelling or natural disturbance. The critical factor, from a biological point of view, is whether or not trees with old growth characteristics are present within, or near, those areas. Primarily, it is the things that large, old trees provide, such as hollows, that make the difference. The understorey and litter, with their associated microclimate, the biological



processes and the animals all may be found in disturbed forest, providing the disturbance has not been very recent.

Therefore, species will not become extinct as a result of areas of old growth jarrah and karri forest being reduced, as long as sufficient trees with old growth characteristics are maintained in the forest. Disturbance does not necessarily lessen or detract from the biological conservation values of a forest; any disturbance will favour or disadvantage different species, provided that the disturbance does not result in permanent changes to communities and processes that are part of that forest. With respect to high conservation value areas in forests, we know from the results of biological surveys that the areas of highest conservation value, from the biological point of view, are not the karri and jarrah forests per se. The areas of highest plant and animal diversity, and where also many rare or threatened species exist, are the non-forest

Map illustrating the comprehensive and representative network of reserves throughout the South West forests.

communities, which are an integral part of the forest ecosystem. Thus, the vegetation along creeks and rivers, swamps and their surrounds, heath communities, treeless flats and their surrounds, granite outcrops and woodland areas on the edge of the forest are far and away the richest areas biologically—a prime reason why nonforest vegetation types are such an important component of the forest reserve system.

Nevertheless, there are extensive areas of forest of both jarrah and karri that are also in reserves. In particular, considerable areas of ecologically mature forest with negligible to low levels of disturbance have been set aside for their 'intangible' values. These are forests where people may experience the feel of undisturbed nature and, especially in



Areas of old growth forest have been set aside for their intangible values. Photo – Bill Bachman

the more remote reserves in the southern forests, a wilderness feeling.

Within conservation reserves, there are 135 000 hectares of unlogged (old growth) jarrah forest (representing 35 per cent of jarrah forest in reserves) and 40000 hectares of unlogged (old growth) karri forest (representing 75 per cent of karri forest in reserves). In addition, a further 28 000 hectares of unlogged jarrah and 13 000 hectares of unlogged karri are in areas excluded from logging, such as in stream and road reserves. The biological value of these unlogged forests is that they add to the total diversity of the forest. Their intangible values also fulfil the aesthetic, as well as deeper needs of humans for undisturbed places.

RESERVING JUDGMENT

The commonly held view that insufficient areas of forest have been reserved cannot be justified on biological grounds. A comprehensive and representative system of reserves has been established and added to over

ECOLOGICAL AND EVOLUTIONARY PRINCIPLES

The following are some of the biological principles that the Department of Conservation and Land Management (CALM) recognises in its management of forests:

Species vary in their tolerance of variations in climate, soil and topography, and other environmental conditions, and are not distributed haphazardly over the landscape.

Environmental heterogeneity increases the number of species living in the same locality through expanding the supply of resources, providing more transitional zones, and creating refuges that enable prey to persist in the presence of their native predators.

★ A small number of species dominate the rest numerically—most species in ecosystems are naturally rare because their population size is limited by shortage of resources (food, breeding sites and shelter), by disease, by predation and other factors.

The chemical constituents of organisms are used again and again through recycling.

Species introduced to Australia have profound ecological impacts on elements of the native plant and animal life, because natural controls present in their place of origin are absent from Australia.

Following disturbance, communities change progressively in species composition (succession), eventually resembling closely the pre-disturbance state unless another disturbance takes place.

Most organisms die young, through being eaten by another organism or being weakened by starvation or stress.

There is a doomed surplus of individuals at the end of the breeding season, with not enough suitable habitat available.

Dispersal is a continual and obligatory process for most mobile species, making good any losses of local populations (other factors being unchanged). Sessile organisms tend to disperse their progeny on site, mostly onto the soil surface.

a long period of time, based on knowledge acquired over several decades about vegetation, flora and vertebrate fauna.

In the northern jarrah forest, the only vegetation complexes that are not adequately reserved are those now occurring only outside State forest. These areas—along rivers and in forest and woodland to the east—were targeted for farming in the early days of settlement. Similarly, several vegetation complexes near Collie are poorly represented because of past clearing for coal mining operations.

In the southern forests, where there has been less clearing for agriculture, it has been possible to reserve nearly 159 000 hectares of unlogged forest in national parks, nature reserves, conservation parks and other reserves. Much of the 61 000 hectares of forest along roads, rivers and streams is also unlogged. This is an integral part of the reserve system, and will remain so.

In total, some 512 000 hectares of the jarrah forest (representing 33 per cent) and 81 000 hectares of karri forest (representing 46 per cent) are protected in the reserve system (see map).

HEALTHY REGENERATION

It is sometimes claimed that timber harvesting in State forest has resulted in ecological decline. In fact, Western Australia's forests are in sound ecological condition, and the reason for this is that professional foresters ensure that every hectare of State forest that has been logged is regenerated. Vegetation cover returns to pre-logging levels within five to ten years.

Clearing of native vegetation outside State forest is permanent, as the land is used for other purposes such as agriculture, horticulture and urban and industrial development. Currently, an average of 14 500 hectares of jarrah forest and 1 500 hectares of karri forest are logged each year; some one per cent and two per cent, respectively, of each forest type. This means that most of the forest remains undisturbed for most of the time. The scale of disturbance—between one and ten hectares in jarrah forest and averaging 50 hectares in karri forest—is also very small.

Logging, be it clearfelling (the removal of all timber) in small, dispersed areas (coupes), or selection felling (the removal of selected trees), is a forest management practice that has resulted in healthy forest regeneration and environmental heterogeneity. This practice has several benefits.

First, clearfelling creates areas of forest of different ages in close proximity to each other, thus enabling fauna species that live in young, regrowth forest to commingle with those species living in older growth forest.

Second, logging operations disturb some of the soil surface and provide a tilth favourable for germinating the seeds of many plant species. This helps increase local diversity.

Third, the germination of some hardseeded plant species is favoured by the higher soil temperatures of dry soil caused by prescribed burning following clearfelling.

Fourth, the provision for undisturbed areas, by means of coupe dispersion, assists with recolonisation, by both animals and plants, of nearby clearfelled coupes. Over time, there is a fairly orderly succession of species returning to coupes as the forest regenerates and the trees grow.

This disturbance process creates an opportunity for young animals, and seeds, from the surrounding forest to establish in apiece of unoccupied habitat. In the natural order of things, most of these young animals would starve and die in the absence of vacant habitat. For example, only 15 per cent of young woylies survive for more than a few months after leaving their mother. Woylies produce three young each year, so there is always a huge surplus.

This process also occurs in burnt areas, young animals from unburnt patches and surrounding areas invade the regenerating burnt areas to replace those lost in the fire. Dispersion of cutting coupes across a wide area and burning in different seasons, both spring and autumn, creates diversity and helps this recolonising process.

FACT OR OPINION?

Opponents of logging and burning in the forests of Western Australia are entitled to their points of view. But their opinions are, however, not supported by the known facts. As time passes, we will gain more knowledge and greater understanding, but this will not change the basic fact that with good management, forests can be used for timber production purposes, while retaining their conservation values. It is





Top: Graph illustrating the return of birds to karri forest following clearfelling and regeneration. Data – A.Tingay & S.R.Tingay, *Bird Communities in the Karri Forest of Western Australia*.

the nature of scientific inquiry that absolute truth or perfect knowledge is never attained—the process is one of closer and closer approximation to the truth through the elimination of error.

The last 25 years have seen large gains in knowledge of the ecology of our forests. These gains, in turn, have resulted in a stronger scientific basis for delineating the conservation estate, better management of timber harvesting and protective burning, and keener understanding of the biology of the two species pivotal to the entire forest jarrah and karri. Above: Spatial arrangement of logged coupes of jarrah and karri near Pemberton, in relation to road, river and stream reserves of mature forest. Photo – Dept of Land Administration (Lic 478/95)

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The research data referred to are available from the library at CALM's Como Research Centre on (09) 334 0314.





MOUNT UGUSTUS NATIONAL PARK

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ON 3 JUNE 1858, EXPLORER FRANCIS THOMAS GREGORY BECAME THE FIRST EUROPEAN TO ASCEND MOUNT AUGUSTUS, WHICH HE HAD FIRST SIGHTED SOME FOUR DAYS EARLIER. THIS ENORMOUS ROCK IS RICH IN ABORIGINAL ART, DATING BACK THOUSANDS OF YEARS, AND IS ITSELF ABOUT 1700 MILLION YEARS OLD. BUT IT IS NOT ONLY THREE TIMES OLDER THAN AYERS ROCK, IT IS ALSO TWICE ITS SIZE, MAKING MOUNT AUGUSTUS THE LARGEST ROCK IN THE WORLD.

BY DAVID GOUGH & TERRY BLOOMER

ount Augustus, or Burringurrah as it is known by the local Wadjari Aboriginal people, is about 850 kilometres north of Perth and midway between the Great Northern and North West Coastal highways. One of the most spectacular solitary peaks in the world, it rises 717 metres above the surrounding plain (1 106 metres above sea level) and is clearly visible from the air for more than 160 kilometres. The rock, which culminates in a small peak on a plateau, is about eight kilometres long and covers an area of 4 795 hectares. At about twice the size of Uluru [Ayers Rock] it is the biggest rock in the world. However, because Mt Augustus is covered with vegetation, it looks less stark.

But that is not the only difference. Uluru is a monolith (a single block of stone of uniform quality and considerable



size), whereas Mt Augustus is a monocline—the result of sand accumulation that was eventually uplifted and folded. The granite beneath its surface is between 1 650 and 1 900 million years old, making it not only twice as big, but three times older than Uluru.

THE DREAMING

In Aboriginal mythology, mobs of people travelling across the country were



often transmuted into the form of a range, and individuals became hills, peaks or other distinctive features of the landscape.

The formation of Mt Augustus in the Dreaming is recounted in three known stories.

In the first story, an old man is said to have broken away from the mob [now the Kennedy Range]. He transgressed Aboriginal law by revealing ceremonial events to people who were not entitled to see them. Because of this, he was tracked down and speared by the tribesmen, then beaten by the womenfolk. His dead body lay on the plain—its form becoming the shape of Mt Augustus.

The second story relates to a boy named Burringurrah, who was undergoing his initiation into manhood. The rigours of the process so distressed him that he ran away, thereby breaking Aboriginal law. Tribesmen pursued the boy, finally catching up with him and spearing him in the upper right leg as his punishment. He fell to the ground; the spearhead broke from its shaft and protruded from his leg. The boy tried to crawl away, but the women beat him with their *mulgurrahs* [fighting sticks]. He collapsed and died, lying on his belly with his left leg bent up beside his body.

The third story relates to a big man a stranger from the east, probably from the Carnarvon Range. He was old but powerful, and the people were scared. They caught him up, speared him in the leg, and knocked him down, then the women hit him with their *wanas* [digging sticks]. There he died, where the land was once flat.

As you look at Mt Augustus you can see the lying form of a body with the stump of the spear in the leg. The geological fracture lines at the western end of the mount indicate the wounds inflicted by the womenfolk.

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Main: The deep red of sunrise reflects off the surface of the rock. Photo – Jiri Lochman Inset: The polished surface of the rocks seen along the Gorge Trail. Photo – David Gough

Left: In contrast to Uluru, Mt Augustus is covered in vegetation. Photo – Jiri Lochman



ABORIGINAL HISTORY

Several Aboriginal tribes inhabited areas in what is now known as the Upper Gascoyne region.

Tindale, in his book *Aboriginal Tribes* of *Australia*, suggests that Mt Augustus was a natural boundary between two tribal areas—the smaller area of the Ninanu tribe to the north and the much larger area of the Wadjari tribe to the south.

Wadjaris from the Burringurrah Community recall their grandfathers telling them of the times when their people camped beside Cattle Pool, a large permanent pool shaded by big white river gums on the Lyons River, north of Mt Augustus. It was one of only very few permanent pools in the inland Gascoyne that remained through the drought periods; and during such times, tribes wandered outside their normal territories in search of water. If they found water, there would almost certainly be a supply of food, as animals would also congregate near the pool.

EXPLORERS AND PASTORALISTS

On 3 June 1858, explorer Francis Thomas Gregory became the first European to ascend Mount Augustus. But he had first sighted the enormous monocline some four days earlier. He recounted the event in his journal:

"31st May.—... Leaving the party busily catching fish... I walked with Mr Nairne to the summit of a granite hill two miles northward, from which I had a number of cross-bearings to hills already observed from Mount Thompson. One of considerable elevation bearing north 121 degrees 30 minutes east, distance fifty miles, lay directly up the valley of the river, and was ultimately named Mount Augustus, after my brother, now conducting the expedition in quest of the remains of Dr. Leichhardt."

After setting course for the mount and finding it to be further than expected, Gregory finally arrived at Cattle Pool on 2 June, and found evidence of an Aboriginal encampment. The following day, he took a party and climbed the rock.

It took less than 20 years for settlers to follow Gregory into the Upper Gascoyne region, and sheep and cattle stations soon began to spring up along the Gascoyne and Lyons rivers.

Author Rhonda McDonald, who spent some of her childhood at Bangemall where her father ran the hotel and a gold mine, tells the stories of these early settlement days in her book *Winning the Gascoyne*.

"In 1886 Samuel James Phillips and John Hugh Phillips explored that section of the Upper Gascoyne [around Mt Augustus] with the view of selecting and taking up grazing country."

Mt Augustus station was taken up a year later, and ownership passed down through the Phillips family over successive years.

After the first world war, the station was managed by Ernest Potts, who extended the homestead—formerly only three mud brick rooms—and gathered a good camp of natives and stockmen. About 17 000 head of cattle were eventually held on the station and some 1 500 bullocks were taken each year to Meekatharra. The Mt Augustus cattle were renowned for being of excellent quality and temperament.

Potts managed the station for 35 years before his death from heart attack in 1955. The property then passed through a number of owners and managers and today is owned and managed by Don and Dot Hammerquist.

West of Mt Augustus, on Cobra Station, is the historic Bangemall Hotel

and goldfield. In 1896, South Australian Percy Aycliffe decided to build a wayside inn, originally named Eurana, for thirsty prospectors. In 1910, Aycliffe sold the hotel and its name was changed to the Bangemall Hotel. Charlie Cornish, from the north-west, bought it in 1919 and held it until 1940, when it was purchased by the Fitzgeralds, who owned the nearby Cobra Station. The hotel was closed and converted into the Cobra homestead.

In 1979, Cobra Station was purchased for a tourist development by a business syndicate from Perth. After considerable delays, the hotel was classified by the National Trust. An historic inn licence was granted in 1983 and the old pub was reopened. Cobra Station was purchased in 1989 by Dennis and Alexa Lang, who restocked the station and now use the old hotel as the homestead.

Creation of a national park over the Mt Augustus area was first recommended in the mid 1970s in the Environmental Protection Authority's System 8 report. Ten years later, after being approached by the then Department of Lands and Surveys, the lessees of Cobra Station agreed to voluntarily surrender a portion of their lease over the rock. A few years later, negotiations between the Department of Conservation and Land Management (CALM) and the lessees of Mt Augustus Station resulted in the voluntary release of the remainder of the rock.

So on 22 September 1989, Mount Augustus and the land immediately surrounding it—a total area of 9 168 hectares—was declared a national park. Since then, walktrails have been marked, signs constructed and visitor facilities put in at various sites. Interpretation material, for information shelters at the Mt Augustus Tourist Resort and at the start of the Summit Trail, is due to be in place this year.

MANAGEMENT

While no formal or draft management plan exists for Mt Augustus National Park, as yet, it is nevertheless an important nature-based tourism destination, and therefore needs to be managed carefully to retain and protect both its natural and cultural values. A ranger is stationed at the park during the main visitor season (April to October) and is available to provide

A wedge-tailed eagle swoops low over the surrounding plain in search of food. Photo – Robert Garvey guidance and information about the park's plants, animals and Aboriginal heritage.

Ranger Tony Tapper was stationed there during 1991 and was instrumental in planning the first walk trails. These and subsequent trails and facilities were provided over the following two years with the help of local Aborigines from the Burringurrah Community, and Tony's early contact with them helped provide much of the background information for naming the recreation sites.

Mt Augustus currently attracts around 4 000 visitors a year, and the day-use areas and walktrails are able to cope with those numbers without undue damage being caused. But with the inevitable increase in visitor numbers over the next few years, management strategies will need to be reviewed to ensure that serious damage does not occur.

Another problem in managing such a remote national park is the repair work needed after bad weather. Cyclone Bobby, which passed through the Gascoyne in late February 1995, deposited some 100 mm of rain in just 24 hours, with lesser, but still substantial, amounts in the following days. The runoff from the rock caused considerable erosion on the Drive Trail, some site access roads and parts of the



Right: Aboriginal engravings at Mundee depict animal tracks. Photo – David Gough

Far right: The rare Mt Augustus foxglove. Photo – Robert Garvey

Below right: The rarely recorded Douglas' toadlet was recently collected at Mt Augustus. Photo – Jiri Lochman

Summit Trail, but work was soon under way to fix up the damage.

No formal plant or animal surveys have yet been conducted in the Mt Augustus National Park, but rangers stationed there over the past few years have observed and recorded some of the wildlife during their day-to-day work.

PLANTS

During winter and early spring, especially after good rains, areas of the plains around the rock are carpeted in everlastings. The trumpet-like flowers of turpentine bush are also very striking in winter. After rain, the rock takes on a green hue as new growth appears on the vegetation, and grasses sprout from dormant seeds.

The general vegetation is tall, open mulga scrubland with some red river gum and a variety of acacias, including gidgee and sandplain wattle. The miniritchie can easily be recognised by its unusual red curly bark.

Other plants include grasses such as silkyhead and limestone grass, the common stiffleaf sedge and annuals such as namana, wild carrot and the fringed lily *Thysanotus manglesianus*.

Several rare plant species have been found in the area. These include Wittwer's thryptomene (*Thryptomene wittweri*), known only from Mt Augustus and Mt Meharry; the Mt Augustus foxglove (*Pityrodia augustensis*), which is known to grow only in creeklines on and near the rock; and the snail orchid (*Pterostylis nana*), which is probably at its most northern limit.

ANIMALS

Mammals recorded at Mt Augustus by park rangers include the euro, dingo, red kangaroo, long-tailed dunnart, echidna, spinifex hopping mouse and common rock rat.

Reptile species are numerous and







varied. They include the ringed brown snake, red-tailed skink (*Morethia ruficauda exquisita*), ring-tailed and western netted dragons, black-tailed monitor, marbled velvet gecko and pygmy python. The threatened Pilbara olive python (*Morelia olivacea barroni*) recorded at Mt Augustus is at the southern extent of its known range.

During a recent visit by CALM's Gascoyne District Manager Ron Shepherd, senior interpretation officer Gil Field and communications officer David Gough, the rarely recorded Douglas' toadlet (*Pseudophryne douglasi*) was collected in a gorge on the south side of the rock. The animal had previously been collected from only three isolated populations in the Pilbara.

In 1989, Alan Rose, then the ranger at Stirling Range National Park, visited Mt Augustus with his wife Sandy and recorded 30 bird species including the crested bellbird, white-winged triller, rainbow bee-eater and wedge-tailed eagle. By 1994, species recorded by rangers at Mt Augustus had increased to almost 100, including waterbirds such as the white-faced heron, magpie goose, and straw-necked ibis; birds of prey such as the collared sparrowhawk and peregrine falcon; and a variety of honeyeaters, parrots and fairy-wrens. Other birds include the yellow-throated miner, painted firetail, bush stonecurlew and the ubiquitous spinifex pigeon, found throughout northern parts of the State.



TOURISM

The journey to Mount Augustus National Park is relatively easy for most vehicles. Travelling from Perth, you can make a round trip via Meekatharra and Landor Station, returning via Cobra Station, Gascoyne Junction, Carnarvon and Geraldton. However, the section along almost 1 000 kilometres of graded roads can still be hot and dusty, and you need to carry plenty of water and supplies.

A seasonal road from Mt Augustus via Dooley Downs and Pingandy stations leads to the Ashburton Downs–Mt Vernon Road and provides a shorter route if you want to continue north to Karijini National Park and the Pilbara. Contact the shire offices at either Gascoyne Junction or Meekatharra to check the condition of the roads before planning your trip. Packaged coached tours and tailor-made airtours are available from Perth. Details of these can be obtained from the WA Tourist Centre. Camping is not permitted within the national park, and at present, most people base themselves either at the Mt Augustus Outback Tourist Resort or Cobra Station and spend a few days exploring and climbing the rock.

The Resort is on the north-east side of the rock and is run by Peter and Joylene Vogelsanger. Accommodation is available in comfortable units, or you can use the campsite and powered van sites. There is a public telephone and a shop where you can obtain fuel, food, souvenirs and park brochures. Peter has a good knowledge of the area and can provide additional tourist information.

Accommodation at Cobra Station, 37 kilometres west of Mt Augustus, includes units, station rooms and unpowered camping and caravan sites. Fuel and food can be obtained here, but the station is closed on Saturdays. *Left:* A bungarra (*Varanus gouldii*), one of many species of lizard found at Mt Augustus.

Below: Mt Augustus rises more than 700 metres above a plain of open mulga scrubland. Photos – Robert Garvey

SITES & TRAILS

About 10 kilometres north of Cobra Station is Edithanna Pool. The pool attracts a wide range of birds, making it a good spot for keen ornithologists.

Just off the main road from Cobra Station, as you approach the boundary of the national park, is Emu Hill Lookout. This is a great place for photographers, who capture the changing colours of sunset on the rock's surface.

The 49-kilometre Burringurrah Drive Trail, which runs around Mt Augustus, provides views of the changing faces of the rock and access to its recreation sites and walktrails.

Starting at the end of the track opposite Mt Augustus Outback Tourist Resort you'll find *Warrarla*, a pleasant picnic site set among a grove of large river gums. From here you can take a short stroll into Kotke Gorge.

About eight kilometres west of here is *Goordgeela* and Cave Hill. A fairly steep, four-kilometre return trail runs up to the cave. The cave ceiling is unstable and rock falls occur from time to time, but from its mouth, there are good views of the Lyons River and of the Godfrey and Kenneth Ranges to the north.

Near the north-western end of the rock is *Goolinee* or Cattle Pool. This pictures que day-use picnic area is nestled beside a permanent pool on the Lyons River,



Right: Walkers on the Summit Trail pause to enjoy the views of the plain and ranges to the south of the rock. Photo – Robert Garvey

which attracts numerous waterbirds, especially after rains. There is plenty of shade and the water looks very inviting on a hot day, but thick reed beds in the pool can make swimming hazardous.

Not far away is The Pound, a natural basin used earlier this century for holding cattle before droving them to Meekatharra—a journey of about 10–12 days on the hoof. A short walk takes you up to the saddle, from where there are good views over the Lyons River. Facing back to The Pound, it's easy to imagine yourself watching over the herd of cattle as you sit and watch the reflections of the setting sun on the high eastern slopes of the canyon.

South of The Pound is Beedoboondu and the start of the Summit Trail. The return walk to the summit, a distance of some 12 kilometres, takes about six to eight hours, but it's worth it for the panoramic views north. It's an arduous walk and only recommended if you are fit; don't attempt it during summer or on hot days in spring and autumn. If you do attempt the walk, inform the ranger or resort staff of your plans, start early in the morning and take plenty of water. For the first three kilometres there is a choice of routes. The Ranger Trail is the easier of the two, while the more adventurous or sure-footed may prefer the Gully Trail; but be warned, the Gully Trail can be very slippery after rain. Whichever trail you choose, you can change over where they briefly meet at the 'elbow', about 1 500 metres from the start. The two trails finally join about three kilometres from the summit, so if you don't feel like going on, you can return to the carpark along a different route. On the way up, don't forget to turn around for great views of the plain and ranges to the south.

Aboriginal engravings, which depict animal tracks and hunters, can be seen by crawling under Flintstone Rock, a large slab of rock lying across the stream bed about 250 metres from the carpark. The other sites of Aboriginal engravings are at the south-east corner of Mt Augustus.



Mundee is found along an easy 300metre return walk. The rock wall has engravings of kangaroo, emu and bustard tracks in three cave-like overhangs. Aboriginal mythology has it that in the beginning, when the rocks were still soft, a Dreaming spirit did these engravings with his finger.

Just south of *Mundee* is Edney's Trail, and about 150 metres from the start of the trail are more Aboriginal engravings of animal tracks at a place called *Ooramboo*. Edney Spring is 100 metres farther on. The six-kilometre return walk to Edney's Lookout takes about two-anda-half hours. It's ideal if you feel unsure about tackling the more strenuous Summit Trail, or have limited time. The elevated 360-degree views from the lookout are spectacular and it's worth spending some time there relaxing and looking at the many distant mountain ranges before making your way back down. There are many things to do and see at Mt Augustus National Park. But whatever your interest, be it bushwalking, birdwatching or photography, the biggest attraction is the rock itself. During dawn and dusk, its colour changes almost minute by minute from deep indigo to bright pink, orange or red, and occasionally green reflecting the mood of the rock and the spirits living there. Just as Uluru attracts hundreds of thousands of visitors each year, increasing numbers of people will come to Mt Augustus to try to capture those moods in photographs or simply to enjoy the experience.

Although not so well known as Uluru, Mt Augustus offers tourists a rich Aboriginal heritage, abundant wildlife, stunning scenery and spectacular views from its summit. The biggest rock in the world is one of the natural wonders of the world. But if you never go, you'll never know.

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Terry Bloomer is currently the ranger at Mt Augustus National Park and is based at the Mt Augustus Tourist Resort. He is always pleased to provide information to help make your visit more enjoyable.

The authors acknowledge the valuable assistance of CALM mobile ranger Tony Tapper, CALM Gascoyne District Manager Ron Shepherd, staff at CALM's Science and Information Division (Wildlife Research Centre, Woodvale), Peter Bindon of the WA Museum, staff at the Aboriginal Affairs Department, Peter Bridge of Hesperian Press and author Rhonda McDonald, in researching and preparing this article.







THREE SPRINGS DAVIESIA

A member of the pea family (Fabaceae), the Three Springs daviesia is a straggling, much branched shrub that grows to about two metres in height. Daviesias do not have true leaves, but are similar to the wattles in having modified leaf stems (phyllodes) that are remarkably leaf-like in appearance. The small, typically pea-shaped flowers are yellow-maroon in colour and appear quite early in the season, usually from July to early September.

Although first collected by W.E. Blackall between Coorow and Arrino in 1932, this attractive shrub is yet to be named by taxonomists. Further collections were made by R.T. Lange, north of Three Springs in 1958, and Charles Chapman, a noted amateur Western Australian botanist, near the Arrowsmith River in 1972 and 1973. Repeat surveys of these areas between 1975 and 1980 by Dr Mike Crisp (Australian National University) and Charles Chapman found only one surviving population.

At that time, the Three Springs daviesia was thought to be one of Western Australia's most endangered plants. It was gazetted as 'declared rare flora' in September 1987. Fortunately, more recent finds by Three Springs Shire gardener, Charles Strahan, have significantly improved the species chance of survival in the wild. His most recent find was on private property, in January 1995.

Three Springs daviesia is endemic to the Three Springs area of Western Australia, surviving in just five mostly small populations over a distance of 10 kilometres. Its favoured habitat is near the crests of hills, where it grows on lateritic gravel and brown sandyloam among open mallee scrub and heath, but clearing of native vegetation for agriculture has significantly reduced available habitat. The species appears to be a disturbance opportunist. Current roadside populations are likely to

> By Andrew Brown Photos by Andrew Brown and Sue Patrick

have appeared since the shoulders of the roads were graded, and one population occurs in an old gravel pit.

Biological factors may also be influencing the rarity of the species. Thomas Schwarten, of Kings Park and Botanic Garden, has found that the majority of seeds produced by the plant are sterile. This may mean that self pollination does not produce viable seed and that transfer of pollen from the flowers of one plant to those of another is required.

Due to the extreme threats to this species' survival in the wild, Interim Wildlife Management Guidelines (IWMGs) are being written by CALM's Western Australian Threatened Species and Communities Unit (WATSCU). Eventually, a full Recovery Plan will be written to replace these guidelines, with a long term aim of achieving self-sustaining natural populations. The species is also one of many covered by the forthcoming Moora District Threatened Flora Management Program.



s the name testifies, the Goldfields region has a glamorous history of boom-and-bust goldrushes, of cities springing up overnight and disappearing just as quickly. Swag-bearing prospectors combed the countryside, leaving behind fascinating middens of old artefacts. Pastoralists fenced the land, introduced livestock and pushed back the boundaries of the red centre. This is the story we all know; it is the lore of the frontier country.

But accompanying the sometimes frenzied activity that gave the Goldfields its name, was a less publicised industry, one that was equally important to the development of the region: forestry. For contrary to the popular image, the region is not merely a vast inland sea of low

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Main: 1920 regrowth capped mallee (Eucalyptus pileata), near Bullabulling. Notice the ribbon bark, which is shed annually. Inset: Minirichie bark. Photos – Steve Hopper

Above right: Victoria Desert mallee (E. concinna) produces fine brown timber with woodwind instrument potential.

Photo – Steve Hopper

Below: Logging 1920 regrowth red morrel (E. longicornis) at Jaurdi Station. Photo – Steve Sadler

Below right: Phil Panton of Timbers of the Goldfields sawing Goldfields blackbutt (*E. lesouefii*). Photo – Steve Sadler scrub as far as the eye can see. Rather, there are tough stands of extraordinarily adapted eucalypts and acacias that rise from the dusty plains, defying the parched environment. This is a land rich in timber, timber of exceptional character.

TREES AMID THE GOLD DUST

As early as the first gold rushes of the 1890s, timber that was needed for mining infrastructure, fuel and construction was extracted fromwoodlands surrounding the present site of Kalgoorlie-Boulder. As demand increased, an

elaborate network of narrow-gauge railways, called the Woodlines, was developed by opportunistic timber and firewood companies. The wide swathes through the bush that marked the routes of the Woodlines can still be followed today.

At their peak, the Woodlines were supplying more than half-a-million tonnes of timber a year. Between 1900 and 1965, three-and-a-half million hectares of eucalypt and acacia woodland were clearfelled or cut over, yielding an estimated 30 million tonnes of timber, which fed the ever-burgeoning mining industry and towns. The wood also



satisfied a wider demand for sawn timber, railway sleepers and domestic fuel.

Nature was tolerant of those early harvesters, who had a pressing, highvolume need for an available resource, the character of which they didn't fully appreciate. The three million hectares that were virtually stripped bare are now covered with a vigorous new layer of 40 to 100-year-old regrowth woodland, whose remarkable timber properties are only now coming to be understood. In the region extending from the edge of the Wheatbelt to the Nullarbor Plain and inwards through







Left: Kalgoorlie woodturner Peter Grainger turning native willow after completing a redwood (E. transcontinentalis)vase. Photo – Steve Sadler

Below left: Sawn boards and Goldfields craft timber species stored ready for drying at Timbers of the Goldfields. Photo – Steve Sadler

Below right: The solar kiln installed at Timbers of the Goldfields for seasoning sawn timber and for research purposes. Photo – Steve Sadler

pastoral and desert country, a further five million hectares of uncut eucalypt woodland and 15 million hectares of acacia woodland offer up hundreds of species to be explored by a small but intensive specialist market.

WOOD THAT SINKS

The woodlands of the Goldfields are a marvel of nature. Nowhere else in the world does such an arid environment support vegetation of such density and size. An average annual rainfall of 250 millimetres puts the region on a par with arid areas of Arizona, Southern Africa, and the Mediterranean. But woodlands are not normally a feature of such landscapes.

Adapted to harsh, dry conditions, these species have to be tough. As a result, they are extremely slow-growing. This is one feature that gives them their quirky edge as speciality timbers: they are extraordinarily dense.

Density is measured as a ratio of weight to volume. Jarrah, the well-known and widely-used South West timber, is described as a 'dense hardwood'. It has a dry density measurement of 850 kilograms per cubic metre (kg/m³). Anything higher than 1000 kg/m³ sinks in water. Most Goldfields eucalypts have a dry density measurement greater than 1100 kg/m³, ranking them among the densest timbers in the world.

JEWELS IN THE MARKET PLACE

While not a friendly attribute to many mass-market wooden products, high timber density is a valuable feature in the manufacture of certain speciality items, particularly those that are subjected to sustained high-impact use, such as percussion musical instruments, parquetry flooring, specialist furniture and joinery.

Another unique feature of the Goldfields woodland species is their very low green moisture content. While green moisture proportions of as little as 30 per cent cause some unusual problems for seasoning sawn timber, they are a dream for wood-turners. With such low moisture, Goldfields species yield unusually stable unseasoned timber. Because the green wood is much easier to handle, these timbers make much more efficient material for wood-turners, who can bring their product a lot closer to completion before seasoning.

Added to these unusual features is the attractive appearance of Goldfields timbers: the creamy-coloured native willow (*Pittosporum phylliraeoides*) with its lace-like 'fish scale' patterning; the subtle red–pink hues of the red eucalypts, including the almost blood-red Dundas mahogany (*Eucalyptus brockwayii*). The list goes on: the superbly patterned gimlet (*E. salubris*) is distinctive for its deeply





figured, fine grained timber, the result of natural fluting of the trunk, and its walnut-like streaks of brown. The extremely dense (1300 kg/m3) and hard western myall (Acacia papyrocarpa) varies in colour, depending on the growing area, from rich chocolate brown near the Nullarbor to golden brown in the heart of the Goldfields, and bears a gold fleck and striking ripple grain, which gives it a three-dimensional appearance. And the white cypress pine (Callitris glaucophylla), which is yellow, brown and tan with streaks of varied colour, has the added bonus of an unusual and appealing aroma. These are features that delight the senses. They are the raw materials for fine artistry, and they represent only a handful out of more than a hundred species that have so far been sampled and described. There are many more yet to be explored among the diverse vegetation and species of the region.

Given this rich resource, sawmillers, joiners, wood turners and crafters are limited only by their imagination to find niches in the speciality market. This is a 'top-shelf' enterprise, where only small amounts of timber are required to produce one-of-a-kind luxury products. A brown, deeply figured section of gimlet, for example, swept with a swirling grain, might compete well with prize jarrah for the attention of someone wanting an attractive coffee table. A high-quality, intricate inlay of luscious, ruby-red



Above: Western myall woodland fringing the Nullarbor Plain. Photo – Steve Hopper

Below left: Creekline minirichie (*Acacia cyperophylla*) east of Wiluna. Photo – Ian Kealley

Below right: Mature Goldfields eucalypt woodland dominated by salmon gum (*E. salmonophloia*). Photo – Steve Hopper

Dundas mahogany might be the only suitable finishing touch to the front door of your dream home. Attractive gift items and novelties such as wind spirals, vases, bowls, coasters, pens, trophies, jewellery—the list is endless—all have a place in a high-premium market.

SUSTAINING THE RESOURCE

With renewed interest and increasing demand for the Goldfields timbers, careful planning is necessary for their management. Long gone are the days of the Woodlines, when mass guantities of timber were there for the taking. Goldfields logging is now conducted under strictly regulated harvesting contracts and forest produce licences issued by CALM. Trained specialist contractors carry out a highly selective thinning of the regrowth woodland, extracting specific sawlog or speciality timber products. Sawlog yield will be less than one tonne per hectare. Timber is also salvaged ahead of minesite clearing.

Speciality timbers from the wide range of other non-sawlog Goldfields





species are also opportunistically collected by contractors for research purposes and under Forest Produce Licences. Conditions for this collection are strict and cutting is rigorously controlled. Planning is also under way to determine the future use of the large resource available from the millions of untapped hectares of Goldfields woodlands.

BEYOND THE GOLD HORIZON

Forestry has a long association with sustainable and renewable resource management, carried out in one way or another over centuries of varied land use. The Goldfields are no exception. But the industry that was once a secondary support to the extraction of gold from the ground has become, this time around, a pursuit in its own right.

The revival of the timber industry in the Goldfields has brought land use full circle, and the different culture that now prevails is a mark of progress. It provides a welcome diversification of land use in an area where mining and pastoralism have dominated. But perhaps more significantly, where trees were once clearfelled to feed the most basic needs of a greedily growing gold industry, they are now gently, almost lovingly, handpicked and handled, to add the most elegant and subtle aesthetic detail to our lives. In the legendary riches of the Goldfields, these are the gems among the gold.

FROM FLUTE TO FRUIT: THE GOLDFIELDS SPECIALTY TIMBER INDUSTRY GROUP

The dormant potential for Goldfields timber might still be asleep today had it not been awakened in the mid 1980s by a chance holiday encounter between an American music professor and a travelling Western Australian forester. The University of Washington's Professor Felix Skowronek was on a long-term worldwide quest to find dense, hard timbers to make thin-walled flutes, when he heard about the Goldfields. He began steady correspondence with CALM's Goldfields Regional Office, which culminated in visits to the region in 1988 and 1993 to gather samples.

Media coverage of, and timber collecting during, Professor Skowronek's first visit stimulated a lot of interest among hobby and professional woodworkers in Western Australia, who began to contact CALM in increasing numbers. In 1991, CALM opened public discussion on the potential for a speciality timber industry for the Goldfields. The response was strong enough for an introductory meeting to be held later that year, and in 1992, the Goldfields Specialty Timber Industry Group (GSTIG) was officially formed, incorporating in May 1993.

One of GSTIG's first undertakings was to organise a Woodline Festival as part of Kalgoorlie-Boulder's 1993 centenary celebrations. The festival, which involved an exhibition, historical display, demonstration, field trip, musical instrumentmaking workshop and sales, was an unmitigated success.

GSTIG supported an initiative by Timbers of the Goldfields, a private company owned by local operator Phil Panton, to construct a solar kiln based on technology developed by CALM's Harvey Wood Utilisation Research Centre. Boosted by a \$25 000 grant from the Federal Government's Renewable Energy Research program, the kiln has allowed sawn timber to be experimentally seasoned under controlled conditions.

GSTIG is also involved in a \$140 000 program of research funded by the WA Government Regional Initiatives Fund, private enterprise, CALM and the Goldfields Esperance Development Commission. A locally based committee, which includes Kalgoorlie College, is steering the project, which involves identifying the properties, sawing and seasoning characteristics and overall potential of timbers for application in a wide range of specialist markets. GSTIG now has some 65 members who meet monthly to discuss the issues arising from their sunrise industry, and to organise field trips, craft workshops, wood-turning courses and other activities.

And the flutes? Professor Skowronek's project is still in progress, with some promising interim results identifying some timbers as being world class woodwind instrument timbers. With hundreds of timbers yet to be tested, his partnership with the Goldfields is far from over.

GSTIG can be contacted at PO Box 10173, Kalgoorlie 6430, or phone (090) 21 2677.



Bowl turned from berrigan (*Eremophila* longifolia) by Bill Moriarity of Kalgoorlie. Goblet and flower turned from sandalwood (*Santalum spicatum*), and carved by Gordon Ward of Kelmscott. Photo – Steve Sadler





Fighting wildfires: breaking the triangle

by Rick Sneeuwjagt and Nigel Higgs

Every year, Western Australia has hundreds of bushfires, many of which, if not contained quickly, can threaten life and property. Most are put out before they develop; some become raging wildfires with flames soaring 100 metres or more, leaving a wake of blackened bush.

In this article we look at how the Department of Conservation and Land Management tackles the problem. he basic science of fire is simple it is a combination of heat, fuel and oxygen that together form the sides of the 'fire triangle'. Break the nexus along just one side of the triangle and the fire goes out.

The home owner, burning a backyard pile of leaves, can easily remove any one of the three ingredients. The fuel (the leaves) can be raked away from the flames; the heat can be removed by squirting with water using a garden hose; the oxygen can be excluded by smothering the fire with earth.

The same principles hold for big, intense wildfires. Control can be achieved by cooling the heat of the fire (by wetting the fuel) or by constructing fuel breaks with machinery, and lighting controlled back burns to starve it of fuel. The strategy depends on the size and intensity of the fire and the resources available.

Although fire has been part of Australia's natural environment for thousands of years, it now poses many problems. Where once vast tracts of forests and woodlands stretched untouched across the south-west, today there is a mosaic of farms, towns and settlements among bushland. Timber, water catchments, national parks and many other resources and community assets face the threat of damage or destruction by uncontrolled fires.

Wildfires in natural areas are not static. They can move rapidly, often



across difficult and inaccessible terrain, and their behaviour is not always predictable. Most wildfires don't stop at night and can often run unabated for days on end.

In WA's long, hot, dry summers, there may be numerous fires burning at any given time. The more extreme the weather, the more likely there will be a series of intense fires. For example, during the passage of Cyclone Alby, through the south-west of Western Australia on 4 April 1978, more than 60 fires were burning within or near forests. In this situation, fire controllers not only had to assess and set suppression priorities, they had to keep a constant eye on the predicted behaviour of all fires, as any change in the weather could mean a dramatic rearrangement of those priorities. Fires in light fuels that were not threatening life or property were allowed to burn until the more dangerous fires had been suppressed.

Each year, Western Australia's hot dry summer brings with it hundreds of wildfires as a result of natural causes such as lightning, or through human activities including arson, carelessness and accidents. Ninety-five per cent of these wildfires are caused by human activity—a strong pointer to the need for public education, regulation and, where necessary, prosecution.

Department of Conservation and Land Management (CALM) fire crews attend an average of around 300 fires each year, more than half of which are on private property and other lands not managed by CALM. In some years, such as the summer of 1994–95, the number of fires may exceed 500. And yet despite this high number of fires, an average of more than 90 per cent are extinguished before they reach 10 hectares in size, and relatively little damage is incurred.

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The intense heat generated by 30-metre flames, burning through this heavy ground vegetation near Walpole, represents a serious hazard to firefighters. Photo – Kim Howe

Left: When fires jump from tree crown to tree crown, no amount of equipment or human resources can stop them. Photo – Kim Howe



PREVENT, PREPARE, SUPPRESS

The fact that relatively few fires in the South West forests develop into major incidents hinges on the successful application of the preparedness, prevention and suppression measures that are the foundations of CALM's fire management policy. The principal goal of this policy is to protect lives, property and environmental values from damage or destruction from wildfires. But while protection of human life, property and community values is the priority, fire controllers also have to consider the impact of the suppression actionparticularly on the environment and its ecosystems-and the cost of the operation compared with the values under threat.

Fire prevention itself has two key areas of activity. The first is reducing the risk of fires starting. This involves public education, liaison with local fire brigades and local shires and enforcing the Bush Fires Act. The second focuses on reducing the fire hazard on CALM-managed lands and adjoining areas by reducing the amount of fuel available through prescribed burning.

The Scout motto 'be prepared' also applies to fire management. The degree to which wildfires can be extinguished before they develop depends on rapid detection and fast access by fire crews. Throughout the native hardwood forests of the south-west, CALM maintains a constant surveillance during the fire season—from October to April—using a

Once the running fire has been stopped, the hard work of making it safe and mopping up burning material begins. Photo – Lachlan McCaw

network of lookout towers and spotter planes. The towers enable 'smokes' to be identified early, so that spotter aircraft can be scrambled to the fire. Pilots can plot exact locations to provide fire controllers with information on fire behaviour and details of factors such as access and values threatened.

The faster fires are detected and crews despatched, the greater the chance that the flames can be quelled before the fire develops into an inferno. This means having rapid access, fire breaks, water points and fuel-reduced buffers that must be regularly maintained. Other aspects of preparation include providing adequate numbers of appropriate fire appliances and heavy earth-moving equipment, training for fire crews and supervisors, communications networks, maps and recording systems.

STAGES OF FIRE

The speed and intensity of wildfires and the damage they can cause—depends on the prevailing weather, the topography and the quantity, make up and moisture content of litter and ground vegetation, which fuels the fire.

Bushfires, particularly forest fires, don't 'explode' into conflagrations, but rather, develop in stages. In the first stage, within



Firefighters must be well trained and alert to sudden changes in fire behaviour if they are to avoid being caught out by erratic fires. Fortunately, no CALM firefighters have been killed during fire control operations in the past 40 years. Photo – Lachlan McCaw

an hour of the first start, fire behaviour is determined by the surrounding environment such as the weather and topography. The speed and intensity of the fire builds up steadily. If fire crews can get to the fire during this initial stage, extinguishing it using hand tools and pumper units is a fairly simple task.

If fuel levels are low as a result of a recent prescribed burn, wildfire behaviour will rarely build up beyond the first stage. However, if fuel loads are high, fire behaviour will quickly increase to the second stage. Here, the fire goes through a transition and other factors arise that have a big bearing on how the fire behaves. It begins to create its own environment-even its own winds and currents. Its intensity increases, with flames reaching three metres or more. Embers will be blown ahead of the fire, starting new fires: this is known as 'spotting'. Suppression becomes exceedingly difficult and heavy earthmoving machinery is required as the heat and ferocity of the flames make it unsafe to attack the fire with hand tools.

The third stage is when the fire reaches the tree canopy. The build up in fire intensity and size depends directly on the existence of both high loadings of ground fuels and hot, dry, windy weather. When these factors come together, flames soar high above the tree tops and the crown fire creates intense fire whirlwinds. Burning embers can be thrown many kilometres ahead of the main fire front and the energy released can be the equivalent of a medium size nuclear explosion—every 10 minutes. That's enough energy to power a city of about 20 000 inhabitants. Suppression by ground forces or aircraft is impossible and extremely dangerous to attempt. Control of such infernos can only be possible once the weather moderates and the fire runs into a low fuel area.

FIVE RESPONSES TO FIRE

No two wildfires are the same. They vary in size, intensity and pattern of development. Even different sectors of the same fire can vary greatly because of varying winds, fuels and slopes. Fire controllers often have to make value judgments on where and how they deploy their resources most effectively. But invariably they have five basic response options. First, they can try to suppress the fire immediately by attacking the flames. This is the direct approach where crews can reach the fire quickly and extinguish it with hand tools such as 'rake-hoes', knapsack sprays or vehicle mounted pumping units and earth-moving machinery. If the fire is too hot to be attacked head on, crews may still be successful by working along the flanks and pinching in the fire front. An indirect or parallel attack, involving the construction of a fire line a short distance from the fire edge, can be effective where fires are too hot to handle by direct attack.

Second, they can allow the fire to run until it reaches a wide fuel break, such as an area in which fuel loadings have been reduced through prescribed burning, or a natural barrier such as a lake, sand dunes or the ocean. Pastures that are irrigated, ploughed or eaten-out also offer effective fire barriers. Narrow breaks, roads and rivers are rarely effective as barriers to well-developed fires.

A third option is to 'back burn'. This

WHY WE USE BUFFERS

The use of strategically placed buffers—areas of reduced fuel loads—is the major tactic in suppressing fires burning in areas of high fuel loads, especially in severe fire weather. These low-fuel buffers not only provide zones from which the fire can be attacked when the fire behaviour decreases, they are also vital in providing fire crews with safe refuges and accessible areas from which they can suppress spot fires that appear ahead of the main fire front.

The success of this option hinges on the buffer's width and proximity to the headfire. On open grasslands, low-fuel buffers about 100 metres wide are generally sufficient to contain fast-running fires. But for very high intensity forest fires that are crowning and throwing spot fires well ahead of the flame front, these low-fuel zones have to be up to six kilometres wide.

The effectiveness of fuel-reduced buffers was clearly demonstrated during the Cyclone Alby fires in April 1978. Dozens of fierce wildfires—driven by cyclonic winds of more than 120 km/h—were contained to relatively small areas when they ran into areas that had been prescribed burned two to four years earlier. Even in the pastoral country of the Kimberley, strategic buffers have been effective in preventing whole nature reserves—such as the Prince Regent Nature Reserve—from being burned out in dry season wildfires.

Fuel-reduced buffers are an integral part of CALM's Wildfire Threat Analysis strategy, which identifies factors such as values at risk, response times and access for fire crews, fuel loadings and likely fire behaviour. A good example is at Dwellingup, which was devastated in the wildfires of 1961. Around this forest community, CALM maintains fuel-reduced buffers six kilometres wide on the northern perimeter and three kilometres on the southern edge.

In the karri forest, these buffers are placed so that serious wildfires can be contained before they exceed 500 hectares; in the jarrah forest, the maximum loss area ranges between 2 000 and 6 000 hectares, as this forest type can survive severe fires better than karri.

Low-fuel buffers are also a key protection measure for high value conservation reserves to minimise the possibility of wildfires consuming big areas in one hit. These reserves include the Shannon, D'Entrecasteaux, Walpole-Nornalup and Leeuwin-Naturalist national parks, the Lane Poole Reserve in the forest areas and Fitzgerald River National Park in the south coast heathlands. is one of the most highly demanding tactics fire controllers can use, and if things go wrong, and the back burn 'back fires', the fire bosses can soon find themselves with not just one raging wildfire, but several. The key to successful back burning is lighting up the bush well ahead of the 'headfire'. This is done from a road, or prepared fire break or areas with low fuel loadings. CALM research has shown that timing is critical. Usually an hour or more is needed for the back burn to cross a sufficiently wide strip to prevent the main fire from leaping through it and possibly threatening the safety of fire crews. Escapes from back burns are highly likely where weather is hot, dry and windy, or where there are insufficient forces available to suppress the numerous spot fires that inevitably occur across the back burn boundary.

The fourth option is the 'let it burn' option, in other words, to let it burn until it rains or the fire runs out of fuel, and the final option is a combination of two or more of the above.

The foremost considerations in selecting the most appropriate suppression option are the safety of the fire crews and the likely threats to the values at risk. The direct or parallel (indirect) approaches are used where it is safe to do so, life and property values are present and environmental resource values are high. The 'let it burn' tactic is only applied where the likely impact on community and environmental values is very low, the cost of suppression is greater than any benefits gained, firefighting resources are scarce or the country is remote and inaccessible.

ATTACK!

In most forest areas and near towns and farmlands, there are too many values at stake to risk allowing fires to simply burn out in the hope that it will rain. Long experience shows that the chance of successfully suppressing wildfires is highest when fires can be attacked in the initial development stage.

Opposite: High intensity wildfires in heavy fuels (*above*) demand many resources and pose a severe threat to firefighters and private property. Such headfires cannot be attacked directly. Moderate fires require fewer resources. The fuel reduced buffer will provide a refuge for firefighters from which to mount a direct attack (*below*).





The old bushmen's adage of extinguishing fires while they're 'the size of yer hat' is all too true.

To ensure rapid suppression of fires threatening high community values, it is necessary to keep natural fuel loads at relatively low levels, either by mechanical means, grazing or prescribed burning.

Potentially, the direct attack approach is the most hazardous to fire crews and requires a high degree of training and expertise by fire crews and control staff. Environmental considerations also have to be taken into account. These include preventing the spread of dieback by firefighting units, and ensuring fire access lines do not lead to soil erosion and irreparable damage to fragile and susceptible ecosystems.

The direct attack strategy can be costly, as it demands big numbers of machines, pumpers and fire crews. But in the south-west of the State and in the agricultural lands where community values are high, and in cases where it is necessary to prevent an entire reserve of special conservation significance from being burned out, there is no alternative Map indicating the location of fires caused by summer lightning strikes between 1987 and 1992.

if the damage is to be minimised.

In the open rangelands. such as the Goldfields. Nullarbor, Pilbara and Kimberley regions, and in the deserts of the interior, direct attack generally isn't feasible except where wildfires threaten communities, homesteads, or accessible recreation sites. In remote regions, the fire controller's only real option is to monitor the fire using aircraft, ground reconnaissance or satellite imagery to alert isolated communities and residents of possible danger and to take suppression action when the fire presents a serious threat to these values.

COORDINATING THE FORCES

Fighting wildfires is not only arduous and hazardous, it requires an enormous degree of planning and coordination of resources. Big fires, such as those that burned parts of the Gnangara pine plantation, 30 kilometres north of Perth, on New Year's Eve in 1994, and at the Pinjar plantation two months later, can involve organising 200 or more firefighters and officers on the ground and as many as 100 more personnel providing back up support in coordination, administration, catering, transport and first aid, and handling inquiries from the public and the news media.

Often, these personnel belong to a number of different organisations including the firefighting agencies, police and emergency services, first aid and community services.

The crew at the fire face is just one element in an organisation that varies in size and complexity according to the problem. A fire crew may consist of a crew leader, two or three firefighters in a heavy duty pumper unit, and perhaps an earth-moving machine and operator. If the fire escalates, more crews are brought in and the fire ground is divided into sectors, each with a commander who works directly under a fire operations officer. A forward control point is established and a fire management team consisting of a controller, operations officer, planning officer and logistics officer takes control. At very big fires, several sectors may be coordinated into divisions, each with a divisional commander, who in turn reports to the Operations Office.

COOPERATION IS THE KEY

Controlling big wildfires such as the one described above is too big a task for any single organisation in Western Australia. CALM works closely with the WA Fire Brigade and the volunteer bush fire brigades, through the Bush Fires Board, with back up from other agencies such as the Police, State Emergency Service, St John Ambulance, Western Power, the WA Water Authority and the armed forces. Agencies such as these have been consistently involved in training exercises.

Protecting life, property, wildlife and resources are the main reasons for fighting wildfires. In many cases, this needs the close cooperation of many organisations, sharing information, and coordinating expertise, personnel and equipment. The expertise is not something gained overnight. It takes years of training and practice at prescribed burns, small fires and in fire simulation exercises. Collectively, the prevention, preparedness and suppression measures adopted by agencies such as CALM is helping to conserve the South West forest areas and make them a safer area in which to live.

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The Smart Collection

The Western Australian Herbarium is no longer simply a plant museum, . it is a dynamic scientific resource. By using the latest technology, staff and volunteers have turned historically collected information into 'a research tool that is ready to speed along the information super highway.

> by Alex Chapman and Paul Gioia

orking smart has become a byword of the modern corporation, but it seems at first glance irrelevant to something as steeped in history and archaic charm as a herbarium. After all, this is the place where you can wander up to a shelf and pull out two folders containing what seem to be identical specimens of dried plant material. One was collected by John Drummond in 1839, the other was collected last year by a PhD student. But then you notice a difference. The label on Drummond's specimen is laboriously, albeit beautifully, written by hand in copperplate. The student's has a computer-generated label, the work of WAHERB, a dynamic resident of cyberspace that has been developed by the Western Australian Herbarium and is equipping it for life in the 21st century.

HOW IT WORKS

For many centuries, plant specimens have been collected from the wild, pressed and described in Latin according to the Linnaean system of classification, established by the 18th century Swedish

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Top left: Rhubarb fungus. Top right: Cauliflower fungus. Centre: Flowers of the Pindan wattle. Bottom: Seed pods of the Kurara. Photos – Babs & Bert Wells/CALM

Below: The WA Herbarium now tightly integrates its specimen databasing operations (below left) with its traditional tasks of taxonomy and curation (below right). In late 1994, operators finished the initial phase of databasing the specimen collection when the last of the 350 000 record backlog was entered into the WAHERB database. Photos – Donna Swan naturalist Linnaeus, that uses two Latin names—the first being the genus and the second the specific name—to arrive at the species name.

Although the practice of collecting has not changed greatly since the days of the earliest botanists, the way in which this information is stored and used has undergone enormous change thanks to technological advances.

Dried specimens are still the basic tools of taxonomists, the scientists who name, describe and classify species. When a plant is collected in the field, information about its locality, latitude and longitude and habitat is recorded in a field book. Specimens for the vascular collection (flowering plants, ferns and their allies and cone-bearing plants) are dried, then frozen, to preserve them and to kill any insects they may harbour. The specimens are then mounted on stiff sheets of cardboard and labelled with all the pertinent habitat information from the collector's field book. The nonvascular collection (mosses and their relatives, algae, fungi and lichens) is usually stored in special packets or boxes.

It is estimated that about one-third of Western Australia's flora has still not been described, despite the fact that the Herbarium has about 350 000 plant specimens in its collection and is adding to it at a rate of about 12 000 per year. The importance of such work is sometimes overlooked, but without this basic building block, the more glamorous fields, such as DNA research and tissue culture, could not exist.

The Herbarium's work is vital to the Department of Conservation and Land Management (CALM). If plants are classified authoritatively, information related to a species can be reliably documented. While this information is obviously important as a basic research tool in botany, it has a number of practicable and commercial applications as well. For example, it is often vital for land managers to know how certain plants cope with fire or salinity; what sort of plants were indigenous to an area due for rehabilitation; and how the State's threatened flora can best be conserved. The core information about different forms of a particular plant is also vital to commercial growers experimenting with the development of new varieties.

PLANTS WITH BAR CODES

The data now managed by the Herbarium fall into four major types: specimen labels, names, descriptions and biogeographic data. Having all this information is no use at all unless it can be accessed quickly and easily; and integrating all four types of data will provide a powerful conservation device.

In an innovative move, the WA Herbarium introduced a bar coding system for its research collection almost a decade ago-when supermarkets were only just starting to toy with the idea. This was a turning point in the management of the vast pool of knowledge contained in the Herbarium collection, as it revolutionised the processing of specimens. It accompanied the development of the database, known as WAHERB, which has proven to be a powerful tool. WAHERB effectively manages the flow of specimens, while providing fast access to invaluable label information and forming a dynamic link to the never-ending





reclassification of the collection.

In 1990, a database administrator was appointed and external funds granted to increase the rate of data input. This led to a doubling of the annual rate at which specimen details were entered, with about 90 000 specimens being put into the database each year. In December 1994, the databasing of label information from the specimens already in the collection was completed. This was the culmination of ten years' sustained effort by many staff and volunteers. Other advances included the automated production of specimen labels, automation of herbarium loan procedures and a major shift towards obtaining data from all new collections.

The aim of the WAHERB system was to make information on a specimen's identity, appearance and location readily accessible, and to link it to other information systems, thereby fulfilling CALM's role for providing information on the State's flora and fauna.

This year, the focus is on refining data quality and standards, and on ensuring the accuracy of location data so that future products are reliable.

WAHERB's companion, HERBIE, is a personal computer program that allows individual collectors, such as CALM staff, volunteers and other related conservation groups, to maintain their own specimen collection details. There are a number of advantages to using HERBIE. For the user, the program helps store, retrieve and print label information for their own use. HERBIE also allows individual collectors to capture data in a compatible format so specimen information can be uploaded directly into WAHERB without retyping.

WHAT'S IN A NAME?

The name identifying a plant is the foundation upon which all other information about it is built. In 1985, the WA Herbarium published a revised second edition of the *Census of the Vascular Plants of Western Australia*, which includes species names of most plants in the State. However, there was no way of ensuring that the Herbarium contained a valid representative of those names.

In 1991, the WACENSUS database was initiated in order to automate, where possible, the tasks involved in keeping an up-to-date list of published names, to



Above: A cone-bearing plant from the genus *Cycas*. Photo – Kevin Kenneally

Right (top to bottom): Jelly fungus, beard lichen, scarlet bracket fungus, the earthball and club moss. Information about the names of cryptogamic plants such as these is included for the first time in the new publication of the *Census of WA Plants*. Photos – Babs & Bert Wells/CALM

build on the foundation of the previous census and to broaden its scope to include non-vascular plants as well as unpublished names that were in use.

Plant taxonomy is not a static field. Names sometimes change, plants are reclassified or species are divided. WACENSUS was designed to track relationships between names. For example, it could indicate not only that a name was no longer current, but also which other names needed to be considered in finding the most appropriate current name. WACENSUS provides name data linked to WAHERB and individual users' databases, and also automates the production of the new *Census of Western Australian Plants*.

In the same way that HERBIE is a small version of WAHERB, a companion to WACENSUS, called SEDIT, exists for personal or project use. SEDIT allows users to enter species names, which can be validated against the names supplied by WACENSUS. This helps ensure that species names in users' databases remain consistent with WACENSUS and retain their integrity and value.

THE KEY TO IDENTITY

Plants are commonly identified by the use of a 'key'—a sequence of statements about their physical characteristics. A key consists of a series of 'either/or' choices ('Is the flower blue or pink?'), each choice leading to another. Through the process of elimination, the reader is guided to the correct plant name.







Designing a useful key is a challenge, a task that computers can make easier. The Descriptive Language for Taxonomy (DELTA) is an international standard developed over the last twenty years. It allows those involved with classifying and describing organisms to capture their base data in such a way that it can be automatically transformed into a number of different products, including keys. Once the data is fully entered in this manner, it may be automatically converted into descriptions, either

Left (top to bottom): Holly-leaf banksia, honey-suckle grevillea, nodding banksia and pink pokers. Descriptive database projects compiling DELTA data on the genera of WA flowering plants (initially those in Proteaceae), Australian Acacias and the genus Olearia will result in a comprehensive set of interactive keys. Photos – Babs & Bert Wells/CALM printed or interactive keys, or output for further scientific analysis of relationships. It is the plain descriptive text and the interactive keys that are the most used features of the DELTA system.

MAPPING THE FLORA

The main purpose of checking location accuracy for WAHERB specimen records is to provide reliable maps at a specified accuracy level to CALM staff. Perhaps the greatest demand in this area

Below: Interactive mapping applications can help visualise species distributions and display descriptions, drawings and images of the plant derived from a range of DELTA projects. Photo – Leonie O'Halloran



Left: The Sturt pea was one of the first Australian plants collected by an Englishman (William Dampier in 1699) and was one of the first to be described, albeit using the pre-Linnaean system, in 1703. It was formally named in 1832 and given its most well-known name, *Clianthus formosus*, in 1950. It was reclassified as *Swainsona formosa* in 1990. Photo – Babs & Bert Wells/CALM

Right: Dancing orchid. The Descriptive Catalogue of WA Plants is a joint project between the WA Herbarium, the Wildflower Society of WA and Kings Park to produce a book and interactive key briefly describing every plant species in the State. To date, all monocots have been described. Photo – Babs & Bert Wells/CALM

is for simplified but informative maps of where species occur. Geographic Information Systems software is used to manipulate and view this information.

Another of the WA Herbarium's innovative software applications allows users to prepare and place existing species distribution data from WAHERB onto a scalable map of the State. Predefined additional information such as roadways, hydrology, conservation reserves and place names, as well as scale and title information, can also be added. The resulting map can then be printed, if required, or used for further interrogation of the data. For example, when the user enters the name of the species to be mapped, the application retrieves the locations directly from WAHERB and displays them as points on the map. Selecting any point will then display the related specimen data and, optionally, bring up a standard species description, illustration or image prepared from one of the DELTA projects. This illustrates the application's ability to integrate all four major types of Herbarium data (specimen labels, names, descriptions and biogeography).

HERBARIUM IN CYBERSPACE

With the establishment of CALM communications networks and access to the Internet worldwide network, the possibilities for distributing information are enormous. A site on the Internet is aready being established by CALM, with access to selected herbarium data being one of the features. Specimen data (with only generalised localities to protect the



DELTA AT WORK: THE INTERACTIVE KEY

The traditional printed key requires the user to have considerable taxonomic knowledge. An interactive key prompts users to answer appropriate questions about the plant they are trying to identify. As well as selecting the questions based on a user's previous answer, it can also display notes or images to illustrate the terminology. The program can then display photos and line drawings of the resulting species to confirm the identification.

CALM's Science and Information.Division is developing a method of using DELTA (Descriptive Language for Taxonomy) that will ultimately lead to the availability of interactive keys for all the State's flora. Although this is a very long-term goal, various groups, such as the 282 threatened flora species, can be prioritised for this treatment. Choosing from a range of 120 characters coded for each species, a user can key out a specimen to find out if they have a threatened species and display the images and map of known distribution to confirm the identification. Once the project is finalised and the appropriate images gathered, this set of data can be published as a CD-ROM providing a very informative and easily distributable source of reliable data on these important species. The data can be updated and released



at the same time as the yearly gazettal of threatened flora prepared by CALM's Wildlife Branch.

Photo — Leonie O'Halloran

native flora) and census information can be made available for query, and collaboration with CSIRO scientists will result in the ability to transform DELTA descriptive data directly for presentation on the Internet.

As we move into the 21st century, conservation will remain the key role of the WA Herbarium. And it is well equipped for the job, having embraced the notion of electronic databasing 10 years ago. Now wasn't that a smart move? Alex Chapman is a research scientist with CALM and has a research interest in presenting DELTA descriptive data on the Internet. He can be contacted at CALM's WA Herbarium on (09) 334 0500.

Paul Gioia is a research scientist with CALM and has a particular interest in designing computer systems for biological data. He can be contacted at CALM's Wildlife Research Centre (Woodvale) on (09) 405 5140.



In summer, the Swan Estuary is a beautiful, warm and windy, saltsprayed loafing ground for both wildlife and humans, but on many winter days, it is a perfect, cool, still and sunlit sanctuary where nature is the supreme artist.

On days when the estuary is like a mill pond and the water surface mirrors all surrounding vistas, a distant, dark patch of disturbance may be discerned. It is the feeding ritual of hundreds of little black cormorants (*Phalacrocorax sulcirostris*).

Usually flanked by an entourage of pesky, scavenging silver gulls, large flocks of little black cormorants forage in inland waters and marine inlets. These gregarious birds feed cooperatively by surrounding schools of fish in open water and forming lines across inlets to intercept fish leaving with outgoing tides.

Swimming in a tight raft across the water surface, birds from the rear of the formation take off, fly over and dive immediately in front of the advancing group. The result is a flock that appears to roll across the surface of the water. Meanwhile, underwater, individuals zip in all directions, pursuit-diving for prey by using their powerful, large, webbed feet in unison and their wings, at times slightly open, for stability and direction.

Successful catches are bought to the surface, usually impaled behind the gills on the hook at the end of the upper bill. In a few well-executed and skilful flicks and tosses, the prey is turned and swallowed head first.

As well as a variety of fish, the little black cormorant also feeds on crustacea, aquatic insects and molluscs.

Commotion on the Swan

After feeding, the birds either gather in groups on secluded beaches and spits, or individually seek pole-tops, jetties, walls or moored boats to recuperate and dry-off. They are often seen standing with their backs to the sun and wings outstretched, and after a time, begin to preen their feathers and regain body temperature.

Although water-repellent when not immersed, their plumage is permeable under water and sheds air so that buoyancy is reduced. This limits the time they can spend in the cold winter water to less than thirty minutes. When loafing, it is interesting to note the birds' comfort behaviour. They exhibit fluttering of the small pouch under the lower mandible (to dissipate heat), direct head-scratching, true yawning and jaw stretching. Little black cormorants nest mainly in freshwater, vegetated lakes and swamps throughout the State; near Perth, colonies have been observed at Booragoon Swamp and on the Murray River at Yunderup. In the south-west of the State, eggs are laid between August and October, and young are usually flying by November or December.

During the breeding season, little black cormorants attain various lighter lines and patches and a metallic sheen to their normally dull black-brown plumage. Courtship rituals are the order of the day, where movements from both sexes include circle-flying, hopping, penguin-walking, entwining of necks and pre and post take-off postures. Males usually give a variety of croaks, grunts and groans, whereas females hiss or are relatively silent.

BY JOHN HUNTER

DID YOU KNOW?

- There are more than thirty species of cormorant in the world; they, like the pelican, belong to the 'totipalmate swimmers', which differ from all other web-footed birds by having the hind toe joined to the front three by a web.
- True shags are not cormorants; they are placed in different genera in most modern classifications. They have a shorter tail and are unable to perch in trees, on wires or similar thin perches.
- A flightless cormorant (Nannopterum harrisi) of the Galápagos Islands has evolved small, useless wings, possibly as a response to its restricted island habitat, where feeding grounds, nest sites and roost sites are within walking and swimming distance of each other, and predators are absent.

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Edney Spring is a freshwater seep at the base of Mt Augustus. It is one of only a few permanent water sources in the area and was a focal point for Aboriginal tribes during long, hot, summer months.

Photo - Simon Nevill
