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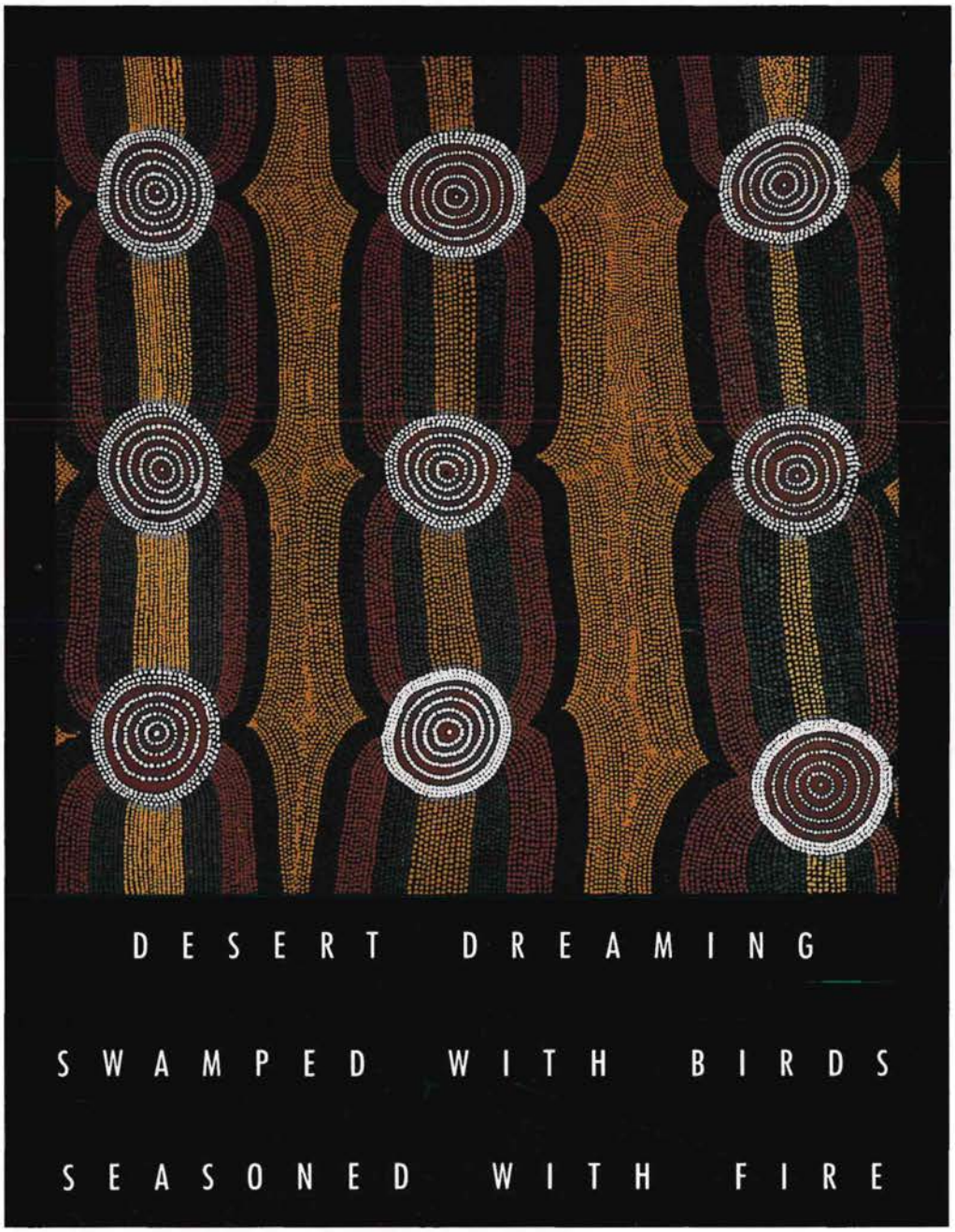
AUTUMN 1990

LANDSCOPE

W.A.'S CONSERVATION, FORESTS AND WILDLIFE MAGAZINE



DESERT DREAMING

SWAMPED WITH BIRDS

SEASONED WITH FIRE

THEIR SWIMMING POOL WAS 3600 MILLION YEARS OLD, BUT THEY DISCOVERED THE FOOD WAS DELIGHTFULLY FRESH.

The whole fish was expertly turned over on an open fire for 20 minutes, then sprinkled with a unique bush herb and devoured by the expedition in minutes.

They had walked a mere three kilometres that morning, but the overwhelming sights and experiences of the Pilbara had aroused everyone's appetite.

They had discovered 3600 million year old rock pools, idyllic waterfalls and awesome cliff top views of the north west wilderness.

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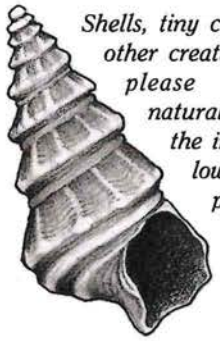
LANDSCOPE

VOLUME FIVE NO 2 AUTUMN EDITION 1990

Rock-wallabies threw down the gauntlet to scientists trying to trap them for research. Who ended up winning the catch-me-if-you-can contest?
See page 35.

Scientists will use modern technology to restore two rare and endangered mammals to an area in the Gibson Desert from which they have become extinct.
See page 10.



Shells, tiny crabs and sundry other creatures are sure to please the curious naturalist who invades the intertidal zone at low tide. Explore the place where the shore meets the sea on page 23.

Waterbirds flock to the Vasse-Wonnerup wetlands in their tens of thousands, some travelling over 10 000 kilometres from summer breedings grounds in northern China and Siberia.
Turn to page 17.

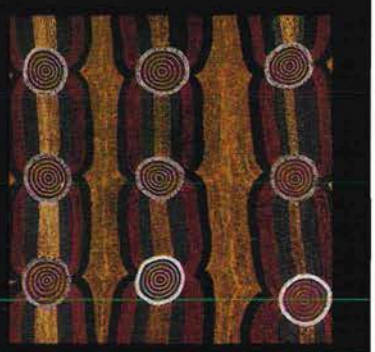
It's the burning question! Is prescribed burning in spring or autumn better for the jarrah forest? Or is there another alternative?
See page 28.

FEATURES

REGULARS

COVER

The designs of desert artist Benny Tjapaltjarri show events associated with the Pakuru or golden bandicoot dreaming in the Gibson Desert. The three central roundels depict rockholes and the others represent hills. The background dots show the vegetation of the area.



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IN PERSPECTIVE

GONE TODAY, HERE TOMORROW

The story of the decline of native mammals in our deserts - 'Desert Dreaming' - and the research and management that has been carried out to resurrect them, has all the elements to make it the conservation story of this century.

So much of Australia's culture and history is based on the outback. Yet most of us live on the perimeter of the continent and know little of what is happening in our vast heartland. Typically, the focus of the environmental debate in Australia has been in our cities or, at best, a few hundred kilometres from the coast in the high rainfall areas where our forests grow.

The 'Desert Dreaming' story reveals that while we have been preoccupied with our coastal fringe, a catastrophic drama has been played out in the area that our myths tell us is the real Australia.

The story is not only significant because of its setting. It is also a story of how perceptive and persistent scientists working with Aboriginal people identified the problem, its causes and the research strategy needed to devise a solution.

The story is not without irony. The arrogant presumption that Europeans knew best led to the destruction of Aboriginal social structure, and resulted in the cessation of burning practices which sustained the habitation of native mammals. The traditional burning regimes are being reintroduced with the guidance of Aborigines and with technology developed to deal with the problem of wildfires in high forests.

Finally, the story is important because it demonstrates that, even in complex ecosystems, we can repair the mistakes of the past with good science and teamwork.

The Publisher

WOUNDED WILDLIFE

The attitude of most drivers when they hit our local wildlife is appalling. I wonder if they would drive on without a thought or care for what is left on the road if they had hit humans or horses.

In the past five days I have rescued three kangaroos that have been hit and left on the road, alive but unable to move, at Canning Vale, Baldivis and Jandakot.

Luckily, other motorists behind these cars stopped and the animals eventually came to me. One had a spinal injury but lived for several hours. Another was released after treatment and a third, with a tiny joey, has a leg injury and a broken arm. We hope she will make it.

Wake up Australians - it's time to realise what unique wildlife we have.

LYNN HANCOCK
SHANTI MARSUPIAL HOSPITAL, WELLARD

NUMBAT SIGHTING

Following on from the article in the September 1985 issue, I would like to report two numbat sightings by my wife and nineteen-year-old son on the Mount Barker-Porongorup Road. They had clear sightings and are adamant that the animals involved were numbats.

P. FELTON
ALBANY

Your information has been passed on to CALM's Wildlife Research staff. Thank you - Ed.

LONGING TO VISIT

Since I became acquainted with your magazine I have meant to write and tell you how much I enjoy it. Your questionnaire in the current issue has prompted me to get down to it.

I was first sent a subscription by friends in Shark Bay and I am enthralled by it. I have never visited Western Australia but now know so much about the marvellous animal and plant life and your beautiful country. Maybe I shall never see it for myself, but I would like to think that one day I may make the trip. Until then those dolphins at Monkey Mia and the flowers in the bush will remain an unfulfilled ambition. And I think your photography is superb.

HILDA DENYER
SOUTHWOLD, SUFFOLK

Your letters are welcome. Please address any correspondence to

LANDSCOPE EDITOR
CALM
50 HAYMAN ROAD
COMO WA 6152

ZAP THE WRAP!

We recently received a gift subscription to LANDSCOPE, with which we were delighted. We were, however, disappointed to notice that the magazine is packaged in plastic and printed on glossy white paper. A recycled paper wrapper would seem more appropriate for a conservation magazine, and perhaps your Department could also consider the use of recycled paper for parts of the magazine itself.

JULIET JOHNSON
LEEDERVILLE

Our apologies for an omission in Elizabeth George's article 'Unravelling the Mysteries of Verticordia' *in the last issue of* Landscope. *We should have acknowledged the work of Alex George, who has recently completed a taxonomic review of the genus, which should soon be published in the Western Australian Herbarium journal* Nuytsia.

TROPICAL REEFS DISPLAY

Some of the wealth of the Cocos (Keeling) Islands is currently on display at the WA Museum.

It is the result of a team of marine biologists from the WA Museum crossing the Indian Ocean to explore the Islands last year.

The display features specimens from the remote twin coral atolls, including starfish, sea urchins, corals, crabs and molluscs, and gives an insight into the historical background and marine environment of the islands.

The Cocos Islands were discovered by a sea captain, William Keeling of the British East India Company, in the 17th century.

The islands were uninhabited until Alexander Hare established a settlement in 1826. He was joined a year later by John Clunies-Ross, whose family developed coconut plantations using imported Malay labour.

Australia accepted the islands as a Territory in the mid-1950s and finally purchased them from the Clunies-Ross family in 1978.

One of the items on display is a local fishing boat that symbolises the meeting of Malay and Scottish cultures in the Islands. The broad-bottomed hybrid 'jukong' combines the design of Malay fishing craft with that of a British whaleboat.

The jukong, a craft unique to the Cocos Islands.

A diver surveying Cocos reefs for a WA Museum research project. Photos - Courtesy of WA Museum

The jukong is no longer built on Cocos and is slowly being replaced by aluminium boats with outboard motors.

The Museum's Cocos Islands field trip involved marine biologists from the Natural Science Division. It is the most recent expedition in a series being mounted as part of the Tropical Reefs Program initiated in 1974.

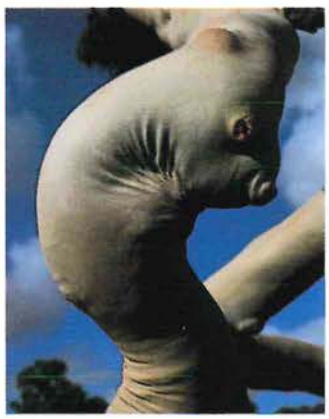
The program surveys the marine fauna of reefs off Western Australia's northern coast and compares the specimens found with those of reefs of the Pacific and Indian Oceans.

Ashmore, Cartier, Seringapatam, Scott, Rowley Shoals, Ningaloo, the Houtman Abrolhos and Christmas Island reefs have been studied.

The Museum will make recommendations on the conservation and management of the Cocos Islands' marine fauna.

The display will run until the end of April in the Museum's small Francis Street foyer.

DISCOVERING A NEW SPECIES?



During a recent walk in the Darling Range near Perth, Mack Seale of the Kings Park Guides spotted this quaint character perched in a lemon-scented gum. He suspects it could be the extremely rare 'Koala citriodorus' and wonders if there have been other sightings.

CAPE CRUSADERS

West Cape Howe National Park will soon have a draft management plan and users of the Park are helping to put it together.

The Park, on the south coast between Albany and Denmark, was declared in 1985. Its sandy beaches and rocky headlands, tall karri forest and low wind-pruned coastal heaths are home to fauna such as the ringtail possum, the quokka and the Red-eared Firetail.

The Cape includes Torbay Head, the southernmost point in WA, and has impressive cliffs of "black granite" (actually a rock called gabbro).

Fishing, camping, bush-walking and picnicking, diving, rockclimbing and hang-gliding are popular Park activities.

Shelley Beach in West Cape Howe National Park provides one of the premier hang-gliding spots in WA.
Photo - Tony Tapper

The area has suffered badly from uncontrolled vehicle use over the years and user groups are keen to see the damage repaired. Groups and Park visitors from as far away as England have been consulted.

CALM's South Coast Region held a workshop, attended by 60 people from 14 user groups, near Albany late last year.

The participants considered management issues such as access, dieback, information, fire management, visitor facilities and rehabilitation. Strategies for managing each issue were developed in an intensive workshop session.

One thing was clear - current use is causing serious erosion of coastal dunes. The plan will rationalise access routes to halt this process. A few stable tracks are needed to replace the myriad of unstable ones that currently criss-cross the Park.

Signs advising drivers to lower their tyre pressure when in sand country were suggested to help reduce damage to sand dunes. These are about to be installed in the Park.

"All four-wheel-drive owners should be carrying a tyre pump in their vehicle to enable them to adjust tyre pressures to suit the terrain," said one participant.

Community involvement in the draft management plan has achieved more than just an exchange of ideas. Interaction among user groups is also improving understanding of the Park's different uses and of the range of views about its management.

Community support is essential if the final plan is to be implemented successfully. In the case of West Cape Howe, we're off to a flying start.

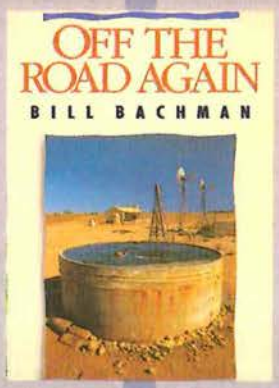
IAN HERFORD

*Scented sun orchid (*Thelymitra nuda*) can be seen flowering at West Cape Howe during warm, sunny weather.*

The well-known black cliffs of West Cape Howe.
Photos - Tony Tapper

BOOK REVIEW

FREELANCE photographer Bill Bachman has written and photographed a new book, entitled *Off the Road Again*. It slowly took shape as Bachman and his wife made their way across the "top end" - through Central Australia, the Northern Territory and the Kimberley.



Although the text is well written and entertaining it is the photographs that dominate the book. Bachman has produced some inspiring images of the Australian outback.

Some photographs emphasise the landscape's vast foregrounds, empty horizons and enormous skies. Others home in on slabs of colour, slices of light and detail: Bachman shows that the Australian landscape is as much about shape and texture as about space and light.

Off The Road Again retails at $16.95 and is available from most bookshops.

IN LEAGUE WITH NATURE

For two weeks each spring, a campsite, nestled in the tree-clad Bickley Valley near Perth, becomes home to 50 young students of natural history.

The camp equips students to become WA Gould League leaders in their schools, where they will put ideas learnt at the camp into practice. Upper primary school students are selected for the camp from schools throughout the State.

The Gould League promotes the study of the State's natural history. Its name commemorates famous 19th century naturalist John Gould and his wife, artist Elizabeth Coxen Gould.

The organisation's first camp was held in 1951 to mark the 50th anniversary of the Commonwealth of Australia. The campsite, 15 kilometres from Perth among the foothills of the Darling Scarp, is close to the Bickley Reservoir.

The reservoir is near the end of a deep ravine in the hills, and Bickley Brook runs along its base. The creek and dam contain various freshwater habitats for aquatic animals such as water rats, frogs and gilgies. Paperbarks, reeds and rushes fringe the wetlands, providing habitats for the reed warbler, little grebe, ducks and cormorants.

The dense scrub along the creek shelters small birds including wrens, thornbills and robins. Water rats feed on gilgies or mussels from platforms on the edge of the water.

Flooded gums and melaleucas grow on slopes near the water. Marri and wandoo, with one-sided bottlebrush as an understorey, grow a little further back, providing knot-holes and spouts for nesting kingfishers, pardalotes, tree martins and parrots. Sittellas are usually seen in the jarrah forest on the ridges.

The camp fosters children's appreciation of nature and stresses the importance of careful observation and accurate recording.

The day's activities begin with an excursion along one of the nature trails. The children are encouraged to note items of interest such as birds nesting or bees swarming. Groups report their finds after returning from their bushwalk.

The afternoon session often begins with a short lecture by a staff member or visiting expert, on a subject such as reptiles of the area, plant pressing, bird sketching or setting up an aquarium. The evening program often includes a guest speaker from the WA Museum, CSIRO, CALM, Kings Park or one of the Universities on some aspect of their research.

Up to the mid-1970s it was possible to live-trap possums, water rats and short-nosed bandicoots. However, numbers of these animals have declined, possibly because of fox predation, increased urban pressures on the surrounding bushland, lowering of the water level in the reservoir and more frequent wildfires.

Students examining the rare plant Anthocercis gracilis, *(illustrated left) discovered by a young Gould League student. Photo - Kevin Kenneally Illustration - Margaret Menadue*

Some interesting observations and discoveries have been made at the camp. In the field, students collect a small piece of plant and bring it back to the classroom. They identify it using a field herbarium of specimens collected and pressed on previous camps.

One student collected an unusual plant with pendulous, bell-shaped flowers. It was later identified as *Anthocercis gracilis*, first collected by the Colonial Botanist, James Drummond, between 1837 and 1842. This plant is now gazetted rare and endangered. One of the highlights of the 1989 camp was relocating the population and counting the number of individual plants present - a practical exercise in conservation.

The interaction between the students, staff and professional scientists is important. Some former students have become professional biologists but the camp's main purpose is to instill conservation as an attitude of mind. One former camp student is Andrew Brown, now a CALM staff member and co-author of *Orchids of South-West Australia.*

KEVIN KENNEALLY AND DAPHNE EDINGER

THE SPINIFEX HOPPING-MOUSE

The spinifex hopping-mouse is found in the arid interior of Australia.

Slightly larger than the introduced mouse, it is well adapted to the desert. It will drink water if available, but if necessary it can live entirely upon a diet of dry seeds.

It avoids day-time heat by sheltering in a cool burrow, an elaborate network of tunnels and chambers, almost a metre below ground.

Photographer Michael Morcombe excavated a burrow in sand-dune country in the North-West of WA. Trails of tiny footprints led to a small round hole, a vertical shaft almost a metre deep, where a plug of soft soil blocked the tunnel during the day.

Along the main horizontal tunnel was a chamber, with a grass nest containing newborn hopping-mice. Other tunnels led to escape shafts, hidden by clumps of spinifex.

Hopping-mice have a two-footed leaping action and look rather like miniature kangaroos. Above the ground they are extremely fast, leaping high and erratically.

One of their predators, the desert death-adder, sometimes

lies close to the burrow entrance, waiting for a mouse to emerge. This snake's patterned body makes it extremely difficult to see against the green and gold spinifex and red sand.

STORY AND PHOTOS BY MICHAEL MORCOMBE

TURNING THE TIDE

Seaweek (March 25 to April 1) is to oceans what Arbor Day is to trees. The week of activities should remind our predominantly coastal-based populations about the wonders of the oceans and the need to look after them.

Seaweek will aim to raise our awareness of the need to care for and understand the ocean ecosystems.

The theme of Seaweek 1990 is to 'turn the tide'. Activities will target issues such as marine conservation, recreation and pollution, sustainable use of the oceans and boating safety.

On March 25 there will be a marine open day at Hillary's Boat Harbour, featuring the Cousteau Society's research vessel *Alcyone*, free snorkelling courses, guided tours of CALM's Boyinaboat Dive Trail, displays, tours of Underwater World and much more. The Department of Conservation and Land Management (CALM) will have a display. With Marmion and Ningaloo Marine Parks, and several more ocean and estuarine parks soon to come under its control, CALM has a great interest in and responsibility for the marine environment.

Many other Seaweek activities, including a week of special events at Atlantis Marine Park, have been planned by the Marine Education Society of Australasia.

DRAGONS OF THE SEAS

The collection of a 'pregnant' male seadragon by divers from Underwater World last September provided a rare chance to study seadragons in captivity.

Seadragons are found only in southern Australian waters and hang almost motionless in the water, tiny fins fluttering to give stability and balance. Splashes of yellow, red and purple cover their bodies.

They are slow swimmers, but their fragile leafy appendages provide perfect camouflage among seagrass beds. Although quite common along our coast, they are rarely seen, even by experienced divers. Only the rolling of their swivelling eyes betrays them to predators.

Seadragons mate from September to December. The female produces 100 to 250 eggs, which she wipes against a wrinkled area of skin underneath the male's tail. The eggs adhere to this patch, which forms cup-like moulds around the eggs. The oxygen-rich blood vessels in the tissue keep the egg oxygenated during the eight-week incubation period.

The male seadragon caught by Underwater World had about 80 eggs, which were pink and covered in a green/brown algae. When they hatched, the young seadragons emerged tail first and swam freely after a few minutes. The yolk sac still attached to their bodies provided the young with two days' sustenance.

After 50 days the young seadragons had grown 90 millimetres long. They will not reach their full adult size of 40 to 45 centimetres for at least two years. After a year the animals will be 20 centimetres long and sexually mature.

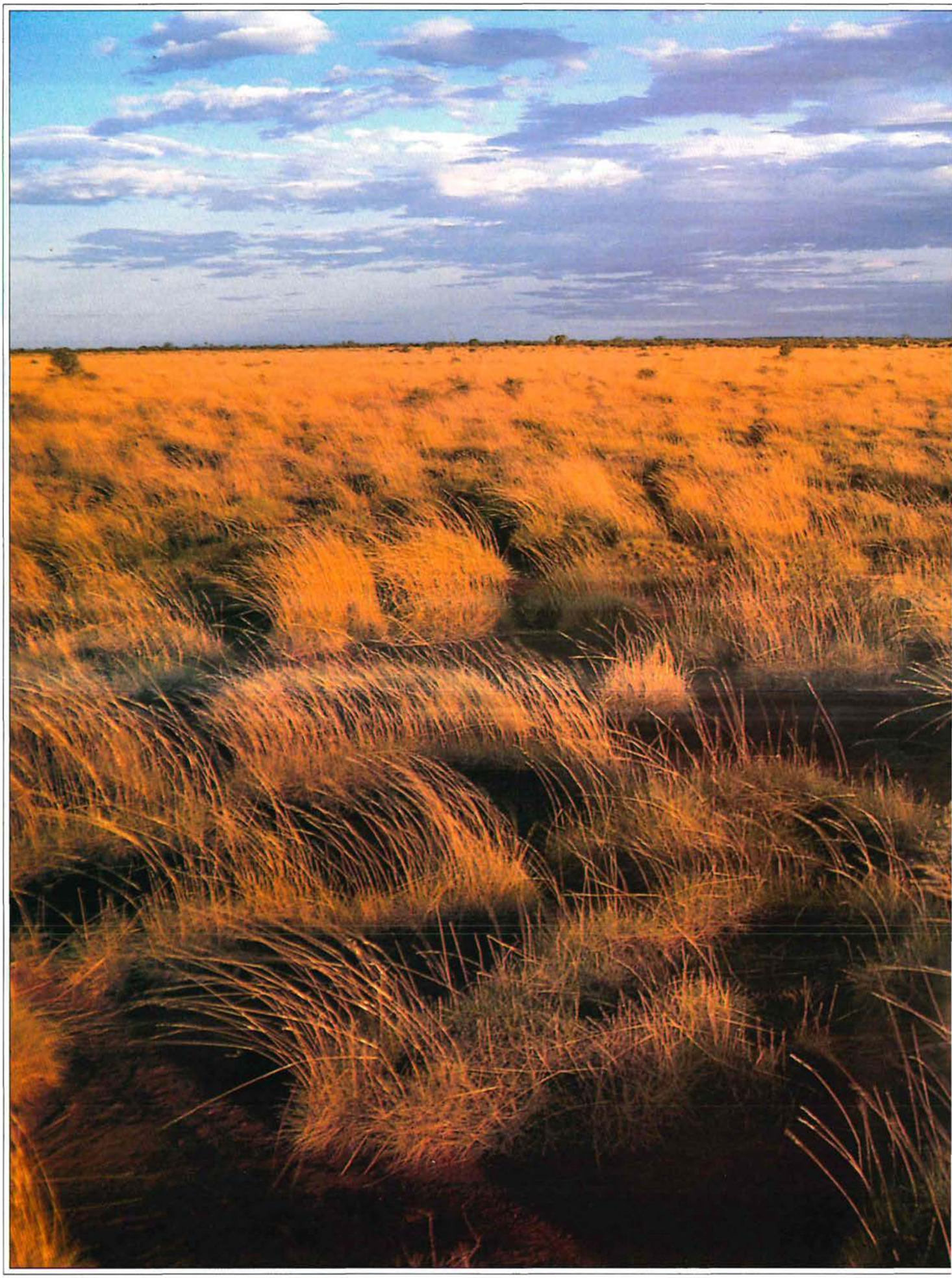
Another male has since hatched 20 eggs, which will also be monitored.

Seadragons have no teeth, so keeping them in captivity is difficult. However, Underwater World aims to care for the dragons through a complete life cycle and eventually release them into the ocean.

Little is known about them but it is hoped that constant care, observation and research will increase our understanding of these amazing fish.

*A two-week-old common seadragon (*Phyllopteryx taeniolatus*) that recently hatched at Underwater World.*

*The leafy seadragon (*Phycodurus eques*), which looks incredibly like a piece of seagrass, is a close relative of the common seadragon. Photos - Van Worley*▼



DESERT DREAMING

THE REINTRODUCTION OF RARE AND ENDANGERED ANIMALS TO THE GIBSON DESERT

by Neil Burrows and Carolyn Thomson

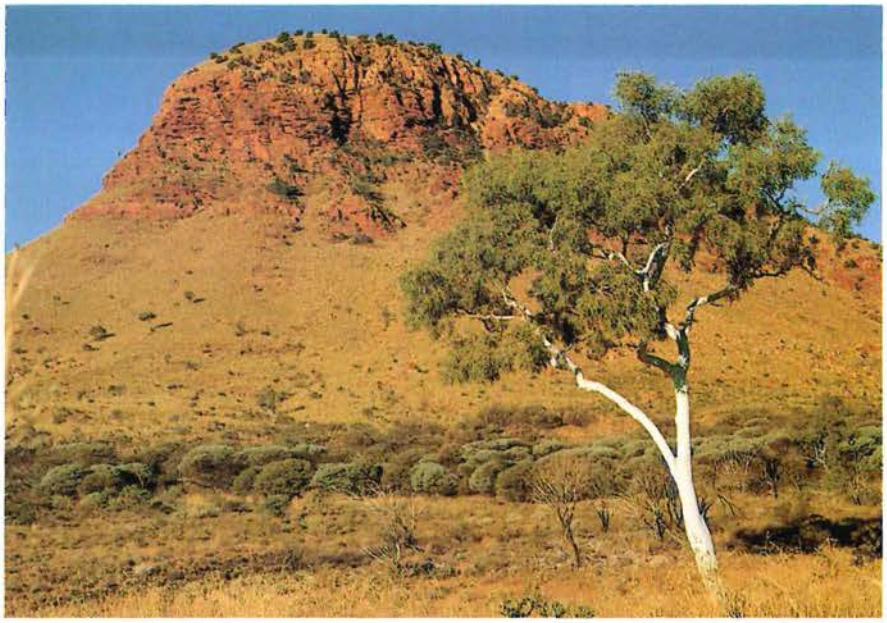
WHEN several pairs of rare burrowing bettongs and golden bandicoots are airlifted from Barrow Island in the far north of WA, and reintroduced into the Gibson Desert Nature Reserve in central Western Australia, it will be the culmination of many years of painstaking labour.

The beginnings of the project can be traced to the work of scientists Andrew Burbidge and Norm McKenzie from the Department of Conservation and Land Management (CALM) and Ken Johnson of the Conservation Commission of the Northern Territory in desert regions of WA and the NT in the 1970s. They became alarmed at the rapid extinction of medium-sized mammal species (those in the critical weight range of between 35 grams and 5.5 kilograms) in arid areas. Strangely, they found that this massive decline was comparatively recent. It had only occurred over the last 30 to 50 years. The WA Museum and early explorers had reported and collected many mammal species that could no longer be found in these areas.

The extinction of animal species in modern times is usually associated with human activities. However, Europeans hadn't been directly active in these areas - the country appeared to be virtually pristine. So scientists had to look for some other explanation for the vanishing stock of desert mammals.

By a process of elimination, scientists formed the idea that the extinction of mammal species primarily resulted from Aborigines leaving the land and ceasing their traditional burning practices. Like Aborigines in other parts of Australia, Aborigines of the Gibson Desert used to burn to bring up green feed for mammal species they hunted and to "clean the land". The frequent, mostly small fires they lit resulted in many areas of vegetation of different ages. An aerial photograph from the 1940s clearly shows this patchwork burning pattern.

Changes in desert fire regimes were described in an article in *Landscope* Winter 1987: "As Aborigines moved to European settlements and the deserts became depopulated a 'natural' fire regime took over - one of infrequent but very extensive hot summer wildfires, usually started by lightning. This change is thought to have had a profound effect on the mammals, depriving them of diversity of shelter and feeding areas, and leading to rapid decline and local or total extinction."



Although the Gibson Desert seems pristine many changes have recently occurred: feral animals have invaded, Aboriginals have left the land and many mammal species have declined or disappeared.
Photo - Neil Burrows▲

Previous page:
Spinifex landscape
Photo - David Pearson
Burrowing bettong *(Bettongia lesueur)*
Photo - Jiri Lochman

A huge fire during the hotter months could burn out thousands of hectares. Mammals such as the burrowing bettong would probably survive such a fire, as they live in a network of warrens and could shelter underground. However, with the vegetation temporarily removed, they wouldn't have had anything to eat and would be easier prey for predators.

Other mammals, such as the rufous hare-wallaby, need vegetation of differing ages. They feed on the soft, green shoots of young spinifex, shrubs and herbs that emerge after fire. They shelter in mature spinifex, which makes an excellent hide but does not offer much nourishment. Such animals would be adversely affected by larger, less regular fires that create large areas with vegetation of a uniform age.

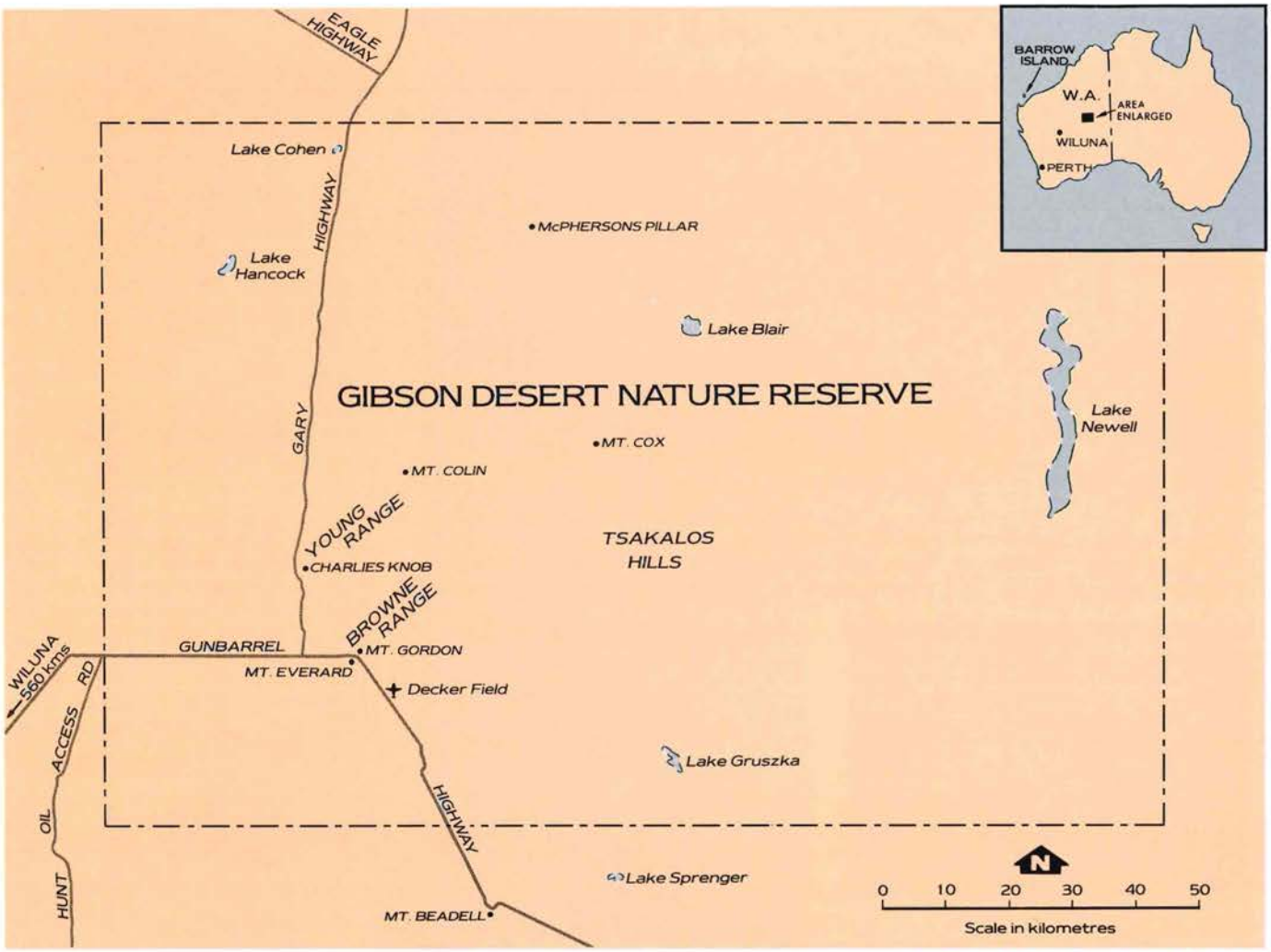
Another possible explanation was that the extinction was the result of the introduction of feral animals such as foxes and cats. However, cats were present for a long time without having much effect and foxes did not become established in some areas until after the mammals became extinct. However, foxes probably speeded the extinction by removing relict populations of mammals left after big fires, and preventing them from spreading again if conditions became suitable.

It seemed that the Aborigines of the Gibson Desert were the key to the mystery, so CALM's Research Director Andrew Burbidge and other research scientists returned to the desert to talk to them.

"During 1982-1985 we visited many Aboriginal communities throughout Australia's central deserts seeking information about desert mammals. We talked to groups of old people, showing them mammal skins, asking questions, taking notes," said Andrew.

These studies showed that more than one-third of the mammal species of central Australia had vanished. The scientists also gathered a large amount of biological information about many of these species.

As a result of this work, CALM research staff embarked on an ambitious project to reintroduce certain mammal species to the Gibson Desert.



The golden bandicoot or Pakuru *(Isoodon auratus)*, one of the mammals that scientists are seeking to reintroduce (right), and the patterns that symbolise its travels in the Dreamtime (far right).
Photo - Bert and Babs Wells
Painting - Benny Tjapaltjarri

Although nature conservation concerns in the desert do not have a very high profile in the public eye, they are a high priority for CALM. More than half of all land managed by the Department is in the arid zone - over 10 million hectares.

The Gibson Desert was chosen for the project because something was already known about the vegetation, landforms and existing fauna as a result of survey work in the area. It is land managed by CALM, it is reasonably accessible, and contains fairly low numbers of feral animals.

The Gibson Desert Nature Reserve covers 1.8 million hectares, and is 600 kilometres east of Wiluna. It includes vast, undulating spinifex plains, interspersed with mulga. In places there are extensive salt lakes, small freshwater lakes, small spinifex-covered sand-dunes and low rocky ranges with occasional breakaways.

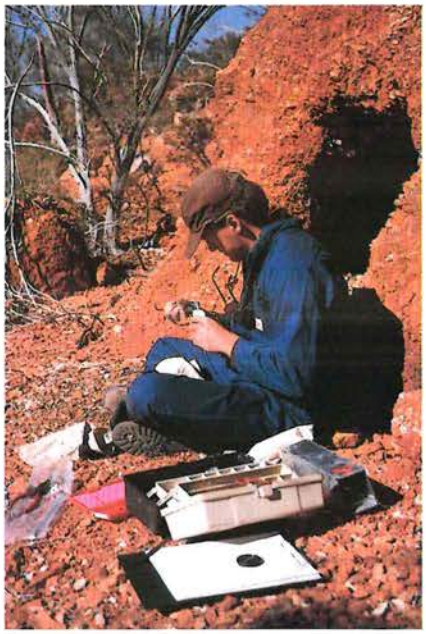
The mammal release is scheduled for May 1991, but before it can become a reality, much groundwork has to be done.

Action must be taken to secure the mammals' habitat from predators. Foxes will be controlled and their numbers monitored. CALM Researchers David Algar and Tom Leftwich have surveyed, sexed and aged Gibson Desert fox populations and analysed their stomach contents.

To prepare the habitat for the reintroduction of the mammals, CALM has also commenced a prescribed patch burning program in the Gibson Desert. This is no easy task. Fire management in the populated and well-resourced areas of the South-West has evolved to a high level of sophistication and organisation, but the vast expanse of the Gibson Desert

Landsat imagery of part of the Gibson Desert Nature Reserve - the red-brown patches show recently burnt areas.
Photo - Department of Land Administration ▲▲

The effects of fire on lizards, such as this dragon, are being studied.
Photo - Jiri Lochman ▲



Scientist David Pearson measuring a small mammal in the Reserve.
Photo - Janet Gardner ▶

is a far cry from the jarrah and karri forests of the South-West.

None of the resources used for fire management in more populated areas exist. Roads and tracks to the reserve are rough and sometimes inaccessible. There are no firebreaks and there is no way of putting out a fire once it starts.

A specific type of fire regime is needed, one that leaves a patchwork pattern of vegetation of different ages across the landscape: from recently regenerated herbfields to long-unburnt patches of spinifex. This would provide suitable animal habitat and prevent the development of massive wildfires.

CALM fire researchers Neil Burrows, Alex Robinson, Bruce Ward and Karan Maisey studied the behaviour of spinifex fires to predict when and how spinifex would burn and under what weather conditions fires would self-extinguish. This was critical to achieving the desired system of "patch" burns. Igniting spinifex under the wrong weather conditions could result in a large wildfire, or, at the other extreme, no fires at all.

Wind speed was found to be the critical weather element controlling fire behaviour. Fires will not spread in even the most flammable spinifex if wind speed is less than about 12-15 km/h. Other important factors determining the behaviour of spinifex fires include the patchiness of the spinifex clumps, the size of bare patches of ground, air temperature, relative humidity and the moisture content of the spinifex.

Historical weather records from the Giles Meteorological Station showed researchers that September was likely to have the most suitable weather for patch burning. Strong winds early in the day would ensure that fires ignited by small incendiaries dropped from an aeroplane would spread. Winds could be expected to ease during the day and, by mid to late afternoon, fires would go out by themselves.

In September 1988, the first aerial research burn took place in the Gibson Desert. An area to the west of the Gary "Highway" (a rough track joining the Gunbarrel "Highway" and the Canning Stock Route) was chosen for the trial. Vegetation types common in the reserve were represented within the trial site and ground access was possible along Gary Highway.

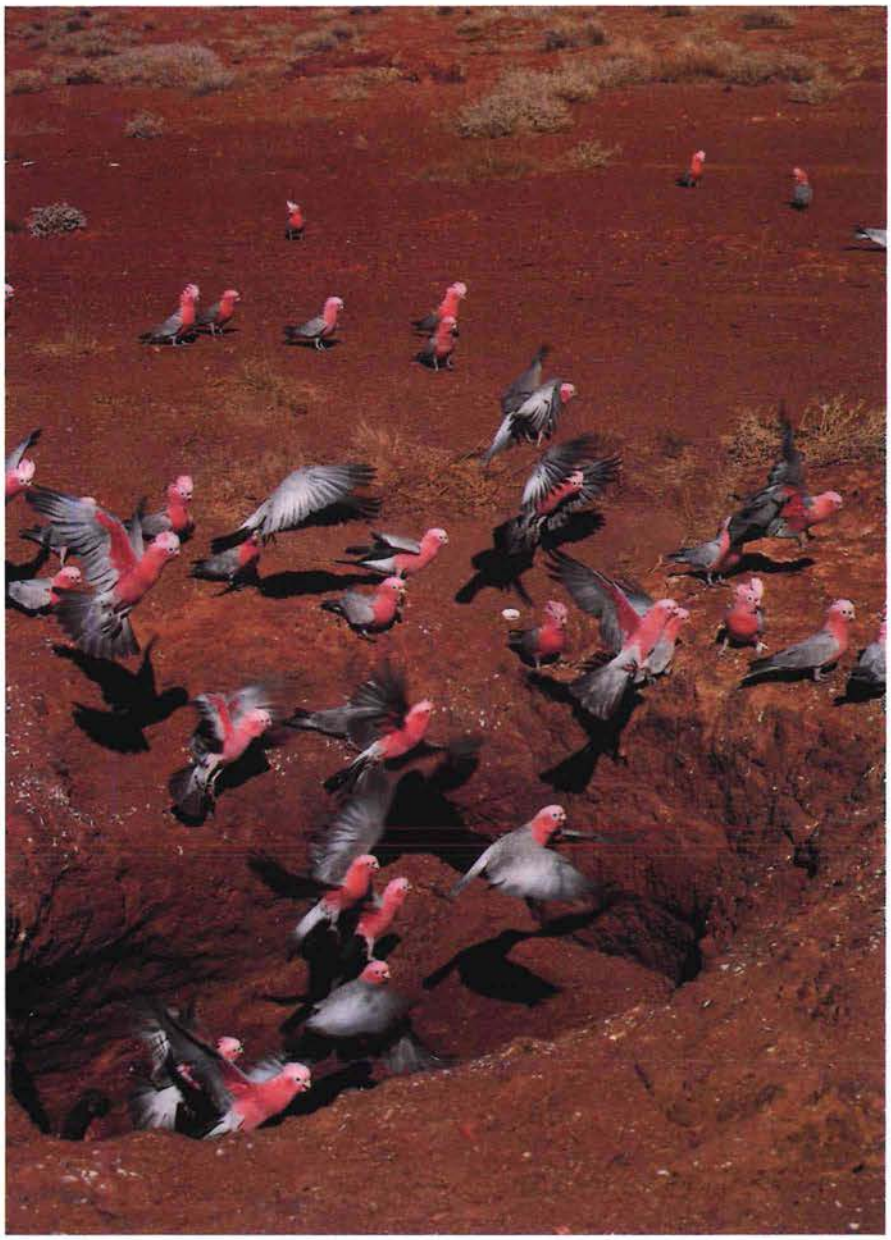
Landsat satellite imagery provided useful vegetation and landform maps needed for the trial. With some ground work, the satellite images could be used to locate vegetation types, lakes, claypans, recently burnt areas and other features. Detailed descriptions of the major vegetation types were made and representative areas were photographed from the ground and from the air.

Researchers decided to use aircraft for the burn because of the large area to be burned, its inaccessibility and cost-effectiveness. Incendiaries dropped from a plane resulted in a large number of small fires with patches of unburnt areas in between - in effect mimicking the traditional Aboriginal burning pattern.

Scientists are now monitoring the ecological effects of these patch burns and are preparing plans for prescribed burning in other desert reserves.

"We are looking at the whole ecosystem, not just mammals - and how fire affects them," said CALM's David Pearson, who, along with Janet Gardner, is studying lizards and small mammals in the spinifex community.

Andrew Burbidge and Phillip Fuller have established sites to study the effects of patch burning on birds. Eight study



Flocks of galahs can be seen in the Gibson Desert after rain, but move out of the area in periods of drought.
Photo - David Pearson◄

The desert mouse *(Pseudomys desertor)* still persists in the Gibson Desert.
Photo - David Pearson▲▲

Aborigines who have traditional associations with the Gibson Desert have been sharing their knowledge about animals in the area with scientists.
Photo - David Pearson▲

plots, each of one square kilometre, have been marked: four in burnt and four in adjacent unburnt areas of each vegetation type. One pair is situated in mulga country, one in sand-dunes and two in two different types of spinifex. They are returning in different seasons to record the numbers and types of birds using the areas.

"Because of the poor summer rains in 1988 and 1989 the burnt areas do not have many birds using them," said Phillip Fuller.

"However, a couple of years ago we did some experimental burning by lighting small fires. When we returned the following year after good summer rains there had been a dramatic change: the burnt area was a mass of flowers and seeds."

Work has advanced to such a stage that in May this year scientists will select the release sites and survey fox numbers and their distribution. In September 1990 the release areas will be baited to remove foxes and cats.

The two mammal species selected for release are the burrowing bettong and the golden bandicoot. The burrowing bettong is found only on Barrow, Bernier and Dorre Islands and the golden bandicoot is now found only on Barrow Island and in remote parts of the north Kimberley. Both animals were once widespread on the mainland.

CALM scientists Per Christensen and Graeme Liddelow will oversee the releases.

"Once the animals have been landed we will do our utmost to ensure they survive," said Per.

"We will be following their progress for 24 hours of the day. We will supplement the mammals' diet if they run short of food. We will record their behaviour and foraging habits, when and where they move about, how far they travel to find food, what habitat they adopt and every facet of their breeding behaviour.

"Although the released animals will be given every chance of surviving, there is a possibility that they won't. If they don't, we will at least be in a position to know why and be better prepared for future attempts at fauna reintroduction," he said.

CALM will be building on experience gained during its successful numbat, woylie and Noisy Scrub-bird reintroduction projects in the South-West. The only other place where such an ambitious program has been undertaken in the desert is in the Tanami Desert in the Northern Territory. Here, the Conservation Commission has built a fenced compound for the rufous hare-wallabies they are seeking to reintroduce.

OLD FLAMES

On September 13 1988, all was ready for the first attempt at aerial patch burning in the desert. CALM staff from the Goldfields Regional Office in Kalgoorlie had upgraded a disused mining company airstrip (by dragging it with a large piece of iron behind a four-wheel-drive!) and arranged for aircraft fuel to be trucked out from Wiluna. An aircrew, with long experience in aerial burning in the jarrah and karri forests, had arrived and was ready for action.

The day dawned clear and cool. The early morning wind blew from the north-west at about 12 km/h. Weather forecasts were relayed via telephone to Kalgoorlie and by high frequency radio to the Gibson Desert at 0845 hours and again at 1445 hours. Lee-Anne Martin in the Kalgoorlie Office relayed that the morning forecast was for winds from the north-west at 12-15 km/h, backing west at 10 km/h by 1400 hours. Conditions were marginal for fire spread, but just right for attempting the first patch burn. At 1127 hours, the first incendiary tumbled from the aeroplane and lit the spinifex. For the first time in probably 40 years, flames once again licked this part of the desert.

By about 1330 hours, the wind had eased and the fires slowed and began to go out. Aerial observations confirmed that the pattern of burnt patches had met with the prescription. The fires had behaved as expected. As a means of ignition, the incendiary capsules exceeded expectations. Because of the high proportion of bare ground, researchers had only expected about two or three capsules out of 10 to ignite the spinifex. However, up to 80 per cent of capsules ignited. The high success rate was attributed to capsules bouncing across the ground and catching in spinifex clumps - Dambusters style.

Over nine days, some 75 000 hectares of the Gibson Desert Nature Reserve were successfully patch burned by aerial ignition. Overall, about 10 to 15 per cent of this area actually burned. Patch size varied from a few square metres to more than 50 hectares. Fires often burned in narrow strips downwind - ideal firebreaks for preventing the build-up of summer wildfires.

The resulting patchiness of these burns resembles the fire patterns created by nomadic Aborigines shown on early aerial photographs.

CALM scientists make regular field trips to the Gibson Desert to undertake research, despite the lack of facilities.
Photo - David Pearson ▲

And through all this CALM is keeping the local Aboriginal communities involved and informed. Scientist David Pearson also has the task of liaising with the Aboriginal communities of Warburton and surrounding areas.

"The mammal fauna of the desert was very important to Aboriginal people for food and is a significant part of their mythology and culture," said David.

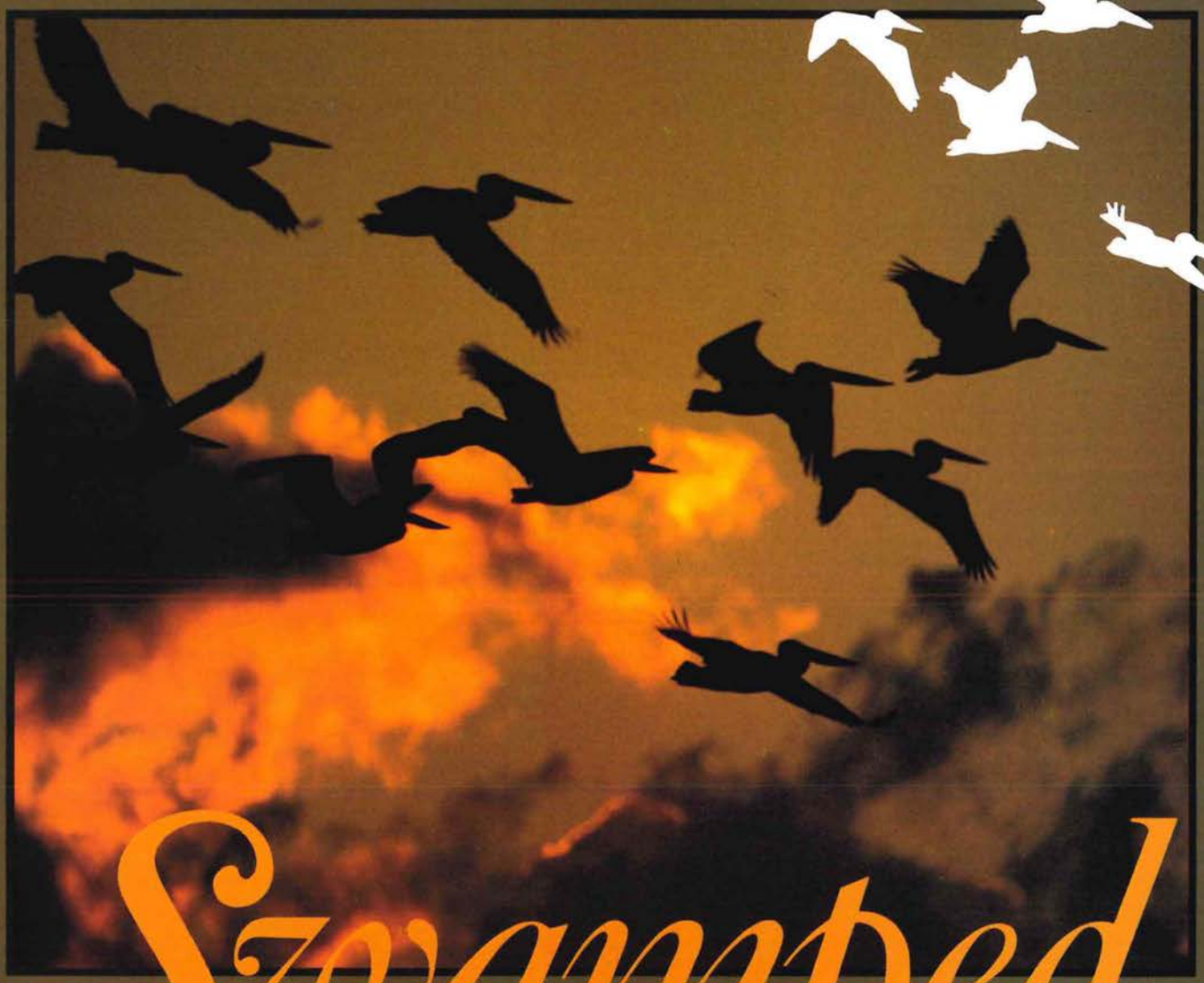
He takes Aboriginal people out to view aerial burning to explain what CALM is doing and why. CALM would also like to involve Aborigines in the tracking of the reintroduced mammals.

Aboriginal people have also been employed over the last few years to search for remnant populations of mammals such as the dalgyte and the black-footed rock wallaby on Aboriginal reserves, vacant Crown land and nature reserves.

Ultimately, it is hoped that this work will halt further extinctions and ensure that currently endangered animal species will populate the deserts of Western Australia for thousands of years to come.

Neil Burrows is a CALM Senior Research Scientist and the co-ordinator of the program to reintroduce endangered mammals to the Gibson Desert. He has also been studying fire behaviour in the desert community. He can be contacted at Como on (09) 367 0333.

Carolyn Thomson is a CALM Communications Officer and *Landscope* Editor. She can be contacted at CALM Public Affairs Branch, (09) 389 8644.



Swamped WITH BIRDS

BY JIM LANE

Waterbirds flock to the Vasse-Wonnerup wetlands in their tens of thousands, giving it one of the highest concentrations of birds in Australia.

MORE than 75 species have so far been recorded, several of them rare. Nesting birds, resting birds, nomadic birds and migrants. Pink-eared, hoary-headed, blue-billed, whiskered, straw-necked, red-kneed, long-toed and spotless. Tattlers, warblers, shovelers, turnstones, knots, rails, hardheads and stints.

The Vasse-Wonnerup wetlands lie on the outskirts of Busselton, 200 kilometres south of Perth. The coastal town is the gateway to one of WA's most popular holiday regions, where people escape the heat of summer to enjoy the rugged coast, sheltered beaches, forests, caves, farmlands and vineyards of the South-West.

The wetlands vary from broad expanses of open water to sheltered bays and inlets. Shorelines are fringed by flooded pastures or native rush and paperbark.

The surrounding pastures are lush green in spring, turning to golden hay in summer. To the south is the last substantial area of tuart forest in the world - only 2 000 hectares. Stately tuarts (*Eucalyptus gomphocephala*) grow to 30 metres or more and are home for parrots and possums, bandicoots and kangaroos. To the north lie low dunes skirted by peppermint and wattle, behind beaches of sand and shell and clear green waters.

Not far from Vasse-Wonnerup is one of the largest ibis breeding colonies in the State. As well as several thousand ibis, there are large numbers of egret, spoonbills, herons and cormorants. Many hundreds of these birds feed around the Vasse-Wonnerup wetlands and adjoining pastures.

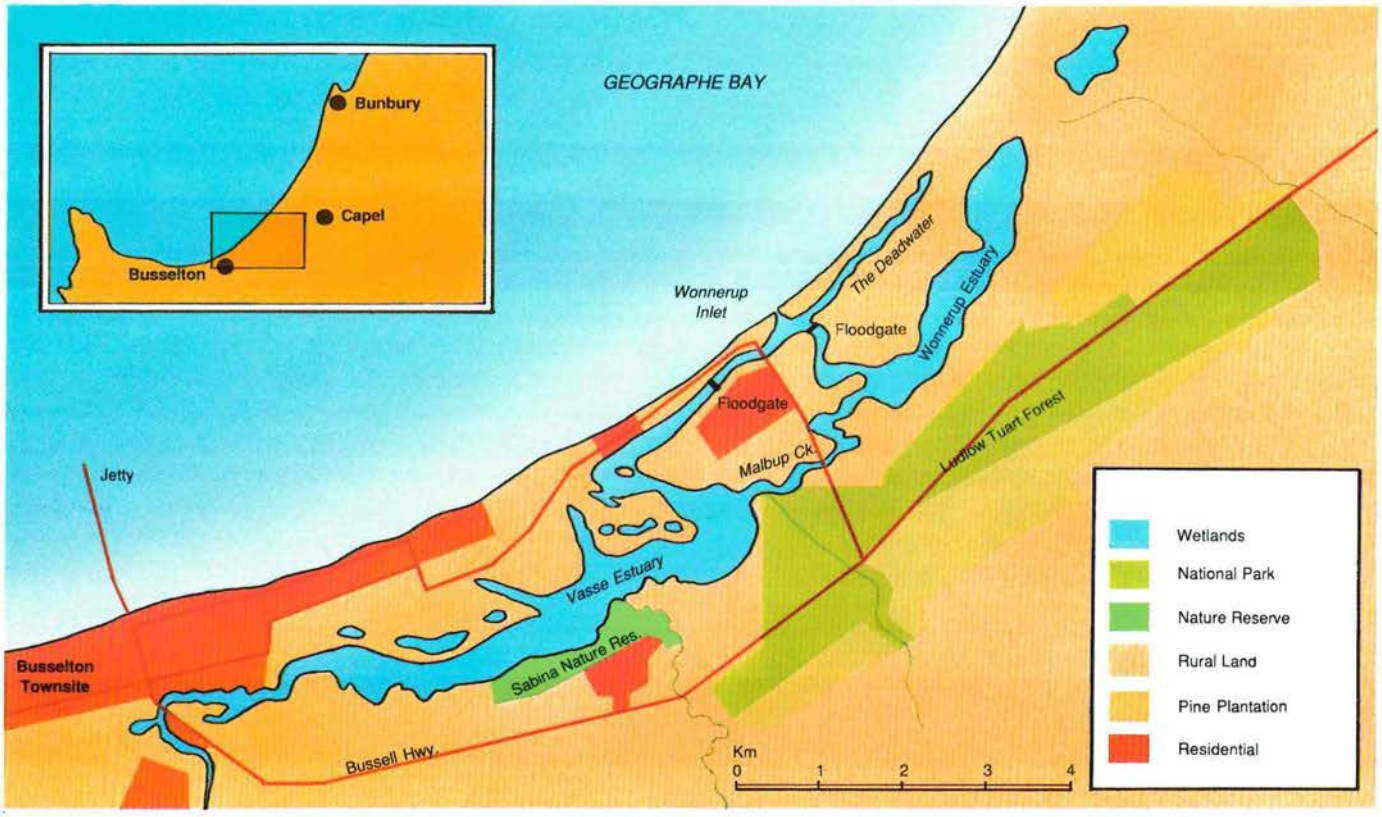
Great Egrets can be seen poised at the water's edge, ready to stab at unwary fish or frogs, or perhaps a newly-hatched tiger snake, of which there is no shortage. Spoonbills wade in shallow waters, sweeping their bills from side to side,

The Vasse-Wonnerup wetlands lie in close proximity to the Busselton townsite. ▲

Black Swans (*Cygnus atratus*) create an island nest to protect their eggs and young from terrestrial predators. ▶

Great Egrets (*Egretta alba*) inhabit the shallow marshes, shallow waters and grassy fringes of Vasse-Wonnerup.
Photos - Cliff Winfield ▶▶

Previous page. Photo - Michael Morcombe



slightly open, sifting invertebrates from the cloudy water.

Dabbling ducks are spread out across the shallows in their thousands. Diving ducks slip quietly beneath murky waters. Brooding ducks are followed by small flotillas of young. "Steaming" ducks power across the water's surface with plumes of spray behind. Coots are omnipresent; pattering feet, whirring wings, harsh shrieks from nearby rushes, bobbing black dots among distant waves.

Transequatorial migratory waders, otherwise unremarkable grey-brown birds of 30 grams or less, make twice-yearly journeys of 10 000 kilometres or more from summer breeding grounds in northern China and Siberia to wintering grounds in South-East Asia, Australia and New Zealand. Sharp-tailed Sandpipers visit in their thousands; so do lesser numbers of Greenshank and Plover. Long-toed Stints, one of the rarest waders to visit Australia, are commonly seen.

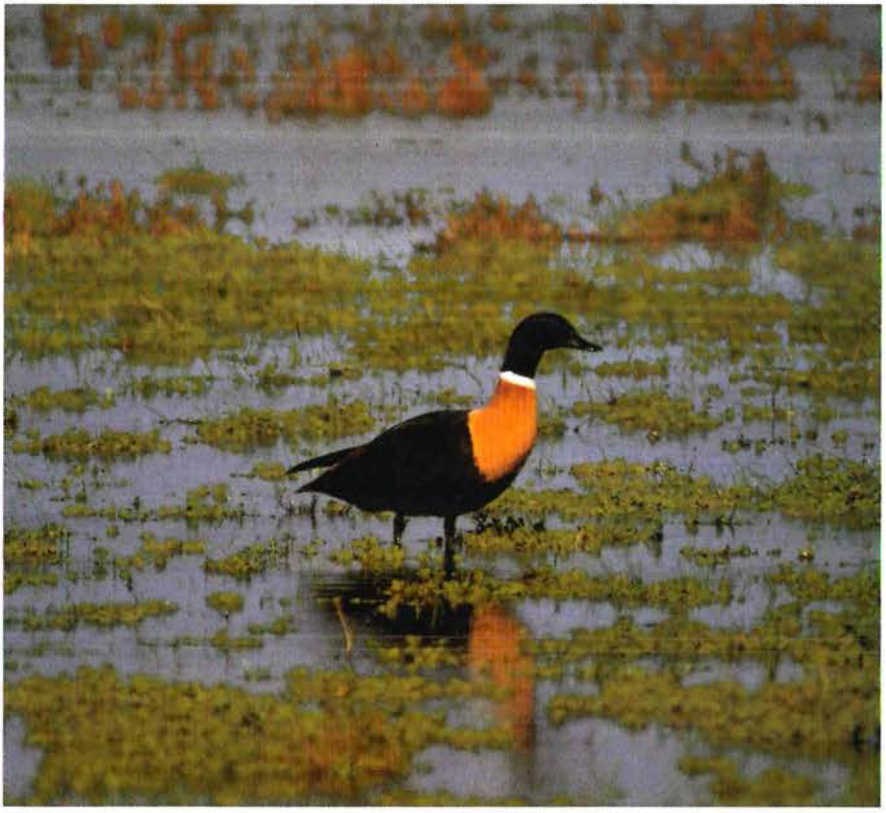
Australian waders - stilts and avocets - congregate in thousands, probing or sweeping the soft muds and shallow waters for their prey. Tightly-packed flocks are scattered around the edges of the wetlands' gently-shelving bays.

Swamp Harriers sweep low over the marshes searching for unwary prey. Whistling Kites circle higher above, on the lookout for rotting fish, or perhaps the remains of a swan or duck fallen victim to a fox the previous night. As harrier, kite, eagle or osprey pass over the shallows and marshes, great flocks of waterbirds may rise in alarm, then settle again as danger passes, to feed, roost or simply loaf.

Secretive crakes and rails and other diminutive types venture cautiously across the mudflats in search of food, darting back to protective rushbeds at the slightest hint of danger.

But it doesn't all happen at once; the wetlands change dramatically with the seasons. The first heavy rains arrive in May or June, at the start of winter. Rivers flow and wetlands begin to fill. The migratory waders have already departed for their arctic breeding grounds. Most of the ducks have also left to breed on nearby swamps or perhaps on inland lakes or dams. Most birds have left. Those that remain do so to breed, or perhaps to winter in the wetlands.

Black Swans are the first to nest. They need to begin quickly if the cygnets are to fly before summer. Last year's nest mounds are repaired and new mounds built as waters rise in June. Each mound



A pair of Pacific Black Ducks (*Anas superciliosa*) on one of the small freshwater ponds in the floodplain that surrounds the estuary.
Photo - Cliff Winfield ▲

Australian Shelduck (*Tadorna tadornoides*) using flooded pasture. More than 10 000 ducks use the Vasse-Wonnerup wetlands each year.
Photo - Cliff Winfield ◀

Waders from Siberia and northern China, pelicans from northern WA, and avocets from lakes in Australia's arid interior migrate to Vasse-Wonnerup each year. Other waterbirds may arrive from Lake Eyre in SA and ducks from throughout the South-West congregate on the coast during summer. ▶

is an island surrounded by shallow waters, secure from terrestrial intruders. Eggs are laid and a 40-day incubation begins.

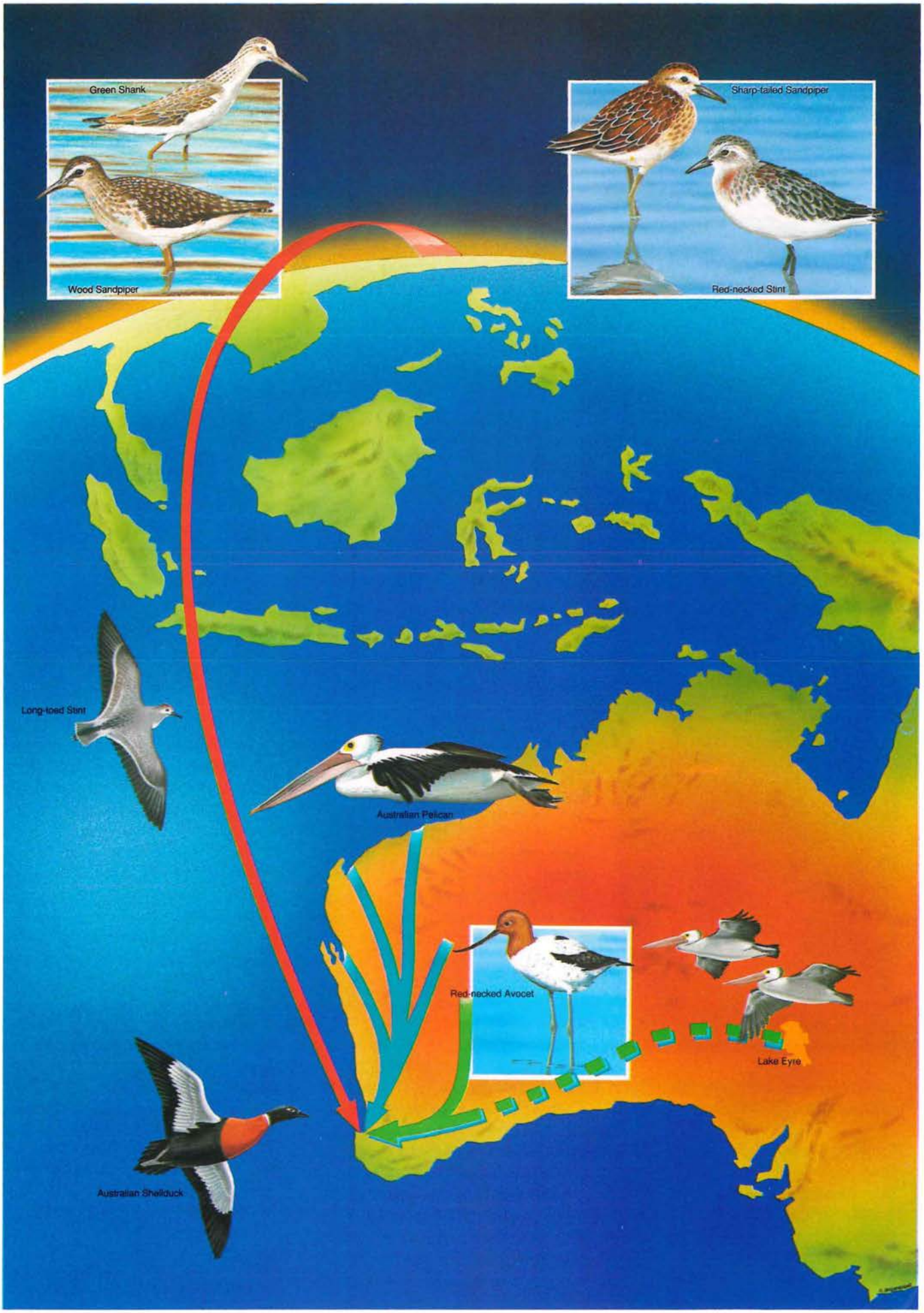
Swans are not the only resident breeders. Ducks also pair in winter and search for suitable nest sites, perhaps a sheltered spot among the pastures or beneath some low-branching shrub, or up a tree in hollow limb or sheltered fork.

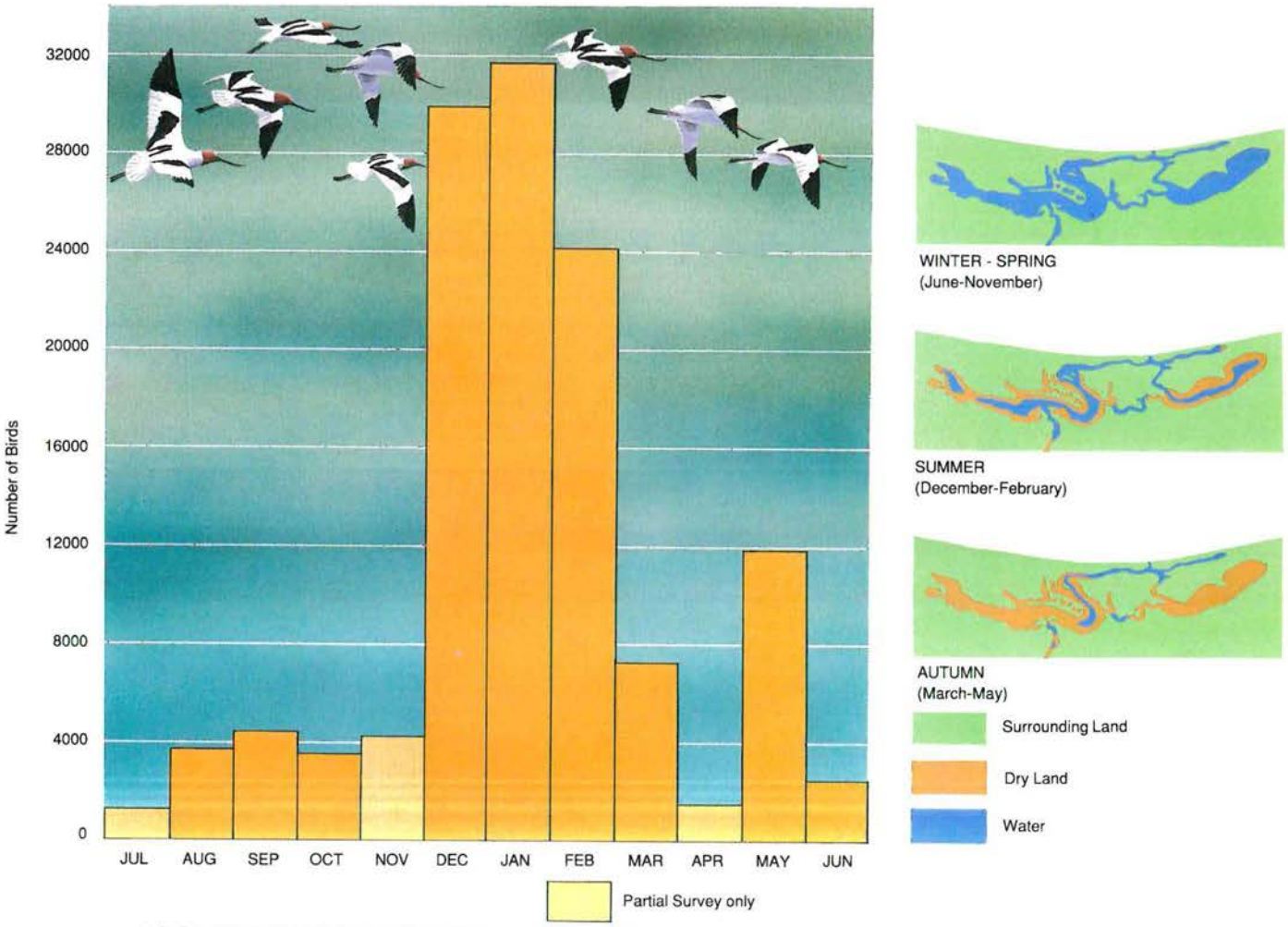
Some non-breeding birds also remain, mainly in small numbers - a few grebes and cormorants, some heron and ibis. Coots are the exception. Large rafts of coot - hundreds or even thousands - remain to ride out the winter storms.

Winter turns to spring. The winter floodwaters of Vasse-Wonnerup reach their peak and begin to ebb. Days lengthen and sunlight, warmth and nutrients fuel aquatic growth. Profuse growth of submerged plants and algae, clouds of aquatic invertebrates and shoals of tiny fish provide food for the many birds that will soon gather.

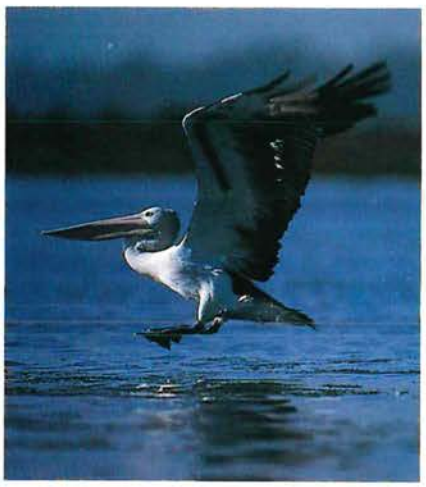
By early spring the swans have completed their lengthy incubation and the cygnets have left their island nests. Family parties - a hundred or more - are now a common sight. As spring progresses they are joined by others from surrounding districts. By November several thousand swans have gathered to feed.

Ducklings also hatch and leave the nest in spring. The fortunate have only a few metres to travel to reach the relative safety of the water's edge. Others may have to journey half a kilometre or more


Green Shank
Wood Sandpiper
Sharp-tailed Sandpiper
Red-necked Stint
Long-toed Stint
Australian Pelican
Red-necked Avocet
Lake Eyre
Australian Shelduck



MONTHLY VARIATION IN NUMBERS OF BIRDS USING THE VASSE-WONNERUP WETLANDS



An Australian Pelican comes in to land at Vasse-Wonnerup. It is one of seven species in the the world.
Photo - Cliff Winfield ◄

across open paddocks to reach the water; a hazardous journey with foxes and ravens about!

Spring dries to summer. The rains have been replaced by hot, dry winds from the east. The nutrient-rich waters slowly shallow and retreat, leaving hundreds of hectares of ankle-deep water and steadily emerging muds that provide a vast smorgasbord for the taking. Waterbirds come in by the thousands; more than 30 000 birds of 60 different species. Twelve thousand teal, 5 000 stilt, 4 000 black duck, coot and avocet. The vast food resources support these birds through December, January and February. Then, as the water recedes, the wetlands' carrying capacity declines and many birds must disperse to other sites.

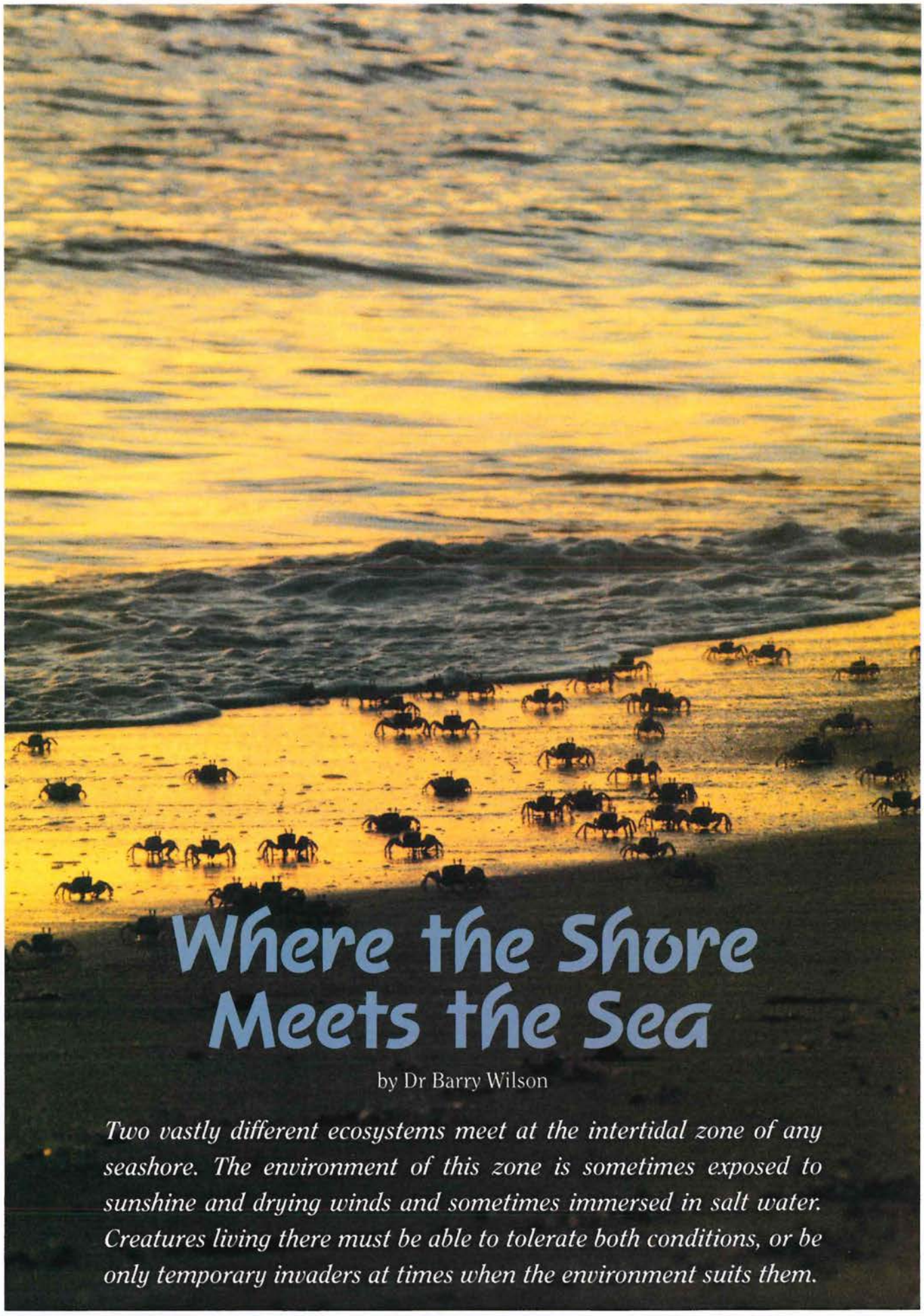
Late summer turns to autumn and there is still no rain to speak of. The Wonnerup is dry and so is much of the Vasse. The waters are at their lowest ebb. There are fewer birds now, though by no means all have left. A flock of 300 pelicans *en route* to northern breeding grounds has stopped over to feast with heron or egret on schools of stranded fish. A thousand shelduck sift organic ooze in the shallows. Most swans have moved to more permanent waters, though perhaps a few hundred remain.

By mid-autumn the migrants have left, heading north along the coast to Exmouth or Broome, where they make a brief stop to wait for favourable winds and then move on through Asia to the USSR. For Vasse-Wonnerup the cycle is completed. The days shorten. Rain clouds gather and winter approaches.

What does the future hold? For generations agriculture has fashioned this landscape. Now, with urban expansion and coastal development, rural tranquillity can no longer be assured.

It is important to secure the future of these productive wetlands and protect them from encroachment. With sound planning and skilled management, Vasse-Wonnerup could become one of Australia's best-known and most impressive wetland conservation areas.⊡

Jim Lane is a Principal Research Scientist at CALM's Wildlife Research Centre at Woodvale (phone (09) 405 5100). He has worked on waterbird and wetland management and research for 16 years.



Where the Shore Meets the Sea

by Dr Barry Wilson

Two vastly different ecosystems meet at the intertidal zone of any seashore. The environment of this zone is sometimes exposed to sunshine and drying winds and sometimes immersed in salt water. Creatures living there must be able to tolerate both conditions, or be only temporary invaders at times when the environment suits them.

PREDATORY and carnivorous fish from the sea invade the intertidal zone at high tide. Predatory, or simply curious, *Homo sapiens* can invade it from the land at low tide and enjoy one of the most fascinating places on the earth's surface.

Take the intertidal sand-flats of Shark Bay. In the early morning when the tide is out, the sea air is cool and crisp. In the periods of low spring tides, wide yellow sand-flats, gently rippled by retreating waves, are left bare as far out as the seagrass meadows and you can walk there with dry feet.

The seemingly inanimate sand-flat may contain vast quantities of living creatures. On a tidal sand-flat at the tip of Peron Peninsula one early morning in December, orange-red cliffs behind us, my friends and I came across a colony of the stromb shell *(Strombus campbelli)* during a mass spawning orgy. These odd little molluscs have two eyes on long, flexible stalks, one longer than the other. The edge of the shell lip has a notch in it so that the eye-stalks can be held aloft while the animal is face down in the sand. One wonders what strange perceptions of the air-world they must receive through these two visual organs which can see in two directions at once.

Mating pairs were scattered all over the sand, the male strombs with enormous muscular penises on the right side of their heads. Some time after mating, a few days most likely, the females lay their egg-masses: long strings of jelly, wound tightly back and forth into oblong blobs three or four centimetres long, left partly buried in the wet sand.

There are tens of thousands of tiny eggs embedded in each jelly string. They become multi-cellular and grow, turn into larvae within a few days, and eventually escape from the jelly and swim away to join the ocean plankton. Later, when they have grown a shell, they find another sand-flat and settle back to the bottom. How they find a suitable habitat after drifting about in the ocean for so long is unknown. How they find a mate is also a mystery, but that, at least, is probably a matter of chemistry.

Adult strombs on the sand-flats feed on the minute particles of organic matter derived from the seagrass meadows further out on the edge of the flats. They gather it up with stout snouts which function like vacuum cleaners. They crawl about in their hundreds, leaving jerky tracks where they dragged their shells across the sand.

Two local children, David and Richard Pollock, explore the Shark Bay sand-flats at low tide.
Photo - Barry Wilson ▲▲

Stromb shells *(Strombus campbelli)* with an egg mass.
Photo - Barry Wilson ▲

The proposed Shark Bay Marine Park and Peron National Park will protect the shoreline habitats of Peron Peninsula.
Photo - Jiri Lochman ▼

Previous page. Photo - Patrick Baker

The two snorkel-like siphons of this burrowing bivalve channel oxygen and food-bearing water through the gills.
Photo - Barry Wilson▲

Spiny heart urchins (*Echinocardium* sp.) can give curious naturalists a painful surprise.
Photo - Barry Wilson ◀

The slender, pointed creeper shells *(Cerithium vertagus)* also crawl about on the sand gathering particles of decayed matter for food, but they protect themselves from drying out in the air by burrowing under the surface. As they move about they leave thick tracks that look as though someone has aimlessly drawn lines in the sand.

Tracks in the sand at low tide are fascinating. After a while you can recognise which animal has made them even though the maker is buried and invisible. Slender olive shells (*Oliva australis*), which prey on worms, crawl in straight or curved lines as if they have some direction in life, while the globose sand snails, *(Polinices conicus)* seem utterly confused about their mission and their trails criss-cross in a seemingly aimless tangle. These voracious gastropods eat bivalves, which they kill by drilling small holes in the shell. Like everywhere else, sand-flats are a world of struggle and savagery.

Another predatory mollusc on the Shark Bay flats is the volute *(Cymbiola nivosa)*. These creatures have a large patterned and coloured body and a beautiful shell. They crawl about on the surface of the sand when hunting but otherwise lie buried below the surface. At low tide they can be completely invisible, but begin to pop up just before the tide turns to cover the flats. First lumps and then tell-tale cracks appear.

But the inexperienced naturalist can make a terrible mistake if he or she digs into these lumps expecting to find a volute. The spiny heart-urchin, *(Echinocardium* sp.*)* makes a very similar lump as it emerges from the sand, and prying fingers can get a painful surprise.

Bivalves are perhaps the most abundant burrowing molluscs on the Shark Bay sand-flats. There are many kinds, some present in vast numbers. Walking over the flat you may hardly be aware of their presence, as they close shop at low tide and most show no visible sign on the surface of the sand. But when the tidal waters cover the flats the bivalves move close to the surface, spread their valves apart a little and extend their siphon tubes. One siphon sucks water into the body cavity and through the gills; the other is the exhaust chimney through which water and wastes are ejected.

Most bivalves feed on plankton, bacteria or organic particles floating in the water. The gills extract oxygen and minute food particles from the water as it passes through, turning ocean energy into flesh and blood.

While the molluscs are the most obvious creatures of the sand-flat, micro-organisms, minute worms, crustaceans and bacteria are also present in uncountable billions. The sand is alive!

This, of course, is the reason for the predatory invaders. We were not the only air-breathers present during our low-tide venture onto the Peron flats. Several kinds of sea-birds were also there for the pickings. They pecked about for their preferred prey, leaving tell-tale marks on the sand - evidence of the tastes and behaviour peculiar to each bird.

And I must mention those vicious clowns of the shoreline, the ghost crabs *(Ocypode convexa)*. In the midday heat these ungainly animals live in deep burrows on the upper part of the beach. They block the entrance with sand and seaweed to prevent themselves drying out. At night they come out and scuttle about, clicking and clacking, all 10 legs more or less working in synchrony, and scavenge far up into the dunes. Many a camper in these parts has woken in terror at the strange noises made by ghost crabs. On the early morning low tide the crabs scavenge out onto the sand-flats, sometimes dragging edible debris home to their burrows.

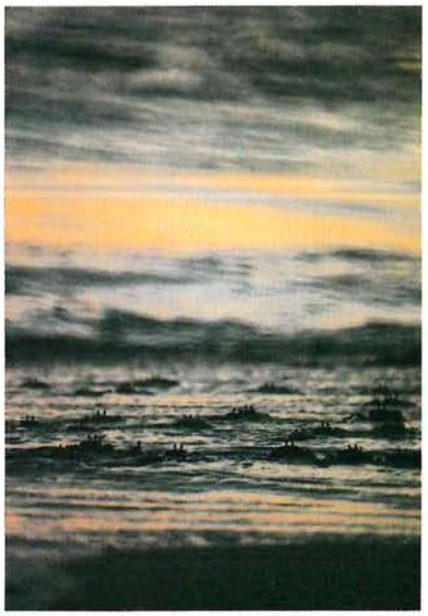
When the tide turns and the sea again floods over the flats, ocean invaders come to harvest the rich resources of the intertidal zone. We watched schools of mullet and whiting swimming along the edge of the advancing water, snuffling in the sand for their breakfast.

Later, with masks and snorkels, we swam over the flats where we had walked, and were thrilled by a school of great trevally, 20 and 30 pounders, which had rushed in to see what was new. Perhaps the greatest thrill while we snorkelled was to meet a two-metre-long shovel-nosed shark quietly gliding into the

shallows. These creatures use their long noses to shovel in the sand and dig out the bivalves, which they crush with thick bony jaw-plates. At low tide, impressions of these monstrous predators' bodies, where they have lain in the sand making their meal, can be seen on the flats.

The fish, sharks and other sea invaders have the best of the intertidal flats. Curious human visitors have only an hour or so to explore at low tide, before the sea returns and closes another daily chapter in the book of natural history. ⊡

Dr Barry Wilson is a marine biologist and CALM's Director of Nature Conservation. He can be contacted at CALM's Policy Directorate on (09) 386 8811.



Bar-tailed Godwits are migratory waders which feed on the tiny sand-flat creatures at low tide.
Photo - Michael Morcombe▲▲

The naturalist retreats from the advancing tide.
Photo - Barry Wilson◀

Ghost crabs scuttle to safety in the rising water.
Photo - Patrick Baker▲

ENDANGERED!

OCEAN FERN

An unusual fern was recently rediscovered on a remote island off the south coast of Western Australia - the only place in the State where it is found.

The thick, glossy dark-green leaves of shore spleenwort (*Asplenium obtusatum*) grow to 50 centimetres long and have a plastic appearance.

The fern has a scattered distribution along temperate and sub-Antarctic coasts of the southern hemisphere. It inhabits exposed maritime cliffs, where it grows in shallow peaty soil in pockets of granite-gneiss rock about 100 to 200 metres above the sea.

Shore spleenwort was first recorded in Western Australia in 1866 on Breaksea Island, where it is now thought to be extinct, probably due to grazing by rabbits introduced when the island was a lighthouse post.

However, the fern is widespread in New South Wales, Victoria and Tasmania.

The fern has not been recorded in Western Australia since 1975. An

attempt to search for it in late spring, 1988, had to be cancelled because of adverse weather, but in early November 1989 a small team of CALM officers left for the remote island off the south coast.

The island is mostly exposed granite rock, soaring high above sea level. Its sheer southern face plummets into the Southern Ocean. At the time of the survey, the gently sloping north-eastern and eastern faces were ablaze with wildflowers.

An inflatable dinghy was used to circumnavigate the island to select the area where we were most likely to find the fern: a deep ravine or valley permanently exposed to the lashing of salt-laden winds and weather extremes.

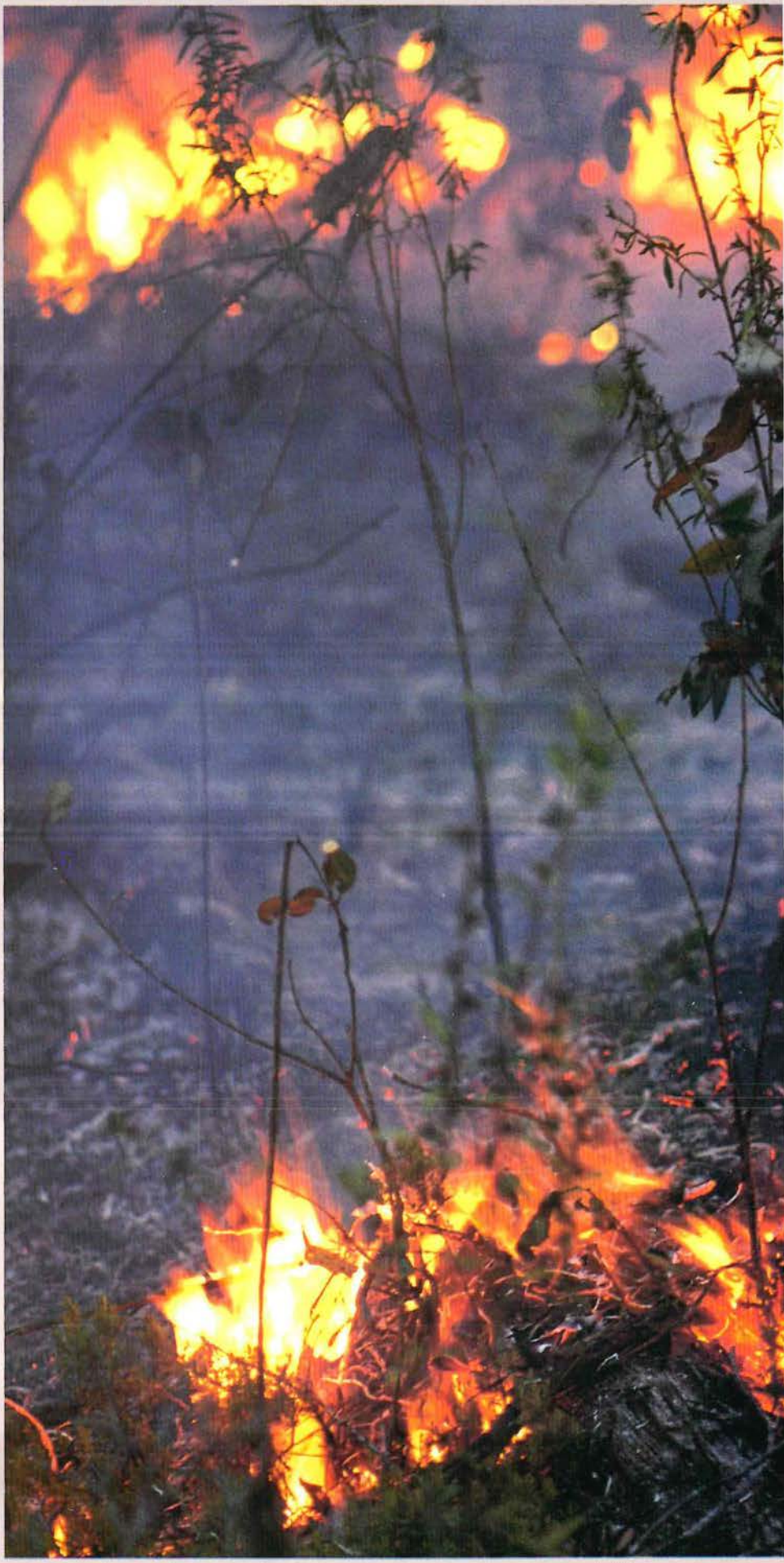
On the first afternoon, Wildlife Officer Ray Smith and I pushed our way down to the valley in failing light. Ray located the first plant 100 metres above sea level.

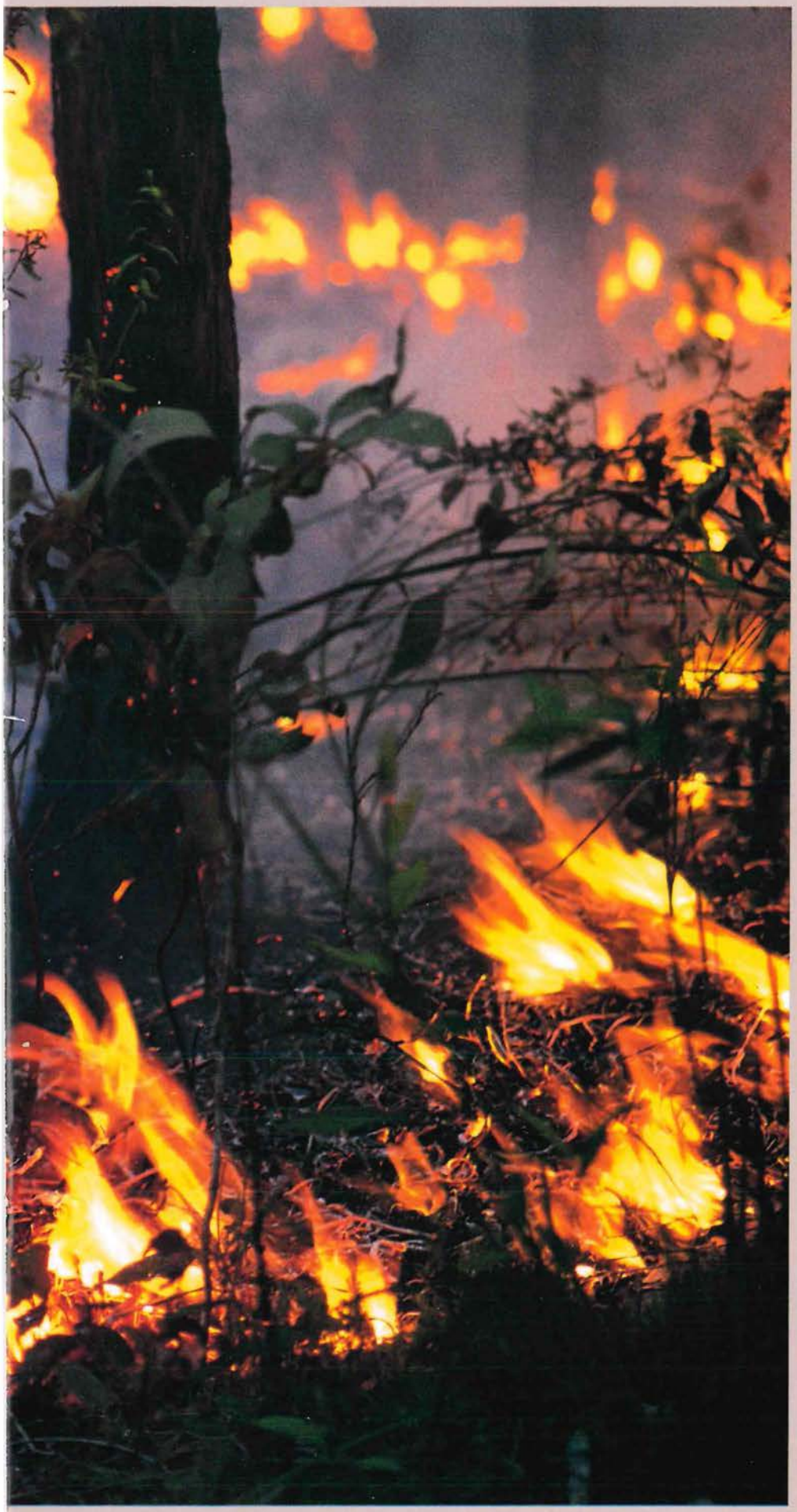
We discovered more populations of the fern at a lower level under huge granite overhangs in the humid, densely vegetated ravine. Clumps of vigorously growing fern were arranged in a 'Japanese garden' of moss-covered rocks and crystal-clear pools.

Shore spleenwort is one of five *Asplenium* species in Western Australia.

Peter Lambert

SEASONED WITH FIRE





by Neil Burrows

Over the summer months in the southern half of Western Australia, bushfires rage through thousands of hectares of natural land. But fire cannot be allowed to run wild. Wildfires can destroy homes, buildings, fences, crops, stock and timber and endanger human life. The Department of Conservation and Land Management (CALM) has a prescribed burning program to reduce fuels in forests and prevent large, intense wildfires. However, the practice is controversial. There is concern that fuel reduction burning has adverse environmental effects. What is the real impact of such fires on the natural environment?

IN the wake of a bushfire the landscape is left blackened and seemingly lifeless. But before long, green shoots appear. The zamia palm is first to resprout, from rootstock buried in the soil and shielded from the heat. Seedlings emerge, plants sprout new leaves, life returns.

This is not the first time the bush has been burnt and it will not be the last. Over thousands of years, plants and animals evolved traits to help them survive in our fiery climate. Before European settlement, fires were started by lightning or by Nyungar hunters and gatherers. Today, lightning fires still regularly occur, but most fires are started by people, either deliberately or accidentally. Unlike the bush, towns and farms cannot adapt to survive the flames and they must be protected against large and intense wildfires. Even remnant bushland is threatened; introduced grasses and other weeds, quick to seize an opportunity, invade natural bush after fire. Outside the forest zone, large, intense wildfires could also threaten the future of rare or endangered animals, such as the Ground Parrot and Noisy Scrub-bird, which require long-unburnt vegetation.

Ironically, the most effective tool to minimise the effects of forest fires is fire itself. Not the type of fire which burns under hot, dry and windy conditions, when flames roar from the tree tops, and consume every leaf and twig. Not the kind of fire which spreads rapidly, preventing any chance of control. Rather, it is the type of fire which burns under cool, humid conditions, when flames trickle through the undergrowth at knee height, slowly consuming dead leaves and twigs that have accumulated on the forest floor. Such a fire can only be set after the opening rains in autumn or at the end of the rains in spring. Setting this type of fire every five to seven years, a practice known as fuel reduction burning, has successfully reduced destruction from bushfires. In the 30 or so years since fuel reduction burning was introduced to WA forests, no major bushfires have occurred.

However, fuel reduction burning is the subject of fierce debate. Some people believe that fuel reduction burning in spring adversely affects wildflowers and breeding animals, such as birds, and that late summer or early autumn is a better time to burn. Some argue that any form of burning is environmentally damaging. Others claim that the bush should be burnt more regularly.

The effects of fire on the ecology of WA forests have been studied for over 30 years. So far the results have shown that the effects of fire are very variable, and depend on the fire regime which applies. The 'fire regime' amounts to the cumulative effects of the interval between fires, their intensity (how hot the fires have been), the season during which they burn and their size. Forest ecosystems can persist and thrive under a wide range of fire regimes, although some plant and animal species are favoured by regimes which may not suit others. To compare the complex ecological effects of spring versus autumn fires concentrates on only one element of a fire regime (the season of burning), and ignores other factors such as fire intensity and frequency.

The most important difference between spring and autumn fires is the amount of live and dead vegetation (fuel) consumed by the fire. The amount of fuel burnt by a fire largely depends on fuel moisture content. In spring, following winter rains, logs, leaves, twigs, soil and living vegetation are damp. In summer and early autumn the entire forest is much drier, and fires burn more intensely and spread more rapidly.

Flames in a typical prescribed spring fire are usually about half to one metre high, whereas, in autumn, flames are often two or three times this height. Flame height is a useful estimate of fire

Previous page.
Prescribed burning is done on a five to seven year cycle, depending on the fire hazard in each area.
Photo - Jiri Lochman

The nesting activities of some species of birds may be disturbed by spring burning, but within two years they begin to recolonise the regenerating vegetation.
Photo - Graeme Liddelow◀

Wildfires such as this are easier to fight, and also cause less damage, where fuels are reduced by prescribed burning.
Photo - Neil Burrows▼

intensity, which is a measure of the heat energy output of a fire. The taller the flames, the more intense the fire.

The most striking visual difference between a forest burnt in spring and a forest burnt in autumn is the colour of the vegetation. Soon after a low intensity spring burn, the understorey is a mottled green and brown colour. The brown leaves are those killed by the heat of the flames. After a summer or autumn fire, almost the entire forest is black and brown, indicating that all leaves have been killed, from the low shrubs to the tops of the jarrah trees. The vegetation soon regenerates, but fires which completely scorch the forest can physically damage the boles and canopies of trees, especially the smaller ones. Scorched eucalypt leaves are more rapidly replaced after spring than after autumn burns.

The dry forest fuels in autumn result in fires which burn almost the entire forest. It is rare to find unburnt patches. In spring, however, moister areas such as swamps, and along creeks and gullies, rarely burn. Surveys have shown that about 20 per cent of a forest ignited under spring conditions does not burn. These unburnt patches and gullies are important animal habitat and provide refuge areas from which animals can recolonise the burnt forest when vegetation regenerates. Autumn burns tend to burn more hollow logs, used by many native mammals for nests and burrows, than spring burns.

Wildflowers are at their peak during spring. About 70 per cent of plant species flower over the late winter and spring period. A spring fire inevitably destroys a high proportion of flowers and the foliage of low understorey plants, detracting from the beauty of the forest. It also reduces the food base for insects and other animals which feed on flowers and seeds. Autumn fires have a similar impact on species which flower at that time.

Scientific data about the effects of spring and autumn fire on insects and other invertebrates are inconclusive. Some researchers have reported that autumn burning may have less impact on the soil and on litter invertebrates than spring burning. Others have shown that there is no significant difference between litter fauna in forests which have been burnt regularly in spring and forests which have been long unburnt. Clearly, more research is needed.

Each year CALM firefighters battle some 400 wildfires throughout the jarrah forest.
Photo - Neil Burrows ▲

Cats paw is one of many wildflowers of the jarrah forest which regenerate quickly after fire.
Photo - Marie Lochman ▶

In forests which receive little effective summer rainfall (such as the northern jarrah forest), repeated frequent spring burning over many decades causes a gradual depletion of a group of woody plants, known as seeders. These depend on seed stored in the soil or in woody fruits on the plants for regeneration after fire. Plants such as prickly moses (*Acacia pulchella*) and heartleaf poison (*Gastrolobium bilobum*) form dense thickets after summer or early autumn wildfires, but regenerate poorly after low intensity spring fires. This is because the seeds buried in the soil germinate more successfully when heated, and fires which burn when the fuel and soil are dry (in summer or early autumn) heat the soil more than fires which burn in spring, when fuels and soils are damp. Seeds which germinate after the opening winter rains also have the moist winter months to become established, while many of the seedlings which germinate after a spring fire often die over the hot summer months. (This is not a problem in areas which receive summer rain and which have a longer growing period, such as the karri and southern jarrah forests.) Almost all seeders in the jarrah forest understorey reach flowering age by five years, so burning does not occur before they flower.

However, even repeated spring burning will not eliminate soil-stored seed. Seeds deep in the soil can last up to 100 years and these are germinated by occasional summer bushfires or an autumn burn.

Understorey plants in the forest zone which resprout from below ground appear to be unaffected either by spring or autumn fires at intervals of five to seven years. On some sites, in fact, species such as honey bush (*Hakea lissocarpha*) and tea-tree (*Agonis parviceps*) increase in numbers after spring fires, at the expense of the seeders.

Fire affects mammal species according to the amount of habitat disturbance and the rate at which vegetation regenerates. Autumn fires burn all of the forest litter, and kill or scorch the understorey, so have a greater short-term impact on mammals than spring fires, as they depend on the litter and understorey for food and shelter. At least one important forest

mammal, the chuditch, is clearly favoured more by spring than by autumn fires.

On the other hand, lack of fire can be disastrous for some mammals. For example, the endangered mainland tammar wallaby lives in dense *Melaleuca viminea* thickets which require infrequent (25 to 30 years) and intense fires in summer or early autumn to regenerate. Burning is being conducted during dry soil conditions in autumn to regenerate *Melaleuca* thickets which occur in broad valleys in the eastern forests. When these thickets have regenerated then the endangered tammar wallaby will be reintroduced from populations in the forest east of Manjimup.

Birds are also affected to the extent that a fire disturbs their habitat. This varies according to the requirements of each species; birds which use the forest floor and low understorey are most affected by spring fires. While spring fires may coincide with nesting, studies have shown that, in the jarrah forest, most birds have finished breeding by the time prescribed burning commences. There is some mortality among nestlings, especially in species which nest on or near the ground. Many birds are completely unaffected by spring burns, because they survive in unburnt patches. Elsewhere, bird numbers decline in the first two years after a spring fire, but they then increase. Birds are highly mobile and can recolonise burnt areas from surrounding unburnt forest, as soon as the habitat is suitable.

Autumn fires, which defoliate the understorey and scorch the overstorey, cause great initial disturbance to habitat and to birds and animals. However, the effects of both spring and autumn fires are relatively short-lived as the vegetation regenerates quickly. Fuel reduction burning is conducted in blocks of around 2 000 to 3 000 hectares scattered throughout the forest, so recently burnt areas are surrounded by forest that may not have been burnt for several years. This allows recolonisation from unburnt patches.

A large, uncontrolled bushfire causes much more disturbance to birds and other animals than does patch prescribed burning. Wildfires can spread rapidly and consume all live and dead vegetation over thousands of hectares. Many animals, including birds, kangaroos and possums, are unable to escape the flames and smoke. Animals that survive are exposed to predators and often die from famine.

The choice between a spring burn and an autumn burn is often determined by what is practical. Of the 200 000 hectares of State forest on which prescribed burning is carried out each year, up to 25 per cent is burnt in autumn. The proportion varies from year to year, depending on weather conditions. Most fuel reduction burning is carried out in spring and early summer, because there are more days when fuels are moist and the weather is mild and predictable. This results in fires of low intensity, which can be easily and cheaply controlled. There are few suitable days in autumn during which forest burning can be safely carried out. Dry fuels and the often unstable weather conditions in autumn increase the risk of fires escaping or causing undesirable damage. Autumn fires are more costly, as much more effort is required to prepare areas for burning and to mop up smouldering logs after burning.

There are both positive and negative ecological aspects of spring and autumn burning. In most forests, the ideal fire regime, one which results in minimal impact and damage caused by wildfires and one which caters for the natural environment, is a combination of spring and autumn burning.

For many years, CALM has been progressively increasing the area of forest burnt in autumn, and implementing a burning cycle that incorporates a mixture of spring and autumn burning. A more systematic approach is now being developed. For example, a forest would be given two spring burns, then an autumn burn, at five to seven year intervals. Then a 10 to 14 year period would elapse before the cycle was recommenced, with

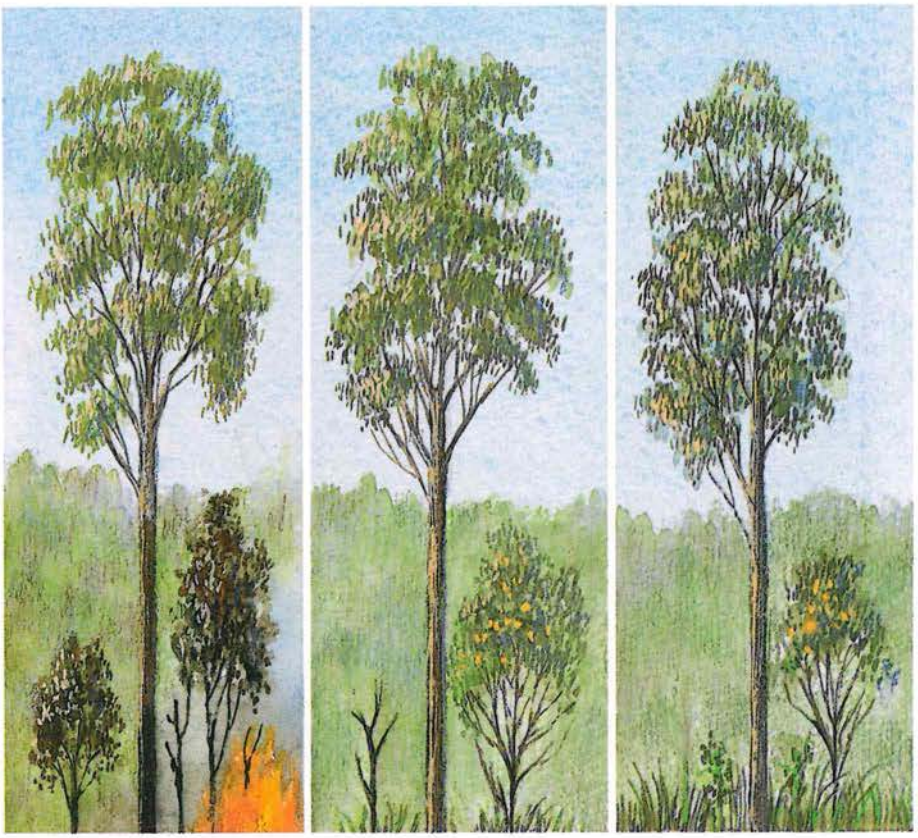
Top to bottom: long unburnt bush, where short-lived seeders have died out; five months after an autumn fire in the same location the vegetation is resprouting and the heat from the fire has cracked the hard-coated *Acacia* seeds buried deep in the soil; one year after the fire regeneration is well under way; two years after the fire the seeders are over a metre high and dominate the site; after three years the acacias are full-grown and flowering.
Photos - Neil Burrows

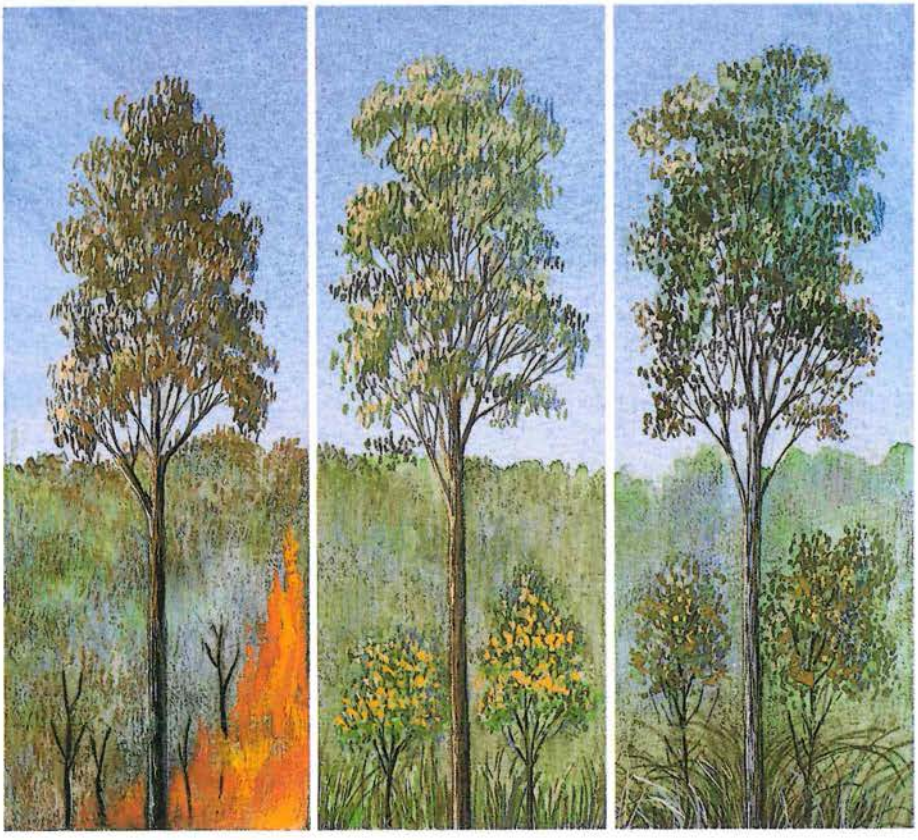
Western grey kangaroos prefer recently burnt bush, as they can graze on the new shoots which germinate after fire.
Photo - Jiri Lochman▲

another fuel reduction burn in spring. The extended period between burns would allow seed stored in the soil to replenish, and provide a range of vegetation ages throughout the forest. This cycle will help to regenerate seeders, such as certain *Acacia* species (which help to fix nitrogen in the soil and may inhibit the spread of dieback) and species important for tammar habitat (such as *Melaleuca viminea*). This forest fire regime would help protect both human and conservation values.

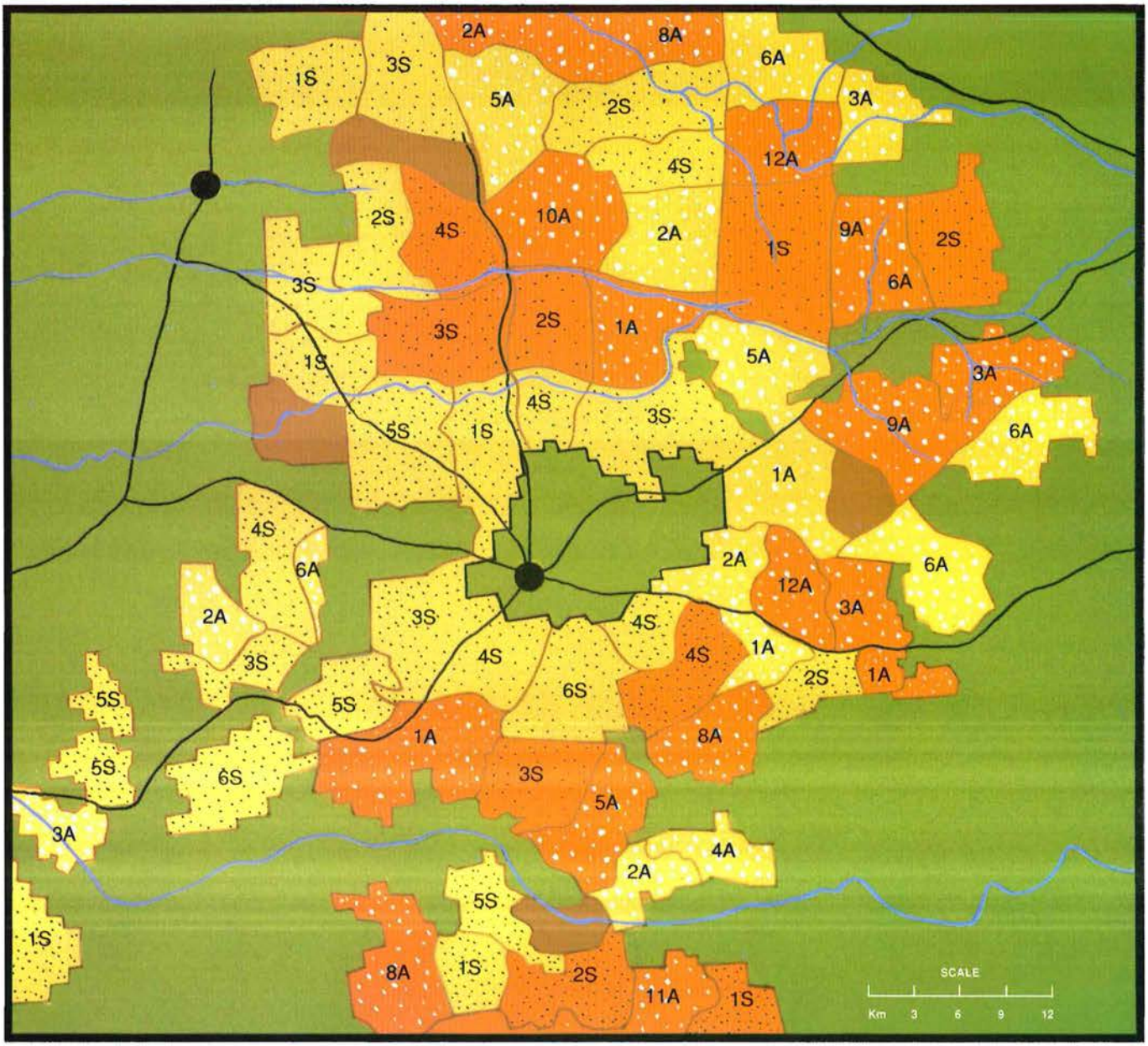
Such a regime would focus on areas where regeneration of seed species and habitat is most necessary. Generally, this applies to the jarrah forest north of a line from Busselton to Albany. However, it would not be practical in all areas. Because of the threat to human life and property, extended burning rotations cannot be applied to forest areas around townships and areas considered essential to break up the run of potential wildfires through large, forested zones.

Fire management on natural lands is an evolutionary process, influenced by social attitudes, scientific knowledge and resources available to managers. Fire, whether it is in spring or autumn, frequent or infrequent, will affect the forest ecosystem in complex and subtle ways. CALM scientists are continually monitoring and studying the effects of fire in burnt and long-unburnt forests. They have found no evidence of any wildlife threatened with extinction as a result of the forest fire management methods currently being applied. Although thickets of seed species can gradually degenerate as a result of either long absence of fire or repeated and frequent spring fires, they can be easily regenerated by a fire





Flame height is about two and a half times higher in an autumn burn and scorching is much more extensive. However, seeders such as some *Acacia* species regenerate much more vigorously after an autumn burn, then begin to die off after about 10 years.



Areas which can be placed on a rotation burning cycle (two spring burns, then an autumn burn).

Strategic buffers to protect towns from wildfire and prevent major wildfires.

A Last burnt in autumn

S Last burnt in spring

No.= years since last burn

Unburnt

Farmland

Forest tracks or firebreaks

Towns

An example of a burning regime that incorporates a mixture of spring and autumn burning and buffers against wildfires. It includes areas of forest that have been recently burnt, areas that have not been burnt for 12 to 14 years and areas that will not be burnt at all.▲

set when soils are dry in autumn. It seems that a diverse fire regime, incorporating fires in different seasons and at varying time intervals, is most appropriate today. Continuing research and field experience will help to refine the methods used.

It is an axiom of land management that the first step to managing land is to protect it. Frequent wildfires can damage human and conservation values in the natural environment. The challenge is to control wildfires while maintaining the ecological integrity of our unique bushland.▣

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FURTHER READING LIST

Fire ecology is a particularly complex issue, the intricacies of which are difficult to explain in a short article. The following reading list is recommended for those who want to follow up the issue further:

Impact of fire in the eucalypt forest ecosystem of southern Western Australia: a critical review, by Per Christensen and Ian Abbott (a technical paper available free from CALM's Como Office).

Effect of prescribed burning on the flora and fauna of south-west Australian forests, by Per Christensen and Peter Kimber (also available from the CALM office in Como).

Fire and the Australian Biota, edited by A.M. Gill, R.H. Groves and I.R. Noble.

Trappings of Success

Ecological research on the population dynamics of rock-wallabies has revealed that the fox is a major threat to marsupials. The ability to trap rock-wallabies was the key to this discovery, and this was made possible by a new trap designed by CALM's Bob Bromilow. Jack Kinnear describes these engaging escape-artists and provides an encouraging update to the fox problem.

IN 1978 in the central wheatbelt, Technical Officer Mike Onus and I commenced a survey of the last surviving populations of rock-wallabies in the South-West. We systematically inspected almost every nook and cranny for signs of rock-wallabies. We failed to find any traces of one population, another was nearly extinct, and the remainder had suffered a massive population decline

We had no clue as to what was wrong; only a daunting list of possible reasons: habitat damage, human disturbance, habitat fragmentation, drought, malnutrition, too many wildfires, not enough wildfires, viral infections, bacterial diseases, parasites, genetic deterioration due to inbreeding, foxes, feral cats, competition from rabbits - take your pick! After eight years and the addition of a new member to our team, Bob Bromilow, our evidence singled out the fox as the major reason for the decline of the rock-wallabies and for their dangerously low numbers

This research generated shock waves throughout the Australian conservation community, though it hardly surprised scientist Per Christensen. In a 1980 article in *Forest Focus* entitled 'A Sad Day for the Fauna', Per presented evidence which implied that the fox was a devastating destroyer of our unique marsupial fauna. He felt that the fox was one of the most pressing problems in Australian wildlife conservation. I concur with Per except for one small point. When the European fox was introduced into Australia, it was more than a sad day; it was a day that marked the beginning of a wildlife tragedy that is still going on today.

We confirmed Christensen's hypothesis through a simple experiment. We reasoned that if foxes were responsible for the decline of rock-wallabies then fox control should reverse the situation. This proved to be so. Under fox control the rock-wallabies increased. Moreover, they failed to increase significantly wherever we made no effort to control the fox.

Yet while the experiment was conceptually simple, it was by no means an easy task to carry out. At one stage, we almost abandoned the project. The reason? We could not reliably trap the rock-wallabies and it was absolutely essential that we be able to do so! Fortunately, Bob Bromilow joined us at this critical moment and quickly retrieved the situation.

Rock-wallabies, well adapted to life on rock-piles, became accomplished escape-artists, able to squeeze through a tiny hole in the roof of one of the early traps used by researchers, after eating the delicious apple set as bait.
Photo - Jiri Lochman▲

RARE AND ENDANGERED: SPECIES IN RECEIVERSHIP

Why do species end up endangered? This is a difficult question that can be best answered in very technical and mathematical ways. Perhaps the best explanation is to look at life as a business, with a species being in the survival business. Within a natural community, successful species stay in business because, in the long run, they retain their capacity to keep their numbers up. Endangered species are like businesses which lose their share of the market and hence decline.

Every business has assets which are normally used to produce profits, given good management and a favourable business climate. The comparable assets of species are the number of individuals (the mums and dads) in a population contributing to the production of young. Profit is generated when the offspring survive to breed, and this is reflected in population growth. Unprofitable species show no population growth even when times are good, and therefore become endangered; a situation which is similar to a business existing on the verge of bankruptcy.

Conservation ecologists may be compared to accountants called in to investigate the affairs of a business placed in receivership. Such experts examine the books in order to find out what went wrong. This is not possible when one investigates the ecology of an endangered species. The only thing an ecologist can do is to study the animals themselves. By

doing this, it may be possible to create a set of books which reveal how an endangered species is going about, and apparently failing in, its business of survival.

POPULATION ECOLOGY - BEAN COUNTING IN THE BUSH

Accountants are sometimes uncharitably referred to as bean counters. In ecology the equivalent is the population ecologist. Population ecologists deal with numbers, profit and loss to try to explain why populations increase or decrease. They collect vital statistics of populations - things like birth rates, death rates and the life-spans or survival times of animals and plants. They like to know the age structure of a population, whether it is comprised mainly of young or old individuals. They count animals to measure the rate at which a population grows or declines. If it is not feasible to count every individual in a population, they count as many as possible, then use mathematical models and computers to generate population estimates.

Censusing wildlife populations is seldom easy, because animals like rock-wallabies will not queue up to be counted, and it is pointless to ask them when they were born or who died recently. Nor is it instructive to observe their activities through binoculars; they simply stare back. It is essential to get in there amongst them to catch them, age them, measure them, examine them, tag them, then let them go without harming them, and then do it all over again at some other time. All this is standard procedure for studying marsupials. The trouble was, we were up against a different sort of animal, a very intelligent and elusive wallaby, and one that proved to be adept at evading capture.

TRAPPING ROCK-WALLABIES: CATCH-ME-IF-YOU-CAN

At first we were confident that proven trapping techniques would work. Three wire-mesh wallaby traps were set in position and baited with freshly cut apples. Next morning, we found all of the traps had worked, except that none contained apples, and none contained rock-wallabies. This was disconcerting, but not too worrying, because one of the strengths of the scientific method is the process of replication and confirmation. So we tried again and we confirmed our original results - no apples and no rock-wallabies.

Our traps were high-sided with partially opened dome-shaped roofs. Nobody had ever experienced problems

Black-flanked rock-wallabies, although once widespread, are now found only in isolated colonies in arid deserts and parts of the Wheatbelt.
Photo - Bert and Babs Wells ▲▲

A solution to the fox problem may soon be at hand, as a result of advances in biotechnology.
Photo - Courtesy of Agricultural Protection Board ▲

with wallabies escaping by this opening. Nevertheless, we decided to close off this possible avenue of escape, even if it seemed slightly silly.

We reset and baited this improved version and again we were `done' by the rock-wallabies. Analysis revealed they had squeezed through a small hole in the roof of the trap - a remarkable feat for a wallaby. Our failure to catch any was becoming a talking point. A nameless colleague equated our success rate to that of the hapless coyote in the road-runner show. Another suggested that if we planned to continue this line of research, it might be wise to invest in an apple orchard.

In desperation, we wired and stitched up our traps until they were escape-proof. Again they were set, and we caught our first rock-wallabies, three of them to be exact. But success brought no joy. All three looked as if they had just finished a ten-round bout with the wire, and all three looked like they had lost by a unanimous decision. Fortunately their condition looked far worse than it really was, and we later caught them again in perfect condition.

We had failed to appreciate that rock-wallabies live in the three-dimensional world of rock-piles, where it is just as natural to jump upwards as straight ahead. And of course they are superbly adapted to their rocky habitat; built for strength and agility, they differ from other wallabies in that they are more compact and nuggety. This explained why they were such accomplished escape-artists, and why they banged themselves about with such force in a trap.

Very chastened, we withdrew from the rock. However, we had good reasons for returning in spite of our problems, because these rock-wallaby populations were proving to be eminently suitable for conservation research. They were willing to enter traps, so they were very trappable providing that we got our act together. Thus we returned, and the catch-me-if-you-can contest was on in earnest. However, as time passed, it gradually became apparent that it was not a fair contest, because the rock-wallabies kept changing the rules; they cheated a lot, and they always won the game.

It was imperative to come up with a new trap design to prevent these muscle-bound wallabies from braining themselves. Wire materials were obviously unsuitable. We obtained some strong nylon netting normally used to make fishing nets, and it was cut and sewn to make a chamber shaped like a wind-sock closed at one end. This was attached to a door frame and extended by guy ropes attached to steel pegs driven into the ground. To reach the apple placed inside a wallaby had to step on a treadle board which released a trigger which dropped the door.

The new design worked well at first. Rock-wallabies readily entered and, when they struggled, the loosely suspended netting yielded without inflicting injury. But soon we stopped catching wallabies, and all that remained of the apple bait was a damp spot.

It seemed that we had created some apple addicts who had learnt how to steal apples without being caught. Instead of entering the trap, they pressed their muzzles against the side of the loosely-suspended netting until they made contact with the apple. They proceeded to reduce it to apple sauce, which was licked up through the netting. This explained the damp spot.

To counter this we placed a hessian curtain around the trap (except for the entrance) to obscure the bait from their beady little eyes, and we were once more in the business of catching rock-wallabies - for a while at least. Then it started all over again: no rock-wallabies, no apple, just a damp spot.

Researcher Mike Onus with a rock-wallaby. The animals are ear-tagged and then measured to determine their age and reproductive status. Photo - Jiri Lochman▲

The rock-wallabies were using the traps as a trampoline by jumping over the curtain to land on the netting roof. (they left their calling card in the form of a dropping on the top of the netting). This bouncing around triggered the trap and it was apple sauce time again.

By now we had run out of ideas. Our Mark III trap was working, up to a point, and it was gentle on the rock-wallabies. Using it we had progressed to the point where we were able to eliminate most causes other than fox predation, but in order to test this hypothesis we needed a genuinely reliable trap. The tangled maze of ropes, netting and anchor pegs was awkward to carry. The trigger mechanism was crude, not easily set and hopelessly erratic. At times the weight of an elephant would not trigger it, but at other times a moth fluttering by seemed sufficient.

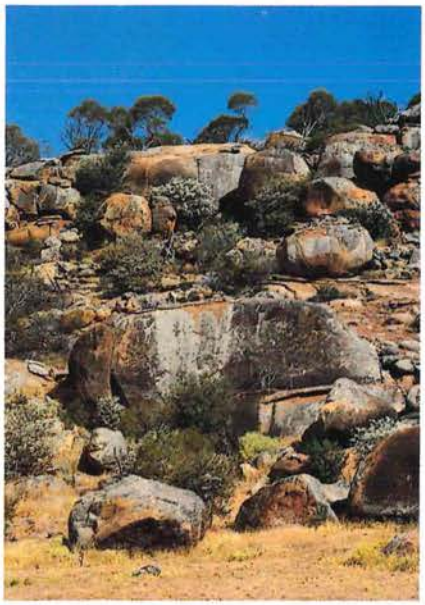
THE BROMILOW TRAP: A MATCH-WINNING DESIGN

Bob Bromilow took note of this situation when he joined our research team and he offered to redesign the trap. Using his fitter and turner skills and his inventive flair, he quickly produced a design that swept away all of our previously intractable problems. Gone was the tangle of rope, netting and pegs. In its place was a complete trap that collapsed neatly and was easily carried and setup. It was still a gentle trap, but now the netting was neatly suspended from a light-weight aluminium frame which was high enough to thwart the trampoline artists. And to cap it off, the frame was tightly shrouded with hessian to obscure the apple delights from greedy little eyes. If a wallaby wanted some apple, then it could have it, but only if it entered the trap via the door - and then we had them, every time.

All of these improvements were impressive enough, but the creative part of Bob's design to my mind was the trigger mechanism. It was made from a magnetic latch of the type used to secure cupboard doors, and unlike the previous trap, it was easily set and reliable. Above all, it is a humane trap, one that we could use, much to our relief and peace of mind, without risk to our endangered friends.

A full description of Bob's trap design has been recently published in an international wildlife journal. It is known as the Bromilow Trap and requests for information about it have come from overseas.

The Bromilow Trap has been adopted by other wildlife research groups and has been used in many other locations. It has some minor limitations. For example, when native rodents are abundant, they trigger traps set for other species. After consuming the bait, they leave by chewing a hole in the netting. The woylie or rat-kangaroo can also create its own exit because, unlike most members of the kangaroo family, it has a specialised set of sharp premolars. Fortunately only a small percentage become chewers. In the case of rock-wallabies, the Bromilow Trap had one shortcoming - it made some rock-wallabies "trap-happy". Mike Onus caught certain rock-wallabies so often that he did not read the tag number - a glance at a pair of very familiar ears told him who it was.



Nangeen Hill Nature Reserve in the Wheatbelt is prime rock-wallaby habitat.
Photo - Jack Kinnear▲

When a wallaby steps on the treadle board the door is released and the animal ensnared.
Photo - Jiri Lochman▲▲

Bob Bromilow, the designer of the Bromilow trap.
Photo - Courtesy of the West Australian▲

The Bromilow trap is used all over WA for a range of species. Here, it is set up on Enderby Island in the Pilbara, ready to catch rock-wallabies.
Photo - Bert and Babs Wells▲

The woylie, another rare and endangered mammal species that has been severely reduced in number because of the fox.
Photo - Jiri Lochman◀

THE FOX PROBLEM: NEW DEVELOPMENTS

When we began our study of rock-wallabies, we compared them in their endangered state to a business on the edge of bankruptcy. Over a period of four years in which we trapped and counted them, there was no profit because there was no population growth. After another four years, this time with fox control, we found them to be a very profitable species because their numbers increased dramatically.

Fox predation is not an isolated case restricted to rock-wallabies. In November 1984, we initiated another experimental fox control program in Tutanning Nature Reserve with the object of tracking the population dynamics of three rare species (the tammar wallaby, the woylie, and the brush-tailed possum). After five years of fox control, all three species have increased substantially, and we expect them to continue to do so.

We have now established that four marsupial species are at risk from fox predation. Senior Research Scientist Tony Friend's studies on the numbat extend the list to five, and it seems that the list is longer - how long, we do not yet know. These are dismal statistics, but there is a brighter side: in responding to fox control, these five species have demonstrated that they can, in business parlance, "trade out" of their receivership situation. This is a heartening discovery, for it signifies that although these species may now need help from CALM, they are not beyond recovery.

This is a very important point because these species have shown by their population growth response that they are capable in the main of looking after themselves were it not for the fox. In other words, despite all of the disturbances and environmental changes brought on by European settlement, and provided that we don't completely destroy their existing habitat, these species can flourish once again.

In bringing the fox to heel, we will have to change the ecological rules under which it is currently operating. We must introduce some effective constraints because the fox is too greedy and efficient a predator. It is not satisfied with some of the profit a prey species has to offer - it tends to take all of it and more.

What we must do is genetically engineer a solution, because we cannot wait for nature to provide one. Fortunately, a new and powerful biotechnology, forged from basic research in molecular biology, is emerging, and it is pleasing to report that the first steps are about to be taken to harness this technology and bring the fox under control.

Meanwhile, there is still a lot of trapping to be done, and with our Bromilow Traps we are now well equipped to do so.⊡

Jack Kinnear is a Senior Research Scientist at CALM's Wildlife Research Centre at Woodvale, telephone (09) 405 5100. He has been researching rock-wallabies and investigating fox control since 1978.

Back from the Brink

by Alan Danks

The Noisy Scrub-bird, one of Western Australia's rarest birds, had a close brush with extinction. When it was rediscovered in 1961, 72 years after the previous sighting, the species was in a highly vulnerable position. The total population of less than 100 was confined to the Mount Gardner area near Albany. Such a small population would have soon succumbed to the pressures of habitat degradation, increased fire frequency and, possibly, to genetic problems caused by inbreeding.

TWO Peoples Bay Nature Reserve was created to protect the bird's habitat and the bird has now been the subject of management and research for almost 25 years.

The knowledge necessary to manage both the bird's habitat and population came from detailed research over many years by CSIRO's Division of Wildlife and Ecology.

Noisy Scrub-birds are small, semi-flightless inhabitants of dense scrub and thickets, and need long-unburnt bush for the protective cover and rich supply of invertebrate food that it provides. This is a specialised requirement in the fire-prone environment of the South-West, and such habitat is usually found only in protected gullies, overgrown swamps and alongside streams.

Breeding males are territorial and defend their areas with a loud song (ear-splitting at close quarters!). They are larger and more distinctively marked than the females and seem preoccupied with territorial defence and mating, leaving the hard work of nest-building, incubating and raising young to the female. Understandably, each female can raise only one chick per year.

Despite their low reproductive rate, scrub-bird numbers have substantially increased in the last two decades. Excluding fire from the Mount Gardner area has allowed further vegetation growth, increasing the available habitat, and the birds have steadily occupied new areas.

Two Peoples Bay Nature Reserve is now managed mainly as a sanctuary for the Noisy Scrub-bird after its rediscovery there in 1961.
Photo - Tony Tapper ▲▲

The male Noisy Scrub-bird has an ear-splitting call, a loud whistle accelerating to an even louder crescendo, used to defend its territory.
Photo - Allan Rose ▲

Photo previous page - Ray Smith

The population of Two Peoples Bay Nature Reserve is now around 500 - a five-fold increase since 1970. This recovery shows that the species can build up its numbers, given the right environment and some protection. Even so, if the population remained confined to a single area, the species would be extremely vulnerable to wildfire, disease or climate change.

To overcome this "all the eggs in one basket" problem, the scrub-birds need to be more widespread. However, their poor flying ability and special habitat requirements mean they cannot cross open pasture or recently burnt bush. Although some have managed to disperse a short distance outside the nature reserve, scrub-birds need help to cover the longer distances necessary to reach more substantial habitat. A program to capture Noisy Scrub-birds from the Two Peoples Bay population and release them in areas of suitable habitat within the species' former range in the South-West began six years ago.

At Mount Manypeaks, 15 kilometres from Mount Gardner, several deep gullies contain almost ideal habitat. In 1983 Graeme Folley, former Reserve Officer at Two Peoples Bay, Don Merton of the New Zealand Department of Conservation and I began a program to capture, handle, house, and transport Noisy Scrub-birds.

This elusive bird often lives in impenetrable thickets. Working out practical and reliable ways to catch this will-o'-the-wisp consumed much time and energy during the first translocation. Fortunately the rest was easier. The birds were not too stressed by their capture, settled down well in temporary captivity and accepted being transported in padded boxes in vehicles and on our backs.

Since 1983 more scrub-birds have been released at Mount Manypeaks and at two sites to the west of Albany in the Denmark and Walpole areas. The translocation process has been refined and volunteers have joined the project - some have returned regularly and become indispensable. Many Department of Conservation and Land Management (CALM) staff are also involved.

Establishing new colonies is a long-term process. Transferred birds need time to adjust to their new habitat, to find reliable sources of food and shelter, to establish territories and raise young.

The release areas are monitored each year by recording the number and location of all males defending territory. Increases in the number of territorial males, over the number of males originally released, indicate local breeding. The parent population at Two Peoples Bay is also monitored. So far the regular removal of adult birds from the area has had no negative effect.

The scrub-birds seem to like the habitat and conditions at Mount Manypeaks. Since 1986 there have been annual increases in the number of singing males and by 1988 the number exceeded the 18 males originally released, showing that breeding was occurring and the colony was expanding. The colony should continue to expand into the unoccupied habitat on the mountain for many years.

Excluding fire from the Mount Gardner area inTwo Peoples Bay has caused an expansion in scrub-bird habitat.
Photo - Tony Tapper▲

The small round wings of the Noisy Scrub-bird are not very powerful and the bird is semi-flightless.
Photo - Bert and Babs Wells▼

Scrub-birds were released in the Walpole-Nornalup National Park in 1986 and 1987, but have been slow to establish territories. Three males were heard singing in 1986. None were heard in 1987 or 1988 but two were heard in 1989. This means some birds are still in the release area and there could be some breeding. The slow start may be due to sub-optimal habitat - the habitat here differs more from Two Peoples Bay than does the habitat on Mount Manypeaks.

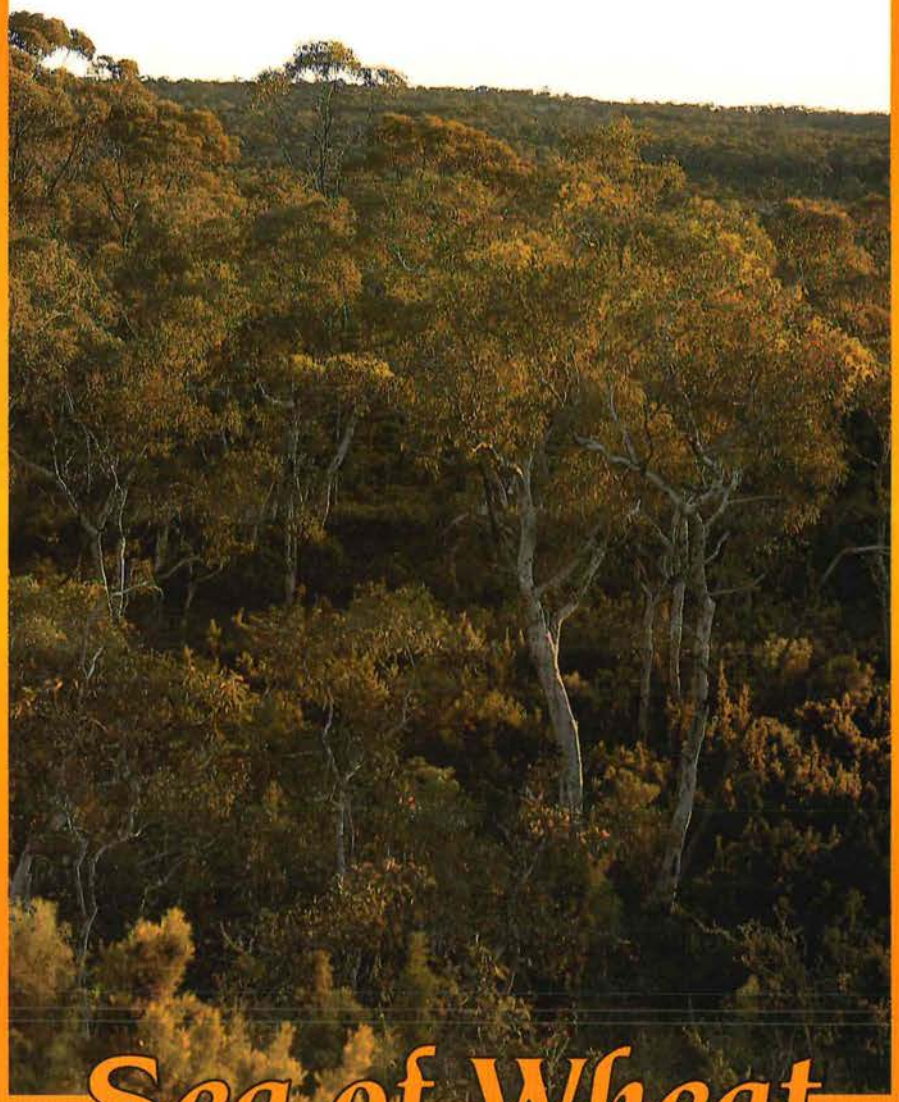
Last year a group of Noisy Scrub-birds was released in the Quarram Nature Reserve near Denmark. At the end of the translocation, four males were heard singing close to the release site - an auspicious start. However, several years may elapse before we can be certain a viable colony has been established.

Meanwhile, new release areas are being sought and further releases planned. All scrub-bird areas will be monitored regularly and some areas may need more birds to help them establish. This work will continue for many years.

Not long ago all the Noisy Scrub-birds in the world were confined to a few gullies on one mountain. Today, with a little help, the number of these intriguing birds has expanded and they have been spread over a wider area, giving them greater security than they have had at any time in the last 100 years.▣

Alan Danks is CALM's Reserve Management Officer at Two Peoples Bay. He has been involved with the Noisy Scrub-bird translocation project since it began in 1983 and can be contacted at Two Peoples Bay on (098) 46 4276.

Island of Bush



Sea of Wheat

by **GORDON FRIEND**

TUTANNING Nature Reserve has been acclaimed as one of the richest and most important conservation areas in Western Australia. The 2140 hectare reserve is an important haven for several of the State's rarest mammals, and boasts some of the richest flora sites in the world.

For a place so devoted to preserving flora and fauna, Tutanning lies in an area surprisingly devoid of undisturbed bush. Some 20 kilometres east of Pingelly in the central Wheatbelt, the reserve encompasses the Dutarning Range (after which it is named, but with different spelling) lying between the Avon and Hotham Rivers. This region was first settled in the late 1840s around the area now known as Mourambine, as people followed the rivers east and south from Beverley and York. The Dutarning Range was named by John Forrest in 1869, and the township of Pingelly had its genesis some 15 years later around a freshwater spring on the route of the Great Southern Railway.

Tutanning is an outstanding remnant of the original ecosystem. It harbours some 35 species of reptiles, seven species of frogs and 10 species of native mammals. The reserve is an important haven for several of the State's rarest mammals, including the woylie (*Bettongia penicillata*), the tammar (*Macropus eugenii*) and the red-tailed wambenger (*Phascogale calura*), and is a refuge for the rare malleefowl (*Leipoa ocellata*).

It is also extremely rich in plant life. Over 620 species are recorded to date, several of them rare or of restricted distribution (*Caladenia integra, Stylidium expeditionis, Hakea loranthifolia, Dryandra proteoides* and *Pomaderris bilocularis*). The areas of heathland (kwongan) are the smallest but the richest, recent studies having recorded 315 plant species from 11 sites totalling only 64 hectares. Thus, more than half of the plant species recorded on the reserve come from only about three per cent of its area. Such sites are amongst the most floristically rich in the world.

Hakea gilbertii is one of many flowering plants found on the Reserve.
Photo - Cliff Winfield ▲

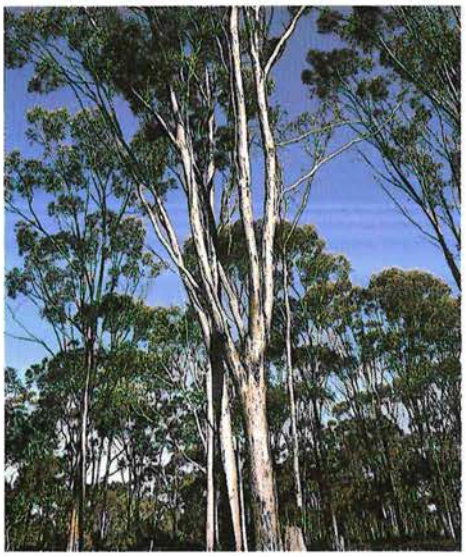
Tutanning Nature Reserve contains one of the few remaining populations of the woylie. This small creature feeds on fungi, which it digs from the ground.
Photo - Gordon Friend ▼

A FORBIDDING LAND

Although it was no doubt well known and frequented by Aborigines, the area did not at first welcome Europeans. Early settlers had a tough time eking out an existence in the harsh landscape, most living in shacks and gathering sandalwood or stripping mallet bark for a meagre

income, and keeping a few pigs to supplement their monotonous diet. To these pioneers the rich and abundant fauna was more a source of food and problems than a fragile resource to be protected. In his hand-written reminiscences, settler H. Potts describes the toil of stripping mallet bark near Pingelly in 1905, and how the "boody rats" (the burrowing bettong, *Bettongia lesueur*, now extinct on mainland Australia) would annoy the men all night licking the tins and coming into the tent to eat potatoes and flour, and jumping on their beds.

In these early times fences were uncommon, and the settlers' animals roamed freely through the uncleared bush. Many met an untimely end after eating poison bushes (*Gastrolobium* spp.), which contain fluoracetate compounds deadly to introduced sheep, cattle and horses. This problem, together with the difficulty of clearing the tough bush, and the lack of financial incentives, meant that the pace of settlement was slow during the early 1900s. Gradually, however, farming methods improved and the region became recognised for its agricultural potential. More settlers arrived, particularly in the post-war years of the 1920s and 1950s, when soldier settlement schemes and high wheat and wool prices stimulated rapid development. Vast bushlands were opened up for farming, and heavy machinery soon cleared the diverse native woodlands and heathlands.



Brown mallet grows beneath breakaways in fairly rocky country. The tree's bark is rich in tannins and, during the early years of settlement, mallet bark was harvested for tanning.
Photo - Jiri Lochman ◀

The black-headed monitor (*Varanus tristus*) is fairly uncommon on the reserve. It is semi-arboreal.
Photo - David Mitchell ▼

By the late 1950s only scattered and often small remnants of the original bush remained. Many of these remnants were unsuitable for agriculture, while others were set aside as reserves for mallet (*Eucalyptus astringens*), or supported dense stands of poison bush. This was the case in the Dutarning Range area, where poison bush was very common and several mallet reserves existed. In about 1958, however, much of the area was thrown open for selection. Applications were immediately forthcoming from adjacent landholders.

PIONEERS IN CONSERVATION

It quickly became clear that, without precautions, little would remain of the rich, varied beauty of Tutanning's bush and wildlife. Mr J.P. Marshall, a farmer who owned land south of the Dutarning Range, and Professor A.R. Main and Mr R.D. Royce, of the Fauna Protection Advisory Committee, urged that the land be assessed as a potential fauna reserve. This request, unusual at the time, succeeded on 28 January 1960: Tutanning, referred to then as the East Pingelly Nature Reserve, was vested in the Fauna Protection Advisory Committee for the purpose of "Protection of Fauna". The concept of a conservation reserve had crystallised.

Further history was made on the hot afternoon of Friday 6 November 1964. About 80 people gathered for the official opening of WA's first biological research station and living quarters at Tutanning, realising a pioneering ambition embodied in the original concept of the reserve. What made the occasion even more notable is the fact that some private property had been exchanged for a parcel of State land and added to the reserve for the station site.

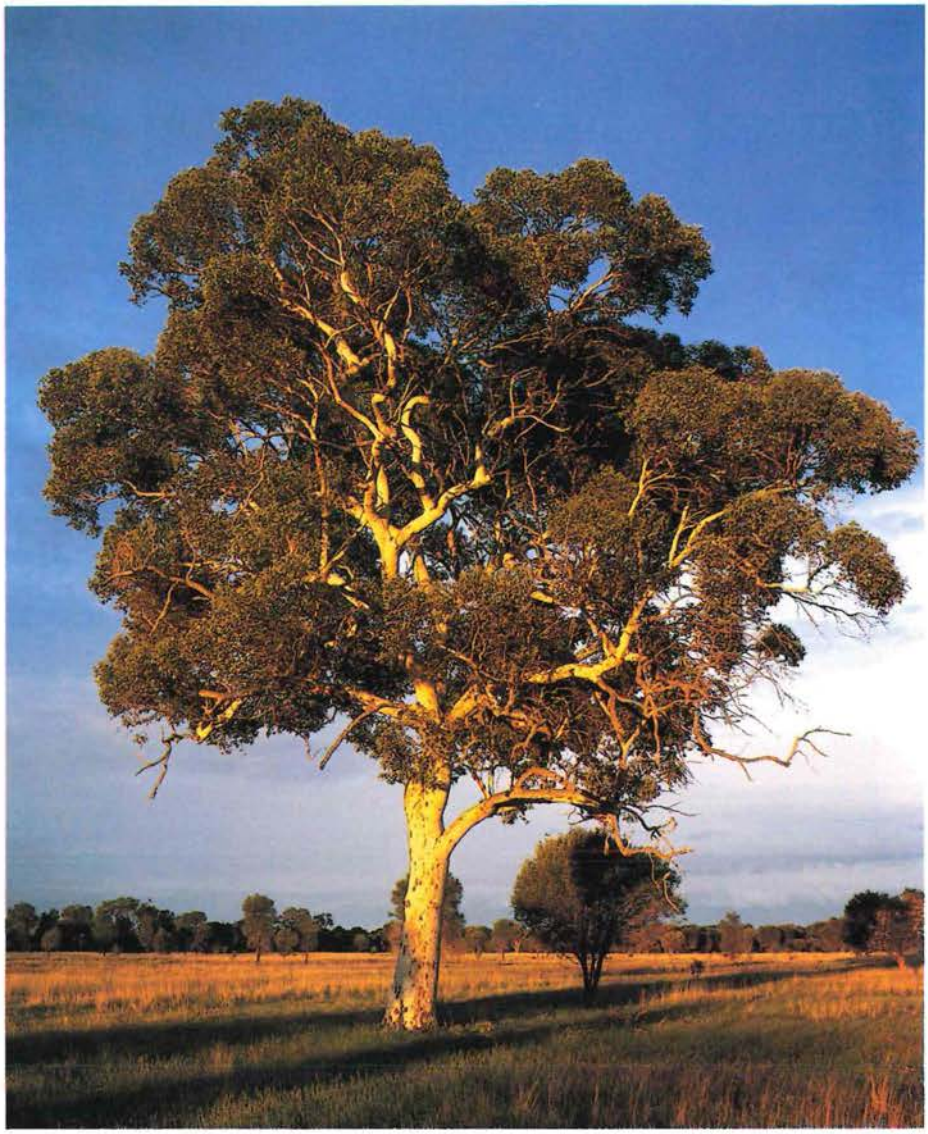
COMMUNITY ACCEPTANCE

The reserve was a "guinea pig" in terms of land acquisition, both for conservation and for research into the management of remnant vegetation throughout the Wheatbelt. There was considerable scepticism within the community about such areas, which were regarded by some as little more than a refuge for weeds and vermin and a fire hazard. Crops adjacent to the reserve were damaged by grazing kangaroos, and the maintenance of boundary fences to control these animals was deemed the farmer's responsibility. There followed a long, and often spirited, dialogue between landholders and reserve staff. Local government members were heard to say that the district needed many things, but Tutanning was certainly not one of them!

Scientists, however, quickly recognised the potential of the reserve for field-based research. It had an outstanding but unstudied flora and fauna, and accommodation and laboratory facilities were all laid on. The reserve became a much sought-after area by both local and overseas workers. Research projects carried out on Tutanning covered a broad range of topics, including flora and fauna colonisation in freshwater ponds on granite outcrops, germination inhibitors in plants, population ecology of woylies, possums and lizards, and eco-physiology and population studies of plants.

Over time, as the local people saw that the reserve was being used and not neglected, they began to accept its value and the need for conservation in general. Community field days became regular events, and a management committee of local farmers and residents was set up.

This change in attitude culminated in the reserve being reclassified as "Class A" in late 1970 (it now requires the approval of both Houses of Parliament to change the classification of the reserve), and it was vested in the Western Australian Wildlife Authority for the purpose of "Conservation of Flora and Fauna". By the late 1970s further additions of land had increased the size of Tutanning to its current 2140 hectares.



Some land that was cleared and farmed has been added to the reserve. Regeneration experiments are under way to restore the area to bushland.
Photo - Gordon Friend ▲

WILDLIFE UNDER THREAT

One of the main reasons for securing Tutanning as a conservation reserve was its rich variety of animals and plants. This was particularly so with mammals. In 1906 G.C. Shortridge camped at Woyerling Spring, five kilometres east of the present reserve, and collected specimens for the British Museum of Natural History. In March that year he wrote to his colleague Mr Oldfield Thomas and reported that an amazing tally of mammals, some 270 specimens, had been collected! This collection comprised many species that are now either very rare or extinct on the mainland (e.g. crescent nailtail wallaby, banded hare-wallaby, burrowing bettong and bilby) or have considerably reduced distributions (e.g. numbat, chuditch and Mitchell's hopping mouse).

Shortridge was so impressed with the mammal fauna that he stayed in the district for about six months, and stated in a later letter to Thomas (May 1906) that he had collected more mammal specimens there than in all the other places of his trip put together.

At this time the Pingelly District probably supported about 26 species of native mammals, and introduced species such as rabbits and foxes had not then gained a strong foothold. By the time the Tutanning Reserve was proclaimed in 1960, clearing and burning for agricultural

CALM undertakes low-intensity burns in the buffers around some Wheatbelt nature reserves to protect them from wildfires.
Photo - Gordon Friend ▲

development, combined with the impact of the now common introduced species, had eliminated about 10 of these native mammal species. The equivalent figure for plant species will never be known, as no systematic collecting was undertaken before clearing.

Although numbats, chuditch, woylies and tammars were still occasionally seen on Tutanning in the early 1960s, it was clear to researchers like Professor Bert Main that urgent ecological management was required if these species were to survive on what was now essentially an island of bush in a vast sea of wheat. This could only be achieved through a program of detailed research on the species' life histories, habitat requirements and the impact of management practices like prescribed burning.

ECOLOGICAL STUDIES

Professor Main and other researchers set about examining the habitat requirements and ecology of key animal and plant species like the woylie, the tammar and sheoaks (*Allocasuarina huegeliana*). This work provided considerable insight into the role of fire and animal-plant interactions in the functioning of such ecosystems.

Fire is a particularly contentious and difficult management issue in small, isolated nature reserves. On the one hand, managers must try to protect lives, property and conservation values from wildfires. Fire regenerates vegetation and provides cover and food for many key animal species like woylies and tammars, whose decline can reduce grazing pressure on sheoaks and lead to profound changes in the ecosystem. On the other hand, prescribed block burning on such small reserves, while favouring herbivorous species, can lead to overgrazing of the new vegetation by the larger western grey kangaroos (*Macropus fuliginosus*), which prefer to eat in open areas.

These issues had to be addressed if Tutanning was to sustain viable populations of Wheatbelt flora and fauna. A program of active management was necessary, backed up by experimental research and long-term monitoring. Such management began in the early 1970s with a series of random prescribed burns in small blocks over a five-year period. In the early 1980s intensive research began on the effects of such burning on the vegetation. Since 1986, pioneering work has started on the fire ecology of small vertebrates and invertebrates on remnant patches of vegetation. Much of this research focuses on the areas of species-rich kwongan vegetation, and is showing that this vegetation type also supports a great variety of small animal life. Revegetation experiments on cleared sections within the Reserve have also begun, and a new and exciting phase of experimental management is now developing.

THE FUTURE

Sadly, the decline of animal (and probably plant) species, typical of small isolated remnants of bush, has not yet been halted at Tutanning. In the last decade numbats, quendas and western ringtail possums seem to have disappeared from the Reserve, and it now contains only about 40 per cent of the mammal species that were present when Shortridge collected in the district.

There is, however, new hope. Researchers have recently found evidence of the positive effects of fox control on native animal populations (see *Landscope*, Summer 1988-89); and, thanks to separate studies, reintroducing fauna to depleted areas is now a real possibility. Furthermore, experimental studies of fire effects and fire management are now getting under way in the far South-West and inland arid areas, as well as the Wheatbelt.

All of this means that the fauna is getting a second chance. Tutanning will figure prominently in this new experimental phase of research and management, and continue as a pioneer ecological research facility and a unique conservation reserve. It is a fitting tribute to those who had the vision to set it aside for conservation so many years ago.⊡

CALM Senior Research Scientist Gordon Friend is studying the effect of fire on small animals in the Wheatbelt and South Coast regions. He is based at CALM's Wildlife Research Centre (phone (09) 405 5100).

UNDER FIRE

by Tanyia Maxted

Fitzgerald River National Park is turning green again - just a few months after almost half of the remote South Coast heathland was burnt by wildfires.

Unseasonal rains have given the park a green tinge as native grasses resprout and new shoots appear on charred blackboys.

Some 152 600 hectares were burnt by the fires, which were lit by lightning storms in late December.

In similar conditions to those which caused the Ash Wednesday disaster in the Eastern States, firefighters from CALM and the Ravensthorpe and Jerramungup bush fire brigades fought almost continuously for two weeks to contain the fires.

A further two weeks was spent "mopping up" after the fires, and aircraft patrolled the park until mid-January.

During the height of the fire, fronts moved as fast as 8 km/h and in just eight hours on the first day more than 100 000 hectares was burnt.

Difficult terrain, high winds (up to 56 km/h) and high temperatures (up to 40 degrees) worked against firefighters, but they were able to keep the fire from the fauna-rich northern part of the park.

Images taken from satellites during and after the fires will complement existing maps of past fires in the park and allow accurate mapping of the extent of the fire.

They will also allow planners to determine the ages of unburnt sections of the park that will carry fire and

determine the effectiveness of five-year-old vegetation to stop or slow down a wildfire. This will involve measuring how far the recent wildfires travelled into a central section of the area burnt by wildfire in 1985.

Satellite imagery may also be useful in determining if coastal erosion (such as mobile dunes) is occurring within the park.To record this, planners will compare the mobile dune area on pre-fire images with images taken post-fire on an annual basis.

CALM planners and scientists are moulding Fitzgerald's future as rehabilitation of the park begins. Parts of the park's management plan are being rewritten, in consultation with the local community.

Volunteers from both the country and the city have begun helping to rebuild park facilities, collect seed from endemic plants and stabilise sensitive coastal areas to protect them from windblow.

The park's rare flora and fauna are being surveyed and monitored by researchers to gauge species' response to the fire, using monitoring sites already established in the park.

Of Fitzgerald's 1748 plant species, 250 are rare or geographically restricted. The park's high floral diversity gives it the status of one of only two International Biosphere Reserves in WA.

A new beginning: the fires were hot enough to cause widespread seed germination.
Photo - Lachlan McCaw▲

Some of the park's unique flora that was burnt in the fire. All plants are expected to recover.
Photo - Jiri Lochman▼

Plant species that haven't been seen in the park for a number of years are expected to rise from the ashes, along with orchids and other flowering plants that respond well to fire.

The park is also rich in fauna, with 184 bird species (four rare and one in need of special protection), 22 native mammals (six declared rare), 12 frog species and 41 reptiles (one in need of special protection).

The park is a sanctuary for the Ground Parrot and dibbler; it is the only conservation reserve in WA that is home to the heath rat and is the largest reserve with tammar, red-tailed wambenger, woylie, western mouse, Western Bristlebird and Western Whipbird present.

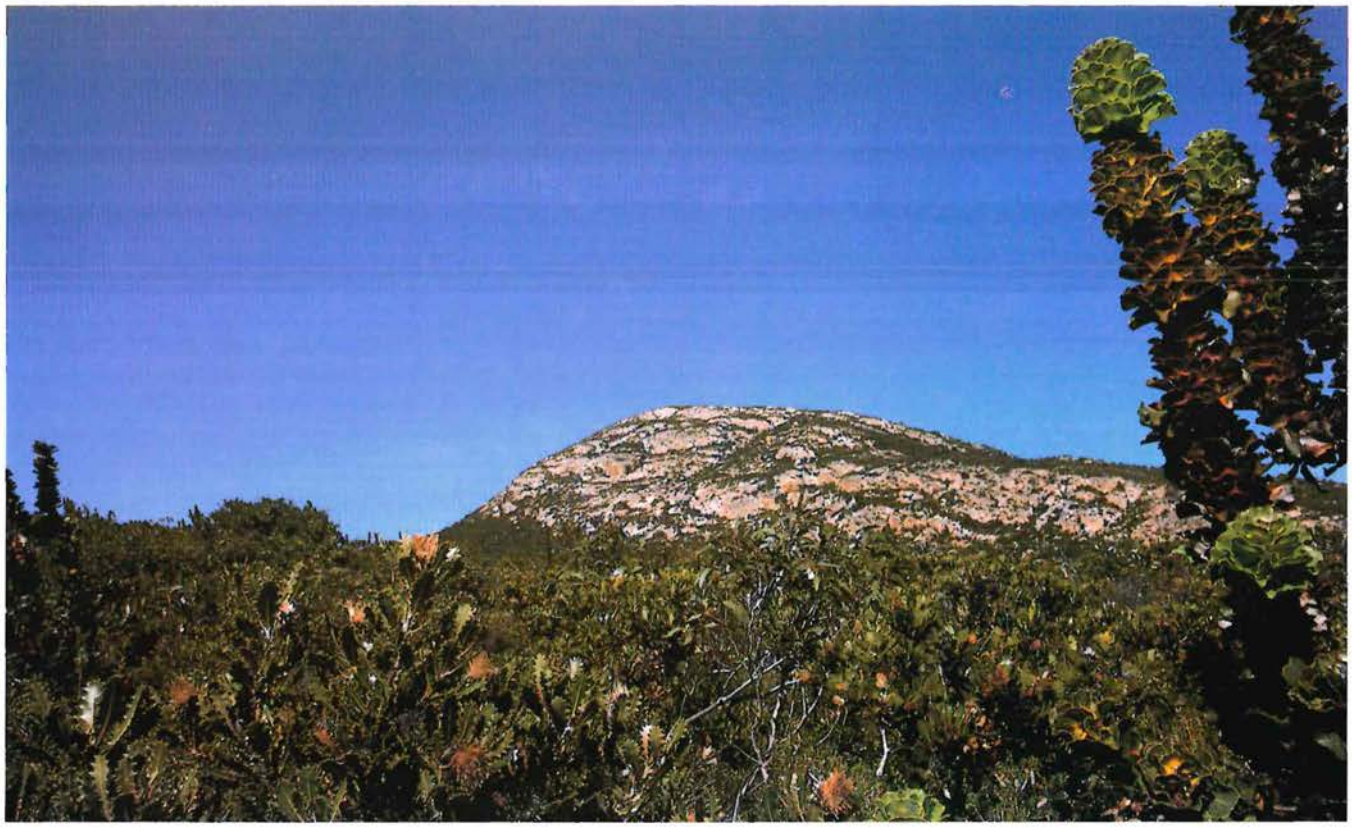
Most of the areas that were known habitats of rare fauna in the park's northern section were kept free of fire. Some of these species appear to require habitat that hasn't been burnt for at least 20 years.

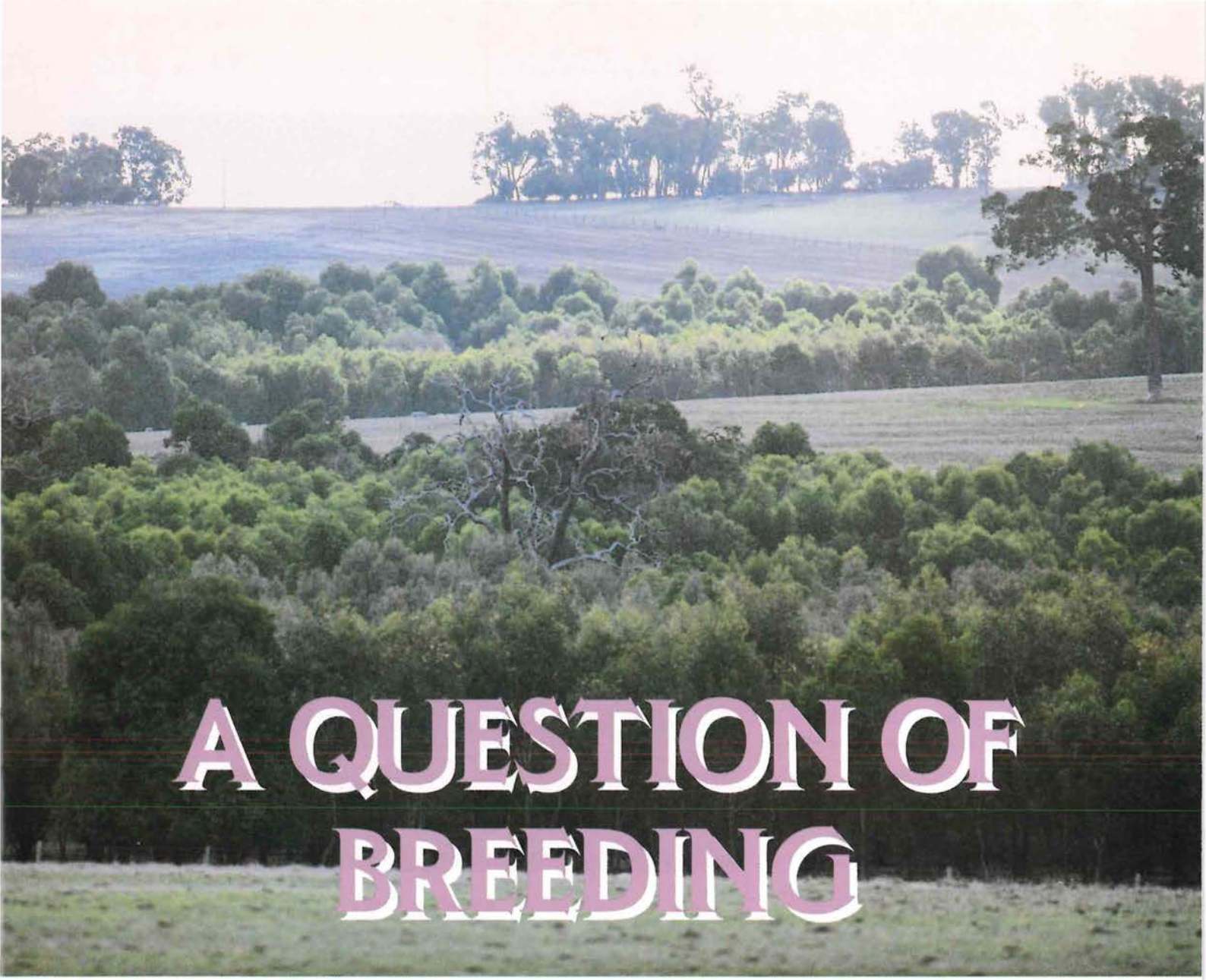
To achieve this, fire controllers deliberately focussed firefighting efforts on containing the fire in the middle of the park rather than backburning from boundaries.

This autumn, CALM, with assistance from the local brigades, will burn narrow strips to protect the remaining unburnt areas within the park.

Future editions of *Landscope* will feature articles on the park's rehabilitation and associated research, flora regeneration and the return and behaviour of fauna.⊡

Tanyia Maxted is a Communications Officer at CALM Public Affairs in Crawley, phone (09) 389 8644.





A QUESTION OF BREEDING

by John Bartle,
Trevor Butcher and
Richard Mazanec

In planning a tree-planting program the grower will naturally ask, 'What species should I plant?' But this is really only the first question. For the discerning planter, just as for the knowledgeable farmer, planting stock quickly becomes a question of breeding. Which seed source for that particular species will give the best results?

MOST agricultural plants and animals have been subject to careful selection and breeding over many generations, and well-bred seed or stock is readily available. Tree breeding has also been a long-established practice in pine forestry. But the process of genetic improvement has only just begun in eucalypts.

For most of the eucalypts the only available source of seed is native forests. In any wild population of a species, a diversity of attributes can be found; this means that there is scope to select seed which has the most desirable of these attributes.

Some species have such a large variation across their range that they can be divided into subspecies. For example, there are four recognised subspecies of Tasmanian bluegum (*Eucalyptus globulus*). Each can be distinguished by the number of flowers in each cluster and the size and shape of the fruit. Trial plantings in the lower South-West of WA have shown that these subspecies also differ from each other in vigour and in production of wood.

Even within a species or subspecies, where the differences in appearance are small, there may still be important differences in adaptation and performance. For example, river red gum (*E. camaldulensis*) from the Lake Albacutya district of western Victoria is recognised around the world as the best seed source for planting in winter rainfall climates. Such a distinctive, geographically defined variant is called a *provenance*. Information on provenance variation, which is demonstrated through carefully designed trials, is a very useful guide to better tree-seed selection.

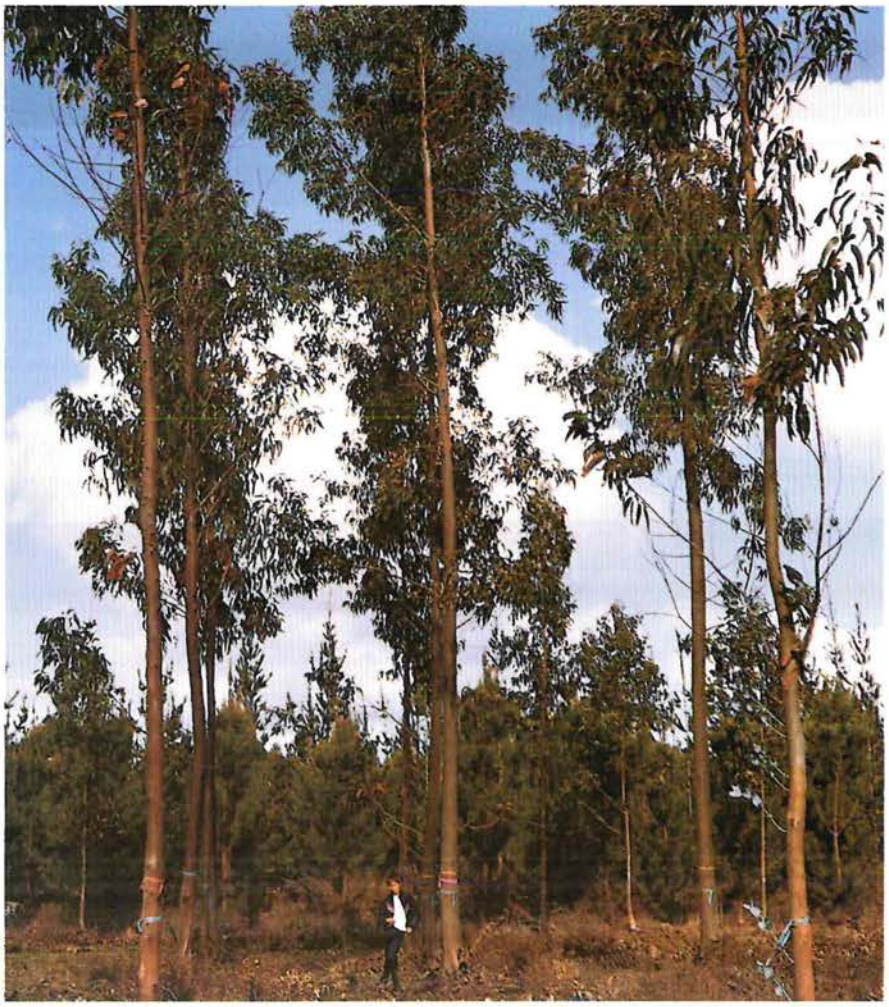
Large-scale tree-planting along streams in the Wellington Catchment is used to arrest salinity and produce timber. Genetic improvement will enhance the tree's performance.
Photo - Robert Garvey▲

There is also some variation between individuals within a provenance. Some trees are dominant and display other desirable characteristics, which will be inherited to some degree by their progeny. Seed collection should therefore focus on the superior trees within the stand.

BREEDING BETTER SEED

The genetic improvement which can be gained just by careful selection of wild seed is valuable, but limited. There is potential for much greater advances by active tree breeding, which involves the production of seed after crossing selected, planted trees. In its simplest form, the selected parent trees can be in an already established plantation, as long as this has been grown from the seed of a large number of parent trees of the best provenance. Such an area (called a 'seed production area') will produce seed that will grow more vigorously than from wild seed of the same parent trees produced in the wild.

This is because of the 'neighbourhood inbreeding' effect which occurs in natural stands. Since pollination and dispersal of seed in eucalypts occurs over only a limited distance, each 'neighbourhood' consists of partly related individuals. Therefore, natural 'outcrossing' can commonly be between partly related individuals, resulting in seed that is slightly less vigorous. The random mixing of seed from the many parent trees used to establish the seed production area breaks the neighbourhood inbreeding effect.



This is why a seed production area should be grown from the seed of widely spaced parent trees. An investigation of the size of the neighbourhood inbreeding effect carried out on mountain ash (*E. regnans*) in Victoria showed a 12 per cent reduction in volume of wood grown to four years of age.

SEED ORCHARDS

A more advanced stage of managed seed production is to establish seed orchards of selected superior stock. There are two main types of seed orchards. Firstly, the superior trees can be multiplied by cloning. This bypasses sexual reproduction (seed) and preserves the full genetic superiority of the parents. Cloning techniques include grafting, cuttings or various laboratory culturing methods known as micropropagation (including tissue culture). Superior trees multiplied in this way can be used to grow clonal seed orchards. Secondly, seed can be collected from superior trees to produce conventional seedlings for planting in a seedling orchard. Since the seed from the parent trees has been 'open-pollinated', the transfer of the genetic superiority of the parents to the seed orchard is not so efficient. However, it is a lot cheaper and easier to do.

The most improved seed is produced when superior trees placed in seed orchards are generated from a well-designed breeding program. Breeding activity is centred on a population which is established from 'families' of seed

A stand of superior bluegum parent trees near Busselton, used as grafting stock and for seed production. ▲

Mature trees are stimulated to produce shoots used for tissue culture and grafting. ◄

Young seedlings have been established in a breeding trial near Mumballup. Photos - Trevor Butcher ▼

collected from good-quality trees across the full native range of the species or provenance. Repeated cycles of selection, crossing and testing, carried out with meticulous recording of individual and family pedigrees, will produce continuous genetic improvement. This is the stage to which pine tree breeding has advanced in many parts of Australia.

With the expected development of large-scale automated micropropagation techniques, it may become economical to bypass the seed orchard. Superior trees could then be directly multiplied by micropropagation to produce the field planting stock, saving years of time by not going through the seed production step. To facilitate this practice, the creation of an elite nucleus in the breeding population will conveniently package the outstanding genetic material. The first species of eucalypt to which micropropagation has been applied in WA is river red gum. Clones selected for salinity tolerance are now available.

Another important benefit of commercial micropropagation is its application to hybrids (crosses between species). Hybrids can give combinations of traits that might not occur naturally. For example, a hybrid of bluegum and river red gum might combine the rapid growth and good pulpwood qualities of the former with the waterlogging and salinity tolerance of the latter. Being infertile, such hybrids can only be propagated vegetatively. Rapid improvement in the yield of eucalypt pulpwood has been achieved by this method overseas, especially in Brazil.

EUCALYPT BREEDING IN WA

Work to increase the range of species and improve the quality of eucalypt seed in WA began in the early 1980s. A major program of seed collection to form breeding populations of eastern states species suitable for rehabilitation of bauxite-mined areas was commissioned by ALCOA in 1982. This has given the State high-quality breeding stock of many species, which are also valuable for rehabilitation of degraded farmland, wood production on farmland, and amenity planting. CALM has augmented this work with collections of local species, mainly the major forest zone species: jarrah, karri, marri and wandoo.

Good breeding populations have now been established for 16 species. Intensive breeding work will be confined to a few major species, such as Tasmanian bluegum, due to its importance to the infant farmland-based pulpwood industry. There will be somewhat less intensive testing and selection of other species and the breeding populations will function mainly as seed production areas. Improved seed should start to become available in three to five years' time.

There is a pressing need to extend genetic improvement to other native tree species, especially for planting in the Wheatbelt. This work would aim to secure what is left of the genetic diversity of these species, establish it in seed production areas, and provide outcrossed seed for planting. Such outcrossed seed would greatly enhance the prospects of these species coping with the extreme change that has been imposed on their environment.

The size of this task is very large. One way in which it might be done is with the support of farmers and other enthusiasts. For example, a Keysbrook farmer, Neil Kentish, and his nursery man, Bob Harrington, have made a collection of *E. lane-poolei*. This is a rare species which occurs as small scattered populations on farmland along the foot of the Darling Scarp from Mundijong to North Dandalup. CALM is keen to encourage this type of commitment and can provide technical advice on how it can best be done.

Genetic improvement offers long-term gains in the performance of productive trees and in the protection of local species. It will be the foundation of the diversity and success of trees in our rural landscape in the next century.⊡

SPECIES OF EUCALYPTS UNDERGOING GENETIC IMPROVEMENT IN WESTERN AUSTRALIA

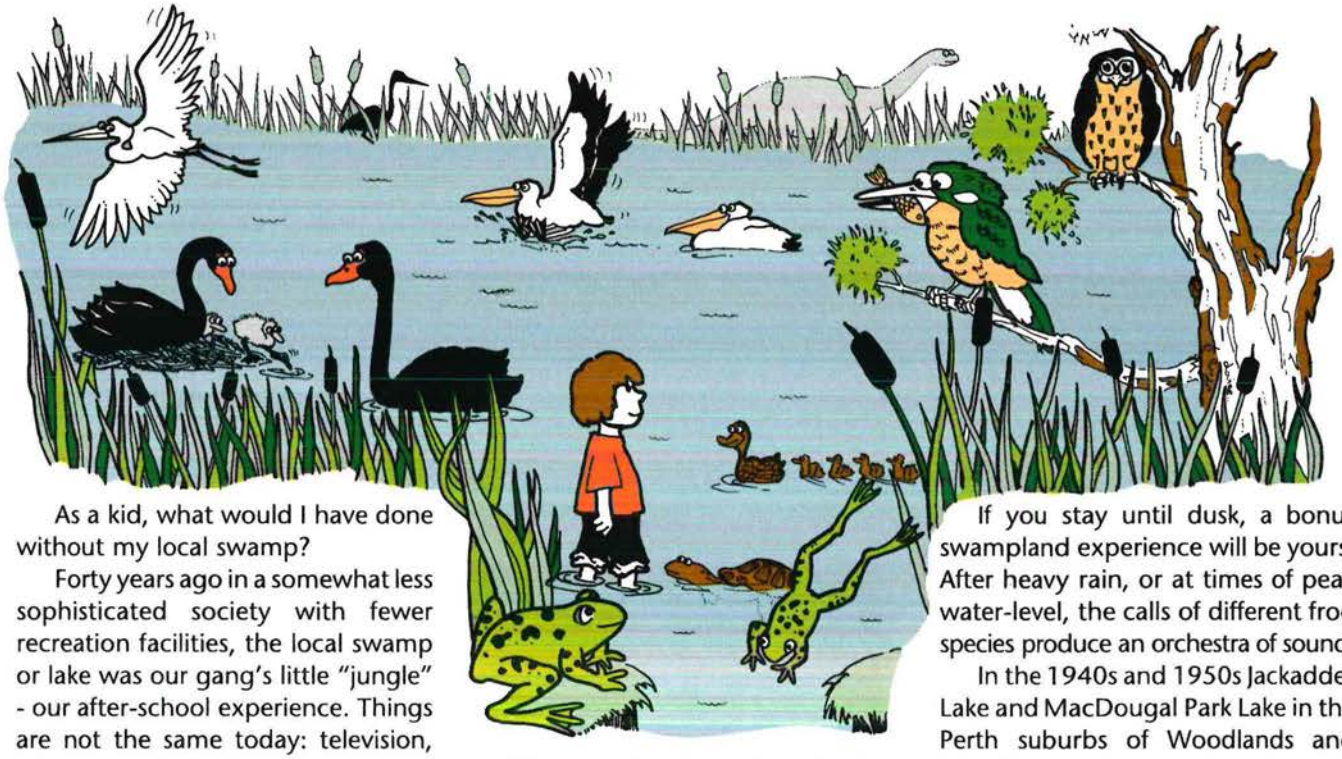
SPECIES	COMMON NAME	1	2	3
E. globulus	Tasmanian bluegum	1980	high	1995
E. resinifera	Red mahogany	1986	low	1993
E. maculata	Spotted gum	1985	med	1993
E. saligna	Sydney bluegum	1987	med	1995
E. pilularis	Blackbutt	1987	low	1995
E. muellerana	Yellow stringybark	1988	med	1998
E. botryoides	False mahogany	1989	high	1998
E. viminalis	Manna gum	1991	high	2000
E. camaldulensis	River red gum	1984	med	1998
E. sideroxylon	Red ironbark	1986	med	1998
E. microcarpa	Grey box	1986	med	1998
E. wandoo	Wandoo	1983	med	1995
E. accedens	Powderbark wandoo	1984	med	1995
E. marginata	Jarrah	1988	high	2000
E. diversicolor	Karri	1980	med	1995
E. calophylla	Marri	1992	med	2000

1 Date of establishment of breeding population
2 Current priority for breeding work
3 Expected date for beginning the production of improved seed

Grafting is used to produce large numbers of superior trees from a single individual.
Photo - Trevor Butcher▲

John Bartle is working on revegetation of disturbed land, while Trevor Butcher and Richard Mazanec run the genetic improvement program on eucalypts. For further information contact CALM's Como Research Centre, (09) 367 0299.

URBAN ANTICS!



As a kid, what would I have done without my local swamp?

Forty years ago in a somewhat less sophisticated society with fewer recreation facilities, the local swamp or lake was our gang's little "jungle" - our after-school experience. Things are not the same today: television, super toys and other entertainments keep us from such places.

Some 3000 million years ago, life on our planet evolved from primeval bodies of water. Today, wetland depressions still provide a keyhole view of primitive life-forms and jog memories of childhood escapades.

There is nothing more relaxing and enlightening than to plonk your feet into the shallows of a secluded pond in a well-vegetated swamp. Let's imagine you've done just that. SHHHHHHH - remain still and quiet. Let your senses tune in to this other world.

Look down and you will see water fleas, tadpoles, shrimp, small fish and a myriad of other water bugs swimming over your feet. Keep still and you will be buzzed by different types of coloured dragonflies. As these marvellous creatures skim across the water their huge multi-celled eyes enable them to catch insects on the wing and devour them while still in flight.

Coots, ducks, moorhens, and sometimes swans, raise a cacophony of sounds as they squabble for territory and crash through reeds and thickets.

The occasional moving shadow above is a swamp harrier, kestrel or goshawk searching for a meal of unprotected duckling, insects or water rat.

Time to move out a little deeper. Methane gas bubbles from your footsteps in the mud, giving off an unpleasant but nonetheless stimulating, smell.

If you look to the shore you may see a heron or egret stalking fish, frogs, small tortoises, gilgies or other dwellers of the shallows.

Raise your eyes to the branches of overhanging trees and you may spot the motionless forms of night herons, owls or frogmouths as they await darkness to take their part in the swamp community.

Glance back to the still, reflective waters and, from time to time, you will see concentric rings of disturbance, as long-necked tortoises push their heads through the surface for a breath of fresh air and a look around.

Your attention could be distracted at this stage as a kingfisher slices through the air to snatch a lizard from a log on the opposite shoreline.

If you stay until dusk, a bonus swampland experience will be yours. After heavy rain, or at times of peak water-level, the calls of different frog species produce an orchestra of sound.

In the 1940s and 1950s Jackadder Lake and MacDougal Park Lake in the Perth suburbs of Woodlands and Manning provided my initiation into wetland exploration. These areas were then pristine swamps on the edge of civilisation in Perth.

I hope you, too, can find places like these to make contact with your ancestral beginnings.

JOHN HUNTER

Did you know ...

Before European settlement, Aborigines who lived by our urban swamps preyed heavily on the long-necked tortoise. Today, prolific numbers of long-necked tortoises prey on young water birds, causing some species to have second or third broods.

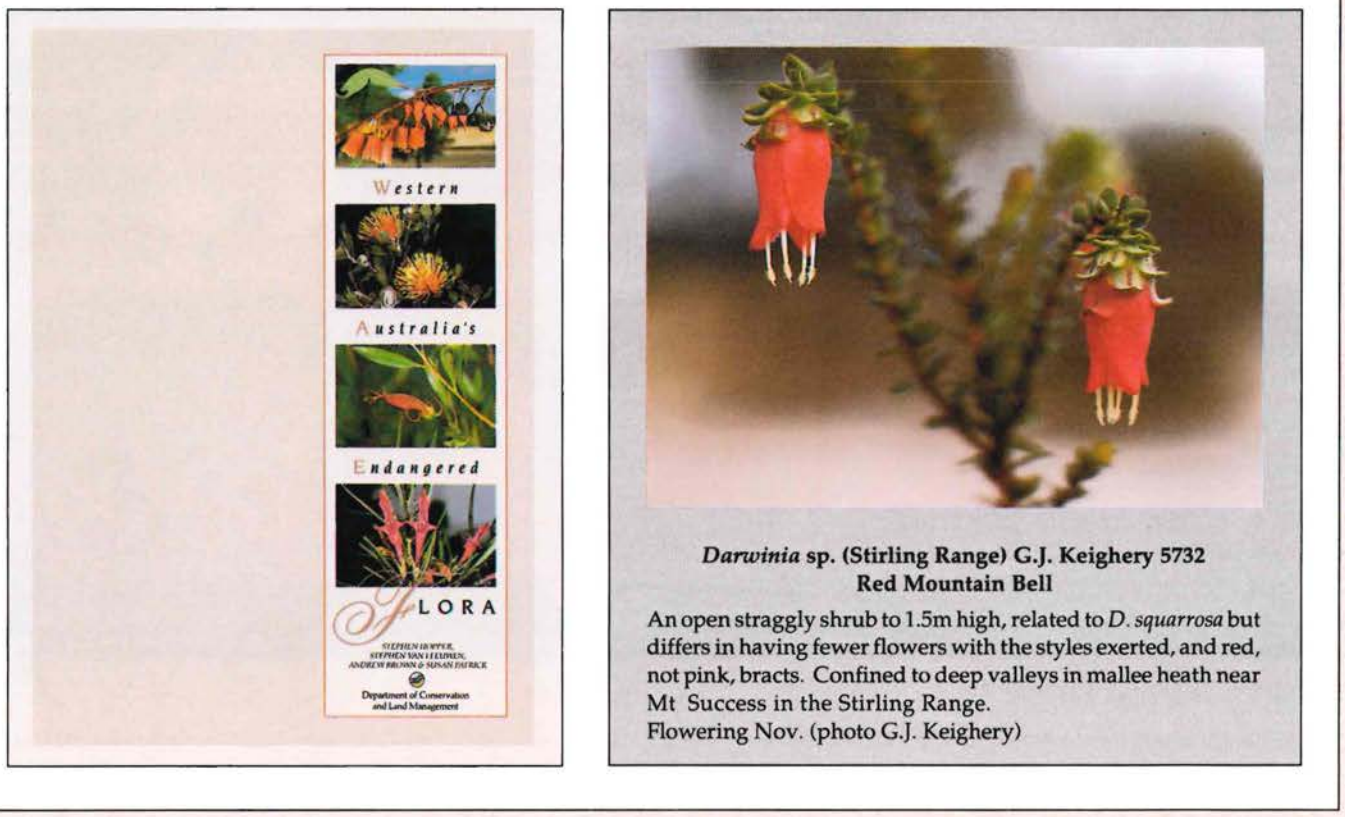
In the last 200 years, 75 per cent of pristine wetland habitat on the Swan coastal plain has been destroyed by land reclamation or the diversion of water.

A book, A Naturalists' Guide To Perth, *$10.95 from CALM's Como office, will help you to enjoy urban wildlife and wetland habitat.*

LIMITED EDITION

Endangered Flora of WA

Each year, Western Australia's landscape is transformed into a spectacular wildflower garden. Many of these wildflowers occur over a very limited range and are declared endangered (rare) under provisions of the Wildlife Conservation Act. ***WESTERN AUSTRALIA'S ENDANGERED FLORA*** is the most comprehensive guide available to these endangered plants - a noteworthy addition to every flora enthusiast's library. Beautifully illustrated, with stunning photographs of all 238 plants declared endangered in Western Australia.
This limited edition top-quality book is now available for the low price of **$24.95**.



***Darwinia* sp. (Stirling Range) G.J. Keighery 5732**
Red Mountain Bell

An open straggly shrub to 1.5m high, related to *D. squarrosa* but differs in having fewer flowers with the styles exerted, and red, not pink, bracts. Confined to deep valleys in mallee heath near Mt Success in the Stirling Range.
Flowering Nov. (photo G.J. Keighery)

WESTERN AUSTRALIA'S ENDANGERED FLORA

by Stephen Hopper, Stephen van Leeuwen, Andrew Brown and Susan Patrick.
140 pages; $24.95; quality paperback.
Available from major bookstores or direct from the Department of Conservation and Land Management, 50 Hayman Road, Como, WA.
(Or simply phone 367 0481 to order your copy now)

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L O O K I N G B A C K

R O C K H O P P E R S H E A D H O M E

Three Rockhopper Penguins from the sub-Antarctic, which stranded on the WA coast, should by now have made their way back to colder climes. After being cared for by local groups, they were released behind St Aluoarn Island at Augusta. The birds hop with great agility over rocks with feet together and jump into the sea feet first, instead of diving like other penguins.

Photo – Ray Smith