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LANDSCOPE

I.A.S. CONSERVATION, FORESTS AND WILDLIFE MAGAZINE



Kings **P**ark
rising from the ashes



Perth's **I**sland **E**scapes



Poster
humpbacks head south

§

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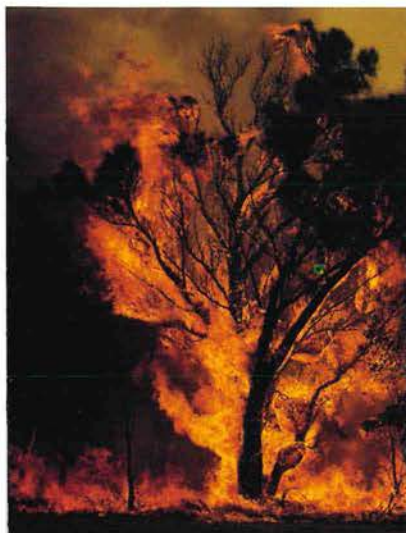
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discover WA
FOR YOURSELF

LANDSCOPE

VOLUME FIVE NO 1 SPRING EDITION 1989



Perth people were devastated when a fire tore through their favourite bushland retreat. But, with Spring, new life and colour is returning.



Rottnest isn't the only unspoilt island on Perth's doorstep- what about Penguin, Garden, Seal and Carnac Islands? They are steeped in history and provide a haven for some unique wildlife.



Algae has clogged the estuaries near Mandurah, killing fish and creating an eyesore. What is the solution?



Explore the waterways of the South-West by canoe.



Jarrah dieback- the word strikes fear into any forester's heart- but research is fuelling the fight against the killer fungus.



What's new in Kings Park this spring? Artist, Susan Tingay, couldn't resist this magnificent collection of spring orchids. From left- cowslip orchid (*Caladenia flava*), jug orchid (*Pterostylis recurva*), King spider orchid (*Caladenia huegelii*), donkey orchid (*Diuris longifolia*), rabbit orchid (*Caladenia menziesii*), and pink fairy orchid (*Caladenia latifolia*).

Back Cover: Stimson's python (*Morelia stimsoni*)
Photo-Jiri Lochman

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HUMPBACKS HEAD SOUTH

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Published by Dr S Shea, Executive Director

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RECORD PLANTING

At a time when environmental gloom and doom stories pervade the media, it is a pleasure to record some of the environmental successes which occur every day but are rarely reported.

For example, WA has just completed a record tree planting program this year. Over 1 600 CALM staff, farmers, contractors and community groups have successfully planted 13 million trees this year. This is the largest tree planting program ever undertaken in the State and probably the largest in Australia's history.

While planting a tree is an important and emotional thing to do, it is more important to plan the planting properly and to look after the trees after they have been planted.

This edition of Landscape contains an article which will be useful to all tree planters.

Twenty years ago jarrah dieback featured as one of Western Australia's major environmental problems. The story of jarrah dieback is recorded in this edition. While it is true that the problem has not been solved, the future of the forest is now very optimistic.

Apart from the fact that much progress has been made in understanding and managing the disease, it is important to record the fact that a significant amount of funding for the research came from the mining and timber industries.

Phytophthora cinnamomi has the potential to destroy some of the most diverse and unique plant communities on the South Coast of Western Australia. We need a paradigm shift in our understanding of plant pathology if we are to avoid this tragedy.

The Publisher

TORTOISE TALK

There was a slight error in your story (Winter 1989) of the western short-necked swamp tortoise.

The tortoise was actually discovered by Mr A. Gates, a landowner in the area inhabited by the tortoises, who gave it to Robert Boyd, the boy who *Landscape* credited with finding it. The owners also offered the land to the Government at a very low price so it could be made into a reserve.

The WA Naturalists Club also had a hand in the find, since it encouraged the Wildlife Shows after the war, and my sister Lucy built up the Junior Naturalists of which Robert was a member. At one of these Wildlife Shows, Robert asked me to identify his tortoise. I passed the problem on to L. Glauert, then Director of the WA Museum. He described the tortoise as a new species and wondered how such a large animal had been overlooked for so long.

The final key to the puzzle was provided by Dr Ernest Williams of Harvard University. A tortoise had been sent to the Vienna Museum in 1839. The label bluntly stated it came from New Holland but nothing more. It was identical to the new tortoise. So after more than 100 years, this short-necked tortoise was given a habitation.

I also warned that predation was not only by feral dogs, cats and foxes. Those introduced white human collectors were almost certainly poaching live animals to be smuggled abroad. Dr Tom Spence, then head of the South Perth Zoo, told me that individuals were fetching \$5 000 in West Germany.

Since I was also responsible for World Wildlife Fund Australia being set up in Australia, my connection with this charming animal continued.

Congratulations to all concerned and also on the high quality of *Landscape*.

VINCENT SERVENTY,
HUNTERS HILL, NSW

DAWESVILLE SUNRISE

I enclose a slide taken from our front verandah which you might like for *Landscape*. My husband and I have been fishing on the estuary since 1938 and it was the best sunrise we have ever seen. We both enjoy *Landscape*. My husband is 85 and cannot see but enjoys me reading it to him.



Dawesville, near Mandurah, at sunrise.

It's thankful that CALM is doing what it can for the environment. We see the damage that has been done in the last 20 years. We have five acres, part of which is fenced just for the wildflowers.

W TOUSSAINT
DAWESVILLE

MORE ON ORCHIDS

As a most avid amateur collector/reader of natural history magazines from the United States, Canada and Britain, as well as Australia, I find *Landscape* the most enjoyable of them all.

Is it because WA has a wonderful landscape and an amazing abundance of flora and fauna; is it because the articles are pitched at a level which the layman can appreciate, or is it the beautiful overall presentation? I believe all three.

I visited your State during the wildflower season last year and found and photographed over 45 species of terrestrial orchids. An article on orchids would be most exciting.

ANN TINDALL
NORTH KEW, VIC

DOZING ON THE DRYSDALE (INDEED!)



Although this entry in the *Landscape* Photographic Competition didn't make it to the top ten, we couldn't let this contestant's important message go unnoticed - slip, slop, slap on a hat this summer - keep cool!



MORE ON MARRI

I enjoyed the article by Cliff Winfield in *Landscape* Winter 1989 but felt that there were some interesting highlights to add.

The origin of the attractive pink-flowering marri was not mentioned. There are a few trees growing in the vicinity of the old Tone Mill south-east of Manjimup and near Denmark and Walpole.

It was stated in *Forestry* in Western Australia (Bulletin 63, 1957, 1966) that sound marri timber was strong, elastic and durable. Marri fenceposts lasted about 20 years and treated marri sleepers, boiled in vats containing molasses and arsenious oxide, were tested in 1912 and had an average life of 25 years.

Forester Dick Perry, in an article entitled "*Eucalyptus calophylla* - The Tree of the Future" (Forest Notes 3.2 June 1965), listed marri's attributes. It:

- ♦ had very adaptable soil requirements;
- ♦ was more drought-resistant than jarrah;
- ♦ was relatively easy to establish;
- ♦ was very fire-resistant;
- ♦ produced a timber with an attractive grain that was strong, durable, easy to work and seasoned with a minimum of degrade;

- ♦ produced top quality honey in quantity;

- ♦ had a rapid growth rate;

I believe Gandy's sawmill at Manjimup cut nothing else but marri for years. Conservator of Forests Alan Harris (1953-69) had 25 buildings built from marri (five at Dwellingup). Today, some of the finest furniture is made from marri timber.

The attractive pink-flowering marri only grows in a few locations in the wild, but it is grown in many parks and gardens.

Photo- John Green

Dick Perry, who did valuable pine-breeding work, suggested that 20 or more trees "with top vigour, high quality boles and an absolute minimum of gum defects" be selected for a research program. He suggested locating and marking the stump after a log of outstanding quality was milled, so as to obtain scions for grafting from the resulting coppice. He said a pollinating program could also be conducted.

It is pleasing that a research program for breeding high quality marri timber is underway at last.

ANDREW THOMSON
WATERFORD

HILLS BELLS

There seems much to be said for W. Jackson's suggestion (*Landscape* Winter 1989) to set up a special display area of cultivated mountain bells (*Darwinia* species) for travellers to enjoy.

It has the twin merits of giving tourists an easy opportunity to see the much publicised "bells" while reducing some of the ever-increasing pressure on their native habitats.

Several species have been shown to be readily cultivated and *Darwinia meeboldii* and *D. oxylepis* are currently flowering in Kings Park's "rare and endangered plants" garden next to the glasshouses.

While the State is justifiably famous for its wonderfully diverse flora, too often over zealous tourist promoters fail to point out that, at best, the season lasts only a quarter of the year. Variable rainfall can also result in "good" and "bad" seasons. This combination of factors must often produce disappointed and disgruntled visitors who feel WA has failed to "come up with the goods". Any step that can be taken to offset this situation should be explored.

The suggestion is one such step that I am sure many conservationists would be keen to see put in place.

MACK SEALE
CLAREMONT

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Increases in
production costs have
forced an increase in
Landscape's price to \$3.95.

BUTTERFLY EXHIBITION

Some of the world's most spectacular butterflies and moths are currently on display at the WA Museum.

Long-tailed moon moths from South-East Asia, black and yellow birdwing butterflies from Asia, iridescent blue morphos from South America and swallowtails from Queensland are all included in the exhibition, entitled "Jewels of the Rainforest".

The equally impressive collection of insects ranges from pretty jewel beetles from the State's South-West and the world's largest beetle - the hercules - to bees and grasshoppers.

Most of the butterflies come from the extensive private collections of Perth collectors Bob Hay and Hugh Bollam, supplemented by the Museum's collection.

Dr Terry Houston, the Museum's Curator of Insects, says that the display has two main aims.

"The world's butterfly population is under increasing pressure. In many instances, populations have been considerably reduced; species like the birdwing are extremely rare and can be sold for hundreds of dollars," he said.

"This display of butterflies from rainforests, ranging from the Amazon to Asia, shows many beautiful creatures threatened with extinction as the forests are cleared and populations can no longer be sustained."

He said that the display of local bees and beetles highlighted the research done in the Museum's department of terrestrial invertebrates.

"Jewels of the Rainforest" opened in September with a special showing (followed by a week of parades) of a Liz Davenport fashion collection inspired by the butterflies.



The blue morpho butterfly is one of many species on display at the WA Museum.

Curator of Insects Terry Houston with some of the 'rainforest jewels'.

Photos- Courtesy of WA Museum



The exhibition is in the Museum's new Upper Beaufort Street Gallery and runs until the end of November.

Novelty items, posters, prints, books and hand-painted scarves are on sale in a special exhibition shop.

IN THE CAN

One of the entries for *Landscape's* photographic competition caught our eye.

Peter Buck, Magistrate at Fremantle Court House,

snapped this lizard that literally got stuck into the amber fluid up near Broome.

Peter, relieving as Magistrate in Broome recently, was travelling along a dirt track near Beagle Bay with the Sergeant-in-Charge of Broome Police, Les Stone.

Les spotted the lizard, zig-zagging all over the road in front of their vehicle, with its head firmly encased in an aluminium beer can.

The lizard was released from the can with the help of Magistrate Buck's pocket knife

and was returned to the wild none the worse for wear.

One can only imagine the torment endured by creatures that aren't lucky enough to be



spotted and rescued by passing motorists, as a result of careless littering by thoughtless people.

THE SALT OF LIFE

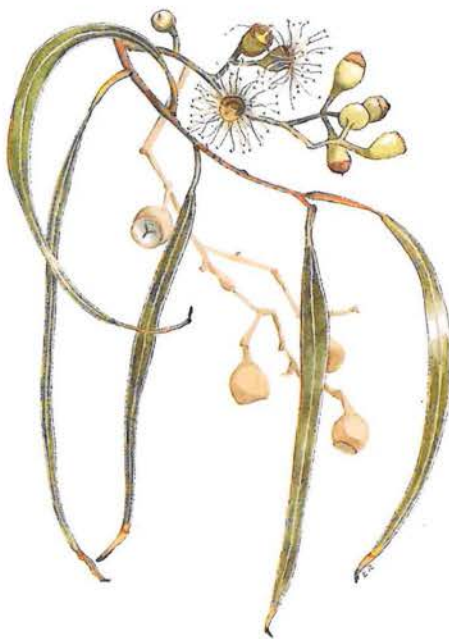
A Western Australian project to revegetate saline wasteland has produced trees so salt-tolerant that trials have been set up in Kwinana to irrigate them with seawater.

The five year old project combines screening and cloning technology from Murdoch University and the University of WA.

It is funded by Alcoa of Australia, the Federal Department of Industry Technology and Commerce and Neville Stanley studentships from the Technology and Industry Development Authority.

Seedlings are screened by subjecting them to varying degrees of salt and waterlogged conditions. The survivors are then cloned through tissue culture to produce plantlets with the same tolerance.

Salt-tolerant clones were first planted in WA in 1983. Today they are planted throughout the State and sold to government departments, farmers and conservation groups.



Eucalyptus citrioida

Illustration- Elizabeth Rippey (Courtesy of Alcoa of Australia Ltd)

Fifty thousand have already been sold this year with orders for more.

While Alcoa has funded the project since January, Federal Government funds supported the project for the previous three years. Funds are now being sought through the Government's National Soil Conservation Program.

Project research manager

Dr Paul van de Moezel says the project leads the world in cloning for salt tolerance.

The clones have enormous export potential. Clones have already been sent to California, Thailand and the eastern States (where the CSIRO in Canberra and Victoria's Department of Conservation, Forests and Lands are also developing salt-tolerant plants).

Countries such as Saudi Arabia are seeking plants that will grow in salt water so they can irrigate the land with seawater. India, Thailand, Middle Eastern and African countries have also shown interest.

Since the project began, more than 100 native species have been screened with the most tolerant species of eucalypts, casuarinas, acacias and melaleucas now being cloned.

River red gum (*Eucalyptus camaldulensis*) is the most cloned species. As well as being naturally tolerant to salt and waterlogging, it is tall, grows quickly, provides shelter and shade, and the timber can be used for fuel, pulp, posts and charcoal. It is presently planted in about 40 countries.

The Tasmanian bluegum and tagasaste - a shrub which acts as livestock feed in summer - have shown low salt tolerance.

Alcoa grows seedlings for the project from seed and passes them to the University of WA for screening.

The survivors are cloned at Murdoch University and the offspring multiplied to supply commercial orders.

Dr van de Moezel says the project aims to reclaim salt-affected land where virtually nothing else will grow.

Trials are being run on private land. About one hectare on each farm is ripped, mounded and weeded before planting. Clones are planted in June and July and their survival and growth is compared with unselected non-cloned seedlings.

This year 2 500 clones will be planted in trials in WA, and 10 000 in the eastern States.

Selected ectomycorrhizal fungi are being added in some trials. Specific fungi have been isolated and screened for their ability to improve growth and survival of clones under saline conditions.

CAT TALES

The northern quoll (*Dasyurus hallucatus*) is noted for its aggression and it's not hard to see why.

Its diet is varied and may include mammals, reptiles, insects and a variety of soft fruits.

It is found across northern Australia from the Pilbara region of Western Australia to the north-eastern coast of Queensland.

The northern quoll occasionally lives in or around man-made dwellings but is

most abundant in broken, rocky country with sparse vegetation.

The young are carried by the mother for 8-10 weeks. As many as one third of the young may be lost by September.

The remainder are suckled in the nest until they are about five months old, by which time the mother's nipples may be cut and infected because of her infants' sharp teeth.

Photo- Wade Hughes



RARE WALLABIES SIGHTED

Rare spectacled hare wallabies have been sighted further north than previously recorded in WA.

Two of the rare animals were recently photographed 170 km west of Kununurra on Gibb River Rd, near the Durack River Crossing.



Department of Agriculture staff Phil Wiese and Belinda Wyckstra saw the wallabies in their car's headlights after they stopped to wait for another vehicle. They showed the photos to staff at CALM's Kununurra office, who identified the animals as spectacled hare-wallabies.

While spectacled hare-wallabies are common on Barrow Island, they are now

rare on the Pilbara mainland and believed to be extinct in the State's tropical desert areas. They can still be found in parts of the Northern Territory and Queensland.

There have only been two previous recordings of the species in the Kimberley - one from St George Range near Noonkanbah Station in 1911 and one from 100 km south-east of Derby in 1958.

The spectacled hare-wallaby lives in tussock and spinifex grassland. In the Pilbara, frequent burning of this grassland by pastoralists has prevented the development of large spinifex hummocks required for shelter. On Barrow Island the animal spends the day in hides tunnelled into these large hummocks.

The species once occurred on the Montebello Islands, but became extinct there due to feral cats, well before the atomic explosions of the early 1950s.

It is a selective feeder, eating colonising shrubs and the tips of spinifex leaves.



Two rare spectacled hare-wallabies were recently seen way beyond their known range.

The wallaby tunnels hides into large spinifex hummocks.
Photos- Jiri Lochman



CONFERRING ON CORRIDORS

A major international conference was held in Busselton in September to examine the effectiveness of corridors of vegetation in wildlife management.

Entitled "Nature Conservation and the Role of Corridors", the conference followed a similar one held in 1985, which examined the role of remnants of native vegetation.

In Western Australian agricultural areas, little remains of the original native bush. If wildlife is to survive in farming areas, it will have to be in the patches of bush that remain, and it is important that they are connected by corridors of native vegetation to permit movement of wildlife.

The conference, from September 11-15th, was organised and sponsored by CALM, the CSIRO, the Main Roads Department and the Roadside Conservation Committee, with assistance from ALCOA and Westralian Sands.

It attracted a capacity attendance of 100 wildlife scientists, landscape architects, foresters, planners, engineers and members of the general public, from all over Australia and seven other countries.



Illustration- Tim Harvey

Five speakers reviewed areas such as values of corridors, movement of flora and fauna, inventory and management. Each day workshops examined topics related to the day's theme.

By bringing together scientists and managers, the conference helped to achieve a greater understanding of the value of bush corridors and how to manage them.

BOOK REVIEW

THE MAGIC of Kings Park has been captured in a new botanical guide, *Bushland Plants of Kings Park*.

Written by Eleanor Bennett, the book gives a complete detailed guide to the Park's native flora. It is illustrated with more than 70 beautiful paintings by Patricia Dundas and features a detailed history of Kings Park, a comprehensive map and colour

The Bushland Plants of Kings Park
Western Australia



photographs of the bush.

Divided into five major categories- trees, shrubs, twining, herbs and grasses- the book gives botanical and common names and is an excellent reference for plant lovers.

Bushland Plants of Kings Park is available from the Kings Park Board Office or all good bookshops for \$29.95.

The book was sponsored by Westralian Forest Industries.



ATTACK!

A rapid sequence of photographs captured a Swamp Harrier's unexpected attack on a Whistling Kite, depicting a rapid flurry of outstretched talons and thrashing wings.

The immature Whistling Kite, distinguished by its spotted plumage, was perched on a floating clump of grass when the Swamp Harrier, which had been circling overhead, dived.

Rather than attacking the kite, the harrier seemed intent on taking any food that the kite may have had. It circled around, wings still uplifted, examining the kite's talons.

After the initial shock, the kite, while watching the harrier intently, held its ground. The harrier, realising there was no food, departed.

The Swamp Harrier is found throughout Australia wherever there is suitable wetlands habitat, but is usually seen in the higher rainfall coastal areas.

The dark shape of the harrier usually sweeps low over the swamps, its distinctive white rump showing as it banks to circle. The prey consists of waterbirds and small mammals including rats. Carrion also attracts these birds, giving this opportunity for photography.

Lake-edge shallows with clumps of grass rising above the water provided a site where carrion could be left, easily visible to patrolling harriers, yet not accessible to cats or foxes.



A hide was built under a low shady tree at a distance at which a flying harrier would be sufficiently large in the photograph with a 350 mm focal length lens, or a standing bird with 500 mm. Many photographs of harriers and kites landing and feeding were taken over a period of several weeks.

STORY AND PHOTOS BY
MICHAEL MORCOMBE

1. The Swamp Harrier swoops down to attack.
2. The kite recoils in panic as the harrier attacks.
3. The wings held high; the harrier bullies the kite.
4. The harrier inspects the kite's talons to see if it has food to take.
5. The Swamp Harrier returns to its nest in reeds.

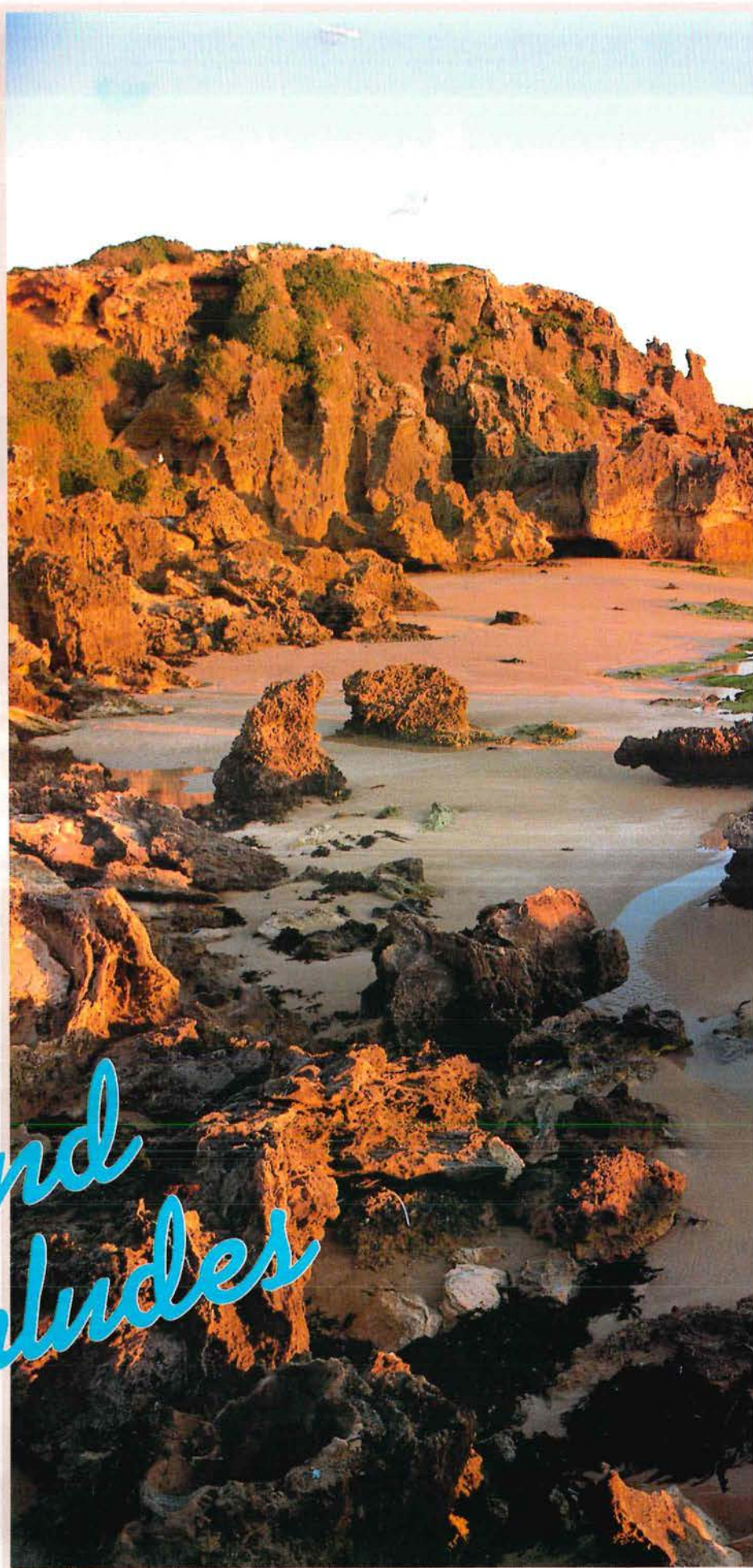


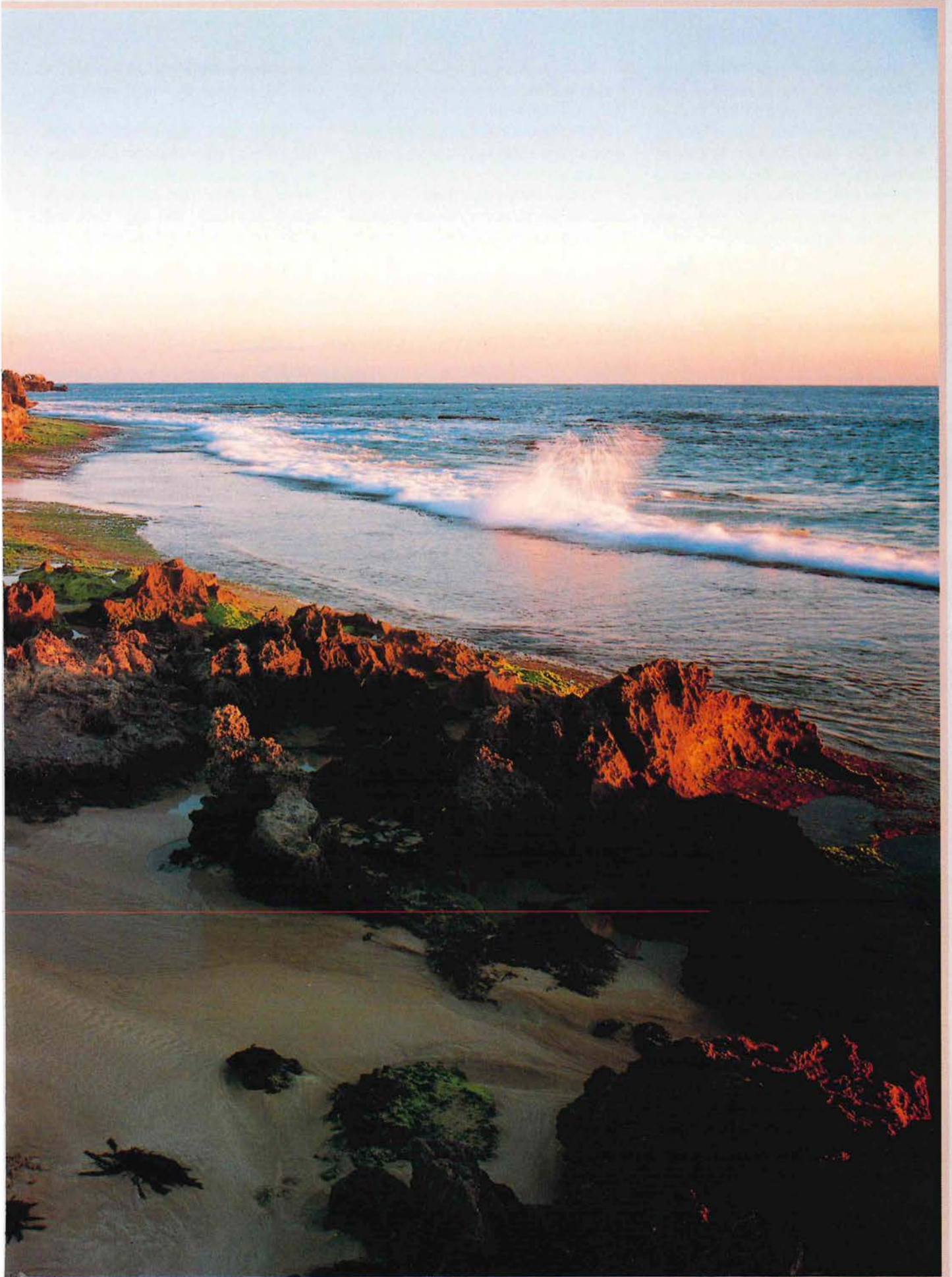
As
the first winter chill bites the
air, people around the world
chase
the sun to distant islands,
seeking refuge from the cold
weather.

Many islands off Perth's
coast are sanctuaries to
visitors
of a different kind; an array
of birds and animals.

Some
stay, others return home
after another peaceful
season
at their winter island resort.

Kylie **B**yfield
takes
a look at these unusual
tourists and
their...





Alex Bond

As the sun sets, squealing gulls wheel across the waves in search of food. Then night descends and hundreds of Little Penguins waddle ashore, heading back to sea again at dawn. As the day warms up, boats dot the sheltered bay and their colourful passengers spill onto the beach. By evening they have gone, leaving the animals in peace once more.

Such is the daily cycle of life on Penguin Island, one of a string of islands lying on Perth's doorstep. Its neighbours are Seal, Garden and Carnac Islands and several tiny 'rock' islands jutting out of the sea.

These islands are home to many animals. Some are permanent residents while others are travellers, pausing to

rest or breed before moving on with the seasons, perhaps to return again next year.

While each island has its own character, all are biologically significant and have high recreation, research and historical value. They are protected to ensure that they, and their flora and fauna, are cared for and respected.





More than 160 years ago, a navy captain on a voyage of exploration along the WA coast noted that Cockburn Sound possessed great attractions for a sailor in search of a port and a particular island had the potential to be developed as a naval base. Two years later, in 1829, the officer returned as Governor of the Swan River Colony and claimed the island as part of his land grant. Little did Governor James Stirling know then that, 149 years later, Garden Island would indeed become a naval base.

This 1214-hectare island is a gateway to history. Lying two kilometres off the coast at Point Peron, about 45 kilometres south-west of Perth, it was known to early Dutch navigators more than 300 years ago. In 1801, it was named Bauche by French explorer Captain Nicholas Baudin.

It was here that the first settlers arrived with Captain Fremantle and Governor Stirling in April and June 1829. They made their home at Cliff Head on the island's east side, sinking a well and planting the vegetable gardens that gave the island its name. Later that year, many of the settlers shifted to the mainland and founded Perth. Others remained on the island for several years, although the original settlement was destroyed by fire in 1834.

Since then, the island has served many purposes. During the First and Second World Wars, it was closed to the public and garrisoned by the army for coastal defence. It was also a training ground for the Services Reconnaissance Department ('Z Force'). Before and after the war, the island was a popular recreation site. Many holiday shacks were built on land leased from the Commonwealth and a ferry transported people to and from the mainland.

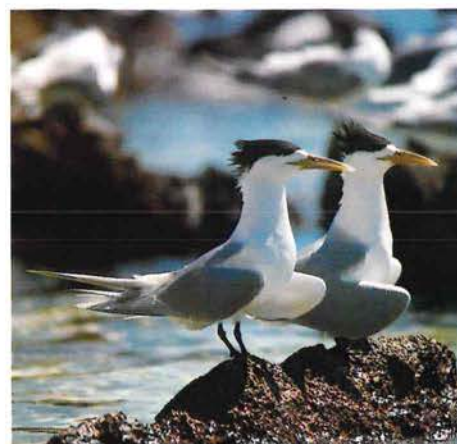
In June 1978, however, the HMAS Stirling naval base was commissioned and the island was handed over to the Navy.

The last holiday shacks were demolished in 1981.



Bottle-nosed dolphins (*Tursiops truncatus*) are often seen in Cockburn Sound near Garden Island.
Photo- Dick Beilby▲

During their nuptial period Crested Terns (*Sterna bergii*) develop complete black caps. After breeding the cap begins to moult and is replaced by 'eclipse plumage'.
Photo- Gerhardt Saueracker▶



Today, the island remains a popular recreation site. Although visitors cannot stay overnight for security reasons, they can enjoy about two-thirds of the island's coastline not used by the Navy. Some tourist coaches can cross the Navy's causeway, but most visitors can only reach the island by boat.

Daytrippers can laze on the peaceful white beaches, swim or sail in the bays or try to hook a fish. Toilets and barbecues are provided. The Department of Conservation and Land Management (CALM) plans to upgrade these in the near future. No walktrails are provided as visitors are not encouraged to roam the island because of the danger from tiger snakes.

Pillboxes and gun emplacements lie in dunes along the western shore. A memorial to the 'Z Force' has also been erected within the grounds of HMAS Stirling. Meanwhile, a memorial to the first settlers at Cliff Head maintains a quiet vigil over Buchanan Bay. From here, visitors can enjoy the view and peer down the settlers' original well.

Garden Island is covered in thick scrub which provides hidden homes for animals such as the rare tammar wallaby, the lined skink and the carpet snake.

Many species of birds, some of them rare on the mainland, also live here, including the Brush Bronzewing, which has disappeared from Rottnest Island and much of its former South-West range. Fairy Terns, Silver Gulls and Ospreys nest on the island and wading birds are occasionally seen.

The vegetation has high conservation values. Most of the island is covered in acacia, melaleuca, Rottnest cypress, Rottnest tea-tree and honey-myrtle. Most of the cypress and tea-tree grow on the northern half. One section has not been burnt for about 65 years and provides a valuable example of undisturbed coastal vegetation. The pure stands of Rottnest cypress on Garden Island are rare elsewhere.

Both the Navy and CALM have put a lot of effort into maintaining Garden Island's natural areas. The Navy has helped fund a number of protection programs for both fire management and noxious weed control. It has also funded research programs on the island's flora and the tammar wallaby.



Carnac Island lies about four kilometres north of Garden Island and, like its nearest neighbour, played an important role in the early settlement of the Swan River Colony. It was named by the then Captain James Stirling after his First Lieutenant, John Rivett Carnac.

On 25 April 1829, the ship *Challenger* ran aground on a reef in the rocky passage between the islands. Several weeks later, Governor James Stirling arrived in the new colony with the first settlers on the *Parmelia*. Impatient to get ashore, Stirling decided not to wait for a heavy ocean swell to subside - and the ship promptly ran aground on a sandbank just off Carnac Island. It is believed the settlers had to disembark in order to free the vessel.

The arrival of the settlers marked the beginning of the island's chequered history. In 1832, the heroic Aboriginal leader, Yagan, and two others were imprisoned on the island for allegedly killing one of the European settlers. Prison warden R.M. Lyon had instructions to find out about Aboriginal culture so the white settlers could negotiate a treaty of peace with the Aborigines.

All went well for a time until storekeeper John Morgan, on a regular voyage to deliver stores, was stranded on

the island due to stormy weather. When he woke the next morning the storm had passed, but his boat and the prisoners were gone.

Lyon had learned much about the natives, however, and in March 1833, he published Lyon's Aboriginal Vocabulary in the Perth Gazette. The Aboriginal name for Carnac Island was listed as Ngooloomayup.

Its prison days over, the island became the site of a whaling station in 1837. The industry was short-lived and operations ceased the following year. The island's history in the middle of the century is sketchy but it is known that a timber house was built in 1851. The island was gazetted as a quarantine station in 1884, but was not used as such until 1905.

The Commonwealth acquired the island for defence purposes in 1916, but transferred it back to the State in 1961 for the princely sum of 500 pounds. Two years later, the 17.2-hectare island was gazetted as an 'A' class nature reserve for recreation and the conservation of fauna - and it remains so today.



Carnac Island is an important resting area for Australian sea-lions. More than 30 bird species also inhabit the island, which is the northern limit of the Little Penguin's breeding range and the southern limit for that of the Wedge-tailed Shearwater in Western Australia. Large nesting colonies of Silver Gulls and Pied Cormorants are established here while Pied Oystercatchers, Bridled Terns and Ospreys occasionally visit. Dense vegetation is home to King's skinks and a large population of tiger snakes, which prey on mice and seabird chicks.

People also find the island an ideal rest point and many boats anchor in its sheltered bay on weekends and holidays. Daytrippers spill out onto the island's eastern beach while the surrounding reefs are popular for diving and snorkelling. Visitors are encouraged to respect the island and its inhabitants. Sea-lions should be treated with care as they can become aggressive when disturbed.

There is an intriguing story that Carnac Island's tiger snakes were released there in 1929. In 1981, research scientist Andrew Burbidge received a phone call from a Mr Bydder of East Fremantle. He said that as a young man he had known a Richard ('Rocky') Vane, who was well known as the seller of "Vane's Goanna Salve". He also kept many snakes and had a sideshow with a snake pit at a place called White City at the bottom of William Street. Vane occasionally allowed the snakes to bite him and his wife, to build up their immunity, but on one occasion his wife died. As a result, the Police closed Vane's show and ordered him to get rid of the snakes. Bydder accompanied Vane in a boat to Carnac Island, where he released between 70 and 100 tiger snakes.

Although Mr Bydder's story has not been verified by research, current genetic studies on the tiger snakes could provide the answers.

Visitors to Carnac Island should not leave the beach- venomous tiger snakes (*Notechis scutatus*) are common.

Photo- Jiri Lochman ▲

In 1827 the *Parmelia* became stuck on a sandbar near Carnac Island and 29 of the first settlers to arrive in the Swan River Colony were beached on the island to lighten the load.

Photo- Margaret Langley ◀





Windsurfers sometimes visit Penguin Island but most visitors prefer to relax and soak in the island atmosphere.

Photo- Robert Garvey ▲ ▲

Penguin Island has the largest breeding colony of Little Penguins on the west coast. ▲

Eccentric mining engineer, Seaforth McKenzie, lived on the island in the 1920s in caves he hollowed out from the limestone rocks.

Photos- Alex Bond ◀

Penguin Island

The year is 1924. A tall man with a shock of white hair and a 'goatie' beard stands on a rock above the swirling surf, frantically waving a floppy old army hat to greet people approaching the island in a makeshift sailboat. He helps them ashore and welcomes them to his kingdom.

The man is Seaforth McKenzie - the first person known to have lived on Penguin Island. The island, lying less than one kilometre off the Safety Bay coast about 55 kilometres south of Perth, takes its name from the Little Penguins which breed there.

The Canadian-born mining engineer lived on the island from about 1916-1925. Apparently disillusioned with life,

Seaforth found his way to the 12.5-hectare island early this century and quickly made it his own private Utopia. He made his home in hollowed-out limestone caves, one of which was christened 'The Palace'. Here, a ball was staged after Seaforth was crowned 'King of the Island' at a ceremony attended by fishermen and prominent Perth people. A lover of literature, Seaforth would often invite his literary friends to lamp-lit poetry readings in the 'library' cave.

Ill-health eventually forced Seaforth, described as the "bearded man with gallant manners and a twinkling eye", to leave the island. He lived on the mainland for a short time before returning to his previous home, New Zealand. There he died in May 1947, aged 87.

Today, the only reminders of Seaforth are some nails in the cave walls, a few gnarled fig trees, and an old well. But one of his traditions lingers on; people still escape to the island for relaxation and good times.

At one stage, part of the island was leased to a private company - Penguin Island Pty Ltd - which built shacks to house holidaymakers. When CALM inherited the island from the National Parks Authority in 1985, it also inherited concerns about the condition of the buildings and the impact people were having on the island.

In 1987, CALM bought out the lease, which was not due to expire until 1993, and now manages the island as an 'A' class nature reserve for flora and fauna conservation and public recreation. The shacks are gone, soon to be replaced by a small information and education centre and improved recreation facilities.

The island is closed each year during the penguin breeding season, usually from June to about October, when hundreds of Little Penguins come ashore at night to lay their eggs. But for the rest of the year, visitors can enjoy the island's beaches and surrounds.

Reefs open to the sea whip up waves for surfers, whereas boardsailers prefer to ride the wind on the mainland side. Divers and snorkellers explore the underwater world while others enjoy more sedate pastimes such as fishing, swimming, birdwatching or exploring on foot.

Many families pack a picnic lunch and catch a ferry to the island while boat owners make the short voyage in private craft. Some people choose to walk to the island across a sandbar, although this is extremely dangerous. Visitors are encouraged to help protect the island environment by not disturbing its animal and plant communities and leaving their pets at home.

The Little Penguins, the smallest members of the penguin family, nest in burrows in the sand, under dense bush or in rock crevices. They live in harmony with more than 30 other bird species, including the Silver Gull, Little Shearwater, Pied Oystercatcher and Pied Cormorant. The tropical Bridled Terns also migrate to the island in spring to breed.

The island's vegetation includes ground covers such as sea rockets, which anchor the otherwise mobile sand dunes and provide habitat for reptiles and other small creatures. Coastal wattie grows on the island's central dunes.



Penguin Island caters for many recreation activities that don't harm the environment, including surfing, diving, snorkelling, swimming and beach walking.

Photo- Alex Bond ▲



Walktrails are provided on Penguin Island to ensure visitors don't walk on the fragile vegetation and disturb the small creatures it shelters.

Photo- Marie Lochman ◀



People visit Seal Island in tourist ferries and small boats but should watch the wildlife from offshore.

Photo- Alex Bond ▲

Visitors to Seal Island should take care to avoid the Australian sea-lions (*Neophoca cinerea*) that bask on the beach and swim in the nearby ocean.

Photo- Jiri Lochman ◀

Penguin Island's nearest neighbour is Seal Island, about one kilometre to the north. It is gazetted as a nature reserve for the conservation of fauna, primarily the Australian sea-lions that use it as a rest point almost all year round.

Seaforth McKenzie occasionally sailed to this two-hectare island during his years on Penguin Island, landing on a small beach. Today's visitors must also come by boat, but they are encouraged to watch the sea-lions from offshore. The island has no facilities and its coastal vegetation is fragile.

ISLAND TREASURES

All over the world, islands provide some of the most popular tourist destinations and wildlife conservation areas. But forget the up-market sales hype: some fascinating islands lie on Perth's doorstep. Just ask the thousands of visitors - some human, some not - who have already enjoyed such an island interlude. □



ENDANGERED!



FOREST FROGS

Two endangered species of frogs, about the size of a thumbnail, are confined to small pockets of Western Australia's lower South-West. *Geocrinia alba* ssp. nov. and *G. vitellina* ssp. nov. - which are to be included on the list of gazetted rare fauna - are vulnerable because of their limited ranges and unusual breeding biology. Their survival can only be guaranteed with the protection of creek systems in the area.

Two other species of frogs are restricted to damp sites in the South-West: *G. rosea* and *G. lutea*. They have wider ranges and are not at risk.

G. alba is confined to a few sites in the Witchcliffe and Karridale areas. It is found in a forest corridor connecting the main forest belt along the Blackwood River to the coastal Boranup forest.

Much of this area is privately owned and subject to clearing for farming. Clearing and subsequent grazing destroys the frog habitat. Protection of suitable creeks in the area will be essential

to maintain the habitat and ensure the survival of this species.

G. vitellina, possibly Australia's most restricted vertebrate, is confined to small seepages on a few creeks north of the Blackwood River. Its total distribution is thought to be less than 30-hectares. Fortunately, this area is reserved land managed by the Department of Conservation and Land Management (CALM) and a special management plan to protect the frog's habitat is currently being prepared.

G. rosea, on the other hand, is widely distributed throughout the western section of the karri forest. It is separated from *G. lutea* by the Pingerup Plains, north of Broke Inlet. *G. lutea* is found only within 12 kilometres of Walpole.

Although usually found in creek systems, males at the centre of *G. rosea*'s range may be heard calling from rotting logs. Here in the karri forest, low sites and streamsides provide a suitable habitat.

Both *G. rosea* and *G. lutea* are found principally within national parks or State forest. At the centre of their range, they are able to survive fire and other disturbances without difficulty.

The four species of frogs can be easily distinguished by their brightly-coloured bellies. *G. rosea* has a red belly ('*rosea*' is Latin for red), while that of *G. lutea* is yellow, *G. alba* white and *G. vitellina* an egg-yolk colour. *G. rosea* and *G. lutea* males also have black chins.

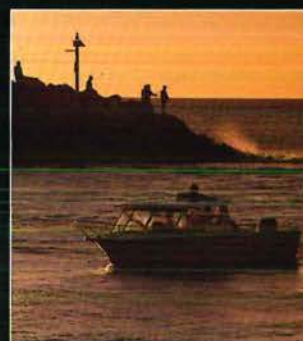
These frogs are unusual in that they never enter water, preferring to lay their eggs in moist soil depressions. When hatched, the tadpoles remain in the jelly surrounding the eggs, drawing on food reserves in the egg yolk. Other WA frogs share this unusual breeding biology, known as direct development.

GRANT WARDELL-JOHNSON
AND DALE ROBERTS

THE DAWESVILLE DILEMMA



to cut or not to cut



OVER the last 40 years, the Peel Inlet-Harvey Estuary ecosystem has come close to biological collapse. Phosphorus leached from farmlands has changed the estuary from a low nutrient ecosystem dominated by seagrasses to one that is nutrient-rich, contains excessive algae and is hostile to oxygen-breathing animals. The problem threatens to undermine two of the region's major industries: tourism and fishing.

Mandurah, the region's principal town, is a premier tourist resort. The town's economy relies heavily on attracting many of the 650 000 tourists who visit the South-West each year, spending more than \$80 million. However, the algal problem obviously detracts from the area's attraction.

The Peel-Harvey estuary supports WA's largest commercial estuarine fishery. While commercial catches of weed-eating fish such as yelloweye mullet, cobbler and sea mullet have increased, crustaceans and other fish species have decreased due to mass mortality caused by algae deoxygenating the water. Also, in algae-affected areas less productive gill-netting must be used because of poor water clarity.

Fishermen first brought the declining health of the estuary to light in 1960, when they complained of a slimy, red algae clogging their nets. The first complaints of weed fouling the shore came in 1969. Weed accumulation and decomposition has been a public nuisance of varying degrees ever since.

Excessive algae in the estuary detracts from its attraction as a popular tourist destination.

Photo - Alex Bond ►

Aerial view of the delta of the Harvey River which delivers phosphorus-enriched water into the inlet.

Photo - Robert Karri-Davies ◄

The Peel-Harvey Estuary is important for fishing, birdlife and recreation.

Photos - (from left) Alex Bond, Michael Morcombe, Alex Bond ◄



Phosphorus (used in fertilisers) has leached from farmlands and caused the growth of excessive algae in the Peel Inlet- Harvey Estuary. ▲

The Dawesville Cut, a man-made channel to the sea to improve flushing of excessive nutrients out to the ocean, is one of the options being considered by the State Government.

Photos- Alex Bond ►

The problem began with a type of weed called goat weed (*Cladophora*), but then other species, such as rope weed (*Chaetomorpha*), increased in abundance.

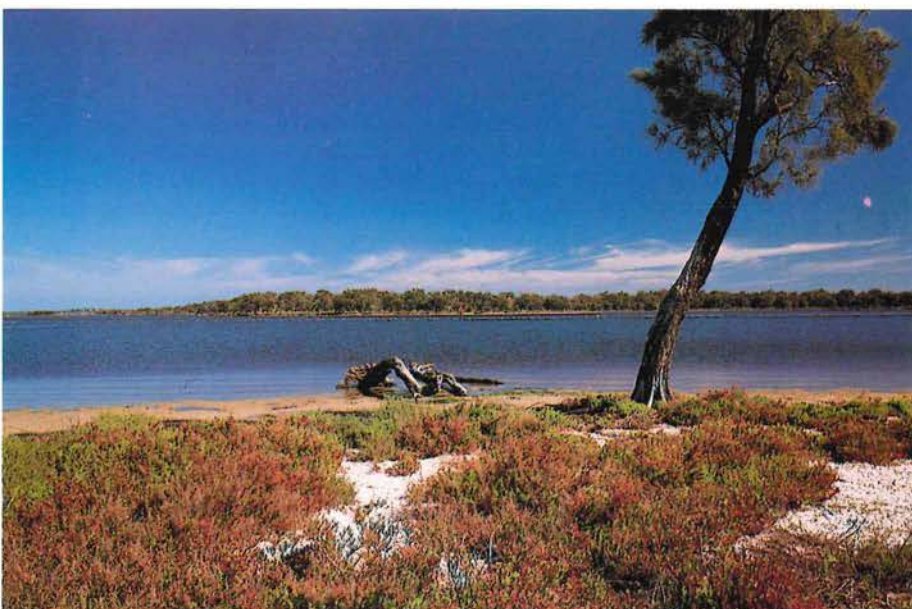


But these merely set the scene for the major villain: *Nodularia*, a tiny blue-green algae. *Nodularia* bloomed on a large scale in Harvey Estuary in 1973



and 1974 and its appearance showed that the severely disturbed system had taken a dramatic turn for the worse.

Scientific investigation of the problem began in 1976, when the Environmental Protection Authority (EPA) asked its Estuarine and Marine Advisory Committee to determine the cause of excessive algae in Peel Inlet and propose methods for its control. The Committee found that the abundance of bottom-living, large green algae (macroalgae) was caused by excess nutrients, derived from fertilisers used in the farming areas in the catchment of the estuary. It recommended that nutrient input to the estuary should be reduced by catchment management and, if possible, increased flushing of nutrient-rich water to the sea.



Nodularia bloomed again in the Harvey Estuary in 1978 and spread throughout the whole Peel-Harvey system in 1980, spurring an investigation into how to implement these recommendations.

A feasibility study was carried out by the University of Western Australia's Centre for Water Research to examine possible management options. Its proposals were adopted by the Peel-Harvey Study Group (with representatives from the Waterways Commission, the Peel Inlet Management Authority and the Departments of Agriculture, Marine and Harbours and Conservation and Environment), which published a report in August 1985.

The EPA assessed the Group's conclusions and published a report in December 1985, recommending a combined strategy of catchment management to control phosphorus inputs to the estuary and the construction of a new channel to the ocean at Dawesville, about 12 km south-west of Mandurah. Without the Dawesville Channel to flush excess phosphorus to the sea, it was felt that stringent catchment management would take so long to achieve a clean, healthy estuary that further environmental deterioration might make eventual recovery almost impossible.

Engineering studies for the Dawesville Channel are now underway, along with dredging of the existing Mandurah



Channel, catchment monitoring and management and studies of land use change on the coastal plain.

Essentially, the problem has two components: macroalgae and *Nodularia*. Macroalgae, referred to as "weed", grow on the bottom and float to the surface *en masse*. *Nodularia* grows as microscopic filaments throughout the water, but floats to the surface in calm weather to form a scum. Apart from

being ugly, the decomposing weed gives off high concentrations of hydrogen sulphide gas which has been blamed for serious illness in local residents and has an unpleasant smell.

Since 1974, the local authorities have used tractors equipped with rakes to clear weed from beaches. In 1983 a floating harvester, which collected weed in water deeper than half a metre was introduced. However, weed harvesting addresses the



Local authorities have resorted to using tractors to harvest the accumulating weed, but this addresses the symptoms, not the cause.
Photo- Alex Bond ◀

Red and green kangaroo paws are among the vegetation that grows in the Dawesville Cut area.
Photo- Alex Bond ▶

Banded stilts sometimes visit the Peel Inlet, where they feed on worms and small crustaceans in the shallow water around the edge of the estuary.
Photo- Michael Morcombe ▼

symptoms, not the cause. It has cost more than \$1 million over the last 13 years and is ineffective against *Nodularia*. Destruction of marginal vegetation by the tractors has caused considerable erosion of the shoreline.

The Peel-Harvey system is a shallow, coastal lagoon of about 133 square kilometres. The bottom is well lit and the water is inadequately flushed because its one opening to the sea, the Mandurah

Channel, is narrow and prone to silting and its river inflow takes place over only a few months of the year. These conditions are ideal for excessive algal growth.

Although only about 18 per cent of the whole catchment area is on the coastal plain, it contributes 90 per cent of the phosphorus which enters the Peel-Harvey estuary each year. Intensive agriculture



such as piggeries, market gardens and sheep holding yards have contributed most of the remaining 10 per cent. Only 60 tonnes of the estimated 143 tonnes of phosphorus that enters the Peel-Harvey estuary each year is flushed out through the Mandurah Channel. The remaining 83 tonnes stays in the system.

The amount of phosphorus entering the system is linked to the amount of rainfall in the catchment area. The last 10 years has been a period of below-average rainfall, so a return to normal or

above-average rainfall (such as winter 1988) will worsen the problem.

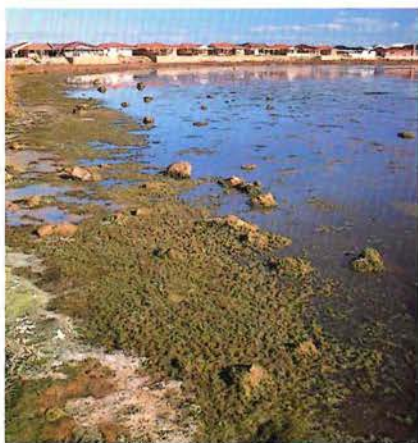
Because the sediments have become a rich repository of phosphorus, a cycle of sediment-plant interchange has evolved. In winter, tiny plants called diatoms bloom, trapping inflowing phosphorus. When they die and decay, oxygen is taken out of the surface sediments, releasing some of the phosphorus held in the sediments. This promotes *Nodularia* blooms in spring and early summer. When salinity increases in late summer, *Nodularia* dies out and macroalgae grow. When macroalgae decay over the sediment surface, there is a decrease in oxygen and subsequent phosphorus release from the sediments.

Over the past 12 years, several management options have been considered: weed harvesting, fertiliser management, conversion of land use from agriculture to forestry, a moratorium on further clearing and drainage, enlarging the Mandurah Channel, algicides, use of nitrate to control release of phosphorus from the sediments and construction of the Dawesville Channel.

In May 1988, the Peel-Harvey Study Group issued its Stage 2 Environmental Review and Management Program, which suggested a three-pronged attack: continuing weed harvesting, catchment management and construction of the Dawesville Channel.

In 1985, a survey of individual residents and community groups indicated majority support for a high-cost, immediate solution such as the Dawesville Channel. However, professional fishermen opposed the idea. They considered that proper dredging of the Mandurah Channel would provide adequate flushing. Concern was expressed that a new channel would complicate fishing operations and affect commercial catches. In 1988, submissions to the EPA on the Peel-Harvey Study Group's Stage 2 report, indicated a turnabout in public opinion. The majority of the 84 submissions were from the public and most opposed the Dawesville Channel. Concerns related to conservation, recreation, public health and the economic effects of the Channel. The general feeling seemed to be that it had been foisted on the public without enough exploration of other options. The Dawesville Channel would be 1.5-2 km long, 150-200 m wide and 4.5-6.5 m deep. The cost, an estimated \$35.6 million,





excludes land purchase. For a few years after construction, a further \$2.4 million would need to be spent each year on operation, maintenance and estuary monitoring, reducing to \$1.6-1.8 million annually after about five years. Construction would take three years.

Although it is the most expensive option, the Peel-Harvey Study Group believes that the Dawesville Channel is necessary to save the estuary from environmental disaster.

According to Waterways Commission scientist Rob Atkins, agriculture in the catchment area would have to be drastically reduced, if not eliminated, to

The sulphurous gas given off by the algae has been blamed for illness in local residents. ◀

The decomposing algae that accumulates on the Peel Inlets' shores is an eyesore. ▲

Only 60 tonnes of the estimated 143 tonnes of phosphorus that enters the Peel-Harvey estuary each year is flushed out through the Mandurah Channel.

Photos- Alex Bond ▶

Little Pied Cormorants, which nest in the fringes of the estuary, are among the rich birdlife the area supports.

Photo- Michael Morcombe ▼

achieve the same result as the Dawesville Channel: "This would be socially and economically unacceptable. The Channel is also insurance against future population growth."

The EPA has endorsed this view, as computer modelling has predicted that the Dawesville Channel will have more beneficial than detrimental effects on estuarine ecology.

The Channel will turn the estuary into a more marine ecosystem, as it was until 3 000 to 4 000 years ago when exchange with the ocean became obstructed, forcing a shift to a more estuarine ecosystem.

Proponents of the Channel claim that it would eliminate the worst aspect of the algal problem, *Nodularia*, through increased salinity, reduced phosphorus, clearer water and improved light levels.

Macroalgae would flourish with improved light levels, but only until sediment nutrient reserves were depleted. But macroalgae are more of a problem in human terms than ecologically since they are, indirectly, a rich food resource for crabs, prawns and fish and they provide cover from predators.

Other plant life in the estuary is likely to benefit from the Channel. Phytoplankton and benthic (bottom-living) diatoms are expected to adapt to a marine species composition and benefit from improved light and a larger intertidal area. Seagrasses would probably extend their range, while wetland vegetation would receive a more regular pattern of inundation and exposure.

The disappearance of *Nodularia* would mean better grazing for zooplankton and no more mass mortality of invertebrates such as worms, shrimps and molluscs; the main food of many birds and fish.

For fish and crustaceans, the Dawesville Channel would be another



Restoring Nature's Balance

Commercial tree farming is one option being considered by landholders to solve eutrophication of the Peel Inlet-Harvey Estuary.

So far about 1000 ha of cleared farmland in the Estuary's catchment has been planted with eucalypts by the Department of Conservation and Land Management (CALM) through its reforestation program.

The trees, whether grown by the hectare or as shelterbelts, use water that would otherwise carry phosphorus to the estuary and help solve waterlogging problems.

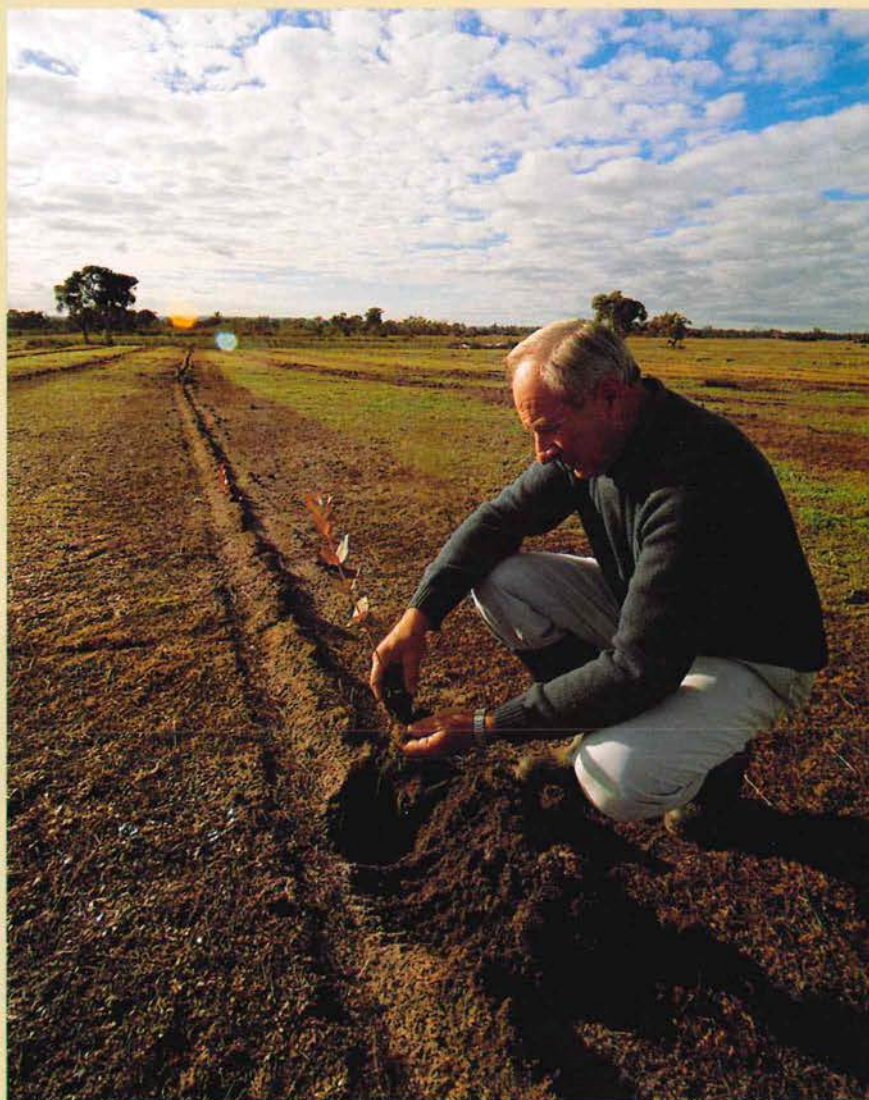
Owners of larger properties in the area have been quick to convert some or all of their farm to growing trees, while owners of smaller farms have been more hesitant.

Agriculture Department Senior Research Officer Ross George says some farmers have reservations about the economics and feasibility of tree farming. But he says if the economics are right farmers will join the scheme.

In its sharefarming reforestation program, CALM funds the planting of eucalypt trees on a farmer's property and pays an annuity to the farmer each year while the trees mature.

Species planted are all Australian eucalypts, including Tasmanian bluegum, false mahogany, ribbon gum and Sydney bluegum.

CALM Principal Research Scientist John Bartle believes tree farming is competitive with traditional agriculture. He says planting trees



Sir Donald Eckersley examines bluegum trees which are part of a 127-hectare planting on his farm at Harvey. This year CALM has planted 2 200-hectares of Eucalyptus globulus plantations in co-operation with farmers.▲

needn't change a farmer's lifestyle, as trees provide shelter for livestock.

John says some farmers have a negative attitude towards tree farming in the Peel-Harvey area, despite the scheme being oversubscribed by farmers in other regions.

CALM will undertake two to three years of further research and demonstration work with farmers to promote the "sustainable farming" option. This will see the planting of shelterbelts and other small areas for commercial use.

CALM is presently running trials in Baldavis with eucalypts to soak up effluent from piggeries.

route for migration and recruitment. The more marine conditions would favour a greater diversity of species. Most fish and crustaceans would adapt to changes in food species and tidal amplitude.

Birds are the most uncertain factor in the environmental equation. The Peel-Harvey estuary is the most important waterbird habitat in the South-West but not enough is known about the birds' diets and how they use the estuary. It is unlikely that the Channel would affect long-legged waders, waterfowl, rushdwellers and gulls at all. Migratory waders and fish-eaters would not be affected if additional roosting sites were constructed from dredge spoil. However, the estuary supports large numbers of resident waders which may be affected by the increased tidal variation limiting or interrupting their feeding.

Bob Kagi, Associate Professor at Curtin University of Technology and an environmental chemist, objects to the Dawesville Channel on three grounds. He claims it is too costly an option at a time when the State economy can ill afford it, aspects such as sand pumping mean that it is designed to fight nature and it is an incomplete solution.



Experts are not sure how the proposed Dawesville Cut would affect birdlife in the estuary.

Photo- Michael Morcombe ▲

The application of powdered limestone to the sediments in the estuary may be a possible solution to the algae problems.

Photo- Alex Bond ►

He feels that the Dawesville Channel became the major thrust of management proposals for the Peel-Harvey system before other options were thoroughly evaluated. These include establishing a buffer zone of trees around the southern Harvey estuary or a drain to divert as much phosphorus runoff as possible to the south, for example, through the Myalup Drain to the sea.

Bob believes another option, the application of powdered limestone to the sediments, should be further explored. Research by the EPA indicates that phosphorus is bound in the sediments by iron compounds. Adding limestone amends the pH of the sediments to approximate that of seawater, and

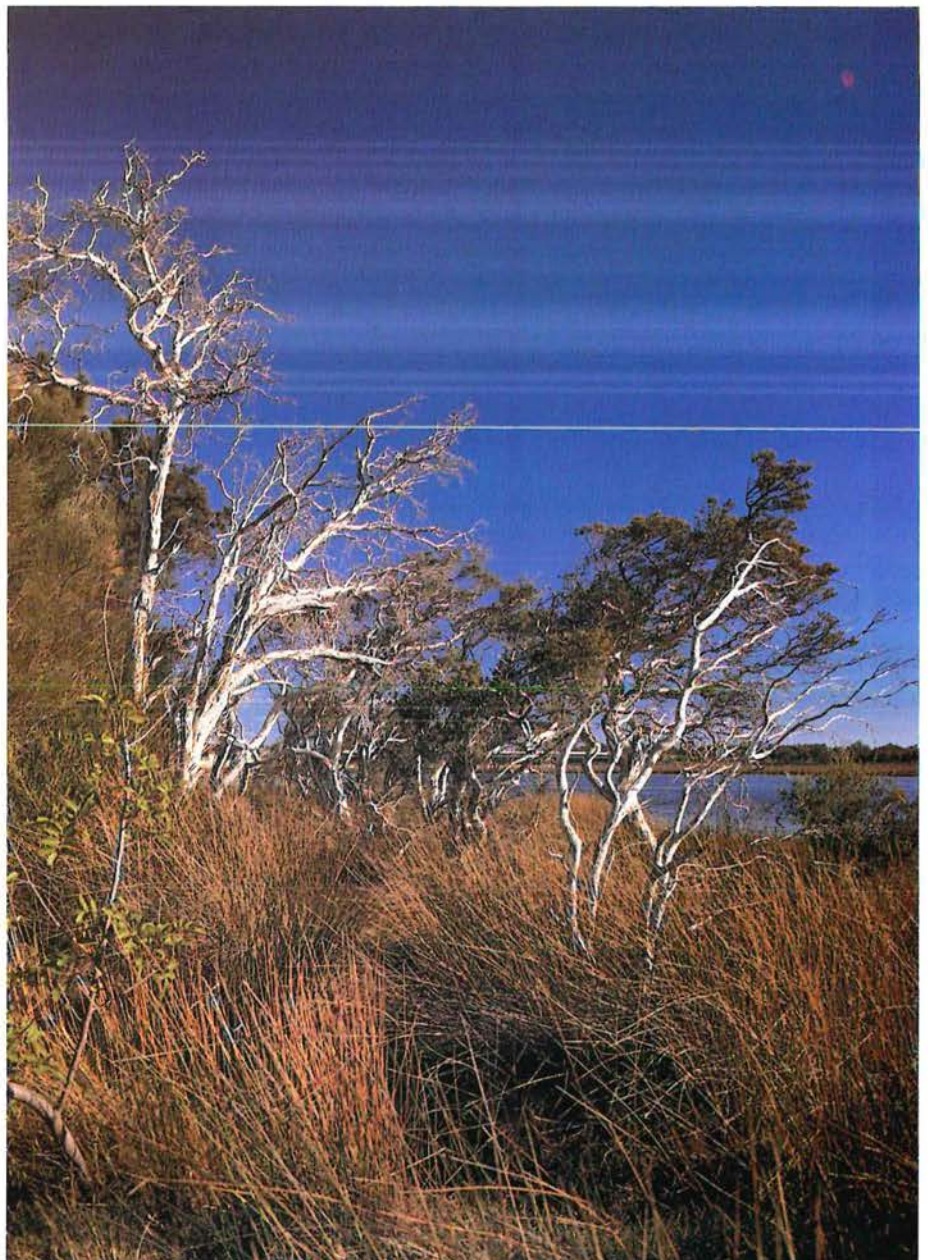
insoluble calcium compounds (apatites) form. When bound with calcium to form an apatite, phosphorus is rendered inert.

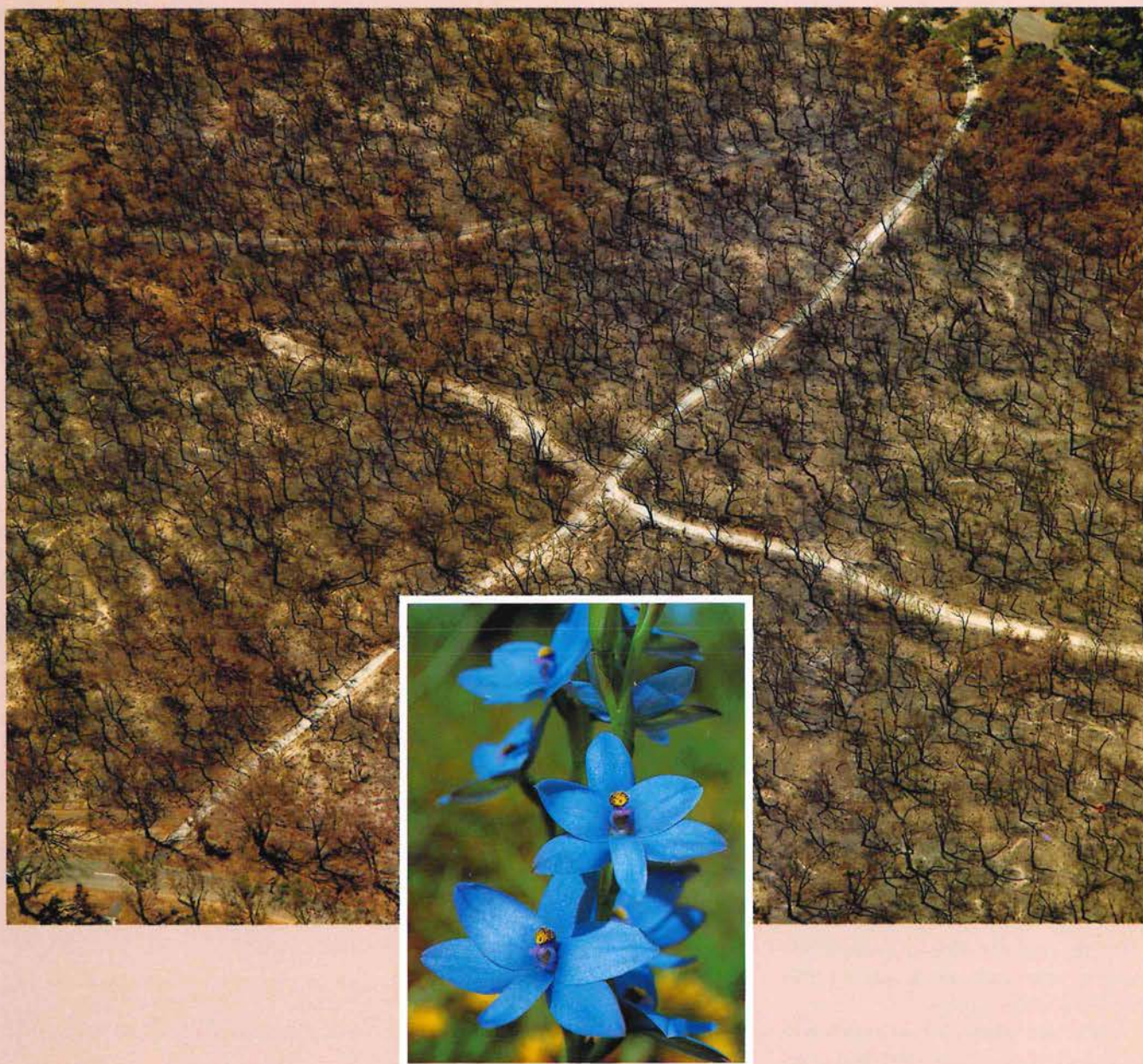
Bob sees this man-made option as running parallel to the natural system, as there is evidence that apatite is already forming in the estuary. He has obtained reports that indicate that phosphorus input to the Mississippi River is controlled naturally by the formation of apatites.

Earlier this year, the State Government put the Channel's construction "on hold", while the various options are reconsidered.

Time is running out for the Peel-Harvey ecosystem. The future will reveal whether the 'Dawesville Cut' is indeed the kindest cut of all. □

ANDREW BELL





KINGS PARK

Rising From The Ashes

Kings Park is ablaze with colour this spring. The fire that tore through the natural bushland earlier this year has given rise to the one of the best wildflower seasons the Park has ever had.

THE fire was extremely hot, completely burning the understorey shrubs, foliage and small branches of the trees. In some cooler spots, the canopy was only scorched but trees gradually lost their leaves over several weeks.

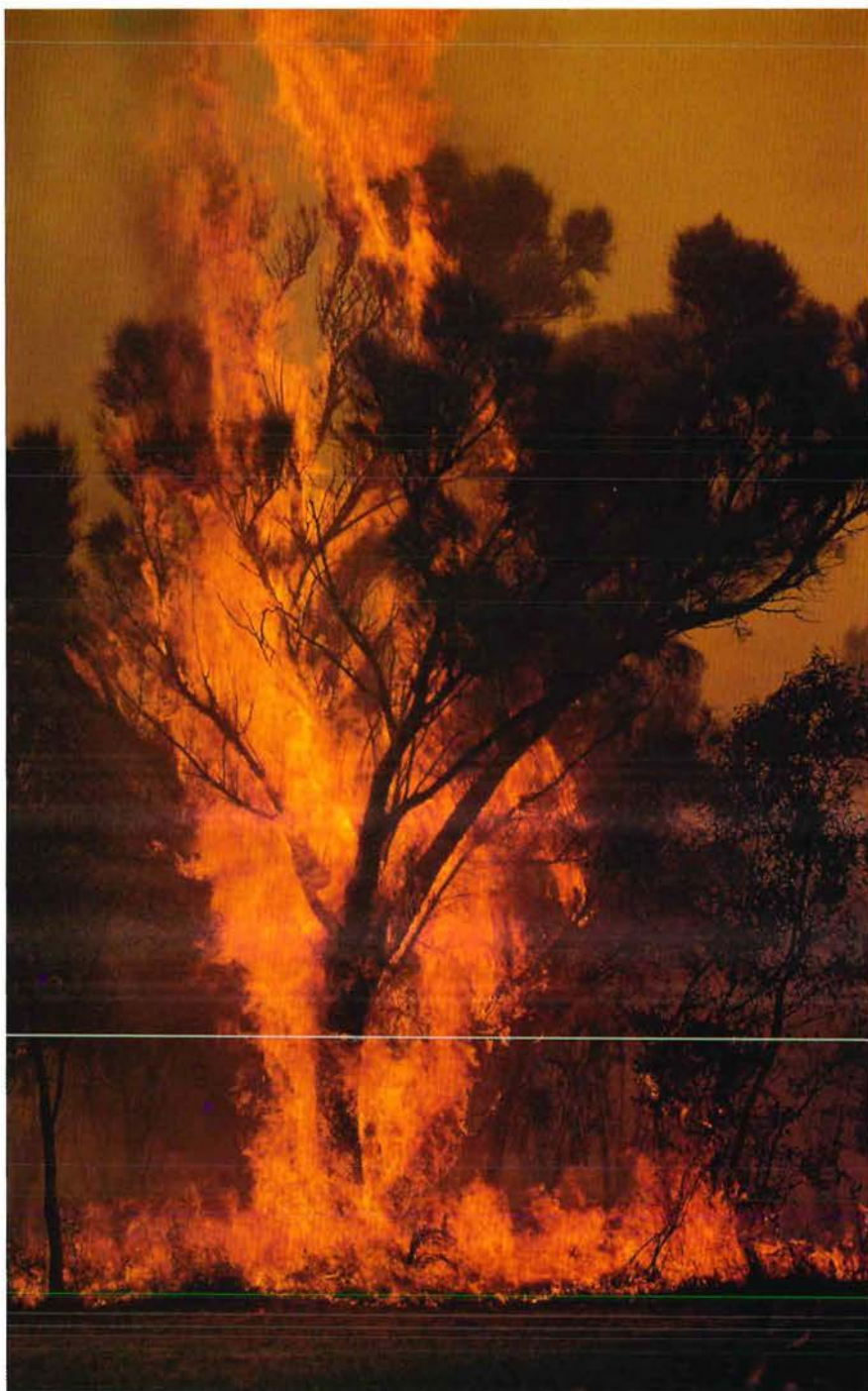
Fortunately, our native flora is well adapted to the occasional bushfire and many plants need fire to regenerate. Most larger trees in Kings Park, such as eucalypts and some banksias, have thick, protective bark which resists all but the fiercest fires. After fire scorches the crown, epicormic buds (special leaf-buds just under the bark of the trunk and branches) shoot out from the bark as clumps of foliage so the tree can carry out its essential functions.

The blackboy is extremely resilient to fire. Its trunk is made of a dense matting of burnt leaf-bases that protect the leaf buds. CSIRO Research Scientist Malcolm Gill has shown that flowering of blackboys is stimulated by fire.

Many species of native plants have massive rootstocks or tubers beneath the soil, and these burst into new shoots after a fire.

The fruits of many trees are hard, woody and highly fire-resistant, such as the 'honkey nut' of marri and the large woody fruits of the banksias. The heat from a fire will often split the fruit's casing and release the seeds inside them. Over the next few days, or weeks in the case of banksias, the seeds drop out onto the fertile ashbed below.

However, plants which regenerate only from seed, such as parrotbush, can be wiped out if the interval between fires is too brief. Some plants may take five years to produce their first flowers, so they need time to build up reserves of seed, either on the plant or in the soil.



Fire consumes a large sheoak tree in the Park. Fortunately sheoaks survive fire and recover with time.▲

Several roads had to be closed and the large crowds that had gathered to watch were kept from the danger area.◀◀

Firefighters had to wait for the fire to burn out when it reached Winthrop Avenue and put out spot fires that jumped the road.

Photos - Carolyn Thomson ◀

Previous page:

Aerial photo - Richard Woldendorp
Orchid photo - Andrew Brown



REGENERATION

About a month after the Kings Park fire, zamia palm leaves began to unfurl and blackboys started to regrow. New growth began to shoot from the trunks and branches of the banksias, eucalypts and sheoaks. Resprouting shrubs such as blueboy and pixie mops burst into new growth, from lignotubers protected by the soil. Many of the other species with stored food reserves in their tubers such as orchids and milkmaids or rhizomes (such as flax lily), start growing well before winter.

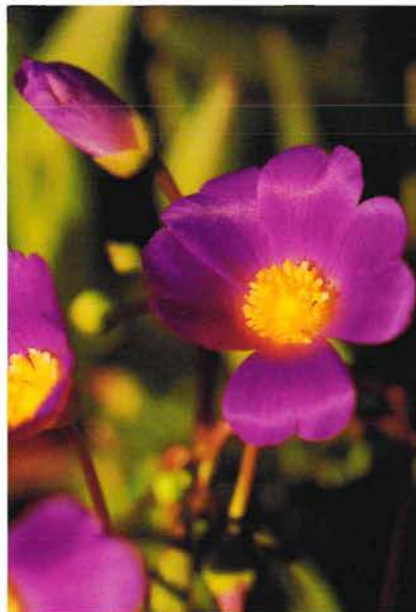
Because of the disappointing early winter rains of 1989, few seedlings germinated before mid-July, except for running postman. However, after this time, parrotbush, *Hakea prostrata* and kangaroo paw seedlings filled open areas left by dead trees and shrubs, although some ashbeds were still bare. Temporary plants such as parakeelya, slender lobelia and button creeper took advantage of the open conditions and extra nutrients from the ashbeds. These species may only be seen for one or two years after a bushfire, before they are shaded by perennial plants.

In August, the red and green kangaroo paws, swan river myrtle and several other shrubs began to flower on their new growth. Many others will flower in profusion because of the removal of the surrounding competition, whilst the red ink sundew, several species of orchids and blackboys are stimulated into flowering because of the production of ethylene gas during the fire.

In fact, Kings Park is shaping up to have one of the best native orchid displays on record. Twenty-nine species are known to occur in the Park. Many of these will

Above: zamia palm (*Macrozamia riedlei*).
Photo - Michael Morcombe ◀
Shoots from sheoak (*Allocasuarina fraseriana*).
Photo - Gerhardt Freudenthaller ▲
Jug orchid (*Pterostylis recurva*);
and donkey orchid (*Diuris longifolia*).
Photos - Andrew Brown ▶

Below: Parakeelya (*Calandrinia balonensis*);
Swan River myrtle (*Hypocalymma robustum*).
Photos - Michael Morcombe ▼



flower in greater profusion and some will only flower this season because of the fire. The absence of dense scrub also makes the diminutive species such as the flying duck and hare orchids much easier to spot.

Some species have already flowered and finished. In early September, the hare orchid, white bunny and banded greenhood contained large ripe seed capsules ready to burst. By mid-September, large areas of the bush were dotted with blazes of yellow when the cowslip orchid burst into full bloom. In a contrast of colour and form, the red beaks were in full flower. This is quite an event, as in unburnt bush they are seen only as large oval leaves, commonly called elephant ears.

By this time, the sweet fragrance of the tall leek orchid was noticeable, although the spikes of the black or green flowers look so much like the blackened remains of shrubs that they are often difficult to tell apart from a distance. Many other orchids, including the brightly coloured pansy donkey, dainty pink fairy, king spider, bird and blue lady add a touch of colour and beauty to the otherwise drab spaces between regenerating shrubs and trees.

The fire did cause many problems. There are many dead trees, some weed species have invaded the bush and the cost of controlling the fire was enormous. It will probably be many years before tree smokebush and other woody reseederers flower in the burnt areas.



Above: white spider orchid (*Caladenia longicauda*); purple enamel orchid (*Elythranthera brunonis*); bird orchid (*Pterostylis barbata*); and dwarf pink orchid (*Caladenia reptans*). ▲

Masses of cowslip orchids (*Caladenia flava*) are now abundant in Kings Park. Fire stimulates their flowering.

Photos - Andrew Brown ◀

Photo - Robert Karri-Davies ▼



MANAGEMENT PROGRAM

Kings Park Board has a program to overcome some of the problems caused by the fire.

Urban bushland remnants such as Kings Park are isolated in a sea of alien plants and altered landscapes and weeds are always present, competing with native plants for space and nutrients. During regeneration after fire, perennial weeds (especially veld grass and weeping love grass) which regrow from dormant buds and seed can outgrow reseeding natives.

Their dead leaves also increase the chance of another fire. To reduce this problem, the selective herbicide fusilade is being used in the bushland and quadrats set up to monitor its effectiveness.

In some areas, locally collected native plant seeds may have to be sown next year or, as a last resort, tube stock planted out.

The fire has also sparked several research projects. Tree death and regrowth is being monitored and permanent quadrats to study regeneration have been established. Studies on *Lobelia gibbosa* and orchids are also underway.

The Australian bush is much more fire-resistant than most people believe. With a bit of help, the Kings Park bush will recover, as it has from countless bushfires over the centuries. However, hot summer fires are a great risk to people, effect the appearance of the bush and make it vulnerable to weeds. It will be important in the future to try and prevent huge fires like the one in 1989.

BOB DIXON

LANDSCAPE PHOTOGRAPHIC COMPETITION

OVERWHELMING! That's the only way to describe the response to the *Landscape* photographic competition. Four judges had the difficult task of selecting winners from over 500 entries. Photographs were judged on aesthetic appeal, technical quality, subject matter and degree of difficulty.

The quality of entries was excellent; the winning photographs are shown on this page and a selection is published overleaf.

Winners in each category will receive a KONICA CV colour video recorder valued at \$899 and runners-up a KONICA Jump 35mm weatherproof camera worth \$169.

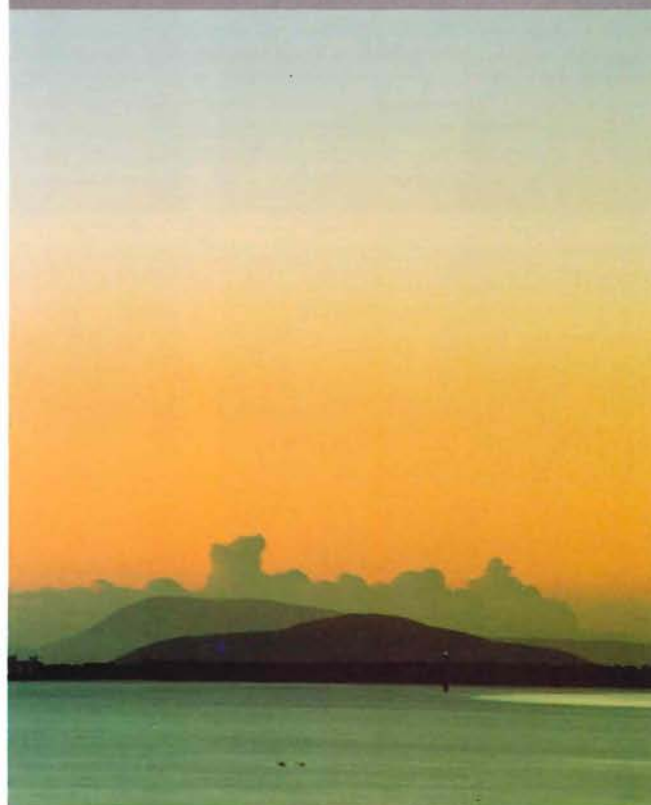


WINNER - WILDLIFE



WILLIAM JACKSON - WALPOLE

WINNER - LANDSCAPE



RUSSELL PEARSON - ESPERANCE

RUNNER-UP - WILDLIFE



GEOFFREY ROGERSON - DENMARK

RUNNER-UP - LANDSCAPE



JACQUI WILLIAMS - FORRESTFIELD

PHOTOGRAPHIC COMPETITION

PICK OF THE PICS



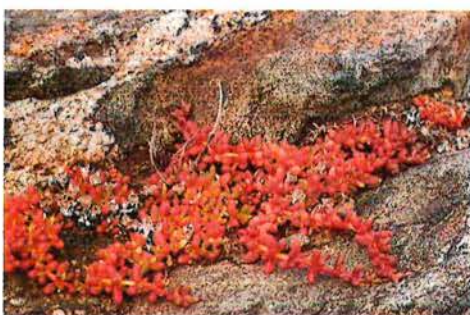
DENNIS OMEARA - LEEDERVILLE



KIRSTY BROWNE-COOPER - SWANBOURNE



MARK BLOWERS - KINGSLEY



PRISCILLA BROADBENT - MT BARKER



HELEN TAYLOR - HOPETOUN



BERNIE WARD - FORRESTFIELD



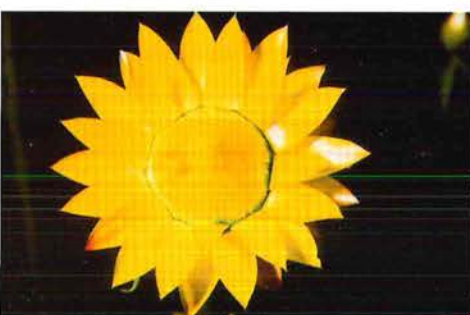
WILLIAM HALL - MT PLEASANT



COLLEEN HENRY-HALL - COTTESLOE



NANCY DAWS - MUNDARING



DERRY DALZELL - GREENWOOD



KELLY DENTON - KATANNING



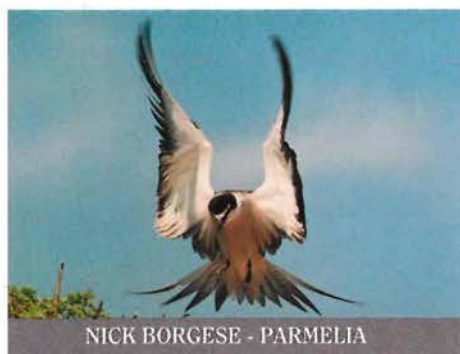
NOELLA ROSS - BULLCREEK



SAM WARD - BICTON



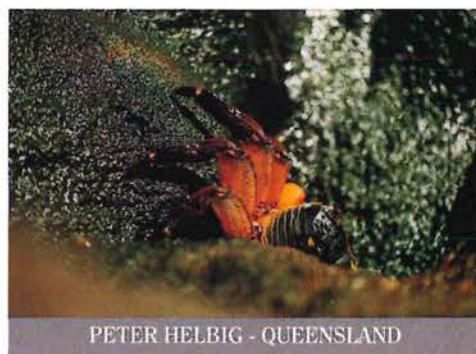
BARBARA MADDEN - ALBANY



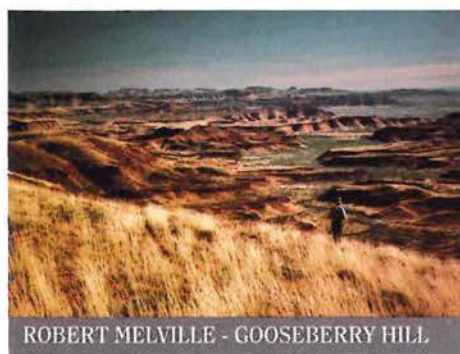
NICK BORGESE - PARMELIA



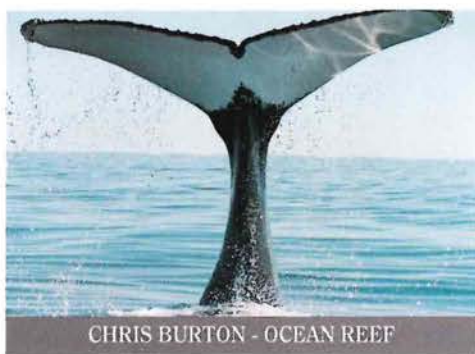
CRAIG MELDRUM - MUNDARING



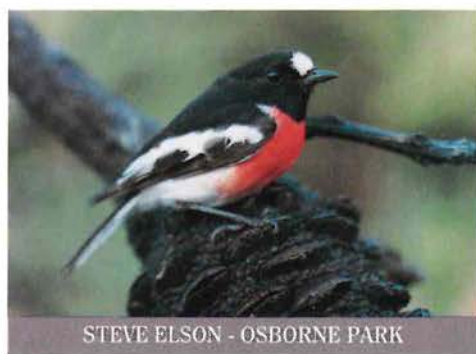
PETER HELBIG - QUEENSLAND



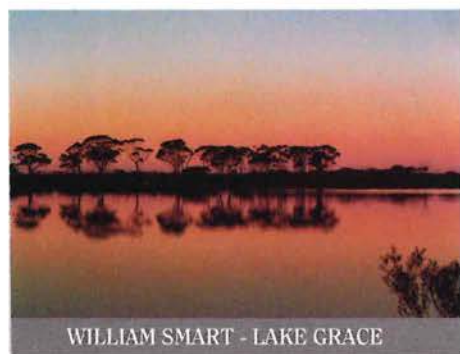
ROBERT MELVILLE - GOOSEBERRY HILL



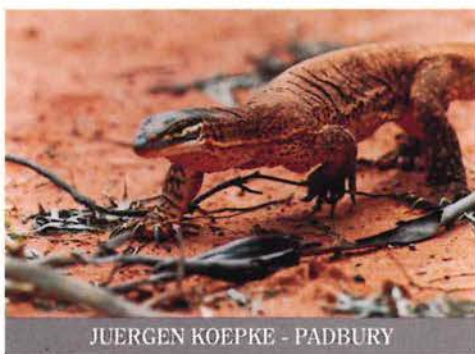
CHRIS BURTON - OCEAN REEF



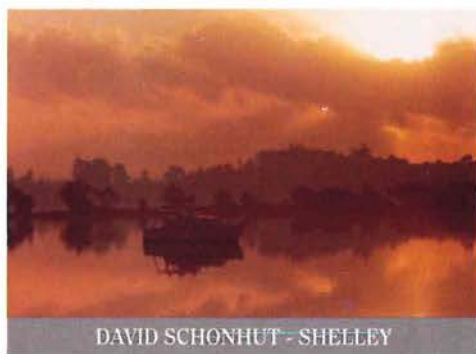
STEVE ELSON - OSBORNE PARK



WILLIAM SMART - LAKE GRACE



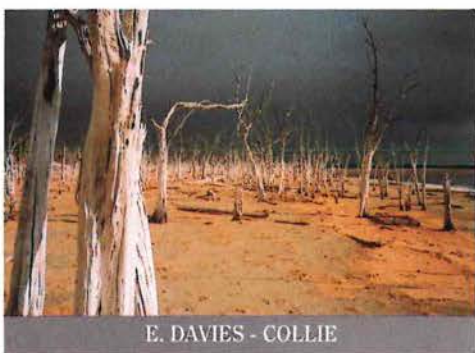
JUERGEN KOEPKE - PADBURY



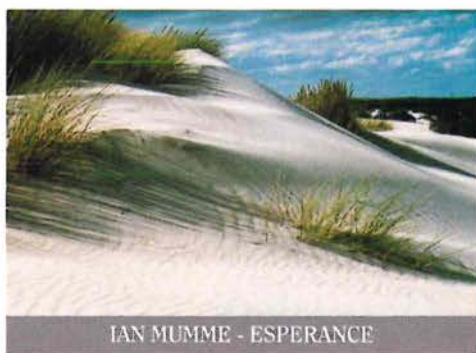
DAVID SCHONHUT - SHELLEY



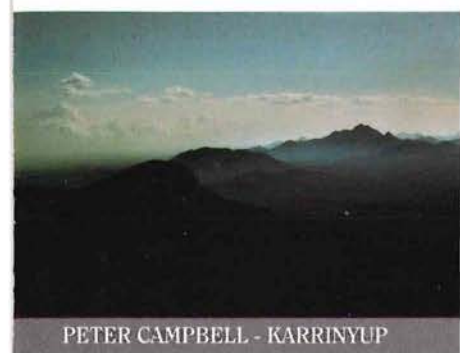
JON PRIDHAM - MANDURAH



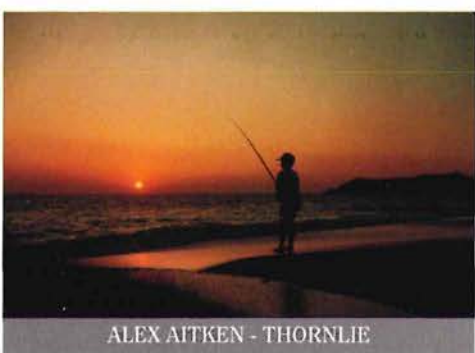
E. DAVIES - COLLIE



IAN MUMME - ESPERANCE



PETER CAMPBELL - KARRINYUP

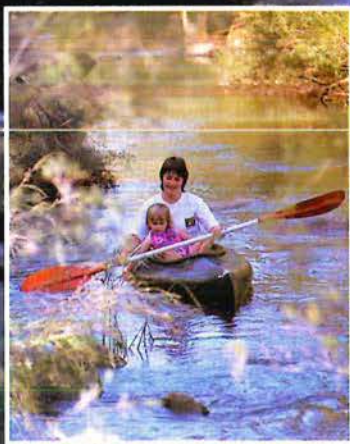


ALEX AITKEN - THORNIE



KENNETH ELSE - DENMARK

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STILL WATERS

What ancient mode of transport this; canoeing. Evolved from carved logs to coloured fibreglass and plastic, no longer ferrying us to new continents or new hunting grounds, the canoe is a means of exploring wilderness areas fragile to human feet. Instead of new shores we seek solitude in the bush, on rivers, lakes and estuaries. Many watery trails snake through Western Australia's dense forest, woodlands and coastal heath.

CALM's Tammie Reid explores the waterways of the South-West by open Canadian canoe, paddling waters first disturbed by Europeans more than a century ago.

ACROSS the sedges drapes a jewelled spider's web.

As the canoes glide underneath we're still in the karri forest...tall, looming and moist. The still waters are cold. Debris brushes our boats and the smell of wet leaves and damp earth taints the air. A western grey fantail flits from branch to twig...what are we doing in her territory?

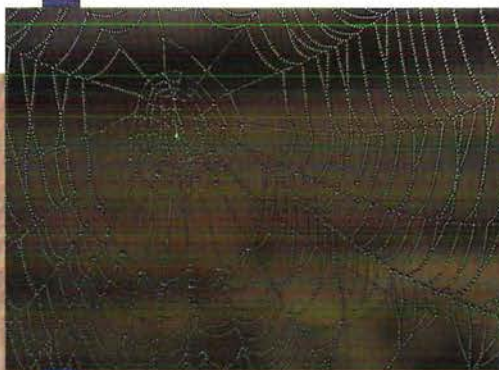
Our three Canadian canoes are laden with gear stowed in black watertight drums. We have fresh water on board as the coves and inlets we plan to paddle are too salty for drinking, due to tidal influence and upland agricultural clearing. In the same area only 150 years ago, explorer Nairne Clarke noted in his diary that the same rivers yielded sweet fresh water and refreshed his party.

We're paddling down the Deep River to Nornalup Inlet. There we'll find a protected campsite for the night, then canoe up the Frankland River to our car which we shuttled into place earlier on.

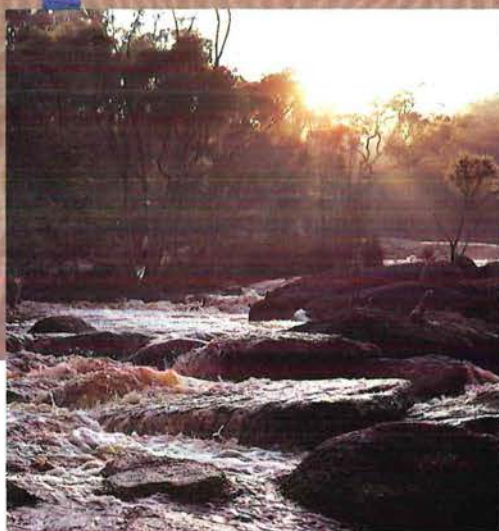
As the river nears the inlet, the vegetation on the banks begins to change from shady eucalypts to open, tufted sedges, paperbark sentinels and thick rushes. After a few hundred strokes we pass over the river delta and the estuary expands before us. Here the waves can be rough and our canoes have little freeboard. The danger of sinking is real.

We decide to lunch on the beach of a sandy island. Its resident pelicans paddle off to a safe distance, agreeing to share their patch.

Refreshed and with new layers of sunscreen, long-sleeved shirts and floppy hats, we push off to continue. The breeze has freshened and one of our



Dew pearls spell a sticky end for river insects.
Photo- Hans Versluis ◀



Rapids can be an exciting obstacle but are best avoided if you are inexperienced.
Photo- Hugh Chevis ◀

A two-person Canadian and single kayak explore the Frankland River. The open design is used for more recreational paddling- the single kayak is enclosed so the canoeist can eskimo roll.
Photo- Photo Index ▼



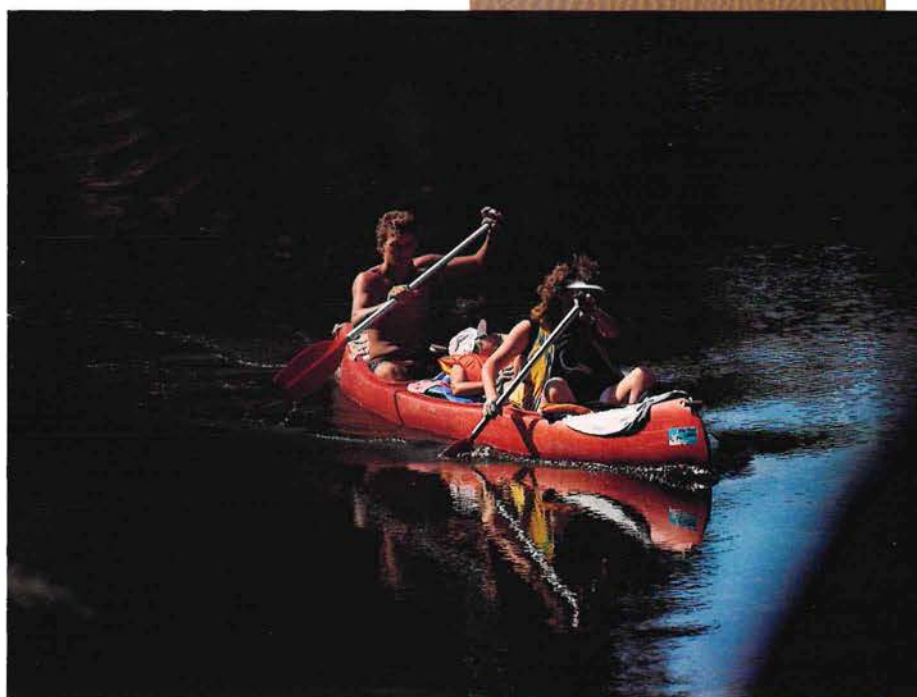
crew jokes about the sense of sailing - and why not? My arms could do with a rest. Soon we've rigged up a spinnaker by lacing the tent flies and rafting the three boats together, using paddles as spars with steering oars at the back.

We make good speed but can only travel downwind, which suits us for the moment. Canoeing was never meant to be so easy and we pay for it as we separate to paddle across wind to our campsite on the leeward side.

One canoe fills and sinks. The buoyancy tanks keep it off the bottom and the watertight drums bob about. The wet, bedraggled crew gather their chattels and flop back into the rescued boat.

The murky bottom slowly gives way to shallows. We have to get out and pull our canoes over the last 500 metres to shore. After unpacking for the night's camp, one canoeist pulls out a fishing rig and paddles off to catch a tasty morsel or two.

As the wind drops, the setting sun silhouettes karri tops on the far knolls. Ospreys have been known to nest there, but we haven't seen any soaring overhead or fishing yet.



That night I tell the story of Preston, an early explorer who sailed by this coast 150 or so years ago in a flat-bottomed whaleboat that had oars and a small sail, but like ours, too little freeboard. His party was forced to land at Point D'Entrecasteaux in seas so heavy they couldn't get off again. They finished the voyage on foot, walking all the way to the mouth of the Murray River - now Mandurah. It makes our capsize today seem insignificant.

Another day dawns. We all sit expectantly around the billy, still tucked inside our sleeping bags. After a leisurely breakfast, people head off to the inlet mouth for a body surf, paddle off to catch herring for the pan or stroll across the dunes to the Southern Ocean less than a kilometre away. No one is in a hurry, as this is our last day.

Packed up, we head across the inlet towards the mouth of the Frankland River. My arms and shoulders have a dull ache as the strokes can only be varied by changing sides and not rhythm.

The paddle upstream is easy, but hot, as the sun climbs higher and the seabreeze refuses to come in. One paddler abandons ship to cool off and we all stop for a swim.

We negotiate the last broad river bends in silence as each person soaks up the tranquility of this beautiful national park. Paperbarks give way to karri forest and the river again turns to a deep satin

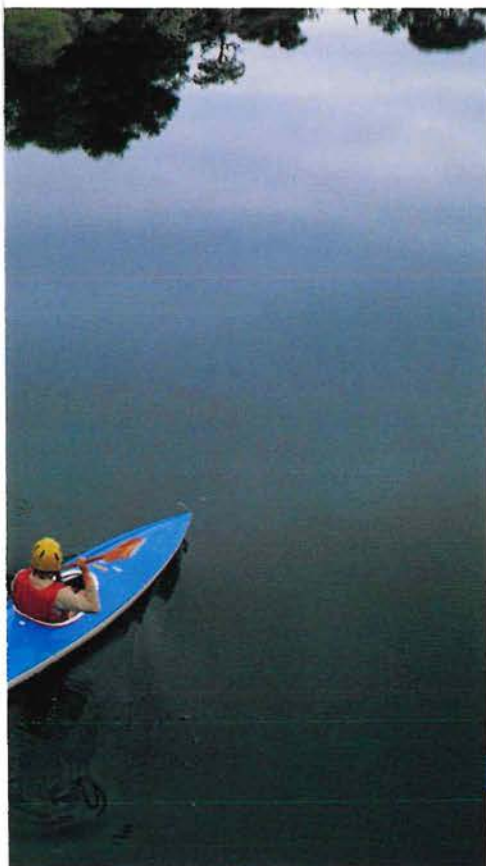


Canoeing is an activity for all the family.

Photo- Robert Garvey▲

Limbo on the Warren River; it's not all plain flat water paddling.

Photo- Photo Index▲



brown, stained by the tannins of rotting leaves and bark.

At journey's end canoes are tied on roof racks, clothing bundled into the boot...another memorable paddle on the rivers and estuaries of the South-West is over.

There will be many other trips on watery trails that gurgle and swirl as the paddle dips in and out....

PADDLES UP - FUN FOR ALL

Canoeing is a year-round activity suitable for people of any age or ability. You don't have to have your own boat, just the desire to learn new skills, meet new people and make the most of the many peaceful waterways the State has to offer.

To start with you can join a club in Perth, or hire canoes on scenic rivers. It's not all flat water though. Western Australia boasts many fast-moving rivers that offer heart-stopping whitewater adventure.

If you enjoy the thrills of shooting rapids there are seasonal slalom and rapid races at Harvey and on the Avon River. Many Western Australians are already familiar with the annual race



White-water canoeists negotiate ti-trees and rocks.
Photo- Kerry Cook ▲

through the Avon Valley from Northam to Bayswater - the Avon Descent.

Canoe touring is also popular. This is a more leisurely paddle through country that you otherwise wouldn't get to experience. Groups of three or more plan a route, pack all necessary equipment (camping gear, life jacket, first aid and survival kit, spare paddles, map, warm clothes) and more than enough food. Cars are shuttled to the finish and authorities and/or friends told about the length of the trip and given check points.

Trips like these are full of fun and discovery. For safety, canoeists should always paddle with at least one partner - preferably someone experienced. Buoyancy vests (and helmets for



Canoeists just want to have fun - wearing buoyancy vests just in case.
Photo- Photo Index ◀

Trees in fast-moving water are a hazard to be avoided.
Photo- Lachlan McGaw ▼

When the paddle's over it's time to pack up and relax.
Photo- Lachlan McGaw ▼



whitewater) are a must, and you should be able to swim confidently.

Always allow for a change in weather and dress accordingly. It doesn't take much wind or cold water to chill - the result can be hypothermia. Pack plenty of water too, dehydration is another killer.

Some of the most paddled rivers suitable for novice canoeists in the South-West are the Swan, Murray, Warren and Blackwood.

The Swan stretches 12.8 km from the Upper Swan Bridge to Middle Swan Bridge near Great Northern Highway. It can be paddled in a day.

The Murray River lies south of Perth, emptying into the Peel Inlet. The lower Murray can be paddled in two to three days, covering 40.6 km. Overnight camping facilities are available.

The Warren is a picturesque river starting from the South Western Highway amongst karri forest, ending near Pemberton in the Warren National Park. Excellent campsites exist along the river banks. The 45.7 km trip can be paddled in two to three days.

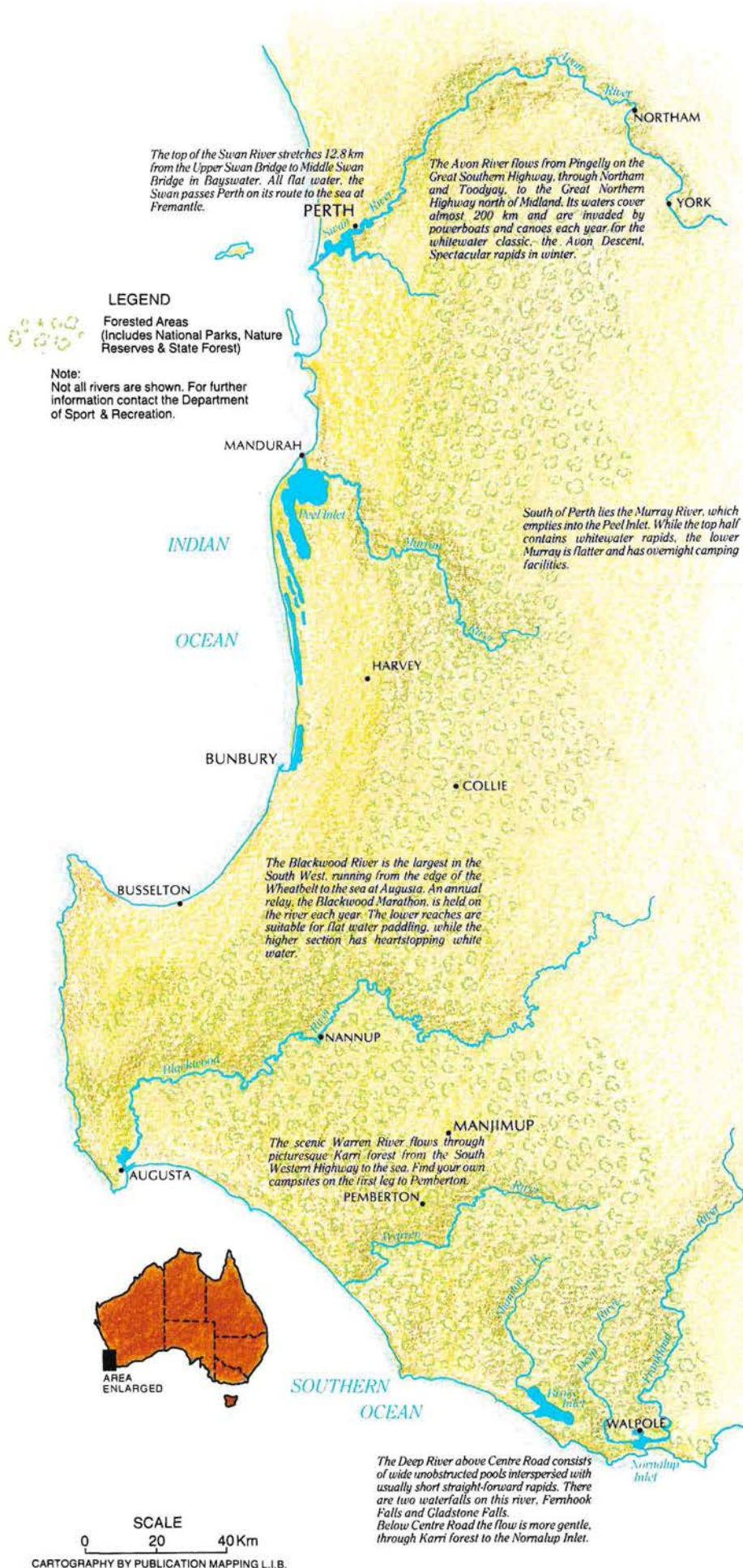
The Blackwood River is the largest in the South-West. A good canoeing section, nearly 46 km long, winds from Blackwood Bridge at Nannup to Darradup Bridge near Augusta.

Maps on these rivers are available from the Department of Sport and Recreation, but it is advisable to double check with the local Department of Conservation and Land Management (CALM) office before finalising arrangements. Roads shown on maps can be temporarily closed or impassable.

Perth has four canoe clubs affiliated with the Amateur Canoe Association of WA (ACAWA): Swan Canoe Club, Ascot Kayak Club, the University Canoe Club, Darling Range and Tertiary Education Canoe Club. □

TANYIA MAXTED

For further information contact ACAWA c/o Multisport Office, PO Box 28 Wembley 6014, telephone 387 5756. Canoe tours can be booked at the WA Tourist Centre at 772 Hay St, Perth or by telephoning 322 2999.



A photograph of a jarrah forest with several tall, slender tree trunks in the foreground and a dense canopy of green and yellowing leaves in the background. The text 'TREE KILLER' is overlaid in large, bold, red letters with a black outline.

TREE KILLER

THE FIGHT AGAINST JARRAH DIEBACK

by Bryan Shearer and Ray Bailey

In 1922, patches of dying jarrah were noticed in the Darling Range near Karragullen, 35 km south-east of Perth. This was the first sign of what became known as "jarrah dieback", a disease that has since caused the death of thousands of hectares of WA's unique jarrah forest.

THE FIGHT AGAINST JARRAH DIEBACK

FOR half a century, the confusing behaviour of jarrah dieback was a big frustration for researchers. Susceptible understorey plants in affected areas died every year, yet jarrah died only sporadically. Then, for no apparent reason, swathes of forest would suddenly collapse. A forester would note the limits of a patch of dead jarrah, only to return in a fortnight to find the devastation advanced by as much as 50 m.

The destroyer was finally identified in 1965 by Dr Frank Podger as a killer fungus, *Phytophthora cinnamomi*. The disease is incurable, and has laid waste to large areas of trees, shrubs and plants in other parts of the world. Massive research was needed if the problem was to be curbed. The questions facing researchers were: How do we stop the fungus spreading? How do we detect it in the soil? How do we manage it, or even cure it? And how does it kill?

STOPPING THE SPREAD

Quite unknowingly, people spread the fungus throughout the South-West by moving infected soil. For example, before the fungus was identified, gravel from dieback areas was used in road construction. From the original small dead patches, the impact of the disease increased in range and severity. An estimated 280 000 ha of Crown land were infected by 1977.

QUARANTINE

A comprehensive hygiene management program was developed in the late 1960s and large areas of forest were quarantined. Vehicle access was controlled by closing roads and restricting entry when damp soil was likely to stick to wheels and machinery. Washing down equipment became standard practice.

By preventing new infections and allowing existing ones to run their course, quarantine also aided the accurate mapping of disease distribution.

MAPPING

In the late 1970s, the development of 70 mm shadowless colour aerial photography greatly increased the accuracy of detecting and mapping disease distribution. Disease boundaries could be accurately plotted onto 1:25 000 maps,



Mass collapse of jarrah occurred in the 1960s, 1970s and 1980s after summer rainfall fell in certain sites.

Photo - Bryan Shearer ▲▲

Spore sacs of *P. cinnamomi* release zoospores that swim in free water and infect nearby roots. ▲

not only by sightings and by recovering *P. cinnamomi* from soil and plant samples, but also by identifying the deaths of susceptible trees and plants (indicator species) from the air. CALM staff were trained to interpret the photographs, and quickly became expert at mapping the patterns of death. By photographing the jarrah forest every few years, interpreters could identify every infection in the forest and locate areas for quarantine. Mapping further progressed with the development of 230 mm shadowless colour aerial photography.

The mapping system developed by CALM staff for the jarrah forest is arguably the most sophisticated forest disease detection technique in the world.

HYGIENIC FOREST OPERATIONS

Once the cause of the disease was known and its distribution mapped, all operations could be carried out hygienically to prevent the disease spreading.

Although various hygienic logging techniques were developed early in the 1970s, increased knowledge made a new system possible late in the decade. It was applied to all operations, including fire control, road construction and maintenance, and timber regeneration. Hygienic procedures were aimed at minimising the consequences if any one element in the system accidentally failed. The system has three main components: planning, exclusion and training.

In the planning phase, maps of disease distribution are used to plan the areas of operation and to determine the best hygiene methods to use. During the exclusion phase, roads are isolated and vehicle cleaning points established. Activities are confined to periods of least risk to minimise the spread of the fungus. Finally, staff are taught the biology of the fungus during their training in protective procedures.

Hygiene methods developed in State forests are now being adapted to mining and recreation areas as well as to national parks and nature reserves in the South-West.



False-colour imagery of jarrah forest. A large infected area shows up in red, while green represents healthy forest.

AN EARLY WARNING SYSTEM

Bull banksia (*Banksia grandis*) is widely distributed in the understorey of the jarrah forest. It provides a foodbase for the dieback fungus and is usually the first species to die in infected forest. This gives dramatic warning that the fungus is present. The extensive root system of bull banksia provides a "freeway" along which the growing fungus drives through the soil in summer - as much as one centimetre a day - when the surface soil is too dry and hostile for the fungus to survive. Reducing bull banksia therefore inhibits development of *P. cinnamomi*, exposing it to the withering summers. One of the aims of the Forest Improvement and Rehabilitation Scheme (FIRS), begun in 1978, is the reduction of bull banksia in the understorey. This treatment, planned by CALM and funded by ALCOA, is now being applied to forest adjacent to areas being mined for bauxite.

CAUGHT IN THE ACT

At first, researchers could not account for the long periods of apparent inactivity before and after the dieback fungus struck, the sudden ferocity of its onslaught when it did, and its neglect of some areas of jarrah compared with others.

What gave researchers the answer was rain - rain in the middle of summer. In January 1982, continuous rain soaked parts of the jarrah forest for two days. The conditions for the fungus to produce spores and grow were ideal: midsummer warmth combined with saturated soil. Nothing happened at that time; but between one and two years later, jarrah stands in that area collapsed. The fungus had struck.

Researchers and field workers redoubled their efforts, sampling roots, soil and plant material. Still they found no sign of the fungus until, almost as a last resort, they disregarded the accepted belief that the fungus was only active in the topsoil and dug deeper into the ground. With a jarrah tree excavated to reveal the tops of its vertical tap roots, the diseased tissues caused by *P. cinnamomi* were at last found - two metres below the surface along the top of a layer of solid subsoil (caprock). Other freshly killed jarrah was excavated, with similar results. The killer was finally caught in the act.



Bull banksia is one of the jarrah forest species most susceptible to dieback, and is the first to die in infected areas.
Photo - Cliff Winfield ▲

HOW DOES IT KILL?

The fungus was being spread in three ways: at surface level by human activity; through the laterally spreading roots of bull banksia; and several metres below ground, by water flowing through the soil on top of the caprock layer. Every time it rained the fungus was spread further, though not necessarily to every jarrah site. Once spread it lay dormant in the roots of trees and plants, ready to become active only when warmth and moisture occurred at the same time - rare conditions which applied during the major outbreaks of jarrah dieback observed during the fifties, sixties, seventies and early eighties. When a period of hot weather was followed by sudden rain, the fungus pounced, attacking the major vertical roots of the jarrah and almost choking off their water. Once the hot weather returned, the trees, massively needing water yet suddenly unable to receive it, died within days or even hours.

INTERIM FOUNDATION FOR JARRAH DIEBACK RESEARCH

*The discovery of *P. cinnamomi* in 1965 led to a research offensive through the 1960s and 1970s which had far-reaching effects on forest management. Joint Commonwealth-State ventures funded research into the biology of the fungus by the Forests Department, the CSIRO and the universities. In 1978, the aluminium and timber industries complemented government funding through a research foundation whose work was to last for nearly a decade. The role of the foundation, chaired by the Conservator of Forests with representatives from industry, universities and government departments, was to fund new and existing research. The foundation supported studies in jarrah forest ecology, understorey manipulation, host response to infection, tissue culture of jarrah, and the activity of the fungus in the soil.*

Contributors to the Dieback Research Fund

- Alcoa of Australia
- Worsley Alumina
- Forest Products Association
- Wesfi

Research Funded

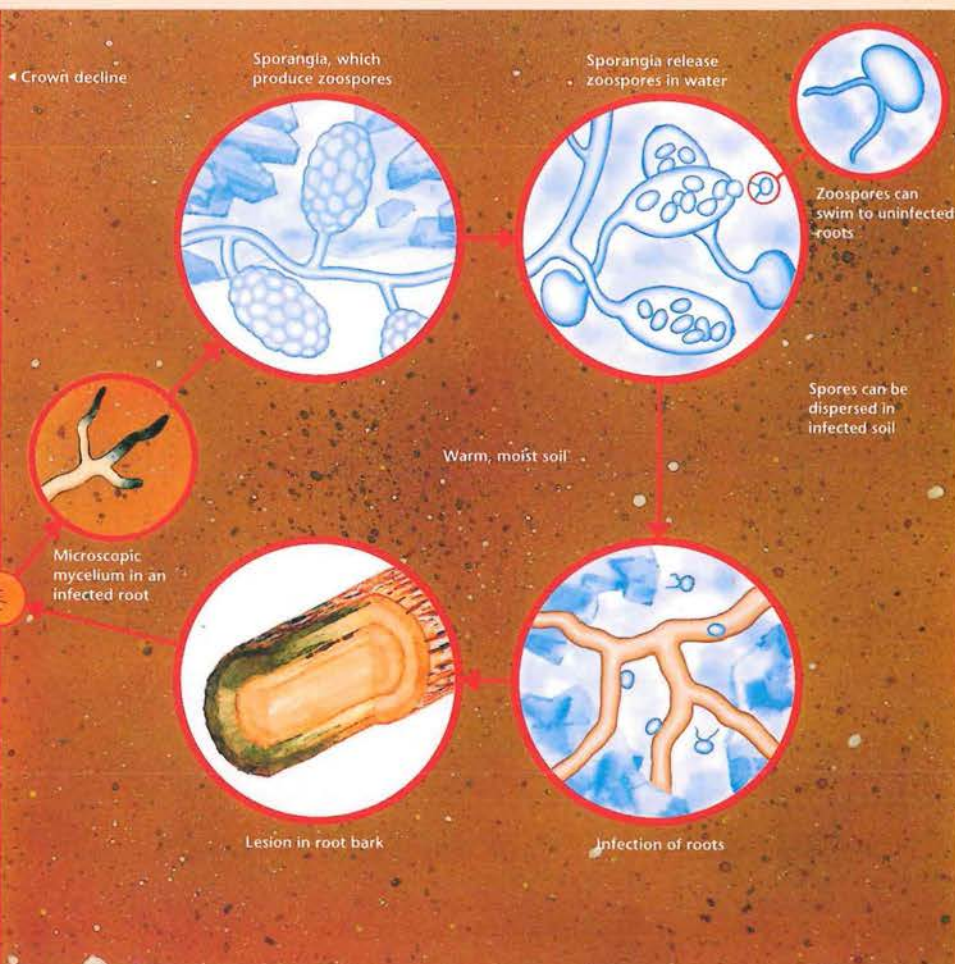
Forest ecology
(CALM, CSIRO, University of Western Australia and Curtin University)

Understorey manipulation
(CALM, CSIRO, Curtin University)

Host response to infection
(CALM, Melbourne and Murdoch Universities)

Tissue culture of jarrah
(Murdoch University)

Factors affecting activity of the fungus in the soil
(CALM)



THE KILLER FUNGUS

It was not until 1965, after years of research by many scientists, that Dr Frank Podger identified the cause of jarrah dieback as *Phytophthora cinnamomi*. This pathogen was first described by a Dutch expert on plant disease in 1922 - ironically, the same year as the discovery of dieback in Western Australia.

An introduced, soil-borne fungus, *P. cinnamomi* is believed to have evolved in South-East Asia. The word *Phytophthora* comes from Greek *phyton* (plant) and *phthora* (destruction). Even though it grows best in tropical conditions, the fungus attacks nearly 1000 plant species throughout the world and is one of the most widespread plant pathogens known to man. It was probably introduced to Western Australia before the early 1900s when quarantine procedures were not in place.

Phytophthora cinnamomi has only relatively recently been introduced into the plant communities of south-western Australia, so they have not had the chance

to evolve much resistance to the disease. South-West plant species have adapted to poor soils and drought by developing specialised root systems for maximum intake of nutrients and water, but that is precisely what makes them vulnerable to the fungus.



Photo - L. Harman

The life cycle of *P. cinnamomi* depends on moist conditions. The fungus is parasitic, and requires a living host on which to feed. The main body of a fungus - the mycelium - is a mass of threads, capable of producing the millions of tiny spores which reproduce the fungus.



There are two main kinds of spores. One, the zoospore, is small and spreads rapidly through water and moist soil. As they move through the soil zoospores lodge on plant roots, infect them, and, in susceptible plants, produce mycelium. The mycelium

grows, feeding on the host, rotting the roots and cutting off the plant's water supply. The other type of spore, the chlamydospore, is larger than the zoospore, and can survive in the soil for long periods, provided conditions do not become too dry. They cannot move on their own, but can be transferred in particles of infected soil. When conditions are favourable the fungus again becomes active: the chlamydospores produce mycelium and zoospores.

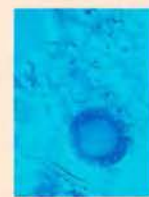


Photo - J. Tippet



Photo - J. Tippet

After infection, the fungus invades root bark and forms lesions which may extend into the tree collar. Infection of roots and collar results in death of host and crown decline.

PROGRESS IN THE FOREST

Forest pathology is a complex research area, needing a considerable commitment of resources. That is where the support of a foundation for jarrah dieback research was so vital (see p.41). Large trees are difficult to work with, and the soils on which they grow often have layers that resist penetration. Extremes of scale must be contended with. Jarrah trees over 30m tall can live for centuries, with years between reproductive cycles; and a fungus that lives in microscopic soil pores and intercellular spaces has a life span of weeks to months, with a reproductive cycle of hours to days. The forest occupies a large area with a great diversity of microclimates affecting host and pathogen. The techniques needed for inoculation, excavation and assessment are therefore labour-intensive and expensive. Because trees are long-lived, factors affecting disease and attempted controls cannot be adequately tested within a few years.

Nevertheless, recent research has covered all this ground. Some of the results:

■ **Natural Barriers:** When *P. cinnamomi* infects jarrah, growth of the fungus in the outer bark can be limited by the tree's natural defences. However, these barriers are least effective when warm, moist conditions favour rapid fungal growth. Moisture level within the bark is affected by water availability within a site and the occurrence of summer rains. Once the jarrah's susceptibility is defined, the effect on the disease of different management options, under a range of site and climatic conditions, can be properly assessed.

■ **Using Host Resistance:** Testing the response of jarrah to infection has shown that some trees are genetically more resistant to the dieback fungus than others. Considerable progress in the tissue propagation of jarrah has meant that a small piece of plant material, like a bud or stamen, can be used to produce a new plant. Thus tissue culture can be used to propagate resistant plants and help re-establish jarrah on infected and mined areas.



Research has shown that changing jarrah forest understorey to favour prickly moses (*Acacia pulchella*) helps to inhibit the spread of the fungus.

Photo - Syd Shea ▲

Scientists washed down and exposed jarrah roots to study how they were infected by the dieback fungus.

Photo - Bryan Shearer ▲

Experimental burning of bull banksia, a strategy which may help reduce the spread of the fungus.

Photo - L. Harman ▼

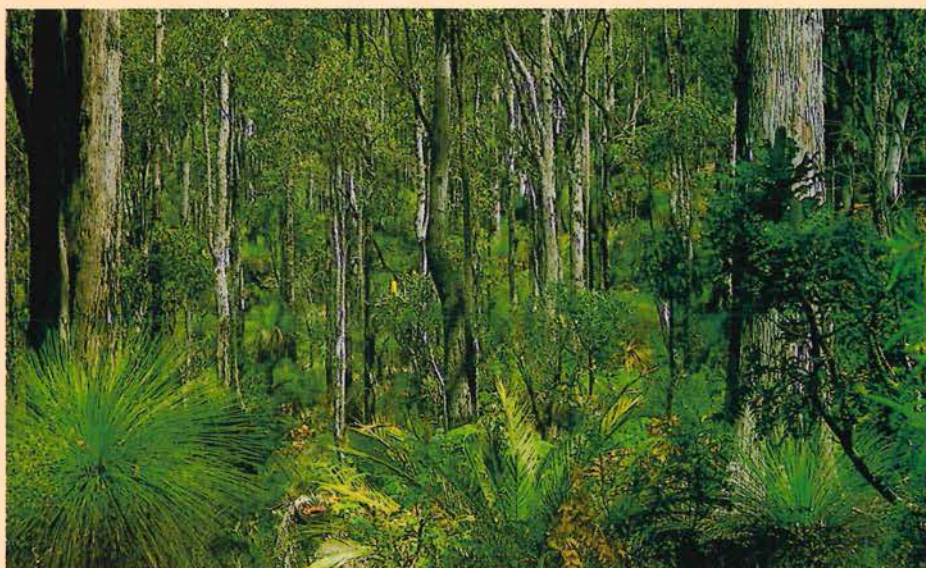
■ **Firing the Banksia:** Research suggests that replacing susceptible species, such as banksias, with resistant legumes, such as prickly moses (*Acacia pulchella*), reduces dieback survival. Changing the understorey to one dominated by wattles alters the physical, chemical and microbiological environment of the soil to disfavour the fungus.

Burning the bull banksia-dominated understorey can result in one dominated by acacias. The use of fire to change the understorey offers a management strategy to reduce disease development over large areas, but practical application has not been as straightforward as initially hoped. More information is needed on fire ecology, acacia ecology and follow-up methods of bull banksia suppression.

■ **Enemies in the Soil:** The fungus is food for microbes in the soil. In some areas of the forest, such as under legume stands, these microbes help to suppress dieback. At present there is no practical way of applying such biological control to the forest on a wide scale. However, selected microbes could be used during rehabilitation of degraded areas.

■ **Forest Floor Mosaics:** Before the discovery that *P. cinnamomi* caused mass death of jarrah by attacking its vertical roots deep in the soil, it was thought that the whole jarrah forest could be at risk. After 1983, it was recognised that the site conditions that make jarrah vulnerable to dieback do not occur throughout the forest. These conditions include the impeding, water-spreading layer beneath the soil surface, enabling the fungus to





THE JARRAH FOREST

The jarrah forest is the most widespread forest type in the South-West of WA.

It grows predominantly on the infertile lateritic soil of the Darling Plateau. Lateritic soils are deep clays overlain by gravel. They were formed millions of years ago by chemical weathering of the eroded surface of the far more ancient granite basement rock.

The forest's dominant tree, jarrah, is a tall, straight eucalypt with dark grey fibrous bark. Its timber is renowned throughout the world for its red colour, durability and quality finish.



jarrah bark

However, many other tree and plant species, including marri, blackbutt and sheoak, make up the jarrah forest ecosystem, each growing where soil type and soil water best suits their needs. Not all of them are susceptible to the dieback fungus, while others, such as bull banksia, quickly succumb to the disease.



fringed lily

Over the forest's range, 300 species of colourful wildflowers grow in identifiable plant communities. These make up the complex shrub layer. The jarrah forest is the only place



Western Spinebill

in the world where many of the species are found.

Some of the most spectacular are members of the Proteaceae group; the banksias, dryandras, grevilleas and hakeas. Many have large flowers which attract numerous nectar-seeking birds, such as the



Acacia drumondii

Western Spinebill. The forest also provides habitat for a variety of animals.

Dieback is present in about 14 per cent of the State's jarrah forest. The disease is not randomly distributed and its intensity varies with site and vegetation type. Jarrah forest growing on the fertile, red, loamy soils in the young, dissected river valleys on the western edge of the Darling Scarp appears to be particularly resistant to the disease. Forest growing on the laterite soils of the upland areas and the silty or sandy soils in the shallow valleys is susceptible but to different degrees.



native cat

THE FIGHT AGAINST JARRAH DIEBACK

release spores, disperse, and infect the jarrah at depth. There are many jarrah sites where different conditions apply. This finding brought a much greater appreciation that the jarrah forest is comprised of a mosaic of site types with different drainage characteristics. Jarrah death ranges from high to low, depending on site characteristics and management. Time and further study of the mosaic nature of the forest floor will show whether the killer fungus is likely to erupt in any future mass killings of jarrah.

Systems have now been developed to rate uninfected areas according to the likely hazard of jarrah mortality, should the fungus be introduced. This will assist planning by determining the proportion of the uninfected landscape occupied by low, intermediate and high hazard sites.

Risk of Infection: More and more is being learnt about how conditions within the forest influence the activity of the fungus in the soil. The dispersal of spores in water seeping below the soil surface is being monitored and related to the type of forest and the climatic conditions. Determining moisture and temperature conditions that affect the dieback fungus's release of spores and even survival will help to assess the risk of infection.

Assessing Damage: Because jarrah trees die from lack of water after the dieback fungus destroys their roots, the damage being done to a living tree can be estimated by measuring the rate at which the tree uses water. This information can now be obtained by processes which no longer require the tree to be dug up.

Measuring the amount of water loss



Dieback is threatening the remnant populations of *Banksia brownii*, a rare species of the South Coast.

Photo - Greg Keighery ▲

Vehicles are washed down in all important natural areas, as a precaution against spread of dieback disease.

Photo - John Green ▼

from living trees in infected areas shows how healthy the root systems are. Monitoring water loss from plants in different parts of the forest under different conditions will reveal how long some plant species are vulnerable to infection as the result of disturbance or climate.

Chemotherapy: The systemic fungicide Phosphorous acid has arrested lesion extension in bull banksia. This finding offers the first possible practical

application of chemotherapy to infected plants in the forest. Promising results have been obtained in the use of chemicals to eradicate *P. cinnamomi* from the soil in spot infections. Evaluation of these control methods is continuing.

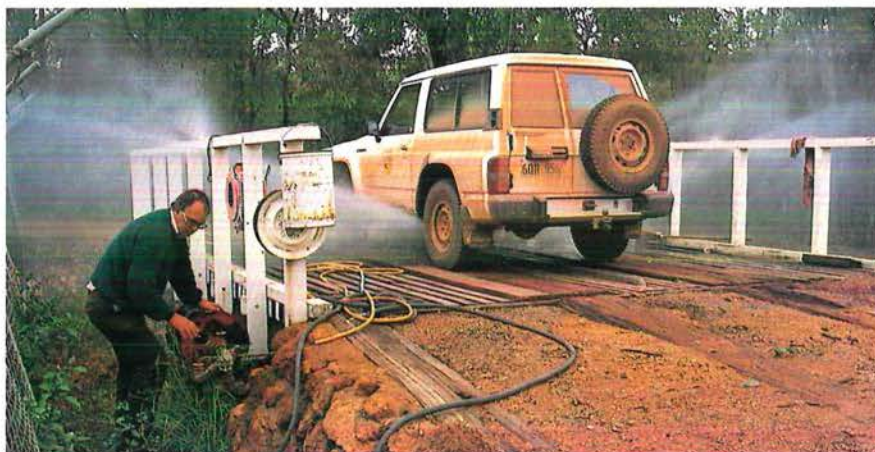
PROGNOSIS

CALM has developed hygiene methods that restrict the spread of the killer fungus, and methods that reduce its development in existing areas of infection. However, rate-reducing methods (such as using resistant biotypes and enhancing host resistance, altering the understorey, stimulating antagonistic microflora, modifying forest floor drainage, and chemical control), need further development and testing before practical application.

Phytophthora cinnamomi is a major problem in the jarrah forest. However, there is now a far better understanding of the conditions that favour pathogen dispersal and host infection; there is in particular a greater knowledge of the type of site and environment that may favour either the disease or the forest. This information, together with methods to prevent introduction and minimise spread, has shown that the cost of maintaining healthy forest is small compared to the irreversible loss in conservation, aesthetic and production values if forest is affected by disease.

The effects of the dieback fungus on plant communities other than the jarrah forest are not being ignored. Although *P. cinnamomi* has mainly been associated with jarrah dieback, it also threatens woodlands and heaths that have a high proportion of susceptible species. Hygiene methods have been applied to prevent introduction and minimise spread, and research into dieback in these communities continues.

About 75 per cent of the known plant species of the South-West are unique to the region, and many are susceptible to the dieback fungus. Introduction of the fungus threatens some plant species, such as *Banksia brownii*, with extinction. The co-operative efforts that have fuelled the fight against jarrah dieback must be maintained to help keep our unique flora free from disease. □





A STATELY COLLECTION

by Carolyn Thomson

Botanists from CALM's Herbarium can find themselves knee-deep in a North-West billabong dappled with water-lilies...and saltwater crocodiles. They may have to wade across the reefs fringing offshore islands in the West Kimberley at low tide, dodging sea-snakes and stingrays. Or they may be studying the plants on an isolated scrub-covered hill in the Stirling Range, or pushing through the dense, prickly heathlands on the sandplains of the South-West. But for dedicated botanists the effort is well worth it. They may be lucky enough to find a plant that has never been collected and described before.



From top:
red boronia
(*Boronia heterophylla*);
Diplopeltis stuartii;
bush pomegranate
(*Balaustion
microphyllum*);
and Albany pitcher plant
(*Cephalotus follicularis*).
Photos - Michael Morcombe

THE more mundane work of mounting specimens and classifying plants is just as vital, as it too contributes to the huge task of documenting and managing the extensive flora of the State.

The hub of these activities is the Western Australian Herbarium in Kensington, where rows of steel shelves house over 400 000 pressed and dried plant specimens. Here, botanists can be found identifying, naming, classifying, curating and generally probing into WA flora, much of it unique to the State and quite a bit of it still poorly known and unstudied.

Along with the extensive research collection, the Herbarium contains a Community Reference Herbarium, the State's botanical library and a huge computerised database that will eventually store readily accessible information on the entire Herbarium collection. There are also regional herbaria in Albany, Manjimup and Karratha as well as 55 field herbaria in national parks, reserves and CALM's regional and district offices.

DISCOVERY AND GROWTH

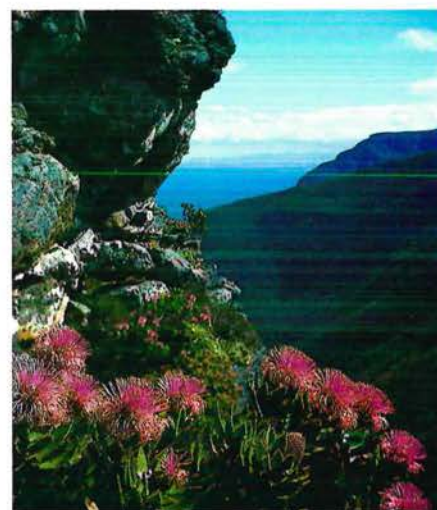
The discovery of the Australian continent created great excitement in botanic circles. Since 1699 a host of visiting botanists and explorers have collected Western Australian plants, including William Dampier, Robert Brown (the botanist on Matthew Flinder's voyage), James Drummond and Ludwig Preiss. Most of these historic specimens found their way into vast collections in herbaria in Berlin, Geneva, Paris, London, Florence, Kiev and other parts of Europe.

It wasn't until the 1890s that official herbaria were established in the State, in the newly formed Museum and in the Department of Agriculture. The latter appointed a botanist and began a collection of economically important plants. In 1916 the Forests Department established a herbarium for species from South-West forests.

However, the unique character of Western Australia's flora attracted world-wide interest and the State needed a single herbarium recognised by the herbaria of the world.

The decision was made in 1928 to merge the three herbaria into a single State Herbarium. The amalgamation was finally completed in 1959 when the Museum collection was transferred on permanent loan to the Herbarium in the Department of Agriculture.

The whole Herbarium was transferred in 1988 to the Department of Conservation and Land Management (CALM) to form a vital arm of its Research Division. Along with its expanded role in CALM, the Herbarium also has a new



Pink-flowering *Isopogon latifolius* is confined to the upper peaks of the Stirling Ranges. It was described in 1830 by Robert Brown, the botanist on the Matthew Flinders expedition.

Photo - Michael Morcombe ▲

Large hibbertia (*Hibbertia lasiopus*) is common in the gravel soils of the jarrah forest.

Photo - Michael Morcombe ▼



Curator, Jim Armstrong, formerly the Assistant Director of the Australian National Botanic Garden in Canberra.

MANAGING FLORA

The Herbarium aims to provide a system of internationally accepted names for the estimated 11 000 plant species found in WA. Of these, about 8 000 species are currently described and a further 3 000 are recognised yet have no scientific names. About 800 exotic species are naturalised in WA. Without the Herbarium to provide information on the characteristics, habitat and distribution of the State's species, managing flora in natural areas would be difficult.

The Herbarium's work is vital to CALM. If plants are reliably named and can be identified, then information about their biology can be stored and retrieved. For example, information on how plants cope with fire is of particular use for land managers. CALM also needs botanical information on the State's rare flora in order to manage and conserve it.

Because of its origin in the Department of Agriculture, the Herbarium has always played an important role in identifying poisonous and other problem plants. For example, in some areas of the State the introduced prickly pear threatens agriculture and it is hard to eradicate when established.

But some varieties are more damaging than others, and that's where the Herbarium comes

in. The Department of Agriculture collects samples in the field and the Herbarium's identification will show whether or not an infestation must be destroyed. Similarly, all agricultural weeds and naturalised plants in reserves and national parks must be identified accurately before the Herbarium can give advice on their control.

TERMITES AND HELICOPTERS

The task of collecting WA's flora takes the Herbarium's botanists to some of the most isolated and far-flung parts of the State. At the moment a major project is to document the flora of the Kimberley, which until recently was largely uncharted botanical territory. They might work in luxuriant Kimberley rainforests, with orchids festooning the branches, or in the dry and highly dissected Edgar Ranges at the top of the Great Sandy Desert, south-west of Broome.

Collecting techniques in these parts have to be adapted to the region's special conditions. A lot of rainforest trees and tall eucalypts in the North-West, for example, are heavily "piped out" by termites and are too dangerous to climb, so botanists have to use a gun to shoot the flowering branches off the tree to obtain specimens.

Then there are the hazards, which amount to more than just the crocodiles. Kevin Kenneally described an occasion when he and fellow botanist Bruce Maslin were collecting specimens on the Mitchell Plateau when a cyclone suddenly developed.

"The rain was so heavy we could not see. We had to take refuge in a cave while we waited for the helicopter that had dropped us off to come and collect us. Fortunately the pilot made it through, but because of poor visibility we had to land four times on the way back," he said.



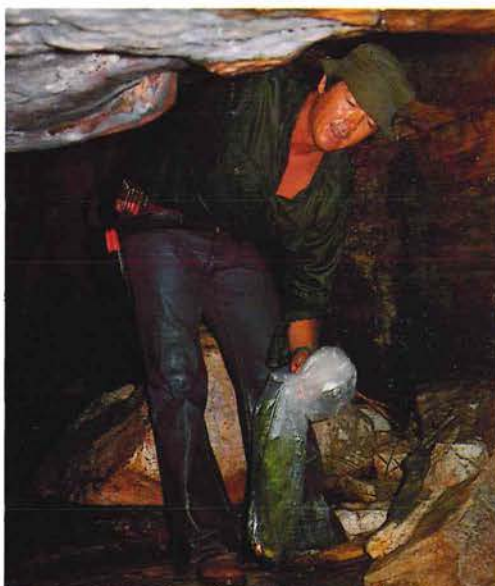
From top:
illyarrie (*Eucalyptus erythrocorys*);
Sturt's desert pea (*Clianthus formosus*);
lemon-scented darwinia (*Darwinia citriodora*);
and native bee on *Boronia gracilipes*.
Photos - Jiri Lochman

The Mitchell Plateau Falls during a collecting expedition in 1982; 400 mm of rain fell in only 48 hours due to Cyclone Bruno.

Photo - Kevin Kenneally ▼

Botanist Kevin Kenneally had to shelter in a rock cave on the Mitchell Plateau, after Cyclone Bruno developed during a collecting expedition in January 1982.

Photo - Bruce Maslin ►





From top:
flying duck orchid
(*Paracaleana nigrita*);
scarlet banksia
(*Banksia coccinea*);
jewel beetles feeding on
Melaleuca flower; and
native bee on wild tomato
(*Solanum* sp.).
Photos - Jiri Lochman

Much Herbarium collecting is done in the plant-rich South-West of Western Australia, one of the richest botanical areas of the world, noted especially for the number of woody shrub species. The Stirling Range, for example, or the Mount Lesueur area (*Landscape*, Winter 1989), have yet to reveal all their botanical treasures. New species and new localities for plants, many of which may be rare, are recorded on almost every field trip.

SPECIMENS

Dried and liquid preserved specimens form the basis for botanical studies on the naming and classification of plants. When properly prepared, they retain the features needed for their accurate identification. When a plant is collected in the field, the locality, latitude and longitude and habitat information is recorded in a field book. Individual plants always grow in identifiable plant groups or communities, so it is also important to record the plant's habitat.

When the specimen arrives at the Herbarium it must be thoroughly dried, then frozen at sub-zero temperature for several days to kill insects. Insects could wipe out decades of work, so it is also necessary to fumigate the building regularly. The specimen is mounted on a stiff sheet with the accompanying habitat details, and the task of incorporating it into the collection commences. Each of the Herbarium's 400 000 specimens is filed according to a system of classification that reflects its relationships.

Most of the collection is of flowering plant species. But the Herbarium also has separate collections of Western Australian fungi, mosses and liverworts and a large collection of lichens and marine and freshwater algae.

NAMING

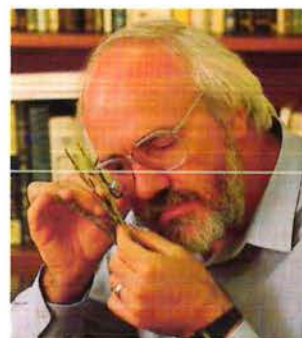
Research carried out at the Herbarium often results in discoveries, and in the last decade Herbarium staff named more than 300 new plant species.

The scientific naming of plants is governed by a set of rules established by an international committee. Each new species must be described in Latin and published in an appropriate scientific journal. The name can commemorate the plant's discoverer or some other person, relate to its geographical region, or describe an interesting feature of the plant.



New Curator, Jim Armstrong, wants to increase the Herbarium's public profile.

Photo - Wilf Hendriks ▼



When it is formally described, the botanist must designate one Herbarium specimen from among those studied as the Type of the species. This "Type Specimen" assumes special importance - it becomes the physical reference point for the new name.

TAKING PLANTS TO THE PEOPLE

Jim Armstrong is keen to enhance the Herbarium's profile, to let the public know what it does and how important its work is.

Publications are one approach. A two-volume *Flora of the Perth Region* was published in 1987; it describes 2057 species and retails for \$47.00. *The Flora of the Kimberley Region* should be published by 1991. The Herbarium will eventually produce a series of publications on the flora of most of the State's regions. A range of research publications and journals, including *Kingia* and *Nuytsia*, are also produced.



CALM's Suzanne Curry collecting a Type specimen from an *Acacia* on Landor Station, on the Gascoyne River.
Photo - Bruce Maslin ▲

Plants grow in identifiable plant communities. This jarrah forest understorey contains white myrtle, coral vine and zamias.
Photo - Michael Morcombe ◀

Members of the public who wish to identify their own specimens can use the Community Reference Herbarium. With representative specimens of two thirds of the State's flora, it is an important resource for use in identifying and obtaining information on the native and naturalised plants of WA. To identify a plant using the Community Reference Herbarium, you would need to bring your specimen to the Herbarium and compare it with those in the reference collection.

However, to ensure the security of the collection, Herbarium staff must treat all incoming specimens for insects before they can be taken into the building. Enquire at the front office. If the collection is less than 9 cm thick it can be treated immediately in a microwave oven. Otherwise, arrangements need to be made in advance.

A reference library is located with the Community Reference Herbarium. It has many helpful botanical works to assist users to identify their specimens. The Herbarium is open from 8.30 am to 4.30 pm on weekdays.

COLLECTIONS



The Herbarium's 400 000 plant specimens have a replacement value of \$15 million!

There are two major collections. The vascular collection (flowering plants, ferns and their allies, and cone-bearing plants) is mounted on stiff sheets of paper for storage, whereas the non-vascular collections (mosses and their relatives, algae, fungi and lichens) are mostly placed in special packets.

The entire collection is named and arranged according to a standard classification system that groups related plants. Using such a system, specimens of any particular species can be quickly located and the label information on it retrieved by researchers.

Many of the 12 000 plant specimens added to the Herbarium each year are collected by Herbarium staff and other research staff in CALM. Duplicate material of the specimens is used by the Herbarium to exchange with other herbaria throughout the world and to acquire additional specimens for the collection.

Properly conserved and maintained, the Herbarium collections are an increasingly valuable permanent record of the State's vanishing spectrum of plant life.



From top:
teasel banksia
(*Banksia pulchella*);
blue pincushion flower
(*Brunonia australis*);
native bee on pigface
(*Carpobrotus* sp.);
and Albany bottlebrush
(*Callistemon speciosus*).
Photos - Jiri Lochman



From top:
a sundew
(*Drosera indica*);
Cassia venusta;
Guichenotia macrantha;
and wild honeysuckle
(*Lambertia ericifolia*).
Photos - Jiri Lochman



NEW HORIZONS

WA is one of the last frontiers of botanical studies. Despite the huge number of specimens housed at the Herbarium, there is still much to find out. New plants are being discovered all the time.

"We still know very little about the flora of this State," says Jim Armstrong. He points out that the National Herbarium of NSW has more than a million specimens for an area representing a third of the size of WA.

"Every time we take a close look at a group it results in a 40 to 50 per cent increase in the number of named species, subspecies and varieties (taxa). For example, 150 new taxa of eucalypts have been discovered in the last decade.

"Least is known about the marine flora of the State," says Jim. "There are flowering plants in the sea with bizarre reproductive systems - they are actually pollinated by water. Understanding the State's marine flora is becoming increasingly relevant with the establishment of marine parks."

LOOKING TO THE FUTURE

As well as its vital role in flora management, the Herbarium also provides an indispensable public service. Many people rely on the Herbarium to determine the identity of botanical materials, including investigators from a variety of scientific fields and land-use professionals who prepare environmental impact reports or planning documents.

One seed of the deadly crab-eyes (*Abrus precatorius*) will kill an adult. It is found throughout the tropics and the seeds were used for decorations by some Aboriginal tribes.
Photo - Michael Morcombe ▲

Graham Donation collecting gubinge fruit from coastal rainforest near Broome. The Herbarium is documenting Aboriginal uses of plants in the region.
Photo - Kevin Kenneally ▼



The collection is also used by visiting researchers from other institutions. Working space is provided for the 20 to 30 interstate and overseas botanists who visit WA each year. Specimens are routinely loaned to other botanical institutions for study and in 1988 more than 8 000 specimens were loaned to herbaria throughout the world.

Jim summed up the Herbarium's role succinctly: "I see it as a museum with a difference - it's the centre for botanical research in Western Australia and the heart of flora conservation research in CALM." □

Putting down roots

A TREE PLANTER'S GUIDE

by Tanyia Maxted



Planting trees is no longer an Arbor Day ritual reserved for schools, community groups and dignitaries. Or something you only do in your backyard to block out nosey neighbours. Tree planting has become a national necessity for people who live on and care about the land.



THE wholesale clearing of Western Australia's bush for settlement and agricultural development has caused immense environmental problems, for example, salinity, soil erosion and loss of habitat for native wildlife. Tree planting is part of the solution.

Sustainable farming practices must be developed to help turn degraded country into usable, arable land. Options include commercial tree growing schemes, growing forage shrubs, establishment of windbreaks and shelterbelts (agroforestry or sharefarming), saltland reclamation and the protection of remnant vegetation.

But you can't just plant any type of tree anywhere. The site and its characteristics, tree species and purpose (be it for shade, shelter, aesthetics or to reduce salinity) are all factors to consider. Before planting, soil has to be prepared, and once in the ground trees have to be maintained - watered and kept free of invading weeds and grasses.



Widespread clearing has seen water that would have been absorbed by trees left to run its own course - eroding land and spreading weeds.

Photo - Robert Garvey (Courtesy of WACAP Treefarmers) ▲

Trees shelter stock from sun and wind. Young eucalypts, however, should be fenced off from hungry stock.

Photo - Robert Garvey ▼▼



Paperbark wetland turns to salt wasteland as water tables rise, along with salinity levels.

Photo - Robert Garvey (Courtesy of WACAP Treefarmers) ▲

A pine shelterbelt protects this lupin crop and will provide timber in years to come.

Photo - Tanya Maxted ▼



SITE SPECIES AND PURPOSE

Whether you're planting nursery-grown trees on a suburban block in Perth, seedlings on a rehabilitated quarry site or direct seeding a 500-hectare paddock in the Wheatbelt, select the tree for the conditions and purpose and try the local species first.

If trees are to be grown in salt-affected areas, you will need salt-tolerant species such as river red gum (*Eucalyptus camaldulensis*).

Shelterbelts need low trees with dense foliage close to the ground, such as the bushy yate (*E. lehmannii*). Pine trees also make effective shelterbelts.

In small city gardens small trees like Rottneest cypress (*Callitris preissii*) or Fremantle mallee (*E. foecunda*) are ideal.

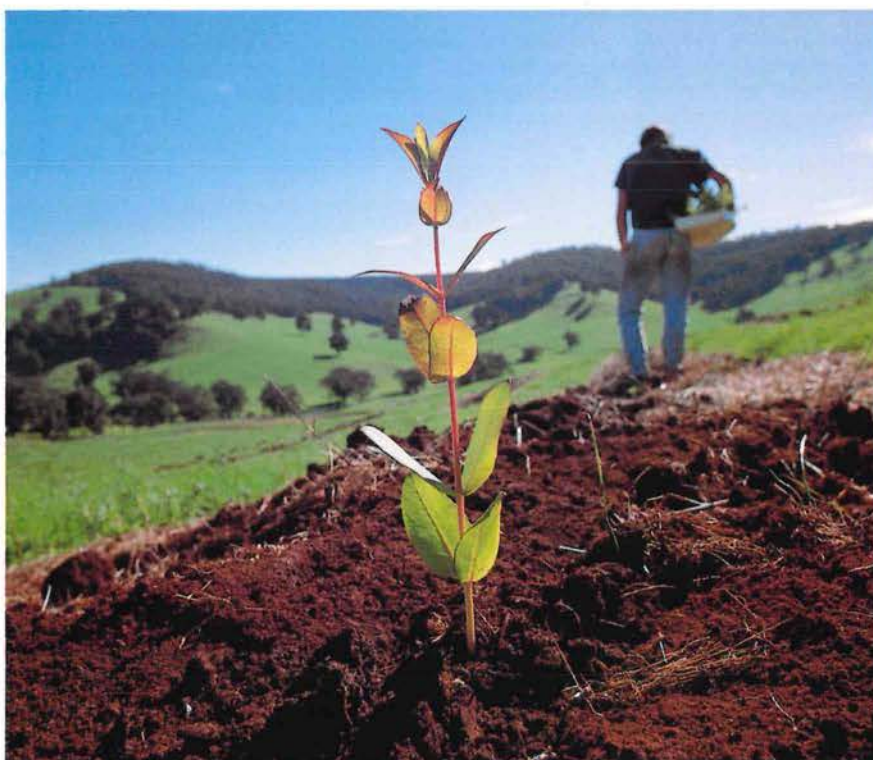
Local species are best. These trees have some important advantages and developed under the climatic conditions of the area, which is extremely important in areas of low rainfall. Trees native to the Perth area are available from some nurseries.



River red gum (*Eucalyptus camaldulensis*) in its natural habitat. This eucalypt is perhaps the most widely-planted in Australia.
Photo - Michael Morcombe ◀

This firmly-planted young seedling will play a vital role once established.
Photo - Robert Garvey (Courtesy of WACAP Treefarmers) ▼

The bushy yate (*E. lehmannii*) bursts into flower; it is valuable planted as a shelterbelt.
Photo - Michael Morcombe ▼



You can also grow your own trees from seed. Seeds from many native trees can be easily collected during summer, but first obtain a permit from the authority managing the land (e.g. local council, CALM). Seed can be purchased from commercial seed companies and CALM's Manjimup nursery.

As well as local trees, also consider planting local understorey plants, such as chenille honey-myrtle (*Melaleuca huegelii*).

Where the local species doesn't meet requirements, select trees occurring in similar soil types and growing under identical or lower rainfalls.

Choose species carefully when planting small sites. Large trees in confined spaces or under powerlines need regular pruning. This is costly and detrimental to the appearance and biological value of the tree. Small trees will give good shade and are far less costly to maintain. In areas of unrestricted space, large trees can be planted to provide height and effective landscaping.

CALM publishes leaflets which give rainfall requirements, tree heights, preferred soil types, a description of the tree and its recommended use. These are available from all CALM offices and are a useful guide for tree selection.



PLANTING STOCK

For mass planting, seedlings seven to eight months old are ideal. Their leaf and root size is in balance and under natural conditions these will establish themselves by developing a deep root system to tap the moisture.

The larger the tree in a pot, the less chance it has to develop an adequate root system. The larger foliage area of such advanced stock is out of balance with its root capabilities. This places greater moisture stress on the plant, hence it will need frequent watering to survive the summer.

Another problem of large potted stock is that the tap root will coil if left in a container too long. After planting, the tree grows and the roots thicken. A restriction develops which can result in a severe setback or even strangulation of the tree. Coiling often leads to trees blowing over in high winds.

HOW TO PLANT FOR SUCCESS

For nursery-potted stock:

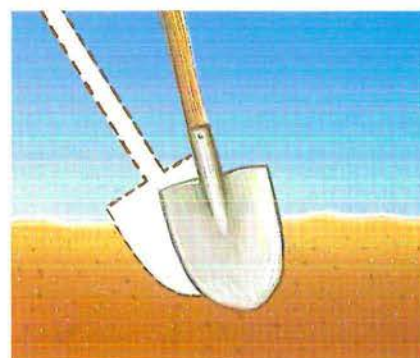
- ❖ Remove all weed and grass competition from a metre square. Dig a hole in prepared, moist ground, big enough (at least half a metre) to accommodate the teased root system.
- ❖ Place your fingers either side of the tree, invert the pot and tap the edge firmly on a solid object. The plant will slide out easily.
- ❖ Gently tease the side and basal roots until they hang loosely. If the tap root springs back into a coil, remove with a pair of secateurs.
- ❖ Position the plant in the centre of the hole 10-20 mm deeper than it was in the container. Be careful not to turn the roots upward or allow them to coil.
- ❖ Fill the loosened soil gradually back into the hole and firm with your feet (it's important not to leave any air pockets).
- ❖ Build a saucer around the plant using soil away from the tree. Water thoroughly to ensure soil and roots are in close contact.
- ❖ Mulch to conserve water. Use straw, rocks or sawdust etc.
- ❖ Fertilise, but wait at least two weeks after planting. Bury 50 to 100 g evenly, 150 mm from the tree. This will boost growth when watered in.
- ❖ Provide a barrier to keep animals (rabbits, stock, dogs) away from the trees.

Staking is not usually necessary, but old pantyhose can be used to secure the tree loosely to allow slight movement.

When hand-planting jiffy pots, completely saturate the plant beforehand.

If the peat surrounding the plant roots dries out, root penetration will be restricted.

Before planting remove the peat at the base of the jiffy pot and tease the lower roots. Then plant as for potted stock. Keep the peat rims of the pot beneath the surface soil level. If the peat is exposed to the air, it will act as a wick and dry the pot and soil.





PLANTING

Planting time will differ between areas, but it should be during June, July and August for most of the South-West. In areas of reliable winter rains, planting should begin once initial rains have penetrated the soil and more rains can be expected. This gives the plant time to establish itself before summer.

Where rainfall is unpredictable, plant in the cooler months and water regularly until established.

In low-lying wet areas (where flooding can be a problem by the end of winter) early planting is not advisable as young trees in saturated soil will die. Mound the soil above the water and plant the trees on the mounds, or wait until the water level has dropped below the soil surface (see diagram above).



Chenille honey-myrtle (*Melaleuca huegelii*) of the Myrtaceae family.
Photo - Jiri Lochman ▲



Grass removed, ground prepared, the large-scale planting for timber begins.

Photo - Robert Garvey, (Courtesy of WACAP Treefarmers) ▲

MAINTENANCE

The first year is crucial for the newly-planted trees' survival. Weeds and grasses that will compete for nutrients and water need to be removed from within a metre of a newly-planted tree.

Add fertiliser two to six weeks after planting to promote faster growth and increase the tree's drought resistance. All fertilisers, in particular those with a high nitrogen content, can damage plants and must be applied carefully, at least 150 mm from the tree, evenly spread and buried.

No more than 100 g should be applied; more will not give better growth but might kill the tree.

When planting, slow-release fertilisers such as Agriform tablets and Osmocote can be used, as the chances of damage to the plant are minimal. Commercial fertilisers can be compressed and made

into slow-release tablets at a low cost.

Potato Manure E is not damaging if applied at the rate of one handful per tree. It should be scattered around the base or placed in a hole on the downward slope, 150 mm from the trunk of the tree and at a similar depth in the soil.

CALM uses Agras No.1 or No.2 in similar quantities and speared into the soil to establish eucalypt trees.

Pine trees require only superphosphate on most soils; applied in the same way as other fertilisers. Where soils are known to be deficient in copper and zinc, a super copper zinc mixture is used.

Repeated fertiliser applications the following year will further increase health and growth.

It is difficult to specify watering needs as factors such as rainfall, soil type,

temperature, drying winds, plant size and water quality will determine how often you need to water.

During years of normal rainfall, in moisture-retaining soils where the rainfall is above 500 mm, trees can be established without watering if soil preparation and weed control have been carried out.

In poor sandy soils of the same rainfall, and all soil types of lower rainfall, watering during the first summer may be necessary, although this is impossible with large-scale planting.

Water should be applied in heavy, widely-spaced applications rather than light, frequent ones, which tend to create a surface root system. Where the water salinity level is relatively high, the accumulation of salts in the upper soil profile can be avoided by infrequent, but deeply penetrating waterings. □

W I L D F L O W E R

From its windswept coastline to its rugged interior, the Greenough/Gascoyne region of Western Australia is an area of remarkable diversity.

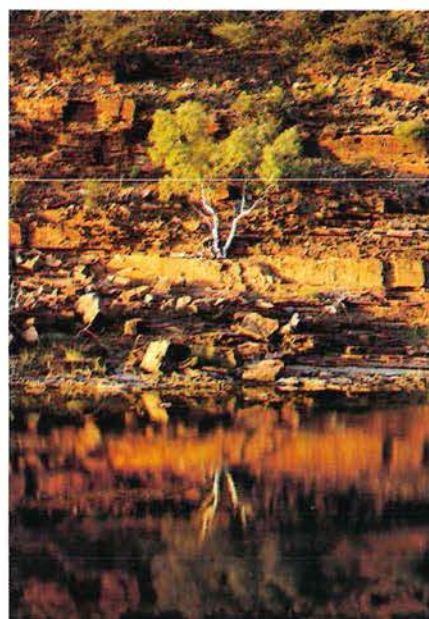


Everlastings (Helipterum roseum) flower between August and November around Northampton.

Photo - Phil Roberts ▲

Kalbarri National Park is centred on the Murchison River Gorge, shown here, but also has picturesque coastal cliffs and gullies.

Photo - Jiri Lochman ▲▲



The first European visitors to these shores were the fated victims who tragically misjudged the notorious "Roaring Forties" that swept their ships towards the coast; many shipwrecks abound in this part of the State.

From the coastal city of Geraldton through to the rolling green hills of Greenough and Dongara, and the vivid wildflowers further inland, the landscape tells much about the variety of the natural environment and the ways settlers shaped the environment.

There are deserted towns, stock wells, buildings, rivers and streams, shipwrecks and salt pans.

In late winter and early spring magnificent sweeps of wildflowers bloom, even in the most arid regions. Large tracts of sandy or lateritic plain support a scrubby vegetation known as kwongan.

The undulating country, mostly below 300 m in altitude, has only a few rivers, such as the Murchison. This drains a large area extending inland almost to Meekatharra. In its lower reaches, within Kalbarri National

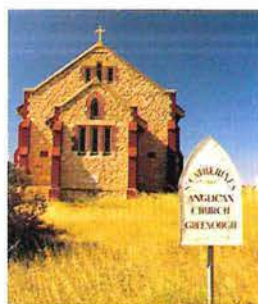


Photo - Jiri Lochman



Yellow bells (Geleznowia verrucosa) is a relative of the boronias and grows on northern sandheaths.

Photos - Phil Roberts ▲

Custard orchid (Thelymitra villosa) is confined to damp depressions in the region. The degree of spotting varies from region to region. ▲



W O N D E R L A N D



Daisies (Brachycome species) make a striking display at Nanga, not far from Shark Bay.

Photo - Phil Roberts ▲

The owl-like Tawny Frogmouth favours open forests and woodlands. It relies on camouflage for protection and does not move when approached.

Photo - Phil Roberts ►

There are only eight known populations of Eucalyptus synandra, a wispy, delicate mallee, with a smooth red and white trunk.

Photo - Phil Roberts ◀



The blue spot butterfly fish (Chaetodon plebeius) at Freycinet Bay in the Ningaloo Marine Park have evolved well-suited to pecking at polyps of coral.

Photo - Phil Roberts ▼



Honey possum (Tarsipes rostratus).

Photo - Jiri Lochman ▲

Park, the river has carved a deep, winding gorge into colourful sandstone rock.

The soils of the coastal plains are mostly sands and gravels lacking nutrients such as nitrogen and phosphorus, yet some of the richest flora abounds on these sites.

Many species are indigenous to the northern sandplains. The vegetation is typically low scrub, but in places it includes mallee eucalypts. There are some areas of low woodland and, especially north of Moora, some large salt lakes.

The most prominent plant families are the Proteaceae, Myrtaceae and Leguminaceae. Many species of Banksia and Dryandra grow there and produce copious nectar. Although birds and insects are attracted by this, it is believed that small marsupials are the true pollinators of these native flowers.

Wildlife Officer and keen photographer Phil Roberts has captured many of the region's scenic features, including its flora, while working in the area.



URBAN ANTICS

FLORAL PREDATORS

Each spring, a carpet of colour invades our gardens, street verges, parks and vacant lots.

The nearby Darling Range, with its forested valleys and creeks, bristles with an influx of family picnic groups enjoying the traditional barbecue of snags, chops, a wine or two and forty winks on a warm slab of granite.

It was one of these days that alerted me to an extraordinary wildflower that often goes unnoticed, the sundew or *Drosera*.

While sitting on a somewhat barren patch of ground in the Gleneagle Forest south-east of Perth, a twinkle of sunlight caught my eye. Crawling on my hands and knees to the source, I discovered a plant with a delicate lacework of fine stems and branchlets supporting tiny leaves with droplets of fluid on their hairlike edges.

On closer inspection, I saw two tiny pink flowers perched precariously atop the delicate sundew, *Drosera menziesii*.

Drosera capture insects, attracted to the dewy nectar produced by the glands on their leaves (lamina) and digest their prey through enzymes secreted by the glands.

After landing on the leaf's sticky secretions a struggling insect is trapped in the pool of fluid and drowns.

Most *Drosera* in Australia are found in the South-West. New species are still being discovered in remote parts.

Drosera survive as tubers during summer at 4-60 cm below ground. After summer dormancy (one to four months) the buds shoot and, after the first winter rains, vigorous growth begins.

There are four basic types of *Drosera*; erect *Drosera*, climbing or scrambling *Drosera*, fan-leaved *Drosera* and rosetted *Drosera*.

Rosetted *Drosera* produce their leaves in a flat rosette at ground level.

Climbing or scrambling *Drosera* rely on nearby herbs or shrubs for

support. They attach some of their leaves to the support plant while leaving others to catch prey. The main advantage of the climbing habit is to display flowers above the surrounding vegetation.

Erect *Drosera* are similar, however, their stems are generally strong enough to support themselves. The king of erect sundews *D. gigantea* is an asparagus-like bush a metre high, with flowers at the end of many lateral branches.

Fan-leaved *Drosera* have large fan-shaped leaves, which can easily account for large moths and butterflies, at the base of their main erect or semi-erect stems.

Tuberous *Drosera* produce flowers of varying colour and size, depending on the species. Strong, highly fragrant perfumes attract insects both for pollination and as potential prey.

So when wandering through areas in the South-West, keep your eyes peeled. Not for large foliage or flowers but for that tell-tale wisp of spider-

web and dew-like reflection. It'll be a sundew - but be careful, don't walk on it.

JOHN HUNTER

Did you know...

The famous Albany pitcher plant is a relative of the sundews, but has one large receptacle filled with fluid and an upper trapdoor.

There are one or two reports of small mammals and birds being trapped by the pitchers of *Nepenthes* (a tropical pitcher plant).

Most sundew flowers last only one day. Two tuberous species produce flowers which remain open day and night until pollinated.

Rosetted sundews flower before the vegetated parts are formed, while the climbing and erect species do not flower until after the plant is fully grown.



edited by
GEORGE BARNARD



A Quality Publication

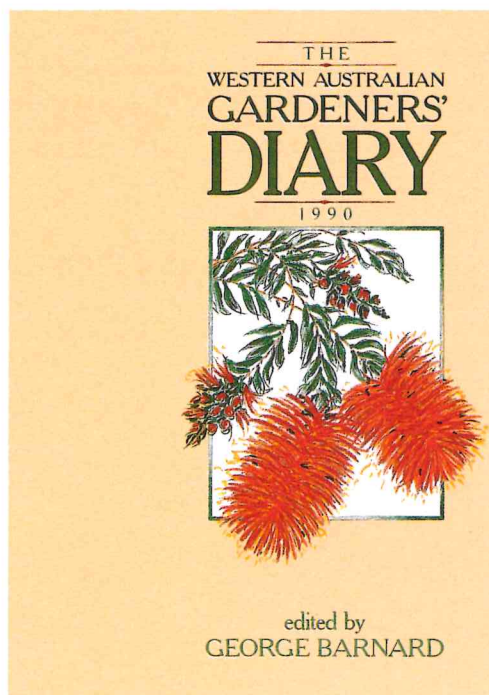
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