Kimberley Tourism Manual

A GUIDE TO INTERPRETING THE KIMBERLEY FOR TOUR AGENCIES, OPERATORS, DRIVERS, GUIDES, STORYTELLERS AND OTHERS

KIMBERLEY TOURISM ASSOCIATION

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

WESTERN AUSTRALIAN

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WESTERN AUSTRALIAN TOURIST CENTRE

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Section 4:

Foreword

The Kimberley region in the far north of Western Australia is one of the world's last great frontier destinations. It is the magnificent natural attractions of the area that draw visitors and nature based tourism has become a significant contributor to the Kimberley economy.

The quality of a nature based tourism experience is closely linked to the level of interpretation and quality of information presented by tour operators and guides. This manual provides comprehensive information about the natural and cultural values of the Kimberley and will assist tour operators to enrich the experiences of visitors.

The long term viability of the nature based tourism industry in the Kimberley region depends on maintaining the integrity of the natural environment. Tour guides and drivers play a vital role in visitors' appreciation of the environment and in ensuring that visitors behave appropriately to keep these remote areas unspoilt. This manual encourages best practice in tourism that is ecologically sustainable.

We commend this manual to everyone involved in the tourism industry in the Kimberley. Members of the Kimberley Tourism Association have a commitment to ensuring that all visitors to the Kimberley receive the best possible service and will find this manual a valuable resource. The wealth of information about the Kimberley in this publication will also be of interest to the wider community.

The Kimberley Tourism Association and CALM would like to thank the many contributors to this manual in particular the Western Australian Tourism Commission.

Syd Shea

Executive Director
Department of Conservation
and Land Management

Brian Tolhurst

Chief Executive Officer
Kimberley Tourism
Association

About this manual

This manual is a guide to interpreting the Kimberley region of northwest Australia for those working in and with the tourism industry. It brings together information on a range of topics and presents it as thematic stories. Within each theme, concepts are identified for understanding the nature of the Kimberley. Some of the issues of life in the Kimberley are addressed with the intent that the tourism industry can make a positive contribution to minimising its impact on the environment while enriching the experiences of visitors.

This is a guide to promoting the natural and cultural values of the Kimberley region, and the facilities and services available to the tourism industry in natural areas, in particular the conservation reserves. The information is pitched at a level suitable for people in the tourism industry and presented in a loose leaf format so it can be updated as required.

The aim of this manual is to:

- set a basic standard in the tourism industry for knowledge of the Kimberley region;
- identify the significant themes for interpreting the Kimberley;
- increase understanding and appreciation of the diversity of natural communities and ecological concepts to be experienced in the Kimberley;
- develop the interpretive skills of tour guides, activity leaders and customer service staff;
- promote the natural and cultural heritage values of the Kimberley;
- encourage best practice in tourism that is ecologically sustainable, socially responsible and economically viable; and
- provide enriching experiences for visitors to the Kimberley while minimising their impact on the environment, so creating advocates for the tourism industry.

The success of this manual in achieving these objectives depends upon your constructive input to enable us to better meet your needs. Every effort has been made to ensure the informataion in this manual is correct and up-to-date at the time of publication. Inevitably some information will date. As we anticipate regular updates your comments and suggestions about improvements are valuable. Please provide us with a completed copy of the evaluation form provided in this manual so that we can continue to improve tourism resources for you, the visitor and the Kimberley.

This manual has been produced by the Department of Conservation and Land Management (CALM), Western Australia, with input from the Kimberley Tourism Association and the Western Australian Tourism Commission.

Registration

If you wish to receive updates of the information for this manual, return a completed copy of this registration form and we will send them to you as they become available.

Tick the applicable boxes.

❑ Please send me the updates of information as they become available.

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An evaluation

We want this manual to be as user-friendly as possible. Please send us your comments at any time. Please complete the evaluation and send with any comments to:

The Department of Conservation
and Land Management
PO Box 942
Kununurra WA 6743

Circle your preferred response.

1. In preparing myself and/or others for visiting the Kimberley region, I found this manual:

very useful / useful / OK / not very useful

2. At sites visited in the Kimberley I found this manual:

very useful / useful / OK / not very useful

3. I found these topics most useful:

4. I found these topics least useful:

5. I would like to know more about these topics:

6. Generally, I found the amount of information:

too much / enough / not enough

7. Generally, I found the format of loose leaf folder with maps, diagrams and illustrations:

very good / good / OK / poor

8. I rate my understanding of the language and concepts used in this manual as:

very good / good / OK / not good /
too complex / too simple

9. The manual has enabled me to better interpret these topics for visitors:

10. Using this manual has made these changes to my actions:

11. These changes should be made to improve the next edition or updates of this manual (attach a separate page if necessary):

12. Other comments about this manual:

13. This is how I describe my role in the Kimberley tourism industry:

14. Kimberley conservation reserves and other tourist attractions I have visited or taken tours to include:

WEST KIMBERLEY

- ☐ Geikie Gorge
- ☐ Windjana Gorge
- ☐ Tunnel Creek
- ☐ Mount Hart Pastoral Lease
- ☐ Gubinge Road Vine Thicket, Cable Beach
- ☐ Buccaneer Archipelago
- ☐ Coulomb Point Nature Reserve
- ☐ Island nature reserves
- ☐ Rowley Shoals Marine Park
- ☐ Other

_____

NORTH KIMBERLEY

- ☐ Drysdale River National Park
- ☐ Mitchell Falls
- ☐ Prince Regent Nature Reserve
- ☐ Other

_____

EAST KIMBERLEY

- ☐ Purnululu National Park
- ☐ Mirima National Park
- ☐ Keep River National Park
- ☐ Lake Argyle
- ☐ Lake Kununurra
- ☐ Kununurra Arboretum
- ☐ Wolfe Creek Meteorite Crater
- ☐ Parry Lagoons Nature Reserve
- ☐ Point Spring Nature Reserve
- ☐ Other

_____

Section 1

Section 1:

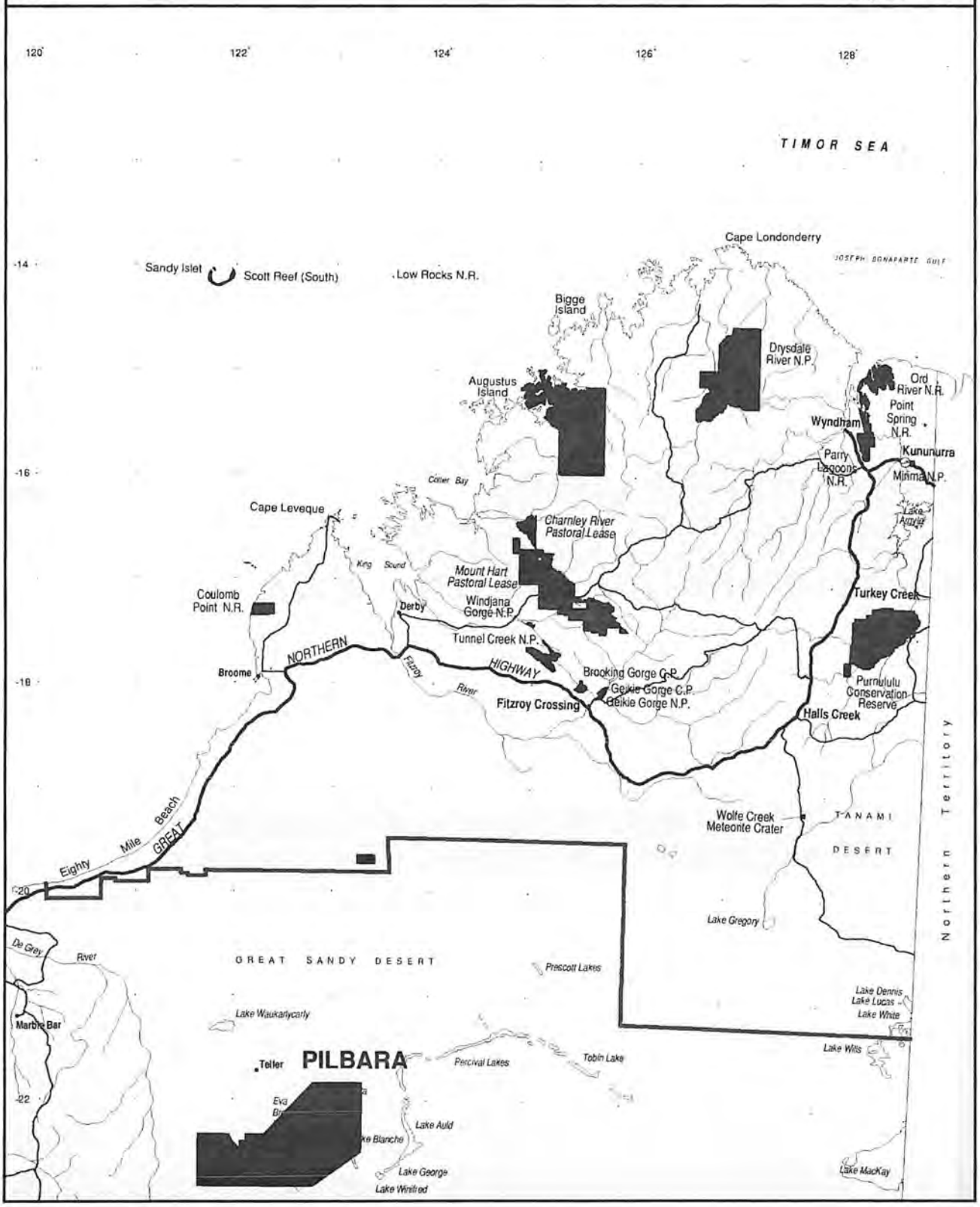
Interpreting the Kimberley region

CALM Managed Estate in the Kimberley Region

CALM
CONSERVATION and LAND MANAGEMENT

SCALE
0 100 200 300 400 Km

Information Management Branch
Geospatial Section



1.1

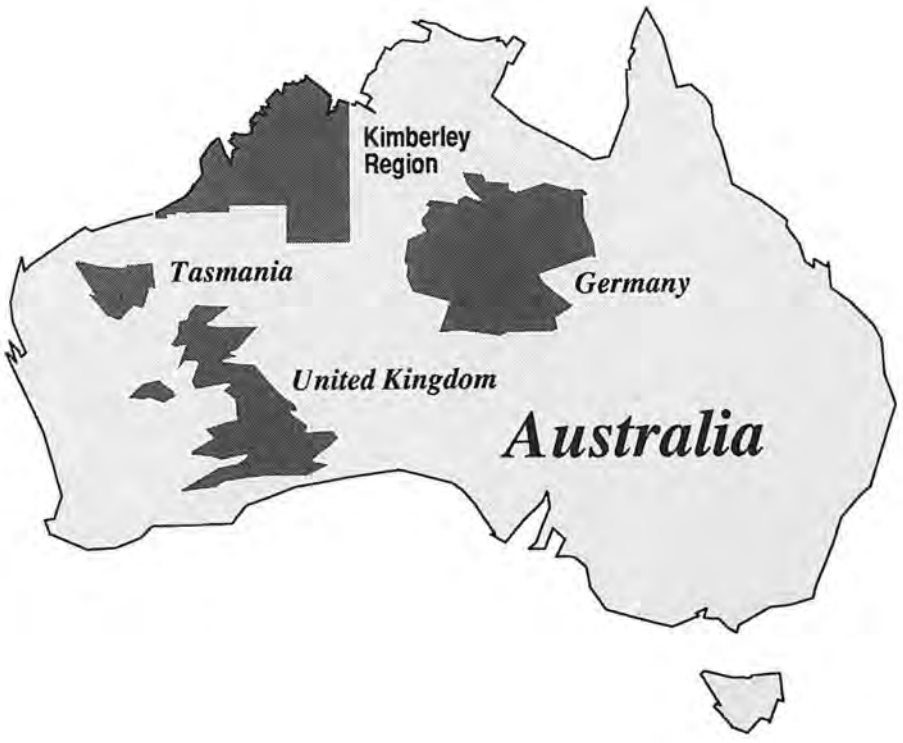
Sense of place: a Kimberley perspective

LOCATION

The Kimberley region is in the extreme north of Western Australia between latitudes 14 and 21° south, and longitudes 121 and 129°east. The Great Sandy Desert forms an irregular southern boundary, while to the north and west are the Timor Sea and the Indian Ocean. Abutting the Northern Territory border, the Kimberley has much more in common with the 'Top End' of Australia than the rest of Western Australia. The equivalent latitudinal band on the east coast of Australia is from south of Mackay to north of Cooktown on Cape York Peninsula.

SIZE

The Kimberley is an immense region, occupying 16.6 per cent of Western Australia. It covers an area of 421,000 square kilometres, roughly 700 kilometres east-west by 600 kilometres north-south. That's five times the size of Tasmania, 1.7 times the size of the United Kingdom and about the same size as Germany.



REMOTENESS

The remoteness of the Kimberley is part of the attraction. By road Broome is 2,200 kilometres from Perth and 1,100 kilometres from Kununurra. Kununurra is 830 kilometres from Darwin. Broome is closer to Denpasar in Bali, Indonesia than it is to Perth.

It is the remoteness, inaccessibility of much of the country, relatively small population and lack of disturbance that has protected the natural values of the Kimberley.

LANDSCAPE

The Kimberley is complex. It is made up of a huge central plateau of dissected sandstone ranges; an extensive limestone range formed from an ancient barrier reef; a rugged coastline of steep-sided tidal gulfs, mangrove-fringed estuaries and numerous offshore islands; the floodplains of the Fitzroy and Ord Rivers; large tracts of undulating sand country, and the extensive grasslands and woodlands that are the dominant vegetation.

PEOPLE

Consider these natural features along with a rich Aboriginal heritage and cultural diversity: 45 per cent of the Kimberley population is Aboriginal, made up of numerous language groups with specific land and community affiliations. The mixing of races and cultures from Asia (Japan, Indonesia and China) and Europe (mostly English), means the character of the Kimberley is culturally diverse. In 1996 the number of visitors to the Kimberley was ten times the resident population, with the number of visitors from overseas one and a half times the number of residents.

PERSPECTIVES

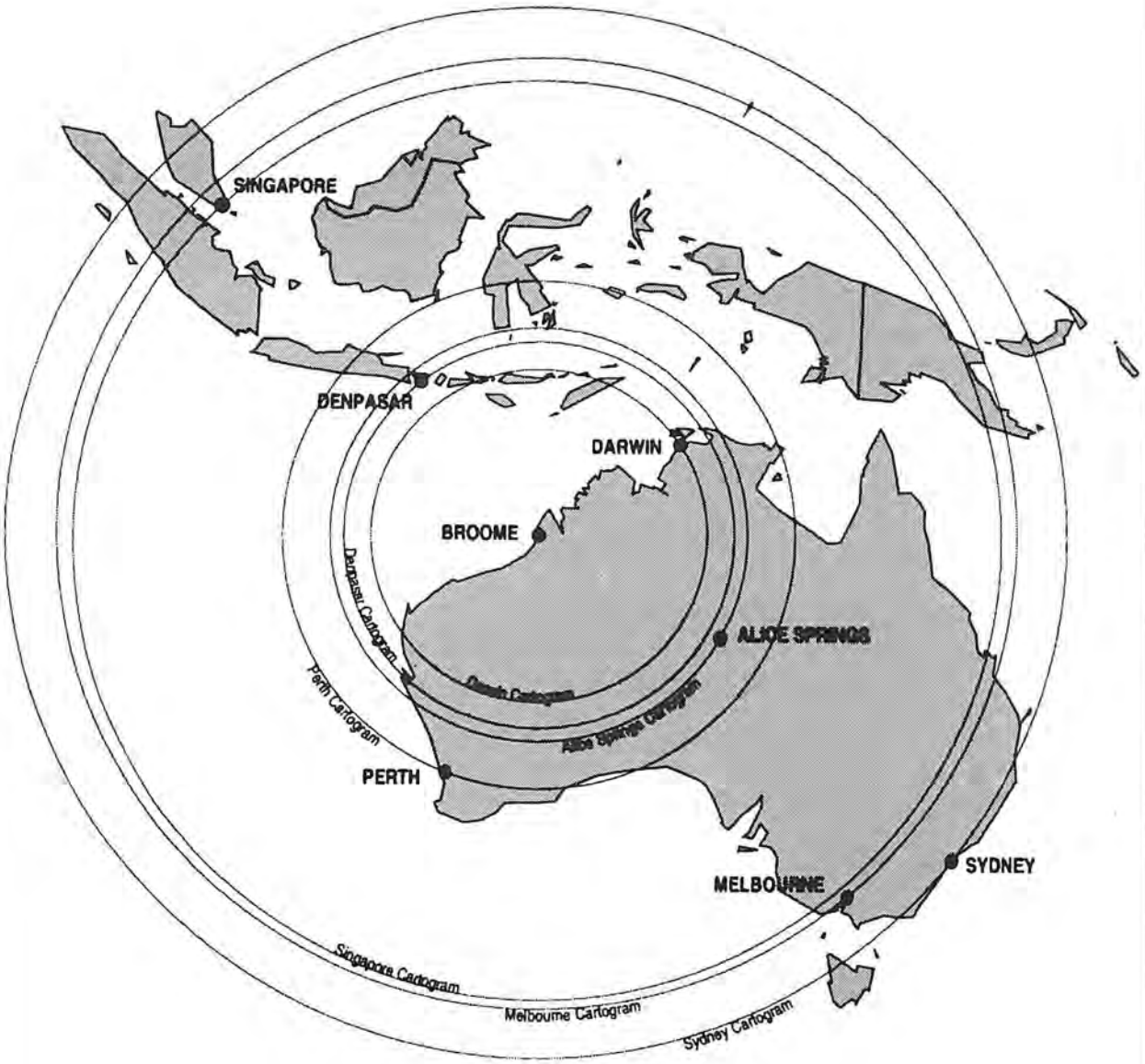
Kimberley Aboriginal groups are as diverse as other cultures, both resident and visiting the Kimberley. There is not one unified Aboriginal perspective, just as there is not for other groups. Cultural perspectives of the Kimberley are perhaps more revealing of one's own background than the character of the Kimberley. If we look at the natural world there is equal diversity in perspectives amongst scientists. Geologists, botanists, geographers and ecologists have all produced maps of the Kimberley. Most recently landscape character types and biogeographical regions have been identified towards a shared perspective of the land and waters of the Kimberley.

This manual is for the tourism industry. The diversity of clients and participants in the tourism industry requires a simplification of the natural and cultural perspectives of the Kimberley. More detailed and personal perspectives are the products and outcomes of a dynamic tourism industry that can cater for niche markets.

Eight major natural communities are identified in this section of the manual to assist with the interpretation of the Kimberley's natural values and environments. An understanding of the relationships of plants, animals and landforms within each community provides the context for investigating the places identified in Section 2: Places to go, things to know and do.

CULTURAL PERSPECTIVES

The cultural heritage of the Kimberley is put into historic perspective from traditional Aboriginal groups through to the contemporary multicultural society to be found in the larger Kimberley towns. Deeper understanding of these cultures requires guided access and interpretation.



CENTRAL POINT (Broome) DISTANCE CARTOGRAMS

0 1000 2000 3000km

Scale Bar

1.2

Cycles of change: sun, rain, wind, stars and tides

CLIMATE

Located within the tropical climatic zone, the Kimberley experiences the effect of the monsoons. The dry monsoonal climate is characterised by two dominant seasons separated by short transitional periods. The 'wet' season extends over the summer months from November to April, with rain falling mostly in January and February. The rest of the year is the 'dry' in which very little rain falls.

The 'wet' is hot, humid and cloudy with winds from the northwest, and frequent thunderstorms that bring most of the region's rain. Tropical cyclones form off the coast on an average of twice a year, crossing inland every second year. They can produce heavy rain and intense winds causing damage to the built and natural environments. In sharp contrast, the 'dry' is a time of sunny days and cooler nights when the 'southeast trade winds' blow from the heart of Australia.

TEMPERATURES

On the coast, the extremes of temperature experienced further inland are moderated. Sea breezes result from contrasts in land and sea temperatures, as earth and water heat up and cool down at different rates. The average coastal maximum ranges from 33°C in January to about 30°C in July. Inland the average maximum range is 39°C in January to 27°C in July. Similarly the coastal minimum ranges from 24°C in January to 15°C in July. The inland range is 24°C in January to 12°C in July.

RAINFALL

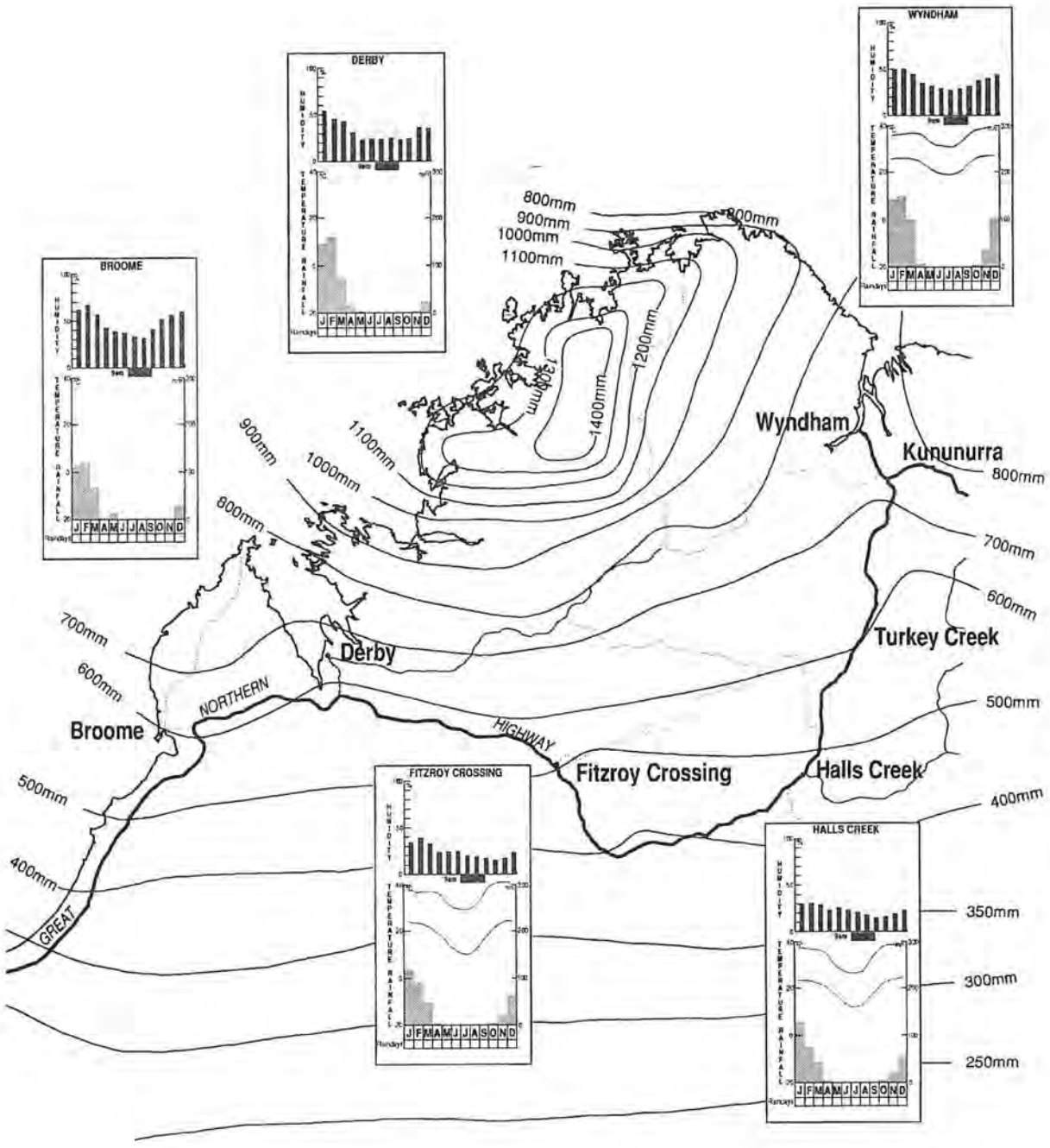
Rainfall similarly reflects a gradient from proximity to the coast. Rainfall ranges from 350 millimetres (14 inches) in the south to 1400 millimetres (56 inches) on the north coast. The Kimberley is characterised by extremes of rainfall, temperature and humidity and the seasons in which they occur. This seasonal variation has a significant effect on the lives of the people, plants and animals of the Kimberley region.

THE 'BUILD-UP'

At the end of the 'dry' most people are waiting for the cloud and rain to bring relief from the increasing heat and humidity of early summer in the hot, dry tropics. Cloud build-up heralds the coming of the monsoon. There is a sense of expectation in the air as storms threaten with shifting, twisting clouds. Lightning is often seen at night as distant storms build up. However the longed-for rain does not always eventuate.

THE 'WET'

When the thunderstorms arrive, they bring dramatic changes in mood to the landscape. Colours are significantly richer and the previously parched land is rejuvenated with fresh growth. The grasses grow tall and the rivers, creeks and waterfalls flow. This is the tropical summer some call 'the green season'. However it is also a time of floods, impassable roads and creeks, high winds and cyclones.


DERBY
WYNDHAM
BROOME
FITZROY CROSSING
HALLS CREEK
J F M A M J J A S O N D
800mm
900mm
1000mm
1100mm
1200mm
1300mm
1400mm
Wyndham
Kununurra
Derby
Broome
Turkey Creek
Fitzroy Crossing
Halls Creek
NORTHERN
HIGHWAY
GREAT
700mm
600mm
500mm
400mm
350mm
300mm
250mm

Trees such as the boab and kapok bush that have been without leaves during the 'dry', now reveal large green leaves in response to the rains. Insects and frogs chorus during the night, and life is full of vitality.

THE 'DRY'

By May, it is all over for the 'wet'. Slowly the green is dried out of the landscape, to be replaced by golden yellow grasses, dry cracking soils, shrinking rivers and creeks that are soon reduced to placid waterholes that provide a welcome respite for wildlife from the pending harshness of the 'dry'. In the 'dry' the sky is nearly always clear. At night, the clarity of the night sky and the stars is a significant experience for residents and visitors alike.

Further Reading

Kimberley Climatic Survey, Bureau of Meteorology

THE NIGHT SKY

The Kimberley region contains some of the best stargazing country in the world. The diamond studded Kimberley sky is an amazing spectacle to behold, especially in mid winter (May through October) when the centre of our own Milky Way Galaxy is presented to advantage directly overhead. The skies at this time of the year are typically clear and blue by day and spectacularly star-strewn by night. Fine and mild weather means that maximum enjoyment can be gained from nights spent out of doors under this magnificent canopy.

THE SOUTHERN CROSS

There are many features unique to our southern hemisphere skies. Perhaps the most famous is the Southern Cross. With its near neighbours, the Pointers, it indicates the South Celestial Pole. This is the point in the sky about which the Earth rotates on its southern axis and so indicates south. Northern hemisphere observers have a 'pole star' to indicate the North Celestial Pole but in the south we have no such star, so we use this famous constellation to point the way for us.

MAGELLANIC CLOUDS

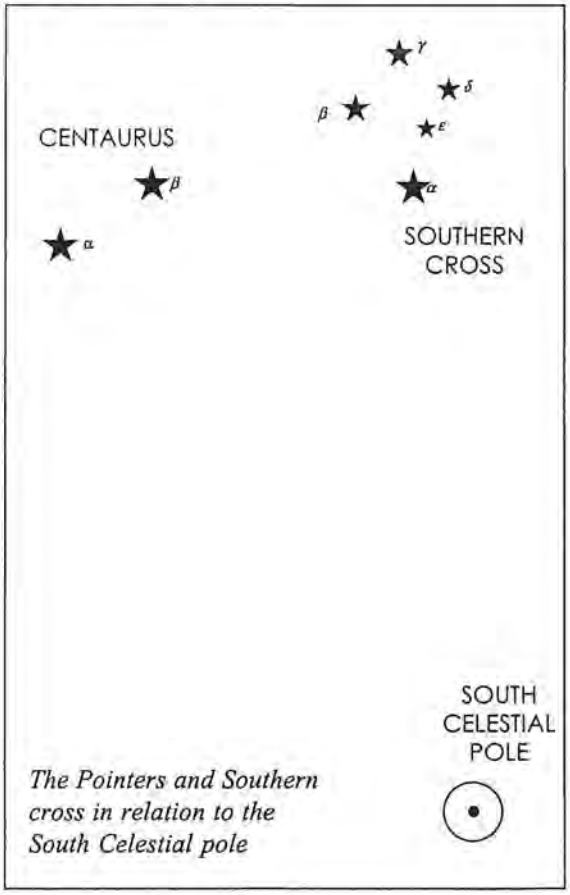
Two dwarf galaxies, the large and small Magellanic Clouds also feature in this region of the sky. These galaxies are around 170 000 light years away and are thought to rotate around our own much larger Milky Way galaxy. This spectacle is unique to our southern skies, having no equivalent in the northern hemisphere.

CLUSTERS, NEBULAE, PLANETS

The plane of our own galaxy dominates the winter sky displaying many fine deep space clusters and nebulae visible even to the naked eye and truly superb through a modest pair of binoculars. The brightness of planets such as Venus, Mars, Jupiter and Saturn leads many people to ask what they are as they outshine even the brightest stars.

Further Information

Detailed information and educational tours of the night sky are available in the Kimberley through Astro Tours of the Kimberley. Telephone (08) 9193 5362.



The Pointers and Southern cross in relation to the South Celestial pole

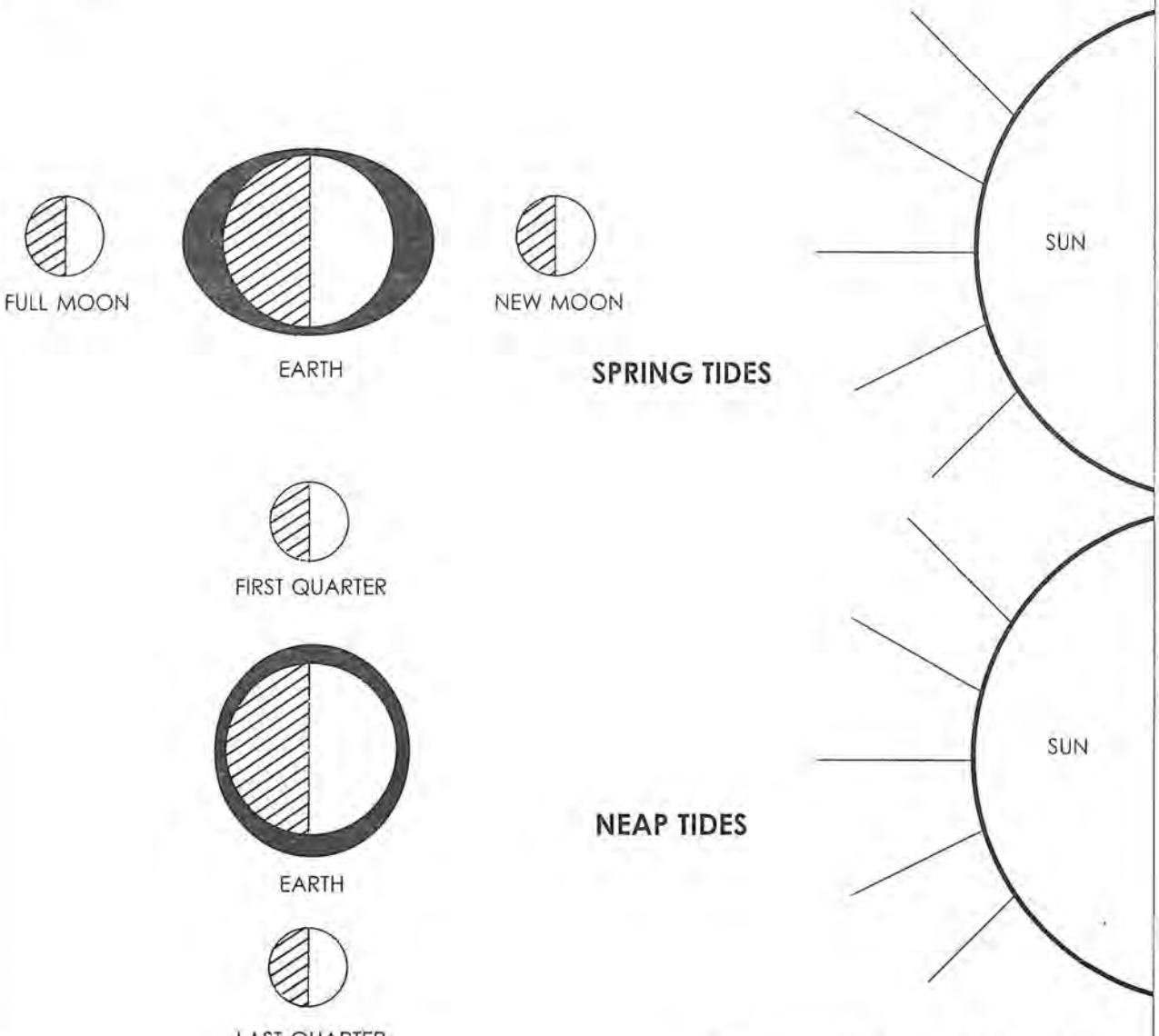
TIDES

Along the Kimberley coast, the tidal ranges are among the highest in the world. The gravitational pull of the moon creates the periodic rise and fall of the seas known as the tides. The moon's gravity produces two bulges on the oceans forming the high tides. Tides follow the moon in its apparent motion around the earth. Generally tides rise and fall twice in the time between moonrises.

The tide producing force of the sun is less than half that of the moon but at Full Moon and New Moon when the sun and moon are pulling along the same line, higher than usual tides known as spring tides occur. Conversely when the moon is halfway between full and new, the tide does not rise as high and is known as a neap tide.

TIDAL RANGES

The tidal ranges in the Kimberley are among the highest in the world, over 12 metres in places. Derby has the highest tidal range of any port in the southern hemisphere with high tides of up to 10.8 metres. Locally, the tides are influenced by a combination of the shape of the coastline and the size, depth, and shape of the ocean floor. Shallow coastal waters found on the wide continental shelf of the Kimberley coast increase tidal ranges. The narrow bays and funnel-shaped estuaries and inlets found along the Kimberley coastline also accentuate tidal ranges.



The influence of the Lunar Cycle on Tides

1.3

Natural communities: exploring ecological processes

From an ecological perspective, all communities are made up of people, plants and animals, and the natural processes that support them. In human-centred communities, such as cities, suburbs and towns, the plants and animals are often overlooked. In natural communities, the relationships of the landforms with the plants and animals are the defining characteristics.

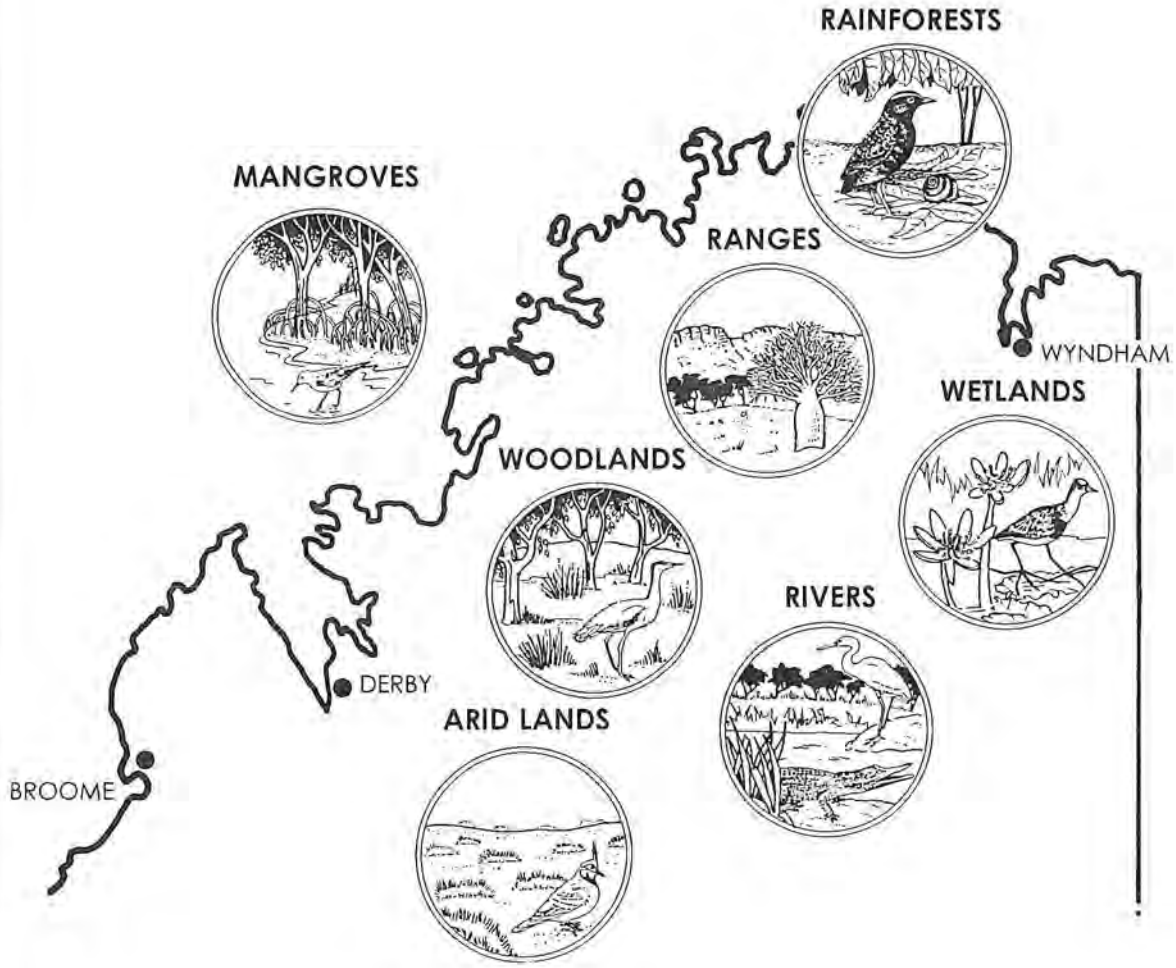
The natural environment of the Kimberley is made up of a number of distinctive natural communities:

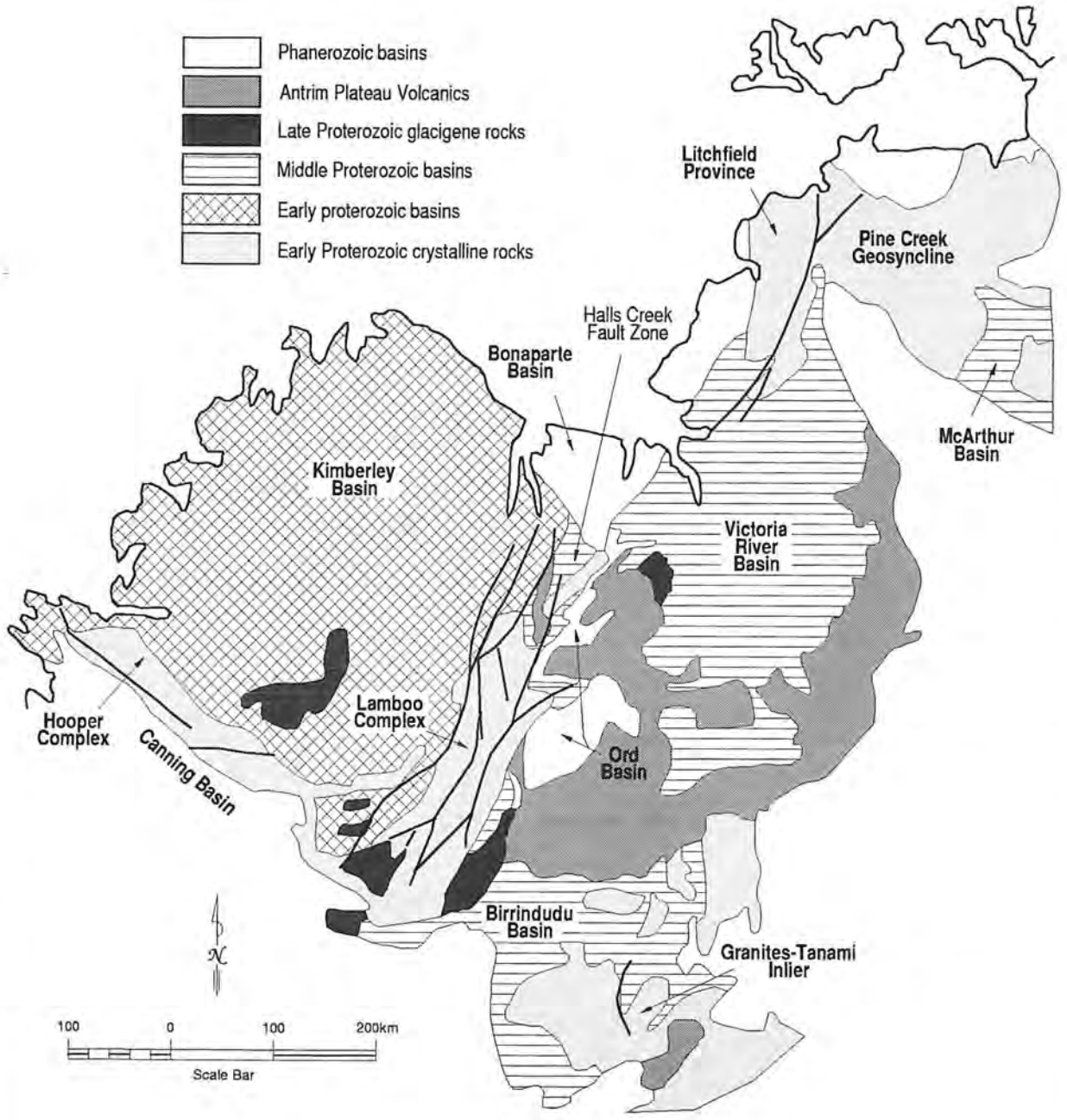
- ranges;
- rainforests;
- woodlands;
- grasslands;
- arid lands;
- river wetlands;
- coastal wetlands; and
- oceans, islands and reefs.

Within each of these communities is a complex of interacting factors. The plants, animals, insects and other invertebrates, micro-organisms, rocks, soil, water, aspect to the sun and resultant microclimate all combine in subtle ways to make each place special. However it is the common characteristics shared between places that define a natural community's identity. This macro-context is a filing system for the specific details of each place you visit.

You can develop your perception of the nature of the Kimberley by looking for characteristics common to different places you visit within the same natural community. Once you recognise the common characteristics it is apparent that there is a pattern to the distribution, but the pattern is never quite the same.

KIMBERLEY - NATURAL COMMUNITIES




Phanerozoic basins
Antrim Plateau Volcanics
Late Proterozoic glacigene rocks
Middle Proterozoic basins
Early proterozoic basins
Early Proterozoic crystalline rocks
Litchfield Province
Pine Creek Geosyncline
Halls Creek Fault Zone
Bonaparte Basin
McArthur Basin
Kimberley Basin
Victoria River Basin
Lamboo Complex
Hooper Complex
Canning Basin
Ord Basin
Birrindudu Basin
Granites-Tanami Inlier
N
100 0 100 200km
Scale Bar

THE RANGES OF THE KIMBERLEY

The landscape of the Kimberley is a complex of rugged ranges, rocky plateaux and escarpments, cliffs, ridges, hills, outcrops and boulders dissected by gorges, gullies, steep-sided and broad, flat valleys. Near the Western Australia-Northern Territory border which defines the eastern boundary of the Kimberley, the Ord River cuts its way through the ranges to enter the sea in the Cambridge Gulf. To the north and west are the Timor Sea and the Indian Ocean where this stony country adjoins gulfs, bays and inlets. To the south is the floodplain of the Fitzroy River and beyond the extensive sandplains that roll into the dunes of the Great Sandy and Tanami Deserts.

ORIGINS

The origin of the rocks that make up the landscape of the Kimberley is equally complex. Volcanic activity with outpourings of lava has formed basalt while intrusions of magma (molten rock) beneath the land's surface have formed granites and dolerites now exposed in places by erosion. Sediments weathered from rocks have accumulated in immense basins producing sedimentary rocks such as sandstone, conglomerate and siltstone, at times beneath primordial seas. The subsequent retreat of the sea and the uplifting of the land now belies their origins. Movements within the earth's crust have buried volcanic and sedimentary rocks at depths of up to 20 kilometres in the Earth's crust and the resultant heat and pressure have produced metamorphic rocks such as schist and gneiss.

GEOLOGICAL UNITS

Geologists have divided the Kimberley into six broad units; the Halls Creek Province which is made up of the Hooper Complex and the Lamboo Complex, and the five sedimentary basins - the Kimberley, Canning, Ord, Bonaparte and Birrindudu basins. Basins are a low area in the earth's crust where sediments derived from erosion and weathering of the landscape have accumulated carried by rivers or winds or occasionally glaciers .

CONTINENTAL COLLISION

The oldest rocks in the Kimberley occur within the Halls Creek Province. They were formed between 1800 and 1900 million years ago at a time of considerable geological activity when a piece of ancient continental crust, which underlies much of the Kimberley region, collided with the rest of northern Australia. At this time a succession of igneous activities with volcanic outflows of lava and intrusions of magma occurred, along with erosion, sedimentation and metamorphic activities from folding and faulting.

These rocks form the Hooper Complex in the West Kimberley and the Lamboo Complex in the East Kimberley.

THE KIMBERLEY BASIN

About 1800 million years ago the Kimberley Basin formed with sedimentary rocks being deposited in a shallow sea. A major river system brought sediment in to the Kimberley Basin from the north forming thick layers of sandstones. Since being deposited these rocks have remained relatively undeformed and now form the Kimberley Plateau with its spectacular scarps and gorges.

DEPOSITS, DEFORMATIONS AND DIAMONDS

About 1600 million years ago the sediments of the Birrindudu Basin were deposited. Then between 1200 and 1000 million years ago a period of folding, faulting and metamorphism took place in the Halls Creek Province. The Halls Creek Fault System which extends from Darwin in the northeast to the edge of the Great Sandy Desert became active. About 1200 million years ago the diamond bearing 'lamproite' rock known as Argyle Kimberlite 1 (AK1) formed when a magma intrusion crystallised. The Halls Creek Fault may have provided a pathway from deep within the earth along which diamond-rich magma reached the earth's surface.

ICE AGE

There is evidence that between 600 and 700 million years ago much of southern, central and northern Australia was affected by an ice age. In the Kimberley region several extensive ice-scoured pavements have been recognised. Glacial deposits or 'tillites' lie above the pavements and represent the chaotic, unsorted deposits of pebbles and boulders left by melting glaciers and compacted to form sedimentary rock. These deposits also show grooves and scratches due to ice scouring.

VOLCANOES

About 540 million years ago, a period of volcanic activity produced widespread flows of lava. These can be traced across the northern part of the Northern Territory and into the Mt Isa area of Queensland forming one of the most extensive occurrences of plateau basalts in the world. They are thickest near the Halls Creek Fault System, suggesting that the East Kimberley was a major eruptive centre.

THE CANNING BASIN

Deposits of sedimentary rocks in the Canning Basin began about 500 million years ago in a shallow sea and continued until about 375 million years ago when the sea deepened.

GREAT BARRIER REEF

In the late Devonian period about 350 million years ago a barrier reef system now preserved as the Napier and Oscar ranges developed along the northern margin of the Canning Basin. The reef fringed a land mass formed by what is now the Kimberley Plateau and extends into the Bonaparte Basin where it is now preserved in the Ning Bing Range. Where floodwaters have cut through these limestone ranges, fossilised marine lifeforms can be seen.

THE ORD AND BONAPARTE BASINS

At the same time in the Halls Creek Province, movement of the Halls Creek Fault System uplifted the area now occupied by the Osmand Range north of Purnululu. Material eroded from this uplift was deposited into the Ord Basin to the south accumulating as sandstones and conglomerates that now form the Bungle Bungle Range. Similar deposits are found in the Bonaparte Basin to the north today forming the Ragged Range and the eroded sandstone plateau of Mirima near Kununurra.

IN RECENT TIMES

Around 300 million years ago another ice age affected much of Australia. Sedimentary rocks continued to be deposited in the Canning Basin. For the last 200 million years there has been much erosion in the Kimberley region and rocks younger than 250 million years are not found in the East Kimberley or on the Kimberley Plateau. 70 to 50 million years ago weathering of the surface rocks during times of high rainfall and humidity leached out silica and concentrated aluminium to form laterite. Today only remnants of laterite remain, for example on the Mitchell Plateau. About 20 million years ago diamond-bearing lamproite rock formed around Ellendale in the West Kimberley as magma intrusions crystallised. Following the last ice age 17 000 years ago a rise in sea level drowned the Kimberley coastline with seas now filling what were once river valleys.

ANIMALS AND BIRDS OF THE RANGES

Many animals have adapted to life among the rocks of the Kimberley ranges. The scaly-tailed possum, the short-eared rock-wallaby, the white-quilled rock-pigeon and the sandstone shrike-thrush find refuge from the heat of the day in caves, crevices and overhangs. The ranges also provide roosting places in caves and crevices for bats. Also found here are predators such as the olive python which immobilises its prey by crushing.

PLANTS OF THE RANGES

Many plants are specifically adapted to life in the ranges. The rock fig (*Ficus platypoda*) has long roots that seek moisture in the crevices. The kapok bush (*Cochlospermum fraseri*) has adapted to life on the hill sides by losing its leaves in the dry season to reduce moisture loss. The boab (*Adansonia gregorii*) and the red-

flowered, sticky kurrajong (*Brachychiton viscidulus*) are two other distinctive plants of the ranges that employ the same adaptation to the Kimberley's contrasting seasons. However, it is the hardy spinifex that can grow on the thinnest of soils on the rocky ranges. Its cylindrical spine-like leaves reduce water loss from transpiration, and the hummock growth-form mulches the ground surface.

The fires that frequently ravage the grasslands of the Kimberley are often constrained by the ranges where there is less vegetation to provide fuel. Most Australian and Kimberley plants have adapted to fire, regenerating from insulated trunks, underground tubers and woody seeds that germinate after fire. Rainforest trees and others, like the northern cypress pine (*Callitris intratropica*), which may be killed by fire, may find refuge in the ranges.

▲ *To find out more about the ranges of the Kimberley see Section 2: Places to go, things to know and do.*

Kurrajong

- Devonian reef national parks
- Mount Hart Pastoral Lease
- Drysdale River National Park
- Mitchell Plateau
- Purnululu National Park
- Mirima National Park
- Keep River National Park

Some interpretive activities for the ranges of the Kimberley:

- Geology and geomorphology are best interpreted as hands-on experiences and as demonstrations to assist visualisation of landscaping processes.
- Try telling the story while passing the relevant rocks around among your group.
- Recreate weathering and erosion processes with a 'mud-map' drawn in the sand, a bucket of water and a mixture of sand and stone.

Further Reading

Geology and Landforms of the Kimberley
Department of Conservation and Land Management (Bush Book Series)

Kapok

RAINFORESTS

Rainforests are distinguished by a profusion of vines and plants only found in rainforest communities. In Western Australia, tropical rainforest is only found in the Kimberley, and only where there is adequate rainfall, and humidity. Small patches of 'monsoon' rainforest are sprinkled along the northwest coastline between Broome and Kununurra in a belt less than 150 kilometres wide. They are distinguished from 'evergreen' jungles in that they are mostly leafless (deciduous) during the dry season, 'raingreen' during the wet season, and less tall than 'evergreen' rainforest and lacking woody epiphytes (plants that grow on others but are not parasitic). They are often described as semi-deciduous vine thickets.

These monsoon forests grow predominantly on sites protected from fire, shaded beneath cliffs, along watercourses and, in the southwest Kimberley, behind coastal dunes. They vary in size from clumps of a few plants to communities of sometimes more than 50 hectares. They are part of a great corridor of monsoon forests across Asia and Australia that have seasonally dry climates. They have been isolated from 'Top End' rainforests as a result of climatic changes over thousands of years.

Of over 20 types of rainforest found in Australia, three are found in the Kimberley.

COMPLEX MESOPHYLL VINE FOREST

Complex mesophyll vine forest is found along watercourses (mesophyll means 'small leaf'.) Here a variety of trees up to 20 metres tall form a dense canopy with little undergrowth, like the 'jungles' of the wet tropics. You can see this type of rainforest at Point Spring Nature Reserve, near Kununurra.

SEMI-EVERGREEN MESOPHYLL VINE FOREST

The semi-evergreen mesophyll vine forest occurs on steep slopes. It generally consists of scattered trees, mostly deciduous, up to 15 metres, standing above a dense understorey of shrubs and vines, but little undergrowth. This type of rainforest can be found in the Mitchell Plateau area.

DECIDUOUS VINE THICKETS

In the drier areas deciduous vine thickets contain scattered trees up to nine metres, above a more open understorey of shrubs. Gubinge Road Vine thicket behind the dunes at Cable Beach in Broome is a deciduous vine thicket, fed by water seeping out of the dunes.

THE CANOPY

In a rainforest the canopies of the trees merge together, significantly reducing the amount of sunlight reaching the forest floor. Subsequently, rainforests are known as closed forests. The canopy of these rainforests creates a 'hothouse' effect that maintains humidity throughout the winter dry season.

RAINFOREST PLANTS AND ANIMALS

Many species of plants and animals such as snails, earthworms, spiders and insects are only found in rainforest communities. Of the 453 plant species recorded in Kimberley rainforests, nearly 200 plants are confined to these rainforests. Many birds such as the rose-crowned fruit-dove, rainbow pitta and rufous owl rely on the rainforests for their persistence in the region. They are dependent on the supply of fruits and the creatures in the leaf litter of the rainforest floor. Although the total area of Kimberley rainforest patches is small (8000ha; less than 0.005 per cent of the region) their significance to plants and animals is considerable. One quarter of Kimberley plants and 45 per cent of the birds have been found within the 1500 rainforest patches.

Aboriginal people continue to harvest 'bush tucker' and 'bush medicine' from rainforest plants. This traditional knowledge is passed on from generation to generation through visits to the rainforest country to harvest the fruits, leaves and bark.

▲ *To find out more about Kimberley rainforests see Section 2: Places to go, things to know and do.*

- Gubinge Road Vine Thicket, Cable Beach
- Mitchell Plateau
- Point Spring Nature Reserve
- Coulomb Point Nature Reserve.

Some interpretive activities for Kimberley rainforests:

Rainforests are places for discoveries, if you take time to explore with an enquiring mind.

- See how many different leaves you can find on the ground to discover plant diversity at its best for a small area of bush.
- Look closely at the leaves of rainforest plants. Ask what they have in common. Many have a distinctive 'drip tip' to shed water during the 'wet'.
- How much of the rainforest floor is covered in leaves, and how much of the sun is kept out by the canopy? What would happen to soil moisture if either the living or dead leaves are removed?
- Can you find anything living in the leaf litter? Put a sheet of white paper down on the ground and as you sweep your hand through the leaf litter watch what springs, hops or crawls onto the paper.

Further Reading:

Plants of Northern Territory Monsoon Vine Forests
Glenn Wightman and Milton Andrews
Northern Territory Conservation Commission

'W.A.'s Rainforests'
Landscope Vol 3 No 2 Summer 1987

'Piecing Together the Remnants'
Landscope Vol 4 No 3 Autumn 1989

Companion to Kimberley Rainforests Australia
K.F.Kenneally and N.L.McKenzie.

Kimberley Rainforests, Australia.
Edited by N.L.McKenzie, R.B.Johnston, P.G.Kendrick (1991) Surrey Beatty and Sons Pty.Ltd, Chipping Norton, New South Wales.

The Kimberley Rainforests of Western Australia
Brochure, Department of Conservation and Land Management

Gubinge

Caesalpinia vine

WOODLANDS

Semi-arid, tropical woodland is the most extensive natural community in the Kimberley. It is dominated by eucalyptus trees from six to 20m tall. The trees of a woodland are widely spaced so that their canopies allow plenty of sunlight to reach the shrubs and grasses below. A woodland is distinguished from a forest when the crown of the tree is as deep as the trunk. In a forest the trunk is taller than the crown of the tree, and the trees are spaced closer together.

The widely spaced distribution of woodland trees means that it is often difficult to distinguish when the grassland begins and the woodland ends. Woodlands and grasslands are found throughout the Kimberley ranges, but it is the flat to undulating valleys and plains that the woodland prefers.

TREES AND SOIL

The woodland community at any particular place usually has two or three dominant trees, which vary with the type of soil. With many different types of soil over the extensive range of tropical woodland, many types of trees can be found in the Kimberley woodland.

Most common on the sandy soils of the East Kimberley are the woollybutt (*Eucalyptus miniata*), with its distinctive smooth, white upper trunk and fibrous, brown stocking at its base, and the stringybark (*Eucalyptus tetrodonta*) with its rough, fibrous, grey bark.

On the sandplains of the West Kimberley the wattles (acacias) form dense thickets of pindan vegetation. Where there is an emergent tree layer of eucalypts and grevilleas, these thickets are called 'pindan woodland'.

The narrow-leaved, grey box (*Eucalyptus tectifica*) with its drooping foliage and scaly bark is very common throughout the Kimberley where there are well drained soils.

On the black soil plains of the Kimberley few trees can withstand the expansion and contraction of the soil in response to flood and drought. Here the Kimberley bauhinia (*Bauhinia* [formerly *Lysiphyllum*] *cunninghamii*) is often the dominant tree. It is distinctive with drooping branches of dense foliage with each leaf made up of two leaflets.

In one part of the North Kimberley the dominance of the eucalypts is challenged by the Mitchell Plateau fan palm, which thrives on the lateritic soils.

THE UNDERSTOREY

The understorey of the woodland community is rich in species, but with local dominance of particular shrubs. As you come to know some of the grevilleas, acacias and other woodland shrubs, look at the soil, drainage pattern and aspect to the sun they favour. Soon you will be able to predict what plants you will see based on these features of the landscape.

WOODLAND BIRDS AND ANIMALS

Woodlands are special places for animals too. Birds, in particular honeyeaters and insectivorous birds such as the grey-crowned babbler, are common and easily seen because of the openness of the woodland community. Binoculars and a field guide are props for those seeking a closer encounter.

Mammals and reptiles are much more wary of humans who are easily seen or heard approaching. Snakes and lizards are 'solar-heated', controlling their body temperature by the degree of exposure to the sun. They avoid the high sun, but may be seen basking in the early hours of the day. The many mammals of the woodlands similarly avoid the heat of the day to reduce the loss of water. Late afternoon and at night is the time to go looking for wallaroos and wallabies, sugar gliders and possums, bandicoots, the carnivorous northern quoll and others. Watch out for owls and other night-prowlers looking for planigale and other small mammals.

FINDING THE NIGHTLIFE

To enjoy the 'creature feature' you will need a spotlight, stealth and patience, and a fair bit of luck. Many of these woodland creatures require tree hollows for homes. These are what to look for during the day, then to watch with a spotlight when the sun is down and the tree-dwelling (arboreal) animals come out to feed, drink, mate and play.

Animals active at night have specially adapted eyes. The retina is concave and acts like a mirror to maximise the use of night light. You can see this 'night vision' in the torchlight as embers of light called 'eyeshine'.

▲ *To find out more about Kimberley woodlands see Section 3: Places to go, things to know and do.*

- Mount Hart Pastoral Lease
- Drysdale River National Park
- Mitchell Plateau
- Purnululu National Park
- Mirima National Park
- Keep River National Park
- Coulomb Point Nature Reserve

Some interpretive activities for Kimberley woodlands:

- Purchase binoculars and field guides and teach your group how to use them.
- Demonstrate the use of a spotlight for observing animals by holding the torch up to the eye and looking along the beam for 'eyeshine'.
- Make use of CALM's bush books - Common Plants of the Kimberley and Mammals of North-Western Australia - to find out more about specific woodland plants and animals.

Further Reading:

Plants of the Tropical Woodland
Mike Clark and Stuart Traynor
Northern Territory Conservation Commission

THE GRASSLANDS

There are over 250 different grasses in the Kimberley, making it the richest family of plants. Both annual and perennial grasses are common. Most germinate with the initial rains of the 'wet', then grow rapidly to flower and set seed with the coming of the 'dry'.

There is a remarkable diversity of form and habit among these grasses. Botanists divide them broadly into bunch grasses and hummock grasses. The bunch grasses grow as their name suggests, and provide a dense to moderate ground cover. The dominant groups amongst the bunch grasses are the spear grasses, love grasses, wandarrie grasses, oil grasses and kangaroo grasses. The hummock grasses are the spinifex group of grasses.

Grasses are found within all natural communities of the Kimberley, with the exception of the mangrove community. Grasses are a significant component of the woodland community. When the woodland trees become few and far between, the community is considered a grassland. However there are large tracts of grasslands that are treeless or with only scattered low trees. The black soil plains of cracking clays are such areas where the expansion and contraction of the soil with flooding and drought does not allow tree roots to grow.

BIRDS AND ANIMALS

The bunch grasses attract seed-eating birds, particularly the finches and pigeons. Native rodents also feed on the seeds, and in turn attract predatory snakes.

SPINIFEX

In the more arid country of the southern Kimberley and on the stony ranges with very thin soils spinifex grasses predominate. Spinifex is a spiky-leaved grass that grows in hummocks. There are 28 species of spinifex found in the Kimberley.

Look closely at a spinifex hummock. It can support a whole community of creatures. As the plant grows, the leaves in its heart die off, creating a hollow. In older plants the centre dies completely, leaving a ring of live grass which continues to expand as the plant grows. In the heat of the day the outer leaves of the hummock reduce air movement so that air inside the hummock is almost still. In this protected heart, evaporation and temperature are lower and humidity higher than outside the hummock.

Dead leaves decay in the moist centre of the plant, attracting creatures which feed on rotting vegetation, and, in turn, creatures that feed on them. Many native rodents, marsupials, snakes and lizards depend on spinifex for shelter, to keep cool, conserve body moisture and feed in the harsh environment of the spinifex grassland.

USE BY ABORIGINAL PEOPLE

Aboriginal people of the Kimberley use the grasslands as a food source, collecting seeds and roots, and hunting for animals. The seeds of many grasses can be ground and mixed with water to make a paste, then cooked as a damper. A powerful glue is made from fibre and resin-crystals harvested from spinifex and heated. It is used to make and repair tools. The glue is used for attaching a stone axe-head to a wooden handle and a stone adze to the handle of a spear-thrower so that it can also be used for working wood. Patchwork burning of the grasslands is still practiced in some communities to create fresh growth that attracts wallaroos, wallabies and bustards (bush turkeys). These creatures are then more easily located and speared for meat.

WEEDS AND EXOTIC GRASSES

Not all Kimberley grasses are native. The movement of cattle, vehicles and people has brought seeds of exotic grasses and weeds into the Kimberley. See Section 1.6 Weeds - the plant invaders to find out more. The Kapok Grass (*Aerva javanica*) is an exotic grass with an interesting story to tell. The fluffy seeds of this

grass were used to stuff the saddles of the cameleers in the late 1800s. As the saddles wore out the seeds escaped and some found favourable conditions in which to germinate and spread throughout much of the Kimberley.

▲ *To find out more about grasslands see Section 2: Places to go, things to know and do.*

- Wolfe Creek Meteorite Crater
- Parry Lagoons Nature reserve

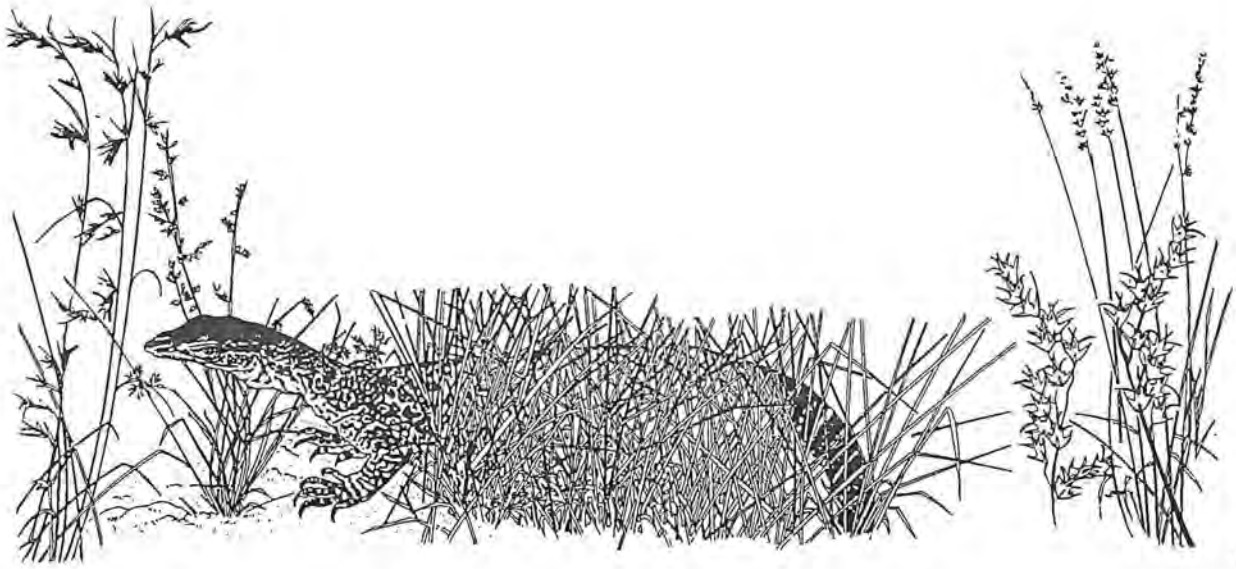
Some interpretive activities for grasslands:

- You can demonstrate the temperature differences inside and outside a spinifex hummock with a thermometer.
- Collect various grass seeds to taste. Try them mixed or sprinkled on top of a damper made with flour (but don't collect them from conservation reserves!).
- Select a number of distinctive grasses and investigate the preferred soil type for each. Now when you see those grasses, see if you can predict the soil type.

Further Reading:

Plants of the Kimberley Region of Western Australia
R. Petheram. B. Kok
University of Western Australia

Plants of the Northern Australian Rangelands
NT Department of Lands, Housing and Local Government



Monitor amongst grasses

ARID LANDS

The arid zone in Western Australia is roughly bounded by the 500 millimetre rainfall isohyet (a line connecting places of equal rainfall) in the north and the 250 millimetre isohyet in the south. This is a vast area of Western Australia. The high evaporation rate of water in the tropics accounts for the differences in northern and southern boundaries of the arid zone. The 500 millimetre rainfall line is south of Broome, and just north of Fitzroy Crossing and Halls Creek.

The southern boundary of the Kimberley region cuts across the top of the Great Sandy Desert. This area is too dry for pastoral or agricultural use. From the air, parallel lines mark the ridges of the dunes that were formed from strong winds during the Ice Ages. Today they are mostly stabilised by vegetation. But it is not all sand dunes. Rocky outcrops, spinifex and samphire plains and ancient drainage systems such as Sturt Creek and Lake Gregory are features of the Great Sandy Desert. The rain that does fall here is unreliable, mostly associated with tropical cyclones. So the plants and animals of the desert have adapted to survive the extreme variability of rainfall as well as variations in daily and seasonal temperatures.

PLANTS

Arid land plants have evolved strategies to minimise water loss. Succulent plants such as samphire store water in their fleshy stems; small, needle-like leaves reduce surface area to volume; hairy leaves catch moisture in the breeze to prevent overheating; low, compact growth forms minimise exposure; hard, persistent seeds remain viable until conditions are favourable for rapid growth. .

ANIMALS

Arid land animals are equally adaptive to these harsh conditions. Reptiles are the most adaptive and abundant. They shelter in burrows and vegetation, preying on ants and other insects that provide moisture. Most mammals shelter in burrows during the day, feeding at night to reduce moisture loss. Carnivorous marsupials such as the stripe-faced dunnart obtain water from their food. Birds and mammals take advantage of good seasons to reproduce and then it is the survival of the fittest. Many arid land birds are nomadic, flying long distances in search of water.

The insect life of the arid lands is the basis of the food chain for most reptiles, mammals and birds. The insects, particularly the termites and grasshoppers, are the herbivores of the desert that the carnivorous creatures depend upon. Termites feed on plant fibre and build their mounds from excreta, soil and saliva. Inside the insulated mound the temperature is constant and the colony thrives on co-operative living and specialisation of labour with workers, soldiers, nurseries and breeders. Ironically the termite mounds also provide a home for other desert dwellers such as small mammals and reptiles.

▲ *To find out more about arid lands of the Kimberley see Section 2: Places to go, things to know and do.*

- Wolfe Creek Meteorite Crater

Also see The grasslands community in this section. Spinifex grasses are also common in the arid lands.

Some interpretive activities for arid lands:

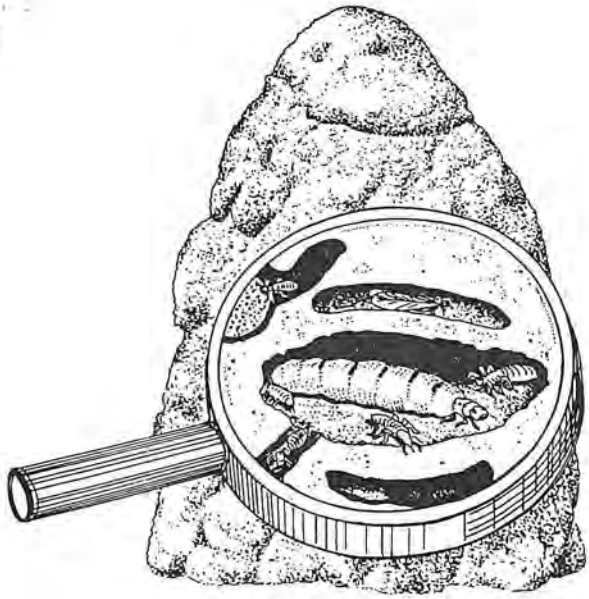
- The myriad of tracks covering the dunes in the morning is evidence of the diversity of insects, reptiles, mammals and birds living in the arid lands. Look for tracks in the sand and see if you can identify which animals may have made them.

- Examine the leaves of arid land plants to experience the many adaptive strategies to minimise water loss. Which is the most frequently used leaf adaptation?

Further Reading:

Wildlife Identikit - Common Animals of Central and Arid Australia.
Peter King. Gerry O'Neill.
Northern Territory Conservation Commission

Exploring Arid Lands.
Judith Harvey
Department of Conservation and Land Management



Termite mound cross-section.

RIVERINE WETLANDS

The tropical riverine wetlands of the Kimberley include the rivers, creeks, floodplains, lakes, lagoons, and waterholes. The 'wet' flushes the waterways and fills the floodplains and lagoons. Aquatic plants and organisms breed profusely in the hot, humid conditions providing food for birds and fish. Waterfowl such as ducks and magpie-geese and large wading birds such as the black-necked stork (jabiru), ibis, spoonbills, and egrets inhabit these tropical wetlands, as do the saltwater and freshwater crocodiles that come in search of the birds and the fish.

OASIS

As the waters recede in the 'dry' the remaining waterholes provide an oasis for wildlife. Sea eagles, osprey, whistling kites and brahminy kites soar, glide and hover looking for fish. Fruit bats roost in riverine vegetation, venturing out at dusk in search of fruits and blossoms. River gums and paperbarks provide corridors for the wildlife that comes to drink at the waterhole. Many birds such as corellas and cormorants become permanent waterhole residents through the 'dry'.

REPTILES

Merten's water monitor can be seen stalking frogs and insects amongst the reeds of the river bank. They are adept swimmers beneath and on the surface of the water, usually with the head held up out of the water and the body submerged. The rockhole frog is a prime target of the monitor as it too is active during the day, travelling across the surface of the water in a series of bounds.

On the banks of the waterholes, freshwater crocodiles bask in the sun, returning to the water when they get too hot. Waterbirds, 'clumsy' fruit bats and other small mammals, reptiles and frogs, insects, crustaceans and fish are food for the 'freshies'.

FISH

Beneath the water the variety of fish species create food chains that culminate in the barramundi, weighing in at as much as 40kg and up to 1.5m. A big 'barra' can live for 20 years. All barramundi are born as males but at six to eight years they change sex to mate with the younger, virile males in the estuaries. The young fish move upstream to freshwater and develop in the waterholes. Several years later they return downstream to mate.

The archer fish is another intriguing resident of the riverine wetlands. This striped predator shoots down insects in flight or from overhanging foliage with a thin jet of water. However, it is the catfish and the small rainbow fish, along with cherubin and other crustaceans that are most common in Kimberley riverine wetlands.

▲ *To find out more about river wetlands of the Kimberley see Section 2: Places to go, things to know and do.*

- Geikie Gorge National Park
- Windjana Gorge National Park
- Drysdale River National Park
- Mitchell Plateau
- Keep River National Park
- Lake Argyle
- Lake Kununurra
- Parry Lagoons Nature Reserve

Some interpretive activities for river wetlands:

- A waterhole away from the heat of the day is the place to see the comings and goings of tropical life. You can't see the changing seasons in one visit to the Kimberley but you can see the patterns of change that take place over just a short period of time.

- Sit, watch and record the number of creatures that you see or hear. Draw on a sheet of paper, or on a sand map, the pattern each makes in its movements. How many of these movements are to and from the waterhole? How many are restricted to the waterhole?
- Shine a torch into the water's edge at night to attract cherubin and other crustaceans, and freshwater turtles.

Water birds

COASTAL WETLANDS

Coastal wetlands include mangrove forests, mudflats, salt marshes, estuaries, tidal lagoons, rocky and sandy shores. Mangroves are a key feature of the Kimberley coastline between Broome and Wyndham. Mangrove communities occur in small patches scattered over a great area of coastline forming narrow fringes on rocky shores to extensive, closed-forests on tidal mudflats and estuaries. Mangrove trees form dense communities called mangals in which a humid microclimate is created. Many plant and animal species are totally dependent on the mangrove community.

MANGROVE ADAPTATIONS

The extensive and specialised root systems of mangrove plants slow water movement so that sediment falls out of suspension. In this way, they colonise, protect, and stabilise the shoreline. There are 17 species of mangrove plants found along the Kimberley coast. They have special features that allow them to survive in sea water and other saline environments. Their air-breathing roots that take on intriguing shapes such as buttresses, stilts and vertical spikes called pneumatophores, allow them to grow in airless mud. Their fruits are adapted to disperse by floating in water, or spearing into the mud. Some species filter out the salt at their roots while others excrete salt from old branches and leaves.

Different mangrove species grow in bands influenced by soil type, salinity, drainage and tidal frequency and duration. At Broome, the mangrove walk trail out towards Buccaneer Rock provides a cross-section of a mangrove community where the plant distribution is indicative of a series of bands.

MANGROVE BIRDS AND ANIMALS

Mangroves provide habitat for a wide variety of fish, birds such as the mangrove fantail and the mangrove golden whistler and other animals such as fruit bats, mudcrabs, mangrove snails, the mangrove snake and saltwater crocodiles. As well as providing a highly productive nursery for fish, mangroves are excellent feeding and breeding grounds for marine life. Mudskippers, crabs and prawns are common among the mud and rocks, and around the roots of mangroves. Oysters and barnacles can be found attached to exposed roots and some marine snails and hermit crabs seek refuge on branches above high tide.

TIDAL MUDFLATS

Kimberley tides can vary from one to 12m. On a gradual sloping shore such as Roebuck Bay, Derby and Wyndham, the tide can recede over a kilometre exposing extensive mudflats. Here feather stars, mudcrabs, marine snails and even sea snakes can be found.

MIGRATORY WADERS

Mangroves and mudflats are such ideal feeding grounds for marine life that they attract international visitors - the migratory shorebirds, appropriately called waders. Around September each year, 800,000 waders of over 30 species visit the northwest coast from breeding grounds in the northern hemisphere, particularly Asia and Siberia. In the Kimberley they feed mostly on micro-organisms of the mudflats, but can be seen on most wetlands and shorelines as they skirt the Australian continent. Sometimes they still have their breeding plumage when they arrive, but mostly they are dull grey to be unobtrusive on the shorelines. In April and May the waders fly back to their northern breeding grounds. A total of 48 species of shorebirds have been recorded in Roebuck Bay. Take a close look at their legs and beaks. All have special features for feeding on the micro-organisms, molluscs and other marine life of the shoreline.

SALT MARSH

Back behind the mangroves and mudflats is the salt marsh where only a spring tide will penetrate. Here grow the samphire plants that can tolerate the occasional inundation and the

frequent salt spray. These succulent plants store moisture in their leaves to cope with the harsh conditions. You will often see Richard's pipit amongst the samphire and grasses looking for insects.

THE COASTLINE

About 17,000 years ago rising sea levels flooded river deltas, coastal plains and valleys. Today much of the Kimberley coast is of rocky shores fronting steep cliff-faces overlooking inlets. Broad sandy shores in the Kimberley are confined to the Dampier Peninsula and south along the '80 mile beach' while small beaches are found along the entire Kimberley coast and islands.

▲ *To find out more about Kimberley coastal wetlands see Section 2: Places to go, things to know and do.*

- Buccaneer Archipelago
- Mitchell Plateau
- Coulomb Point Nature Reserve
- Island nature reserves

Other coastal wetlands to visit

- At Roebuck Bay, Broome there is a short mangrove walk behind the Mangrove Hotel where mangrove plants are identified.
- The Broome Bird Observatory on Roebuck Bay is the place to find out more about shorebirds and migratory waders, mangroves and mudflats and the saltmarsh country of the Roebuck Plains, as well as other birds of the Kimberley.

Some interpretive activities in coastal wetlands:

- Sit and watch the crabs come out of their holes to watch you watching them.
- Take binoculars to look for shorebirds. Note the differences and similarities in beaks, legs, necks and plumage patterns.

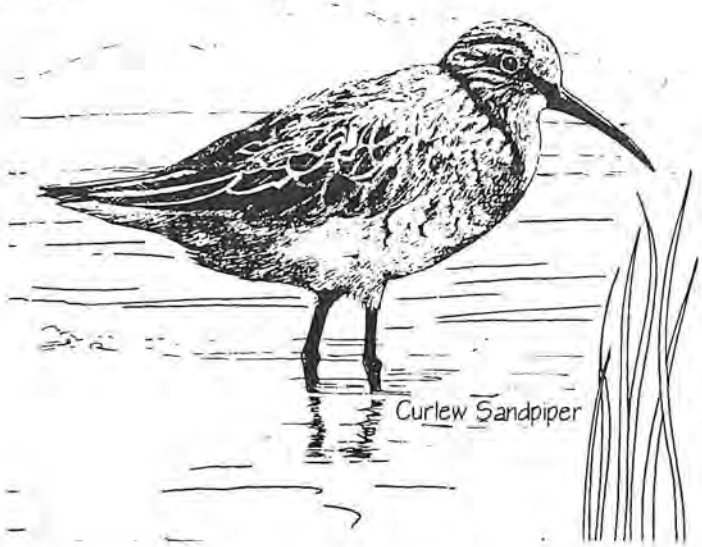
Further Reading:

Mangroves of Western Australia.
V. Semeniuk. K. Kenneally. P. Wilson
Western Australian Naturalists' Club

Mangroves of Australia.
R. Lear. T. Turner.
University of Queensland Press

Mangroves and Mangrove Birds of Western Australia.
R. Johnstone
W.A. Museum

The Birds of Broome Annotated List
P. Collins
Broome Bird Observatory



OCEAN, ISLANDS AND REEFS

Bounded by the Timor Sea to the north and the Indian Ocean to the west, the tropical waters of the Kimberley support a vast array of marine lifeforms. The currents and tides generate constant movement of tropical waters and the mix of nutrients. (See Section 1.2 Cycles of Change...sun, rain, wind, stars and tides.) Many deep-water fish, particularly the schooling fish, take advantage of these ocean currents, preying on smaller fish and other marine life. Occasionally salt-water crocodiles will go out to sea to fish the currents.

CHANGING SEA LEVELS

In the Kimberley, the continental shelf is well offshore. The Earth's climate was much colder 10,000 years ago. The ocean levels were much lower because of the water trapped as ice in the polar ice-caps. The exposure of the sea floor allowed easier passage of people and wildlife between the Indonesian islands and the Australian continent. Today, sea levels have risen, and continue to do so with the melting of the ice caps from the 'greenhouse effect'. However, the islands and reefs on the continental shelf continue to provide habitat for tropical marine life.

REFUGES FOR WILDLIFE

Many of the islands off the Western Australian coast are refuges for wildlife. Some are given special protection as island nature reserves with restrictions on visitors. Some such as Augustus Island in the Bonaparte archipelago have populations of native animals that are now severely depleted on the mainland from disturbance of habitat. Sea birds take advantage of the relative lack of predators on islands to rear their young and their rookeries are found on many of the islands.

TURTLES

Island beaches provide nesting sites for marine turtles. Six species of marine turtles are found in Kimberley waters. They are the loggerhead, flatback, green, hawksbill, leatherback and Olive Ridley turtles. Green and flatback turtles are known to breed in the Kimberley. These turtles return to nesting beaches in the area where they hatched, although in the course of their life they can travel to feeding grounds over a thousand kilometres away.

Turtles lay their eggs on sandy beaches. The female turtle crawls ashore, excavates a hole in the sand, deposits and buries her eggs. It is the temperature in the nest that determines the gender of the hatchlings that dig their way out of the nest after three months. They must avoid predators such as sea birds, crabs, crocodiles and fish, before growing to maturity up to 30 years later. The Lacepede Islands, to the northwest of Broome, are renowned turtle breeding islands on which significant research has been carried out on turtle behaviour.

DUGONGS

Dugongs are herbivorous marine mammals, feeding on seagrasses. Their stronghold is in Shark Bay on the central Western Australian coast where there are 10,000 dugong. They are also found in Kimberley waters although they are not as common. They are mostly solitary animals and defenceless against the attacks of sharks and Aboriginal hunters who hunt dugong as well as turtle for food.

CORALS

Warm, clear tropical waters are favoured conditions for the growth of corals and coral reefs. Coral reefs are among the most diverse natural communities on Earth. Shaped by currents and trimmed by waves and tides, coral reefs support a vast array of plants and animals. Diving on a coral reef reveals a myriad of corals, colourful fish, shells and other creatures of all shapes and colours. The foundation for this diversity of life is the coral polyp (related to the sea anemone). Each polyp builds a skeleton of calcium carbonate. The

coral reefs are formed by the accumulation and cementation of countless coral skeletons over thousands of years. The reef is constructed by colonies of tiny coral polyps, a thin layer of life draped over the remains of their predecessors.

There are over 200 species of corals off the Kimberley coast. Corals are of many different growth forms, depending on the species present and the environmental conditions. There are both hard and soft corals. The soft corals do not form a hard skeleton. Staghorn corals are found in sheltered lagoons. Low-profile tabular forms can withstand the force of waves on the exposed reef fronts. The sprawling plate-corals capture limited sunlight in the deeper waters. The coral reef, in all its complexity, provides homes for other marine life.

Corals are found in favourable conditions along the Kimberley coastline such as Cape Leveque. Fringing reefs are found around some Kimberley islands. However it is the shelf atolls that are best represented in the Kimberley at Rowley Shoals. The coral growth has kept up with the rising sea level and the subsiding continental shelf so that the water surrounding the atoll is now about 440m deep. Because of their isolation at over 330 kilometres (180 nautical miles) from the Kimberley coast, these shelf atolls are among the most unspoilt in the world.

OTHER MARINE LIFE

Although it is the fish that appear most abundant in the marine environment, there is a myriad of other lifeforms. Two of the most distinctive and abundant groups are the molluscs and the echinoderms.

The molluscs are a most diverse group. They include the sea snails, sea slugs (nudibranchs), octopus and squid, and others. Although most have shells, some have been internalised like the cuttlefish.

The echinoderms (sea stars, sea urchins, brittle stars, feather stars and sea cucumbers) similarly display a variety of form. They have in common tough skin, radial symmetry and tube feet. Most sea stars prey on molluscs, opening the shell with their tube feet. The sea urchins, in contrast are herbivorous. Their stiff spines are attached to an internal circular shell. Once the animal dies the spines are shed and the urchin shells are commonly found washed up on the shore.

▲ *To find out more about the oceans, islands and reefs of the Kimberley see Section 3: Places to go, things to know and do.*

- Rowley Shoals Marine Park
- Island nature reserves

Some interpretive activities in the marine environment:

- At Rowley Shoals sit and watch the comings and goings within a coral lagoon both above and below the water line, but keep an eye on the currents and tide. Sea birds patrol overhead, hoping to spy unwary fish in the water. Turtles forage for marine plants and animals. Fish and sea snakes occasionally break the surface.
- At Rowley Shoals dive with snorkel or scuba for those close encounters of an extraordinary kind. Look for creatures representative of the diversity of marine groups. Within each group look for the preferred habitat of the various species.
- Use the book North West Fishes (W.A. Museum) to identify the fish you see while diving or fishing.

Further Reading

Coral Reefs of Western Australia
C. Simpson

North West Fishes
G. Allen
W.A. Museum

Marine Fishes of Tropical Australia and South-east Asia
G. Allen
W.A. Museum

Sea Shells of Western Australia.
F. Wells. C. Bryce
W.A. Museum

1.4

Looking at Kimberley Wildlife: discovering the diversity

KIMBERLEY PLANTS

Over 2000 plant species have been described for the Kimberley. They are representatives of 167 families and 660 genera. The dominant family is the grasses with over 250 species! There are 93 species of wattles in the Acacia genus and 57 species of Eucalyptus. There are now over 100 alien species that have become naturalised.

GETTING TO KNOW PLANTS

The diversity of plant life and the broad distribution of many of these plants make it a significant challenge to become adept at identifying Kimberley plants for visitors and others. Even when we can name a plant, often it is as quickly forgotten by the enquirer, unless a distinguishing feature is pointed out or a particular story associated with the plant. Meeting plants is like meeting people. You remember the person's name if there is something memorable about the person.

The scientific names for plants always carry a story. Often you have to know the Latin translation such as Eucalyptus means 'well covered' referring to the operculum or bud-cap, which drops off as the flower opens. The species name for many plants refers to the first person to collect and describe the species. The Kimberley bauhinia (*Bauhinia* [formerly *Lysiphyllum*] *cunninghamii*) and the green birdflower bush (*Crotalaria cunninghamii*) are named after the famous explorer and botanist Alan Cunningham who travelled widely in the nineteenth century collecting plant specimens.

Visitors' questions are the best indicator of which plants have intrinsic interest. You need to get to know these plants. Get your visitors to help you by looking for the plant in CALM's bush book *Common Plants of the Kimberley*. They learn a skill of plant identification and get the reward of answering their own questions, and you become more knowledgable about Kimberley plants. Your visitors will remember the name if they have to work for it. See the further reading list for other books about plants. The pictorial books are easiest for visitors to use to identify common plants.

BOABS AND BAUHINIAS

Some plants visitors always enquire about are the boab and the Kimberley bauhinia. The boab (*Adansonia gregorii*), with its huge girth, deciduous leaves that are shed to conserve moisture during the dry season and the large boab nuts are obvious distinguishing features. The red flowers and young seed pods of the Kimberley bauhinia (*Bauhinia* [formerly *Lysiphyllum*] *cunninghamii*) are eye-catching, along with the dense foliage on drooping branches. Closer inspection reveals the twin leaflets.

CREATING MEMORABLE EXPERIENCES

By encouraging visitors to look closely at Kimberley plants, rather than just giving them a name, you can create memorable experiences. Stories associated with particular plants can

◆

significantly enhance the experience and imprint on the memory. The boab can live for hundreds of years. Trunk scars from fire can form hollows that have been used to shelter people and stores; as early settlers' homes and as temporary prisons. The boab nut contains a pulp that is rich in vitamin C. Taste it!

CREATING STORIES

You can create your own stories by looking at the ***plant form*** (tree, shrub, heath, grass, herb, vine) and putting the plant into the context of the natural community of which it is a member. Plants and animals needing the same environmental conditions are often found together. A particular habitat will therefore have a particular association of plants and animals. We call this a ***natural community***.

NATURAL COMMUNITIES

The plants within a natural community are usually described according to the height and density of their tallest species. A forest has trees close enough together for their canopies to touch or overlap; if they are further apart they are called a woodland. A low forest or woodland is one whose height is less than 10metres. Shrubby vegetation devoid of trees is heath if it is less than two metres tall, and scrub if more than two metres. Grasslands are predominantly made up of grasses. Ask your visitors which plant community does the particular plant you are looking at belong (forest, woodland, scrub, heath, grassland).

In any area there is usually a mixture of different plant forms (trees, shrubs, heath, grasses, herbs and vines). In each natural community, one form of plant is usually more common than the others. This is often used to give the natural community its name. So, in the Kimberley we have rainforests, woodlands, and grasslands. Where the environmental conditions, in particular water, soil and landform, are more apparent than the plant forms, then the natural community is described accordingly. We have the Kimberley ranges and wetlands - riverine, coastal, and the ocean, islands and reefs. However, a woodland in the north Kimberley will have differences as well as similarities with a woodland in the western Kimberley.

Analysis of natural communities in greater detail across the Kimberley reveals a number of landscape character types. But that's another story. See Section 4 for landscape character types.

▲ *To find out more about Kimberley plants see Section 2: Places to go, things to know and do.*

There are trailside signs interpreting plants at

- Windjana Gorge National Park:-'Savannah Walk'
- Gubinge Road Vine Thicket, Cable Beach:-'Rainforest Walk'
- Purnululu National Park:-'Mini Palms Track'
- Mirima National Park:-'Looking at Plants Trail'

Some interpretive activities with Kimberley plants:

- Prepare with visitors some plant identification cards for those most asked about. You could have your identifications checked at a CALM Office. On the card provide space to sketch the plant form (tree, shrub, heath, grass, herb, vine) and the plant parts (the bark, leaves, flowers, fruit, nut or seeds). Then write a brief description.
- Collect plant specimens, and press them to make a tour herbarium. You can store your pressed specimens in a photograph album (the type with the sticky pages and clear laminate overlays). There is a good example in CALM's Kununurra Office.

  Remember:

  (i) You require a permit from CALM to collect plant specimens.

  (ii) You can't take plant specimens over the border without a permit from Agriculture Western Australia.
- Use your plant identification cards to identify the living plant. Closely examine the plant to complete these observations:

My flowers/fruits are
▼
_____
(colour)

They smell like
▼
_____

My bark feels
▼
_____

I like
▼
_____
soil

I regenerate by
▼
_____

(animal) visits me for food because
▼
_____

(animal) depends on me for shelter
▼
_____

The most difficult time for me is
▼
_____

But I solve this problem by
▼
_____

- Take binoculars to look for birds, and a hand lens for insects, to discover plant-animal associations.

Further Reading

Broome and Beyond
K Kenneally, D Edinger, T Willing
Department of Conservation and Land Management

Flora of the Kimberley
edited by J R Wheeler
CALM

Plants of the Kimberley Region of Western Australia
R. Petheram, B. Kok
University of Western Australia Press

Plants of the Tropical Woodland
M.Clark. S.Traynor
Northern Territory Conservation Commission

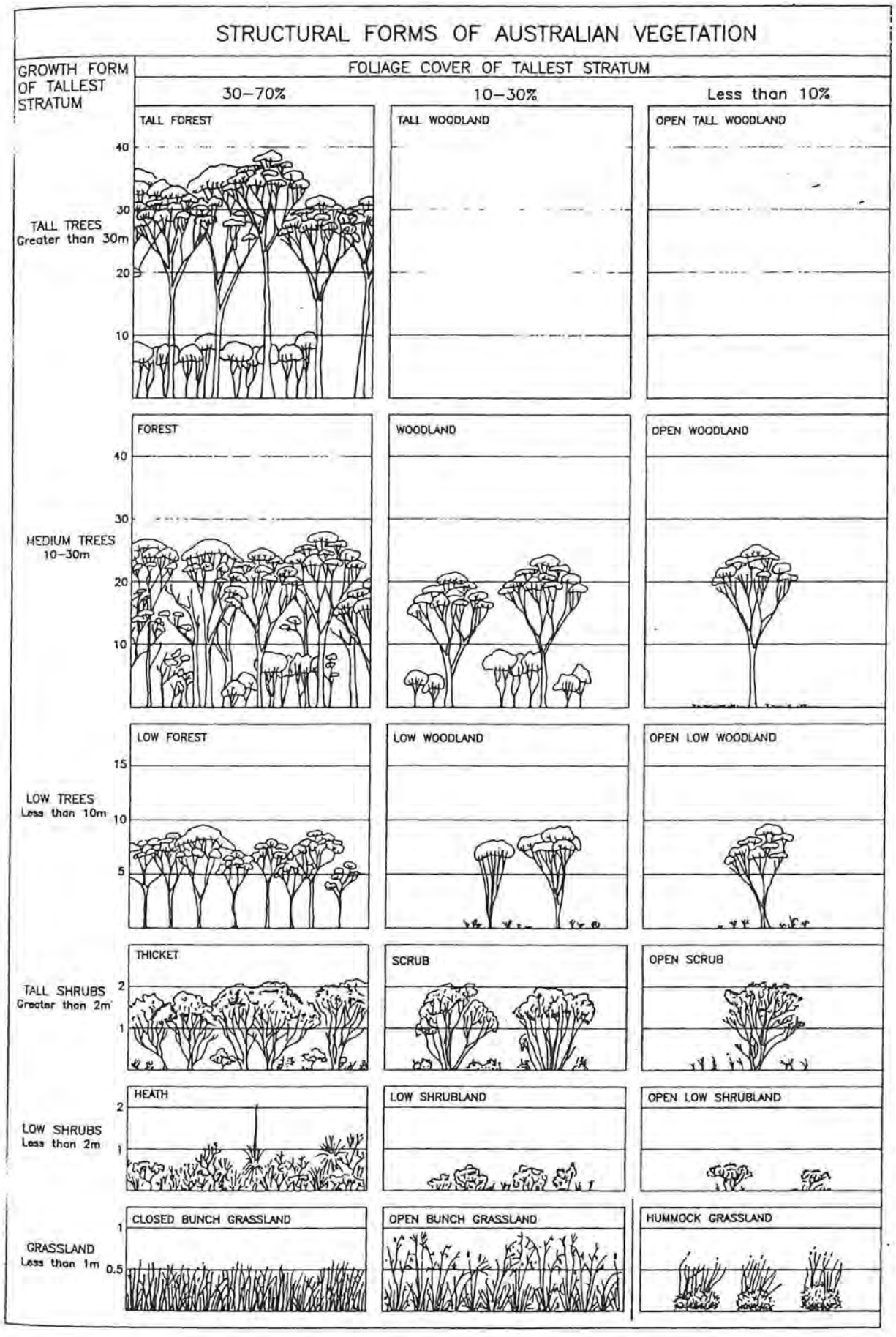
Plants of Northern Territory Monsoon Vine Forests
G Wightmann and M Andrews
Northern Territory Conservation Commission

Field Guide to Eucalypts Vol 3 Northern Australia
Brooker and Kleinig
Inkata Press

Vegetation Survey of Western Australia: Kimberley, Western Australia
J.S. Beard

Traditional Aboriginal Plant resources in the Kalumburu Area
I M Crawford
Western Australian Museum

Kimberley Plants
Department of Conservation and Land Management (Bush Book Series)


STRUCTURAL FORMS OF AUSTRALIAN VEGETATION
GROWTH FORM OF TALLEST STRATUM
FOLIAGE COVER OF TALLEST STRATUM
30–70%
10–30%
Less than 10%
TALL TREES Greater than 30m
MEDIUM TREES 10–30m
LOW TREES Less than 10m
TALL SHRUBS Greater than 2m
LOW SHRUBS Less than 2m
GRASSLAND Less than 1m
TALL FOREST
TALL WOODLAND
OPEN TALL WOODLAND
FOREST
WOODLAND
OPEN WOODLAND
LOW FOREST
LOW WOODLAND
OPEN LOW WOODLAND
THICKET
SCRUB
OPEN SCRUB
HEATH
LOW SHRUBLAND
OPEN LOW SHRUBLAND
CLOSED BUNCH GRASSLAND
OPEN BUNCH GRASSLAND
HUMMOCK GRASSLAND
40
30
20
10
15
5
2
1
1
0.5

ANIMALS

Life on Earth finds its greatest diversity in the tropics, and the Kimberley is no exception. Animal life is abundant across the range of lifeforms - the birds, mammals, reptiles, fish and invertebrates. Creatures such as fruit bats, crocodiles, pythons, frill-neck lizards, archerfish, barramundi and termite colonies are characteristic images of the Kimberley.

To be struck by a sense of awe and wonder at watching a wild creature at close hand for the first time is a memorable experience. To be able to share it with others is perhaps even more so. It provides the chance to rekindle that sense of wonder. However, almost inevitably, looking at native animals becomes a detective story.

GETTING TO KNOW WILDLIFE

Describe what you saw? What shape and size was it? Colour? What was it wearing (fur, feathers or scales)? What was it doing? Why do you think it was doing that? Have you seen it do that before?

We get to know a creature through the process of observation, enquiry, and recall. Ultimately we are able to predict where a familiar creature is likely to be found. It's all a matter of taking time to observe and enquire.

The pictorial book, *Mammals of North-Western Australia* (CALM), provided with this manual is easy to use in identifying Kimberley mammals, and for finding answers to your questions. See the further reading list for other books about animals.

ENRICHING THE EXPERIENCE

The remote and rugged nature of the Kimberley and the comparatively low level of disturbance to the natural environment make the Kimberley a good place for viewing native animals in the wild. However the animal life is not always easily seen. When you do get to see Kimberley creatures make the best of it by enriching the experience with a story about that creature.

ANIMAL RELATIONSHIPS

Wallabies and termites in the Kimberley are the equivalent of the hooved herbivores of Africa. Termites feed on plant fibre and build their mounds from excreta, soil and saliva. The diversity of invertebrates, such as the termites and other ants, attracts specialist predators like the echidna and an abundance of skinks and other lizards. You can build stories like this by considering the relationships of animals with other animals, (predator-prey); animals with plants (food and shelter) and animals with the land or seascape (habitat). It is all a matter of association.

TRACKS AND TRACES

You can make looking for and discovering skats, skulls, tracks and traces of fur, feathers or scales almost as intriguing as seeing the animal. It's all part of being a bush detective. Examining road kills of native animals from a safe place off the road can be a rewarding experience. Look at the form (shape and size) of the creature. Why has it evolved this way? What is the function of the beak or teeth, feet or claws? Enjoy the investigation and let the field guide books provide the verification of your explanations.

▲ *To find out more about Kimberley animals and their preferred habitat see Section 2: Places to go, things to know and do.*

Places with signs interpreting animals are

- Windjana Gorge National Park:- 'Time Walk'
- Geikie Gorge National Park Visitor Centre

Some interpretive activities with Kimberley animals

- Prepare identification cards using silhouettes for groups of animals. Have a member of your group keep the list of species identified within each group. Some animal groups are:

- **mammals**: these include marsupials (kangaroo/wallaby/bandicoot/ possum/ dasyurids) and rodents;
- **birds**: these are divided broadly into perching and non-perching birds. There are over 25 distinctive groups in the Kimberley in a range of sizes. Ask your visitors for comparative sizes with known groups of birds; for instance, a large bird is bigger than a magpie; a medium size bird is smaller than a magpie but bigger than a finch; a small bird is the size of a finch;
- **reptiles**: look at snakes as either pythons which are not venomous (but they still can bite) or others that are venomous with either rear or front fangs (but don't try to find out). Lizards are a diverse group. There are the skinks, dragons, geckos, snake-lizards and monitors;
- **amphibians**: frogs; turtles (marine and freshwater); crocodiles (freshies and salties);
- **fish**: marine and inland freshwater fish; and
- **invertebrates**: winged and others.
- With two or more people take binoculars to look for birds. Have the person using the binoculars describe the bird under observation while their partner looks up the bird in the book based on the descriptions of the observer. You'll need to be able to recognise the shape of a number of familiar groups of birds such as parrots, finches, birds of prey, pigeons, honeyeaters etc. Then the description of colours and colour patterns, along with particular features such as beak and legs help the identification process. Have fun reading and imitating the descriptions of bird calls.

Further Reading:

Mammals of North West Australia
Department of Conservation and Land Management (Bush Book Series)

Common Birds of the Kimberley
Department of Conservation and Land Management (Bush Book Series)

Hazardous Animals of North West Australia
Department of Conservation and Land Management (Bush Book Series)

The Mammals of Australia
Australian Museum / Reed Books

Tracks, Scats and Other Traces A Field Guide to Australian Mammals
B. Triggs
Oxford University Press

Lizards of Western Australia.
(i) Skinks (ii) Dragons and Monitors
(iii) Geckoes and Legless Lizards
G.M.Storr. L.A.Smith. R.E.Johnstone
Western Australian Museum

Frogs of Western Australia
M.J.Tyler. L.A.Smith. R.E.Johnstone
Western Australian Museum

Snakes of Western Australia
G.M.Storr L.A.Smith R.E.Johnstone
Western Australian Museum

A Photographic Guide to Snakes and Other Reptiles of Australia
Gerry Swan
The Australian Museum

Fauna of Kakadu and the Top End
Denise Goodfellow

Birds of Western Australia
Western Australian Museum

Field Guide to the Birds of Australia
Simpson & Day

The Slater Field Guide to Australian Birds
Peter Slater Pat Slater Raoul Slater

Field Guide to the Birds of Australia
Graham Pizzey Frank Knight

Complete Book of Australian Birds
Readers Digest

1.5

Getting to know Kimberley people: considering our cultural heritage

KIMBERLEY ABORIGINAL PEOPLE: UNITY IN DIVERSITY

Kimberley Aboriginal Perspectives

- 'I don't know what happened to you, but all your spirit has gone out of you. No men or women watch over you, for the people who belong to this place - my aunties, sisters, fathers, and grannies - they are all dead now. Only I, that belong to another place, came to visit you, but you were lonely for all those people who died and your spirit has gone away now' an elderly Aboriginal speaking as quoted by Ian Crawford in *The Art of the Wandjina.*
- 'To go back in time, you walk. It gives you respect for what happened when everything was created. It gives you a quietness of mind - and direction.' David Mowaljarlai in *Yorro Yorro.*
- 'These stories are not written down, but they are written on the land, into nature; otherwise we wouldn't take you or anybody and show them. They are there for everyone to see - not just to read about.' David Mowaljarlai in *Yorro Yorro.*
- 'I want to live both ways. I want to run my Law. I want to sing. I want the white man law and my Law. Some is the new way, some the old way. But the old way I think is more better. But this new way I have to keep too.' Stan Brumby in *When the Dust come in Between.*
- You look at your skin. You're different skin, white. And you look at my finger dark. Well that makes no difference. You and me are human beings eh, the same colour?' Peter Ngunung in *When the Dust Come in Between.*
- 'Me, I want to know how they make trouble, the white, the black. And I want to know why we can't sit in peace, be friends. The white man and black man we want to be friends all over.' Stan Brumby in *When the Dust Come in Between.*

Our Kimberley according to the Ngarinyin

LAND

Our Kimberley is living, breathing life. Our land is reflected in us, and we are reflected in the land. Our past, present and future is all in the land, from creation time to future time, all at once.

MEANING

We know who we are because we are reminded of our meaning every day, every part of the day. When we walk or drive looking for bush tucker, we see our relations in the plants and animals. We travel through country which gives us our shape, our form and our meaning.

RESPECT

From before sunrise time in the early morning, when night is raked back and lifts the weight of darkness off our bodies, we call that 'Piccaninny daylight' because that is when the little ones wake and cry for food. We light the campfire, warm our hands and place them on the children, imploring them to be mindful of who they are and how they conduct themselves for the day. We are alert to the day, fearing the powers in the Earth, the sky, the water and below the ground. We call this Woodu time, the first light of awareness, every day. We know every day that Wunggud Power is in us, and in the Earth; we share this with everything that is standing up alive, and we respect it.

IMAGES

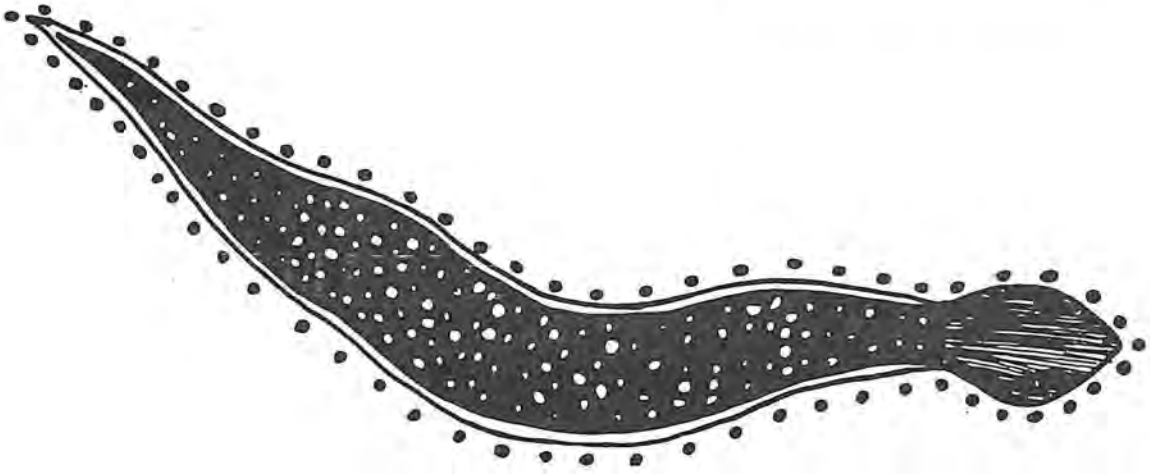
As we go about our daily business we acknowledge the Earth as she reflects our beings. We don't see interesting geology like mountain ranges and river valleys. We see our own reflections; man, woman, children, shapes and forms which remind us that we come from the Earth, and are imaged in the Earth. We see where the snake travels through the land, under the skin, sometimes breaking through the crust and leaving a valley where water now runs as rivers.

Other places we see the hills and ranges where snake still is, now with all trees, grasses, insects, animals living on her back. We see woman image in the Earth, soft, rounded, living and breathing, alive in the power of life. We see man image, his kidney, heart, thighs, all alive and renewing us all the time.

PLACES

We know all the places where birth comes from. Water places, Wunggud waterholes where all of life comes from. We are reminded that all of life is born through the medium of water, and holds the blueprint for creation. Our own children come from these places where they wait as spirit children until their time comes to be enlivened in human form. We respect the Power in these places. Some are taboo for children; some are taboo for boys; some are special healing places; some are places where creation is renewed in a constant process, a continuous present.

Some have paintings where Wandjina rested, or became a painting after creating an animal or a power. All the Wandjina are named, and are alive in those places, doing their work every day. These are our life-giving and life support places. Sometimes they are called 'sacred sites', but to us, they are teaching places where our evidence is physical, in the land itself. They are like beacons telling us where the power grids are within the earth, and within creation. Like telegraph poles that carry electricity from one town to another.



Aboriginal snake

SIGNS

We know when the rains are coming because the signs are there in nature. We know if it is going to be a wet time, or a dry time. Nature gives us all the signs; evidence is written in nature. We know the history of weather, climate, vegetation, animals, everything that you see because the evidence is all there, written in nature's belonging, and our belonging in the family of nature. That is why we are all related. The animals and birds and insects - everything is related in Wurnan, the relationship pattern in our land. We are not separate from the rest of nature - we are all one family.

TOTEM

Our children all know who they are because of where their spirit was born from, what spirit entered them, and what spirit sustains them and governs them for all of their lives. Sometimes this is called our 'totem'. It is our special responsibility because it is the energy that gives us meaning, so we have to look after our totem and respect that place where it lives in nature. Everyone of us is named in totem, in mother country and in father country. we can't escape from the pattern because we die, everything dies, when it leaves the life support system of belonging country.

BUSH UNIVERSITY

We have started our Ngarinyin Culture College, and Bush University to teach people about the true meaning of this Kimberley land. We can only teach from our own country because that is where we belong. Other tribes can speak for their own country. Nobody can speak for anyone else's country because they don't come from there; they don't have the energies of somebody else's country, just their own.

LAW

All of our country and its meaning is told to us from the land, in stories. These stories are not fairy stories. They are Law. Whitefella law is written on paper. You can't really see its meaning. Our Law is written in the land, there for everyone to learn. That's what we teach in Bush University - the Law in the land.

Our Law is alive, in the past, present and future, because the earth is alive, so our stories are being enacted every day, everywhere in everything that is form, shape, and alive. Rocks, ochres, waters, mountains, plants, animals, insects, fish, birds, crocodiles - everything in creation; they all belong in the Earth, and all give us their stories.

TEACHING

Our job is to know the stories, teach them to one another, and make sure that the Law is not trespassed by ignorance. That is our responsibility, and that is what we are doing in Bush University. That is why we Ngarinyin are in this book, so that everyone can come to know the original, living, meaning of this land, and be taught by us, the professional people who know all the stories and their meanings.

We are happy to teach tour operators in Bush University, so they can understand the proper ways to behave, and to respect the tribal Law in the Kimberley. We will teach anyone who wants to learn. In our country, only we can do that teaching, and only we can take people to our significant places, because we are the ones who belong to our land. We can't teach about anybody else's land; other Aboriginal people can talk for their own country. We can teach anybody how to behave respectfully to other Aboriginal people whose land tourists want to see, and who they want to meet. This is the right way to do things. Nobody should trespass other people's knowledge or land. That is our Law.

Further Information:

Ngarinyin Culture College
Ngarinyin Aboriginal Corporation
PO Box 180
Derby 6728
Telephone (08) 91931 513
Fax (08) 91931 607

LOOKING BACK ON OUR ABORIGINAL HERITAGE

ARCHAEOLOGICAL SITES

Archaeologists and anthropologists consider that Aboriginal people have been in Australia for 60,000 years. Some stone artefacts from a rockshelter at Carpenter Gap in the Napier Range are the earliest dated archaeological material from the Kimberley. Sites at Yampi Sound and Collier Bay are 24,000 years old. Older coastal sites have been lost beneath rising sea levels over the last 6,000 years.

ROCK ART

It is estimated that the rock art of the Wandjina figures spans from over 2,000 years through to contemporary Aboriginal renovations. The 'Bradshaw figures', an art-style of fine lines and active figures are much older, and were not periodically maintained like the Wandjina art. Recently mudwasp nests partially covering a Bradshaw painting have been dated at 16,400 years using Optically Stimulated Luminescence techniques.

Bradshaw figure

EARLY HISTORICAL RECORDS

The earliest historical records of Aboriginal people in Western Australia are from the Dutch, French and British maritime explorers from the early 17th century. In the northwest of Western Australia, encounters with Aboriginal people were first recorded by the English Captain William Dampier in 1688 and again in 1699.

LATER HISTORICAL RECORDS

British colonisation of first Albany and then Perth in 1829 accelerated the development of the historical records. The journals of overland explorers into the Kimberley, such as Grey (1837) and Forrest (1879), record some detail about Aboriginal lifestyles. The coming of the pastoralists and missionaries, and ultimately the anthropologists and archaeologists, significantly increased the recorded knowledge of traditional Kimberley Aboriginal society. Today the spiritual traditions continue to be practiced by many Kimberley Aboriginal groups, although their lifestyles and technologies are contemporary.

SITES OF SIGINIFICANCE

Our Kimberley Aboriginal heritage is rich and varied. Throughout the Kimberley are many sites of significance to Aboriginal people. Some of these are sign-posted, such as the midden in Broome next to the Mangrove Resort.

- ***Mythological sites*** are landforms, rocks and waterholes that are places of spiritual significance. Often they are also art sites. They are the physical context of the Dreaming stories that impart Aboriginal law, beliefs, customs and ceremonies.
- ***Gathering sites*** are places of traditional coming together of peoples to carry out ceremonies and customs. Many are still in use in the Kimberley where Aboriginal law is strong. Often they are associated with mythological sites and artefacts of spiritual significance.
- ***Archaeological sites*** are places where artefacts and other evidence of occupation and use have been uncovered. They are not necessarily of significance to Aboriginal people.

- ***All Aboriginal sites are protected by law.*** They may also be protected by Aboriginal custodians. Find out from the Aboriginal Affairs Department, Western Australia and the local custodians the terms for visiting particular Aboriginal sites. There are regional offices of the Aboriginal Affairs Department in Kununurra and Derby. For sites in conservation reserves see CALM for advice.

Aboriginal culture is diverse and complex although the technology was relatively simple.

The evolution of Kimberley Aboriginal culture

About 270 Aboriginal languages were spoken across Australia at the time of colonisation by the British in 1788. There may have been as many as 600 to 700 dialects. At the time of British colonial settlement of Western Australia there were at least 131 social units (tribes, clans or groups) making up over 60,000 people. In the Kimberley 35 dialects were spoken of 15 different languages.

CHANGING LIFESTYLES

The displacement of Aboriginal groups from their tribal lands into missions, towns and cattle station camps changed the pattern of distribution of groups, languages and customs, although the affiliations with the traditional lands remain. Today, six Kimberley languages and dialects have disappeared and four more are only spoken by a few. However, other groups such as the Bardi, Ngarinjin, Bunaba, Miriuwung and others strive to maintain strength in language, culture and Aboriginal law while living contemporary lifestyles.

TODAY

Today Aboriginal people make up about 45 per cent (11,000) of the Kimberley population of 25,000. In Western Australia there are over 40,000 people of Aboriginal descent. Most Kimberley Aboriginal people speak English, although for many it is their second or third language. Aboriginal English is more common than Standard English amongst Aboriginal people in the Kimberley.

Contemporary Kimberley Aboriginal culture

The evolution of Aboriginal culture in contact with other people has produced a mix of contemporary and traditional lifestyles and expressions that are vibrant strands in the fabric of multi-cultural Australia. Today Aboriginal people produce personal accounts of their lives and lifestyles, and express themselves through arts and crafts that significantly enrich the experience of Aboriginal culture. Aboriginal culture is alive!

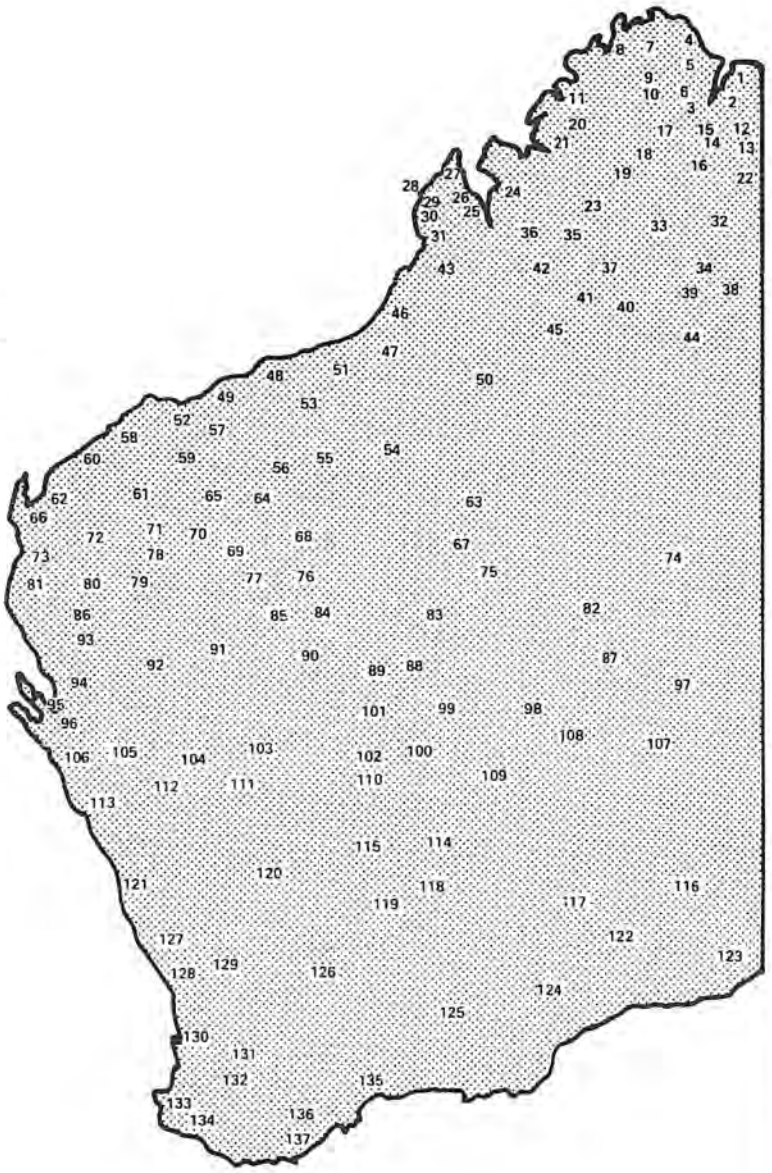
Wherever there are Aboriginal people, in rural or urban environments, there is a strengthening of pride in their Aboriginality. This pride in traditional and contemporary expressions of Aboriginal culture is increasingly shared by other Australians and is attracting the attention of people throughout the world.

Aboriginal people make up 45 per cent of the resident population of the Kimberley. The percentage of Aboriginal people in Kimberley Shires is Wyndham - East Kimberley (includes Kununurra) 30 per cent, Halls Creek 74 per cent, Derby - West Kimberley (includes Fitzroy Crossing) 54 per cent, Broome 39 per cent. Outside of these centres there are numerous Aboriginal communities. There is some transitory movement of people amongst these communities.

LINGUISTIC TRIBAL MAP

This map, compiled from many sources, shows the approximate distribution of groups of Aboriginal people. Some are tribal names, others dialect names. The names shown in some areas are more reliable than in others. Although this map is incomplete, and undoubtedly contains errors, it suggests the complexity of Aboriginal settlement of Western Australia.

1. WULU
2. ARNGA
3. JEIDJI
4. MANUNGU
5. GWINI
6. WEMBRIA
7. GUNIN
8. GAMBRE
9. WILA-WILA
10. MUNUMBURU
11. WUNAMBAL
12. GULUWARIN
13. MIRIWUN
14. ARAWARI
15. BEMBA
16. WALADJANGARI
17. WOLJAMIDI
18. ANDIDJA
19. GUWIDJ
20. NGARINJIN
21. WORORA
22. GIDJA
23. UNGGUMI
24. WARWA
25. NIMANBURU
26. NJUL-NJUL
27. BARD
28. DJABER-DJABER
29. NGORMBAL
30. DJUGAN
31. JANOR
32. DJARU
33. WALGI
34. NJINING
35. BUNABA
36. NJIGINA
37. GUNIAN
38. BUNAIRA
39. GUGADJA
40. JULBARIDJA
41. WALMADJARI
42. MANGALA
43. GARADJARI
44. WAIANGARA
45. WANMAN
46. NJANGUMARDA
47. WIDAGARI
48. NGARLA
49. GARIERA
50. IBARGA
51. NJAMAL
52. NGARLUMA
53. BAWUDUDJARA
54. DARGUDI
55. BALJGU
56. BANDJIMA
57. JINDJIBANDJI
58. MARDUDHUNIRA
59. GURAMA
60. DJUNGURDA
61. BINIGURA
62. NOALA
63. GARDUDJARA
64. NGALA
65. DJUNGURDJA
66. DALANDJI
67. NJIJABALI
68. WIRDINJA
69. WADJARI
70. INAWONGA
71. DJIWALI
72. BUDUNA
73. BAJUNGU
74. NGADAJARA
75. DJIDJIJAMBA
76. MADOIDJA
77. BIDUNGO
78. DENMA
79. WARIANGA
80. DARGARI
81. MAJA
82. NGANAJARA
83. MILAMADA
84. GONIN
85. MANGU
86. IRAWADJARI
87. MANDJINDJA DJARA
88. WANUDJARA
89. DJUBAN
90. NADAJARA
91. WAWULA
92. GURDU
93. INGGARDA
94. MALDJANA
95. BULUGUDA
96. DAGUDA
97. BUNGGURA
98. MUDALGA
99. DJALGANDI
100. GOILA
101. BIRNIRIDJARA
102. WILJARA
103. WARDAL
104. MULIARA
105. BIDUNGU
106. WADJANDI
107. MANGULA
108. MARAWA
109. NANGADADJARA
110. GOARA
111. BADIMARA
112. WIDI
113. NANDA
114. WALJEN
115. NGURLU
116. WANGGAJI
117. DJERARIDJAL
118. MARDO
119. NUNGARA
120. GALAMAI
121. AMANGU
122. MURUMIDJA
123. MIRNING
124. NGADJUNMA
125. GALA:GU
126. NJAGI-NJAGI
127. JUAD
128. WADJUG
129. BALARDUNG
130 BINDJARUB
131. WI:LMAN
132. GANAJANG
133. WARDANDI
134. BIBALMAN
135. WUDJARI
136. GORENG
137. MINING



THE ABORIGINAL AND TORRES STRAIT ISLANDER COMMISSION IN THE KIMBERLEY

The Aboriginal and Torres Strait Islander Commission (ATSIC) through its 35 regional councils and the Torres Strait Regional Authority represent Aboriginal and Torres Strait Islander people in the provision of Government services, resources and programs. ATSIC is the voice for these peoples within the Federal Government. It is made up of elected representatives to the regional councils, as well as administrative staff.

ATSIC sees the disadvantaged position of many Aboriginal peoples as a consequence of the destruction of cultural heritage and dispossession as an indigenous population. ATSIC seeks recognition of Aboriginal people's cultural identity as the First Australians. ATSIC seeks opportunities for Aboriginal employment, education, training and land ownership, along with the improvement of the social well-being, health and other community services, particularly in remote areas that are dependent on Government assistance for survival.

There are three ATSIC regional councils in the Kimberley: Kununurra, Derby and Broome. The regional councils develop policies and allocate funds to programs within their region.

INTERPRETING KIMBERLEY ABORIGINAL CULTURE AND HERITAGE

The best way to discover Aboriginal culture is with local Aboriginal people. They can provide an authentic expression and interpretation of their culture and heritage. More tourists are seeking personal interaction with Aboriginal people and guided activities in addition to viewing and purchasing arts and crafts. Aboriginal communities, resource centres and guides are targets for tourism. However, approval of and support for the tourism industry are required by the relevant Aboriginal groups.

For advice and assistance in developing Aboriginal tourism products contact the

Kimberley Aboriginal Tourism Association
c/o Kimberley Development Commission
PO Box 172
Broome 6725
Telephone (08) 9193 6097
Fax (08) 9193 7527

Kimberley Land Council
PO Box 377
Derby 6728
Telephone (08) 9193 1118
Fax (08) 9193 1163

Aboriginal and Torres Strait Islanders Commission
Public Affairs Officer
256 Adelaide Tce
Perth 6000
Telephone (08) 9220 3211
Fax (08) 9221 3954

Aboriginal Affairs Department
Mr Joseph Wallam
Arts and Culture Section
1st Floor Capita Building
197 St Georges Tce
Perth 6000
Telephone (08) 9235 8000
Fax (08) 9235 8044

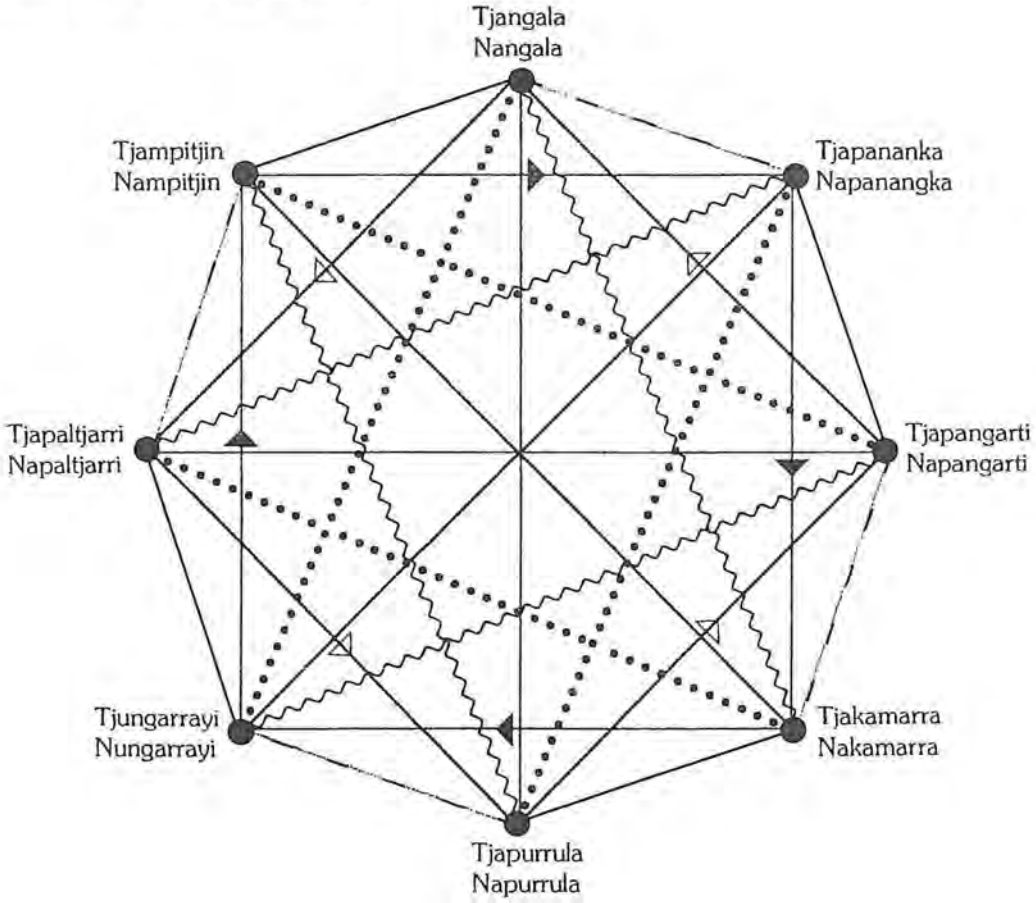
The development of Aboriginal tourism in the Kimberley requires informed and sensitive communication about Aboriginal culture to tourists by all participants in the industry. An understanding of Aboriginal themes and concepts is the framework from which tourist experiences of Aboriginal culture can be further enriched through planned encounters with Aboriginal people, sites and products.

There are two broad themes to interpreting Aboriginal culture and heritage - lifestyle and resource use. Within each of these themes a number of concepts can be developed.

ABORIGINAL LIFESTYLE

The lifestyle theme incorporates the concepts of Aboriginal customs, law and religion.

- **Social organisation:** Traditionally all Aboriginal people were affiliated with a specific language group. Within each group (of which there were about 270 across Australia and 15 in the Kimberley) there were clans or tribes often with distinctive dialects and cultural expressions. (Over 600 of these have been identified within Australia and 35 in the Kimberley) Small groups of a number of families were the usual social organisation for living day to day. However at special events such as ceremonial times including initiations, deaths and celebrations, the clan would come together, perhaps several hundred people strong. In the Kimberley today most Aboriginal people still identify with a particular clan or language group.
- **Skin groups:** Within each group of Aboriginal people, everyone (and in many cases things) is allocated a particular skin group. This is a complex system of interrelationships that is the foundation of Aboriginal law that establishes what is appropriate behaviour and what is taboo.
- **The Dreaming:** The foundation of Aboriginal religion is belief in the Dreaming - the Aboriginal concept of the spiritual continuum of events in time and place. The Dreamtime is the creation period within the Dreaming when the mythological beings such as the Rainbow Serpents were responsible for what we see today in the natural world. There are many places throughout the Kimberley which have particular significance to this creation period and its continuance as a spiritual force today. These places and their stories are best told by Aboriginal people who have been empowered by the local custodians.



Kukatja Pattern of Life
The eight skin groups of males (Tj) and female (N) form a complex web of relationships.
(Ref; Roughtail The Dreaming of the Roughtail Lizard and other stories told by the Kukatja by Gracie Greene, Joe Tramacchi and Lucille Gill)

RESOURCE USE

The Resource use theme incorporates the concepts of food, medicine, tools, clothing and shelter.

- **Use of plants:** plant use was considerable in traditional hunter-gatherer Aboriginal groups. Contemporary Aboriginal people continue to use bush plants and animals for food, medicine, tools and shelter. Bush plant foods are often referred to as 'bush tucker'. Many, such as the fruit of the Gubinge tree (*Terminalia ferdinandia*), are eaten fresh from the tree as fruits, seeds, gums and nectars. Other plants, such as the seeds of the Cycad (*Cycas pruinosa*), must be processed through grinding, soaking and cooking on the coals on a bed of ashes. Many Kimberley plants have medicinal qualities, so that they are called 'bush medicine' in Aboriginal English.
- **Gathering and hunting:** the collection of plant foods and bush medicine is mostly carried out by women. The women also gather small animals such as snakes, lizards and turtles. The larger game such as kangaroos, wallabies, bush turkeys and emus were hunted by the men in groups with spears and spear-throwers. This required great stealth and skill in stalking wary prey. In coastal and riverine environments marine turtles, crocodiles, dugong and fish were sought from the shore and in rafts using wooden-tipped spears with fire-hardened points. All meats are lightly cooked, usually in the skin or shell, on the coals of the fire. Fish is more often cooked beneath the coals, wrapped in bark from the paperbark tree.
- **Tools:** the technology of traditional Kimberley Aboriginal people was of stone, wood, gum and twine. A basic tool kit for men consisted of spears, spear-thrower, boomerangs, digging sticks, stone axe and stone scrapers. A glue made from spinifex resin and twine taken from the tendons of wallabies were the essential repair kit for these tools. Native beeswax was also frequently used as a glue. The women carried the grinding stones, coolamons (carrying dishes), twine bags, clubs and digging sticks.
- **Clothing:** clothing was simple in accordance with a subsistence culture of moving around within a defined territory. Men and women wore only a hairbelt spun from human hair. Items such as tools and food could be placed between the belt and the body freeing the hands for other activity. Bark placed across the shoulders was used to keep off the rain when away from camp. Adornments of ochre (red, yellow and white clays), feathers, seeds and shells were worn on special occasions.
- **Shelter:** camp shelters were made from bark or grasses as thatch over a frame of bush poles or saplings. The camp fires were kept burning at night. Fires were lit from friction by rubbing the edge of a spear-thrower over a split piece of wood holding dry dung as tinder, and was often carried from camp to camp. A length of pandanus trunk will burn very slowly for many hours, much like a cigarette will. On cold nights sleeping with the camp dogs provided additional warmth and protection from the wind.
- **Trade:** Traditionally all resources came from the land and water. However, there was trade among Aboriginal people with items such as Kimberley pearl shell finding its way to central Australia because of its spiritual value. Trade also existed between visiting 'Indonesian people' and northern coastal Aboriginal groups before the coming of the Europeans.
- **Skilful and efficient use of resources:** the well-adapted simplicity of Aboriginal technology epitomises the skilful and efficient use of resources for a hunter-gatherer lifestyle.

▲ *To find out more about places where Aboriginal stories are interpreted for visitors See Section 3: Places to go, things to know and do.*

- At Mirima National Park signs along the 'Looking at Plants Trail' interpret the Miriwoong people's use of particular plants for food, tools, medicine, shelter and ceremony.
- At Windjana Gorge National Park the 'Savannah Walk' interprets specific plant use by Bunaba people.
- At Tunnel Creek National Park and at Lillimilura Station the story of Jandamarra,

also known as Pigeon, is developed at these historic sites.

- At Geikie Gorge National Park the Visitor Centre has a display on the significance of the area to the Bunaba people.
- At Gubinge Road Vine Thicket behind Cable Beach in Broome, trailside signs interpret local Aboriginal use of the vine thicket plants.

Some interpretive activities for enriching experience of Aboriginal heritage and culture:

- An Aboriginal activity leader brings authenticity to cultural tourism.
- If this can't be arranged then have your group consider they are stranded indefinitely in the Kimberley without outside contact. The vehicle is lost and you must live off the land. How do you solve the problems of food, water, shelter, warmth and clothing; social organisation, companionship and entertainment? What tools will you need and how will you obtain them? The solution to these problems evolved over perhaps 60,000 years and developed into the Aboriginal culture by the time of European settlement. Aboriginal culture is now undergoing major change to adapt to vastly different circumstances.

Further Reading:

Lifestyle

Patterns of Life. The Story of the Aboriginal People of Western Australia.
M.E.Lofgren (Western Australian Museum)

The Aboriginal people
R M Gibbs

Traditional Aboriginal Plant Resources in the Kalumburu Area
I M Crawford (Western Australian Museum)

Contemporary

Land of Promises. Aboriginal people and Development in the East Kimberley
Edited by H.Coombs, H.McCann, H.Ross, N.Williams.

Aboriginal People in the Economy of the Kimberley Region
Greg Crough and Christine Christophersen

Aboriginal people and Diamond Mining: The Politics of Resource Development in the East Kimberley Western Australia
M C Dillon and Roderick Dixon

Art and Culture

The Art of the Wandjina. Aboriginal Cave Paintings in Kimberley, Western Australia.
I.M.Crawford

Bradshaws Ancient Rock Paintings of North-West Australia
Grahame L Walsh

Images of Power: Aboriginal Art of the Kimberley
Judith Ryan (National Gallery of Victoria)

Wirrimanu: Aboriginal Art from the Balgo Hills
James Cowan

Painting the Country: Contemporary Aboriginal Art from the Kimberley Region Western Australia
John E Stanton

Mythology in Northern Kimberley, Northwest Australia
A. Capell

Aboriginal Culture in the Kimberley Region
Brian McKenna

Yirra Land Law and Language Strong and Alive
Kimberley Aboriginal Law and Culture Centre

Yorro Yorro: Everything Stand Up Alive: Spirit of the Kimberley
David Mowaljarlai and Jutta Malnic

History

Jandamarra and the Bunaba Resistance
Howard Pedersan and Banjo Woorunmurra

King of Kimberley: The Story of a Tragic Injustice
Rocky Marshall

The Diary of Bishop Torres
translated by Fr Eugene Perez

The Oombulgurri Story
Neville Green

Forrest River Massacre
Neville Green

Kalumburu, The Benedictine Mission and the Aboriginal people 1908-1975
Fr Eugene Perez

Kalumburu War Diary
Fr Eugene Perez

Life Stories

Countrymen: The Life Histories of Four Aboriginal Men
as told to Bruce Shaw

My Country of the Pelican Dreaming: The Life of an Australian Aborigine of the Gadjerong Grant Ngabidj 1904 - 1977
as told to Bruce Shaw

When the Dust Come in Between: Aboriginal Viewpoints in the East Kimberley Prior to 1982
as told to Bruce Shaw

Above Capricorn: Aboriginal Biographies from Northern Australia
Stephen Davies

Joe Nangan's Dreaming
Joe Nangan and Hugh Edwards

Nyibayarri. Kimberley Tracker
Jack Bohemia and Bill McGregor

Jilji, Life in The Great Sandy Desert
Pat Lowe with Jimmy Pike

Gularabulu Stories West Kimberley
Paddy Roe

Moola Bulla, In the Shadow of the Mountain
Edited by the Kimberley Language Resource Centre.

THE COMING OF OTHERS: EARLY EXPLORATION AND SETTLEMENT

Indonesian people have intermittently visited the 'Top End' of Australia for centuries. They fish the waters of the Timor Sea and the Indian Ocean. In the past the prime interest was trepang (sea cucumber) which they boiled in metal tubs on the beaches, before drying for taking back to the islands to trade with others. Some evidence of their presence remains at their beach camps. Some trepang pots have been found, along with the use of the Maccassin pipe by Aboriginal people. Tamarind trees were introduced by the Indonesians, planted to produce fruits for flavouring food while the fishermen were at the beach camps. In the Kimberley, there are several places where these camps were established.

COASTAL EXPLORATION

The earliest recorded visits to the west coast of Australia by Europeans were from the early 17th century. In 1616, the Dutch Captain Dirk Hartog left a commemorative plate on an island in Shark Bay, the most westerly part of Australia. Hartog was followed by other Dutch, British and French maritime explorers.

European exploration of the Kimberley coastline probably began with the Dutchman Abel Tasman in 1644. He was followed by the English Captain William Dampier in 1688 and again in 1699. Places such as Dampier Land, Roebuck Bay, Cygnet Bay and Buccaneer Archipelago were later named after Dampier and his ships.

French maritime exploration was active in 1772 with de St Allouarn and Baudin in 1801. Between 1819 and 1822 the Australian-born Phillip Parker King surveyed the Kimberley coast for the British navy. In 1838 Lieutenant John Lort Stokes on the Beagle discovered and named the Fitzroy River after Captain Robert Fitzroy, a former Commander of the Beagle. At this time explorers began to venture inland.

OVERLAND EXPLORATION

British colonisation of Perth in 1829 provided a base for the overland explorers, in search of grazing lands and minerals. In 1838 George Grey landed at Camden Harbour and explored the hinterland of the Prince Regent River. In 1855 and 1858 A.C.Gregory entered the Kimberley from the southeast. Attempts at white settlement were made in the 1860s at Camden Harbour. The venture failed because pasture was limited and the climate was unsuitable for sheep.

In 1879 Alexander Forrest explored the region further, across the lower Fitzroy and onto the Margaret and Ord Rivers. Forrest named the Ord River after the Governor of Western Australia, Sir Henry St George Ord. His reports led to privately funded expeditions by Durack in 1882 and O'Donnell in 1883.

PASTORALISTS

The epic overland cattle drives from Queensland and New South Wales by Buchanan (1883-84), Durack (1883-85) and MacDonald (1883-86) and others led to the establishment of cattle stations in the central and east Kimberley. In the west Kimberley, there were further shipments of sheep from the south. Numerous stations were established along the Fitzroy River and tributaries. The King Sound Pastoral Company constructed the Lillimilura Homestead, near Windjana Gorge in 1884, one of the earliest homesteads in the Kimberley.

CONFLICT

Continuing conflict with Aboriginal people spearing stock led to increased police numbers in the port settlement of Derby. In 1893 Lillimilura Homestead became a police outpost to protect the white settlers from attack from Aboriginal people. Here the black tracker Pigeon, who was in police service, shot Constable Richardson while assisting in transporting Aboriginal prisoners to Derby. Pigeon, known as Jandamarra by his people the Bunaba, then led raids on several homesteads to obtain guns. Three men were killed at Windjana Gorge, and the new settlers panicked. In 1894 a posse of 30 police and settlers attacked

Jandamarra's gang, where he was wounded, but escaped to his hideout at Tunnel Creek. The police responded in a military-style operation that resulted in the deaths of a number of Aboriginal people at Fitzroy Crossing. For three years Jandamarra led a guerilla-war against police and settlers. He was finally killed in 1897.

Elsewhere in the Kimberley similar conflicts and massacres were occurring. In due course the Aboriginal resistance to white settlement was repressed. Disease amongst the Aboriginal people also decimated the population. The missionaries and government took up the challenge to protect the remaining Aboriginal groups from further atrocities.

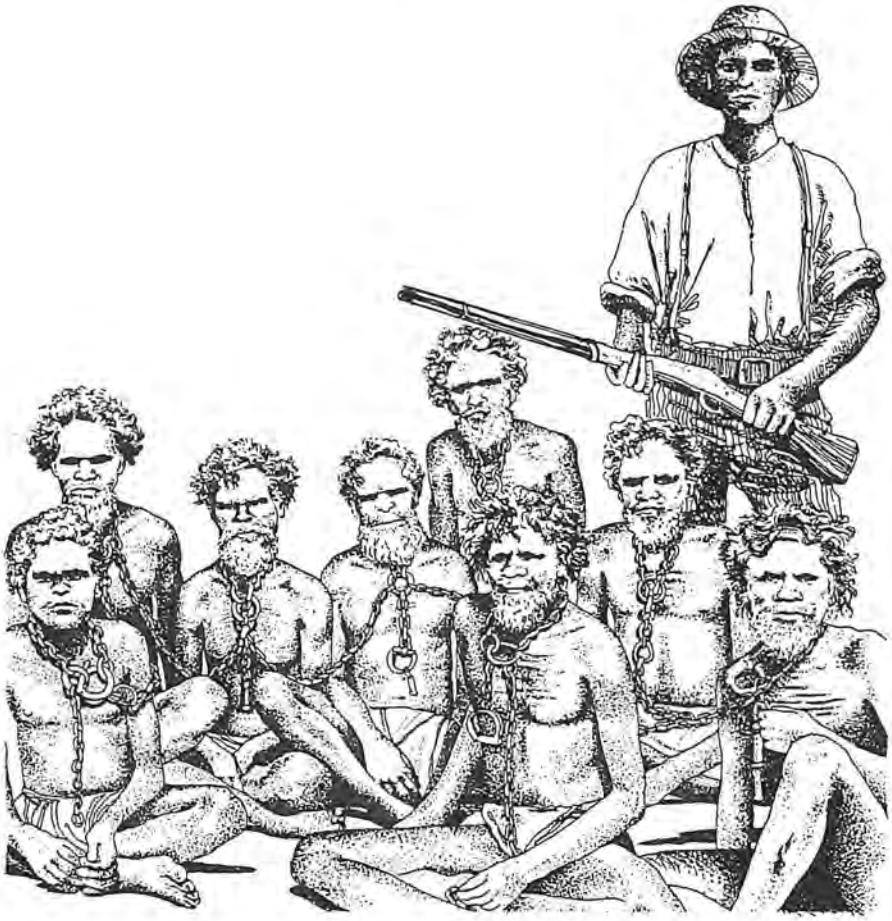
THE MISSIONS AND RATION STATIONS

The first mission in the Kimberley was built at Cunningham Point, northwest of Derby in 1885. It burnt down in 1887. Beagle Bay was established in 1890, and others followed at Oombulgurri (Forrest River 1897/98 and 1913), Sunday Island (1897), Kalumburu (Pago 1908) and Kunmunya (1915).

Government ration stations and refuges were established in the east Kimberley from 1901 at Turkey Creek (Warmun), Moola Bulla (1910) and Violet Valley (1911).

CHANGING LIFESTYLES

Most Aboriginal groups survived through submission to the 'new order' and lived and worked on stations. Many Aboriginal people became significant contributors to the development and maintenance of the pastoral industry in the Kimberley from the 1890's to 1970's. The granting of citizenship to Aboriginal people by referendum of the Australian people, and award wages in 1968 saw most Aboriginal groups evicted from the stations where many had worked for rations rather than wages, and others had lived off the land and the support of others. The drift into towns ultimately led to the establishment of Aboriginal communities.



Aboriginal people in chains.

Further Reading

The History of the North West of Australia
J S Battye

Journals of Two Expeditions ... Vol 1 and Vol 2
George Grey Esq

There Were Three Ships: The Story of the Camden Harbour expedition
Christopher Richards

Kings in Grass Castles
Mary Durack

Tales of the Overland, Queensland to Kimberley in 1885
G.H.Lamond

Fossil Downs, A Saga of the Kimberley
Gordon Mckenzie

Kimberley: Dreaming to Diamonds
Hugh Edwards

Jandamarra and the Bunaba Resistance
Howard Pedersan and Banjo Woorunmurra

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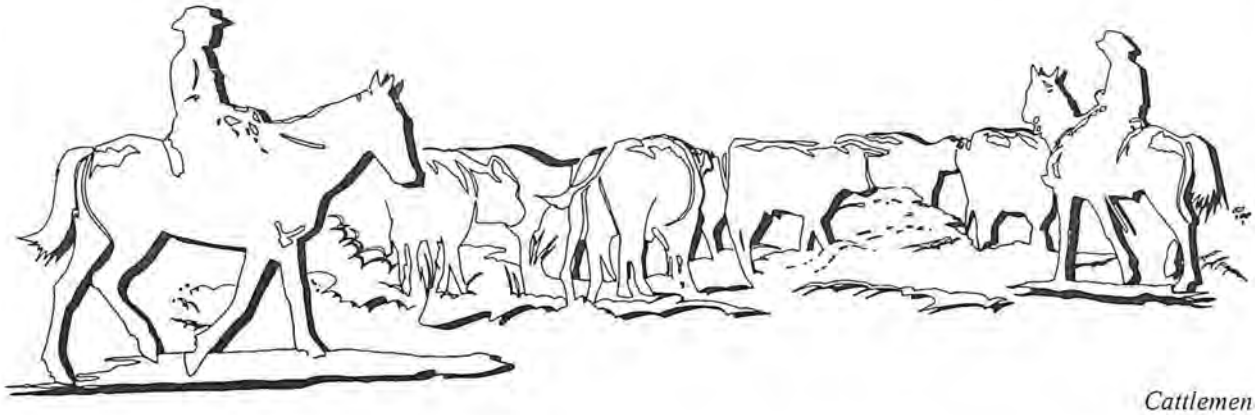
Forrest River Massacre
Neville Green

Kalumburu, The Benedictine Mission and the Aboriginal people 1908-1975
Fr Eugene Perez

Kalumburu War Diary
Fr Eugene Perez

From Patrons to Partners: A History of the Catholic Church in the Kimberley 1884 - 1984
Margaret Zucker



Cattlemen

SENSE OF TIME: A KIMBERLEY CHRONICLE

Pre-1880

- Up to 60,000 years of Aboriginal activities with visits by Indonesian traders, Dutch, British and French maritime explorers in the last few centuries.
- Overland exploration followed by the pastoralists.

1880

- The Kimberley region was named by the Western Australian Government after the Earl of Kimberley, who was the British Secretary of State for the Colonies during the 1880s.

1883

- The townsite of Broome was proclaimed. Broome was named after the Governor of Western Australia Sir Frederick Broome. Broome took over from Cossack as the base for the Kimberley pearling fleet. Pearling commenced in Western Australia during the 1850s and by the 1870s had moved as far north as the Kimberley coast. However, there was little development in Broome until the 1890s.
- The townsite of Derby was proclaimed and named after the Colonial Secretary Lord Derby. Derby developed to serve the pastoral industry and by 1884 a hotel, jetty and tramway were being constructed.

1884

- Halls Creek was named after the prospector Charlie Hall who found a 28 ounce nugget of gold.

1886

- The townsite of Wyndham was surveyed and named in honour of the son of Lady Broome, wife of the Governor of Western Australia.
- The discovery of gold led to the gold rush of 1886. The population of Halls Creek swelled to 2,000 at its peak but by 1890, only 70 remained. Ten thousand people of many nationalities including Chinese visited the region as a result of the gold rush, contributing to the multi-cultural character of the Kimberley that continues today. The gold rush helped the port towns of Wyndham and Derby to develop and the cattle stations found a local market for beef.

1889

- The gold rush was over as miners moved onto other fields and the Kimberley towns were reliant on the vast pastoral leases, providing stores for the stations and facilities for transporting cattle to markets.
- The gold rush had brought about developments in Kimberley communications. There was a six-weekly seamail service between Fremantle and Wyndham, and an additional six-weekly overland service between Wyndham and Halls Creek. The overland telegraph line reached Wyndham from Perth via Roebourne, Broome, Derby, Fitzroy Crossing and Halls Creek.
- A submarine telegraph cable was laid between Cable Beach, Broome and Banjawangie in Indonesia linking Australia with the rest of the world.

1894

- A police post was established near the Fitzroy River at a place known as 'the Crossing'.

1914

- A radio telegraph station was built on Telegraph Hill near Wyndham to assist ships entering Cambridge Gulf and Wyndham Port. It was one of six coastal radio stations established in W.A at that time. During World War I it was used by navel intelligence to intercept radio traffic. The station played a vital role in the tracking and sinking of the German ship, the Emden.

1919

- The Wyndham meatworks opened allowing meat to be transported from the port in

refrigerated ships. Mobs of cattle were driven overland from Kimberley pastoral leases to the meatworks at Wyndham.

1920s

- Broome had a population of 5000 people of many nationalities, especially Japanese, and over 400 luggers producing 80 per cent of the world's mother-of-pearl shell, used for buttons, cutlery and ornaments.

1921

- Derby was the terminus of the first scheduled aviation service in Australia. West Australian Airways began a service between Geraldton and Derby with the first flight on December 5th, 1921. This was a year before Qantas began its service from Charleville to Cloncurry. One of the early pilots for WA was Charles Kingsford Smith.

1929

- Charles Kingsford Smith flying the *Southern Cross* on an attempted record breaking flight, was forced to land on the Kimberley Coast near the Glenelg River.

1930s

- Motor vehicles were starting to replace camels, bullocks, horses, donkeys and mules. Over time, the Kimberley drovers were replaced by trucks.
- Derby Leprosarium was one of two in Western Australia that helped to contain an epidemic from the 1930s to the 1960s.

1934

- The Victorian Section of the Royal Flying Doctor Service established a base at Wyndham. This aerial medical service was founded by John Flynn of the Australian Inland Mission in 1928 following the development of the pedal radio by Alfred Traeger.

1941

- Kimberley Durack, a son of the pioneering Duracks, suggested the idea of a dam on the Ord River to the Director of Public Works Sir Russell Dumas. A small experimental farm was established on the Ord.

1942

- The Japanese had entered World War II and on February 20th, the State Ship the *Koolama* with 180 people aboard was bombed and severely damaged east of Cape Londonderry. Some passengers were taken by boat to Kalumburu mission but 93 people walked overland to the mission in four days. The ship was repaired sufficiently to reach Wyndham but finally sank near the present wharf during a bombing raid on the Wyndham airstrip.
- On March 3rd, 15 flying-boat aircraft in Roebuck Bay and other aircraft at the Broome airstrip were bombed by Japanese planes flying from Kupang in Timor. As many as 200 people may have been killed. Many were Dutch women and children evacuated from Indonesia awaiting their onward flight to Perth.

1943

- Kalumburu mission was bombed, destroying the buildings and killing six people including the Mission Superior. Nearby Truscott airfield was an important staging point for Liberator bombers on their way to strike at the Japanese in Indonesia and Borneo.

1945

- The Kimberley Research Station was established on Ivanhoe Plains, a joint project of Commonwealth and State governments. Crop trials led ultimately to the Ord Irrigation Scheme.

1950s

- The invention of the plastic button led to the decline of the pearling industry in Broome.
- BHP commenced mining iron-ore from Cockatoo and Koolan Islands.

1955

- A Flying Doctor base was established at Derby.
- The Halls Creek townsite was relocated next to the airport on less rugged terrain where expansion could take place.

1956

- The cultured pearl industry began at Kuri Bay. Today there are 12 farms with over 150 registered divers.

1963

- Lake Kununurra formed with the completion of the Diversion Dam, part of the Ord River Irrigation Scheme. The township of Kununurra, the irrigation system, and cotton and rice farms were established.

1971

- The last passenger service by State Shipping Service sailed between Fremantle and Darwin.

1972

- Lake Argyle formed with the completion of the Ord River Dam.

1979

- Home Oil drilled its first well at Blina, 100 kilometres east of Derby. Oil is currently being extracted at a rate of about 1000 barrels a day.

1980

- Television came to the Kimberley

1983

- The Argyle Diamond Mine, south of Kununurra, began operation. The Argyle Kimberlite (diamond-bearing rock) pipe was discovered in 1979 and it is now the world's largest diamond mine producing over 30 per cent of the world's diamonds.

1985

- A reduction in the supply of cattle for slaughter due to drought and the development of live cattle shipments, and industrial strife brought about the closing of the Wyndham meatworks.

1986

- The final sealed section of Highway One around Australia between Fitzroy Crossing and Halls Creek was completed.

1996

- The Ord River Dam hydro-electric power station was completed generating up to 30 megawatts. It supplies the towns of Kununurra and Wyndham as well as the Argyle Diamond Mine.

Some interpretive activities for enriching experience of our Kimberley heritage :

- Readings of selected texts by members of your group around the campfire provides a good stimulus for discussion about how it would have felt to have been confronting the Kimberley 'wilderness' in the past. The Battye Library in Perth can help you with extracts from the diaries of Kimberley explorers. More easily accessible are passages from Mary Durack's books and other Kimberley writers. Hugh Edwards in *Kimberley: Dreaming to Diamonds* quotes from historic records.
- The use of props such as old photographs and illustrations; various 'hats' to represent the characters from the Kimberley's past (the Aboriginal people; the cattlemen; the gold diggers; the police; the Royal Flying Doctor Service etc.) can add a touch of theatre to your campfire recitations, bush yarns, discussions and role plays.

Further Reading:

The History of the North West of Australia
J S Battye

Kimberley: Dreaming to Diamonds
Hugh Edwards

Port of Pearls
Hugh Edwards

Pearls of Broome and Northern Australia
Hugh Edwards

The Australian Geographical Book of the Kimberley
D. McGonigal
Australian Geographic

Kimberley Scenes: Sagas of Australia's Last Frontier
Edited by Cathie Clement and Peter Bridge

Kings in Grass Castles
Mary Durack

Sons in the Saddle
Mary Durack

◆

Tales of the Overland, Queensland to Kimberley in 1885
G.H. Lamond

Fossil Downs, A Saga of the Kimberley
Gordon McKenzie

Discovery of the Kimberley Goldfields
E Playford and I Ruddock

Raparapa, Stories from the Fitzroy River Drovers
Edited by Paul Marshall

The Diary of Bishop Torres
translated by Fr Eugene Perez

Kalumburu, The Benedictine Mission and the Aboriginal people 1908-1975
Fr Eugene Perez

Kalumburu War Diary
Fr Eugene Perez

Truscott: The Diary of Australia's Secret Wartime Kimberley Airbase 1943-46
John and Carol Beasy

The Koolama Incident
Bill Loane

Healing Hands: Memories and Milestones of the Derby Leprosarium
Sr Alphonsus Daly

The Long Road North
edited by F B Morony
Gascoyne Trading

CATTLE

The cattle industry still dominates land use in the Kimberley. 54 per cent of the land is under pastoral lease however much of this is unsuitable for grazing. 34 per cent of Western Australian cattle are in the Kimberley where cattle stations are of immense size (350,000ha on average). Most of the cattle are shorthorns but there are increasing numbers of Brahman cattle. About 90,000 cattle from the Kimberley go to markets or meatworks overseas and in Australia each year. Live export of cattle from Wyndham to Brunei and Sabah, on Malaysian Borneo is increasing.

AGRICULTURE

Agriculture in the Kimberley depends on a regular supply of water. Most agriculture is carried out in the Ord River Irrigation Area where water is provided by the Ord River dams that have created Lake Kununurra and Lake Argyle. The irrigation of the Ivanhoe Plain has seen the trial of over 50 crops since 1945. Today high return and out-of-season crops such as , bananas, rockmelons, watermelons, pumpkins, mangoes, sunflower seeds, chickpeas, soybeans and grain sorghum are successfully competing despite the additional cost of transport to distant markets. Sugar cane is rapidly becoming the major crop with the establishment of a sugar mill in the district. Currently around14 000 hectares are farmed and a further 54,000 hectares have the potential to be irrigated.

A small irrigation project has developed on the Dunham River while a major irrigation development at Camballin has not fulfilled preliminary expectations. Small horticultural developments have occurred near Broome and Derby but are limited by the availability of groundwater.

MINING

Exploration using modern technology is now revealing the secrets of the Kimberley beneath the earth's surface. Mining is an extractive industry which is only as viable as the continuity of supply and demand.

In the 1950s BHP established iron ore mines at Cockatoo Island and Koolan Island. At their peak Cockatoo Island had a population of approximately 600 and Koolan island 900. Mining ceased on Cockatoo Island in 1986 and on Koolan in 1992. Cockatoo has since been re-opened by a small mining company operating on a fly-in fly-out basis.

Lead-zinc ore is mined at Cadjebut to the east of Fitzroy Crossing and trucked to Derby for shipment to Thailand and Korea. Oil is being produced from the Blina Oilfield near Derby and there are large offshore reserves of natural gas north of Broome and north of Wyndham yet to be developed.

The Argyle Diamond Mine south of Kununurra is the largest diamond mine in the world producing more than 30 per cent of the world's diamonds. Five per cent are of gem quality with many in unique colours from pink to yellow and bronze. A further 45 per cent are of near gem quality and used for jewellery while the remaining 50 per cent have industrial uses.

PEARLING

The pearling industry has been in the West Kimberley for almost 130 years and contributes significantly to the Broome economy. The collection and sale of mother-of- pearl shell declined in the 1950s with the invention of the plastic button. However the cultured pearl industry developed and today there are 12 farms with over 150 registered divers.

CONSERVATION

National parks and nature reserves currently make up 4.7 per cent of the Kimberley, but additional land and marine reserves have been proposed.

TOURISM

To find out more about tourism, the boom industry in the Kimberley today, see Section 3: Tourism in the Kimberley.

Some interpretive activities for looking at Kimberley land use:

- Role playing can be a great way to get people involved in contemporary issues and to consider other points of view. Managing the Kimberley for everyone is not an easy task. Many groups have interests in the Kimberley - the Aboriginal people, conservationists, pastoralists, agriculturalists, the mining industry, the tourism industry, tourists and visitors. Involve your group in the debate by handing out cards, each with the name of one of these groups and an outline of their interests and concerns for management of the Kimberley. Nominate a chairperson and have each individual present their case, followed by questions from the others. Have the chairperson make a summary of the debate and conclude on what will be the future for the Kimberley.
- Make an illustrated list of various features from the Kimberley landscape and landuse. Examples are black kite; sugar cane; sorghum; brahman cow; python; crocodile; a frog; granite rock; boab; bauhinia etc. Use this as a 'spotto' card for each member of your group to locate these features while on your tour. The challenge is to see who can spot each item first to score points. But if you are wrong you lose points. When your group has completed the card, reward who was quickest at playing Kimberley spotto.
- To appreciate the produce of a region you really need to consume it. Encourage your group to sample local foods (rockmelons, barramundi), bush tucker (boab pulp), customs (billy tea) and merchandise. You can use these as props for talking about Kimberley produce and the local economy.

Further Reading:

Kimberley Region Economic Development Strategy 1997-2010
Kimberley Development Commission

Kimberley Region Plan Study Report A Strategy for Growth and Conservation
Department of Regional Development and the Northwest
Department of Planning and Urban Development

The Australian Geographic Book of the Kimberley
D. McGonigal
Australian Geographic

Kimberley: Dreaming to Diamonds
Hugh Edwards

Western Australia. An Atlas of Human Endeavour
Editor N. Jarvis
Department of Lands and Surveys/W.A. Education Department

1.6

Caring for the land: taking responsibility

LANDCARE

Land Conservation Districts Committees comprise groups of land users who tackle local land degradation and management issues and set about achieving long term sustainable land use. They can be comprised of pastoralists, farmers, government officials, local shire members and any individuals involved or interested in land management in the district.

There are six Land Conservation District Committees (LCDCs) in the Kimberley.

- North Kimberley LCDC
- Ord River Irrigation Area LCDC
- Halls Creek - East Kimberley LCDC
- West Kimberley LCDC
- Broome Pastoral LCDC
- Broome Coastal LCDC

Some of the aims of the Kimberley LCDs are

- to monitor and regenerate degraded pastures;
- to manage and control fire;
- to control feral animals and weeds; and
- to develop strategies for tourist management.

A number of projects are being undertaken, some with funding from State and National Landcare Programs. In the Ord Irrigation Area water monitoring has been introduced through the Ribbons of Blue programme which involves local school students. In the North Kimberley a co-ordinated approach to fire management and control is being established with assistance from the Bushfires Board of WA. In the Broome area local dune systems are being rehabilitated and coastal management plans are being developed.

Further Information

Agriculture WA
PO Box 19
Kununurra 6743
Telephone (08) 9168 7354
Fax (08) 9168 7333

Agriculture WA
PO Box 278
Derby 6728
Telephone (08) 9191 1555
Fax (08) 9191 1933

FIRE

Visitors to the Kimberley are often surprised by the number of fires they see burning, large areas which have been burnt, or extensive smoke from fires. However fire is a natural feature of the landscape of northern Australia.

PREHISTORY OF FIRE IN THE KIMBERLEY

Commencing with the break up of the Gondwana supercontinent and the subsequent drift northwards of the Australian continent, the climate of Australia has become drier. This trend increased more than 2.5 million years ago, with Australia becoming an arid continent and northern Australia experiencing a wet dry monsoon climate. Lightning strikes during the build up season in northern Australia would have caused fires during this time. Kimberley plants and animals evolved under these conditions and have adapted to fire.

ABORIGINAL PEOPLE AND FIRE: 'FIRESTICK FARMERS'

About 40-60,000 years ago, the arrival of Aboriginal people increased the frequency and occurrence of fire in the landscape. Aboriginal people have been described as 'firestick farmers', using fire as a tool to make the most efficient use of food resources.

Fires were not only used for cooking, warmth and making tools. Patches of land were burnt to flush out game, to expose the burrows of lizards and small animals, and to make walking, tracking and hunting easier. Hunters returning to burnt areas were likely to encounter game since wallaroos and wallabies prefer the tender shoots of grasses, herbs and resprouting spinifex which appear after burning. Firebreaks were also burnt under mild conditions around good bush tucker areas such as rainforest patches, to protect them from destructive fires later in the dry season.

Aboriginal people burnt the bush as they moved camps throughout the year. Early European explorers in the Kimberley reported seeing fires and smoke on the horizon at all times of the year. Burnt areas would have been relatively small after the wet when grasses had not dried out completely and humidity was high. Fires burning later in the dry season when grasses are completely dry, humidity is low and wind more common, have the potential to burn large areas unchecked except for previously burnt areas and natural firebreaks.

The result of this burning is thought to have been a patchwork, or mosaic effect, of burnt and unburnt areas with vegetation of different ages and types. Patch burning has ecological advantages, providing shelter for animals in older vegetation (which is not good food), while new food sources are found in nearby recently burnt areas. Biologists often refer to this as the 'edge effect'. A variety of habitats is created which caters for a greater diversity of plants and animals.

CHANGING FIRE PATTERNS

With the arrival of European settlers about 100 years ago, the pattern of fires changed. Fire was regarded as destructive and an enemy to be excluded. However excluding fire allows dry grasses to accumulate. When a fire inevitably occurs through accident or lightning strike, the fire is potentially more intense, more damaging and burns a larger area.

After Aboriginal people stopped living traditional lifestyles, it is likely that there were fewer fires in the wet season and early dry. The size of late dry season fires probably increased.

Huge areas of the Kimberley are affected by wildfires each year. Wildfires threaten pastoral and agricultural country, assets such as buildings and fences, and tourist facilities, as well as vulnerable ecosystems. The Bushfires Board estimate that in 1995 over nine million hectares in the Kimberley were affected by wildfire.

Uncontrolled fires appear to be having an effect on the plants and animals of the Kimberley. Frequently recurring late dry season fires threaten fire sensitive plants such as cypress pine, and fire sensitive plant communities such as rainforest patches and riverine vegetation, and the animals which depend on them for food and shelter. In addition

KIMBERLEY RAINFOREST CARERS

• IF YOU WANT MORE INFORMATION ABOUT RAINFORESTS CONTACT C.A.L.M. KUNUNURRA. CALL AT THE OFFICE, PHONE 680200 OR WRITE TO P.O.BOX 942 KUNUNURRA 6743

DEPARTMENT OF CONSERVATION AND LAND MANAGEMENT

weed species may be being favoured by this regime and soil stability is being reduced.

Each landholder has a responsibility under the Bush Fires Act to manage fire on his/her property. The Bush Fires Board has an advisory, education and training role. Its policy for the Kimberley is one of fire management rather than fire exclusion.

NOT ALL FIRE IS BAD: PASTORAL MANAGEMENT

Fire is used as a tool by the pastoral industry in the Kimberley. Fire is a cheap method of removing unwanted material such as rank grass or woody weed and has been proven successful in burning breaks for protection from bushfires. Fires can be used to rejuvenate spinifex, increase accessibility to green food, and improve pasture quality. Fire can be used to clear ground to assist in mustering and bull catching.

The Kimberley Bush Fire Protection Working Group has been formed to advise pastoralists about burning.

All Kimberley Shires have regulations about the use of fire. Landholders require permits to burn, which can be obtained from the Shire or Local Fire Control Officer. A landholder wishing to burn must also notify neighbours.

NOT ALL FIRE IS BAD: FIRE MANAGEMENT IN NATIONAL PARKS AND NATURE RESERVES

CALM has a responsibility under the CALM Act and the Bush Fires Act to manage fire in national parks and nature reserves. CALM's Fire Management Programme in the Kimberley aims to protect life and property, to prevent fires escaping to and from adjoining properties, and to protect ecosystems from damaging fire regimes.

Early dry season burning is carried out to establish fuel reduced buffer zones which will limit the spread and development of any subsequent fires. These prescribed burns are planned and organised to have a limited spread according to weather, topography and vegetation factors. Burning is carried out in accordance with the Bush Fires Act, Departmental policy and management plans, and local Shire regulations.

Each park or reserve is evaluated on an annual basis to determine burn requirements taking into consideration previous burning history, fuel loads, vegetation age, habitat management and weed control. Since regional strategies are more effective than single property strategies, CALM liaises with managers of neighbouring lands and the Bush Fires Board.

Burning is carried out by hand on the ground, or for large and inaccessible areas using aircraft. Aerial burning leaves fire patterns that tend to be patchy due to variations in vegetation density and dryness, topography and previous burns.

The burning program normally falls between mid March and mid June each year, beginning in areas of lower rainfall and progressing to the higher rainfall areas. In most cases, bushfire activity from July to December in the Kimberley is not part of a prescribed burning program.

TOURISM AND FIRE

Prescribed burning generally poses no danger to tourists. The burns are designed to protect visitor areas and are carried out when conditions make it unlikely that fires will travel far or fast. Smoke may affect visibility. Air operators in the parks are advised in advance of prescribed burning.

Tourists and tour operators are urged to take care with regard to fire when in the Kimberley and be aware of the regulations of the Bush Fires Act.

Campfires and cooking fires are allowed except on days of very high or extreme fire danger. Fire weather forecasts are issued daily by ABC Radio. The RFDS radio provides the forecasts first thing in the morning. If tour operators and tourists are unable to obtain this information, common sense should be used and fires should not be lit when winds are in excess of 20 kilometres per hour.

Camp and cooking fires must be no closer than three metres to a log or stump, and an area three metres wide surrounding the fire must be completely free of all bush and other inflammable material. The fire MUST NOT be left at any time while it is burning and must be extinguished before the user leaves it. Use a

safe existing fireplace rather than make a new one and keep fires small. Use only dead fallen wood and don't build a fireplace with rocks which scars the site.

There are penalties for breaking laws relating to the use of fire with fines of up to $250,000 or imprisonment for 14 years or both.

Special care is needed with vehicles running on unleaded fuels as the catalytic converters designed to reduce or eliminate harmful exhaust emissions operate at very high temperatures sufficient to ignite dry grass or other vegetation. Avoid driving your vehicle in grass, stubble, or other dry vegetation. Always park you vehicle on cleared ground, never in contact with flammable vegetation. Always keep your engine in tune, as out-of-tune engines run hotter, increasing the fire risk. Inspect the heat shield regularly and clean out any accumulated flammable material.

If threatened by a fire, move to a cleared area or to a formed road, don't panic, keep doors and windows closed. Do not attempt to leave your vehicle until the fire passes.

It is recommended that all fires during the period 1st July to 1st December be reported. No controlled burning should be taking place during this period. Report fires through RFDS Radio, local Shire, pastoralists, police, or by ringing 000. Please provide your name, location of the fire, time and date, estimated size and cause of fire if known. If a deliberate lighting is witnessed, time, date, location, person's name or vehicle registration number should be noted and reported to the Bushfires Board at once.

Further Information

Bush Fires Board of WA
Kimberley Regional Office
PO Box 1094
Kununurra 6743
Telephone (08) 9169 1370
(08) 9169 1372
Fax (08) 9169 1373
Email: fire@bilby.wn.com.au

Further Reading

Kimberley Bush Fire Protection Working Group Brochures
'Bush Fires and the Kimberley Region'
'Kimberley Pastoral Fire Management'

Burning Issues for Conservation in the Top End Leaflets
CSIRO Division of Wildlife & Ecology

Proceedings of a Workshop on Fire Management on Conservation Lands in Northern Australia, Kununurra May 1992. Edited by G Graham.
Department of Conservation and Land Management

Country in Flames
Proceedings of the 1994 symposium on biodiversity and fire in North Australia. Edited by Deborah Bird Rose. Biodiversity Series Paper No 3.
Biodiversity Unit, Department of the Environment, Sport and Territories

Bush Fires Act 1954

Bush Fires Amendment Act 1992

Kimberley Rainforest Carers leaflet

FERAL ANIMALS - THE UNINVITED GUESTS

Feral animals are animals introduced to Australia from other parts of the world, which have now reverted to the wild. When non-native animals are introduced into an area, their activities may be totally different to those of native animals so disturbing the environment. The main feral animals causing damage in the Kimberley region are donkeys, cattle, camels, horses, pigs and cats.

DONKEYS

Donkeys were imported in the late 1800s and early 1900s to be used as pack animals in the development of the Kimberley region. Released to roam freely when the motor vehicle took over, they reverted to a wild state and their numbers have built up substantially. During the dry season feral donkeys concentrate in large numbers in areas with suitable food, roaming over large areas.

CATTLE

Cattle were introduced to the Kimberley region from the eastern states in the late 1800s by the early pastoralists. Open range grazing without fencing meant that cattle were not controlled. Areas near water courses soon became degraded. Cattle roaming outside pastoral leases were not always mustered and became feral.

CAMELS

Like donkeys, camels were introduced to Australia in the 1800s as a beast of burden. With the advent of motor vehicles unwanted animals were released and their descendants became feral. Camels are found on the arid fringes of the Kimberley.

EFFECTS

Grazing animals such as donkeys, cattle, horses and camels destroy vegetation by heavy grazing and trampling. With overuse of areas near water, bare soil is exposed making the land susceptible to erosion. By close cropping they destroy the surface habitats of small animals. As well as contributing to the loss of native habitats, donkeys, cattle, horses and camels compete with native animals for water and food.

Cattle are also a threat to the pockets of rainforest scattered throughout the Kimberley. The closed canopy of the rainforests maintains a shady, moist microclimate in which many specialised species live. Cattle however, trample the rainforest edge seeking shade during the heat of the day. The opening of clearings in the vegetation allows the invasion of grasses. The grasses carry fires into the rainforest where previously the moist environment stopped it. A succession of fires opens up the rainforest to be replaced by grasses and woodland. Gradually the rainforests contract.

PIGS

Feral pigs are a problem in some parts of the Kimberley such as along the Ord and Fitzroy Rivers. Their digging, rooting and wallowing destroys native vegetation, causes erosion and pollutes waterholes. Feral pigs may make an area uninhabitable for native species. They can also carry diseases which threaten the health of other species including humans. Pigs can also pose a danger to humans by charging if approached in the bush.

CATS

Cats have spread throughout Australia probably finding their way ashore from early shipwrecks as well as escaping from settlements. They are opportunistic feeders eating whatever prey is available. They are efficient predators and may have contributed to the disappearance of some species. The loss of only a few breeding animals can reduce populations of rare and endangered species to below a viable size. Cats may have a dramatic impact on remnant populations of native animals and consume vast numbers of native animals each year.

CONTROL

One of the great challenges facing conservation agencies is to develop methods to control feral animals and protect native species from their impact.

Shooting is the most practical and humane method to control feral donkeys. Donkeys are shot under control programmes initiated by the Industry Protection Branch of Agriculture WA, pastoralists, and CALM. Shooting from helicopters allows donkeys in otherwise inaccessible areas to be targeted.

Better stock management and fencing can exclude cattle from sensitive areas such as rainforest pockets and waterholes used by native animals. Pastoralists muster cattle from conservation lands so that only stray animals and cattle in inaccessible areas need to be shot.

The Industry Protection Branch of Agriculture WA undertakes trapping programs to control feral pigs.

Further Information

Industry Protection Branch
Agriculture WA
PO Box 19
Kununurra 6743
Telephone (08) 9168 1166
Fax (08) 9168 1471

Further Reading

'Eating up the Past'
Landscope Vol 3 No 1 (Spring 1987)

'Feral Donkey'
Agriculture Protection Board Advisory Leaflet No 71

'It is estimated that each feral cat kills at least 1000 native animals per year while the average domestic cat kills about 25 native animals per year.' [Australian National Parks & Wildlife Service]

WEEDS - THE PLANT INVADERS

Many plants introduced into Australia from other countries are now environmental weeds. Environmental weeds are introduced plants with the potential to invade and dominate extensive areas in which they do not naturally occur. In the Kimberley there are over 100 exotic plants some of which have become weeds and dominate extensive areas.

Major weed invasions change the natural diversity and balance of ecological communities. These changes threaten the survival of many plants and animals. Weeds compete with native plants for space, nutrients and sunlight. They often replace the native plants which provide food and shelter for native animals.

Weeds typically produce large numbers of seeds which assist their spread. Wind, humans, vehicles, birds or animals can spread seeds into new areas. Some weeds also spread quickly from new shoots above or below the soil surface.

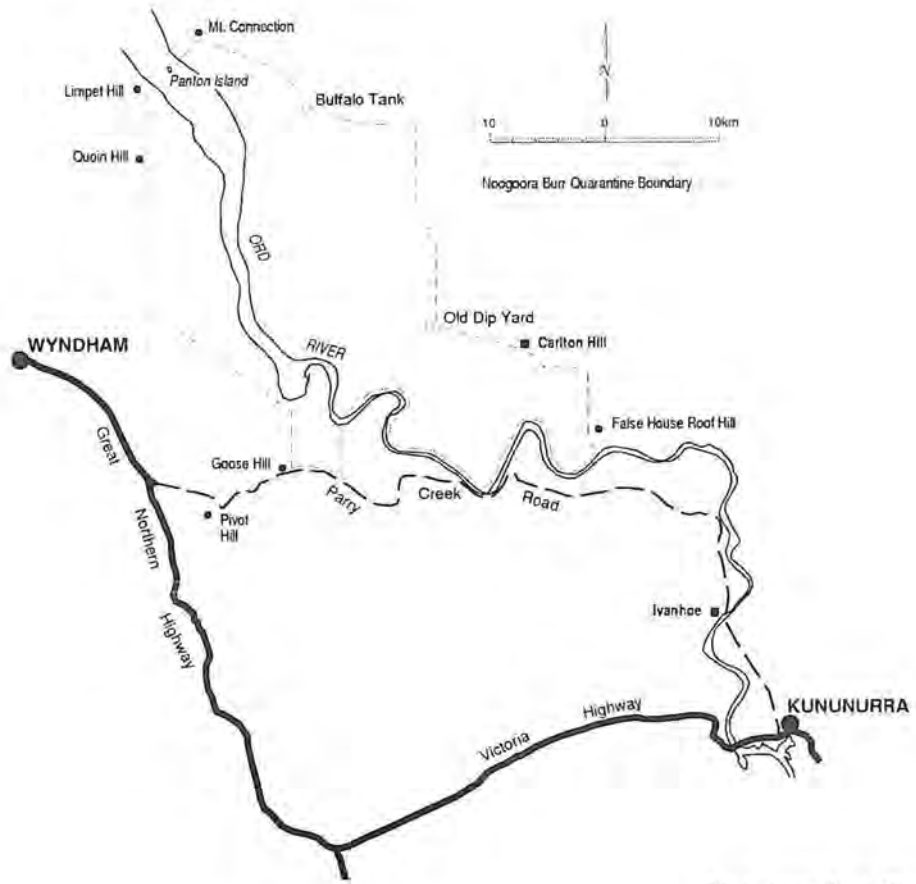
Some weeds rapidly invade disturbed sites. Human activities and introduced animals contribute to soil disturbance, loss of plant cover and soil compaction, creating openings for weeds to establish.

DECLARED WEEDS

Some plants are detrimental to the agricultural and pastoral industries and are listed as declared weeds by Agriculture WA. Declared weeds must not be introduced into Western Australia and depending into which category they are placed must be eradicated, controlled or contained if already present in the state.

NOOGOORA BURR

Noogoora burr (*Xanthium occidentale*) was first noticed on Noogoora Station in Queensland in the 1870s. It was probably introduced as a contaminant of cotton seeds. Noogoora Burr is



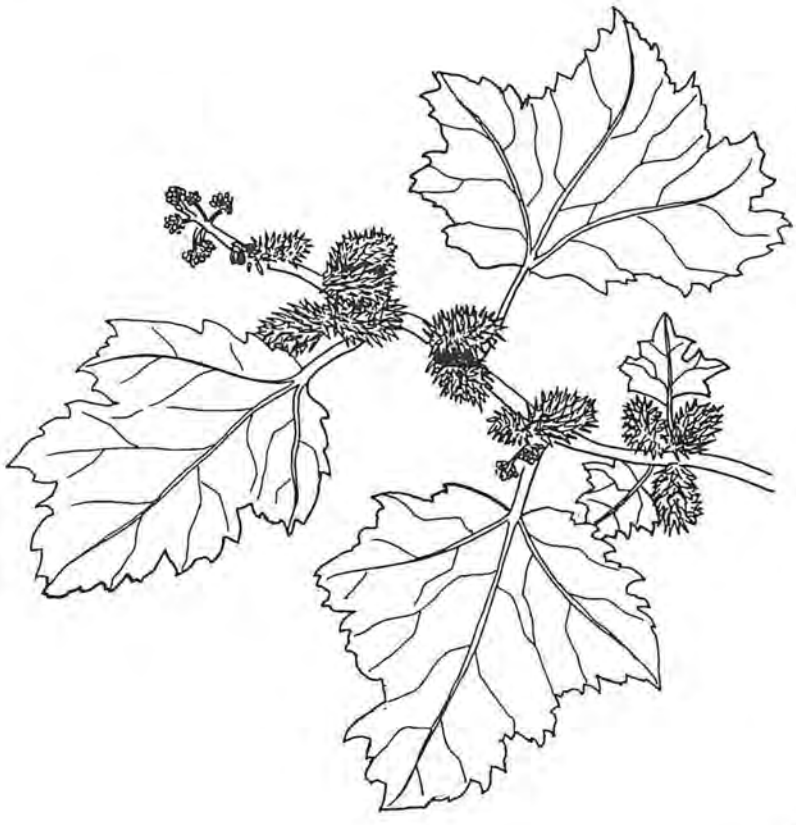
Noogoora Burr Quarantine Areas

Noogoora Burr Quarantine Areas

an important weed economically because the hooked spines on the burr tangle in wool, reducing its value. Young Noogoora Burr plants are toxic to animals and the dry burrs may cause discomfort and injury to animals. The weed's growth can be dense, blocking access to water.

The plant grows up to several metres high with leaves similar to a grapevine. The burrs are woody, one to two centimetres long and densely covered with hooked spines. As the burrs attach readily to animals' coats they assist dispersal. The infestations may also spread by burrs floating on water.

Areas along the lower Ord and Fitzroy rivers infested by the burr have been quarantined by Agriculture WA to prevent its spread. There are penalties for people entering quarantine areas without a permit. The Burr is also found on Gordon Downs and Nicholson stations where Agriculture WA has an eradication programme in place.



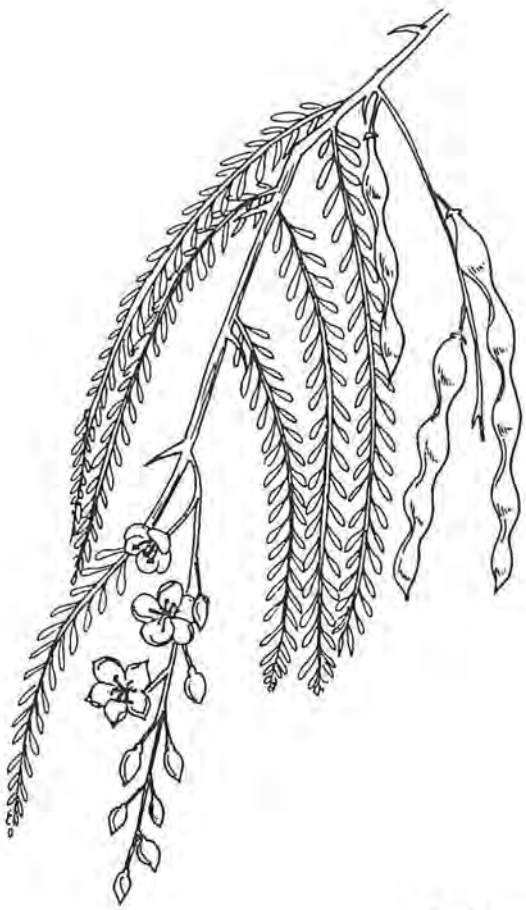
Noogoora Burr

PARKINSONIA

Parkinsonia (*Parkinsonia aculeata*) was introduced to northern Australia from tropical America as an ornamental garden plant because of its attractive foliage and drought tolerance. It forms dense, thorny thickets, mainly along watercourses, which shade out other vegetation and block access to water.

A small tree to eight metres high, it has green bark, and very thin needle-like leaves up to 30 centimetres long, with numerous minute leaflets on both edges. Stiff spines about 12 millimetres long are produced on the branches at the base of each leaf. The yellow flowers are followed by seed pods five to ten centimetres long with several hard, black seeds. The plants are spread by seeds carried on floodwaters and by birds and animals.

The Ord River and Christmas Creek are the main sites of infestation in the Kimberley.



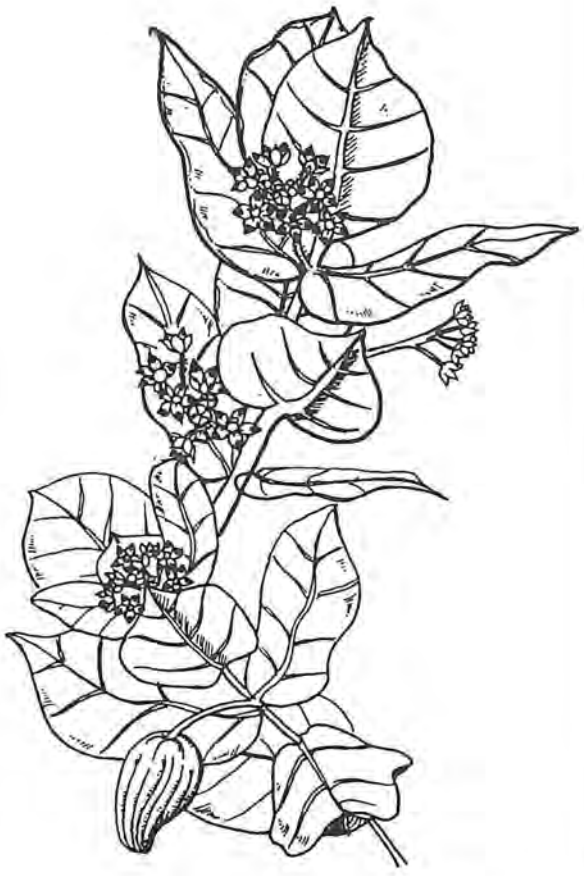
Parkinsonia

CALOTROPIS

Calotropis (*Calotropis procera*) is a native of northern Africa and the Arabian peninsular extending east to India. Its seeds with silky tufts are believed to have been imported to Australia from India during one of the Queensland goldrushes as padding in camel saddles or as an ornamental plant. When cut the plant exudes a white latex which can cause blistering and irritation if in contact with mucous membranes, nausea and vomiting if swallowed, and contains cardiac poisons.

This shrub which grows up to four metres high has white bark and thick grey green rounded leaves up to 15 centimetres long. The waxy flowers are purple and white and followed by large inflated grey green fruit containing numerous seeds.

Calotropis commonly invades old cultivated lands and overgrazed areas forming dense thickets. It occurs extensively in the Ord River Irrigation Area.



Calotropis

BELLYACHE BUSH

A native of the Caribbean region, bellyache bush (*Jatropha gossypifolia*) was introduced to northern Australia as an ornamental plant late last century. Spread by seed, it tends to form dense thickets crowding out other plants. The seeds are poisonous to humans.

This shrub grows up to two metres high with leaves which have three or five deep lobes. The flower is small and dark purple and the fruit is a three-lobed capsule about 12 millimetres long. It is found scattered along the Great Northern Highway, and around towns and homesteads.

Bellyache Bush

OTHER DECLARED WEEDS

Rubber vine, a major weed in north Queensland and originally grown as a garden ornamental, has already been a problem on Koolan Island. Prickly pear also grown as an ornamental has been a problem in other states and a poses a threat to the northwest of Western Australia.

Several weeds established in surrounding regions have the potential to spread into the Kimberley. Every effort must be made to prevent them establishing in the Kimberley. These include Mimosa, which is a huge problem in the Top End of the Northern Territory, and Mesquite, which covers several extensive areas in the Pilbara.

ENVIRONMENTAL WEEDS

Several introduced pasture grasses have become weeds outside pastoral leases. These include birdwood grass and buffel grass, which outcompete native grasses. Leucaena, a tree grown in the Ord irrigation area as a fodder crop, has invaded the margins of the lower Ord.

Mossman River grass (Gallon's Curse) and the ground covering khaki weed are troublesome because of their prickly seeds which have aided their dispersal throughout Australia. The yellow flowering caltrop or bindii bears spiny thorns which assist its spread as well as being damaging and a nuisance. In the Kimberley, these weeds are often found around towns. Hyptis, a woody herb native to tropical South America, with leaves smelling like mint, is widespread across northern Australia. It establishes readily on disturbed soils, forming dense thickets and its spiny burrs aid its dispersal.

Some plants grown as ornamentals in gardens have become environmental weeds in other states and have the potential to do so in the Kimberley. They include lantana (apart from selected non-weedy cultivars), which has become a troublesome weed in the eastern states. The date palm has already established along the banks of Lake Kununurra with the potential to form dense thickets.

CONTROL OF WEEDS

It is most important to prevent the introduction of potential weeds.

- Use native plants rather than exotics for pasture, revegetation, erosion control and landscaping. Commercial nurseries should not stock known environmental weeds.
- Careful washdown and inspection of earthmoving equipment, farm machinery, and vehicles transporting stock can reduce the likelihood of seeds being dispersed.
- Prickles, burrs and seeds collected from clothing and equipment should be disposed of in a hot fire.
- Observation of quarantine regulations is important.

Disturbance of soil and native vegetation should be minimised. Weeds are less likely to invade natural environments if soil and vegetation are not disturbed.

Early treatment to control known or potential environmental weeds before they spread is important. Once weeds cover large areas they are difficult to control.

Control of weeds in an infested area often involves a combination of methods such as handpulling, slashing, burning, chemical treatment with herbicides, and/or biological control by the introduction of a disease or predator. Careful land management, such as changing grazing or burning patterns, can assist weed control.

WHAT THE TOURISM INDUSTRY CAN DO TO HELP CONTROL WEEDS

- Observe all quarantine regulations.
- Keep vehicles clean to prevent the spread of seeds in soil and mud.
- Any prickles and burrs collected from clothing or equipment should be disposed of in a hot fire.
- Do not take native plants or rocks and soil from the bush. As well as being illegal such action disturbs wildlife habitat and allows weeds to invade.
- Weeds invade where native vegetation has been disturbed. Do not drive vehicles off-road and camp only at established campsites. When walking in the bush stay on formed tracks or where there are no tracks, spread out to disperse your impact.

Further Information

Industry Protection Branch
Agriculture WA
PO Box 19
Kununurra 6743
Telephone (08) 9168 1166
Fax (08) 9168 1471

Further Reading

Agriculture Protection Board of WA Infonotes and Advisory Leaflets
'Noogoora Burr'
'Rubber Vine'
'Mesquite'
'Parkinsonia'
'Prickly Pear'

Australian Nature Conservation Agency brochure
'Environmental Weeds in Australia'

Noxious Weeds of Australia
Parsons and Cuthbertson
Inkata Press

Weeds of Natural Ecosystems. A field guide to environmental weeds of the Northern Territory, Australia
Nicholas M Smith
Environment Centre NT

Western Weeds A guide to the weeds of Western Australia
Hussey, Keighery, Cousens, Dodd and Lloyd
Plant Protection Society of Western Australia

PROTECTING OUR WILDLIFE

The Kimberley region has an abundant variety of wildlife which is one of the main attractions for visitors to our region. Conservation of our native plants and animals is important for the tourism industry.

WILDLIFE CONSERVATION ACT

All native plants and animals in Western Australia are protected by the Wildlife Conservation Act. Fauna, which includes birds and reptiles as well as other animals, cannot be killed, captured or disturbed. Flora, that is plants, cannot be gathered, cut, removed or destroyed. It is an offence for anyone to collect, interfere with or disturb wildlife unless they have a permit issued by CALM, whose role it is to protect and manage wildlife.

CALM AND WILDLIFE

CALM assists the protection of wildlife populations and their habitats through the development of a representative system of national parks and nature reserves. The Department also monitors the effects of various land use practices on wildlife. CALM Wildlife Officers investigate breaches of the Wildlife Conservation Act.

The uniqueness of Australia's wildlife makes it attractive. Unlawful collectors will often go to extreme measures and spend large amounts of money to obtain rare specimens. Some rare species are subsequently pushed closer to extinction. Birds in particular are put under great stress and are often injured or killed during trapping and smuggling activities. Wildlife Officers patrol long distances in the Kimberley to detect illegal interference with wildlife, however they rely greatly on public assistance.

HOW THE TOURISM INDUSTRY CAN HELP TO PROTECT OUR WILDLIFE

Wildlife officers appreciate and keep confidential any information from members of the tourism industry and the general public.

People involved in nature based tourism activities are in a good position to notice change in the environment where they operate. Report any suspicious activity that may be a breach of the Wildlife Conservation Act such as interference with wildlife or habitat destruction. Also report if you are approached by potential collectors seeking knowledge about areas where unusual wildlife occurs.

The following information should be noted and passed onto the nearest CALM office, a wildlife officer or a police officer.

- time, date, place
- vehicle make, colour and registration number
- number of people and description
- activity (what they were actually doing)
- species or type of plant or animal involved

By protecting our unique wildlife and natural habitats, we can assure the long term future of the Kimberley nature based tourism industry.

Further Information

Department of Conservation
and Land Management
West Kimberley District Office
Herbert St, Broome
PO Box 65
Broome 6725
Telephone (08) 9192 1036
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East Kimberley District Office
Government Building
Corner Konkerberry Drive and Messmate Way,
Kununurra
PO Box 942
Kununurra 6743
Telephone (08) 9168 4200
Fax (08) 9168 2179

Further Reading

Department of Conservation
and Land Management brochure
'Protecting Wildlife in Western Australia'

Wildlife Conservation Act 1950 - 1980

'Selling Australia's Heritage'
Landscope Vol 1 No 3 (December 1985)

VISITOR MANAGEMENT IN NATIONAL PARKS

LEGISLATION

In Western Australia, CALM is responsible for managing conservation reserves. The CALM Act (1984) provides the legal parameters for conservation reserve management. CALM's visitor services policy directs area managers on specific issues and activities. CALM is required by law to produce management plans for conservation reserves.

MANAGEMENT PLANS

Management plans require public participation before being assessed and approved by the NPNCA (National Parks and Nature Conservation Authority). The membership of the NPNCA is of representatives of public interests. Once the NPNCA has approved a management plan, the final approval rests with the Minister for the Environment. The management plan sets the objectives and the strategies to be implemented by CALM staff.

MANAGING THE RESOURCE AND THE VISITORS

Conservation reserve management involves managing the resource (the land, water and wildlife) and the visitors. The objectives of visitor management are to minimise visitor impact and to enrich visitor experience. Visitors are more likely to support reserve management and so minimise their impact on the resource if they have awareness, understanding and appreciation of the natural and cultural values of the area.

SERVICES AND FACILITIES

Visitor management involves both facilities and services. Some visitor services, such as the provision of information and interpretation of reserve values, are provided before visitors arrive at the reserve. We call this 'pre-visit information'. This helps set the agenda for potential visitors so that their expectations are in accordance with that provided by the management of the reserve.

The tourism industry has a key role to play in seeing that the visitors in tour groups are aware of the opportunities and constraints in visiting conservation reserves. Various conservation reserve tenures such as national parks, marine parks and nature reserves have different management objectives and services for visitors. You need to be familiar with these for each area you visit. See Section 2: Places to go, things to know and do to find out more about the different conservation reserves and the specific facilities and services provided.

SITE DESIGN

Once visitors, either as part of a tour group or independently, arrive at the conservation reserve additional visitor management strategies are applied. The site design encompasses the flow path of vehicles and pedestrians and the provision of signs, facilities and activity areas including parking areas, tables, toilets, shelters, visitor centres, and trails for walks, drives, boats and diving. Good site design considers the environmental conditions, the character of the site and the visitors who use it and the management objectives for the area. The site design and its maintenance are considered the 'body language' of reserve management.

VISITOR PROGRAMS

CALM staff through visitor contact programs are the personification of reserve management. The provision of information and the interpretation of the reserves values are key functions of visitor management. CALM staff use a variety of communication techniques with visitors. Publications, signs and displays are most common. Where there are visitor centres and ranger stations, such as at Geikie Gorge and Purnululu National Parks, other products are available to visitors. At Purnululu National Park, a variety of merchandise including t-shirts, postcards, caps and sock protectors carry the Park image and promote its values . At Geikie Gorge boat tours provide for interactive experiences with


SNIFF
GLOOP
SWAMPS I HAVE KNOWN

visitors to enrich appreciation of the park's values. Interpretive activities for visitors to Mirima National Park develop understanding of the area's landforms and wildlife and support for its management.

SATISFIED CUSTOMERS

The memories and mementoes acquired from a visit to a conservation reserve are the post-visit information that is communicated by our clients to other potential visitors. Satisfied customers are our best marketing tool for ensuring future visitors come with the right expectations and are able to meet their needs for safe, enjoyable and rewarding experiences in the natural environment of the Kimberley.

THE ROLE OF THE TOURISM INDUSTRY

The tourism industry plays a key role in managing visitors. Most visitors have personal contact with someone in the tourism industry. However, few visitors make contact with CALM staff as there are far fewer of them. Only at a few reserves are there adequate staff and facilities to provide interpretive activity programs. The opportunities to influence visitor behaviour are greater for tour guides than for CALM staff. Tour guides have a significant role to play in visitor management by taking responsibility for the actions of their clients and helping their clients to develop a greater appreciation of natural and cultural values.

Operators can also assist by monitoring the activities of persons not directly associated with their activities. If you become aware of any activity that you believe is not appropriate, it is important to report the matter to your nearest CALM office as soon as possible. Examples of inappropriate behaviour might include persons disturbing flora or fauna, unlawful fishing, littering, the erection of illegal structures, irresponsible vehicle use, unsafe fire practices or illegal burning, graffiti or interference with facilities, unruly behaviour and generally any activity that you consider is not in the best interest of the natural environment.

When reporting such matters you should be prepared to provide the following information:

- time
- date
- place
- vehicle details (model, colour, registration)
- persons involved (number and description)
- activity details (what was actually happening)

See Section 3: Tourism in the Kimberley to find out more about how the tourism industry is contributing to minimising visitor impact while enriching the experience of visitors so that we can manage tourism as an ecologically sustainable industry.

Some interpretive activities for looking at visitor management:

Visitor management requires knowing about your visitors, their needs and wants. We can find out this information from surveys and discussions. Ask CALM and/or the KTA for a visitor survey form or prepare your own. You could survey your clients to evaluate your own tour. Once your clients have completed the survey form, collate the results and make time for a group discussion.

'Kangaroo Squash' is a game for kids of all ages. Through physical activity it provokes discussion about managing natural areas for wildlife and visitors. 'Kangaroo Squash' is similar to 'Red Rover' and 'British Bulldog.' Line up your players, identify them as Kimberley animals and have them hop, crawl, waddle or flap over 10m across an imaginary road between two areas of bushland. Identify a number of players as vehicles that tag the crossing animals. The tagged animals are roadkills, some remaining as carnage, others to become additional vehicles. As the animals cross the road in search of food, shelter and mates they are struck by an increasing number of vehicles. When there are many vehicles and few animals call the group in to discuss what happened and how it could be avoided. It is a lot easier to discuss something you have 'experienced' than to discuss abstract concepts such a wildlife and visitor management.

Kangaroo Squash

QUARANTINE

The Ord River Irrigation Area and other parts of the Kimberley have diversified agricultural and horticultural industries. Each crop has pests and diseases which if introduced into uncontaminated areas could endanger local industries. The production of fruits, vegetables and plants is worth millions of dollars to the Kimberley economy annually.

Pests and diseases can hitch a ride with you by hiding in fruit, vegetables, plants and some animals. Please don't assist the spread of plant pests and diseases by moving fruit, vegetables or plants interstate and into restricted areas unless you have approval from your Department of Agriculture or Primary Industry. A single infected fruit can cause a fresh outbreak.

MAKE SURE YOU DO NOT CARRY THE FOLLOWING:

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WHEN TRAVELLING TO THE ORD RIVER IRRIGATION AREA FROM OTHER PARTS OF WESTERN AUSTRALIA

- **Fruit:** the Ord River Irrigation Area is the only major fruit growing area in Western Australia which is free from damaging fruit flies. Do not take any fruit including stone fruit, citrus, tomatoes, cucumbers, zucchini, squash, pumpkins and melons into this area.

WHEN TRAVELLING TO WESTERN AUSTRALIA FROM OTHER STATES AND TERRITORIES

- **Fruit and vegetables and used fruit and produce containers:** Western Australian fruit and vegetable growers are untroubled by some of the pests and diseases found in eastern Australia, such as codling moth, brown rot and Queensland fruit fly. Used fruit and vegetable containers can also harbour pests.
- **Honey:** honey could carry brood diseases to Western Australia's bees.
- **Plants:** some plants are prohibited; others are restricted (including cut flowers and foliage). Soil is not permitted on plants. Uncertified plants will be seized at checkpoints and should not be brought into Western Australia.
- **Soil:** soil can carry insects, weeds and disease organisms.
- **Weeds:** make sure you do not carry any weeds on your vehicle, equipment or clothes. Look for burrs as well as washing off soil.
- **Seeds:** some seeds are not allowed unless certified free from particular diseases and weed seeds.
- **Hay and fodder:** hay and fodder can carry weed seeds.
- **Livestock:** you must notify the Department of Agriculture, Kununurra, at least 48 hours before bringing in stock. Inspection of stock and wash down of vehicles may be required.
- **Birds and animals:** some animals, but not cats and dogs, are banned in Western Australia, even as pets.
- **Aquatic plants:** all aquatic plants must be treated to prevent the introduction of liver fluke snails. Some aquatic plants are prohibited.

WHEN TRAVELLING FROM BROOME TO OTHER PARTS OF WESTERN AUSTRALIA

- Palm plants and foliage: all palm plants and foliage from Broome must be treated against the palm leaf beetle. Broome is the only area in WA known to be infested with the pest.

WHEN TRAVELLING TO SOUTHERN PARTS OF WESTERN AUSTRALIA FROM THE KIMBERLEY

- **Citrus plants and cuttings:** citrus leaf miner is found throughout the northwest. Plants require specific pest freedom certification. Fruit may be taken south.
- **Livestock:** cattle and horses require spraying and inspection for cattle tick before movement south from the Kimberley region.

WHEN TRAVELLING TO THE NORTHERN TERRITORY FROM WESTERN AUSTRALIA

- **Fruit, vegetables and flowers:** there are pests of flowers, potatoes, fruit and vegetables in Western Australia which are not in the Northern Territory.
- **Plants:** banana, grape and some other plants are prohibited; others are restricted. Soil is not permitted on plants.
- **Livestock:** all movement of livestock to the Northern Territory, as well as the importation of stock fodder, should be advised to the Chief Inspector of Stock, Department of Primary Industry and Fisheries, Darwin at least 48 hours before the proposed entry.
- **Birds and animals:** some animals and birds, but not cats and dogs are banned in the Northern Territory, even as pets. Movement of any fauna into the Northern Territory should be notified to the Parks and Wildlife Commission (08) 8989 4525 at least seven days before the proposed entry.

Further Information

Industry Protection Branch
Agriculture WA
PO Box 19
Kununurra, 6743
Telephone (08) 9168 7354
Fax (08) 9168 7333

Department of Primary Industry and Fisheries
GPO Box 2268
Darwin 0801
Telephone (08) 8981 8733
Fax (08) 8941 0223

Section 2

Section 2:

Places to go, things to know and do

2.1

National parks and other places: West Kimberley

DEVONIAN REEF NATIONAL PARKS

THE DEVONIAN REEF

Windjana Gorge, Geikie Gorge and Tunnel Creek cut through rugged limestone ranges which form part of Western Australia's remarkable Devonian 'Great Barrier Reef'. These areas have been made national parks because of their scientific importance and scenic beauty.

The barrier reef formed some 350 million years ago during the Devonian Period. At this time the Canning Basin, a large area of sedimentary rocks extending along the WA coast from Port Hedland to the Dampier Peninsula and inland almost to the Northern Territory border, was covered by a tropical sea. In these warm shallow waters marine life flourished, in particular reef-building algae and the now extinct coral-like stromatoporoids.

This 'Great Barrier Reef' fringed a Devonian mainland that is occupied today by the King Leopold Ranges and the Kimberley Plateau. This ancient land area had a mountainous topography. Torrential rivers flowed from the mountains, carrying huge amounts of sediments including boulders which now form massive conglomerates such as that exposed at Mt Behn.

The reefs are now exposed in a series of limestone ranges including the Napier Range, the Oscar Range, and the Geikie Range, extending for 300 kilometres along the northern edge of the Canning basin. They once probably continued for some 1000 kilometres around the present Kimberley region to join with similar reefs that are exposed to the north of Kununurra at the southern edge of the Bonaparte Basin.

The limestone reefs and their associated deposits wind across the countryside, reaching some 50 to 100m above the surrounding plains, in much the same way as they stood above the ancient sea floor. Since Devonian times the area has gone through a complex history of sedimentation, uplift and erosion over many millions of years. The reefs are exposed today because the shales and other soft sediments laid down in the ocean basin in front of the reefs were easily eroded to form valleys while the resistant limestone reefs remain as ranges.

HOW THE REEF FORMED

Some of the limestones are rich in well-preserved fossils of animals and plants that lived in and around the reefs some 350 million years ago. The reefs were built by various lime-secreting organisms such as algae and stromatoporoids, a group of extinct organisms which resemble corals in their growth forms, but differ in their internal structure. Corals played a minor role, unlike modern reefs, which are constructed mainly by corals and lime-secreting algae.

Fossilised stromatolites are found only in isolated pockets of the Devonian reef where they survived in conditions unsuitable for other organisms. Stromatolites are built by tiny single

celled organisms called cyanobacteria, primitive life forms that first existed on earth 3.5 billion years ago. Today they survive in extreme environments such as the highly saline waters of Shark Bay and Lake Yalgorup.

Limestone was deposited behind and in front of the reef forming a barrier reef complex with three zones. Limestone accumulated behind the reef to form flat bedded back-reef deposits. In front of the reef, limestone accumulated in inclined layers to form marginal slopes. Sandstone, shale and thin layers of limestone were deposited on the ocean floor in the basin. Certain types of fossils are associated with each of these deposits.

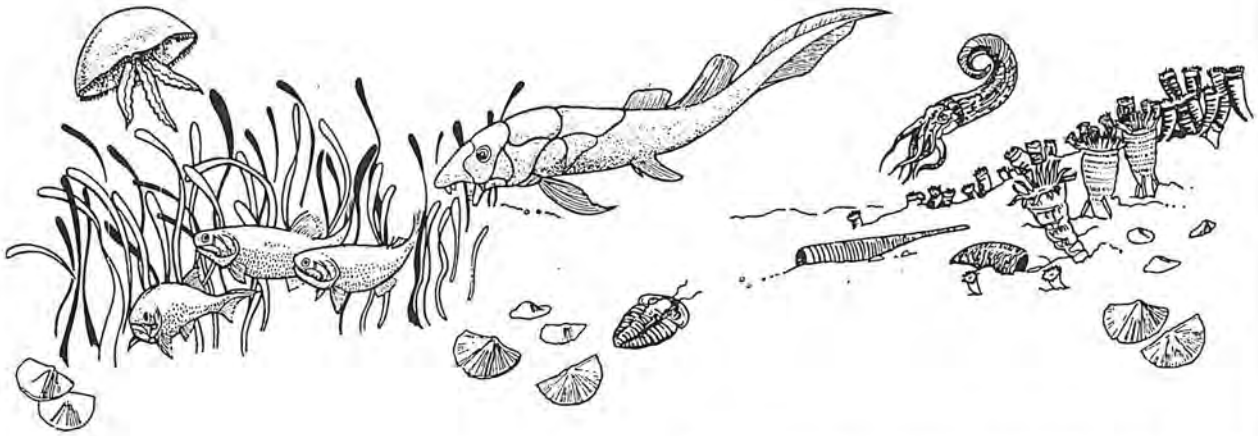
Some reefs grew upwards nearly vertically while others grew outwards over the marginal slope deposits and back-reef deposits. As the ocean floor slowly subsided over the 50 million years of the Devonian period, the reef-building organisms were able to keep pace, building deposits of limestone up to two kilometres thick.

The best exposures of the reefs and their associated back-reef and marginal-slope limestones are found in the spectacular gorges cut through the ranges at Windjana Gorge and Geikie Gorge.

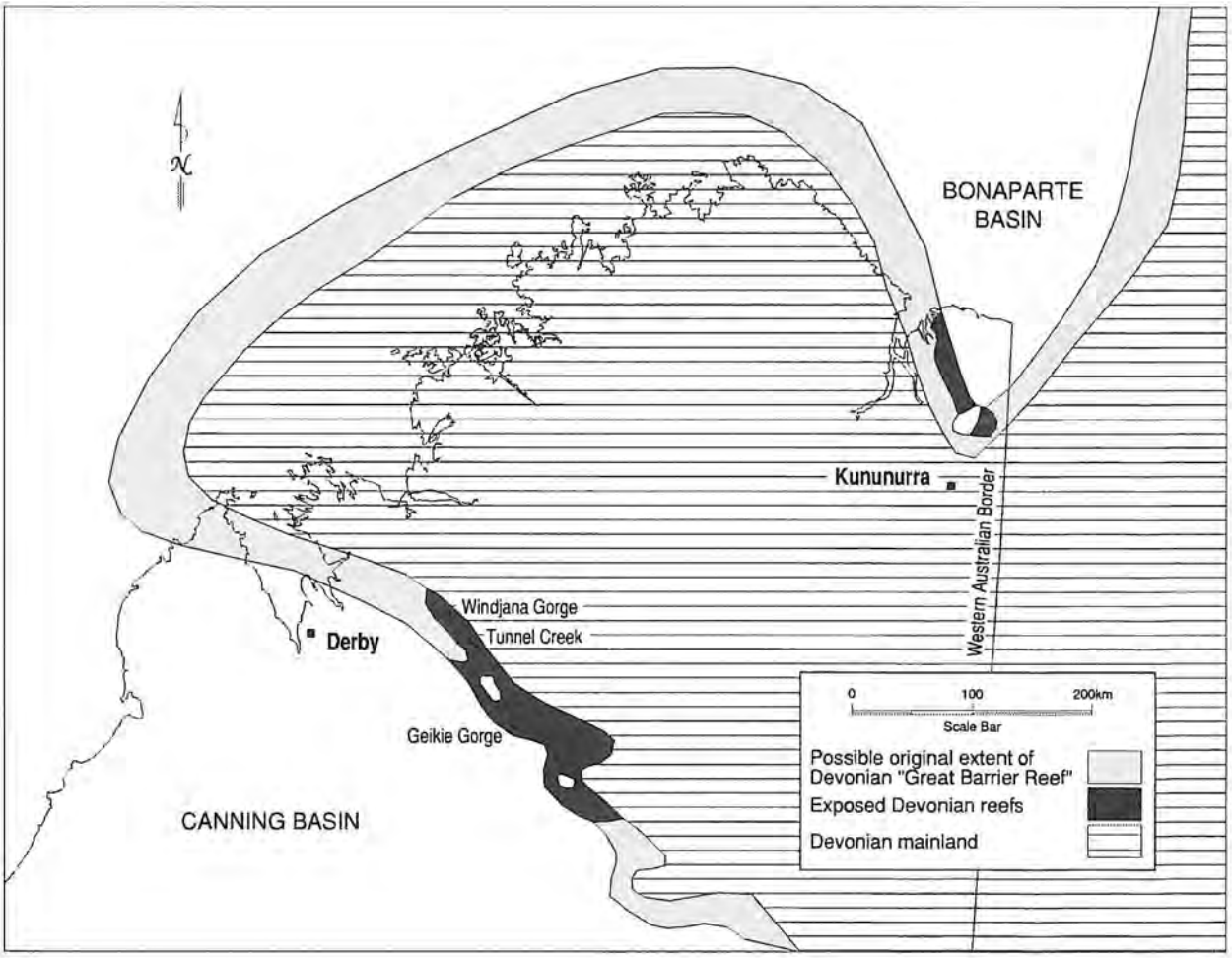
Further Reading

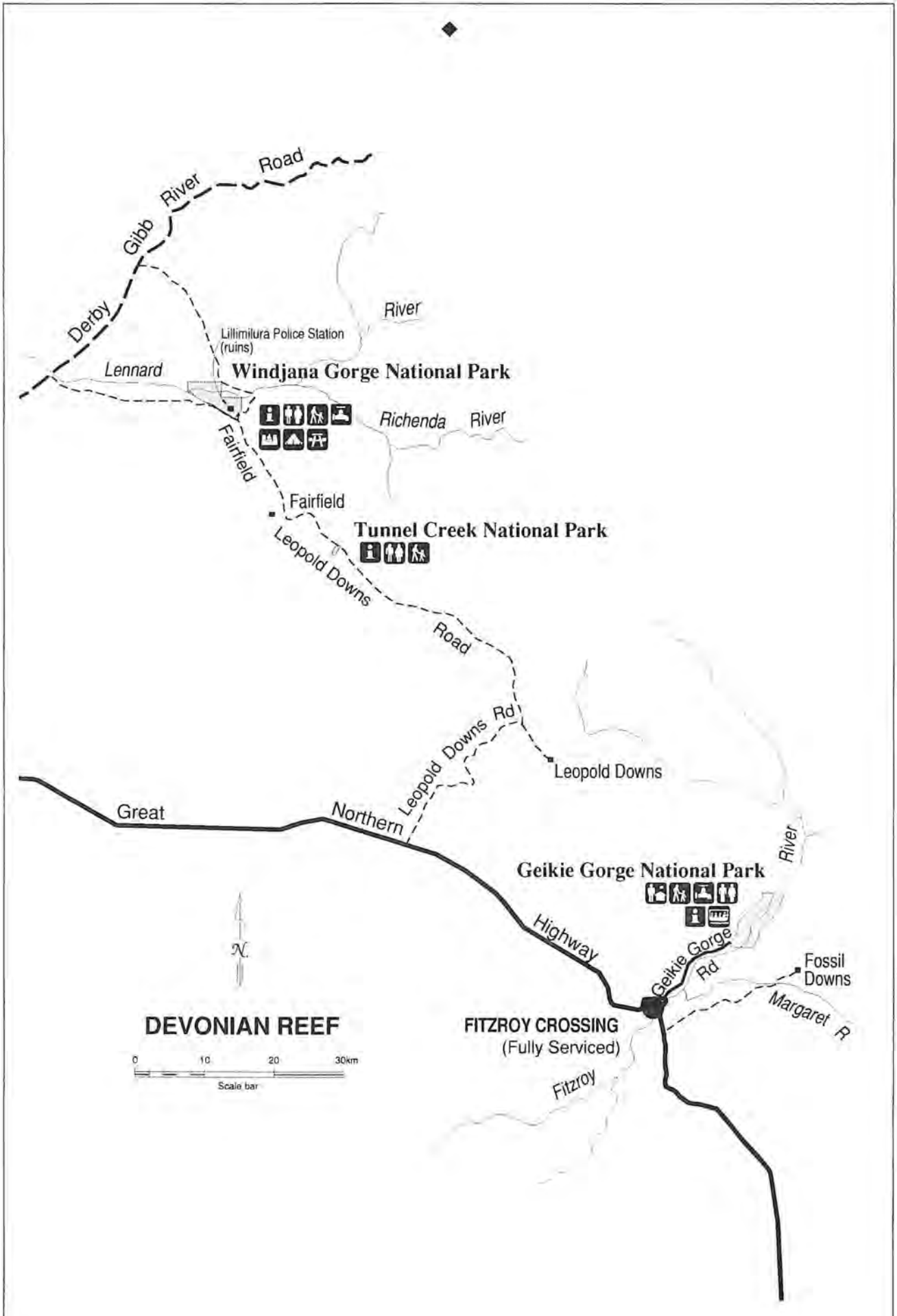
Geology of Windjana Gorge, Geikie Gorge and Tunnel Creek National Parks
Geological Survey of Western Australia
Department of Conservation and Land Management

'The Devonian Reef'
Landscope Vol 1 No 3 (December 1987)



Types of fossils associated with the reef deposits




Derby
Gibb River Road
Lennard
Lillimilura Police Station (ruins)
River
Windjana Gorge National Park
Richenda River
Fairfield
Fairfield
Tunnel Creek National Park
Leopold Downs Road
Leopold Downs Rd
Leopold Downs
Great Northern Highway
Geikie Gorge National Park
River
Geikie Gorge Rd
Fossil Downs
Margaret R
N
DEVONIAN REEF
0 10 20 30km
Scale bar
FITZROY CROSSING
(Fully Serviced)
Fitzroy

GEIKIE GORGE NATIONAL PARK

Where: 280 kilometres east of Derby and 16 kilometres northeast of Fitzroy Crossing on sealed roads.

Area: 3,136 hectares.

Gazetted: January 1967

Attractions/Significance: Scenic gorge carved by the Fitzroy River through the limestone ranges formed as an ancient Devonian reef.

THINGS YOU NEED TO KNOW

Facilities are only available between April and November due to flooding in the wet season.

Toilets, water, gas barbecues and an information shelter are provided at the gorge.

Camping is not permitted in the Park. There are campgrounds at nearby Fitzroy Crossing.

Freshwater crocodiles live in the gorge. Although these crocodiles are not usually a danger to people, parents should exercise caution with small children.

Private boats are permitted in the gorge only after 4.30pm each day. Please check with the rangers before launching boats.

CARING FOR GEIKIE GORGE

Geikie Gorge is a special area for wildlife. The eastern bank of the river is a wildlife sanctuary where access is prohibited.

Keep the park clean; please take your rubbish with you or place it in the bins provided.

Help to protect this area for wildlife. Fires, pets and firearms are not permitted in the park.

THINGS TO DO

The ranger-guided boat tour departs at 8.00am, 9.30am, 11.00am and 3.00pm daily from mid April to mid November. Tickets are available only on site from 15 minutes before departure.

Tour operators can make group bookings through Geikie Gorge National Park.

Telephone (08) 9191 5121
or Fax (08) 9191 5165.

The River Walk trail is an easy 20 minute return walk along the bank of the Fitzroy River to the sand bar.

The Reef Walk trail is a moderate three kilometre return walk (allow one and a half hours) taking you close to the ancient reef for a closer look at the limestone. Carry drinking water and avoid climbing the reef wall as the terrain is extremely rough and danagerous.

ABOUT THE GORGE

Geikie Gorge, some 14 kilometres long, has been carved out by the passage of the Fitzroy River through the Geikie Range. The walls of the gorge are up to 30 metres high and polished white by the floodwaters of the Fitzroy River to a height about ten to 12 metres above the normal river level. Internal features of the limestone including fossils are clearly visible on some of these clean surfaces.

During the wet season the recreation area can be flooded to a depth of 7 metres. In the dry season the river transforms into a peaceful stream beneath the towering cliffs of the Devonian reef.

THE WILDLIFE

Trees and vines, pandanus and reeds

The forest fringing the river in Geikie Gorge is dominated by two species of Cadjeput or Paperbarks, *Melaleuca leucadendra* and *Melaleuca argentea*. Their richly scented, nectar-laden blossoms attract fruit and blossom eating bats such as the black flying fox.

There are also river gums (*Eucalyptus camaldulensis*), the cluster fig (*Ficus racemosa*), the river fig (*Ficus coronulata*), and the freshwater mangrove (*Barringtonia acutangulata*), which bears pendulous red blossoms. The wild passionfruit (*Passiflora foetida*) scrambles over trees and shrubs forming dense thickets.

Thickets of pandanus (*Pandanus aquaticus*) along the river provide a home for the rare and threatened purple-crowned fairy-wren. The

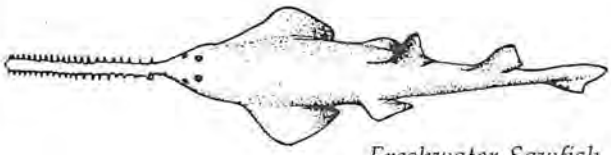
tropical reed (*Phragmites karka*) forms dense stands on the banks where the clamorous reed-warbler may be found and hatchling freshwater crocodiles take refuge.

MAMMALS

Caves in the limestone provide a warm and humid resting place for the golden-furred orange leafnosed-bat. These bats can only live in warm humid caves at 29-32°C because unlike other bats they do not huddle close together to conserve body heat. The short-eared rock-wallaby also lives in the vicinity of the gorge.

AQUATIC CREATURES

Geikie Gorge harbours a large population of freshwater crocodiles. Leichhardt's sawfish and the coach-whip stingray are usually found in the sea but have adapted to life in freshwater in the gorge. Also found are the barramundi, which changes its sex from male to female at six to eight years, and the striped archerfish, which shoots down insect prey from foliage overhanging the water.



Freshwater Sawfish

BIRDS

A wide variety of water birds have been recorded at Geikie Gorge including the darter, the little pied cormorant and egrets. Two species not often found so far from the sea are the white-breasted sea-eagle and the brahminy kite.

Along the cliffs, the sandstone shrike-thrush is found while the restless flycatcher and brush cuckoo frequent the riverine forest. The cuckoo often lays its eggs in the nests of the flycatcher on which it relies to rear its offspring.

LOOKING BACK

Naming the gorge

Geikie Gorge gets its name from Sir Archibald Geikie, a Director General of Geological Survey for Great Britain and Ireland. The gorge was named in 1883 by the West Australian Government geologist Edward Hardman.

'Darngku', an older name

The Bunuba people who have lived in the Fitzroy Valley for thousands of years, call the gorge 'Darngku' (darn-goo). During the Dreamtime, near the large midstream rock in the Gorge, a blind elder drowned after leaving his tribe to go wandering. The old man sighed and sneezed as he sank to the bottom. If you sit quietly around this area you can still hear the sighs of the old man.

The sand bar area where the 'Mayalin' or Margaret River meets the Fitzroy River is known as 'Bungku' (boon-goo) and was a traditional meeting place for the Bunuba people and the Goonlan people who came from the Fossil Downs area.

THE STORY OF FIRE

Near the end of the western wall of the Gorge, in the days before the Bunuba people had fire and so had to eat their food raw, the old crocodile man Lullangarra greedily kept his firesticks for himself. One day the other animals plotted to steal the firesticks from Lullangarra but no-one was brave enough except for Gid Gunya the Black Kite man. Gid Gunya dived down into the murky depths where Lullangarra lived and stole the sticks from him. He then changed into his bird form and set the bush alight to produce fires for everyone to cook with. Even today, Gid Gunya, the Black Kite, can be seen wherever there are fires, maintaining the fires for everyone.

Gid Gunya the Black Kite

TODAY

Today the Bunuba people still maintain strong cultural and spiritual beliefs that are linked with the area. They advise CALM on issues related to the management of the Park.

Further Information

The Department of Conservation and Land Management
West Kimberley District Office
Herbert St, Broome
PO Box 65
Broome 6725
Telephone (08) 9192 1036
Fax (08) 9193 5027

Geikie Gorge National Park
PO Box 37
Fitzroy Crossing 6765
Telephone (08) 9191 5121
Fax (08) 9191 5165

WINDJANA GORGE NATIONAL PARK

Where: 145 kilometres by road (including 77 kilometres of gravel road) from Derby and 150 kilometres (including 111 kilometres of gravel road) from Fitzroy Crossing.

Area: 2,134 hectares.

Gazetted: November 1971

Attractions/Significance: A scenic gorge carved by the Lennard River through the Napier Range, with good exposure of an ancient reef system regarded by geologists as a classic feature of world geology.

THINGS YOU NEED TO KNOW

The park may be inaccessible during the wet season.

A camping area with water, toilets, showers, fireplaces and firewood is open weather permitting between mid April and mid October. Portable generators can be used in the designated area between 7am and 9pm.

An airstrip 2 kilometres south-west of Windjana Gorge allows visitors with limited time to access the park via commercial air charters as part of the Ibis Aerial Highway. To use the strip, advance bookings must be made through the Derby Tourist Bureau and confirmed or cancelled 24 hours prior to the booked date. Telephone (08) 9191 1426 or Fax (08) 9191 1609. There is a landing fee charged per passenger. For pilots making their first landing at Windjana, a ranger will be available to assist as guide for the introductory tour. Any subsequent ranger guided tours will incur a fee. Please indicate whether a ranger is required when booking.

Freshwater crocodiles live in the gorge. Although not usually a danger to people, parents should exercise caution with small children.

CARING FOR WINDJANA

Fishing and netting are discouraged in the gorge.

Dead wood is an important ecological resource in the Kimberley. Please restrict fires to the fireplaces provided and use only the wood provided. Use gas stoves for cooking where possible.

Keep the park clean; take your rubbish with you or place it in bins where provided.

Please avoid spreading weeds by careful removal and disposal of burrs on socks and footwear. Wearing gaiters helps to reduce the spread of burrs.

Help to protect the area for wildlife. Please do not harrass resting crocodiles in any way. Pets and firearms are not permitted in the park.

Windjana Gorge is a special area for wildlife. The northern and western side of the river in the gorge is a wildlife sanctuary where access is prohibited.

Leave rocks, plants and artefacts as you find them for all to enjoy. Refrain from touching Aboriginal paintings as it causes them to deteriorate.

THINGS TO DO

The 'Gorge Walk' trail winds through the gorge for about 3.5 kilometres each way.

The 'Time Walk' trail takes a look at marine life forms fossilised within the limestone of the gorge.

The 'Savannah Walk' trail describes plants and animals of the woodlands.

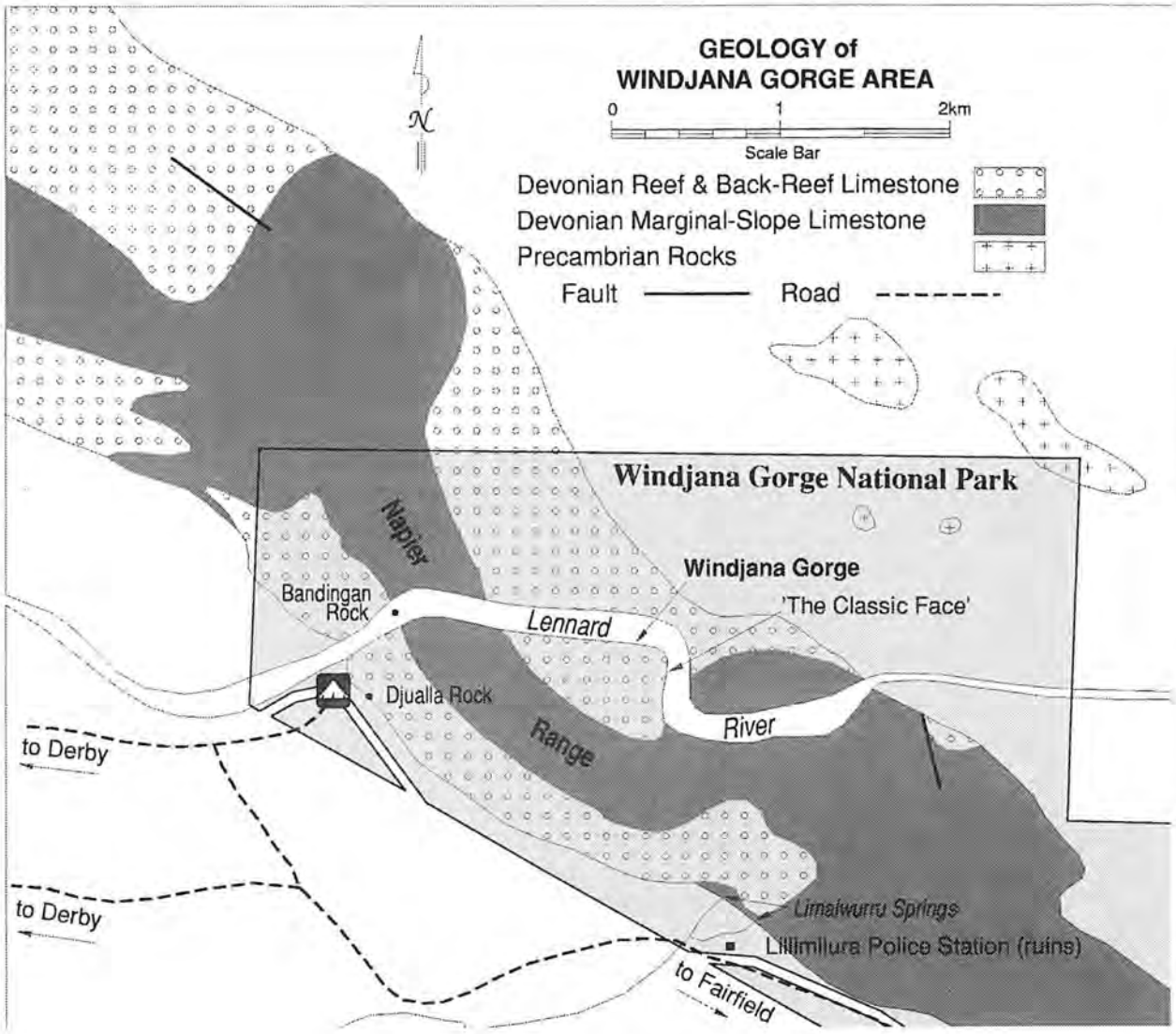
A short walk at Lillimura historic site descibes dramatic events on the Kimberley frontier in the 1890s.

ABOUT THE GORGE

The walls of Windjana Gorge rise abruptly from the wide alluvial floodplain of the Lennard River, reaching up to 100 metres in some places. The 3.5 kilometre long gorge cuts through the limestone of the Napier range. The river flows during and shortly after the wet season. For most of the year water only occurs as isolated pools in the main channel.

The 'Classic Face'

Geologists regard Windjana Gorge as one of the classic features of world geology. Nowhere



else are the relationships between the various deposits of an ancient reef complex so well exposed as they are here.

The most impressive exposure of the reef and its associated deposits in Windjana Gorge is known as the 'Classic Face'. Here the reef is exposed in cross-section. Flat-bedded back-reef and reef limestone grade into a narrow massive vertical reef margin, which is fronted by steeply inclined marginal slope deposits. Changes in fossils are evident with the stromatoporoid *Amphipora* conspicuous in the back-reef. Other stromatoporoids and algae were the dominant reef builders, and sponges are common in the marginal-slope deposits.

During the early phase of reef growth in the Windjana Gorge area, the reef grew mostly vertically as in the 'Classic Face'. Later it extended nearly horizontally over the marginal slope deposits. This reef limestone built almost entirely by algae is exposed at the west end of the gorge.

'Classic Face' at Windjana Gorge

Fossils

The river has taken millions of years to erode out the gorge. At one stage river gravel containing fossil remains of extinct crocodiles and turtles accumulated in a small cave on a wall of the gorge, some 40 metres above the present river level. One of the crocodiles represented among the fossil bones was a giant form about 7 metres long. Another extinct animal whose bones have been found in river gravels at Windjana Gorge is the giant wombat-like marsupial *Diprotodon*.

The wombat-like Diprotodon

THE WILDLIFE

Along the river

In Windjana Gorge, river gums (*Eucalyptus camaldulensis*) and cadjeputs (*Melaleuca leucadendra*) fringe the banks of the Lennard River. Other trees growing in the deep, moist soil of the riverbanks include the shady, broad-leaved Leichhardt tree (*Nauclea orientalis*), and native figs such as the river fig (*Ficus coronulata*), whose leaves are elongated and prominently veined, and the cluster fig (*Ficus racemosa*), which bears clusters of colourful figs on its trunk. The wild passionfruit (*Passiflora foetida*) clambers amongst the trees.

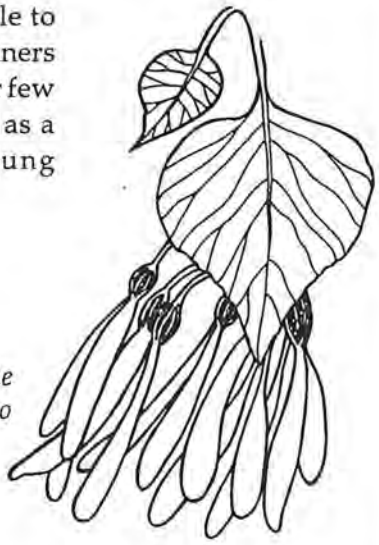
The trees provide shelter for colonies of fruit-eating bats such as the black flying fox, large flocks of noisy little corellas, and water birds such as the secretive black bittern and the cinnamon-coloured, nocturnal rufous night-heron. The barking owl, also active at night, is more often heard than seen and has been mistaken for a dog.

Freshwater crocodiles may be seen in pools in the gorge or basking on the sandy banks to raise their body temperature. The pools contain freshwater fish such as the bony bream, the spangled perch, rainbow fish and the archer fish which shoots its insect prey with a jet of water. These provide food for the little pied cormorant, the darter, egrets and herons.

The Gorge walls

On the limestone of the gorge walls grow hardy clumps of spinifex and the rock fig (*Ficus platypoda*) which clings to the cliffs with clutching roots. The peregrine falcon roosts here and the sandstone shrike-thrush may be seen foraging for insects in the crannies. Caves in the cliffs provide homes for the strictly cave-dwelling yellow-lipped bat, little known and found only in the Kimberley, usually near creeks and pools.

On the slopes of the gorge, grow boabs (*Adansonia gregorii*) and the helicopter or coolaman tree (*Gyrocarpus americanus*) which bears wrinkled winged nuts. The smooth, shiny bark of the coolaman tree was used by Aboriginal people to make light containers for carrying their few possessions and as a cradle for young babies.



Winged nuts of the coolaman tree, also known as the helicopter tree.

The surrounding plains

Outside the gorge the savannah woodland is a stark contrast to the riverine vegetation. Trees such as the Kimberley bauhinia (*Bauhinia* [formerly *Lysiphyllum*] *cunninghamii*) the greybox (*Eucalyptus tectifica*), with its drooping narrow-leaved foliage, and the twin-leaf bloodwood (*Corymbia* [formerly *Eucalyptus*] *cadophora*), with scaly bark and pairs of opposite leaves, stand out above extensive grassland. Here the agile wallaby, recognised by its sandy colour and light stripe on its cheek and thigh, may be seen.

LOOKING BACK

Aboriginal mythology

The Unggumi people, who called the gorge 'Windjana' and the Bunuba people who called the gorge 'Taley,' occupied the area around the gorge for thousands of years. Their history and mythology are recorded in art sites and artefacts, and in traditional stories, songs and dances handed down from generation to generation, some surviving even today.

A large boulder in the gorge sits in a pool of water in which the spirits of babies are to be found. Mythological beings such as the Rainbow Serpent or the Wandjina spirits control the distribution of the child spirits, which live in certain freshwater pools such as the one at Windjana Gorge. When a man eats a fish, turtle or crocodile taken from the pool he might consume the spirit of a child, or the baby

spirit might simply follow him when he visits the pool. Then through a dream of the father, the spirit of the baby is transferred to the mother.

The coming of others

In the late 1800s explorers and pastoralists came to the area with their sheep and cattle. Conflicts developed over the traditional lands and hunting areas of the Aboriginal people. Sheep were speared and Aboriginal people were arrested, chained and walked to Derby, where they worked off their sentences.

A few kilometres east of the gorge are the ruins of Lillimilura Homestead constructed from local limestone in 1884 for the King Sound Pastoral Company. In 1893 Lillimilura Station became a police outpost to protect the white settlers from attack by Aboriginal people.

The Pigeon story

Jandamarra, or Pigeon as he was also known, was a Bunuba Aboriginal from the Napier and Oscar ranges. During his early contact with Europeans, working on stations, he became a highly skilled horseman and marksman. He was held in awe by other Aboriginal people as a 'Muban man' or magical person.

Working for the police, he gained a reputation as one of the best trackers in the Kimberley. Against normal police policy, he was transferred to the Napier ranges, where he had to work for the police among his own people.

During a patrol of the area with Police Constable Richardson, Jandamarra helped to capture 16 Aboriginal people. However, his tribal loyalties came to the fore. While resting at Lillimilura Police Post he shot Richardson, stole some guns and set the captives free.

On November 10, 1894 Jandamarra and his followers attacked a party of five Europeans who were driving cattle to set up a large station in the heart of Bunuba land. Two of them were killed at Windjana Gorge. This was the first time that guns had been used against Europeans in an organised fashion in the Kimberley.

In late 1894 a posse of around 30 heavily armed police and settlers attacked Jandamarra and his followers, who had staked out Windjana Gorge in readiness. Jandamarra was seriously wounded and believed to have died. The police then embarked on a military style campaign against Aboriginal camps around Fitzroy Crossing killing many Aboriginal people.

For three years Jandamarra tried to defend his lands and his people against police and white settlers. His vanishing tricks became legendary. At one point a police patrol managed to follow him to his hideout at the entrance to Tunnel Creek when word was received that he had raided Lillimilura Police Post during their absence. Jandamarra was finally killed near Tunnel Creek on April 1, 1897.

Further Information

The Department of Conservation and Land Management
West Kimberley District Office
Herbert St, Broome
PO Box 65
Broome 6725
Telephone (08) 9192 1036
Fax (08) 9193 5027

Further Reading

Jandamarra and Bunaba Resistance
Pederson, Howard

King of Kimberley: The Story of a Tragic Injustice
Rocky Marshall

TUNNEL CREEK NATIONAL PARK

Where: 180 kilometres by road (including 118 kilometres of gravel road) from Derby and 111 kilometres (including 68 kilometres of gravel road) from Fitzroy Crossing.

Area: 91 hectares.

Gazetted: July 1963

Attractions/Significance: A large tunnel eroded through the limestone of the Napier range.

THINGS YOU NEED TO KNOW

The park may be inaccessible in the wet season.

Camping is not permitted in the park. There is a camping area at nearby Windjana Gorge (36 kilometres).

An information shelter and toilet are provided near the entrance to the tunnel.

The 1.5 kilometre return walk through the tunnel to the other side of the Napier range requires wading through the creek which can be cold and deep. Shoes and a torch are recommended.

Tunnel Creek can be dangerous in the wet season. Be aware that rain falling in the catchment many kilometres away can cause sudden flooding of the creek.

CARING FOR TUNNEL CREEK

Help to protect the area for wildlife. Pets, fires, and firearms are not permitted in the Park.

Keep the park clean; please take your rubbish with you.

Leave rocks, plants and artefacts as you find them for all to enjoy. Refrain from touching Aboriginal paintings as it causes them to deteriorate.

ABOUT THE TUNNEL

Tunnel Creek takes its name from the 750 metre long tunnel carved out of limestone by flowing water. The creek once flowed across the top of the Napier range when the surrounding ground level was higher than it is today. This original watercourse is marked by a shallow valley on top of the range. Water seepage enlarged fractures in the limestone and the creek adopted the underground course which is seen today.

During the dry season it is possible to walk from one entrance to the other. The tunnel is up to 12 metres high, and 15 metres wide, and contains permanent pools of freshwater. Near the centre of the tunnel, the roof has collapsed through to the top of the range. A bench in the tunnel, about eight metres above the present floor, marks an older underground creek level.

At the north entrance of the tunnel fractures can be seen in the algal and stromatoporoid reef limestone, which occurred at an early stage in the growth of the reef. Water seeping through fractures in the limestone has dissolved calcium carbonate and redeposited it as small stalactites and flowstones on the roof and walls of the tunnel.

THE ANIMALS

The 'Cave of Bats'

The tunnel was known as the 'Cave of Bats' in earlier times because at least five species of bat are known to use it. These include the western cave bat, the common bent-wing bat and the rare ghost bat, Australia's only carnivorous bat, which preys on frogs, lizards, small birds and mammals including other bats.

Australia's only carnivorous bat, the Ghost Bat

The yellow-lipped bat, found only in the Kimberley, has been little studied but appears to be a strict cave dweller. The orange leafnosed-bat named for its golden fur prefers limestone caves which provide warmth and humidity to help maintain its body temperature when resting. Unlike other bats, orange leafnosed-bats do not huddle together to keep warm.

Many of these bats are particularly sensitive to disturbance. The ghost bat requires a totally dark refuge during the day. Colonies of the orange leafnosed-bat have abandoned roosts after continual human disturbance. Too much artificial light would be likely to cause these bats to abandon the tunnel.

At times a colony of little red flying foxes roosts where the roof of the tunnel has collapsed. During the day the tunnel provides a protected retreat. At dusk they leave en masse to seek out the blossoms of woodland trees.

Aquatic creatures

Freshwater crocodiles inhabit the pools within the tunnel, feeding on small fish, cherabun (a crustacean), frogs and insects. Rainbowfish, bony bream, spangled perch and fork-tailed catfish are found in the pools.

LOOKING BACK

Late last century Tunnel Creek was a hide-out for Jandamarra, a member of the Bunuba group of Aboriginal people who lived in the area. He was a fighter for Aboriginal rights and avoided the police for several years by using the tunnel as a retreat. In 1897 Jandamarra was killed opposite the tunnel entrance in a gun battle with a police tracker.

Further Information

The Department of Conservation and Land Management

West Kimberley District Office
Herbert St, Broome
PO Box 65
Broome 6725
Telephone (08) 9192 1036
Fax (08) 9193.5027

MT HART PASTORAL LEASE

Where: Mt Hart Homestead is 50 kilometres along a rough four wheel drive track turning off the Gibb River Road 184 kilometres from Derby and 515 kilometres from Kununurra. Bell Gorge is 29 kilometres along a rough four wheel drive track turning off Gibb River Road 214 kilometres from Derby and 485 kilometres from Kununurra. Lennard River Gorge is 8 kilometres along a rough four-wheel-drive track turning off Gibb River Road 190 kilometres from Derby and 509 kilometres from Kununurra.

Area: 392,104 hectares.

Attractions/Significance: The spectacular King Leopold Ranges with several gorges including Bell Gorge and Falls.

THINGS YOU NEED TO KNOW

Tracks to Mt Hart homestead, Silent Grove, Bell Falls and Lennard Gorge are negotiable by four wheel drive vehicles only.

Tracks may be closed during the wet season (November to April) depending on rainfall. To prevent costly damage to tracks and for your own safety, please comply with 'Road Closed' signs and do not use roads when they are wet.

Campsites are provided at Silent Grove with toilets and shower facilities. There are a limited number of secluded campsites along Bell Creek with toilets but no showers. A system of site tags and signs indicates whether sites are available at Bell Creek. Visitors using these campsites may take water from the creek but are reminded to wash well away from the creek to avoid polluting the water.

There is no camping at Mt Hart homestead. Full accommodation only is available and must be booked in advance as facilities are limited. Activities available include swimming, tennis, bushwalking and birdwatching.

Telephone/Fax (08) 9191 4645.

There is a range of air tour options with stopovers at Mt Hart homestead and Silent Grove. Information can be obtained from the Ibis Aerial Highway Brochure, or from local tourist bureaus.

CALM's airstrips at Mt Hart Homestead and Silent Grove are part of the Ibis Aerial Highway. To use the strips, bookings can be made direct or through Derby Tourist Bureau, Telephone (08) 9191 1426 or Fax (08) 9191 1609. Bookings must be confirmed or cancelled 24 hours prior to the booked date. There is a landing fee charged per passenger. For pilots making their first landing at Silent Grove, a ranger will be available to assist as guide for the introductory tour. Any subsequent ranger guided tours will incur a fee. Please indicate whether a ranger is required when booking.

Walking tracks to Bell Falls and into Lennard Gorge are over rough and steep ground. Please be careful if you choose to use them.

CARING FOR MT HART

Help to protect the environment; please stay on designated roads and tracks and camp only at the established campsites.

Light fires only in designated fireplaces and keep fires small to conserve dead wood. Collect wood well away from camping areas. Preferably use gas for cooking.

Please deposit your rubbish in bins where provided or take it with you.

Leave animals, plants and rocks as you find them for all to enjoy.

Pets and firearms are not permitted as they disturb wildlife.

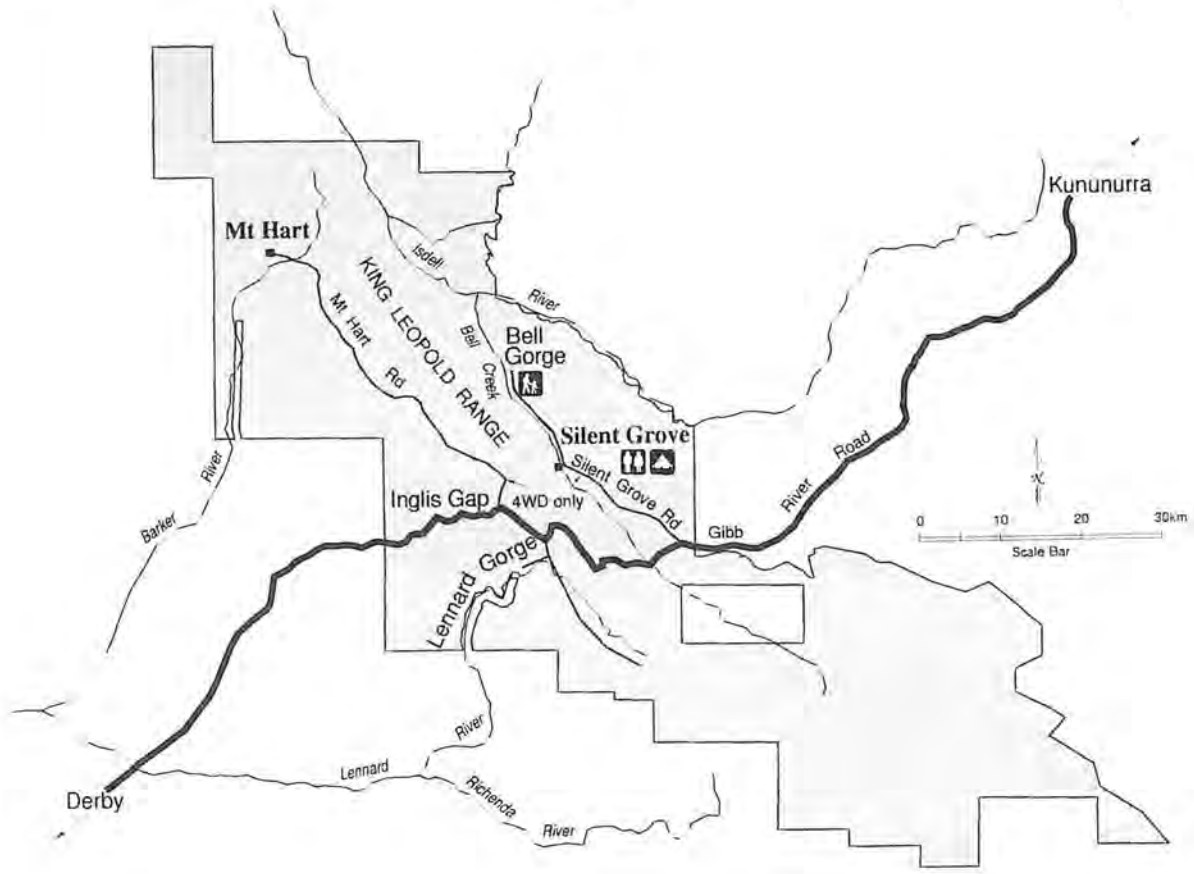
THINGS TO DO

A two kilometre return walk track leads from the carpark at Bell Gorge to a section of the creek just above the falls, where there are spectacular views of the gorge and waterfalls. The track is steep and rocky in sections.

The walking route into Lennard Gorge is over rocky ground and involves negotiating rockfaces. This is a difficult walk and great care should be taken.

THE LANDSCAPE

Mt Hart pastoral lease occupies the steep ridges and hills of the King Leopold ranges.



The Kimberley Basin

A basin is a low area in the earth's crust where sediments have accumulated. About 1800 million years ago in Precambrian times, in a region known as the Kimberley Basin, a thick sequence of layered sedimentary rocks was deposited in shallow water on a slowly subsiding large continental mass. Predominantly white and pink quartz sandstone, there are also thin layers of siltstone and mudstone, basalt that solidified from lava flows, and dolerite where lava intruded into the older sedimentary rocks.

The Hooper Complex

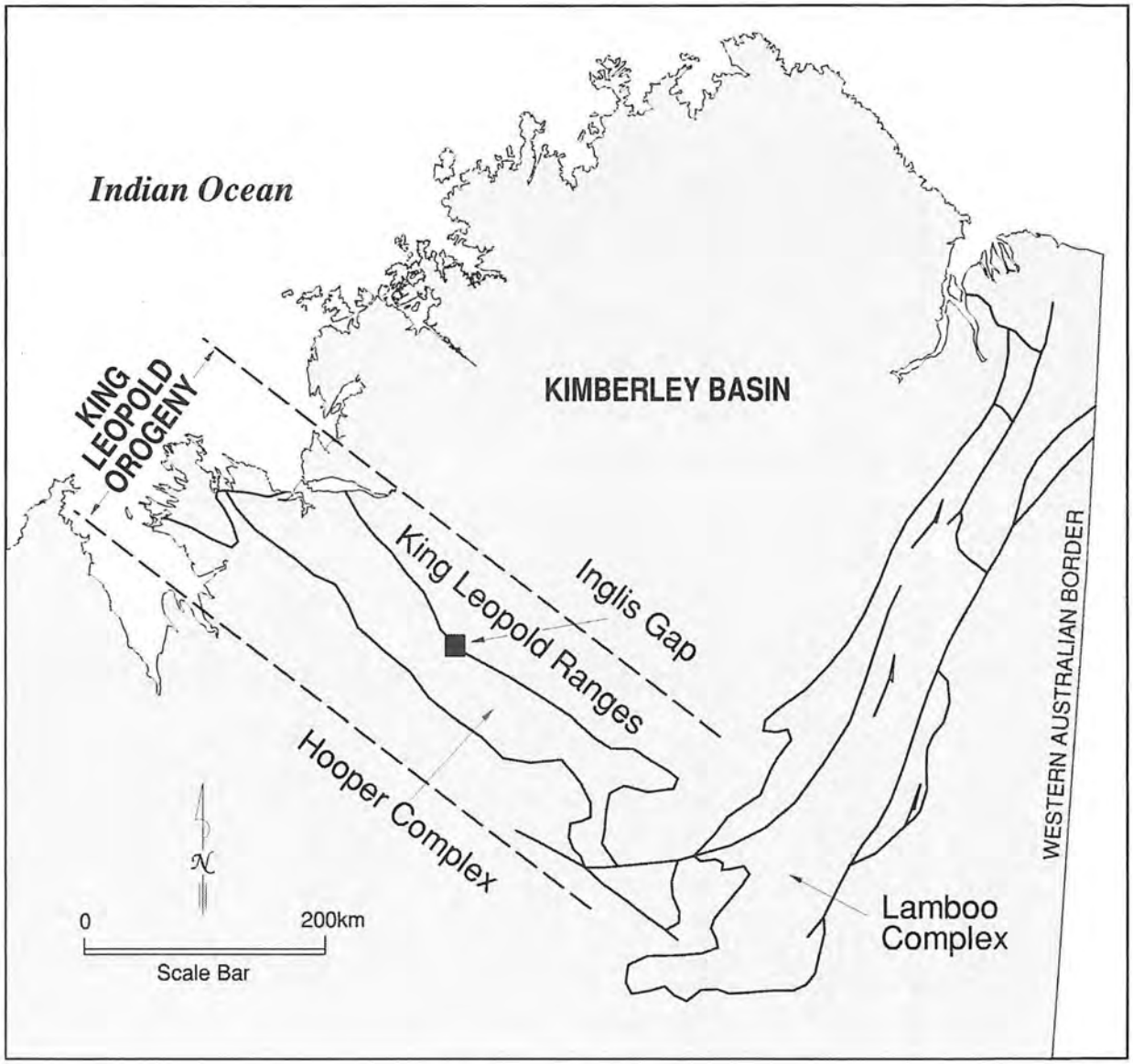
To the southwest of the Kimberley Basin there is an area of older granite, volcanic rocks, and metamorphosed sedimentary rocks forming what is known as the 'Hooper Complex'.

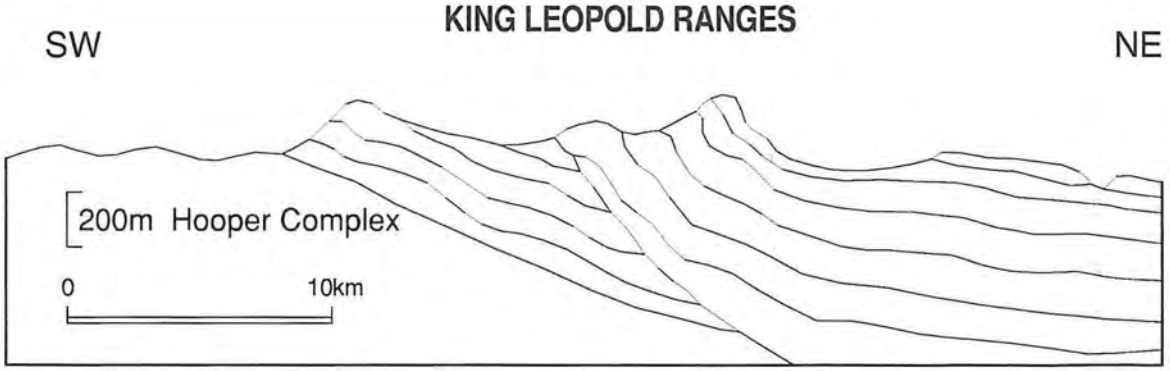
Birth of the King Leopold Ranges

About 560 million years ago the flat lying layers of the Kimberley Basin were pushed over the Hooper Complex to form a major mountain chain. Erosion of this mountain chain has resulted in the rugged terrain of the King Leopold Ranges that is seen today with hogbacks, steep valley walls and often flat valley floors.

North of the ranges, the strata of the Kimberley Basin remain flat lying, extending north to the coast. In the foothills to the southwest of the King Leopold Ranges, the smooth pink granite, jagged grey volcanic rock, and red-brown metamorphosed sedimentary rock of the Hooper Complex can be seen.

In the ranges themselves, folded and faulted rock formations are evidence of the dramatic deformation occurring when the mountain chain was formed. The resistant massive white and pink quartzite sandstone layers form steep and very rugged ridges. The valleys between the ridges have been formed by the erosion of the less resistant mudstone and basalt. The dolerite has been weathered to black soil and rounded black boulders.


Indian Ocean
KING LEOPOLD OROGENY
KIMBERLEY BASIN
King Leopold Ranges
Inglis Gap
Hooper Complex
WESTERN AUSTRALIAN BORDER
Lamboo Complex
N
0
200km
Scale Bar

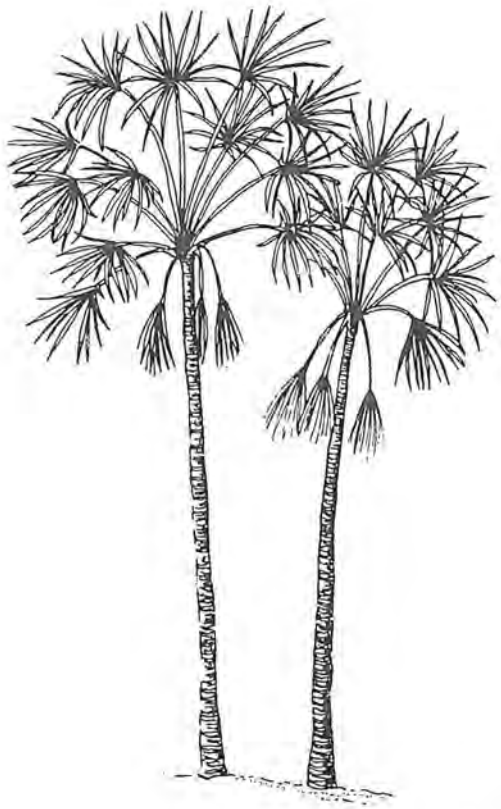

KING LEOPOLD RANGES
SW
NE
200m Hooper Complex
0
10km

THE PLANTS

The woodlands

Open woodland covers the ranges with eucalypts being the dominant trees. The snappy gum (*Eucalyptus brevifolia*) is found on the rocky ridges along with spinifex. The Darwin box (*Eucalyptus tectifica*) and the weeping ghost gum (*Corymbia bella*, formerly *Eucalyptus papuana*) are common on the valley floors with cane grass, an annual Sorghum, as the grass layer.

Other common trees include the boab (*Adansonia gregorii*), the ironwood (*Erythrophleum chlorostachys*), the Kimberley bauhinia (*Bauhinia* [formerly *Lysiphyllum*] *cunninghamii*), the wild mango (*Buchanania obovata*), various terminalias and the Kimberley rose (*Brachychiton viscidulus*). Shrubs include various acacias, the beefwood (*Grevillea striata*) and the kapok (*Cochlospermum fraseri*). Two species of Livistona palms occur, including the fine-leaved *Livistona kimberleyana* which can be seen around Fern Creek on the Gibb River Road.



Livistona kimberleyana

Riverine and rainforest

Along creeks there are river gums (*Eucalyptus camaldulensis*) paperbarks (*Melaleuca* sp) and thickets of screwpine (*Pandanus spiralis*). Isolated pockets of remnant rainforest are also known to occur.

Rare and endemic species

Although comprehensive surveys are yet to be undertaken, several endemic and rare species are known from the ranges. Bold Bluff is one of only three known locations for the rare Cycad (*Cycas furfuracea*). The wattle *Acacia gracillima* and the shrub *Solanum leopoldense* which bears purple flowers and thorny fruits, are restricted mainly to the rocky slopes and gullies of the King Leopold Ranges. The declared rare plant *Eucalyptus mooreana* also occurs in the area.

THE ANIMALS

Although surveys have been limited, the fauna of the area is known to be diverse.

Mammals

Mammals include the echidna, the sugar glider, the northern quoll, the northern brown bandicoot, and the little known rock ringtail possum. Unlike its tree dwelling relatives, it lives exclusively in rocky outcrops sleeping in well protected rock ledges during the day, and climbing trees only at night to feed on blossoms and fruits.

Macropods found in the ranges include the antilopine wallaroo, the euro, the short-eared rock-wallaby and the northern nailtail wallaby. Small nocturnal mammals include the stripe-faced dunnart, the long-tailed planigale and Forrest's mouse.

As well as the dusky leafnosed-bat and the common bent-wing bat, the little known yellow-lipped bat has been found in the ranges. Only recognised recently, it is found near creeks and pools only in wetter areas of the north and west Kimberley.

Reptiles

Reptiles are common. Freshwater crocodiles, Merten's water monitor, and the northern long-necked tortoise can often be seen in creeks in the area.

Birds

The birdlife is rich and includes several declared threatened species such as the red goshawk, the Gouldian finch and the purple-crowned fairy-wren which can sometimes be observed along creeklines. Less commonly observed species which may be seen include the peregrine falcon, the channel-billed cuckoo, and the yellow oriole.

LOOKING BACK

The rugged topography of the King Leopold Ranges formed a natural border to areas occupied by several Aboriginal groups including the Wungemi, Ngarinyin, Wula and Bunaba people.

Early exploration

Alexander Forrest's survey party travelling from the DeGrey River to Port Darwin in 1879, named the King Leopold Ranges after King Leopold of Belgium in recognition of his interest in exploration. However, they were unable to find a way through the rugged ranges. The expedition lost several horses and as a result of their difficulties names such as Mt Hopeless and Devil's Pass were given to features in the area. It is not known for whom Mt Hart was named.

In 1898 the stockman and explorer Frank Hann managed to cross the ranges via the pass that now bears his name. Boab trees along Hann's Pass still have his initials carved into their trunks.

Pastoral days

Mount Hart was first taken up as a pastoral lease around 1919 by Edgar and Chalmers. They were the first of a succession of early pastoralists to go broke and walk off the lease, because the land was too rugged and unsuitable for pasture.

In 1951 Stumpy Fraser moved into the original homestead near a low hill known as Mt Hart but when the nearby waterhole dried up built another about 16 kilometres north. When this waterhole also dried up he built the third Mt Hart Homestead about a kilometre away. In 1957 Stumpy also walked off broke.

In 1962 the property came into the hands of the Mt Hart Pastoral Company owned by Charlie Telford and his family. Charlie built the fourth homestead and planted the original gardens from which many of the plants survive today.

Proposed national park

CALM acquired the area in 1992 to create the proposed King Leopold Range National Park.

Further Information

The Department of Conservation
and Land Management
West Kimberley District Office
Herbert St, Broome
PO Box 65
Broome 6725
Telephone (08) 9192 1036
Fax (08) 9193 5027

Further Reading

'King Leopold's Treasures'
Landscope Vol 7 No 3 (Autumn 1992)
'Oasis in the Leopolds'
Landscope Vol 9 No 4 (Winter 1994)

BUCCANEER ARCHIPELAGO

Where: At the northern end of King Sound, north of Derby.

Area: The islands of the Buccaneer Archipelago range from a few hectares to about 2,400 hectares.

Attractions/Significance: Magnificent coastal and island scenery in an area with huge tidal ranges (up to 12 metres).

THINGS TO DO

Boat and yacht cruises and fishing charters to the archipelago are available from Broome and Derby. Contact local tourist bureaux for details.

Scenic flights over the archipelago and Kimberley coastline are available from Broome and Derby. Contact local tourist bureaux for details.

Resort accommodation is available on Cockatoo Island. Contact Cockatoo Island Resort. Telephone (08) 8981 2886 or Fax (08) 8941 2573.

THE LANDSCAPE

The Buccaneer Archipelago consists of some 800 to 1,000 rocky islands with small embayments, tidal mudflats and secluded white sandy beaches. Abrupt coastal cliffs and promontories overlook the narrow tidal channels that separate the islands from each other and from the mainland. The numerous islands were formed when the coastline was flooded about 17,000 years ago. The rocky outcrops forming the islands consist of very old sandstone from the Kimberley Basin.

The Kimberley Basin

A basin is a low area in the earth's crust where sediments have accumulated. About 1800 million years ago in Precambrian times, in a region known as the Kimberley Basin, a thick sequence of layered sedimentary rocks was deposited in shallow water on a slowly subsiding large continental mass. Predominantly white and pink quartz sandstone, there are also thin layers of siltstone and mudstone, basalt that solidified from lava flows, and dolerite where lava intruded into the older sedimentary rocks.

The Hooper Complex

To the southwest of the Kimberley basin there is an area of older granite, volcanic rocks, and metamorphosed sedimentary rocks forming what is known as the 'Hooper complex'.

Birth of the King Leopold Ranges

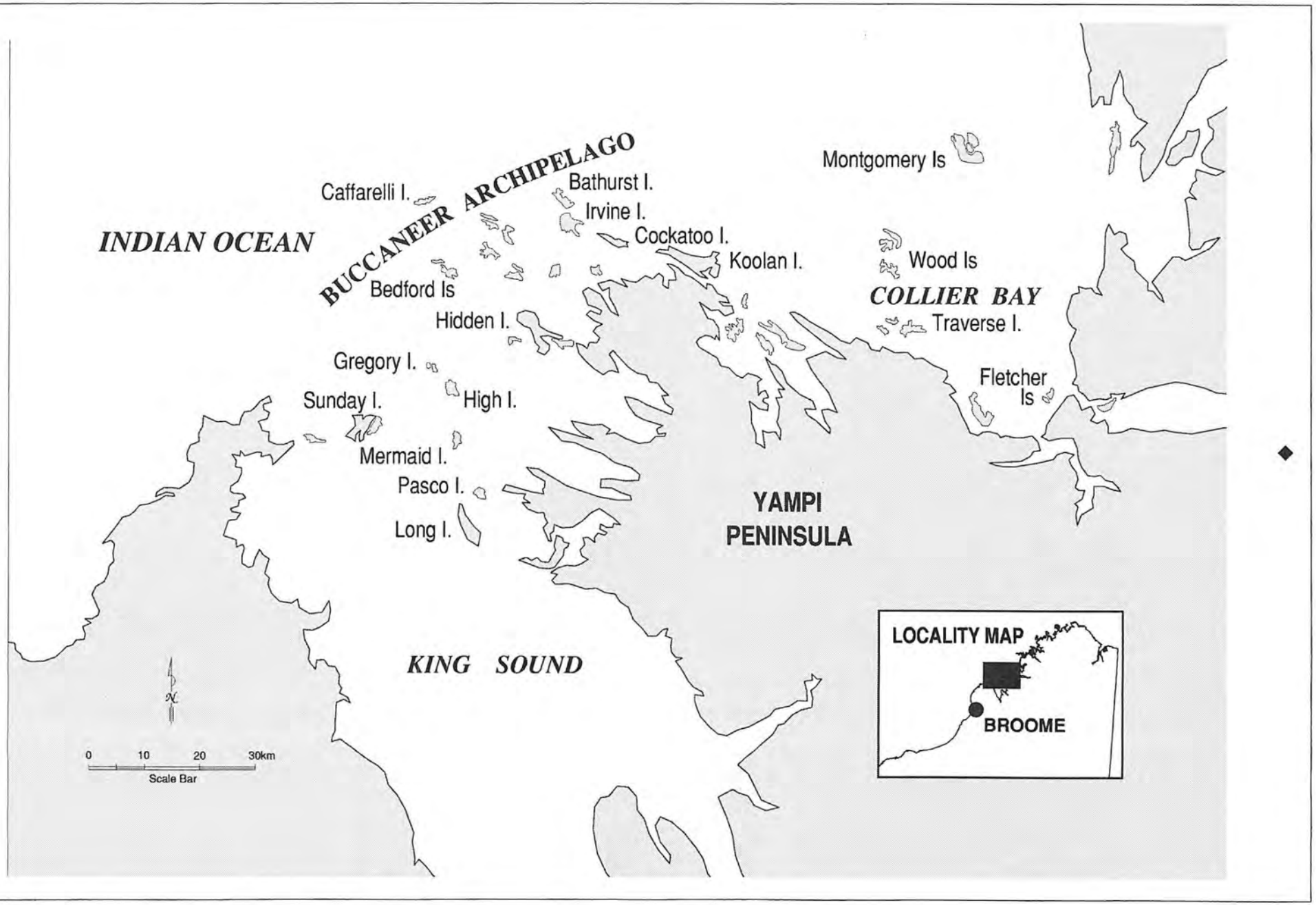
About 560 million years ago the flat lying layers of the Kimberley Basin were pushed over the Hooper Complex to form a major mountain chain. Erosion of this mountain chain has resulted in the rugged terrain of the King Leopold Ranges and the rocky outcrops that form the islands of the Buccaneer Archipelago.

The islands

The islands show a variety of the sedimentary rocks of the Kimberley Basin. Hidden, Sunday, Lachlan, Long, Pasco, King Hall, Sir Frederick, and Cafferelli Islands are formed from the very old white and pink quartz sandstone named 'King Leopold Sandstone'. Irvine and Bathurst Islands are formed from the quartz sandstone called 'Pentecost Sandstone' while Koolan and Cockatoo Islands are formed from the iron ore containing quartz sandstone known by geologists as the 'Yampi Member'.

Tides

The area has huge tidal ranges up to 12 metres. These create such phenomena as the horizontal reversible waterfall in Talbot Bay. The falls are caused by the differential created when the tide flows through narrow gaps connecting tidally inundated inlets. The area has been considered for tidal power generation.


INDIAN OCEAN
BUCCANEER ARCHIPELAGO
Caffarelli I.
Bathurst I.
Irvine I.
Cockatoo I.
Koolan I.
Montgomery Is
Wood Is
COLLIER BAY
Traverse I.
Fletcher Is
Bedford Is
Hidden I.
Gregory I.
Sunday I.
High I.
Mermaid I.
Pasco I.
Long I.
YAMPI PENINSULA
KING SOUND
0 10 20 30km
Scale Bar
LOCALITY MAP
BROOME

THE WILDLIFE

The islands are rugged and sparsely vegetated. Patches of rainforest are found in moist areas and there are fringing mangroves where silt has accumulated. The array of plants and animals found on the islands resembles that found on the adjacent mainland.

The plants

Trees include various eucalypts and the wild mango (*Buchanania obovata*). Common shrubs are the Kimberley heather or turkey bush (*Calytrix exstipulata*), and various acacias. Spinifex (*Plectrachne* sp) is found under the trees and shrubs.

Mangroves

Mangrove communities are found in sheltered bays and tidal creeks. Mangroves found here include the red mangrove (*Rhizophora stylosa*), with long, arching, air-filled stilt roots forming an impenetrable forest in the central area of larger communities. The white mangrove (*Avicennia marina*) with smooth, white bark, and the pornupan (*Sonneratia alba*) with brown slightly flaky bark are found on the seaward edge. Both have air-filled pneumatophores rising up through the mud from their roots allowing them to survive the waterlogging of the incoming tides. The white mangrove has pencil-like pneumatophores while those of the pornupan are cone-shaped. The white mangrove is also found on the landward edge of the mangrove communities along with the yellow mangrove (*Ceriops tagal*) which is recognised by its buttressed stem and yellowish leaves.

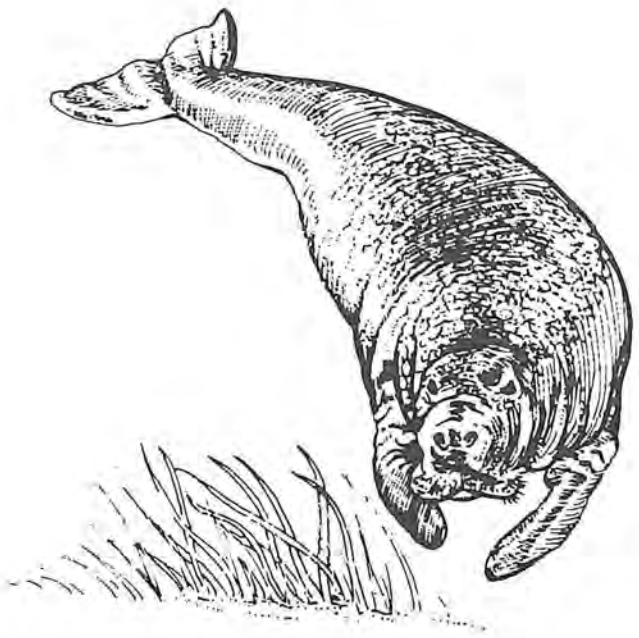
Animals

Nineteen species of mammals have been recorded on the islands of the Archipelago including the narbarlek, the golden-backed tree-rat, the grassland melomys, the ghost bat and the little-known northern leaf-nosed bat.

Twenty-five species of reptiles have been recorded including the taipan, one of Australia's most dangerous snakes.

There have been 118 species of birds recorded on Koolan Island.

Dugongs and turtles are abundant in the surrounding seas, especially on seagrass beds and reefs.



Dugong

LOOKING BACK

Aboriginal people

Bardi, Jawi, Unggarrangu and Umilda Aboriginal people have visited the archipelago for thousands of years and their rock art can be found on some islands and the adjacent mainland. They used rafts of mangrove logs to travel between the islands.

Macassans

Macassan fishermen from Indonesia are thought to have plied the northwest coastline well before the coming of the Europeans, collecting beche de mer (sea cucumbers), turtles and possibly trochus and oyster shells. They left evidence of their campsites with tamarind trees and taro plants growing in remote coastal locations.

Early explorers

The archipelago was sighted by the buccaneer William Dampier on the 15th January, 1688. Later it was named to commemorate Dampier's visit by Captain Phillip Parker King in 1821. King named many of the prominent coastal features of the archipelago on his voyages in 1820 and 1821. The archipelago was explored and surveyed more fully by Lieutenant John Lort Stokes and Captain John Wickham on the Beagle between 1838 and 1841. 'Yampee' was noted by Stokes as an Aboriginal word for water. Yampi Sound comes from 'Yampee Point' as named by Stokes.

Pearling

Pearling in luggers in the 1880s was concentrated in Cygnet Bay, Cascade Bay, Cone Bay and Strickland Bay. The tides and whirlpools in the area caused havoc with the pearling fleets. Many sailors and divers lost their lives and there are isolated graves on many of the islands, a testimony to the dangerous conditions. Cultured pearl farms are now located in these areas.

Iron ore

Cockatoo and Koolan Islands were mined for iron ore. Iron ore was first noticed by pearlers in the 1870s and used as ballast by some ships visiting the area. The first lease was granted in 1907, and in the 1930s Japanese interests looked to develop the deposits. However, it was not until the 1950s that mining developed in earnest. On July 24th 1951, the first ship load of ore sailed for Newcastle in New South Wales.

Cockatoo Island contained one of the world's richest ore bodies. It yielded an average purity of 69 per cent over the life of the mine but quantities of ore came out at 97.34 per cent Fe_2O_3. The ore was a steel grey crystalline haematite of micaceous structure embedded with quartzite and clay silts.

Koolan Island

Koolan Island had a peak population of 950 people. It was a complete community with primary school, police station, recreation facilities and shops. Its 18-hole golf course had the longest hole in the world: number six hole, 867m and rated as par 7. Since mining ceased on Koolan Island in 1992, all buildings and the wharf have been removed and extensive rehabilitation with native species has taken place.

Cockatoo Island

BHP ceased mining on Cockatoo Island in 1986. Many of the original buildings remain and have been renovated, and the island has been developed as a tourist resort. Reworking of the mineral tailings for export to China has occurred in recent years.

ROWLEY SHOALS MARINE PARK

Where: The three separate atolls, Mermaid Reef (17° 07"S, 119° 20"E),

Clerke Reef (17° 10"S, 119° 20"E) and Imperieuse Reef (17° 35'S, 118° 56"E) lie about 330 kilometres (180 nautical miles) west of Broome.

Area: Each atoll covers an area of around 80 to 90 square kilometres. Dimensions of the atolls are Mermaid: 14.5 x 7.6 kilometres, Clerke: 15.8 x 7.6 kilometres, and Imperieuse: 17.8 x 9.5 kilometres.

Attractions: The Rowley Shoals offer spectacular diving conditions in a pristine environment with exceptional water clarity. They have an unusual abundance of extremely large reef fish, almost untouched coral gardens, giant clams and other spectacular shellfish.

THINGS YOU NEED TO KNOW

Commercial operators must be licensed and abide by the conditions of the licence.

Observe accepted safe diving practices.

Fishing is not permitted at Mermaid Reef as this is a marine national nature reserve.

CARING FOR ROWLEY SHOALS

Examine, photograph and enjoy the animal life; do not break or take, as it will never look as good dead in your home as it does alive on the reef.

Do not collect shells. Even dead shells can shelter marine life. Large, spectacular shells are often slow growing and soon become depleted from reefs if collected.

Stay off fragile coral reefs.

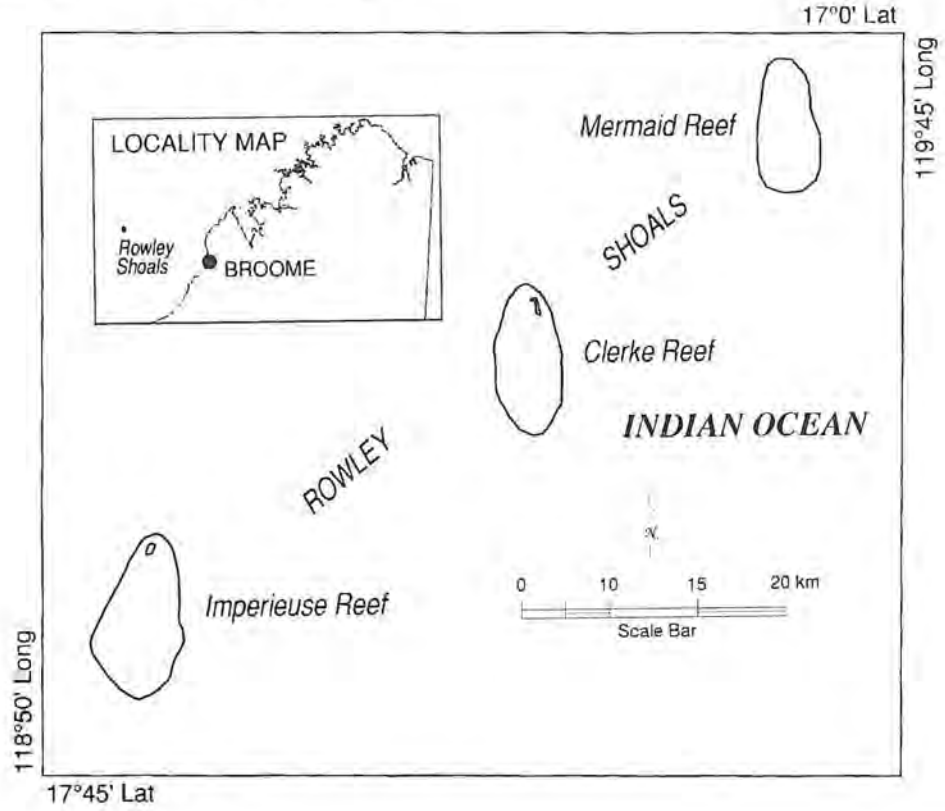
Fishing restrictions apply and are detailed in the licence conditions.

Anchorage areas and waste disposal requirements are outlined in the license conditions.

Use biodegradable products to reduce your impact on the marine environment.

Take all rubbish with you to the mainland.

Do not disturb birds on the islands. Many are resting on their migration between Australia and Asia and red-tailed tropic-birds may be nesting.



ABOUT THE ATOLLS

The atolls of the Rowley shoals are the best examples of atolls on the Australian continental shelf. Each consists of a perimeter coral reef enclosing a central lagoon with prolific growth of patch reefs. Several narrow passages pass through the perimeter reefs. All three atolls have a similar north-south orientation. Each is pear-shaped rising with near vertical sides in water about 500 metres deep, and with a rim of reef-flat that is exposed at low tide.

Mermaid Reef

Mermaid Reef is the most northeasterly of the atolls. Access to the lagoon, which is 20 metres deep at high tide, is through a 60 metre wide passage on the northeastern side. The back reef is covered with staghorn coral and the lagoon floor is uneven, with several coral bommies. There is no permanent land above high tide mark on Mermaid Reef.

Clerke Reef

Clerke reef lies 29 kilometres southwest of Mermaid reef. Gorgonians and soft corals are found on the lower sides of the ridges on the outer reef slope. Within the reef is a small sand cay, Bedwell Island. The lagoon system is more complex and shallower than Mermaid Reef. The deepest basin is no greater than 10m and connected to the sea by three narrow passages. This and an adjacent crest-shaped basin have numerous coral knolls and patch reefs that increase in number towards the south. The largest and shallowest basin contains many living coral pinnacles and extensive staghorn growth.

Imperieuse Reef

Imperieuse Reef is the largest and most southwesterly atoll. The passage connecting the lagoon to the sea is extremely narrow. Satellite imagery shows that its largest central basin appears to be infilling with extensive coral growth. Its small sandy island is called Cunningham Island.

Tidal range

The Shoals have an unusually high tidal range for oceanic islands. When the tide is low their reef flats stand like dam walls enclosing huge lakes, several metres above the surrounding sea. Water gushes from the passages in powerful torrents, like a fast-flowing river. At high tide the reefs disappear beneath the sea with only the sandy islands of Clerke and Imperieuse visible.

THE MARINE LIFE

The Rowley Shoals have been described as reservoirs of biodiversity. This remarkable area is known for its almost untouched coral gardens with over 200 species of corals, and almost 400 species of shellfish including giant clams. There are almost 700 species of fish, including large reef fish such as the potato cod and Maori wrasse that can live to a great age. They are plentiful, curious and fearless of divers. When scientists first visited the area they recorded several species completely new to science.

The coral and fish communities at Rowley Shoals are distinctive in composition and

relative abundance of species. The larvae of many of the species found at the Shoals have probably been carried down by warm currents from the biologically rich tropical areas to the north. Hence the marine life has similarities with that found in Indonesian waters. The clear oceanic waters are ideal for luxuriant coral growth.

Seagrass

Seagrass (*Thalassia hemprichii*) is found in the lagoons. Unlike seaweed, these plants bear flowers and even pollinate underwater by means of currents.

Birds

The red-tailed tropic-bird, recognised by its two long red tail streamers, nests on Bedwell Island, one of only two nesting sites in WA; the other is south of Busselton. Other seabirds including the crested tern and the ruddy turnstone use the islands from time to time. The sandy islands are also important resting places for flocks of migratory birds on route between Australia and Asia.

LOOKING BACK

Naming

The Shoals were named in 1818 by Captain Phillip Parker King. Mermaid Reef was named after his ship, and Clerke Reef after Captain Clerke, who had reported seeing it from a whaler sometime between 1800 and 1809. Imperieuse Reef was named after the vessel from which it was sighted by Captain Rowley in 1800.

Shipwrecks

There is a wreck at Mermaid Reef that is believed to be the Lively, a British whaler lost in the early nineteenth century.

Marine reserves

The two southern atolls, Clerke and Imperiuse Reefs, form the Rowley Shoals Marine Park declared in 1990 and managed by CALM. The northern-most atoll, Mermaid Reef, is not included in the Rowley Shoals Marine Park and is under Commonwealth jurisdiction because it is below sea level at high tide. This atoll has been protected under Commonwealth legislation and is known as the Mermaid Reef Marine National Nature Reserve. This reserve is the management responsibility of Environment Australia.

A memorandum of understanding between CALM and Environment Australia provides for consistent management of both the marine park and the nature reserve.

Recreational fishing activities within the Rowley Shoals Marine Park are managed by the Western Australian Fisheries Department and are not subject to CALM licensing requirements. Prohibitions exist on the taking of certain species of fish within the Rowley Shoals Marine Park, whereas all fishing is prohibited within the Mermaid Reef Marine National Nature Reserve.

Further Information

The Department of Conservation
and Land Management
West Kimberley District Office
Herbert St, Broome
PO Box 65
Broome 6725
Telephone (08) 9192 1036
Fax (08) 9193 5027

Further Reading

'The Rowley Shoals: Coral for Keeps'
Landscope Vol 10 No 1 (Spring 1994)

'Faunal Surveys of the Rowley Shoals, Scott Reef and Seringapatam Reef'
Records of the Western Australian Museum, Supplement No 25 1986

GUBINGE ROAD VINE THICKET, CABLE BEACH

Where: Part of Broome Coastal Park inland from Cable Beach, Broome. Access from the bend on Gubinge Road, proceeding south from the roundabout on Cable Beach Road.

Attractions/Significance: Southernmost rainforest vegetation patches in the Kimberley. Educational nature trail.

THINGS YOU NEED TO KNOW

Help to protect the vine thicket; fires are not permitted.

Camping is not permitted. Caravan Parks with camping areas are located nearby.

Help to keep the area clean; place your rubbish in the bins provided.

Plants, soil and wood are all part of the vine thicket community. Leave things as you find them for all to enjoy.

An easy nature trail winds through the vine thicket. Trailside signs help visitors get to know some of the rainforest plants

Access to Cable Beach is provided by a boardwalk crossing the dunes from near the intersection of Gubinge and DeMarchi roads.

ABOUT THE VINE THICKET

Kimberley rainforests

Small patches of tropical rainforest are scattered along the northwest coast north of Broome in a belt less than 150 kilometres wide. These rainforests are distinguished by a profusion of vines and plants which are found only in rainforest communities

The vine thicket

The Gubinge Road Vine Thicket in the shelter of the dunes behind Cable Beach is the southernmost stand of rainforest vegetation in the Kimberley. Fed by rainfall run-off from the pindan soils and water seeping out of the sand dunes, the vine thicket has a number of distinctive trees, shrubs and vines.

Trees

Many of the trees such as the coolamon or helicopter tree (*Gyrocarpus americanus*) are deciduous, losing their leaves during the winter dry season. Other common trees includes the shiny-leaved Marul tree (*Terminalia petiolaris*), whose purple-black fruit attract fruitbats, and the dark-leaved mangarr tree (*Pouteria sericea*), which bears edible purple, prune-like fruits.

Shrubs

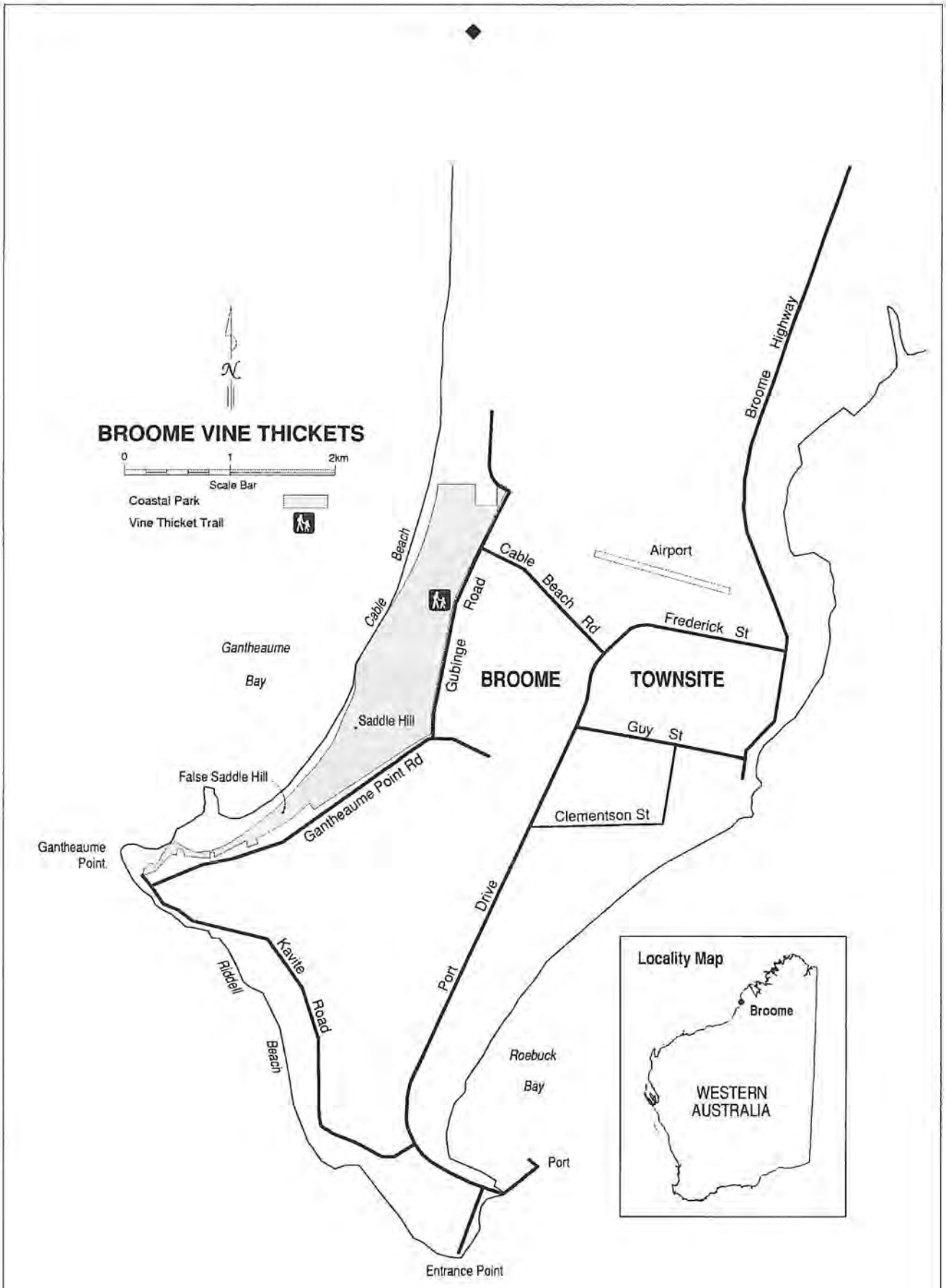
Shrubs include the mistletoe tree (*Exocarpos latifolius*), which is a root parasite needing a host tree to supply nutrients. It is also called the native cherry, because it bears an edible swollen fleshy, red receptacle to which a yellow fruit is attached. *Grewia breviflora* is recognised by its serrated leaves with three distinct longitudinal veins and small colourful yellow-orange flowers followed by globular black fruit. *Mallotus nesophilus* is a bushy plant with rounded leaves, white underneath, yellowish flowers and woody fruit capsules covered by a fine yellow powder.

Vines

Vines include the wild passionfruit (*Passiflora foetida*) and the sprawling shrubby caesalpinia vine (*Caesalpinia major*), which bears spine studded pods that contain large, hard, jade-green seeds when ripe. These are collected by great bowerbirds to adorn their bowers and by Aboriginal children to use as marbles. The crab's-eye bean (*Abrus precatorius*) is another vine with colourful seeds. Although used for decoration by Aboriginal people, the red and black seeds are extremely toxic. The scrambling bambilyee (*Capparis lasiantha*), produces large, delicate, white fragrant flowers. The pickled flower buds of its European relative are known as capers.

Gubinge trees

Near the vine thicket is a fine stand of gubinge trees (*Terminalia ferdinandiana*), also


BROOME VINE THICKETS
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Vine Thicket Trail
Broome Highway
Cable Beach Road
Airport
Frederick St
Gantheaume Bay
Gubinge Road
BROOME
TOWNSITE
Saddle Hill
Guy St
False Saddle Hill
Gantheaume Point Rd
Clementson St
Gantheaume Point
Drive
Kavite Road
Riddell Beach
Port
Roebuck Bay
Port
Entrance Point
Locality Map
Broome
WESTERN AUSTRALIA

called the billy goat plum, which gave Gubinge Road its name. Broad leaves crowded at the ends of the branches and grey flaky bark distinguish the gubinge trees. Their almond sized greenish fruit with a short beak at the tip appear in the wet season and are very high in Vitamin C.

A special place

Vine thickets are important refuges for many plants, birds and snails. The fruits of the rainforest trees and vines are eaten by many birds, such as the red-winged parrot and the great bowerbird, and by some mammals, dispersing the seeds. The vine thickets contain a high proportion of plants with edible fruits making them important seasonal food resources for Aboriginal people.

The Broome Botanical Society has campaigned for a number of years to preserve the vine thickets. A signposted nature trail developed by the Broome Botanical Society and CALM allows visitors to learn more about the plants of the vine thicket.

Further Information

Department of Conservation
and Land Management
West Kimberley District Office
Herbert St, Broome
PO Box 65
Broome 6725
Telephone (08) 9192 1036
Fax (08) 9193 5027

Broome Botanical Society
PO Box 780
Broome 6725
Telephone (08) 9192 2292

The fruit of the Gubinge Tree is very high in Vitamin C.

2.2

National parks and other places: North Kimberley

DRYSDALE RIVER NATIONAL PARK

Where: In the north Kimberley astride the Drysdale and Carson rivers about 150 kilometres west of Wyndham and 100 kilometres south of Kalumburu. The park can be approached from the Gibb River-Kalumburu road on station tracks across Theda Station and Carson River Station. However permission must be obtained before using these tracks.

Area: 448,264 hectares.

Gazetted: September 1974

Attractions/ Significance: The wilderness value of the park offers superb opportunities for bushwalking and nature observation.

THINGS YOU NEED TO KNOW

There are no visitor facilities and no marked walk trails within the park.

There are no designated camping areas in the park. Bush camping (non vehicle based) is permitted but please follow minimal impact practices and leave no trace of your visit.

For access via Theda contact Theda Station on (08) 9161 4329 and call in at the station homestead to register, obtain and pay for a permit. Visitors may camp on Theda Station with permission from the station. Camping fees are charged.

For access via Carson River Station contact Kalumburu Aboriginal Corporation on (08) 9161 4300 or Fax (08) 9161 4387 providing details of your intended visit. You will also need to call at the Kalumburu Aboriginal Community to obtain and pay for a permit before entering Carson River Station. Visitors may camp at Bulldust Yards on Carson River Station with the permission of Kalumburu Aboriginal Corporation. Camping fees are charged.

All visitors accessing Drysdale River National Park via Carson River Station must register with the Kununurra office of CALM. Please advise in person, by phone, fax or writing of proposed dates and itinerary in the park.

Food, fuel or mechanical services are not available at Carson River Station. Food and fuel are available from Kalumburu 20 kilometres north of the Carson River Station turn off.

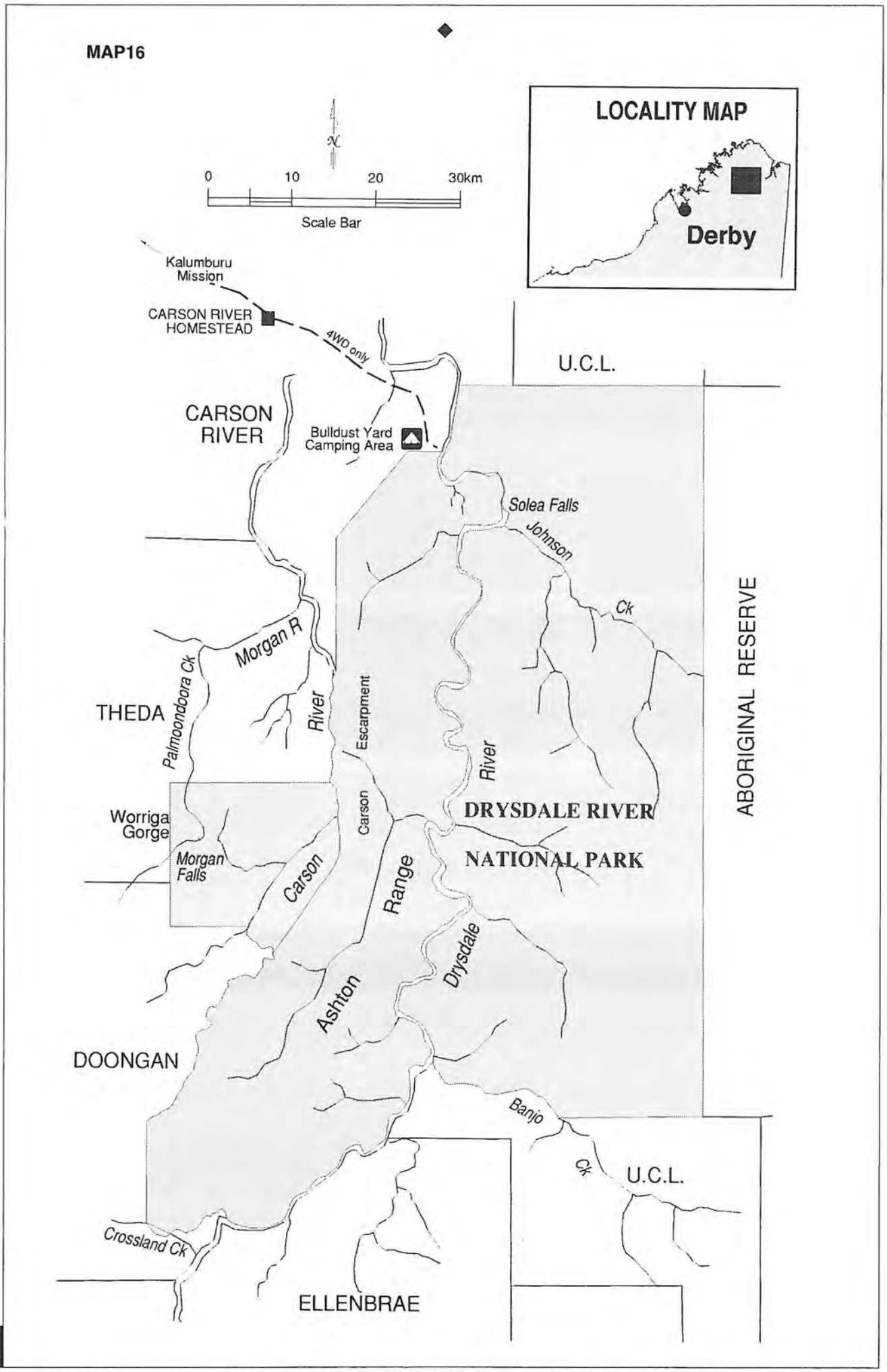
Food and mechanical services are available at Theda Station Telephone (08) 9161 4329.

Food, fuel and mechanical services are available from Drysdale River Station Telephone (08) 9161 4326.

Drysdale River National Park is remote, isolated and extremely rugged. Visitors planning extended walks should have bushwalking experience, be well prepared, carry topographical maps and be aware of the potential hazards that could be encountered.

Travel on roads and tracks other than major highways, during the wet season (Nov to April) is both hazardous and dangerous. Check road conditions with Main Roads Western Australia. Telephone 1800 013 314.

Saltwater crocodiles may inhabit the waters of the Drysdale River below Solea Falls. Do not swim and be wary near riverbanks. Camp well away from the river.


MAP16
LOCALITY MAP
Derby
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Scale Bar
Kalumburu Mission
CARSON RIVER HOMESTEAD
4WD only
U.C.L.
CARSON RIVER
Bulldust Yard Camping Area
Solea Falls
Johnson
Ck
ABORIGINAL RESERVE
Morgan R
Palmoondoora Ck
River
Escarpment
THEDA
Worriga Gorge
Morgan Falls
Carson
Carson
Range
River
DRYSDALE RIVER
NATIONAL PARK
Ashton
Drysdale
DOONGAN
Banjo
Ck
U.C.L.
Crossland Ck
ELLENBRAE

CARING FOR DRYSDALE RIVER NATIONAL PARK

Help to preserve this wilderness area by taking all rubbish out with you.

Fires are only permitted for the purpose of cooking. Dead wood is an important ecological resource in the Kimberley. Please keep your campfires small and use wood sparingly. Use fuel stoves wherever possible.

As no toilets are provided, all human waste and toilet paper is to be buried. Dig a hole at least 15 centimetres deep, and at least 100m away from watercourses and campsites.

Wash well away from rivers and creeks to avoid polluting the water.

Aboriginal sites are of special significance to Aboriginal people and are protected by law. Help to conserve rock art sites; do not touch paintings or engravings and do not remove artefacts.

THE LANDSCAPE

The Kimberley Basin

The park occupies part of an area known as the Kimberley Basin where about 1800 million years ago during Precambrian times a thick sequence of layered sedimentary rock was deposited on a slowly subsiding large continental land mass. A basin is a low area in the earth's crust where sediments have accumulated.

King Leopold sandstone

The oldest layers are a white and pink quartz sandstone named 'King Leopold sandstone' by geologists. This sandstone is found in the extreme west of the park and forms an extremely rugged, very dissected area featuring numerous gorges and waterfalls including Worriga Gorge and Morgan Falls.

Carson volcanics

Volcanic rock was extruded over this sandstone over a wide area. The resulting basalt rock, known as 'Carson volcanics' by geologists, is found in the west of the park. It forms an area of low undulating rocky plains and rounded hills such as the Gattenhof and Coodimirrie hills.

Warton and Pentecost sandstones

Sedimentary rocks were laid down over these basalts forming layers of quartz sandstone named 'Warton sandstone' and 'Pentecost sandstone' by geologists. Occupying most of the park, they form a succession of escarpments and dip slopes such as the Ashton range and the Tadarida escarpment.

The Carson escarpment

Erosion of the basalt rock of the Carson volcanics at its junction with the harder Warton sandstone has formed the Carson escarpment, a major feature of the park.

Rivers and waterfalls

The park is drained mainly by the Drysdale River, while the Carson River drains the western section. Solea Falls is a major waterfall on the Drysdale River; Morgan Falls are found on Palmoondoora Creek.

THE PLANTS

Biological surveys of the park have recorded almost 600 plant species. The vegetation is predominantly open woodland and savannah but tall trees fringe the major rivers and creeks. There are small pockets of rainforest along the Carson Escarpment and in some gorges.

Ferns and orchids

In the shaded gorges and rainforest pockets 25 different ferns have been found, two of which have not been recorded anywhere else in Western Australia. A tree orchid, *Dendrobium affine*, is also common in wetter areas.

Woodlands

The woodlands are dominated by eucalypts. On sandstone the woollybutt (*Eucalyptus miniata*) and the stringybark (*Eucalyptus tetrodonta*) predominate. The Darwin box (*Eucalyptus tectifica*) is common on basalt. Many

shrubs, grasses and herbs make up the understorey. The northern cypress pine (*Callitris intratropica*) is found scattered throughout the park and in a few areas forms small dense stands.

Rivers and swamps

Melaleucas, commonly called paperbarks are the dominant trees along rivers and creeks. However the cluster fig (*Ficus racemosa*) and the Leichhardt pine (*Nauclea orientalis*), both of which bear edible fruits, can also be found here. Many thickets of pandanus are found along the major rivers.

In and around water are many aquatic and swamp plants. Waterlilies include the water snowflake (*Nymphoides indica*), with its delicate white flowers with fringed petals, the giant waterlily (*Nymphaea gigantea*), which bears large blue to white flowers, and the rare *Nymphoides minima* named for its tiny leaves. Swamp plants include a number of bladderworts (*Utricularia* sp) and trigger plants (*Stylidium* sp).

Uncommon plants

Most plants are typical of the region; however, there are unusual species as well. The *Livistona loriphylla* palm found only in the north Kimberley, is common in parts of the Park.

Some of the uncommon plants include species better known from other tropical places than the Kimberley. The true kapok tree (*Bombax ceiba*) bears pods whose woolly seed covering has been used for stuffing mattresses and pillows. The taro (*Colocasia esculenta*), a staple food on many Pacific Islands, was also used as food by Aboriginal people. It grows submerged in or at the edge of watercourses and the roots must be thoroughly cooked to destroy toxins before eating.

THE ANIMALS

Bats

Of the 26 species of native mammals recorded in the park, half are bats. Large colonies of fruit bats, both the little red and the black flying-foxes, are found along the Drysdale River. A rare and little known inhabitant of the park is the pygmy long-eared bat, known outside the park from only the Mitchell Plateau and two locations in the Northern Territory. One of Australia's smallest bats, only a few centimetres long and weighing less than five grams, it appears to be associated with watercourses.

Other mammals

Larger mammals include the short-eared rock-wallaby, at home in rugged sandstone boulder country. The agile wallaby prefers the open woodlands. The common wallaroo or euro uses rocky overhangs to shelter during the day, moving in the cool of evening to graze in the woodlands. The echidna can also be found in the rugged sandstone country.

Smaller marsupials include the sugar glider and the common planigale, a ferocious carnivore, albeit of a tiny size. There are several species of native mice and rats including the water rat, the common rock-rat and the Kimberley mouse.

Birds

Over 130 species of birds have been reported including semi-arid species such as the crested pigeon and masked finch. Some of the less common species recorded in the park include the grey falcon, the peregrine falcon and the Gouldian finch.

The large permanent pools of the Drysdale River with their pandanus thickets provide a suitable home for the purple-crowned fairy-wren. The wrens seldom venture beyond the narrow strip of riverine vegetation that provides them with everything they need. When a flood comes down the river temporarily covering their habitat, the wrens take refuge in the canopies of the riverside paperbarks rather than move into open woodland.

Other creatures

Frogs (13 species) and reptiles (47 species) are plentiful, while the freshwater fish fauna of the park is diverse with 26 species recorded.

LOOKING BACK

Aboriginal people have occupied the North Kimberley for thousands of years and evidence of their use of the Drysdale River area can be found at sites throughout the park. The Wilawila people were thought to be the principal users of the area now covered by the park and the Drysdale River provided many resources to support them.

Bradshaw figures

Some archaeologists propose that it may be an even earlier race of people who were responsible for the many fine examples of rock art of the Bradshaw style that are found in the park. Found in the north and west Kimberley, Bradshaw figures are usually small, red human figures shown dancing and hunting, and closely resemble the style of the Mimi figures of the Northern Territory. Great attention is paid to dress and ornaments; elongated headdresses and weapons are carefully depicted. They are named after Joseph Bradshaw, who led an expedition in 1891 into unknown tracts of the West Kimberley looking for grazing land. He discovered and described the rock paintings of this unusual style.

Bradshaw paintings survive as a stain on hard sandstone surfaces with no trace of surface pigment, suggesting that they are very old. Interestingly, until recently present day Aboriginal people have claimed no association with the Bradshaw paintings and some have described them as 'rubbish paintings'. Some Kalumburu people claim they were painted by a small bird that lives amongst the rocks.

Exploration

Late last century Europeans came into the area. In 1886, C. A. Burrowes, a surveyor for the Victorian Squatting Company, named the Drysdale and Carson rivers after J. A. Drysdale and David Carson who were also involved with the company. The area was visited by the Brockman Exploring Expedition in 1901, and in 1903 by the surveyor A. H. Salmond.

The first vehicle track from Gibb River station to Kalumburu was constructed by the North Kimberley Survey and Mapping Expedition in 1954 while conducting detailed surveys of the area. The surveyor, J. S. Morgan, made a proposal for a reserve in the area and the falls on Palmoondoora Creek, discovered by the expedition, were given his name.

A national park

The Drysdale River National Park was gazetted in 1974 and a biological survey was carried out the following year. The survey team applied to name various physical features in the park. When attempts to obtain local Aboriginal names were unsuccessful, biological names were suggested. Thus many names within the park reflect the fauna and flora that can be found there: eg Glider Gorge, Petrogale Gorge, named for the rock wallaby, and Petrophassa Creek, named for the white-quilled rock-pigeon.

Further Information

The Department of Conservation
and Land Management
East Kimberley District Office
Messmate Way, Kununurra
PO Box 942
Kununurra 6743
Telephone (08) 9168 4200
Fax (08) 9168 2179

Bradshaw paintings

Further Reading

'A Biological Survey of the Drysdale River National Park North Kimberley in August, 1975'
Wildlife Research Bulletin No 6
Western Australian Wildlife Research Centre, Department of Fisheries and Wildlife

'Report on Central North Kimberley Region' North Kimberley Survey and Mapping Expedition, 1954
Western Australia Department of Lands and Survey

MITCHELL FALLS

Where: Onthe Mitchell River 350 kilometres northeast of Derby and 270 kilometres northwest of Wyndham. Access via the Mitchell Plateau track from the Kalumburu to Gibb River road, 172 kilometres north of the Gibb River road junction and 95 kilometres south of Kalumburu.

Area: The Mitchell Plateau occupies an area of approximately 220,000 hectares.

Attractions/Significance: Scenic plateau, with spectacular Mitchell Falls, and tranquil Surveyor's Pool.

THINGS YOU NEED TO KNOW

The track to Mitchell Falls is negotiable by four-wheel-drive vehicles only. The track is maintained on an irregular basis only and may have wash-outs and corrugations. Drive with extreme care.

Travel on tracks and roads other than major highways during the wet season (Nov to April) is both hazardous and dangerous. Check road conditions with Main Roads Western Australia, telephone 1800 013 314 or the Shire of Wyndham-East Kimberley, telephone (08) 9168 1677 .

Tracks north of the Mitchell Plateau airfield are rough while tracks north of Surveyor's Pool are very rough and may be impassable.

Visitors to the Mitchell Falls area should be totally self-sufficient as this is a remote area with few facilities.

Throughout the dry season, fuel, food and mechanical repairs are available from Drysdale River Station. Telephone (08) 9161 4326.

Food and mechanical services are available at Theda station Telephone (08) 9161 4329

Fuel and food are also available from Kalumburu.

Please respect the privacy of Aboriginal communities. There are no services available to the general public.

There is a camping area with toilets at the end of the Mitchell Falls Track. A ranger is based at the camping area from May to October.

Do not leave food or rubbish unattended where animals can scavenge.

It is advisable to boil or treat water taken from creeks before drinking.

Scenic flights are available over the falls and coastline from Kununurra, and during the dry season from Drysdale River Station.

Air charter companies fly to Mitchell Plateau airstrip. During the dry season helicopter flights and ground tours are available. Bookings and details are available from local tourist bureaus and travel agents.

CARING FOR MITCHELL FALLS

Please stay on roads, tracks and trails and camp only at designated camping areas.

Help to keep this remote environment clean; please take your rubbish with you.

Use fuel stoves wherever possible. Dead wood is an important ecological resource in the Kimberley. Collect firewood only from the designated firewood collection zones. Please keep campfires small and use wood sparingly.

Where no toilets are provided, all human waste and toilet paper is to be buried. Dig a hole at least 15 centimetres deep and at least 100m from watercourses and campsites.

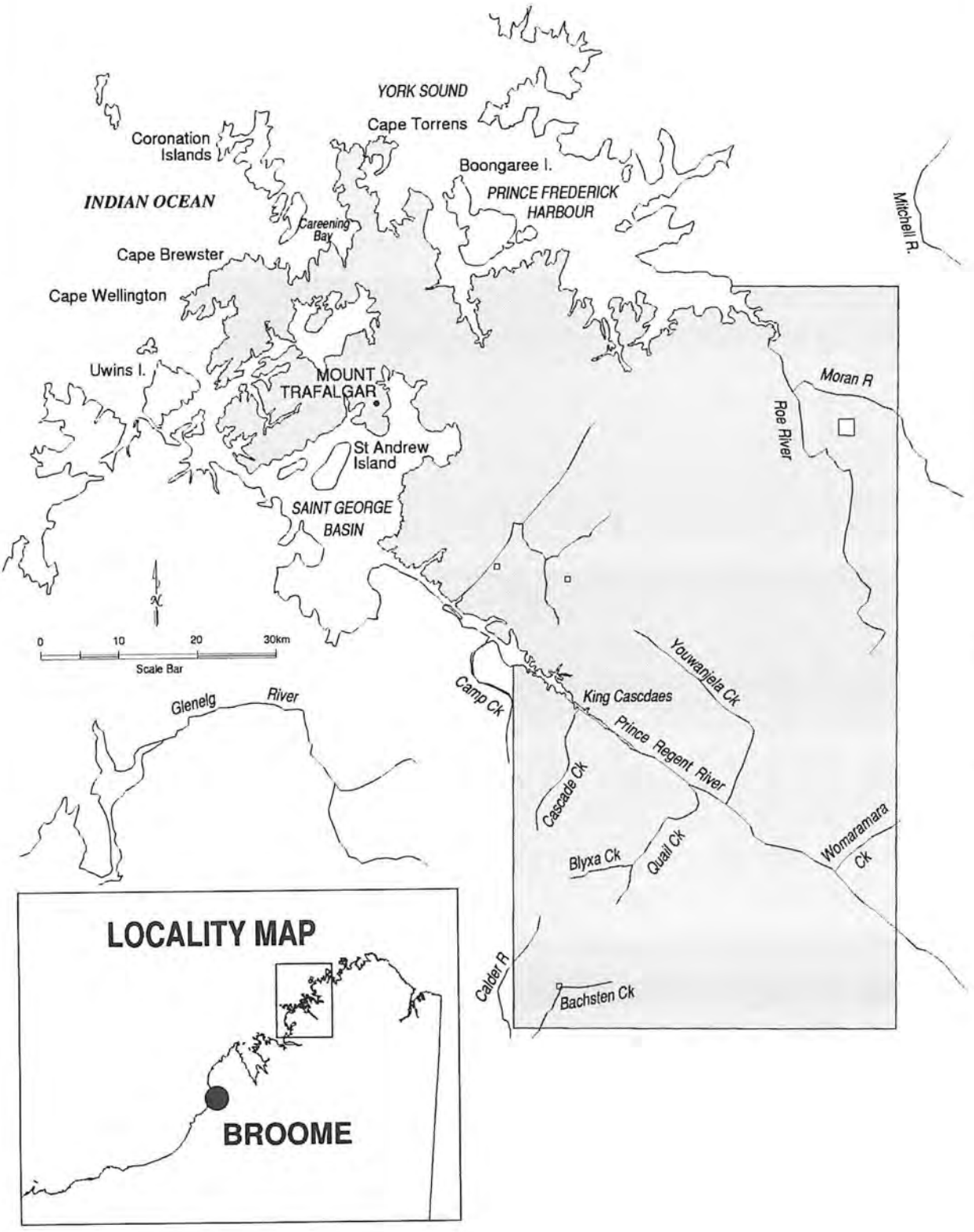
Wash well away from creeks and waterholes to avoid polluting the water. Avoid contaminating waterways with soap or sunscreen.

Aboriginal sites are of special significance to Aboriginal people and are protected by law. Help to conserve rock art sites; do not touch paintings or engravings and do not remove artefacts.

THINGS TO DO

The six kilometre return walk to Mitchell Falls from the camping area is moderate to difficult as it traverses rocky terrain. Take care near the many cliffs. The track to Mitchell Falls continues past Little Mertens Falls (approximately 500 metres from the camping area) and Big Mertens Falls (approximately 2.5 km from the camping area).

It is an easy to moderate eight kilometre return walk to Surveyor's Pool from the


YORK SOUND
Cape Torrens
Coronation Islands
Boongaree I.
PRINCE FREDERICK HARBOUR
INDIAN OCEAN
Careening Bay
Cape Brewster
Cape Wellington
Uwins I.
MOUNT TRAFALGAR
St Andrew Island
SAINT GEORGE BASIN
Mitchell R.
Moran R
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Youwanjela Ck
Camp Ck
King Cascdaes
Prince Regent River
Glenelg River
Cascade Ck
Blyxa Ck
Quail Ck
Womaramara Ck
Calder R
Bachsten Ck
LOCALITY MAP
BROOME

Surveyor's Pool car park. Surveyor's Pool is a tranquil pool surrounded by white bluffs of King Leopold sandstone.

During the dry season helicopter flights are available over Mitchell Falls and the nearby scenic coastline. For details contact Heliwork on (08) 9168 1811.

THE LANDSCAPE

The Kimberley Basin

The Mitchell Plateau is the remains of an elevated laterite capped plain. It occupies part of an area known as the Kimberley Basin where about 1800 million years ago in Precambrian times a thick sequence of layered sedimentary rock was deposited on a slowly subsiding large continental mass. A basin is a low area in the earth's crust where sediments have accumulated.

King Leopold Sandstone

The oldest layers are a white and pink quartz sandstone named 'King Leopold Sndstone' by geologists. This sandstone is found today on the lower lying areas either side of the plateau around the Mitchell and Lawley Rivers. This extremely rough terrain is dominated by ridges of block-like sandstone boulders and narrow steep sided gorges formed along major joints such as at Mitchell Falls and Surveyor's Pool.

Carson Volcanics

Volcanic rock was extruded over the King Leopold Sandstone in a wide area. The resulting dark, fine-grained basalt rock known by geologists as 'Carson Volcanics' underlies the Mitchell Plateau area.

Laterization

Between 70 and 50 million years ago, the surface of the basalt has undergone a weathering process under tropical conditions, which is called laterization. High humidity and rainfall leach elements such as potassium, sodium, magnesium and calcium from the rock. A highly weathered material called laterite results. It may be rich in either iron or aluminium oxides, or both. On Mitchell Plateau the laterite is rich in aluminium, and is called bauxite. A three to 15 metre thick layer of this bauxite deposit forms the Mitchell Plateau. The surface of the plateau is undulating and strewn with laterite boulders. A steep escarpment at least five metres high forms the edge of the plateau. Streams have eroded into this escarpment and below the vertical cliff faces are steep scree slopes. Much of the bauxite laterite contains sufficient aluminium to make it commercially valuable.

THE PLANTS

Over 640 different species of plants have been recorded in the vicinity of Mitchell Falls. The landscape varies from mangroves and swamps, to woodlands and lush rainforest patches, accounting for the diversity and richness of the wildlife.

Fan palms

One of the most conspicuous plants of the Mitchell Plateau is the Mitchell Plateau fan palm (*Livistona eastonii*) which thrives on the lateritic soils and is restricted to the plateau and a smaller area on Doongan Station. Growing up to a height of 18m, some palms have been estimated to be up to 280 years old. The growing shoot was considered an important food by Aboriginal people.

Mitchell Plateau Fan Palms

Woodlands

The Mitchell Plateau fan palm forms an understorey to a woodland of woollybutt (*Eucalyptus miniata*), recognised by its smooth white upper trunk and fibrous brown stocking at its base, and the stringybark (*Eucalyptus tetrodonta*), recognised by its rough, grey bark and small nuts with four teeth-like projections. The Melville Island bloodwood (*Corymbia* [formerly *Eucalyptus*] *nesophilia*), known elsewhere only from Bathurst Island and Cobourg Peninsula in the Northern Territory, and Cape York Peninsula, is found in the woodland of the plateau.

The Darwin box (*Eucalyptus tectifica*), with rough grey bark and drooping, narrow-leaved foliage, is common on basalt soils around the plateau. Various acacias and grevilleas form the understorey with tall grasses such as annual sorghum or canegrass.

On the rugged sandstone country trees become sparse and not as tall. The many stemmed Kalumburu gum (*Eucalyptus herbertiana*), with smooth white bark, is found along with a variety of small trees such as acacias, gardenias, and terminalias. The Kimberley heather or turkey bush (*Calytrix exstipulata*), which bears massed, pink, star-shaped flowers in the dry, is common along with spinifex. The bridal tree (*Xanthostemon paradoxus*), with a prominent, yellowish midvein on its large leaves and bright yellow flowers, also grows on the rocky slopes.

Cycads

Palm-like cycads are common in some areas on the plateau. *Cycas lane-poolei*, with light green leaves, is found in a wet swampy area on the southern edge while *Cycas basaltica*, endemic to the Kimberley, with dark green leaves, is found on the northern, eastern and southern slopes on basalt soils.

Rainforest

On rocky scree slopes around the edges of the plateau and along the coast, and in gorges of the sandstone country, small pockets of rainforest are found. The plants growing here maybe protected from fires by the landforms around them and they may receive more soil moisture in the shaded gorges and from seepage on the scree slopes. In these thickets are a large number of rainforest species. Mitchell Plateau has some of the richest rainforest pockets to be found in WA.

Some of the rainforest plants found here are better known from tropical Asia. The Indian sirus tree (*Albizia lebbeck*), known locally as the rain tree, is widely cultivated and has fern-like leaves and cream flowers followed by long flat pods which remain on the tree for some time after ripening. The kapok tree (*Bombax ceiba*), bears large red flowers when the tree is leafless, which are followed by pods whose woolly seed covering has been used for stuffing mattresses and pillows.

Many of the rainforest trees produce edible fruits, which were sought after by Aboriginal people. The pouteria (*Pouteria sericea*), with leaves dark green above and pale below, bears edible purple, prune-like fruits with speckled seeds resembling birds eggs. The celtis (*Celtis philippinensis*) has brittle leaves with three prominent veins and small edible fleshy red fruits.

Vines scramble over rocks and trees often making the rainforest impenetrable. They include the long yam (*Dioscorea transversa*), whose tuber tasting similar to sweet potato was much sought after by Aboriginal people, and the smilax vine (*Smilax australis*), a vigorous climber with clusters of edible purple-black fleshy berries. The crab's-eye bean (*Abrus precatorius*) bears purple, pea-like flowers followed by pods with decorative red and black seeds which are highly toxic.

Rivers and swamps

Some of these rainforest plants are also found growing beside rivers along with paperbarks (*Melaleuca leucadendra*). Pandanus borders permanent pools and flowing creeks. Low paperbark forests of *Melaleuca leucadendra* also fringe the occasional swamps found on the plateau. In damp areas various trigger plants (*Stylidium* sp), tiny plants with delicate white, pink or mauve flowers, and bladderworts (*Utricularia* sp) grow. Bladderworts are carnivorous plants with no leaves. They trap and eat tiny, aquatic organisms with the minute feeding bladders on their stems.

A rare relative of the waterlilies, endemic to the northwest Kimberley, *Ondinea purpurea* is found in streams in the area. It has both submerged and floating leaves and bears a single pink flower. Ferns are common in shaded gorges and on wet cliffs such as at Surveyor's Pool. Twenty-three types of fern are known from the Mitchell Falls area.

Mangroves

Mangrove communities are found in the Lawley and Mitchell River estuaries and along the coastline of Admiralty Gulf. Fourteen species of mangrove have been recognised in the Mitchell Plateau area. The red mangrove (*Rhizophora stylosa*), with long, arching, air-filled stilt roots, forms a low, often impenetrable forest in the central area of larger communities. The white mangrove (*Avicennia marina*), with smooth, white bark, and the pornupan (*Sonneratia alba*), with brown slightly flaky bark, are found on the seaward edge. Both have air-filled pneumatophores rising up through the mud from their roots allowing them to survive the waterlogging of the incoming tides. The white mangrove has pencil-like pneumatophores while those of the pornupan are cone-shaped. The white mangrove is also found on the landward edge of the mangrove communities along with the yellow mangrove (*Ceriops tagal*), which is recognised by its buttressed stem and yellowish leaves.

THE ANIMALS

The wide diversity of habitats, including many rainforest patches, and the longer wet season make the Mitchell Falls one of the most important areas for wildlife in the Kimberley. As grazing by domestic stock in the area is quite recent compared with other parts of the Kimberley, there has been relatively little degradation of wildlife habitats. Over 40 mammals are known from the area, but it is possible that as many as 50 of the 64 mammals reported from the Kimberley are found here.

Wallaroos and wallabies

The antilopine wallaroo is common on the plateau. The agile wallaby is found in woodland surrounding the plateau, while the common wallaroo inhabits rocky areas. The rugged King Leopold sandstones are home to the short-eared rock-wallaby and the rare monjon, the smallest of the rock-wallabies, found only in the northwest Kimberley.

Possums

The northern brushtail possum and the sugar glider are found in woodlands, while the rare and little known scaly-tailed possum inhabits rugged sandstone. Endemic to the Kimberley, the scaly-tailed possum lives deep in rock-piles during the day, emerging only at night to feed on blossoms and fruits in the trees. This species is of great zoological interest because it is the only member of its genus and it resembles both the brushtail possums and the cuscuses.

Carnivores

Several small carnivorous marsupials which have been recorded from few other locations in the Kimberley are known from the Mitchell Falls area. These include the red-cheeked dunnart, Butler's dunnart and the common planigale. The northern quoll has often been found there.

Rodents

Nine rodents are known including the fawn-footed melomys. An unusual animal for the Kimberley, and better known from Queensland, it is restricted to the rainforest pockets. The Kimberley rock-rat and the common rock-rat are found on sandstone areas. Uncommon rodents include the brush-tailed tree-rat and the golden-backed tree-rat, both of which forage in trees as well as on the ground.

Bats

The many caves and crevices in the sandstone country provide homes for many types of bats. Several rare bats are found such as the yellow-lipped bat and the yellow-bellied sheathtail bat. The ghost bat, Australia's only carnivorous bat, preys on frogs, lizards, small birds and mammals, and even other bats. The little known pygmy long-eared bat is known outside the region only from Drysdale River National Park and two locations in the

Northern Territory. It is one of Australia's smallest bats, only a few centimetres long and weighing less than five grams. The coastal mangroves are important for the northern blossom-bat, which feeds on nectar and pollen.

Reptiles and frogs

Over 90 species of reptiles and amphibians are known from the Mitchell Falls area. Some are restricted to the rugged sandstone areas around the plateau. These include the cave dwelling frog, which closely resembles the green tree frog except for its brown colour, the rough scaled python, and several geckoes and dragon lizards. The taipan, Australia's most dangerous snake because of its large size, large fangs and toxic venom, is found in the area, as is the venomous king brown or mulga snake.

Aquatic creatures

Twenty-one species of fish have been recorded from creeks and rivers draining the plateau including archerfish, rainbowfish, glassfish, gudgeons and grunters. Freshwater eels and the northern snake-necked turtle are also found. Many types of molluscs have been found in Admiralty Gulf.

Birds

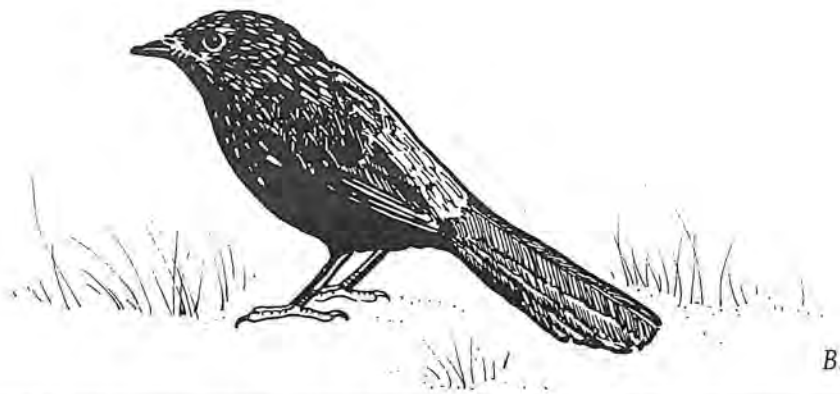
The varied habitats of the Mitchell Falls area support over 200 species of birds including a number of uncommon species such as the pacific baza or crested hawk, the rufous owl, and the Gouldian finch.

The Australian bustard, the northern rosella, the striated pardalote and the pied butcherbird are common on the laterite plateau. The rugged King Leopold sandstone areas support the white-quilled rock-pigeon, the sandstone shrike-thrush and the variegated fairy-wren. The rare black grasswren is endemic to sandstone habitats in the wet northwest Kimberley. Foraging in groups, these dark, thickset birds could be mistaken for rats as they scurry over rocks.

The open woodlands surrounding the plateau support wide ranging species such as the brown quail, the red-backed fairy-wren and the little friarbird. Lorrikeets and honeyeaters such as the banded honeyeater, the yellow-fronted honeyeater and the black-chinned honeyeater wander over a wide area in search of flowering trees and shrubs. In the denser vegetation along rivers, the white-browed robin, and the rufous fantail, birds uncommon in the Kimberley, may be seen, along with the more common northern fantail and the leaden flycatcher.

The orange-footed scrubfowl, the rainbow pitta and the cicada bird are confined to rainforest patches. Also found here are fruit eating birds such as the Torres Strait imperial pigeon, the emerald ground-dove, the figbird, the yellow oriole and the common koel. As they move over large areas in search of food they are probably instrumental in the establishment of new rainforest pockets by depositing seeds.

A number of birds are dependent on the mangrove communities. These include the mangrove gerygone, the mangrove heron, the mangrove robin and the red-headed honeyeater. At least 20 species of waders and terns have been noted around the mangroves and on mudflats.



Black Grasswren

LOOKING BACK

Coastal people

The Mitchell Plateau and adjoining coastal area was inhabited by the Woonambal and Gamberre Aboriginal people for thousands of years. The coastal area offered a diversity of resources. Fish, dugong and turtles were the principal game and birds and eggs supplemented their diet. The mangroves and tidal mudflats provided many shellfish the evidence of which can still be seen today in the extensive shell middens dotting the coastline. Swamps and rivers were rich in plant foods such as roots, and rainforest trees supplied a variety of fruits.

Voyages to the offshore islands were made in simple dugout canoes and rafts and required skilled seamanship, using the tides and winds to their best advantage. Most of these small islands had no permanent freshwater so journeys were normally made during the wet season. While on these islands the men often performed ceremonies that were not to be seen by women and children, who were left on the mainland.

Since moving to Kalumburu Mission in the 1950s, local Aboriginal people have continued to visit the area and in the last few years have established a community there.

Macassans

Macassan fisherman are thought to have plied the northwest coastline well before the coming of Europeans, collecting beche de mer, turtles and shells. However, these early Indonesian visitors did not attempt to colonise the area.

Explorers

In 1819 Phillip Parker King entered Admiralty Gulf in the Mermaid and anchored in a harbour which he named Port Warrender. William Easton is believed to be the first European to traverse the Plateau in 1921 when he led a State Government Expedition into the North Kimberley. He named the Mitchell River after Sir James Mitchell, the Premier of WA at the time.

In 1954, John Morgan surveyed a route from Gibb River Station to the Kalumburu Aboriginal Mission. This survey provided the basis for the road to Kalumburu and subsequently to the Mitchell Plateau.

Mining

A mining camp was established in 1965 by AMAX Bauxite following the discovery of potentially commercial deposits of bauxite. Ken Malcolm, who led the exploratory team, named the Plateau after the Mitchell River which adjoins it. In 1971 the government recognised the significance of the bauxite resources and ratified an Agreement Act that allows the conservation, mining and recreational values of the plateau to be managed. In 1979 the mining rights covered by this Agreement were acquired by the Mitchell Plateau Bauxite Company.

Conservation

Four areas have been proposed as conservation reserves. A large area of land around the Mitchell River, including Mitchell Falls and Surveyor's Pool has been proposed for the Mitchell River National Park. Along with an area around the Hunter River, this proposed park would adjoin Prince Regent Nature Reserve.

An area around the lower reaches of the Lawley River has been proposed as the Lawley River National Park to protect the Lawley River estuary and the associated mangroves and mudflats. A small area along Camp Creek has been proposed as the Camp Creek Conservation Reserve to protect several small rainforest pockets, which are subject to long-term monitoring. A small section of the laterite plateau has been proposed as the Laterite Conservation Reserve to protect a representative sample of the livistona palm (*Livistona eastonii*) woodland and a fine stand of the cycad (*Cycas lane-poolei*).

The Mitchell Plateau and Lawley River area has recently been listed on the Register of the National Estate.

Further Information

The Department of Conservation
and Land Management
East Kimberley District Office
Messmate Way
PO Box 942
Kununurra
Telephone (08) 9168 4200
Fax (08) 9168 2179

Further Reading

Biological Survey of the Mitchell Plateau and Admiralty Gulf, Kimberley, WA
Western Australian Museum

'Rainforests and Bats'
Landscope Vol 9 No 1 Spring 1993

2.3

National parks and other places: East Kimberley

PURNULULU NATIONAL PARK

Where: About 160 kilometres south of Kununurra and 100 kilometres northeast of Halls Creek by air. Vehicle access from the Great Northern highway is signposted 250 kilometres south of Kununurra (50 kilometres south of Warmun) or 109 kilometres north of Halls Creek. From the Highway, the 55 kilometre Spring Creek Track, suitable for four wheel drive vehicles only, leads to the Three Ways Junction in the park.

Area: National Park: 239,723 hectares

Conservation Reserve: 79,602 hectares

Bungle Bungle Range: 45,000 hectares (approximate).

Gazetted: March 1987

Attractions/Significance: Eroded sandstone plateau with striking 'Bungle Bungle' formations, spectacular gorges and scenery.

THINGS YOU NEED TO KNOW

The park is closed to vehicles over the wet season, from January 1 to March 31 each year. At this time roads and tracks may be impassable and are extremely susceptible to damage from vehicle use. In addition, unseasonal rains at other times may result in temporary closure of the park.

Contact the Kununurra office for information about aerial access to the park for day trips and remote camping and walking during the wet season.

Spring Creek track leading into the park is only suitable for four wheel drive vehicles with good clearance. Caravans won't survive the trip in. Specially constructed off-road trailers may be suitable. It can take up to three hours to travel the 55 kilometres into the park.

The first 30 kilometres of Spring Creek track runs through Mabel Downs Station. Camping on the station lease requires the consent of the station manager. Write to PO Box 618, Kununurra, 6743 or telephone (08) 9167 8860.

Food, fuel and mechanical services are not available in the park. The nearest petrol and other supplies are at Warmun (100 kilometres northwest) and Halls Creek (160 kilometres southwest).

Entry and camping fees apply. Please pay your fees at the self registration bay at the visitor centre in the park.

There are camping areas at Kurrajong and Walardi. Toilets, water, fireplaces and firewood are provided. There are no showers. Each has separate zones for commercial groups, campers who wish to use generators and campers who prefer quiet. It is advisable to boil or treat water before drinking.

Toilets are also provided at the carparks at Echidna Chasm, Piccaninny Gorge, Frog Hole/ Mini Palms and at the airstrip.

Bellburn camping area has been set aside for licensed Fly/Drive Operators.

Tour operators conduct four wheel drive safari-type tours into the park. Fly/drive tours are also available. Bookings and details are

available from local tourist bureaus and travel agents.

CARING FOR PURNULULU

To prevent soil erosion and damage to vegetation, please stay on roads and tracks marked on the map.

It is recommended that vehicles be engaged in four wheel drive at all times to help reduce damage to tracks and roads within the park.

Camping is permitted only at the established camping areas to minimise the impact on this fragile environment.

Keep the park clean; please take your rubbish with you. There is no rubbish collection or disposal site in the park. There are rubbish disposal pits at Warmun, Halls Creek and Kununurra.

Please use gas stoves for cooking. Fires may be lit only in the fireplaces provided. Use only the wood supplied as dead wood plays a significant role in the ecological balance in the Park.

Rocks, plants, wood, soil, animals and artefacts are all part of the park. Leave things as you find them for all to enjoy. Do not climb on the rock formations as they are easily broken and eroded.

Aboriginal sites are of special significance to Aboriginal people and are protected by law. Refrain from touching paintings as it causes them to deteriorate.

Pets and firearms are not permitted in the park.

PURNULULU WALKS

For your safety take adequate water with you when walking. At least four litres for each person each day is recommended. Water is available at the camping areas but should be boiled or treated for drinking.

The walk into Echidna Chasm is an easy to moderate two kilometre return walk with some large boulders to be scrambled over. Direct sunlight only enters this narrow chasm around midday. Livistona palms and ferns contrast with the rugged landscape. Allow 1 to 2 hours.

The 1.5 kilometre return walk into Frog Hole is moderate to hard with a sheer, usually dry, waterfall at the end of the gorge. Allow 1 to 2 hours.

The five kilometre return Mini Palms trail is easy at the start but progressively becomes more difficult. The trail leads to a scenic amphitheatre with many young Livistona palms. Allow 3 hours.

The easy 500m return walk to Walanginjdji Lookout provides views of the western side of the Bungle Bungle Range, the limestone ridge, and the distant Osmand Range. Allow 30 minutes.

The easy to moderate two kilometre return walk to Cathedral Gorge passes the dome formations on the way to a pool at the end of a spectacular gorge. *Grevillea psilantha*, endemic to Purnululu is found on the walls of this gorge and the white-quilled rock-pigeon is often seen in the area. Allow 1 to 2 hours.

The 30 kilometre return walk up Piccaninny Creek into Piccaninny Gorge is moderate to difficult and requires overnight camping. Bushwalkers planning to camp overnight in Piccaninny Gorge should register with the ranger before setting out and on their return. It is advisable to carry plenty of water and to take a fuel stove for cooking, as campfires are not permitted. The creek derives its name from Aboriginal mythology in which the domes are regarded as babies of the Bungle Bungle range. The white rocky creek bed and sheer cliff walls combine to form inspiring scenery.

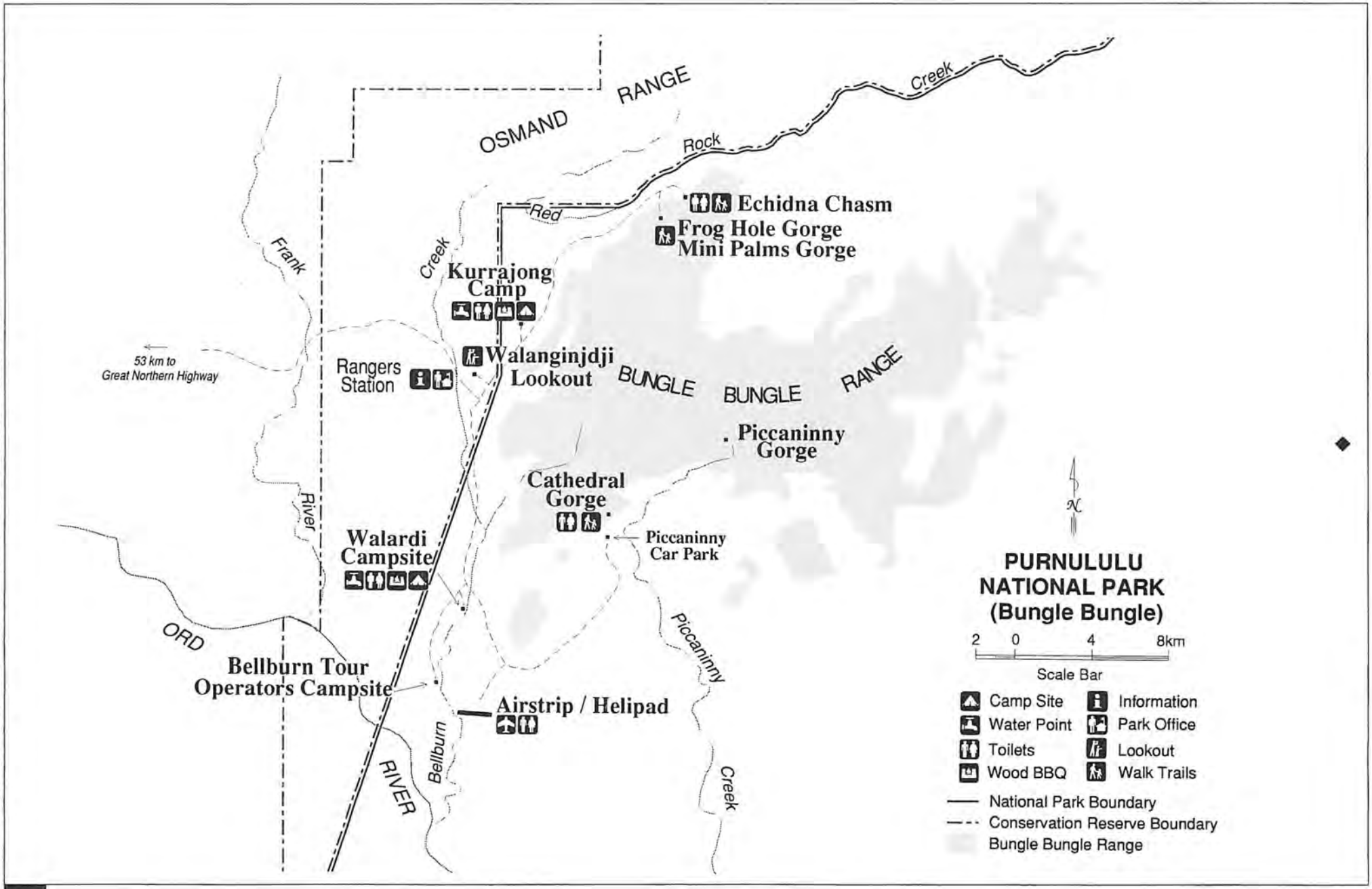
The short, easy, one kilometre Domes Trail is a circuit walk amongst the sandstone domes, beginning at the Piccaninny car park.

THINGS TO DO

Helicopter flights over the Bungle Bungle Range are available from the Bellburn airstrip within the park or from Warmun (Turkey Creek). Bookings can be made with the pilots at the airstrip or through tourist bureaus.

Scenic aerial flights are available from Kununurra and Halls Creek. Bookings and details are available from local tourist bureaus and travel agents.

Visitor activities such as slide nights are held regularly. Check with rangers for details or watch for information displayed in the camping areas.


OSMAND RANGE
Rock Creek
Red Creek
Frank River
Echidna Chasm
Frog Hole Gorge
Mini Palms Gorge
Kurrajong Camp
Walanginjdji Lookout
Rangers Station
53 km to Great Northern Highway
BUNGLE BUNGLE RANGE
Piccaninny Gorge
Cathedral Gorge
Piccaninny Car Park
Walardi Campsite
ORD RIVER
Bellburn Tour Operators Campsite
Airstrip / Helipad
Bellburn
Piccaninny Creek
PURNULULU NATIONAL PARK (Bungle Bungle)
2 0 4 8km
Scale Bar
Camp Site
Water Point
Toilets
Wood BBQ
Information
Park Office
Lookout
Walk Trails
National Park Boundary
Conservation Reserve Boundary
Bungle Bungle Range

THE LANDSCAPE

The Halls Creek Mobile Zone

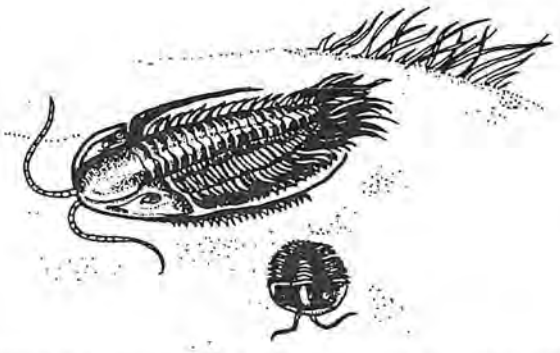
The oldest rocks in the area are volcanic and sedimentary rocks, which are evident to the west of the park in an area known by geologists as the Halls Creek Mobile Zone. These were deposited between 1800 and 1900 million years ago and subsequently deformed, metamorphosed and intruded by granite. The Spring Creek track leading into the park crosses this area of rugged ridges covered by varying rock types such as tonalite, greywacke, phyllite, conglomerate, limestone and dolomite, with some granite intrusions. A major crack has formed in the earth's crust extending more than 850 kilometres from the edge of the Great Sandy Desert northeast to Darwin. Movements along this fault system called the Halls Creek Fault System has occurred several times, with the results still evident today at Calico Springs.

Glaciers

There is evidence that about 680 million years ago the Halls Creek Mobile Zone and the area now occupied by the Osmand Ranges formed a mountain range with glaciers. Tillites are sedimentary rocks formed from debris picked up by ice sheets or glaciers and deposited during the melting of the ice. These rocks can be found on the western side of the park and also to the north at Moonlight Valley on Texas Downs Station.

Volcanoes

Around 530 to 560 million years ago a phase of volcanic activity occurred over a large area of northern Australia. Basalt was ejected from a series of fissures. These rocks are named 'Antrim Plateau Volcanics' by geologists and underlie much of the East Kimberley region. They are at their thickest near the Halls Creek Fault, suggesting that the East Kimberley was a major eruptive centre. They take their name from the Great Antrim Plateau, a range about 50 kilometres east of Halls Creek where they are well exposed. These volcanic rocks are found in the west of the park.



Trilobites, one of the first groups of animals with protective skeletons to appear in the Cambrian

Limestone

In the middle of the Cambrian period, 520 to 530 million years ago, sediments were deposited over the volcanic rocks when a warm shallow sea covered the area. These deposits were predominantly limestone, but also shale and sandstone. Today the exposed relic of this formation is the reef-like limestone ridge on the western side of the Bungle Bungle Range which also overlooks Kurrajong camping area. This limestone, known as 'Linnekar Limestone', contains fossils of trilobites, small conical shells and algae, simple life forms which existed during Cambrian times. Fossils such as fish and shells typically seen in much younger limestone deposits like the Devonian reef ranges in the West Kimberley are not found in the Linnekar Limestone.

Formation of the Bungle Bungle Range

The sandstone and conglomerate which make up the Bungle Bungle Range were deposited 360 to 370 million years ago during the late Devonian period in a low lying area known as the Ord Basin. The rocks which make up the range were deposited under non-marine conditions - not in a sea, as is widely reported.

Pebbles, sand and other sediments were washed by streams and rivers from mountain ranges to the north where the Osmand Range is today. The larger and heavier sediments were deposited out of the fast flowing currents first. Silica sand and finer sediments were carried further downstream to be deposited further from the mountains as the currents slowed. Sandstone on the northwest side of the Bungle Bungle Range in the Echidna Chasm area is coarse with pebbles forming conglomerate.

Geologists have named it 'Boll Conglomerate'. On the southern and eastern sides of the Bungle Bungle Range such as in the Piccaninny Creek area, the sandstone has finer grained sediments and has been named 'Glasshill Sandstone'.

Many of the boulders in the northwest section of the range in the Echidna Chasm area show scratching characteristic of glacial weathering. They are thought to be derived from earlier 680 million year old glacial deposits in the mountain ranges to the north.

As more sediments accumulated over the older layers they were compacted to form the sandstone of the Bungle Bungle Range. During this process, silica from individual grains of sand was dissolved and reprecipitated to form a cement, binding the grains tightly together.

Subsequently the range was uplifted and subjected to intense weathering probably during the Mesozoic period, 65 to 250 million years ago. This leached silica, the main cementing agent of the sandstone, from the interior of the sandstone and redeposited it on the exterior of the sandstone forming a 'skin'. Contrary to its solid appearance, the sandstone is extremely fragile and protected only by the silica skin.

The banding

The orange and grey banding seen on the rocks in the southwest of the massif is due to differences in clay content and porosity of the sandstone layers. The dark grey banding on the domes is due to dark cyanobacteria (formerly known as 'blue-green algae') growing on layers where moisture accumulates. The orange bands are due to the colour of oxidised iron compounds in the silica skin of layers which dry out too quickly for the cyanobacteria to grow.

The Piccaninny Structure

The Piccaninny Structure is located in the centre of the range northeast of Piccaninny Gorge. About six kilometres in diameter, this ancient impact crater, thought to be formed by a meteorite, can be seen from the air. Erosion has changed the appearance; only the lower parts of the impact structure survive. It is difficult to determine the exact age of the structure, but it is younger than the 370 million years old sandstone in which it is found, and older than the thin deposits of laterite found on top of the range.

The plains

Surrounding the remnant plateau of the Bungle Bungle Range are wide plains mostly of sand, derived from millions of years of weathering. All creeks and drainage channels in and around the Bungle Bungle range lead to the Ord River, the major river of the East Kimberley.

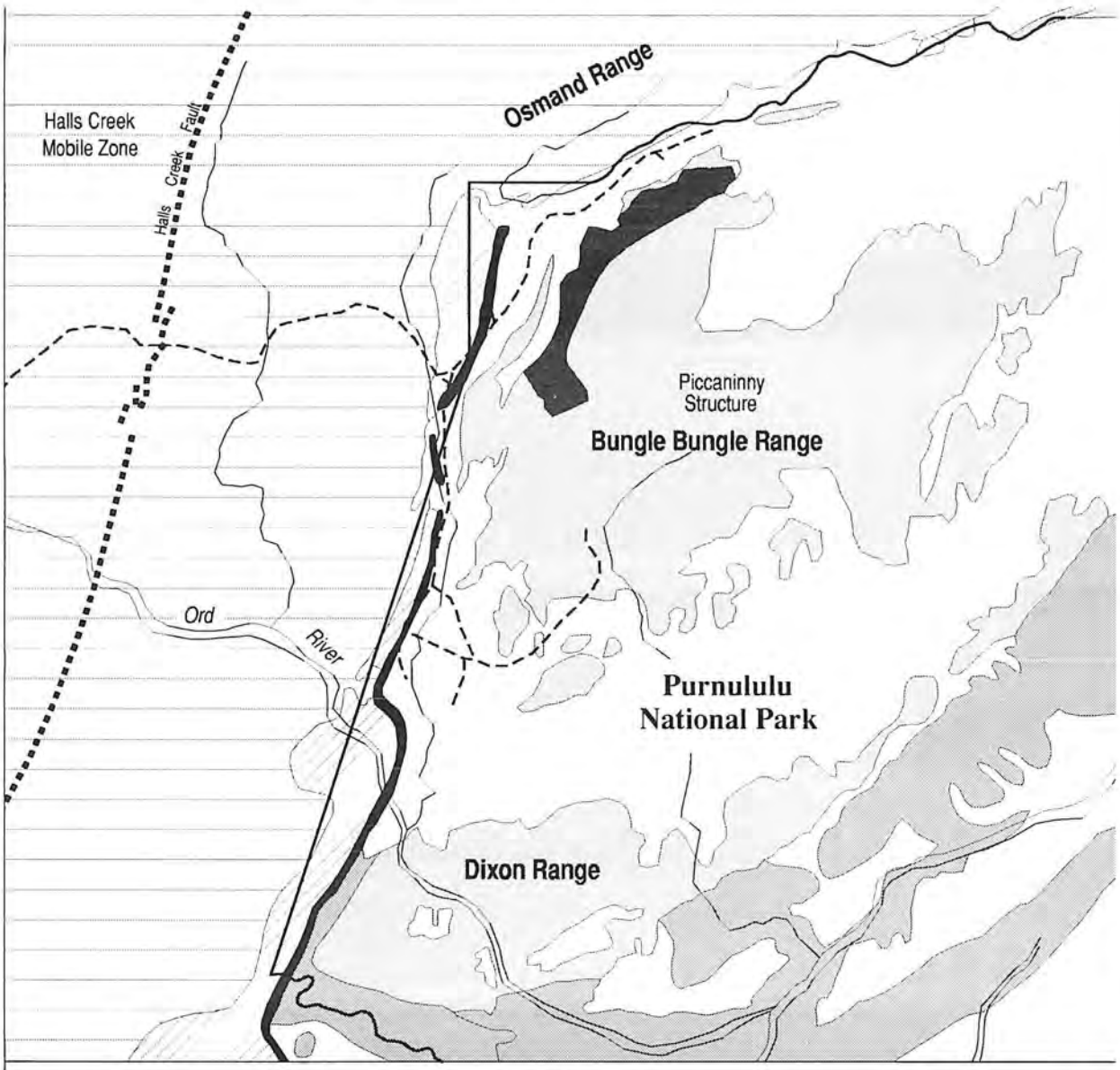
THE PLANTS

The diversity of habitats within the park, ranging from moist sheltered gorges to wide-open semi-arid plains, provides for a wide variety of plants. Over 600 different species have been recorded including 18 types of ferns, which is surprising in an area with annual rainfall of less than 600 millimetres per year. Purnululu National Park is an important conservation area for plants because some species are known only from the park. Some plants are found nowhere else in WA.

In the chasms and gorges

In the sheltered habitats of the chasms and gorges of the Bungle Bungle Range are a number of uncommon species, undescribed species and new records for WA. *Grevillea psilantha* is a low shrub with silver green leaves and cream flowers which only grows in the rocky gorges of the Bungle Bungle Range. The herbs *Lindernia eremophiloides* and an undescribed species of *Stemodia*, growing in damp crevices, are unknown elsewhere. The Bungles spinifex (*Plectrachne bunglensis*) only grows in crevices in the sandstone cliffs of the Bungle Bungle Range. The Morse fern (*Taenitis pinnata*) growing in the sandstone gorges is otherwise only known from distant northeast Queensland and the Pacific Islands.

A striking sight in Purnululu are the fan palms, commonly called 'Bungles Palms', growing on the walls of gorges and from crevices in the rocks, as well as on chasm floors. This palm has recently been named *Livistona victoriae* and is also found in the Victoria River region of

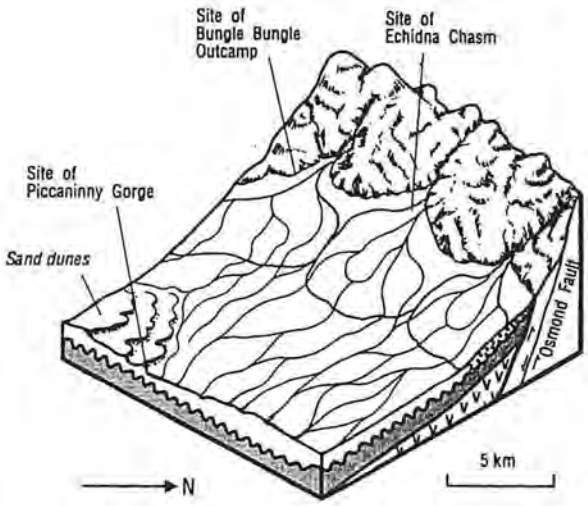


GEOLOGY

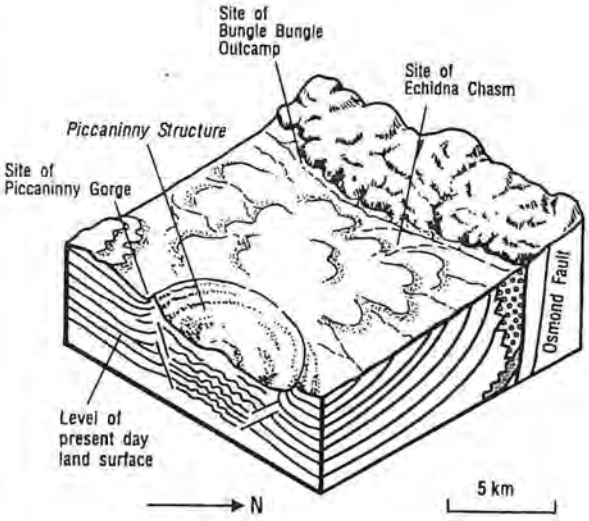
5 0 5 10 15km

Scale Bar

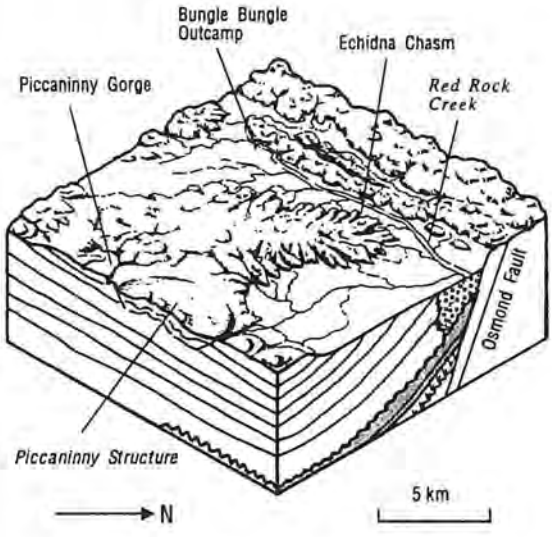
- Proterozoic, Volcanic and Sedimentary Rocks
- Antrim Plateau Volcanics
- Boll Conglomerate Sandstone
- Glasshill Sandstone
- Cambrian Sandstone
- Sandplain and Residual Soils
- Cambrian Limestone



LATE DEVONIAN DEPOSITION



EARLY MESOZOIC IMPACT STRUCTURE



PRESENT DAY

Age m.y.	Era	Period	Geological history
	CAINOZOIC		Development of sandstone towers
100	MESOZOIC	Cretaceous	Erosion of plateau
		Jurassic	Leaching of sandstone commences
200		Triassic	Piccaninny Structure (age uncertain)
	PALAEOZOIC	Permian	
300		Carboniferous	Uplift folding & erosion
			Compaction
		Devonian	Deposition of sand and conglomerate
400		Silurian	
		Ordovician	Uplift & erosion
500		Cambrian	Deposition of carbonate, mud & sand Deposition of basalts
		Late Proterozoic	Glaciation, deposition of tillite
1000			

the Northern Territory. The rock fig (*Ficus leucotricha*), a small tree with smooth grey bark and contorted, exposed roots clinging to the rock, also grows on the gorge walls.

Trees within the gorges of the Bungle Bungle Range include the handsome brittle range gum (*Eucalyptus aspera*), with smooth white-grey upper bark, and small rough grey-green leaves borne in opposite pairs, and the straggly, stunted tropical red box (*Eucalyptus brachyandra*), with fibrous, grey bark, rounded, leathery grey-green leaves and tiny, papery gumnuts. Shrubs include the attractive Kimberley heather or turkey bush (*Calytrix exstipulata*), which bears tiny, pink, star-shaped flowers in the dry season, and the pindan wattle (*Acacia eriopoda*), with narrow, ribbon-like leaves.

Damp, loamy, soil around permanent pools of water in some of the gorges support communities of sedges and other grasses and plants not found in drier sites. These include the sticky-leaved insect-consuming *Byblis liniflora*, and the mauve coloured daisy *Erigeron ambiguus*, which is not known elsewhere in WA.

On the Bungle Bungle Range

On top of the Bungle Bungle Range grow the scaly barked *Eucalyptus cliftoniana*, which bears distinctive globular gumnuts, and *Eucalyptus dichromophloia*, whose white bark is speckled with darker flakes, often reddish. Shrubs include the wattles, *Acacia gonocarpa*, with narrow, light green foliage and whose pale, yellow, flower spikes are followed by ridged woody pods, and *Acacia stipuligera*, which bears golden flower spikes.

Grevilleas are common on the Bungle Bungle Range and surrounding sand plains. The sandstone grevillea (*Grevillea miniata*), with prickly, oblong-shaped, grey-green leaves, has attractive golden yellow flowers, while Wickham's grevillea (*Grevillea wickhamii*) has prickly rounded pale blue-green leaves and red flowers. The silverleaf grevillea (*Grevillea refracta*) has long silvery leaves and reddish-orange flowers. *Grevillea byrnesii*, with toothed leaves and orange-red flowers, is found nowhere else in WA.

Large, pungent clumps of the non-resinous spinifex *Triodia spicata* dominate the grass layer on the range and are also found in fire protected areas of the surrounding sand plains. It is a desert species at the northern limit of its range and has not been recorded elsewhere in the Kimberley.

On the sand plains

The woodlands of the extensive sandplains surrounding the Bungle Bungle range are dominated by the attractive silverleaf bloodwood (*Eucalyptus collina*), whose straight, white trunk bears a silvery-green canopy. Endemic to the Kimberley region, it is also found growing on rocky sandstone slopes in the North Kimberley.

Along creeks and rivers

Lining major water courses are the river red gum (*Eucalyptus camaldulensis*) and the drooping wild plum (*Terminalia platyphylla*), whose broad leaves are borne at the end of pendulous branches. Along the Ord River, the paperbark (*Melaleuca leucadendra*) is also found. Bendee (*Terminalia bursarina*), with dark, rough 'crocodile' bark and tiny leaves arranged spirally on short branches, grows on rocky river beds and typically bends downstream a result of the action of floodwaters.

Annual grasses and exotic species such as the kapok or snow bush (*Aerva javanica*), with profuse white flowers, commonly grow on the river sands after each flood. The high occurrence of annual grasses and exotics on the plains of the Ord River valley reflect a history of grazing and soil degradation.

Other landscapes

The bauhinia (*Bauhinia* [formerly *Lysiphyllum] cunninghamii*), with small butterfly leaves forming a dense foliage, nectar-rich red flowers and rust coloured seed pods, is common on lowland plains. The snappy gum (*Eucalyptus brevifolia*), with whitish bark, hard, brittle timber and an open growth habit, is common on rocky slopes. The common hakea (*Hakea arborescens*), with rough, corky, almost black bark and strap-like leaves, is found on limestone outcrops.

The rainforest

Sheltered gorges of the Osmand Ranges with permanent water support a closed forest with rainforest species such as the large, broad-leaved Leichhardt tree (*Nauclea orientalis*), the glossy, round-leaved *Carallia brachiata*, and the dark green elongated-leaved *Syzygium angophoroides*. *Euodia elleryana*, which is restricted in WA to rainforest pockets in the East Kimberley is also found here. The native lasiandra (*Melastoma polyanthum*), which bears showy, mauve flowers, and various ferns, are common in the understorey. These are the most southeasterly patches of rainforest known in the Kimberley.

THE ANIMALS

Because of its diversity of habitats and location in the transition zone between the sub-humid tropics and the semi-arid regions, Purnululu National Park contains a large and diverse range of animals. New species of a gecko and a skink have been found in the park which are yet to be named and described.

Uncommon species

The Pacific baza or crested hawk is known from the park, and the grey falcon, considered rare although found throughout the continent, is seen quite often.

The northern quoll and the bilby have suffered drastic reductions in range and population in the last century and formerly occurred in the region. Although not sighted recently it is thought that they may still be present in the park. With careful management, the re-establishment of these species may be possible.

The northern nail-tail wallaby has a wide distribution in the savannah woodlands of northern semi-arid Australia but is generally uncommon within this range. Purnululu National Park is one of the few conservation reserves where it occurs in reasonable numbers.

Mammals

Most mammals are nocturnal, avoiding the heat of the day and daytime predators, and so are seldom seen. However, the spinifex and sandstone habitats of the Osmand and Bungle Bungle ranges support a number of rock dwelling species such as the short-eared rock wallaby, the common wallaroo or euro and the common rock rat. The small, carnivorous common planigale is also found.

The secretive rock ringtail possum lives exclusively amongst rocky outcrops, sleeping in well-protected areas during the day, climbing trees only at night to feed on blossoms and fruit. It has a longer snout, and a shorter tail, legs and claws than its tree dwelling relatives, as adaptations to its terrestrial existence.

Two little known and recently described inhabitants of the park restricted to the sandstone areas of the Kimberley are the small, carnivorous ningbing antechinus and the Kimberley mouse.

The nectar rich flowers of the bauhinia are attractive to honeyeaters, insects and humans.

The desert mouse is an arid zone species at the northern limit of its range in the park. Regarded as rare and declining, little is known of its ecology. In Purnululu it is found on rugged stony country which is dissimilar to the grassland and sandy arid habitats where it has previously been reported.

There are many caves in the rugged sandstone country of the Bungle Bungle and Osmand ranges that provide roosting sites for bats. Fourteen species are known from the park. These include the rare yellow-bellied sheathtail bat, and the large-footed myotis, which uses its large feet to rake the surface of water to catch aquatic insects. Distance from the coast and the relative aridity of the area make this an unexpected resident of the park.

The tussock grasslands of the sandplains around the Bungle Bungle Range provide shelter for several small nocturnal mammals. The stripe-faced dunnart eats insects while the tiny delicate mouse eats seeds and the western chestnut mouse eats grasses.

Termites and their mounds

Termite mounds are common and widespread throughout the Bungle Bungle area, as is the echidna, a termite-eating specialist. Although appearing inert, the mounds contribute greatly to the ecology of the area. The termites enrich the otherwise infertile shallow soils, making nutrients available for new plant growth. Clay, grass and woody material are broken down to a re-usable form, and nutrients from several metres below are brought to the surface by termites building the mounds.

The termites are important in the food chain. They are eaten by spiders and ants, which in turn provide food for insectivores such as birds. The mounds provide homes and protection for various animals such as geckoes, goannas, rodents, snakes and even birds such as kingfishers.

Reptiles

Reptiles are common in the park with over 80 species recorded. Skinks and monitors are most likely to be encountered. The rich reptile fauna reflects the change from subhumid to semi-arid environment that the park encompasses.

Rock dwelling species that frequent the ranges include the ridge-tailed monitor, the long-tailed monitor and the dull brown Copland's rock frog. In chasms and gorges Glauert's rock monitor and the common tree snake are common.

In pools, Merten's water monitor and various frogs are often seen. These include the magnificent tree frog, known only from the Kimberley and easily recognised by the bright yellow spots on the back of its otherwise green body. Small, but conspicuous the rockhole frog is active around rockholes during the day and able to travel across the surface of the water in a series of bounces.

On sandplains around the Bungle Bungle Range the sand goanna and the military dragon are common.

The freshwater crocodile, the snake-necked turtle, the short-necked turtle and 15 species of fish are known from the Ord River.

Birds

Birds are the most conspicuous residents of the park with over 140 species recorded. White-quilled rock-pigeons are common in the gorges, the sandstone shrike-thrush forages for insects in crevices and amongst sandstone boulders, while the peregrine falcon roosts high up on the cliffs.

The northern rosella, pied butcherbird and yellow-throated miner are common in the eucalypt woodland and flowering grevilleas attract honeyeaters. Spinifex pigeons are common along tracks, while brown quail are common around the park's camping areas.

In the grasslands of the Ord River valley the Australian bustard, the singing bushlark and

White-quilled Rock-pigeon

golden-headed cisticola are found. Pools along the Ord River provide a suitable habitat for water birds such as cormorants, herons and egrets.

Birds preferring wooded habitats, such as the Pacific baza, common koel, black bittern, and northern fantail, are restricted to the riverine gorges of the Osmand Range and generally are at the inland limit of their range. In contrast, several inland species such as the red-capped robin, the spinifex bird, and the grey-headed honeyeater are at the northern limit of their range in the park.

LOOKING BACK

Radiocarbon dating shows that Aboriginal people have lived in the region for at least 20,000 years. Entry into the area is thought by some to have been from Arnhemland between 20,000 and 40,000 yeas ago. Several groups used the area including Gija, Djaru, Malngin and Miriwoong people. The name 'Purnululu' means sandstone in Gija.

River people

The traditional Aboriginal people of the region were river people with life focussed on the Ord River system. Rivers and creeks were the main geographical features used as reference points. Trading, social and ceremonial gatherings were usually near water.

Food

Food was collected by a variety of means where intimate knowledge of the land's resources was crucial. Large quantities of fish were collected by using immobilising toxins from the crushed leaves and bark of certain plants and by netting with rolls of spinifex pushed through pools. Birds, reptiles and mammals also formed part of the diet of these hunter-gatherers. Roots, leaves and fruits were collected for use as food and medicines.

Trade

A widespread exchange network called 'winan' existed throughout the Kimberley. The Kimberley 'winan' had many links with similar networks in the Western Desert and Daly River areas. Economic commodities such as tools, food, weapons and raw materials were exchanged for goods unavailable locally. Thus pressure flaked spear heads produced in the Ord River area found their way to the coast in exchange for large Baler shells and pearl shell.

Kimberley pressure flaked spear head

The land

The sandplain area around the Bungle Bungle Range and the range itself were also of importance. Sandstone overhangs with rock art, and seed and ochre grinding marks occur at sites around the range. During periods of heavy rain, the run-off from the range forms large temporary pools around its perimeter, which allowed small groups of people to use the resources of the area for a limited time. Oral accounts tell of small groups of people living on top of the massif for short periods. In some places it was necessary to use a 'ladder' made by cutting notches in a pole. To ensure a descent by the same route stone trail markers were used.

In the Purnululu area groups of people speaking a common language were the custodians of extensive areas of land. Each group had elders that were responsible for organising economic and trading relations, settling disputes within their group or territory, arranging and participating in religious rituals, and managing and protecting the local area. The group shared responsibility for the safety of all persons who were on their land. It was therefore important to seek permission before entering the land of another group. People who entered other's land without appropriate permission not only risked suffering severe sanctions but also put the custodians at risk.

Within the Purnululu region Aboriginal people acquired interests in land through their father (and father's father) and through their mother (and mother's father). Interests in land were also acquired through place of birth and the burial sites of close relatives.

The present custodians of Purnululu continue their traditional responsibility. Some were born within the present national park and have close relatives buried there. They describe with sadness the changes to the land and rivers since Europeans arrived. Some formerly large pools have silted up with loss of their populations of fish, turtles and crocodiles. Some 'bush tucker' plants and animals are scarce or gone. Aboriginal custodians feel that if they lose control of their land then the Dreaming will take the plants and animals away for their neglect of traditional practices and ceremonies.

Pastoral days

The area was opened up to cattle grazing after favourable reports from Alexander Forrest's explorations in 1876 and 1879. Cattle were introduced from Queensland and New South Wales in 1884. Ord River Station with 369,680 hectares was the largest lease taken on the Ord, Messrs Panton and Osmand being the original lessees. In the northwest corner of the lease lay the Bungle Bungle Range and the rugged Osmand Range, regarded as 'rubbish country' by the pastoralists because of its low grazing potential and difficulty of management.

The pastoralists Wilson and Madden occupied a lease to the west of the Bungle Bungle range in the early 1900s. In 1941 William Skewthorpe called this station 'Bungle Bungle'; his homestead was near the ranges. The name comes either from a corruption of the Aboriginal name for the area 'Purnululu' or from a misspelling of one of the common Kimberley grasses found there, Bundle Bundle grass.

Good seasons and plenty of surface water saw stock numbers increase rapidly. Large numbers of cattle grazing the river frontages were responsible for the massive erosion still evident in the area today. A few signs remain in the park of the early pastoral history; some old stock yards, derelict fence lines and the bare remains of old camps and some disused bores.

Changing times

Because of increasing silt loads in the Ord River and the threat to the then proposed Lake Argyle, a huge area which included all of Ord River Station was resumed by the government in 1967. Land rehabilitation was begun by the Department of Agriculture.

Until the early 1980s only traditional Aboriginal people and a few local pastoralists, stockmen and geologists knew of the Bungle Bungle Range. In 1983 media attention began to attract tourists to the area. The need to protect and manage the area resulted in Purnululu being declared a national park in 1987.

The involvement of the traditional owners is integral to the management of the park. Their involvement is the first of its kind in WA where the experience and expertise of the traditional owners through their long relationship to the land has been formally acknowledged. Through the guidelines of the park's plan of management the cultural and natural values for the park are to be maintained and enhanced wherever possible.

Purnululu is a special place for the Aboriginal people of the area. It is a country to which they have strong spiritual ties, involving family history and personal identity. Living areas are set aside within the park to allow Aboriginal people to maintain their traditions with independence and pride.

Further Information

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Purnululu National Park
Telephone (08) 9168 7300
Fax (08) 9168 7326

Further Reading

Bungle Bungle Range
Dean Hoatson & others
Australian Geological Survey Organisation

Purnululu National Park Management Plan 1995 -2005
Department of Conservation and Land Management

A Survey of the Wildlife and Vegetation of Purnululu National Park and Adjacent Area.
CALM Research Bulletin No 6

'The Bungle Bungles'
Department of Minerals and Energy Fact Sheet 19

'Bungle Bungle: Birth of a National Park'
Landscope Vol 2 No 2 (Summer 1986/87)

MIRIMA NATIONAL PARK

Where: Two kilometres to the east of Kununurra. Access via Barringtonia Avenue and Hidden Valley Road.

Area: 2068 hectares

Gazetted: August 1982

Attractions/Significance: Striking scenery of sandstone ranges, cliffs and valleys similar in appearance to parts of the Bungle Bungle Range.

THINGS YOU NEED TO KNOW

An information shelter, toilet, tables and walk trails are provided at the car park at the end of Hidden Valley road.

Camping is not permitted in the park. There are caravan parks nearby in Kununurra.

Take adequate water with you when walking. There are no water supplies within the park.

Much of the rock in Mirima National Park is fragile and unstable. To protect yourself and the park stay on the marked trails.

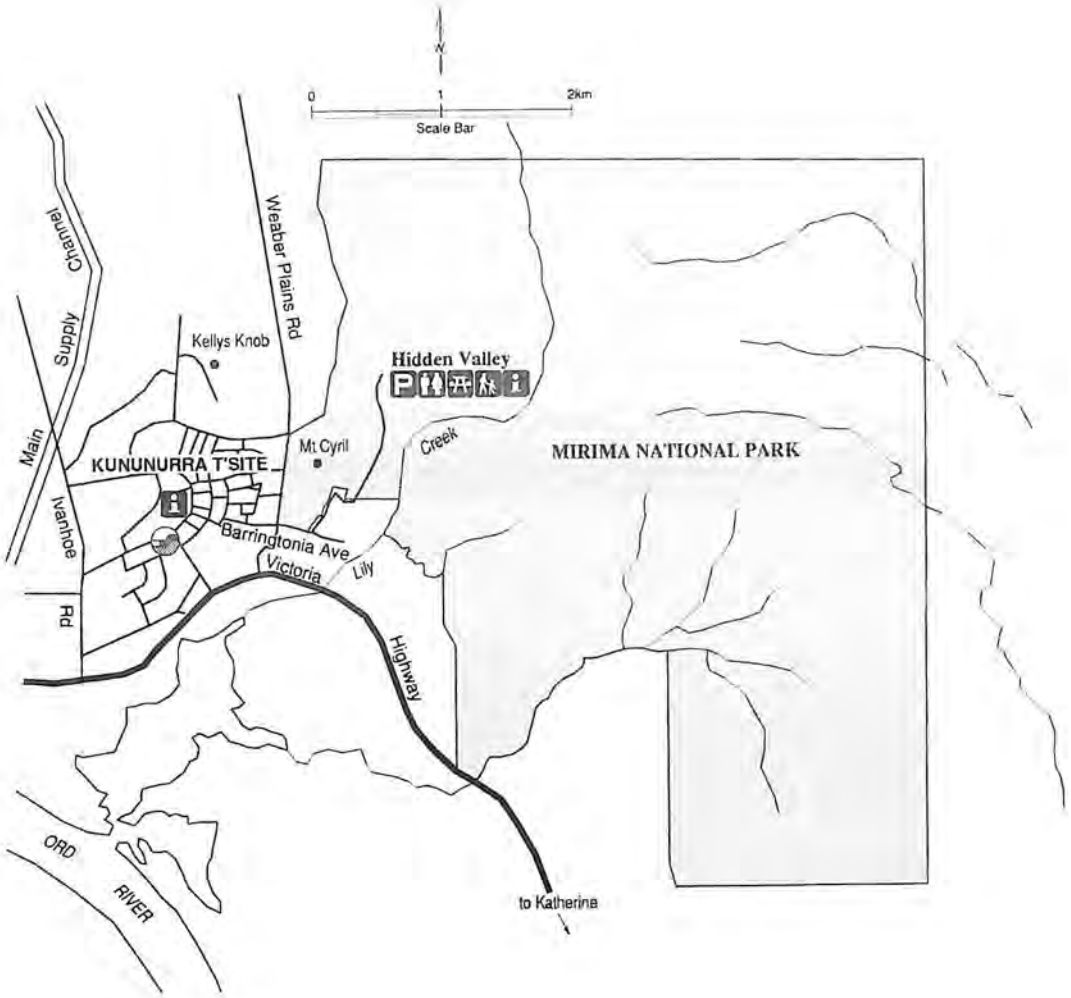
CARING FOR MIRIMA

Help to protect this fragile environment. Camping, fires and pets are not permitted in the park.

Leave the park clean; please take your rubbish with you.

Plants, animals, wood, rocks and soil are all part of the park. Leave things as you find them for all to enjoy.

Aboriginal sites are of special significance to Aboriginal people and are protected by law.



THINGS TO DO

The 'Looking at Plants' trail is an easy 400 metre return walk with trailside signs to help visitors get to know some of the plants in Mirima and their use by the Miriwoong people.

Expansive views of the park and the Ord Valley can be had on the 'Derdbe-gerring banan' trail, a 800 metre return walk of medium difficulty which climbs up steep slopes to the top of the rock formations.

The 'Demboong banan' trail is a short, easy 500 metre return walk through a narrow valley ending with a view of Kununurra through the gap in the range.

During the dry season (May to August) guided walks are conducted in the park by CALM staff. Check the information shelter or contact the Kununurra office for details.

THE LANDSCAPE

Mirima National Park is dominated by a rugged undulating sandstone plateau rising in places to almost 100m above the surrounding alluvial red and yellow sand plains of the Ord River valley. Escarpments on the south, east and west of the plateau have been eroded by the torrential rains of the tropical 'wet' carving out valleys, gorges, outcrops and domes.

During the late Devonian period about 360 million years ago highlands in the vicinity of present day Lake Argyle were eroded by rivers and streams. The resulting sediments were deposited to the north and west by streams and windblown sand dunes. As more sediments accumulated over the older layers they were compacted to form sandstone. During this process, silica from individual grains of sand was dissolved and reprecipitated to form a cement, binding the grains tightly together. The rock formations in Mirima display distinctive horizontal layers, evidence of their sedimentary origin, and well developed cross-bedding a result of the passage of windblown sand dunes.

Subsequently the plateau was subjected to intense weathering probably during the Mesozoic period, 65 to 250 million years ago. This leached silica, the main cementing agent of the sandstone, from the interior of the sandstone and redeposited it on the exterior of the sandstone forming a 'skin'. Contrary to its solid appearance, the sandstone is extremely fragile and protected only by the silica skin.

The orange and grey banding seen on the rocks is due to differences in clay content and porosity of the sandstone layers. The dark grey banding on the domes is due to dark cyanobacteria (formerly known as 'blue-green algae') growing on layers where moisture accumulates. The orange bands are due to the colour of oxidised iron compounds in the silica skin of layers which dry out too quickly for the cyanobacteria to grow.

THE PLANTS

The park encompasses a good representative sample of the plants of the Kimberley area.

On the plains

The open woodland of the plains is dominated by a grass layer of canegrass and spinifex. Canegrass or annual sorghum grows vigorously with the monsoonal rains, sets seed and then dries off during the dry season. The dominant eucalypts are the stringybark (*Eucalyptus tetradonta*) and the woollybutt (*Eucalyptus miniata*), whose colourful orange blossoms are followed by large fluted gumnuts. The woollybutt has a smooth white upper trunk and a fibrous brown stocking at its base.

Other common trees in the park include the boab (*Adansonia gregorii*), the long-fruited Corymbia bloodwood [formerly] (*Eucalyptus polycarpa*), and the ironwood (*Erythrophleum chlorostachys*), named for its hard timber. There are several species of Terminalia including *Terminalia latipes*. The Emu Apple (*Owenia vernicosa*) produces hard apple-like fruit. These, however, are inedible, unlike the small green fruits of the wild mango (*Buchanania obovata*), sought by local Aboriginal people in the wet season and known by them as 'gulay'. Pindan wattles (*Acacia tumida*) flower spectacularly in July.

On the sandstone ranges

The hardy spinifex grows profusely on the sandstone hills along with the brittle range gum (*Eucalyptus aspera*). The kapok bush

(*Cochlospermum fraseri*) has adapted to life on the dry hillsides by losing its leaves in the dry season. It is at this time that it flowers, its otherwise bare branches adorned by large yellow flowers. These are followed by large oval pods enclosing seeds embedded in cottonwool-like fibres. The Kimberley heather or turkey bush (*Calytrix exstipulata*) also bears its small, pink, star shaped flowers during the dry season.

Flowers and pods of the Kapok Bush

Shrubs

Common shrubs in the park include the blue grevillea (*Grevillea agrifolia*) and the silverleaf grevillea (*Grevillea refracta*), whose nectar laden flowers attract honeyeaters. The grey velvety leaved *Cajanus reticulatus*, which bears yellow pea flowers, is common in rocky gullies. Richard's wattle (*Acacia richardsii*) is common in the park and on sandstone around Kununurra but is rarely found elsewhere in the Kimberley.

On the rock walls

Sheltered rock walls support the rock figs *Ficus leucotricha* and *Ficus platypoda*, whose moisture seeking roots are exposed in contorted configurations. *Lindernia cleistandra*, a small herb with soft leaves and mauve flowers and an undescribed species of *Platysace* also grow from cracks in the rock walls. Both are endemic to the area and known only from Mirima and nearby Keep River National Park in the Northern Territory.

THE ANIMALS

Mammals

Mammals tend to avoid the heat of the day sheltering in cool shadowy overhangs and so are not often seen by visitors. The short-eared rock-wallaby frequents the steep sided gorges while the larger wallaroos prefer the wider valley floors where they often graze spinifex regrowing after fires. Small caves in the eroded rock walls provide homes for bats such as the western cave bat and the common sheathtail bat.

Small carnivorous marsupials such as the long-tailed planigale and stripe-faced dunnart find shelter under spinifex and rock ledges only emerging to hunt and feed at night. The stripe-faced dunnart is toward its most northern limit of distribution in Mirima. Several species of native mice including the western chestnut mouse and the delicate mouse are also found in the park.

Reptiles

Reptiles are well represented and may be seen basking in the sun at times. Many skinks and geckoes are found as well as dragons, monitors and legless lizards. Snakes are not often seen but present nevertheless. Of the 11 species recorded in the park only two are venomous, the gwardar and Ingram's brown snake.

Frogs

Frogs such as the ornate burrowing frog, which hibernates underground during the dry, become abundant during the wet season when they breed. Several species of tree frog such as the green tree frog can be found near permanent waterholes.

Birds

Birdlife is abundant with almost 200 species recorded in the park. The location of the park adjacent to the Ord irrigation area with its large body of permanent water has led to the recording of some waterbirds which might not otherwise have been expected in the area.

The melodious song of the pied butcherbird may be enjoyed echoing from the cliffs at Hidden Valley car park along with the noisy but less tuneful yellow-throated miners. A small bird of prey, the Australian kestrel, can also be observed in this area at times.

Along with the sandstone shrike-thrush, the white-quilled rock-pigeon is at home on the sandstone outcrops. Its sudden noisy flight when disturbed is a heart stopper to the unsuspecting.

During the dry season the northern rosella and the colourful rainbow lorikeet are often seen along Hidden Valley road. The delicate variegated fairy-wren can often be seen along the Doomboom banan walk trail if approached quietly. The vivid red and blue colours of the male contrast with the dull grey brown colours of the females and juveniles.

LOOKING BACK

Miriwoong

Mirima is the name given to the area by the Miriwoong people for whom it has been a special place for thousands of years. The overhangs and cliffs provided shelter from the sun and the wet season storms. Rock holes provided permanent water for people and animals and the variety of plants and animals were a rich source of food, tools and medicine.

There is much evidence of past Aboriginal use of Mirima. Rock paintings, engravings, tools, flakes and stone tool-making sites are found in the park. Paintings should not be touched as they are easily damaged. Leave artefacts where you find them

Certain areas of the park are still important in the traditional Aboriginal law of the Miriwoong people and public access to these areas is discouraged at their request. Discussions are under way with people representing the traditional owners of the land around Kununurra with a view to joint management of the park.

The coming of others

Europeans came to the Kimberley late last century and Ivanhoe pastoral lease was established in the area. With the commencement of the Ord Irrigation Project in the 1960s a town site was needed. Land was excised from the Ivanhoe lease for the township of Kununurra.

With increased numbers of people visiting this fragile environment, Mirima National Park was set aside in 1982 to conserve the scenic sandstone outcrops with their Aboriginal cultural sites. The park also protects a representative area of native vegetation and its associated fauna. Today it provides opportunities for people to enjoy a scenic landscape and observe wildlife.

Further Information

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Further Reading

A Biological Survey of Mirima National Park Dec 1993 - Jan 1994
Unpublished Report, Department of Conservation and Land Management.

KEEP RIVER NATIONAL PARK

Where: 40 kilometres to the east of Kununurra just across the Northern Territory border. Access is signposted along the Victoria Highway to Katherine.

Area: 57 540 hectares

Attractions/Significance: Striking scenery of sandstone formations with domes similar to those seen in the Bungle Bungle range; Aboriginal art site.

THINGS YOU NEED TO KNOW

Gravel roads within the park are suitable for conventional vehicles. However, during the wet season roads may be closed because of flooding.

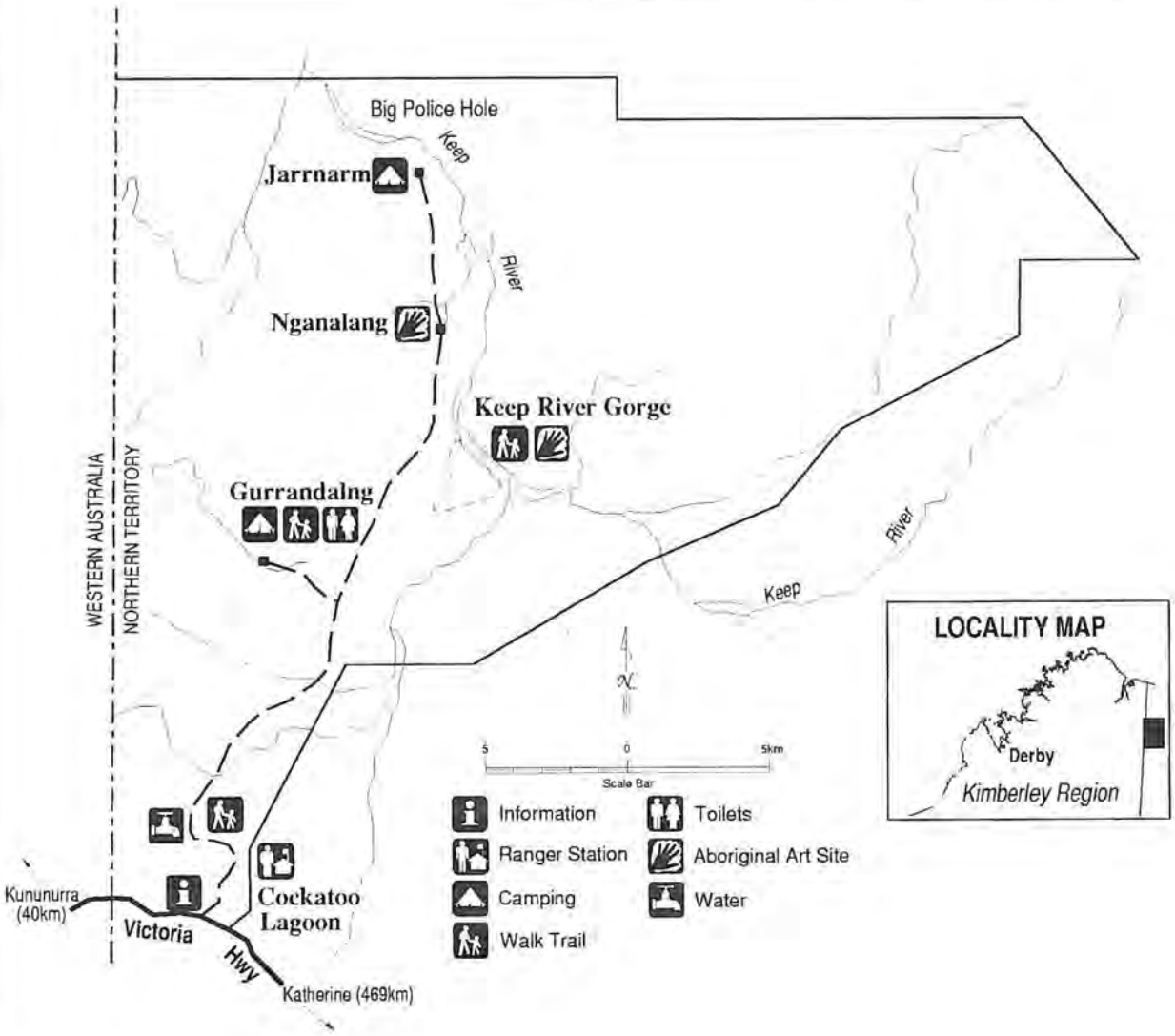
Camping is available at the Gurrandalng camping area in the centre of the park and at the Jarrnarm camping area in the north. Facilities include tables, barbecues and toilets.

Take plenty of drinking water when walking. Water is available from one location within the park.

Bushwalkers planning long walks or camping overnight outside the camping areas are advised to notify a ranger before setting off and on their return.

Saltwater crocodiles are found in the lower reaches of the Keep River. Do not swim. Be wary near the river banks.

If planning a return trip to Keep River National Park from Kununurra be aware of quarantine regulations at the border.



CARING FOR KEEP RIVER

Stay on designated roads and tracks.

Camp only in established camping areas.

Light fires only in the fireplaces provided. Firewood is not provided. Please bring wood with you or collect it along the road into the park.

Keep the park clean; please take your rubbish with you.

Native plants and wildlife are part of the park. Leave things as you find them for all to enjoy.

Aboriginal sites are of special significance to Aboriginal people and are protected under the Territory Parks and Wildlife Conservation Act. Penalties apply if they are touched or interfered with.

Firearms are prohibited in the park.

Pets are not allowed in the park.

THINGS TO DO

The easy three kilometre return Cockatoo Lagoon Walk near the park entrance includes a stop at a bird hide overlooking a peaceful lagoon inhabited by a many waterbirds.

The Gurrandalng Walk commences from the Gurrandalng camping area in the southern section of the park and passes through a labyrinth of domes, escarpments and valleys. This easy and well-signposted three kilometre return trail takes in high points with panoramic views.

The 400 metre return Gingers Hill Walk leads to a hawk hunting hide constructed under the direction of an elder of the Miriwoong people, who in his youth observed and participated in this hunting technique.

The easy four kilometre return Keep River Gorge Walk follows the Keep River through a gorge in the sandstone range.

The six kilometre return Jarrnarm West Walk starts from the Jarrnarm camping area in the north of the park.

The 5.5 kilometre return North walk also starts from the Jarrnarm camping area.

At Nganalang Art Site ancient aboriginal paintings adorn the walls of a spectacular sandstone outcrop. Treat these significant art sites with respect. Do not touch the paintings.

During the dry season from June to September campfire talks are given by rangers. Check at the information shelter or with rangers for details.

THE LANDSCAPE

Keep River National Park has a complex geological history which has resulted in a spectacular landscape with many rock types.

The Halls Creek Mobile Zone

The oldest rocks in the park are metamorphic, volcanic and granite rocks which have been dated at around 2000 million years and are found in an area known by geologists as the Halls Creek Mobile Zone. These rocks crop out in a northeast trending belt extending from the southwest corner of the park.

The Halls Creek Fault System

A major crack has formed in the earth's crust extending more than 850 kilometres from the edge of the Great Sandy Desert northeast to Darwin. Movements have occurred several times along this crack, called the Halls Creek Fault , which extends along the eastern side of the Halls Creek Mobile Zone.

Fitzmaurice Mobile Zone

Part of the Halls Creek Mobile Zone subsided to form a low lying area where sediments accumulated. This area has been named the Fitzmaurice Mobile Zone and extends about 200 kilometres northeast from the northern edge of the park. The extensively faulted quartz containing sandstone of the Fitzmaurice mobile zone is found to the north of the Jarrnarm camping area. Because of its resistance to erosion this quartz containing sandstone forms a conspicuous steep-sided range which includes one of the highest points in the park.

Glaciers

From about 700 million years ago there is evidence of an ice age and it is thought that a vast ice sheet covered the East Kimberley and Victoria River Regions. Tillites are sedimentary

rocks formed from debris picked up by ice sheets or glaciers and deposited during the melting of the ice. These rocks are found on the steep western side of Beasley Knob. A rock pavement three kilometres southwest of Keep River Gorge bears parallel straight lines thought to be made by the rocks embedded at the base of a moving glacier. Sand, iron bearing silt and clay were deposited in glacial lakes after the retreat of the glaciers. The rocks formed from these deposits can be found on the eastern side of Beasley Knob.

Volcanoes

Around 530 to 560 million years ago a phase of volcanic activity occurred over a large area of northern Australia. Basalt was ejected from a series of fissures. These rocks are called 'Antrim Plateau Volcanics' and underlie much of the East Kimberley and Victoria River district. They take their name from the Great Antrim Plateau a range about 50 kilometres east of Halls Creek where they are well exposed. In the park these volcanic rocks underlie blacksoil plains in flat areas and form the low hills in the vicinity of Cockatoo Lagoon.

Devonian sandstone

The prominent highly eroded layered sandstone plateau found around the Gurrandalng Camping Area and extending northwards, formed from sediments deposited during the Late Devonian period about 360 million years ago. Sediments were deposited by wind blown sand dunes and by streams. This sandstone is also found in Mirima National Park.

Coastal deposits

About 310 million years ago layers of sediments were deposited along an east west orientated coastline with seas to the north. The sandstone and limestone formed contains carbonates and marine fossils. It is found in the west of the park close to the Western Australian border in the Burt Range and near Mt Zimmerman.

THE PLANTS

Keep River National Park is in a transition zone between the Northern Territory's wet and dry regions and supports a mix of plant communities similar to those of the adjacent Kimberley. Riverine vegetation is found along permanent watercourses in the sandstone gorge country. Pockets of monsoon vine forest are found in sheltered hollows fed by soaks and springs, while open woodland dominates the drier environments.

Eucalypts

The woodlands are dominated by eucalypts such as the stringybark (*Eucalyptus tetrodonta*), and the woollybutt (*Eucalyptus miniata*), whose upper trunk is smooth and white, while its lower trunk has fibrous brown bark. The snappy gum (*Eucalyptus brevifolia*) is common on rocky slopes.

Along rivers

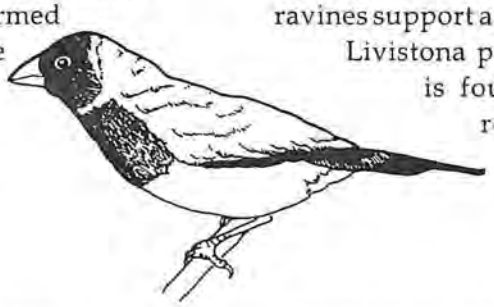
Paperbarks or melaleucas are found along watercourses along with pandanus (*Pandanus spiralis*). The freshwater mangrove (*Barringtonia acutangula*), which bears pendulous red blossoms, and the Cathormion (*Cathormion umbellatum*), which has hard wrinkled brown seed pods, are found where water is permanent.

Boabs

The boab tree (*Adansonia gregorii*), dramatic with its grossly distended trunk, is common throughout much of the Kimberley, but its distribution in the Northern Territory is limited to the Victoria River district.

Palms

The park's sheltered escarpments and ravines support a variety of species including Livistona palms. *Livistona victoriae* as is found in the Victoria River region and in the Bungle Bungle Range.



Gouldian Finch

THE ANIMALS

Mammals

The common wallaroo, the antilopine wallaroo and the agile wallaby are found in the park as well as the less common nailtail wallaby. Thirteen bat species have been recorded, including the ghost bat and the orange leafnosed-bat. Smaller mammals include the common planigale, the ningbing antechinus and several species of native mice and rats.

Birds

The Park is rich in birdlife with species ranging from the occasional emu to breeding populations of the white-quilled rock-pigeon.

The park hosts a rare and highly significant small colony of the vibrantly coloured Gouldian finch, one of Australia's most endangered birds. Gouldian numbers have dwindled rapidly over the past few decades. The Gouldian finch is the subject of an intensive research programme aimed at ensuring its future survival.

Reptiles

Reptiles are well represented and often encountered. Many skinks and geckoes are found as well as dragons, monitors and legless lizards. A new genus of gecko has been found in the park recently. Twelve species of snake have been recorded including the gwardar and the king brown or mulga snake.

Saltwater crocodiles are found in the lower reaches of the Keep River.

Frogs

Frogs are also well represented and include the large green tree frog and the similar looking yellow spotted magnificent tree frog. Also found at Keep River is the spotted grass frog, which was introduced to the Kununurra area from southern Australia, probably inadvertently beneath transportable houses.

Fish

Fish are plentiful in the Keep River, including barramundi. Eighteen species have been identified.

LOOKING BACK

Miriwoong

The traditional custodians of Keep River National Park are the Miriwoong people whose tribal lands are thought to straddle the Northern Territory/Western Australia border and extend from the coast south to Rosewood and Argyle Stations, the present site of the Ord Dam.

The Miriwoong regarded the neighbouring Gadgerong people as countrymen and traditionally met for ceremonies and intermarriage. Through this special relationship the two peoples now manage their affairs as one. Their languages belong to a family of languages spoken throughout the East Kimberley.

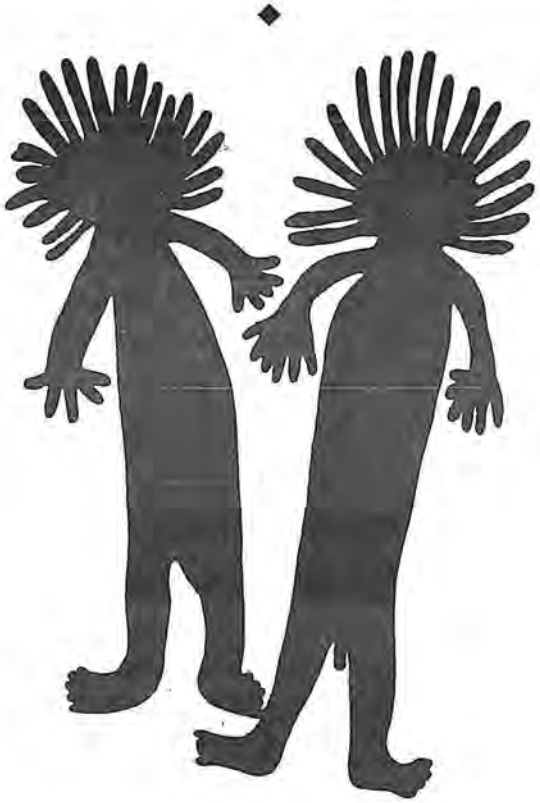
Art sites, sacred sites and shell middens are evidence of Aboriginal people's long association with the area. Today two permanent communities are situated in the park. The Miriwoong people have requested that public access to areas considered sacred be controlled.

Exploration

Early European exploration of the area began when Phillip Parker King explored the northern coastline in the Mermaid making three journeys between 1818 and 1821. Lieutenant John Lort Stokes and Captain John Wickham discovered and named the Victoria River in 1839. In 1855 Augustus Charles Gregory led an expedition exploring the area around the Victoria River. Exploration of the East Kimberley by Alexander Forrest in 1879 and the Durack expedition of 1882 preceded the coming of pastoralists to the area.

Pastoralists

The explorers were followed by pioneering pastoralists who first bought cattle overland from the Gulf country in 1886 to stock the new grazing properties of the Kimberley. The area has been under various leases since 1881 but became part of Newry Station with its establishment in 1890-91 by the Durack family. It has been managed over the years as an outstation of Auvergne Station or as an independent enterprise.



Nganalang Rock Art

Keep River

Keep River is thought to have been named around 1888 after Harry Francis Keep, an agent and storekeeper in Wyndham between 1886 and 1888. With an interest in bringing horses from the Northern Territory to the Halls Creek goldfields, he probably encountered this river on exploration trips with the Duracks. A trip to the Keep River is mentioned in Patsy Durack's diary entry on the 19 August 1894.

A national park

Keep River National Park was established by the Conservation Commission of the Northern Territory in 1981 and extended in 1987. It now covers approximately 600 square kilometres of spectacular scenery, varied ecosystems and important fauna and flora.

The Keep River National Park Local Management Committee has input into the management and development of the park. It includes representatives from traditional custodians, the pastoral industry, the Parks and Wildlife Commission of the Northern Territory, the Shire of Wyndham-East Kimberley and a representative from the tourism industry.

Further Information

Keep River National Park
PO Box 344
Katherine NT 0851
Telephone (08) 9167 8827

Katherine Regional Office
Parks and Wildlife Commission
1920 Giles St
PO Box 344
Katherine NT 0851
Telephone (08) 8973 8770
Fax (08) 8972 2373

Further Reading

Keep River National Park Plan of Management (1992)
Conservation Commission of the Northern Territory

Geology of the Northern Territory - Keep River National Park
Northern Territory Geological Survey
NT Department of Mines and Energy

LAKE ARGYLE

Where: Approximately 50 kilometres south of Kununurra, accessed by a 34 kilometre sealed road to Lake Argyle dam signposted 36 kilometres southeast of Kununurra on the Victoria Highway.

Area: 980 square kilometres at storage level with a length of 75 kilometres (north/south) and a width of 40 kilometres (east/west). 2072 square kilometres at maximum flood.

Attractions/Significance: Lake Argyle is the main storage reservoir for the Ord Irrigation Scheme allowing intensive agriculture on the flat plains of the lower Ord Valley. Australia's largest freshwater lake, with abundant wetland fauna.

- ***Volume:*** 10 760 million cubic metres at Storage Level (11 million megalitres). 34 655 million cubic metres at Flood Level (34 million megalitres).
- ***Levels:*** Highest l evel recorded to date:- 98m (Australian Height Datum). Lowest level recorded since filling:- 78m (AHD). Greatest rise in one wet season 13m.
- ***Depth:*** Maximum depth at Storage Level 43 m (over drowned river channel). Large areas in the southeast are shallow with a depth of less than 0.5m.

THINGS YOU NEED TO KNOW

Camping and hotel accommodation is available at the Lake Argyle Tourist Village. Telephone (08) 9168 7360 or Fax (08) 9168 7355.

Boating on Lake Argyle is subject to navigable waters regulations.

Weather conditions on the lake can change rapidly, particularly during the wet season, creating hazardous conditions for boating.

THINGS TO DO

Lake Argyle offers a wide expanse of water for boating and fishing.

Cruises on the Lake are available. Contact Lake Argyle Cruises for details. Telephone (08) 9168 7361 or Fax (08) 9168 7461.

Argyle Homestead Museum displays memorabilia from the pioneering days of the Duracks. This reconstruction of the Argyle Downs homestead incorporates much of the stone used in the original homestead. The stones were salvaged before the waters of Lake Argyle inundated the homestead.

ABOUT THE LAKE

Lake Argyle has been formed by the damming of the Ord River and was so named because it flooded much of Argyle Downs Station. It is bounded by the Carr Boyd Ranges to the north and west. The eastern and southern shores are mainly low lying.

The dam wall

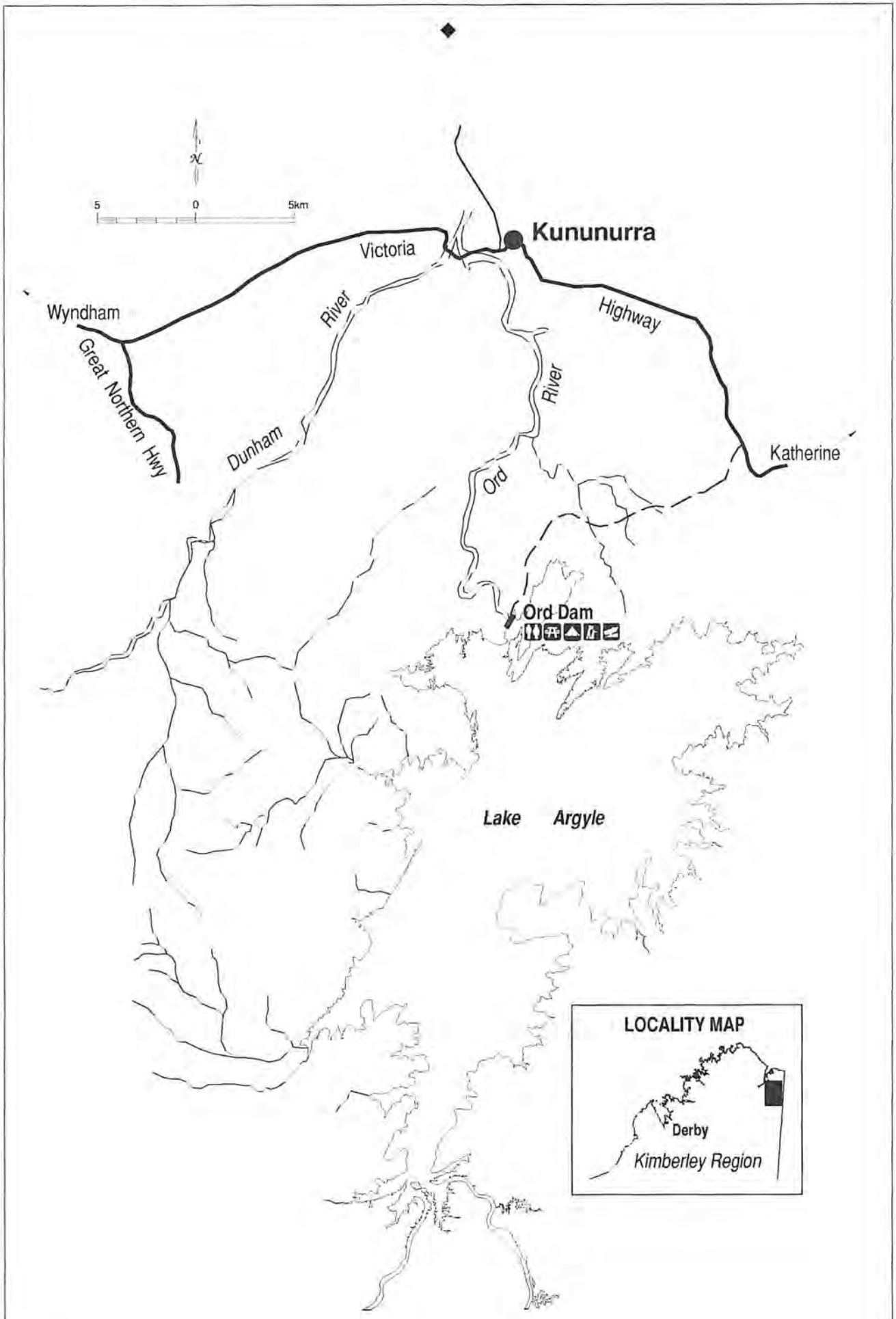
Construction of the dam wall commenced in 1969 and was completed in 1972. A joint Commonwealth and State Government Project, it was built at a cost of $22 million by the contractor Dravo Pty Ltd. The dam wall consists of an impervious clay core protected on both sides by gravel filters and supported by rockfill. The top of the embankment is about 68m above the original river level and 335m in length. In its deepest part the embankment foundation is about 30m below the river level.

The spillway

The spillway consists of an open channel blasted through a rock saddle to enable surplus water to be discharged. The spillway has a length of 2,200m and a bottom width of 12m. It drains into Spillway Creek, which joins with Stonewall Creek to flow into the Ord River downstream from the dam. The Spillway now has a six-metre weir to increase the storage level of Lake Argyle for the Ord Hydro Power Station. The spillway level is now 92.2m (AHD).

Catchment

The lake fills during the wet season with the flow from the Ord River, the Bow River, the Behn River and smaller creeks. The catchment area covers 46,200 square kilometres. The lake first filled during the second wet season after the completion of the dam, first reaching


5
0
5km
Kununurra
Victoria
River
Highway
Wyndham
Great Northern Hwy
Dunham
River
Ord
Katherine
Ord Dam
Lake Argyle
LOCALITY MAP
Derby
Kimberley Region

spillway level, then 86.7m (AHD) on the 11th January 1974. The lake loses approximately three metres per year to evaporation.

Islands

Lake Argyle has about 70 islands, the largest being Hagan Island with an area of about 1400 hectares. Hagan Island also has the highest mountain, Mt Misery at 343m. The islands are rugged outcrops of sandstone and/or siltstone.

Hydro power scheme

In 1995 construction of a 30 megawatt hydro power station at the Argyle Dam Wall commenced and now supplies power to the towns of Kununurra and Wyndham as well as the Argyle Diamond Mine. Around seven million cubic metres of water is released from the lake per day to generate electricity. 220 gigawatt hours of electricity is produced annually.

THE WILDLIFE

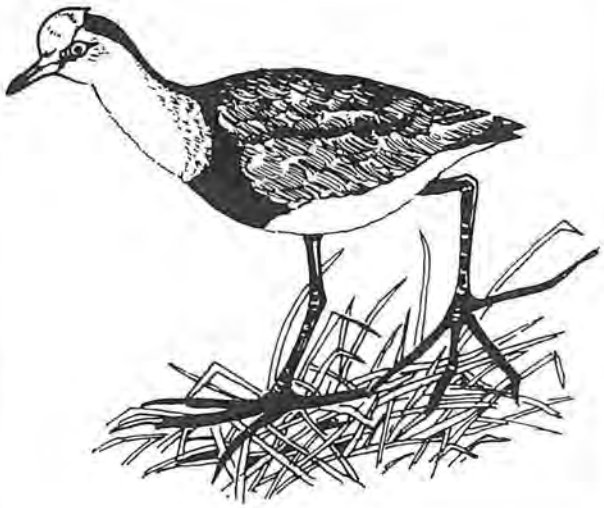
The forming of Lake Argyle has created a unique ecosystem. The wetlands are a major dry season refuge for a large number of waterbirds, a significant migration stopover area for shorebirds and a major habitat for freshwater crocodiles.

Dead trees

Large areas of dead trees occur in shallower parts of the lake, especially at river mouths. These provide nesting sites for birds such as the pied cormorant and osprey and roosting sites for white-breasted woodswallows.

Aquatic plants

Vast areas of shallow water in the east of the lake are covered by mats of aquatic plants such as ribbonweed (*Vallisneria spiralis*), floating pondweed (*Potamogeton tricarinatus*), and red water milfoil (*Myriophyllum verrucosum*). These provide habitat for the comb-crested jacana, popularly called the Jesus bird since it gives the appearance of walking on water.



Comb crested jacana

Fringing plants

Herbs such as the sesbania pea (*Sesbania cannabina*) grow near the high water mark. The brightly coloured yet rarely seen yellow chat favours the shrubs fringing the edge of the water.

Fringing forests

An unexpected side effect of the construction of Lake Argyle was the development of new forests around the fringes of the lake in isolated areas. They are composed of river red gum (*Eucalyptus camaldulensis*), which has extreme tolerance for flooding followed by long periods of drought. The trees occur in even aged tracts corresponding to the annual flooding levels of the lake. The seed source was the riverine forests along major creeks and rivers entering the lake. The rare purple-crowned fairy-wren can be found in these forests particularly amongst thickets of the thorny parkinsonia, a declared weed.

Islands

The rocky islands of Lake Argyle like the nearby rugged ranges of the Carr Boyd Range are sparsely vegetated with spinifex (*Plectrachne* sp). The common wallaroo or euro is found on the larger islands along with a variety of reptiles such as lizards, water monitors, and snakes. Golden orb weaver spiders and their strong webs are often

encountered. The young spiders are effectively dispersed by the wind over many kilometres on a parachute-like web.

Surrounds

Areas surrounding the Lake support a low open woodland over grasses or grasslands with few trees. On the rocky ridges of the Carr Boyd Ranges, where spinifex predominates, the short-eared rock-wallaby may be found.

Crocodiles

Freshwater crocodiles are abundant in Lake Argyle. Estimates have varied from 6-25,000; probably the largest population in the world in one wetland. Saltwater crocodiles have been reported in the lake; however, numbers are thought to be low. Crocodile farms have been issued permits to collect freshwater crocodiles and eggs from the Lake.

At the outlet below the dam a group of freshwater crocodiles can often be seen, some of which have been estimated at over four metres in length.

Birds

Over 240 species of birds have been recorded in the vicinity of Lake Argyle, which is almost one third of the species found in Australia. Birds of prey such as the osprey and white-bellied sea-eagle are commonly seen. In woodland along the shores bush birds such as the great bowerbird and a variety of honeyeaters and finches can be found. The white-quilled rock-pigeon and the sandstone shrike-thrush can be found on the sandstone ridges and islands.

Waterbirds

Vast numbers of waterbirds flock to Lake Argyle for its concentrated and convenient food source. The Royal Australasian Ornithologists Union Remote Wetlands Expedition of 1986 reported 59 species on the Lake, with a total of 181,400 individuals. Eurasian coot, hardhead, grey teal, pacific black duck, and the wandering whistling-duck have all been recorded in thousands.

Migratory waders

Fifteen migrant shorebird species have been recorded at Lake Argyle. The oriental pratincole, the little curlew, the wood sandpiper and others use the low-lying lake margins as a stopover area before dispersing across the Kimberley as the wet season sets in.

Fish

Twenty-six species of fish have been recorded, none of which has been introduced. The giant glassfish is a freshwater fish known in WA only from the Ord River system including Lake Argyle. The large population of silver cobbler in the lake supports a commercial fishery, the only inland freshwater fishery in Australia. 150 tonne live weight of silver cobbler are taken each year using set nets.

LOOKING BACK

Miriwoong

The Miriwoong people occupied the area now covered by Lake Argyle for thousands of years. They were river people with life focussed on the Ord River system. Rivers and creeks were the main geographical features used as reference points. Trading, social and ceremonial gatherings were usually near water.

Miriwun rock shelter

A rock shelter now under the waters of Lake Argyle was excavated by the Western Australian Museum in 1971 before the lake filled. Campsite debris from the Miriwun rock shelter gave a radiocarbon dating age of about 18,000 years. Throughout the 18,000 years of Miriwun's habitation the human occupants exploited a wide range of food. From the river came shellfish, reptiles, catfish and magpie goose eggs. From the land came wallabies, possums, bandicoots, lizards and rodents. The numerous eggshell fragments of the magpie goose, which breeds only in the wet season, indicate that the Miriwun site was used as a wet season camping place.

Explorers and pastoralists

In 1879 the explorer Alexander Forrest reported on the potential of the fertile Ord River basin. Pastoralists came from eastern Australia with mobs of cattle being driven overland.

The Duracks

The Durack family headed by Patsy Durack arrived in the area in 1885 after droving for two years. They settled on the banks of the Behn River and established Argyle Downs, Lissadell and Rosewood stations. Argyle Downs was named after the county of Argyle in the Colony of New South Wales near Goulburn where the Duracks came from. This county was one of many nostalgically named by the government of the colony after English and Scottish counties.

Before the formation of the lake, the Argyle Downs homestead was dismantled and reconstructed some 20 kilometres north of where it was originally built by the Duracks in 1894. Some of the original homestead buildings and yards remain intact under the waters of Lake Argyle today.

The Ord River Irrigation Scheme

Kimberley Durack, a son of the pioneering Duracks, first suggested a dam on the Ord River for irrigation in the 1940s, but it was not until 1960 that the Ord River Project began. Stage one involved the construction of the Diversion Dam, irrigation channels and the township of Kununurra. The second stage centred on the construction of the Ord River dam, 56 kilometres upstream of the diversion dam, to provide the major storage reservoir, Lake Argyle.

Conservation value

The islands in Lake Argyle and the Carr Boyd Ranges to the west and northwest of the lake have been proposed as a national park. Lake Argyle is listed as a 'Wetland of International Importance' under the Ramsar Convention. The Ramsar Convention is a treaty signed by national governments in 1971 in the Iranian town of Ramsar, aiming to conserve wetlands. The Australian Government as a signatory has made a commitment to provide for the conservation of the wetlands it has listed.

Further Information

Water Corporation
PO Box 21
Kununurra 6743
Telephone (08) 9168 0777
Fax (08) 9168 0700

Lake Argyle Cruises
PO Box 710
Kununurra 6743
Telephone (08) 9168 7361
Fax (08) 9168 7461

Further Reading

A Directory of Important Wetlands in Australia
Australian Nature Conservation Agency

'The Fringing Forests of Lake Argyle'
Landscope Vol 3 No 1 Spring 1987

Kings in Grass Castles
Mary Durack

Sons in the Saddle
Mary Durack

LAKE KUNUNURRA

Where: Adjacent to Kununurra, the Victoria Highway crosses the diversion dam five kilometres west of the town.

Area: 2500 hectares

Attractions/Significance: Lake Kununurra was created by the damming of the Ord River to provide a continuous supply of water to the Ord Irrigation Scheme.

THINGS YOU NEED TO KNOW

Saltwater crocodiles may inhabit the Lake.

Freshwater crocodiles live in the lake. Although these crocodiles are not usually a danger to people, parents should exercise caution with small children.

THINGS TO DO

The lake provides opportunities for wildlife observation, recreational boating and fishing.

Scenic and wildlife cruises are available on the lake. Contact local tourist bureaus for details.

ABOUT THE LAKE

Diversion dam

Lake Kununurra has formed by the building of the diversion dam for the Ord Irrigation Scheme. Building of the dam commenced in 1961 and was completed in 1963. There are 20 radial gates within the dam which can be opened to allow a full flow of water into the lower Ord. The roadway across the dam is 20m above the Ord River. It is believed to be one of the first concave dam structures to be built in the world. The dam raises the level of water in the Ord River so that it can be gravity fed to the farms on the Ivanhoe Plain.

Lake and swamps

Lake Kununurra comprises the drowned river channel of the Ord River. The densely vegetated backwaters of the lake form Packsaddle, Lily Creek, Emu Creek and Everglades Swamps.

THE WILDLIFE

Fringing forest

The Lake Kununurra waterway is fringed with a forest of paperbarks (*Melaleuca leucadendra*), flooded box (*Eucalyptus microtheca*), and the river red gum (*Eucalyptus camaldulensis*). Other trees include the broad-leaved Leichhardt tree (*Nauclea orientalis*), and the white dragon tree (*Sesbania formosa*), which bears edible large white pea flowers.

Swamps

In the shallows along the waterway and throughout the swamps are stands of bullrushes, predominantly cumbungi (*Typha domingensis*), but also the tall spikerush (*Eleocharis* sp). Aquatic plants include waterlilies such as the water snowflake (*Nymphoides indica*), which bears small white flowers, and the giant waterlily (*Nymphaea gigantea*), which has large blue purple flowers. Submerged plants include hydrilla (*Hydrilla verticillata*) and ribbonweed (*Vallisneria spiralis*).

Birds

The lake and swamps are rich in birdlife, with 55 waterbirds recorded, many of which breed there such as bitterns and egrets. Comb-crested jacana are common while uncommon birds such as the spotless crake and the oriental reed-warbler have been recorded in the swamps. At times large numbers of magpie geese roost in dead trees in Packsaddle Swamp.

Crocodiles

The lake and swamps are a major breeding area for freshwater crocodiles; numbers are estimated at 7-8,000.

Bats

On Lake Kununurra several colonies of black flying fox can be found in the fringing forests. Their preferred food is blossoms from paperbarks and eucalypts. Some evenings they can be seen flying from their camps at dusk in search of good feeding areas. The little red flying fox and the hoary bat have also been recorded in the area.

Fish

At least 15 species of freshwater fishes, including catfishes, grunters and gudgeons, are known to occur. The striped archerfish, which shoots down insect prey from foliage overhanging the water, is abundant. Cherabun, a type of freshwater crayfish, are also found. Barramundi are rarely caught from the lake.

Turtles

Several turtles inhabit the lake including the northern snake-necked turtle, recognised by its exceptionally long neck, and the northern snapping turtle. The Ord turtle, identified by a salmon pink stripe behind the eye and pink markings on its underside, is only found in Kimberley and western Northern Territory river systems.

LOOKING BACK

Miriwoong

The Ord River valley was occupied by the Miriwoong people for thousands of years. They were river people with life focussed on the Ord River system.

Explorers and pastoralists.

Alexander Forrest's reports of the potential of the fertile Ord River basin in 1879 prompted pastoralists to come from eastern Australia with mobs of cattle being driven overland.

The land now occupied by the township of Kununurra was part of the Ivanhoe pastoral lease.

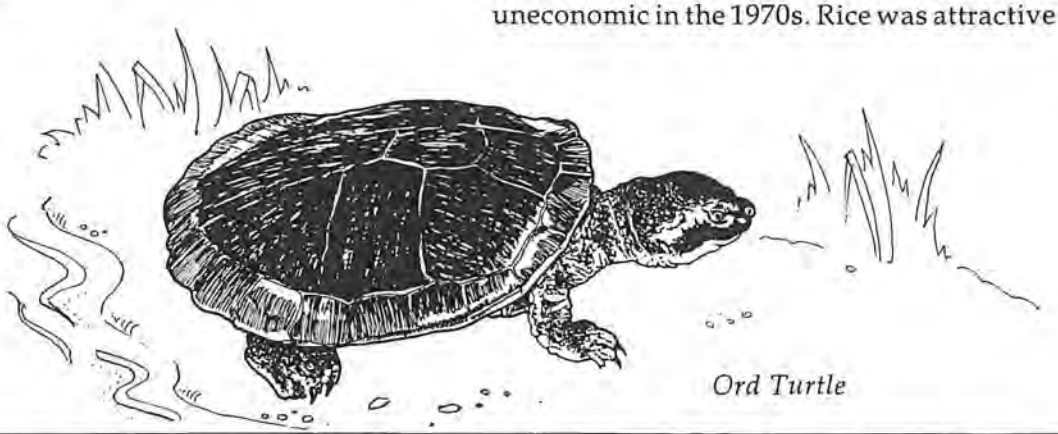
The Ord River Irrigation Scheme

Kimberley Durack, a son of the pioneering Duracks, first suggested a dam on the Ord River for irrigation in the 1940s, but it was not until 1960 that the Ord River Project began. A small experimental farm was established on the Ord in 1941, followed by the Kimberley Research Station in 1945. Early trials demonstrated that under irrigation, rice, cotton, safflower, linseed, and sugar cane grew well in the area.

By 1958 the Western Australian Government was convinced of the viability of an irrigation scheme on the Ord. The Federal Government agreed to share the cost of stage one of the project. Stage one involved the construction of the diversion dam, irrigation channels and the township of Kununurra, which were completed in 1963 at a cost of $20 million.

Stage two, the construction of the Ord River Dam to provide the major storage reservoir of Lake Argyle, was completed in 1972 at a cost of $22 million.

The irrigation scheme has provided the basis for productive horticultural and agricultural industries in the Ord Valley. Cotton was the main commercial crop in the 1960s. However, with insect pests becoming increasingly resistant to pesticides and with the removal of government subsidies, cotton became uneconomic in the 1970s. Rice was attractive to



Ord Turtle

magpie geese, which settled on the crops in tens of thousands to feed on the sweet shoots. These crops were followed by field crops, such as sorghum, sunflower, soybean and maize. In the 1980s high-value hybrid seed crops and horticultural crops such as bananas, mangoes and melons contributed to the strength of the agricultural economy in the Ord Valley. In the 1990s sugar cane is becoming a major field crop.

Kununurra

The name of the town of Kununurra has been taken from the Miriwoong name for the Ord River, and possibly any big river, 'Cununurra'. To avoid confusion with similar sounding place names in Queensland, New South Wales and South Australia, spelling with a 'K' was adopted. The name 'Cununurra' is still used for the clay or cracking black soil found in the Ord Valley.

Conservation value

Packsaddle Swamp on the south side of Lake Kununurra has been proposed as a reserve for nature conservation. Lake Kununurra has been listed together with Lake Argyle as a 'Wetland of International Importance' under the Ramsar convention. The Ramsar Convention is a treaty signed by national governments in 1971 in the Iranian town of Ramsar, aiming to conserve wetlands. The Australian Government as a signatory has made a commitment to provide for the conservation of the wetlands it has listed.

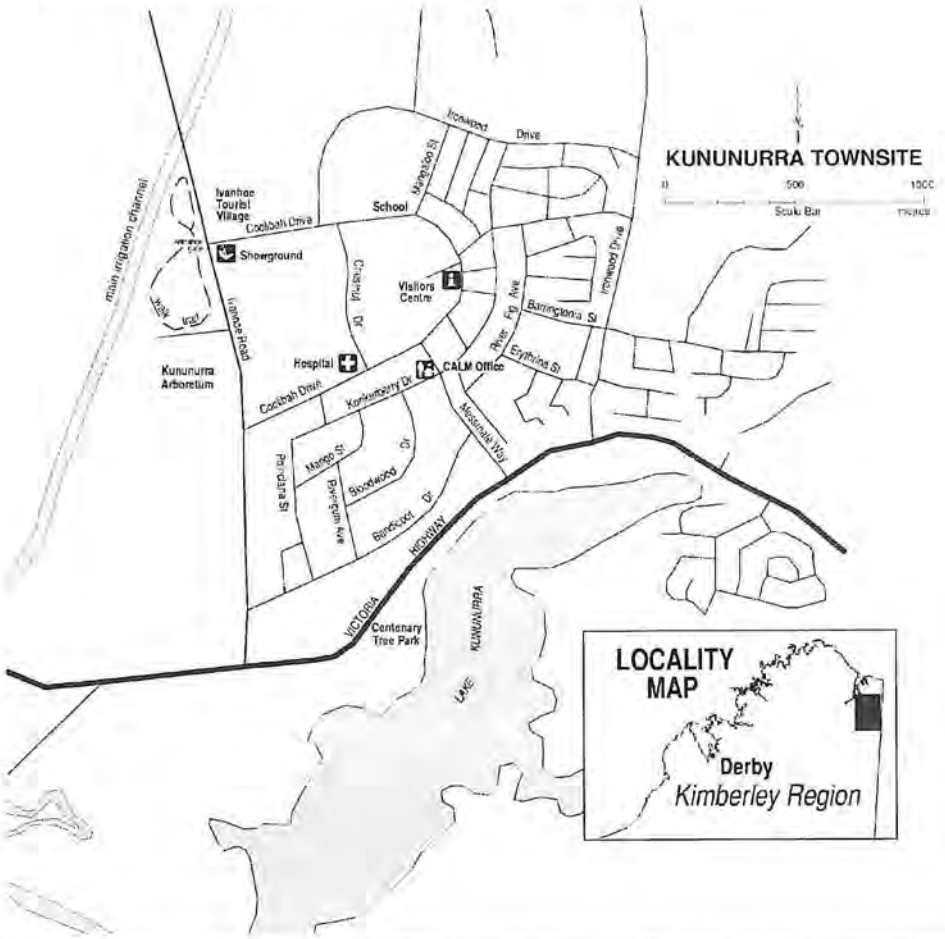
Further Information

Water Corporation
PO Box 21
Kununurra 6743
Telephone (08) 9168 0777
Fax (08) 9168 0700

Further Reading

A Directory of Important Wetlands in Australia
Australian Nature Conservation Agency

Ord River Irrigation Area Kununurra Western Australia
Agriculture WA



KUNUNURRA ARBORETUM

Where: On the western side of Ivanhoe Road, Kununurra. The entrance is opposite the Ivanhoe Caravan Park.

Area: 58 hectares.

Attractions/Significance: Plantings of trees, mostly eucalypts from the Kimberley, but also some exotics. Walk trail with signs describing some of the trees.

THINGS YOU NEED TO KNOW

There is an easy 1.5 kilometre circuit walk trail in the established part of the arboretum with signs describing some of the trees native to the Kimberley.

Pets are allowed but please keep animals under control.

Camping is not permitted. There are caravan parks nearby.

Keep the arboretum clean; please take your rubbish with you.

Drinking water is available.

ABOUT THE ARBORETUM

A 'tree garden'

The Arboretum is a 'tree garden' established in the early 1980s to demonstrate the growth of various trees in a dry monsoonal climate. Most are eucalypts from other areas of the Kimberley. Trees are being trialed for ornamental use as well as potential commercial use. Indian sandalwood was originally trialed here in the early 1980s and is now considered a promising crop for the Ord Irrigation Area.

The landscape

The Arboretum is adjacent to the main irrigation channel for the irrigation area. The overburden from the channel has been dumped in the area giving the previously flat land slight undulations.

Black soil

The black soil or 'cununurra clay' originally supported plants such as the bauhinia (*Lysiphyllum cunninghamii*), and canegrass (*Sorghum* sp), which can still be seen in undeveloped areas. Irrigation transforms this 'cracking' soil to an excellent year round growing medium for a wide range of agricultural crops as well as various trees.

Wildlife

The woodland habitat created by the tree plantings attracts many birds to this area. The nearby irrigation channel and sewerage ponds are used by water birds. At times agile wallabies graze the regrowth on mown areas.

Future plans

In the future CALM plans to relocate its depot and office complex to a site in the arboretum. Landscaping for the new complex will complement previous tree plantings.

Further Information

The Department of Conservation
and Land Management,
East Kimberley District Office,
Messmate Way,
Kununurra

PO Box 942
Kununurra, 6743
Telephone (08) 9168 4200
Fax (08) 9168 2179

WOLFE CREEK METEORITE CRATER RESERVE

Where: Situated on the edge of the Tanami Desert about 100 kilometres south of Halls Creek. It can be reached via the Tanami road, which is gravel and accessible to conventional vehicles during the dry season.

Area: 1460 hectares.

Gazetted: November 1968

Attractions/Significance: A spectacular meteorite crater, the second largest in the world (after Meteor Crater in Arizona, USA), from which fragments of a meteorite have been collected.

THINGS YOU NEED TO KNOW

Camping is not permitted in the reserve.

The area around the reserve is pastoral lease; please stay on the roads marked on the map.

The 200 metre return walk to the top of the crater rim involves a rocky climb. It is not recommended to climb down into the crater because the steep terrain and loose rocks make it dangerous.

CARING FOR WOLFE CREEK CRATER

Help keep the reserve clean, please take your rubbish with you.

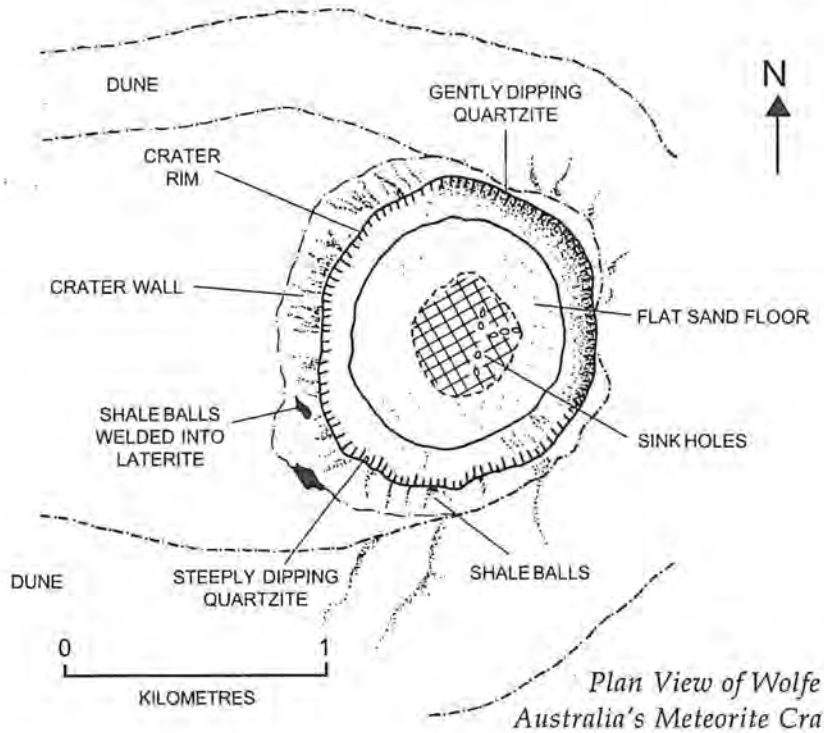
Dead wood is an important ecological resource in the Kimberley. Fires are not permitted; however, gas stoves may be used.

Leave animals, plants and rocks, including meteorite fragments, as you find them for all to enjoy.

Pets and firearms are not permitted.

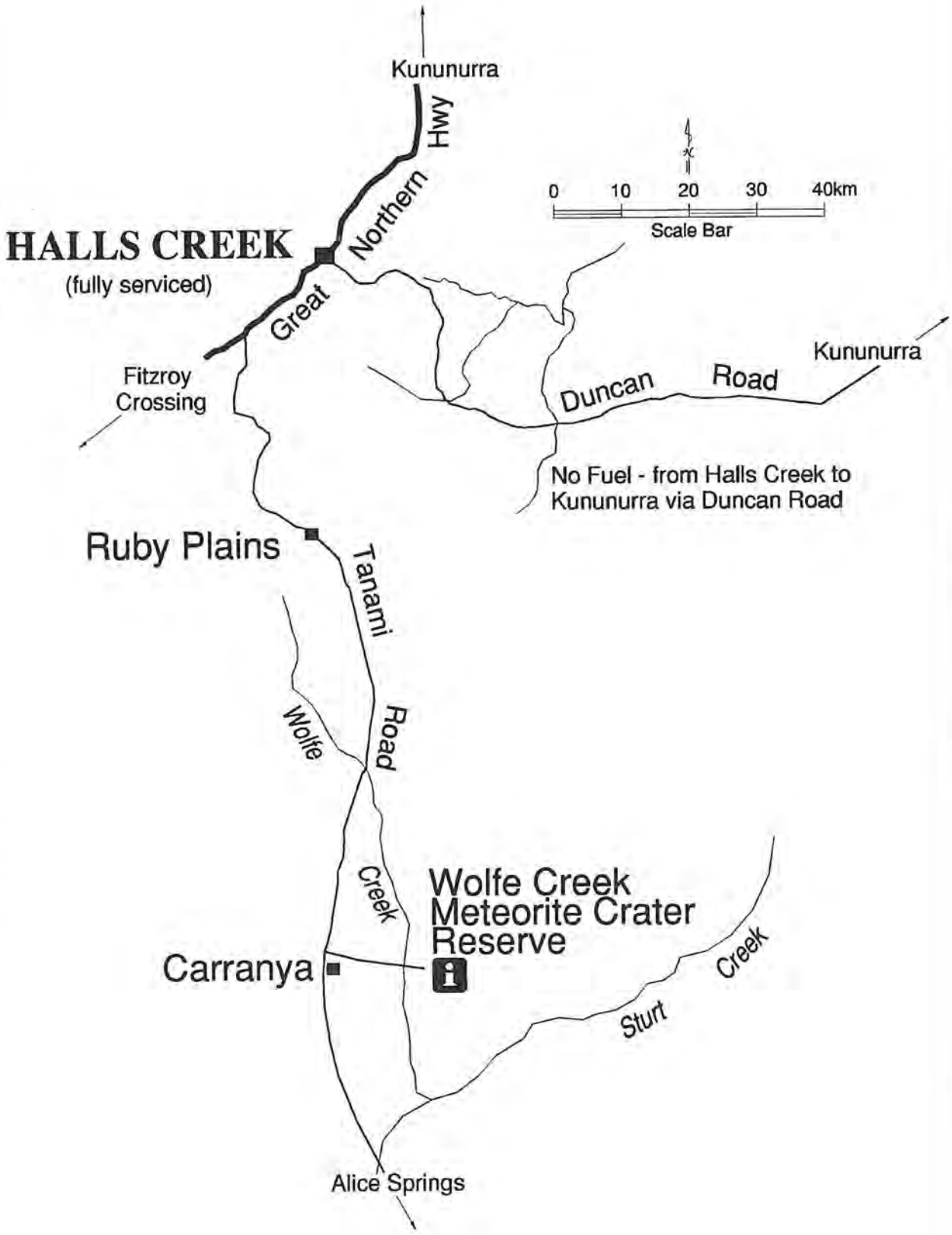
ABOUT THE CRATER

Wolfe Creek Meteorite Crater is almost circular, its diameter varying between 870 and 950m. The outer slopes of the crater rise up at an angle of about 15° to form a ridge, which may be up to 35m above the surrounding sand plain. The inner walls plunge more steeply at angles as much as 40°, to the flat crater floor some 55m below the rim. The crater floor has a diameter of about 675m and lies as much as 25m below the level of the surrounding plain. Originally it would have been as much as 150m deeper, but is now largely filled by sand.



Plan View of Wolfe Creek Crater from Australia's Meteorite Craters, WA Museum

MAP 24


Kununurra
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Northern
HALLS CREEK
(fully serviced)
Great
Fitzroy
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Scale Bar
Kununurra
Duncan Road
No Fuel - from Halls Creek to
Kununurra via Duncan Road
Ruby Plains
Tanami
Road
Wolfe
Creek
Wolfe Creek
Meteorite Crater
Reserve
Carranya
Sturt
Creek
Alice Springs

Sand dunes

The crater is a barrier to sand dune movement from east to west. It is partially surrounded by sand dunes that lie up against its eastern side while the area to the west of the crater is clear of dunes.

The walls

The inner walls of the crater expose the Precambrian quartzite rock, some 700 to 800 million years old, in which the crater is formed. In the area around the crater the quartz rich sandstone lies in flat layers but in the walls of the crater these layers are deformed, folded and turned over on themselves. The outer slopes of the crater are covered by many broken quartzite slabs and remnants of the laterite veneer which covered much of the land surface before the crater was formed.

The floor

The floor of the crater is flat and largely sand covered. The central area is made of porous gypsum and pierced by a number of sink holes. These sink holes lie along two intersecting lines reflecting the position of stress fractures formed by the explosive excavation of the crater.

Meteorite fragments

Iron meteorite fragments have been found about 3.9 kilometres southwest of the crater, the largest being 72.6 grams. These angular fragments are part of a larger body that had broken up.

Shale balls

On the southwestern outer slopes of the crater 'shale-balls' are found. These mostly spherical or rounded objects, often tapered at one end, are made of iron oxide. Some have yielded rare nickel bearing minerals. It is thought these shale-balls are the deeply rusted remains of iron meteorites.

How the crater formed

The crater was formed by a violent explosion. The occurrence of meteorite fragments in the vicinity is evidence that the crater was formed by the impact of a large meteorite striking the earth. The greater proportion of fractured rock and the strongest folding of rocks is evident in the southwestern part of the crater. This suggests that the meteorite travelled from northeast to southwest. Further evidence of the direction of the projectile lies in the distribution of the shale-balls and meteorite fragments both on the southwest of the crater.

The most recent dating techniques of the meteorite fragments and rocks from the crater show that Wolfe Creek crater is around 300,000 years old. The meteorite that formed the crater is thought to have weighed in the order of tens of thousands of tonnes.

Meteorites

Meteorites are fragments of asteroids, which orbit between Mars and Jupiter and represent debris left after the formation of the planets. Most are small and burn up by friction in the atmosphere as shooting stars or meteors. Some survive and land on the Earth's surface as meteorites.

Where are the remains of the meteorite?

When a large meteorite collides with the Earth, it punches a hole in the surface of the land and pulverises the rocks deep below the surface. The enormous mass and velocity is instantly converted to heat and immense energy is generated. Consequently the projectile itself and a portion of the rock it has hit is vaporised. The resultant pressure blasts away the overburden. As a result of the formation of an explosion crater the bulk of the meteorite is destroyed.

Will it happen again?

When all factors are taken into account, meteorite impacts producing craters on the scale of Wolfe Creek Crater are predicted to occur about once every 25,000 years. Potentially global catastrophic events that might cause biological extinctions, such as is postulated for the dinosaurs, may occur only every 50 to 100 million years.

THE PLANTS

On the crater rim

The crater rim supports spinifex grassland (*Triodia intermedia*) with scattered shrubs and small trees such as the snappy gum (*Eucalyptus brevifolia*) and a variety of Grevilleas. The brilliant red flowering Wickham's grevillea (*Grevillea wickhamii*), and the orange flowering silverleaf grevillea (*Grevillea refracta*), attract honeyeaters. The cream flowering caustic bush (*Grevillea pyramidalis*) has a gummy substance on the seed pods which can cause burns to the skin if touched. Aboriginal people used it to mark the skin for ceremonial purposes.

On the crater floor

The vegetation of the crater floor is a low open woodland of the wattle *Acacia ampliceps*. The central area of the crater, made of porous gypsum and pierced by a number of sinkholes supports a dense strand of the moisture loving paperbark *Melaleuca lasiandra*. These trees do not grow in the drier area around the crater and it is thought that the seeds of these plants have been dispersed within the crater by the droppings of birds.

On the surrounding plains

The surrounding red sands support spinifex (*Triodia pungens*) with small trees such as the clubleaf wattle (*Acacia hemignosta*), the lemonwood (*Dolichandrone heterophylla*), and hakeas (*Hakea arborescens*).

THE ANIMALS

The dry desert conditions restrict the number of animals and birds in the Reserve. The red kangaroo occurs here but is rarely seen.

Birds

The spectacular and noisy Major Mitchell cockatoo can at times be seen eating seeds from the wattles on the crater floor. Flowering plants such as grevilleas attract honeyeaters such as the grey-headed honeyeater, the white-headed honeyeater and the black honeyeater. These are birds of the arid zone seldom seen in the wetter areas of the Kimberley.

Reptiles

Several reptiles are found in the reserve including a rare dragon lizard (*Tympanocryptis aurita*), which is known only from the Halls Creek and Wolfe Creek area.

LOOKING BACK

'Gandimalal'

Djaru aborigines call the crater 'Gandimalal' and have known of its existence for thousands of years. Their mythology speaks of two rainbow snakes whose sinuous paths across the desert formed the nearby Sturt and Wolfe Creeks. The crater is where one snake emerged from the ground.

Wider recognition

It was not until as recently as 1947 that other people recognised the crater. It was observed from the air by Dr Reeves, a geologist with Vacuum Oil, during an aerial survey of the Canning basin. Since then it has been visited by many scientists from around the world and was gazetted as a reserve in 1968.

Further Information

The Department of Conservation
and Land Management
East Kimberley District Office
Messmate Way,
Kununurra
PO Box 942
Kununurra 6743
Telephone (08) 9168 4200
Fax (08) 9168 2179

Further Reading

Austalia's Meteorite Craters
Western Australian Museum

2.4

Places for Wildlife: nature reserves

Since European settlement in Australia, three-quarters of our rainforests have been cleared and burnt, two-thirds of our original tree cover have been removed, and more than half our arid lands have been degraded. In the past 300 years, half of all mammal species made extinct worldwide have been Australian.

Throughout the Kimberley there are a number of wild and remote areas. In most of these places all of the original animal species remain, unlike other places in Australia where some animals have become extinct and others teeter on the brink of becoming so. These are fragile, sensitive places that don't take kindly to human disturbance. There is immense value in simply knowing that these places exist largely free of human disturbance.

Nature reserves are areas of land set aside by legislation for the conservation of wildlife and landscapes, for scientific study, and for the preservation of features of archaeological, historic or scientific interest.

In the Kimberley, CALM manages nature reserves primarily for nature conservation. Recreation which may damage the natural ecosystems and commercial exploitation of these areas is not permitted.

Access to some nature reserves may be permitted for low impact activities which do not interfere with natural ecological processes. No camping is permitted in these reserves and activities are confined to the appreciation of natural history and the landscape.

Approval must be obtained from CALM before visiting some nature reserves in the Kimberley.

PARRY LAGOONS NATURE RESERVE

Where: Approximately 20 kilometres south of Wyndham. The main access road is signposted on the Great Northern Highway 15 kilometres from Wyndham and 85 kilometres from Kununurra.

Area: 36,111 hectares.

Gazetted: September 1972

Attractions/Significance: An outstanding area for birdlife, the wetlands are an important feeding and breeding area for many species of birds in WA, a recognised stopover point for migratory waders, and an important drought refuge for Kimberley waterbirds. The Parry Floodplain has been listed as a 'Wetland of International Importance' under the Ramsar Convention and has been listed on the Register of the National Estate.

THINGS YOU NEED TO KNOW

Permission is not required to visit Parry Lagoons Nature Reserve.

Saltwater and freshwater crocodiles inhabit Parry Lagoons. Take care and stay back from the water's edge.

Roads within the Reserve, except for the Old Halls Creek road, are passable by conventional vehicles during the dry season (May to October) but are rough in places.

Roads may be closed during the wet season depending on rainfall. To prevent costly damage to roads and for your own safety, please comply with 'Road Closed' signs.

Camping is available at Parry Creek Farm, a freehold block within the Reserve. Bookings are essential. Telephone (08) 9161 1139.

At Marlgu Billabong a walkway and bird hide provide opportunities to view the spectacular birdlife.

During the dry season CALM staff conduct birdwatching sessions. Contact the Kununurra office for details. Telephone (08) 9168 0200.

CARING FOR PARRY LAGOONS

Please stay on designated roads. Minor tracks have been made illegally and are compacting the soil and/or causing erosion.

Leave the reserve clean; please take your rubbish with you.

Help to protect the environment for wildlife. Camping, fires, pets and firearms are not permitted in the reserve.

THE LANDSCAPE

The floodplain

The northern section of the Reserve occupies the flat Ord River floodplain, which is comprised of alluvial plains of black cracking clay, sand plains and tidal mudflats. Small basalt outcrops occur as isolated hills, such as Telegraph Hill and Pivot Hill, which rise 15 to 35m above the plain.

Parry Creek

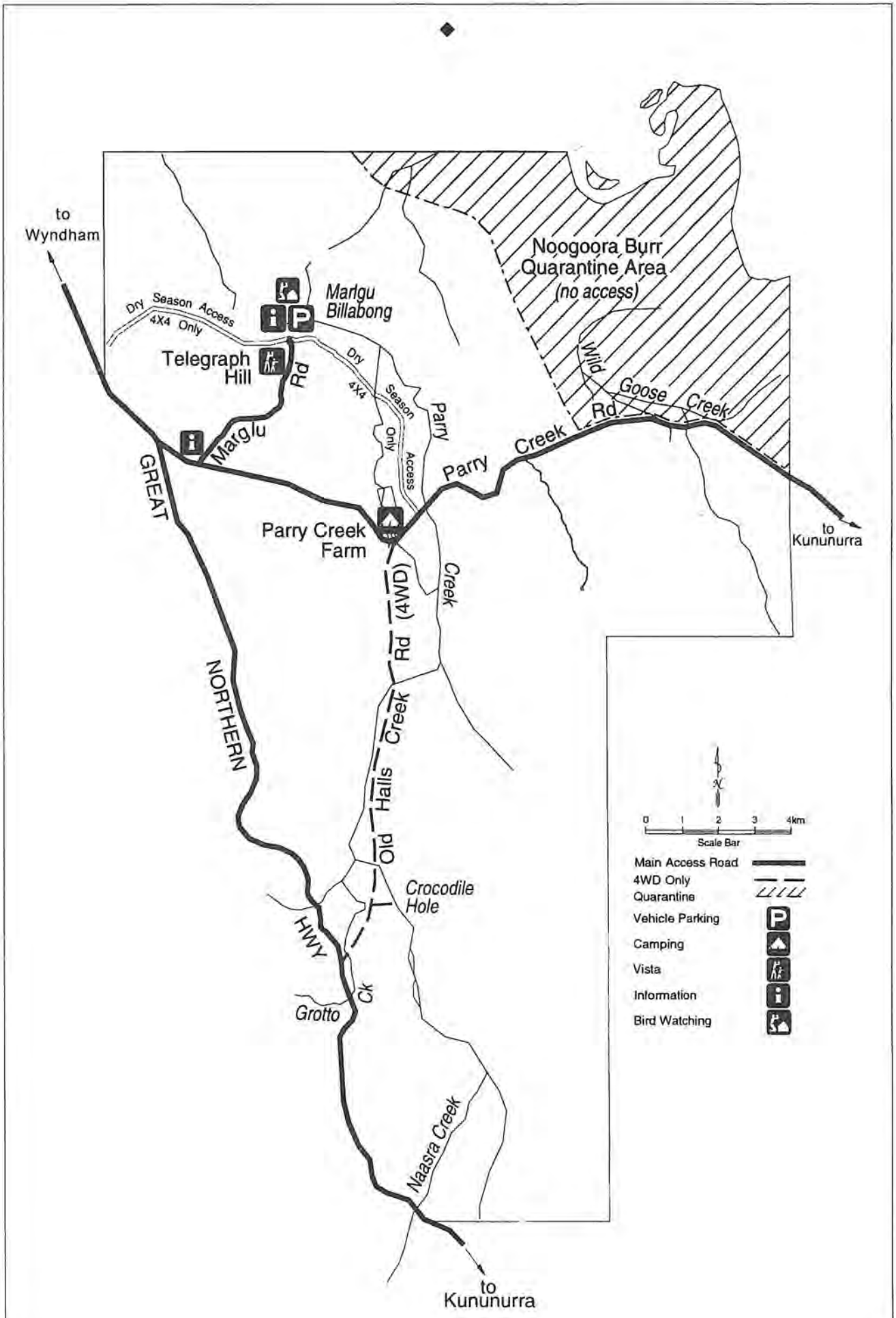
The southern section includes rocky rugged incised hills, cut through the centre by the flat valley surrounding Parry Creek. Although Parry Creek flows only after rain, substantial pools can be found along its course, such as Crocodile Hole. Parry Creek drains north into the flats near Telegraph Hill, ending in the freshwater swamps of Parry Lagoons, which include Marlgu Billabong and Police Hole.

Wild Goose Creek

Wild Goose Creek in the northeast part of the reserve, also seasonal, drains into a series of billabongs and then into the Ord River. The Ord River forms part of the northeast boundary of the reserve and is tidal in this section.

Wet season flooding

Prior to the damming of the Ord River, wet season floods of the Ord River covered the floodplain in most years. The extent of flooding now varies greatly; only in years of high rainfall is the whole floodplain covered.


to
Wyndham
Noogoora Burr
Quarantine Area
(no access)
Marlgu
Billabong
Dry Season Access
4X4 Only
Telegraph
Hill
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Dry
4X4
Season
Only
Parry
Access
Wild
Goose
Creek
Rd
Parry
Creek
Marglu
GREAT
NORTHERN
HWY
Parry Creek
Farm
to
Kununurra
Creek
Rd
(4WD)
Old
Halls
Creek
Crocodile
Hole
Ck
Grotto
Naasra Creek
to
Kununurra
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1
2
3
4km
Scale Bar
Main Access Road
4WD Only
Quarantine
Vehicle Parking
Camping
Vista
Information
Bird Watching

THE PLANTS

Aquatic plants

The seasonal wetlands support a number of aquatic plants. Beautiful waterlilies provide a habitat for comb-crested jacanas or Jesus birds, enabling them to walk on water. They include the giant waterlily (*Nymphaea gigantea*), which bears large blue to white flowers, and the water snowflake (*Nymphoides indica*), with delicate white flowers with fringed petals.

Swamps

Bladderworts (*Utricularia*) and *Ipomoea aquatica*, a pantropical plant used as a fish food in Asia, grow beside the swamps. The bamboo-like tropical reed, *Phragmites karka*, and the sesbania pea (*Sesbania cannabina*) grow at the margins of the wetlands during the wet season. The sesbania dies and collapses to form mats of stems in the dry season.

Grasslands

The grasslands of the flood plains are dominated by Australian wild rice (*Oryza australiense*) in wetter areas, and canegrass (*Sorghum australiense*) in drier areas.

Trees

Trees fringing the wetlands and watercourses include the gutta-percha tree (*Excoecaria parvifolia*), the Leichhardt pine (*Nauclea orientalis*), paperbarks or Melaleucas and the freshwater mangrove (*Barringtonia acutangula*), used by Aboriginal people as a fish poison. Eucalypts include the river red gum (*Eucalyptus camaldulensis*), the flooded box(*Eucalyptus microtheca*), and the ghost gum (*Eucalyptus papuana*).

The rugged hills support open woodland over spinifex and tussock grasses. The valley through which Parry Creek flows supports an attractive woodland of stringybark (*Eucalyptus tetradonta*) and salmon gums (*Eucalyptus bigalerita*).

Boabs (*Adansonia gregorii*) are abundant in many areas of the reserve.

THE BIRDS AND ANIMALS

Birds

The lagoons and billabongs attract thousands of waterbirds especially during the dry season when fresh water in the region becomes scarce. Over 180 species of birds have been recorded on the reserve.

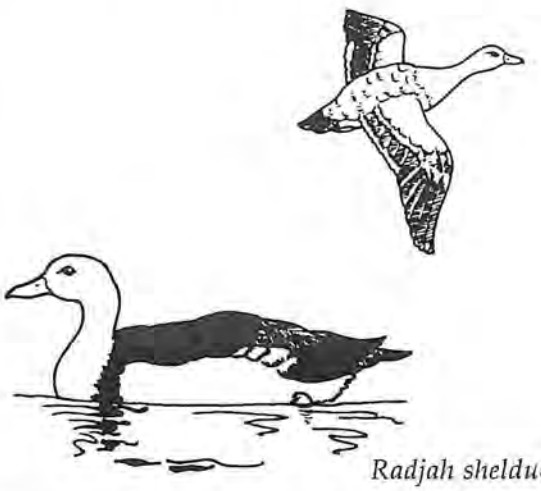
Waterbirds

During the wet season, creeks flow, billabongs fill, the grasslands become green, and in some years the floodplain becomes inundated. Aquatic plants and microorganisms, and insects breed profusely in the warm, shallow waters, providing food which attracts an incredible number and variety of waterbirds. Herons and egrets, ibis, whistling-ducks, magpie geese, darters and cormorants are common. The Radjah shelduck can usually be seen and the rare freckled duck and garganey have been sighted on occasions.

Migratory waders

Around September each year, waders from the northern hemisphere migrate to Australia. Parry Lagoons are an important stopover point for these birds.

Fifteen migrant shorebird species have been recorded. The sharp-tailed sandpiper, the little curlew and the oriental pratincole are commonly seen. The reserve is considered to be the most important site in Australia for the wood sandpiper and the most important site in WA for Swinhoe's snipe.



Radjah shelduck

Birds of the grasslands

The grasslands around the lagoons are utilised by quail, plovers and ground nesting birds such as the singing bushlark for breeding and cover during the dry season. The reserve is the only known locality in WA for the zitting cisticola, and the yellow chat has also be seen here. Finches are numerous in the area and include zebra, long-tailed, double-barred, star, and crimson finches.

Birds of prey

Birds of prey often soar over the lagoons and boabs in the area support the nests of a variety of raptor species.

Mammals

The mammal fauna of the area has not been well studied but is known to include the northern nailtail wallaby, the agile wallaby and the long-haired rat. Parry Creek is the type locality for the Kimberley rock-rat, a species restricted to rugged rocky country in the North Kimberley.

Other creatures

Reptiles include estuarine and freshwater crocodiles, various snakes, Merten's water-monitor and other lizards.

Freshwater fish include the catfish, the rainbowfish, and the archerfish. Barrumundi and other estuarine fish are also found.

LOOKING BACK

Marlgu

'Marlgu' is an Aboriginal name meaning wild bird and this name has been given to the pool where many birds gather. For thousands of years Aboriginal people camped beside the waterholes to fish, collect birds' eggs, and to hunt waterbirds, crocodiles and wallabies.

Explorers

Exploration of the East Kimberley by Alexander Forrest in 1879 on the upper Ord River and the privately funded expeditions of Patsy Durack in 1882 and O'Donnell in 1883 preceded the coming of the graziers. Parry Creek was named after E. Parry, a syndicate member of the Cambridge Downs Pastoral Company, which financed O'Donnell's exploration of the area. The lagoons subsequently took their name from the creek which feeds them.

Pastoral days

Cattle, donkeys, horses, and camels, introduced late last century, grazed preferred grasses and concentrated at the waterholes, destroying or degrading much of the vegetation. Billabongs became silted and shallow as cattle drank from them and ate the water plants. As a result, many billabongs which had previously been permanent became seasonal.

A change in the burning regime, when Aboriginal people ceased to visit the area regularly, may also have altered the vegetation. Previously Aboriginal people had burnt small patches of vegetation throughout the year while hunting game.

Roads

The discovery of gold at Halls Creek in 1884 led to the gold rush of 1886. The Government using prison labour (mostly Aboriginal) subsequently upgraded the bush tracks from the port of Wyndham to Halls Creek and Darwin. On the Old Halls Creek road, which runs through the reserve, the rocks that lined the original hand built road edges and creek crossings can still be seen in places.

Telegraph station

In 1914 a radio and telegraph station was built on Telegraph Hill to assist ships entering Wyndham Port. During World War I it was also used by naval intelligence to intercept radio traffic. The station played a vital role in the tracking and sinking of the German ship Emden. The ruins of the telegraph station are still evident today.

Cattle

In 1919 the Wyndham meatworks opened. The mobs of cattle driven overland from Kimberley pastoral leases were rested and fattened at Marlgu Billabong and at Chimooli, halfway between Marlgu and Wyndham, where there was a dam and holding paddock. Some two million cattle passed through en route to Wyndham abattoir up till 1962. After this time trucks were used to transport livestock. In 1985 the Wyndham meatworks closed because of industrial problems, poor markets and the development of the live cattle trade.

Damming of the Ord

The construction of the diversion dam forming Lake Kununurra in 1963, and more significantly, the Ord River dam forming Lake Argyle in 1972 altered the flow of the Ord River. Water is released in a regulated fashion to allow for irrigation, resulting in a steady flow of water down the river. The massive and frequent flooding of the floodplain from the Ord has ceased and only in periods of intense rainfall does Parry Creek flood the lagoons. Lines of riverine trees well back from the current billabong margins indicate where more normal water levels would have been.

Wildlife reserve

The Reserve was created in 1972 when the then Department of Fisheries and Wildlife (a predecessor of CALM), the Shire of Wyndham-East Kimberley, and the local community recognised the importance of the wetlands for birdlife. It is a good example and one of few tropical floodplains of substantial area in WA. Since the first gazettal there have been several additions consolidating boundaries and increasing the value of the Reserve.

In 1978 the Reserve was listed on the Register of National Estate, and in 1990 the Parry Floodplain was listed as a 'Wetland of International Importance' under the Ramsar Convention. The Ramsar Convention is a treaty signed by national governments in 1971 in the Iranian town of Ramsar aiming to conserve wetlands. The Australian Government as a signatory has made a commitment to provide for the conservation of the wetlands it has listed.

Management

Parry Lagoons Nature Reserve is managed for nature conservation. People's interest and appreciation of the area brings problems mainly associated with access. During the dry months vehicle tracks proliferate across the flats and around waterholes leading to the loss of vegetation. This may disturb wildlife, compact soil and cause erosion. With the construction of better quality tracks and car parks, and through education, vehicles are being limited to designated roads and tracks.

Large uncontrolled fires also pose a threat to the grasslands. Prescribed burning is carried out early in the dry season to help minimise the risk by reducing the build up of flammable material. It is also important for visitors to respect the NO FIRES regulation.

To help visitors appreciate and care for this important wetland, an information shelter, partly funded by Australian Geographic, has been placed in the reserve. A boardwalk and birdhide have been constructed at Marlgu Billabong with the assistance of a National Ecotourism Program grant.

Further Information

The Department of Conservation
and Land Management
East Kimberley District Office
Messmate Way, Kununurra
PO Box 942
Kununurra 6743
Telephone (08) 9168 4200
Fax (08) 9168 2179

Further Reading

'Parry Lagoons'
Landscope Vol 8 No 3 (Autumn 1993)

A Directory of Important Wetlands in Australia
Australian Nature Conservation Agency

POINT SPRING NATURE RESERVE

Where: Approximately 45 kilometres north of Kununurra at the base of the Weaber range.

Area: 303 hectares.

Gazetted: 1977

Attractions/Significance: One of very few closed canopy rainforest patches in the lowlands of the East Kimberley occurs in the reserve. A variety of species depend on Point Spring for their persistence in the district.

THINGS TO KNOW

Approval for persons or groups to visit Point Spring Nature Reserve must be obtained from the Kununurra District Office of CALM prior to the proposed visit. Approval will be given for genuine environmental education purposes only.

Telephone (08) 9168 0200
or Fax (08) 9168 2179

Tracks to Point Spring Nature Reserve are suitable for four-wheel-drive vehicles only. Tracks are closed during the wet season as they cross black soil plains. To prevent costly damage to roads and for your own safety, please comply with 'Road Closed' signs.

CARING FOR POINT SPRING

Help to conserve this special rainforest community. Camping, fires, pets and firearms are not permitted in the reserve.

Plants, animals, wood, rocks and soil are all part of the rainforest community. Leave things as you find them for all to enjoy.

Leave the reserve clean; please take your rubbish with you.

THE LANDSCAPE

The Weaber range

Point Spring is a permanent spring at the base of the Weaber range - a low sandstone range rising from sand and black soil plains. The sandstone which forms the Weaber range, named 'Point Spring sandstone' by geologists, was deposited in a river delta during the Late Carboniferous age about 300 million years ago.

The spring

Point Spring is a series of several soak lines at the base of the range. It drains into a rainforest patch surrounding the spring.

Watercourses

A small swamp to the west of the rainforest patch is spring fed. This swamp dries out during the dry season, especially after poor wet seasons.

A small creek, Melon Creek, runs through the reserve but flows only after rain.

THE PLANTS

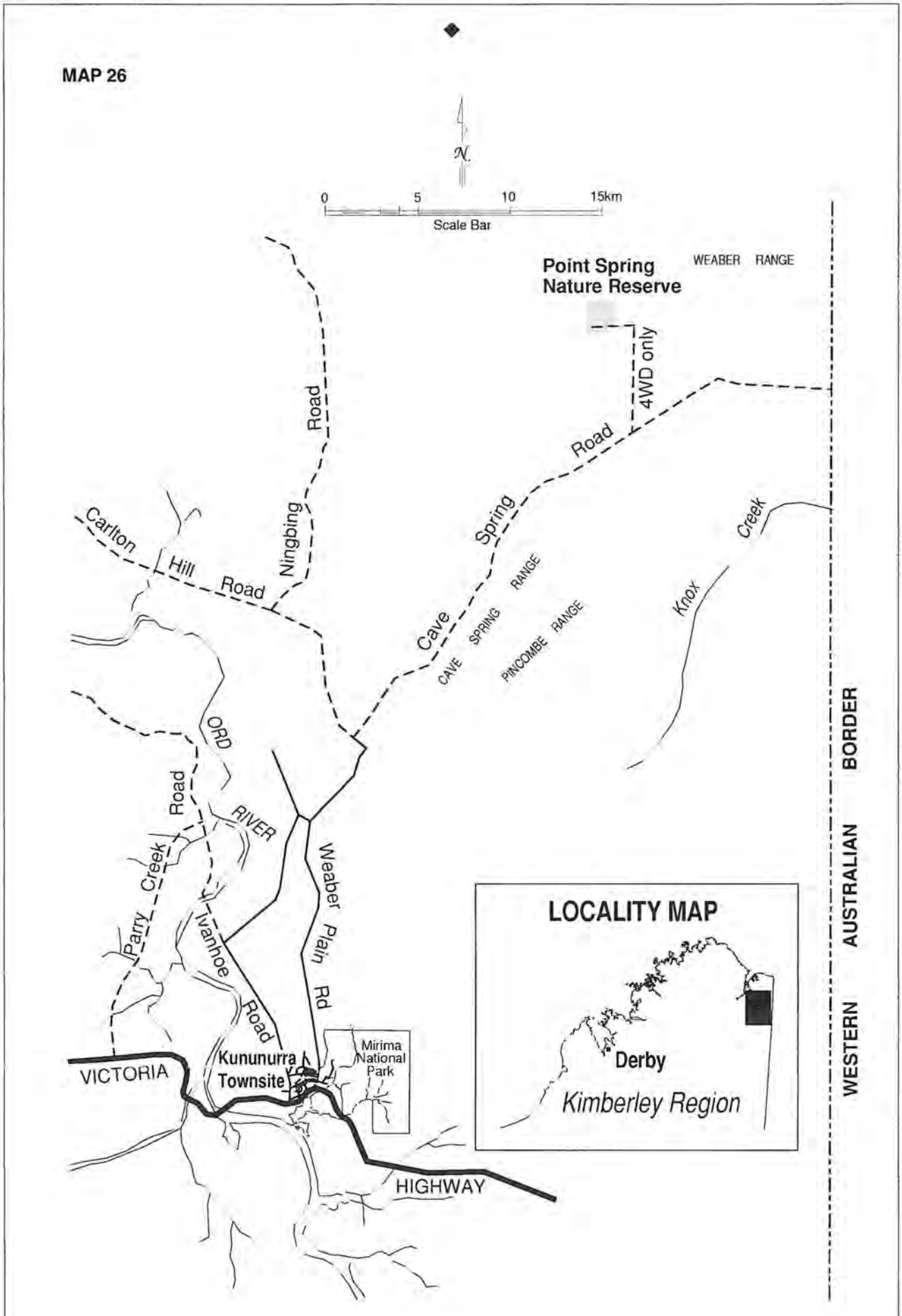
Rainforest

Around the spring, in the small patch of closed canopy rainforest grow trees which are quite different to those in the surrounding woodlands. Their foliage is dense, and their leaves are often broad, glossy, and dark or bright green coloured, in contrast to the narrow, grey-green leaves of the eucalypts.

Trees

Some trees, such as the terminalia (*Terminalia seriocarpa*), with its layered branches, and the cluster fig (*Ficus racemosa*), show buttressing. The cluster fig is also called the stem-fruit fig because it bears large clusters of colourful, edible figs on its trunk and main branches. Another fig, the banyan (*Ficus virens*), often grows from a seed deposited by birds in the fork of a host tree and then produces many aerial roots. These eventually encircle and kill the host tree. It is also called the strangler fig.

The euodia (*Euodia elleryana*), a popular tree for tropical gardens, occurs naturally in WA only in the rainforest patches of the East Kimberley. Its rich glossy green leaves in groups of three, smell of citrus when crushed,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Scale Bar
Point Spring
Nature Reserve
WEABER RANGE
4WD only
Road
Spring
Cave
Creek
Knox
CAVE SPRING RANGE
PINCOMBE RANGE
Carlton
Hill
Road
Ningbing
Road
ORD
RIVER
Road
Parry Creek
Ivanhoe
Road
Weaber Plain Rd
VICTORIA
Kununurra
Townsite
Mirima
National
Park
HIGHWAY
WESTERN AUSTRALIAN BORDER
LOCALITY MAP
Derby
Kimberley Region

and it bears pink, nectar-rich flowers in clusters behind the leaves. The Leichhardt pine (*Nauclea orientalis*) and the sesbania or dragon flower tree (*Sesbania formosa*), which bears large edible pea flowers, are also found in the reserve.

Fruits

Many of the rainforest trees such as the figs produce edible fruits, which are attractive to birds such as the yellow oriole. They were also sought by Aboriginal people. The carallia (*Carallia brachiata*), which is closely related to the mangroves, bears small edible red berries which produce a bright red colour when crushed. It was the seeds of the canarium (*Canarium australianum*), which were eaten, rather than its blue-black fruits.

Creepers

Creepers, such as *Flagellaria indica*, whose leaves have tendrils to help it climb, grow profusely in the wet season and contribute to the humidity of the rainforest microclimate.

THE ANIMALS

Surveys of fauna have not been extensive.

Mammals include the short-eared rock-wallaby, which makes its home in the sandstone range. At times, colonies of fruit bats, black flying foxes and little red flying foxes inhabit the rainforest.

Reptiles include various snakes, such as the olive python, and a variety of lizards such as skinks and monitors.

Birds which may be seen include typical rainforest birds such as the green-backed gerygone which gleans insects in the foliage of the rainforest canopy and the fruit-eating yellow oriole. The swamp attracts waterbirds such as egrets, herons, brolgas and jabirus.

LOOKING BACK

As one of few rainforest patches in the area with large numbers of edible fruits, Point Spring was likely to have been an important food gathering area for the Gadjerong people.

With the coming of the European pastoralists, the permanent water of the spring made the area an important watering and mustering site for cattle. Timber cattle yards, which feature a one way gate and stock water troughs, can still be seen in the reserve today.

Point Spring was originally under the control of the Public Works Department as a water reserve, and Ivanhoe Station still has water rights to the spring. It was gazetted as a nature reserve for the conservation of flora and fauna in April, 1977.

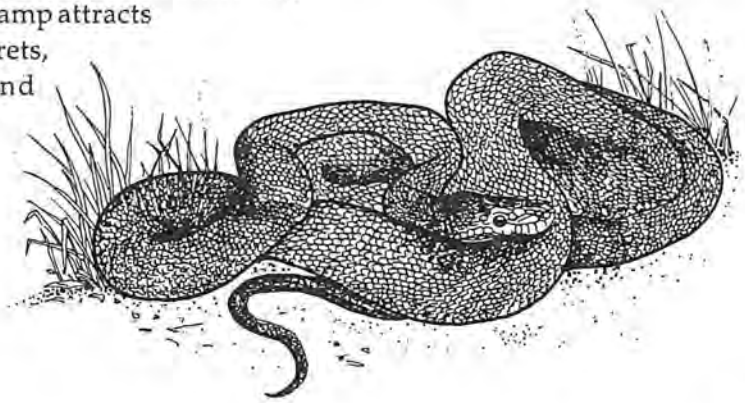
The reserve has been fenced to prevent damage by cattle from the surrounding pastoral lease. Cattle could trample and open up the rainforest and allow the invasion of grasses, making the rainforest more vulnerable to fire.

Further Information

The Department of Conservation
and Land Management
East Kimberley District Office
Messmate Way,
Kununurra
PO Box 942
Kununurra 6743
Telephone (08) 9168 4200
Fax (08) 9168 2179

Further Reading

'WA's Rainforests'
Landscope Vol 3 No 2 (Summer 1987)



Olive python

COULOMB POINT NATURE RESERVE

Where: On the Dampier Peninsular, approximately 75 kilometres north of Broome. Access from Cape Leveque road via the Willie Creek turn-off to Minari 27 kilometres from Broome.

Area: 28,676 hectares.

Gazetted: September 1969

Attractions/Significance: An area of the acacia dominated woodlands known as 'pindan' and attractive tropical coastline with diverse wildlife.

THINGS YOU NEED TO KNOW

Permission is not required to visit Coulomb Point Nature Reserve.

The Cape Leveque road and the road to Minari are passable by conventional vehicle but are often corrugated. Coastal areas of the reserve can be accessed by a narrow track suitable for four wheel drive vehicles only, due to several sandy creek crossings.

Take adequate water with you. There is no drinking water supply within the reserve.

CARING FOR COULOMB POINT

Help to conserve the environment for wildlife. Pets and firearms are not permitted in the reserve

Camping and fires are currently permitted at coastal locations in the reserve, but this policy is subject to review.

Plants, animals, wood, rocks and soil are all part of the reserve. Please leave them as you find them for all to enjoy.

Aboriginal sites are of special significance to Aboriginal people and are protected by law. Do not remove artefacts from midden sites or damage sites in any way.

Leave the reserve clean; please take your rubbish with you.

Please avoid spreading weeds by careful removal and disposal of burrs on tyres and footwear.

THE LANDSCAPE

The Canning Basin

The Dampier Peninsula is underlain by the sedimentary rocks of the Canning Basin, a large area extending along the WA coast from Port Hedland to the Dampier Peninsula and inland almost to the Northern Territory border. A basin is a low area in the earth's crust where sediments have accumulated.

Sandstone and mudstone

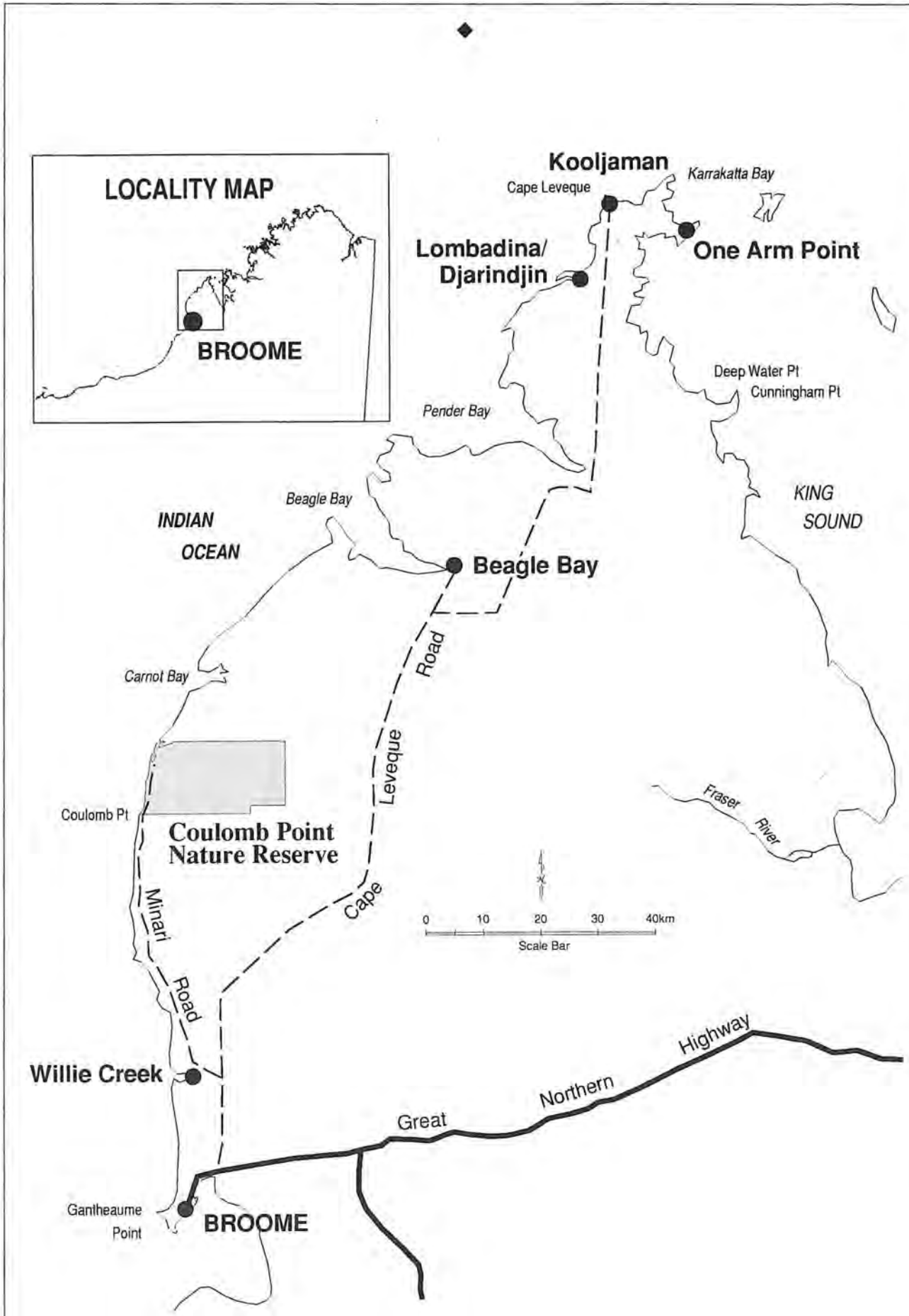
Around 200 million years ago, a fairly flat land surface was formed in the region now occupied by the Dampier Peninsula. Between 180 and 110 million years ago, during the Jurassic period, layers of sandstone and mudstone were deposited in a shallow marine environment. These layers are still virtually flat lying as they have undergone only very slight change.

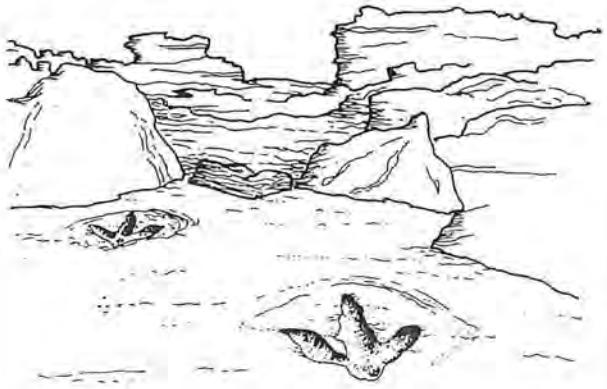
Sandplains

In the last two million years, reddish-grey sandplains have been deposited over these rocks by the action of wind and streams. Along the coast, tidal mudflats, beach sand and windblown sand dunes have formed and are still forming today.

Drainage

In the Reserve there is a system of creeks and watercourses, which is unusual for the peninsula. Most of the Dampier Peninsula has such a gentle gradient that rain floods over a broad area rather than flowing into creeks. In the area of the reserve however, there is a relatively steep gradient due to a gentle uplift that occurred around 35 million years ago.

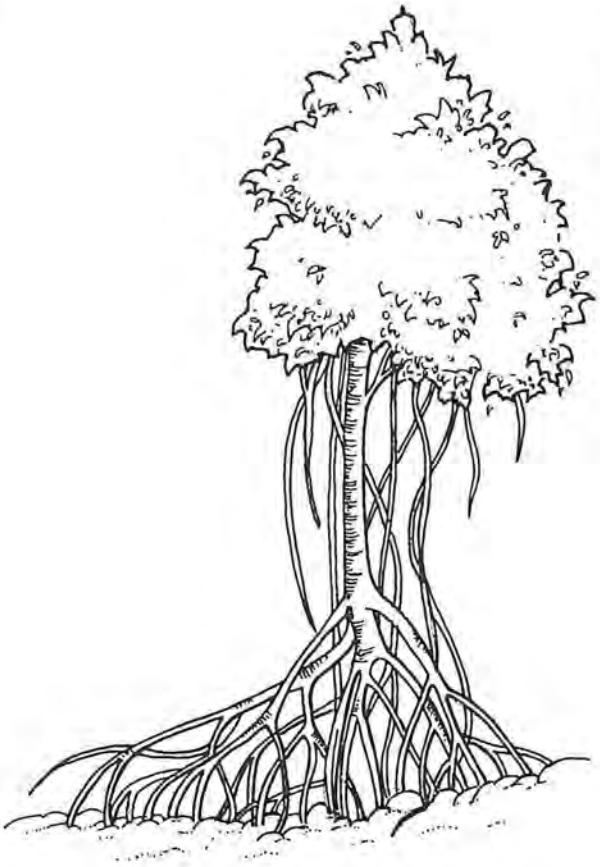

LOCALITY MAP
BROOME
Kooljaman
Cape Leveque
Karrakatta Bay
Lombadina/
Djarindjin
One Arm Point
Deep Water Pt
Cunningham Pt
Pender Bay
KING
SOUND
Beagle Bay
INDIAN
OCEAN
Beagle Bay
Carnot Bay
Road
Leveque
Coulomb Pt
Coulomb Point
Nature Reserve
Fraser River
Minari
Road
Cape
0 10 20 30 40km
Scale Bar
Willie Creek
Great Northern Highway
Gantheaume
Point
BROOME



Megalosauropus broomensis *left footprints in the Broome Sandstone*

Broome Sandstone

The watercourses have exposed a sandstone which geologists have named 'Broome Sandstone'. Dinosaur footprints have been recognised in the Broome Sandstone at Gantheaume Point near Broome, evidence of its formation during the Jurassic period.



The Red Mangrove has air filled stilt roots

THE PLANTS

Several plant communities are represented in Coulomb Point Nature Reserve.

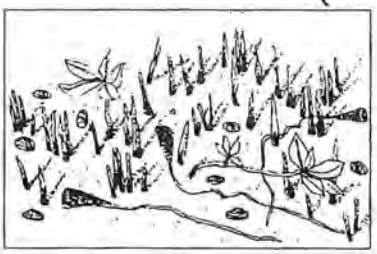
Mangroves

Along the northern coastal section stands of mangroves grow on the tidal mudflats.

The grey mangrove (*Avicennia marina*) is common on the landward edges and in the central areas of the mangrove stands. It is recognised by its smooth, white bark and leaves that are shiny green on the upper side and silvery below. To survive the waterlogged conditions of the incoming tides it has many air-filled, pencil-like structures called pneumatophores, which rise up vertically from its roots, projecting above the mud.

The red mangrove (*Rhizophora stylosa*) is also found in the central areas of the mangrove community, its long arching air-filled stilt roots often forming an impenetrable meshwork. It also has aerial roots descending from its lower branches and glossy green leaves that may have red spots underneath.

The yellow mangrove (*Ceriops tagal*), named for its sometimes yellowish leaves, also grows on the landward edge of the community and can be recognised by its buttressed stem. Along the seaward edges of the mangrove stands can be found the glossy leaved river mangrove (*Aegiceras corniculatum*) and the kapok mangrove (*Camptostemon schultzii*), recognised by its dull green narrow leaves with silvery scales on the undersurface.



The Grey Mangrove has specialised air filled roots called pneumatophores

Mudflats

Broad tidal mudflats are often found behind the mangroves. The tidal areas are bare but beyond them a low shrubland of samphires grows. Often a fringing stand of small coastal paperbarks (*Melaleuca acacioides*) grows at the landward edge of the mudflat.

Sand dunes

On coastal sand dunes, grow tussocks of the beach spinifex, *Spinifex longifolius*, the small, shrubby wattle *Acacia ampliceps* and the Green Birdflower Shrub (*Crotalaria cunninghamii*). This distinctive plant bears masses of green, bird-shaped flowers. Isolated clumps of pandanus occur between the dunes.

Vine thickets and forests

Directly behind the coastal dune systems are pockets of dense vegetation ranging from vine thickets to vine forest. Paperbarks are the main canopy trees of the vine forests. The shiny-leaved marul tree (*Terminalia petiolaris*), whose purple-black fruit attract fruitbats, and the dark-leaved mangarr tree (*Pouteria sericea*), which bears edible purple, prune-like fruits, are also found in the vine forest.

In the understorey are shrubs such as the dogwood (*Fluggea virosa*), which bears along its stems, many edible, fleshy, white round berries tasting of menthol. Also to be found are the pandanus, the parasitic sandalwood tree (*Santalum lanceolatum*) and its close relative the mistletoe tree (*Exocarpos latifolius*), which bears a yellow fruit attached to an edible swollen, fleshy, red receptacle.

Vines include the wild passionfruit (*Passiflora foetida*) and the snake vine (*Tinospora smilacina*), whose woody stems twine snake-like around tree trunks and branches. The sprawling shrubby caesalpinia vine (*Caesalpinia major*) has spine-studded pods that contain large, hard, jade green seeds when ripe. These are collected by great bowerbirds to adorn their bowers and by aboriginal children to use as marbles.

The crab's-eye bean (*Abrus precatorius*) is another vine with colourful seeds. Although used for decoration by aboriginal people, the red and black seeds are extremely toxic. The leafless parasitic dodder laurel (*Cassytha filiformis*) has orange string-like stems that form dense tangled meshes in the canopies of the paperbarks. Aboriginal people have used the dense mesh as a fishing net and have also eaten the small globular fruits which ripen white and translucent.

Sandplains

The vegetation of the sandplains is predominantly open woodland dominated by various eucalypts. Other trees include the bauhinia (*Bauhinia* [formerly *Lysiphyllum*] *cunninghamii*), whose small, butterfly-shaped leaves provide dense foliage on drooping branches, and the helicopter or coolaman tree (*Gyrocarpus americanus*), which bears winged wrinkled nuts and whose light smooth shiny bark and soft wood was used by Aboriginal people to make containers.

The understorey consists of several types of wattles, such as the pindan wattle (*Acacia tumida*), whose leaves are sickle-shaped; the Broome pindan wattle (*Acacia eriopoda*), whose leaves are narrow and ribbon-like; and the candelabra wattle (*Acacia colei*), whose grey-green leaves and papery narrow pods have been used as a bush soap and fish poison.

Along creeks

River red gums (*Eucalyptus camaldulensis*), paperbarks (*Melaleuca viridiflora*), and pandanus grow along freshwater courses while tidal creeks are lined by coastal paperbarks (*Melaleuca acacioides*).

Around swamps

Several freshwater swamps fringed by paperbarks have formed where coastal dunes have blocked watercourses. When water is present following summer rains, the surface of these subcoastal swamps is often covered with a dense bloom of the duckweed (*Lemna aequinoctialis*). When the water levels drop, the damp areas support sedges and insect-eating plants such as the sundews (*Drosera* sp and *Byblis liniflora*).

THE ANIMALS

The animals and birds of the Dampier Peninsula are predominantly species that are found in the subhumid areas of Northern Australia. However because of the proximity to the arid Great Sandy Desert some arid zone species such as the red kangaroo are also present.

Extinctions

More than 33 mammals have been recorded on the peninsula since European settlement. Sadly, several species are now extinct from the area. The golden bandicoot, and the golden-backed tree-rat are now restricted to remote areas of the northwest Kimberley while the burrowing bettong is now found only on islands off the Pilbara coast. Changes in the environment caused by pastoral activities, changes in fire regimes and the encroachment of exotic animals such as the feral cat and cattle are thought to be responsible for these extinctions.

Mammals

The rare and threatened bilby was known in the area up until the late 1970s and it is thought to still survive there. Large mammals still commonly found include the common wallaroo, the agile wallaby, and the northern nail-tail wallaby. Smaller mammals include the long-tailed planigale, the delicate mouse, and the western chestnut mouse.

The Dampier Peninsula has a great variety of bats, with 15 species recorded including the rare yellow-bellied sheathtail bat. This high, fast flier feeds on insects often above the tree canopy.

Reptiles

Reptiles are common, including three species that are only found on the peninsula. The skinks *Lerista apoda* and *Lerista separanda* and Worrell's snake, a very small light-coloured snake with black blotches on its head and neck, are endemic to the area. Nine species of frogs have been recorded.

Birds

Because of the diversity of habitats, in particular coastal environments, the Dampier Peninsula has a large variety of birds with over 200 species recorded.

Birds resident in the pindan woodlands include the grey-crowned babbler, the rufous whistler, and the singing honeyeater. The coastal melaleuca thickets are important for the mangrove gerygone and when flowering attract lorikeets and many honeyeaters such as the white-gaped honeyeater, the rufous-throated honeyeater, and the brown honeyeater. Fruiting trees and shrubs in the vine thickets and forests provide food for red-winged parrots, and great bowerbirds.

Mangrove communities are home to several birds which are confined to mangroves such as the brilliantly coloured red-headed honeyeater, the yellow white-eye, the mangrove golden whistler and the mangrove heron.

Migrants make up approximately 20 per cent of the bird species recorded and include waders and other summer visitors from the northern hemisphere, as well as visitors from southern areas.

LOOKING BACK

Minarringy

The Ngumbarl and other Aboriginal people have used the area around Coulomb Point for thousands of years. It was the focus of a large coastal dune camping area known as 'Minarringy', today often shortened to 'Minari'. Some of the vestiges of these and other camps along the coast, survive today as shell middens.

Along with the sea, the coastal vine thickets provided a wide variety of foods and were important to the aboriginal people not only for food. The Melaleucas of the vine thickets (*Melaleuca dealbata*) are known as 'kumpurr', and have an important role in the creation of mankind and the maintenance of spirituality for some aboriginal people.

Macassans

Macassan fishermen from Indonesia are thought to have plied the northwest coastline well before the coming of the Europeans, collecting beche de mer (sea cucumbers), turtles and possibly trochus and oyster shells.

Explorers

The French Expedition to Australia of 1801 to 1803, under the command of Nicholas Baudin in the Geographe, charted the western coast of the Dampier Peninsula. Louis Freycinet on the Casuarina, is thought to have named Coulomb Point in April, 1803, after the distinguished French physicist, Charles Augustin de Coulomb, who was noted for his research on electricity. His unit for electricity, the coulomb, was later renamed the ampere.

Pearlers and pastoralists

After the explorers came the pearlers and the pastoralists in the late 1800s.

Local aboriginal groups abandoned their semi-nomadic lifestyle and many traditions and tribal boundaries disappeared.

Wildlife reserve

The area now occupied by Coulomb Point Nature Reserve was previously held as Carnot pastoral lease. The Gazettal of the reserve in 1969 followed an Australian Academy of Science Report in 1962 which recommended a reserve in the area.

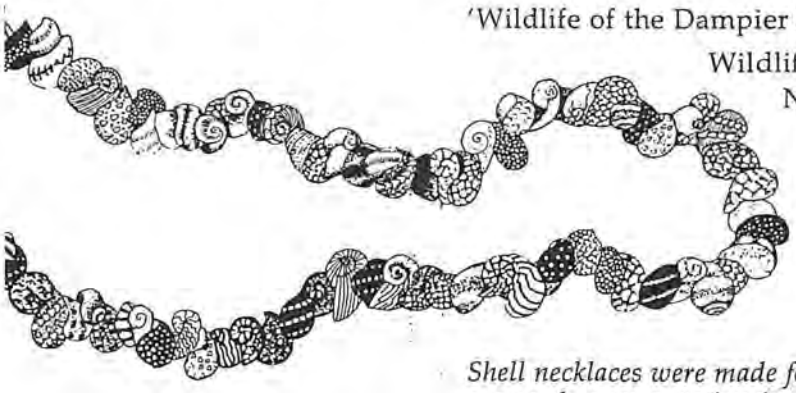
Coulomb Point Nature Reserve is the only conservation reserve on the Dampier Peninsula. Most of the peninsula is held either as pastoral leases or Aboriginal reserves. Most of the land is managed as an open range cattle industry. Unfortunately Coulomb Point Nature Reserve covers only a small area of the Dampier Peninsula and does not adequately represent all the types of habitats and communities found there. Additional conservation reserves have been proposed.

Further Information

The Department of Conservation
and Land Management
West Kimberley District Office
Herbert St, Broome
PO Box 65
Broome 6725
Telephone (08) 9192 1036
Fax (08) 9193 5027

Further Reading

'Wildlife of the Dampier Peninsula'
Wildlife Research Bulletin
No 11
Western Australian
Wildlife Research
Centre, Department
of Fisheries and
Wildlife



Shell necklaces were made for personal ornamentation in coastal areas.

PRINCE REGENT NATURE RESERVE

Where: About 250 kilometres northeast of Derby and 300 kilometres west of Wyndham. There is no vehicle access.

Area: 634,951 hectares.

Gazetted: April 1964

Attractions/Significance: A rugged, remote, high rainfall area of the northwest Kimberley rich in wildlife. Almost two-thirds of the mammal species and about half of the birds found across the Kimberley have been recorded here. The wildlife of the reserve is intact; there have been no extinctions since European settlement. Recognised as being of international significance, the reserve is one of only two UNESCO World Biosphere Reserves in WA. Contains populations of rare and threatened species such as the golden bandicoot.

THINGS TO KNOW

THE RESERVE IS CLASSIFIED AS A PROHIBITED AREA UNDER THE WILDLIFE CONSERVATION ACT. PUBLIC ACCESS IS RESTRICTED.

Scenic flights over the reserve can be arranged. Contact local tourist bureaus or air charter companies.

THE LANDSCAPE

The Kimberley Basin

The Prince Regent Nature Reserve lies largely on an elevated region of rugged and deeply dissected sandstone known as the 'Prince Regent Plateau'. This occupies part of an area known as the Kimberley Basin where about 1800 million years ago in Precambrian times a thick sequence of layered sedimentary rocks was deposited on a slowly subsiding large continental mass. A basin is a low area in the earth's crust where sediments have accumulated.

King Leopold Sandstone

The oldest layers are a white and pink quartz sandstone named 'King Leopold Sandstone' by geologists. This sandstone is found east of the St George basin and forms a very rugged dissected area with many gorges and cliffs.

Carson Volcanics

About 1790 million years ago, sedimentation in the Kimberley Basin was interrupted by the extrusion of volcanic rock over the King Leopold sandstone over a wide area. The resulting basalt rock, known as 'Carson Volcanics' by geologists, is found to the northeast of the Roe River and to the north of the St George basin. Here the landscape is less rugged with rounded soil covered hills.

Warton Sandstone

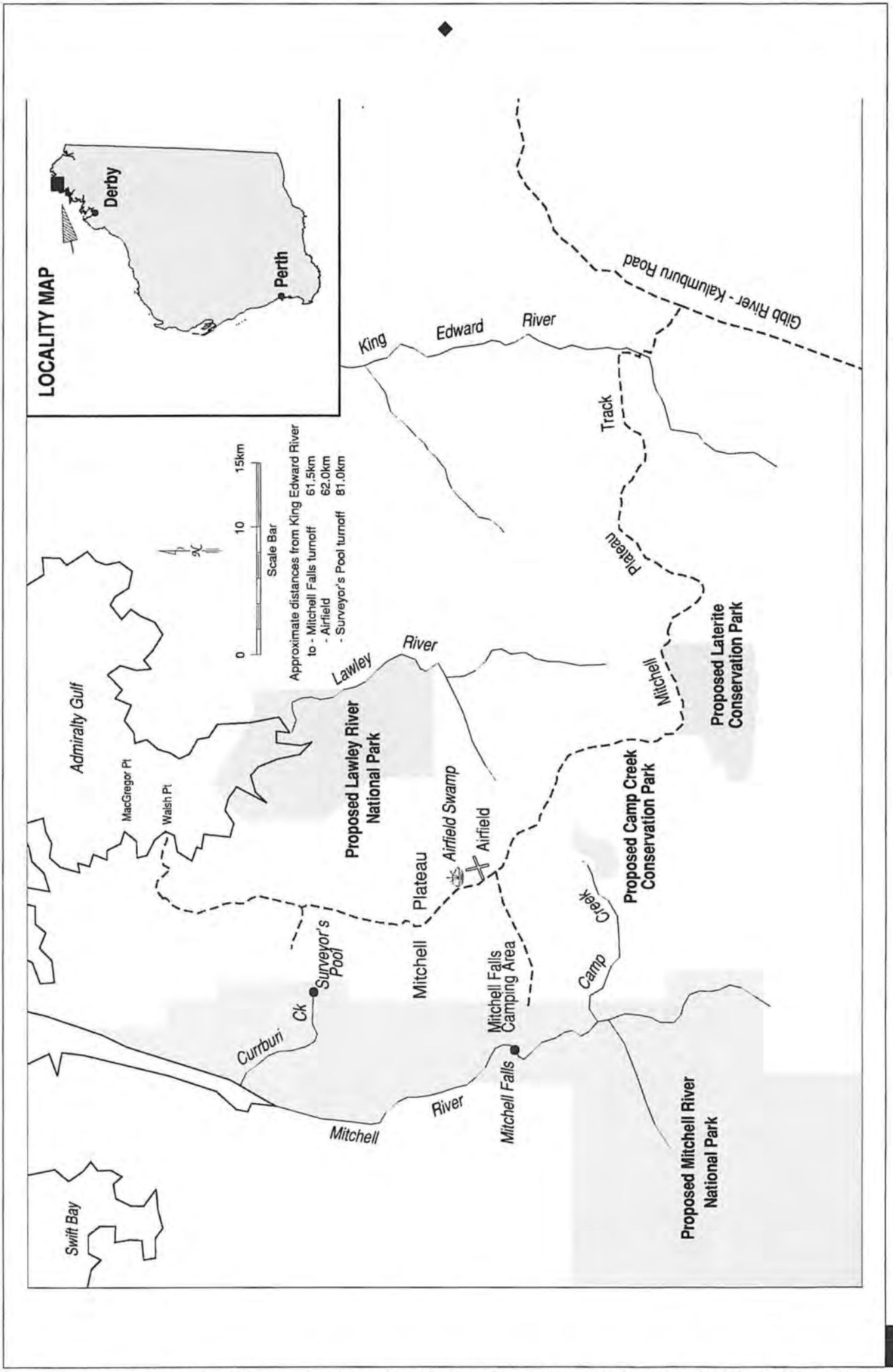
Sedimentary rocks were laid down over these basalts forming a quartz sandstone named 'Warton Sandstone' by geologists. This can be found to the west of the St George basin. The prominent Mt Trafalgar and Mt Waterloo, St Andrew Island and St Patrick Island, and the Marigui Promontory are all capped by Warton Sandstone.

Prince Regent River

Folding and faulting produced the joint or fracture now occupied by the Prince Regent River, which runs almost straight for most of its length, often between rugged near-vertical cliffs.

Rising seas

All of this happened more than 1400 million years ago. Erosion has removed any evidence of what followed. In the last few thousand years, a rise in sea level has flooded the lower parts of river valleys and estuaries forming landlocked harbours such as the St George Basin and Rothsay Water, which open to the seas by narrow straits. These harbours are bounded by precipitous cliffs and large areas of tidal flats.


LOCALITY MAP
Derby
Perth
Gibb River - Kalumburu Road
King Edward River
Track
Plateau
Scale Bar
0
10
15km
Approximate distances from King Edward River
to - Mitchell Falls turnoff 61.5km
- Airfield 62.0km
- Surveyor's Pool turnoff 81.0km
Admiralty Gulf
MacGregor Pt
Walsh Pt
Lawley River
Proposed Lawley River National Park
Airfield Swamp
Airfield
Plateau
Mitchell
Proposed Laterite Conservation Park
Proposed Camp Creek Conservation Park
Camp Creek
Surveyor's Pool
Currburi Ck
Mitchell Falls Camping Area
Mitchell Falls
Mitchell River
Proposed Mitchell River National Park
Swift Bay

THE WILDLIFE

The Prince Regent Nature Reserve is one of the world's outstanding protected areas for wildlife.

Biologically the reserve is representative of much of the northwestern Kimberley. Because it is in the highest rainfall area of WA it is especially important in preserving plants and animals adapted to these conditions.

Diverse and uncommon

The plants include many types of sundews, trigger-plants, and bladderworts, some of which are not known from elsewhere. Many ferns are found in the numerous gullies and gorges; 19 species have been recorded. Streams and swamps are rich in aquatic plants including a rare relative of the waterlilies, *Ondinea purpurea*. Endemic to the northwestern Kimberley, it has both submerged and floating leaves and bears a single purple-pink flower.

Over 500 species of plants have been recorded from the reserve including both common and rare species. The palm *Livistona loriphylla* and the uncommon cycad *Cycas basaltica*, which grows in woodlands on basalt rock, are both restricted to the North Kimberley.

Vine thickets

Many small but important pockets of rainforest occur in the reserve. Their many fruiting species provide food for the black flying fox and birds such as the Torres Strait imperial pigeon, the emerald ground-dove, and the figbird. They provide a home for ground dwelling birds such as the rainbow pitta and the orange-footed scrubfowl. The Kimberley rock-rat, is restricted to rocky habitats with vine thickets, and is found only in the Kimberley.

Mangroves

Mangroves cover extensive areas on tidal flats especially in St George Basin and Rothsay Water, and have a rich species composition. They are important for the mangrove bat and birds such as the red-headed honeyeater, the yellow white-eye, the collared kingfisher, the mangrove gerygone, the broad-billed flycatcher and the mangrove robin.

Crocodiles

Saltwater crocodiles are concentrated in tidal portions of large rivers where mangroves are plentiful. The fastest recovering populations in WA of this previously threatened species are in the Roe River, the Prince Regent River and St George Basin.

Reptiles and fish

Reptiles include the white-lipped dragon and the spectacularly coloured green lizard , both endemic to the northwestern Kimberley. Fourteen species of fish have been recorded in rivers and streams as have a further 21 species in the tidal sections of the Prince Regent River. The large scale grunter is known only from the reserve.

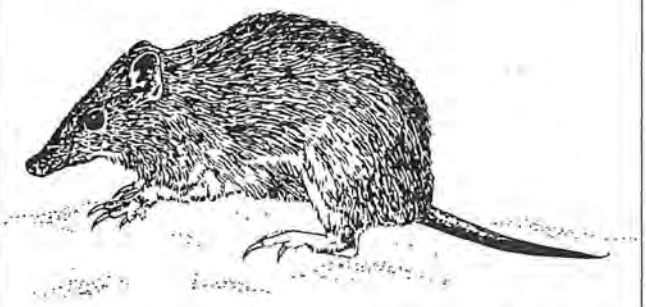
Mammals

Many of the mammals found in the reserve have a preference for the rugged rocky sandstone country that predominates there. The rare and little known scaly-tailed possum, endemic to the Kimberley, apparently lives deep in rockpiles during the day, emerging at night to feed in trees. Resembling both the brush-tailed possums and the cuscuses, and the only member of its genus, the species is of great zoological interest. The rock ringtail possum, found only in the Kimberley and Arnhemland, lives in rocky outcrops and climbs trees only at night to feed.

Rock wallabies include the two smallest members of this group. The rare narbalek is found only in the Kimberley and Arnhemland, sheltering in sandstone crevices during the day. The smaller and little known monjon is endemic to the NW Kimberley and restricted to the rugged King Leopold Sandstone country.

The reserve is extremely important for the survival of the rare and threatened golden bandicoot. Previously widely distributed, its range is now restricted because of changes in land use.

Carnivorous marsupials in the reserve include the rare and little known Ningbing



Golden Bandicoot

antechinus. Uncommon rodents include the Brush-tailed tree-rat, and the golden-backed tree-rat, both of which forage in trees as well as on the ground. The recently described Kimberley mouse is known outside the reserve only from the Drysdale River National Park.

Birds

Over 160 species of birds, about half the total known for the Kimberley, have been recorded including several threatened species. The grey falcon, the orange-footed scrubfowl, the rufous owl, the cicada bird and the white-browed robin are found in the reserve.

The uncommon black grasswren is confined to sandstone outcrops of the northwest Kimberley. Foraging in groups, these dark thickset birds could be mistaken for rats as they scurry over rocks. The reserve is one of only two locations in WA where the king quail has been recorded.

Living heritage

The Prince Regent Nature Reserve is an outstanding conservation area, rich in plants and animals, and its value to nature conservation in Australia is enormous.

LOOKING BACK

The Prince Regent River area is rich in Aboriginal history and contains many sites of significance, including art and burial places. The Worara people occupied the area to the south of the Prince Regent River while the Wunambal people were to the north. Although these original occupants of the land moved to missions and settlements in the 1930s, modern Aboriginal people still have ties to the area.

Explorers

Because of the treacherous tides, early explorers such as Tasman and Dampier did not approach the mainland in the area. Phillip Parker King on the Mermaid was the first to examine the coastline in the Prince Regent River area in 1820. As his ship was leaking, King beached the Mermaid for repairs at Careening Bay. There, the name of the ship was carved on a large boab by the crew. Botanist Allan Cunningham made a collection of plants from which a large number of new species were described, making the area an important type locality.

In the early part of this century a number of expeditions were conducted to assess the potential of the region. The very rugged nature of the terrain, however, precluded pastoral activities.

Wildlife reserve

The Prince Regent Nature Reserve was gazetted in 1964 following the recommendations of an Australian Academy of Science report. Its importance was recognised internationally in 1978 when it was nominated as a World Biosphere Reserve by UNESCO.

'Mermaid' Boab Tree

Further Information

Department of Conservation
and Land Management
East Kimberley District Office
Messmate way, Kununurra
PO Box 942
Kununurra 6743
Telephone (08) 9168 4200
Fax (08) 9168 2179

Further Reading

'Biological Survey of the Prince Regent River Reserve'
Wildlife Research Bulletin No 6
Western Australian Wildlife Research Centre, Department of Fisheries and Wildlife

'Prince Regent: Jewel of the Kimberley'
Landscope Vol 4 No 1 (Spring 1988)

Rainbow pitta

ISLAND NATURE RESERVES

Several islands off the Kimberley coast are nature reserves. These are important nesting sites for several species of sea birds and/or marine turtles.

THINGS YOU NEED TO KNOW

Permission is required to visit these Island nature reserves. Contact the West Kimberley District Office of CALM for access to the Lacepede Islands and Browse Island.

Telephone (08) 9192 1036 or Fax (08) 9193 5027.

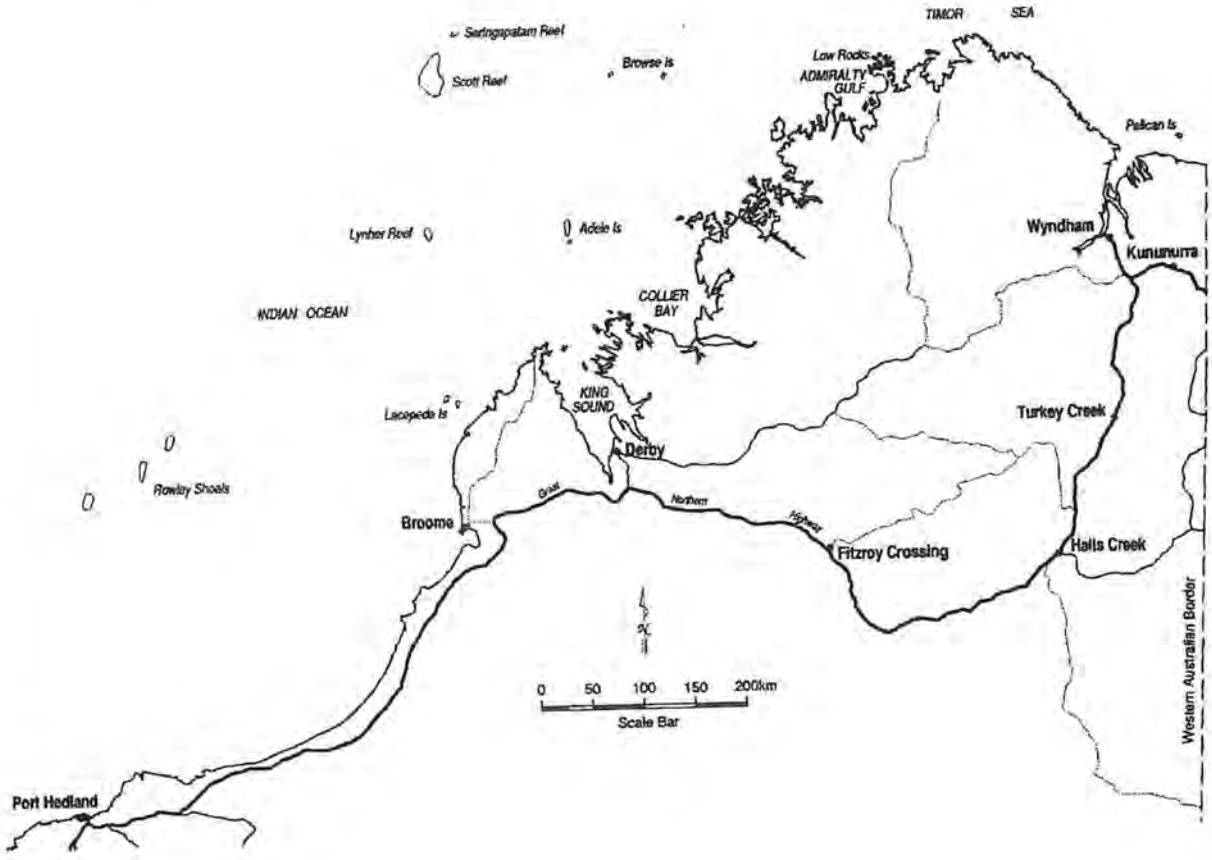
Contact the East Kimberley District Office of CALM for access to Pelican Island and Low Rocks Telephone (08) 9168 4200 or Fax (08) 9168 2179

The islands are important nesting sites for birds and/or turtles. Please do not disturb the wildlife. Confine your activities to the beaches.

Help to protect the environment. Camping, fires, pets and firearms are not permitted on the island nature reserves.

Leave the islands clean; please take your rubbish with you to the mainland.

There is no fresh water on the islands.



LACEPEDE ISLANDS NATURE RESERVE

Where: The Lacepede Islands are made up of four separate islands lying some 20 kilometres off the coast approximately 150 kilometres north of Broome.

Area: West Island 107 hectares.

Middle Island 54 hectares.

East Island 32 hectares.

Sandy Island eight hectares.

Attractions/Significance: Nesting areas for seabirds and turtles. Largest nesting colonies of Brown Booby in the world.

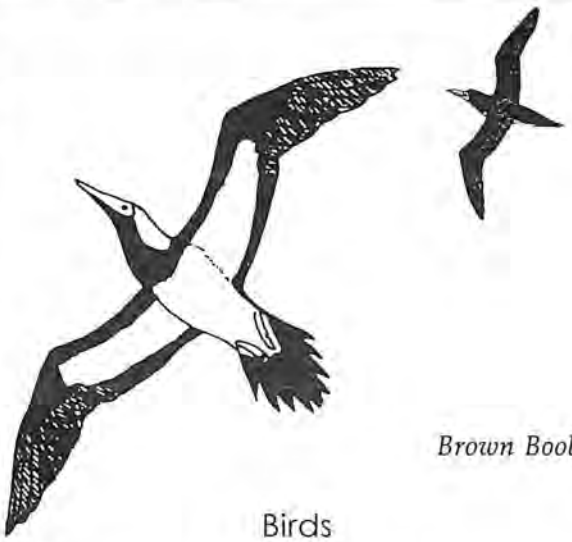
ABOUT THE ISLANDS

The islands are formed of sand lying on limestone and coral reef. The two largest islands, West and Middle islands are nature reserves for the conservation of fauna and flora. East Island is leased to the Commonwealth of Australia for a lighthouse site.

Seabird nesting colonies

The main conservation value of the islands is the significant seabird nesting colonies. The main species are the brown booby, recognised by its dark brown colouring with a white belly, and large yellow bill and feet, and the lesser frigate-bird. The frigate-bird seldom swims or walks, unlike the booby, which dives and pursues fish underwater swimming with both feet and wings. Instead a superb flier, the frigate-bird nests with the boobies so that it can rob them of food and nesting material. It dives on a booby flying back to the rookery with food until it drops its meal. The frigate-bird then swoops down to catch the fish in mid air.

The Lacepede Islands colonies of brown booby are the largest in the world; over 17,000 pairs were counted in 1981. The lesser frigate-bird colonies are the largest in the Indian Ocean; 2,700 pairs were counted in 1981. Other breeding species on the Islands include the Australian pelican, the pied cormorant, the common noddy and fairy and roseate terns.



Brown Booby

Birds

The islands are also visited by other sea birds such as the eastern reef egret and the sooty oystercatcher, recognised by its bright red bill and eye which contrast with its dark plumage. A variety of terns are commonly seen and during the summer months migratory waders such as the ruddy turnstone, the black-tailed godwit, the greenshank and the terek sandpiper may be observed.

Turtles

Very large numbers of green turtles nest on the islands and this is the major rookery for this species in the Kimberley. Marine turtles can be seen in waters surrounding the islands at almost any time but from October to March many female turtles come ashore each night to dig nest holes and lay their eggs. Flatback turtles have also been recorded.

Rats

The black rat has been present on the Islands sometimes in plague numbers, interfering with the breeding of smaller species of sea birds. An eradication campaign in the mid 1980s appears to have been successful.

Plants

The Islands are sparsely vegetated with the tussocky beach spinifex (*Spinifex longifolius*) which helps to stabilize the sandy soil.

Patches of the saltwater couch (*Sporobolus virginicus*), the prickly saltwort (*Salsola kali*) and the beach morning glory (*Ipomoea pes-caprae*), with its spectacular mauve-pink flowers, can also be seen.

LOOKING BACK

The islands were named for Count Lacepede (1756 - 1825), a leading French naturalist by the Baudin expedition in 1801. Until about the 1850s the islands were frequented by American whalers.

From 1876 to 1879 guano was mined from the central area of Middle Island and exported for fertilizer. There was a diplomatic row in 1876 between Britain and the United States after the islands were formally claimed under the Guano Island Act of US Congress.

A cyclone in February 1877 wrecked three barques loading guano. Another in January 1879 wrecked the barque Manfred, whose remains are still visible off the northwest tip of Middle Island and are a protected wreck site. In March 1935, 21 luggers were sunk and 140 lives were lost when yet another cyclone caught Broome's pearling fleet unprepared off the Lacepedes.

PELICAN ISLAND NATURE RESERVE

Where: Pelican Island lies about 110 kilometres northeast of Wyndham in the Joseph Bonaparte Gulf.

Area: Eight hectares.

Attractions/Significance: Site of a Pelican breeding colony.

ABOUT THE ISLAND PELICANS

This is a low sandy island with some rocky sandstone areas with a low vegetation mainly of saltwater couch (*Sporobolus virginicus*). As the name suggests, the island's main feature is as a breeding place for the Australian pelican. Pelicans breed on only five other offshore islands in WA although they also occasionally breed on islands in major rivers and estuaries.

Turtles

Flatback turtles also nest on Pelican Island.

BROWSE ISLAND NATURE RESERVE

Where: Browse Island is situated in the Timor sea about 350 kilometres north of Derby at 14°07'S, 123°33'E.

Area: 13 hectares.

Attractions/Significance: One of the most important turtle nesting sites in Australia.

ABOUT THE ISLAND

Turtles

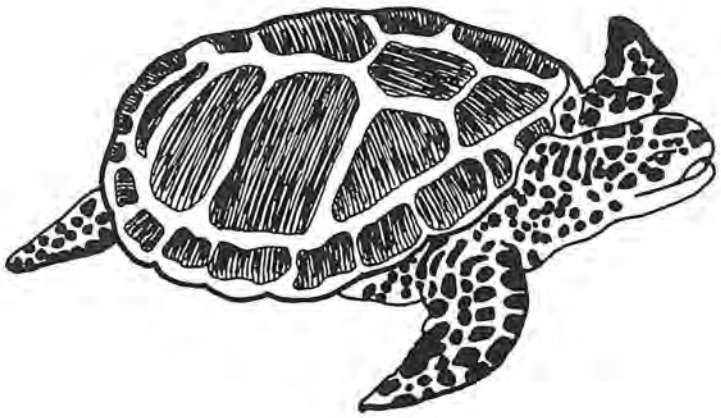
Formed of sand and limestone on a limestone and coral reef, the island once held large deposits of guano but these have been mined out resulting in a disturbed surface. The previous minerals reserve was changed to a nature reserve in 1992 because of the island's importance as a turtle nesting site. Hundreds of turtle nests have been seen at times. The green turtle certainly breeds there and other species may also use it.

Birds

No sea birds are known to breed on Browse Island, but many birds may be observed, such as the eastern reef egret.

Plants

Behind the beaches the sparse vegetation consists mainly of the beach morning glory (*Ipomoea pes-caprae*) and a few scattered bushes of the shiny green fleshy leaved *Scaevola sericea*, which bears white flowers with fringed petals. On the undisturbed coral sands the Indian lantern flower (*Abutilon indicum*) and grasses such as lovegrass (*Eragrostis* sp) grow. Disturbed areas have been colonised by beach morning glory and the prickly saltwort (*Salsola kali*).



Green Turtle

LOW ROCKS NATURE RESERVE

Where: Low Rocks island is situated at 14°04'S, 125°52'E in the northern part of Admiralty Gulf.

Area: Four hectares.

Attractions/Significance: Sea bird nesting colonies.

ABOUT THE ROCKS

Rising seas

Low Rocks Island is a small outcrop of very old, resistant King Leopold sandstone of Precambrian age. This offshore island formed when a rise in sea level flooded the lower parts of river valleys and estuaries. It is thought that the island was part of the mainland as recently as 8,000 to 10,000 years ago. There is little soil and the vegetation consists of scattered grasses.

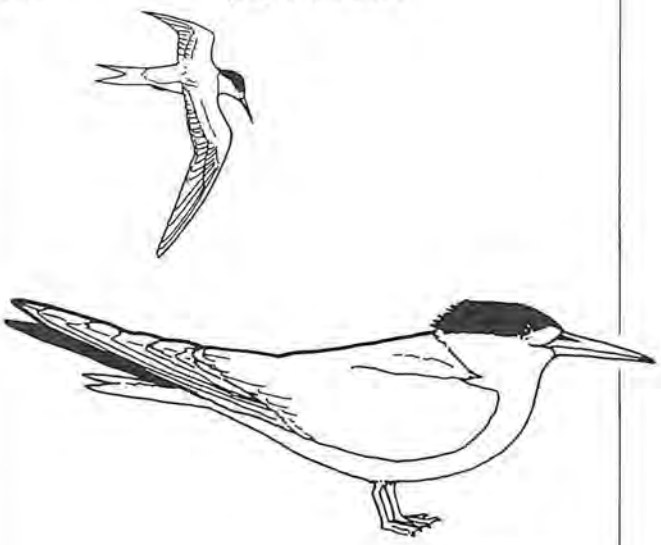
Sea bird nesting colonies

Low Rocks is an important breeding site for the pied cormorant, the bridled tern, recognised by a long white eye-stripe running through its black capped head, and the crested tern, recognised by its crested black capped head. The cormorants build a nest of sticks and debris, while the crested tern's nest is a depression in the ground and the bridled tern lays its eggs on the bare ground.

Further Information

The Department of Conservation
and Land Management
West Kimberley District Office
Herbert St, Broome
PO Box 65
Broome 6725
Telephone (08) 9192 1036
Fax (08) 9193 5027

East Kimberley District Office
Messmate way, Kununurra
PO Box 942
Kununurra 6743
Telephone (08) 9168 4200
Fax (08) 9168 2179



Crested Tern

Section 3

Section 3:

Tourism in the Kimberley

3.1

The participants in the tourism Industry

In 1996, 26,000 people lived in the Kimberley in six towns:

- Broome Population 11 500
- Derby Population 3 500
- Fitzroy Crossing Population 1 500
- Halls Creek Population 1 200
- Kununurra Population 4 500
- Wyndham Population 1 200

There are also many Aboriginal communities throughout the region.

The major employers in the Kimberley are:

- mining 6.6 per cent
- agriculture & pastoralism 10.5 per cent
- wholesale and retail trade 10.5 per cent
- government services 28 per cent
- private sector services 63 per cent

Tourism is the fastest growing industry in the Kimberley. It currently employs approximately 2300 people. This is about 20 per cent of the work force in the region, and earns approximately $140 million annually, or 20 per cent of the region's income. The income earned by the tourism industry in the Kimberley mostly stays in the region with the local employees and businesses. Kimberley tourism is a major contributor to the local economy.

In 1996 there were 260,000 visitors to the Kimberley. CALM visitor statistics (from traffic counter records, surveys and observations) for key sites in Kimberley national parks for 1997/98 were 162,000. The Kimberley provides 5.3 per cent of the State total in tourist expenditure and almost ten per cent of arrivals to commercial accommodation throughout the State.

The tourism industry involves travel, accommodation and experiences. Managing the tourism industry is a collaboration of the public and private sectors.

- The public sector involves Federal, State and Local agencies, and is mostly responsible for planning, research and resource management.
- The private sector is mostly involved in the transport, accommodation and provision of services.

Ultimately the experience of visitors is influenced by the efficiency and effectiveness of the involvement and collaboration of all the contributors to the tourism industry.

State government

Western Australian Tourism Commission

The Minister for Tourism oversees the development of tourism in Western Australia, through the operations of the Western Australian Tourism Commission (WATC). The WATC is responsible for the development of tourism to Western Australia. There are three components: International, Interstate and Intrastate. There is also Perth Conventions Unit and Eventscorp.

Environmental Protection and Conservation and Land Management

The Minister for the Environment oversees the protection and management of the environment for conservation in Western Australia through the Department of Environmental Protection and CALM. CALM's Corporate Plan states:

'We conserve and manage Western Australia's wildlife and the lands, waters and resources entrusted to the Department for the benefit of present and future generations.'

In keeping with this mission, CALM's objective for the Recreation and Tourism Program is:

'to identify, provide and maintain opportunities and services to the community which allow them to enjoy the wildlife, lands, waters and resources without compromising conservation and other management objectives.'

The CALM Kimberley Regional Office is in Kununurra. District Offices are at Broome and Kununurra. Staff are also based at Derby, Fitzroy Crossing and Halls Creek and seasonally at Windjana Gorge, Purnululu and Silent Grove.

Over two million hectares--nearly five per cent--of the Kimberley region is in conservation reserves managed by CALM. CALM staff in the Kimberley include 25 permanent staff, four seasonal staff and several contract employees. Six staff are Aboriginal.

Transport

The Minister for Transport oversees the development and maintenance of all forms of transport in the Kimberley region. Department of Main Roads has a regional office based in Derby and provides maintenance of all roads in the Kimberley under their authority. This includes the Gibb River road.

Other agencies and organisations

The tourism industry in the private sector spans the transport, accommodation, tourism and travel booking agencies, tour operators and guides, merchandise outlets and other services.

Kimberley Tourism Association

Marketing of the region is the responsibility of the Kimberley Tourism Association (KTA), which draws its membership from the span of tour operators, accommodation, and ancillary services and industry. Support is provided by the four shires in the region and the Western Australian Tourism Commission. The Kimberley Tourism Association provides the means by which the region is marketed to the three sectors of the tourism industry: Intrastate, Interstate and International. In 1998/99 there were 223 members of the Association.

Shires

The four Shires in the Kimberley region are:

- Shire of Broome
- Shire of Derby - West Kimberley
- Shire of Halls Creek
- Shire of Wyndham - East Kimberley

Kimberley Aboriginal Tourism Association

Aboriginal tourism is seen as a developing resource for the indigenous people and the Kimberley Aboriginal Tourism Association was formed in 1995 to facilitate and develop the tourism potential of Aboriginal people in the Kimberley region.

Kimberley tourist bureaus

There are six tourist bureaus in the Kimberley region:

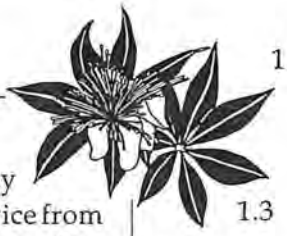
◆ Broome	Open all year
◆ Derby	Open all year
◆ Fitzroy Crossing	Open all year
◆ Halls Creek	Open April to October
◆ Wyndham	Open all year
◆ Kununurra	Open all year

All of the tourist bureaus in the Kimberley are staffed by local people, who have a full and complete knowledge of the attractions and activities in their town. It is always recommended that visitors call into the local tourist bureau shortly after their arrival to obtain up-to-date details and information.

3.2

Kimberley Tourism Association code of conduct and ethics

AIMS OF THE CODE



- Ensure all visitors to the Kimberley Region receive the best possible service from all service providers within the tourism industry.
- Maintain and enhance the reputation, standing and good name of the Kimberley Tourism Association and its collective membership.
- Encourage initiative and enterprise in the belief that properly regulated competitive trading by and between service providers within the Kimberley tourism industry will best serve the public interest and well being of the tourist industry.
- Ensure that the public interest predominates in all considerations of the standards of competitive trading between member service providers in the Kimberley Tourism Association.
- Encourage the growth and development of the Kimberley tourism industry that is consistent with the preceding aims.

CODE OF CONDUCT AND ETHICS

1. Service provider relations with trade and consumers

1.1 Service providers will, where possible, inform their customers of all pertinent facts concerning tours, transportation, accommodation or other tourist services which they provide.

1.2 Service providers will be factual and accurate when called upon to give information to the trade and to consumers.

1.3 Service providers will keep their employees informed in an accurate and timely manner of any alterations to their services.

1.4 Service providers will endeavour to eliminate any practices, which could be damaging to trade or customers or to the dignity and integrity of the tourist industry and the Kimberley Tourism Association.

1.5 Service providers will avoid misleading or doubtful superlatives in their advertising.

1.6 Service providers must advise their intended customers in writing, prior to the time initial payment is made for any booking, about cancellation policies and any service charges that may be imposed.

1.7 Service providers will ensure that their employee dress standard is consistent with an acceptable level of professionalism within their particular section of the industry.

2. Service provider relations with other service providers

2.1 Service providers shall follow the best traditions of salesmanship and fair dealing by according fair, objective and impartial representation of other service providers they may from time to time

represent on behalf of the region or Kimberley Tourism Association.

2.2 Service providers should conduct their business so as to avoid conflict with fellow service providers. In the event of a controversy between service providers, such controversy shall be referred for mediation or arbitration, where appropriate, initially to the Quality Assurance Committee of the Kimberley Tourism Association.

2.3 If an opinion is sought about a competitor, service providers shall render such opinion with professional integrity and courtesy.

2.4 Service providers are to encourage and promote membership of the Kimberley Tourism Association so that the entire tourism industry and the public benefit from the training, experience and high standards of all member service providers.

3. Conduct of service providers

3.1 Service providers will minimise operational and client environmental impacts by sustainable practices, offering information, leading by example, and taking corrective action when and where necessary.

3.2 Service providers will endeavour to prevent both accidental and purposeful actions that cause damage to the environment such as crowding, harassment of wildlife, trampling, off road track/trail/road driving, walking and riding (except as authorised) and the improper disposal of waste.

3.3 Failure of a service provider to abide by this code of conduct and ethics shall render an operator liable for disciplinary action.

4. Dealing with complaints

4.1 If a complaint is lodged against a service provider by trade, consumer, and/or another service provider, the service provider concerned will take immediate steps to amicably deal with the complaint.

4.2 Service providers are required to comply with agreements reached through mediation.

4.3 If a complaint is received by the Kimberley Tourism Association, it will be automatically referred to the Quality Assurance Committee.

5. Enforcement of code of conduct and ethics

5.1 If service providers fail in one or more nominated ethical standards, they may be censured or suspended from membership of the Kimberley Tourism Association. The fact of member suspension will be advised to all tourism bodies associated with the Kimberley Tourism Association.

(cut here and return the declaration below to the Kimberley Tourism Association).

DECLARATION OF ALIGNMENT WITH THE KIMBERLEY TOURISM ASSOCIATION'S OPERATORS' CODE OF CONDUCT AND ETHICS

_____
Business Name

I/We solemnly and sincerely declare that the above named business will be conducted in a spirit which aligns with, and adheres to, the ethical standards nominated by the Kimberley Tourism Association.

_____
Signed

_____
Name (please print)

_____
Position

_____
Date

_____
Witness

_____
Date

3.3

Kimberley carers code

Exploring the Kimberley can be hazardous to the natural environment. We have a responsibility to convey environmental ethics and a code of behaviour to our visitors to minimise their impact on the environment. We want them to have safe, enjoyable, rewarding, memorable and enriching experiences of the Kimberley every time they visit. Therefore, we need to invest in its ecological sustainability and biodiversity.

The Kimberley carers code is your key to doing the right thing. Practice these principles in addition to the specific conditions on your licence. See that your clients are aware of the Kimberley carers code you abide by, and that they too apply the principles. For further information on minimising your impact on the environment, and ultimately your pocket, see 'Best Practice Ecotourism: A Guide to Energy and Waste Minimisation', available from the Federal Department of Tourism.

The Kimberley carers code for the tour operator

Be careful

- Your safety and enjoyment in natural areas is our concern and your responsibility

Be clean

- Use bins where provided, or take your rubbish out with you to an authorized tip site. Food scraps attract dogs and cats, which prey on birds and small animals.
- Don't use soaps and toothpaste in rivers and streams. It harms aquatic life. Wash from a bucket at least 50m from the water.
- Where toilets are not provided, dig a hole to bury waste 15cm deep and at least 100m from camp and water. Wash your hands afterwards.
- Prevent the spread of weeds by removing prickles and burrs from camping equipment when packing up camp. Dispose of prickles and burrs removed from clothing and equipment in a hot fire or rubbish bin.

Be kind

- Protect animals and plants. Leave firearms, snares, traps and pets at home. Pets disturb native animals and can irritate other visitors.
- Use established campsites, don't create a new one. Camp away from river and stream banks as they are susceptible to erosion, compaction and pollution.

Be wise

- Leave animals, plants, wood, rocks and artefacts as you find them for all to enjoy.
- Refrain from touching Aboriginal paintings as it causes them to deteriorate. It is an offence to touch or interfere with Aboriginal sites.

Be cautious

- Follow signs and stay on established roads, tracks and trails to prevent soil erosion.

- Obey road rules. Drive slowly to protect wildlife and straying stock.
- Keep to walk trails to avoid damage to sensitive areas, and possible erosion.

Be cool

- In national parks light fires only in fireplaces provided or bring a portable gas stove.
- Don't light fires on days of very high or extreme fire danger.
- If bush camping without facilities, clear vegetation for 3m above and around your campfire.
- Use only dead wood and use it sparingly. It provides wildlife habitat.
- Make sure the fire is put out with water and soil before you leave.

Be considerate

- Seek approval to enter pastoral leases and Aboriginal lands. Leave things as you find them.

3.4

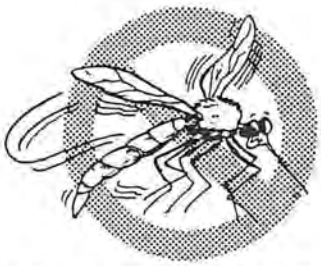
Visitor safety

Exploring the Kimberley can be hazardous to the unprepared. We in the tourism industry have a duty of care for our visitors' health, safety and well being. We want them to have safe, enjoyable, rewarding, memorable and enriching experiences of the Kimberley. We want visitors to come back again and to encourage others. There are some things they need to know regarding the tropics and going bush. However, we don't want to scare them off with tales of terror, no matter how perversely amusing. Remember the message is 'be prepared - not scared!'

The weather and water

- Protect yourself from the sun at all times. You can still get sunburnt on overcast days, from water reflection and from windburn. Sunburn is painful and there is the risk of skin cancer.
- Remember slip, slop, slap and slurp
- Slip on lightweight, loose fitting clothing.
- Slop on sunscreen, preferable 15+ and water resistent.
- Slap on a wide brim hat and sunglasses.
- Slurp plenty of non-alcoholic fluids during the day to replace fluid loss from perspiration. When travelling and walking, always carry water and remember to drink frequently to avoid dehydration. You need two to four litres a day. Avoid drinking alcohol during the day and only drink in moderation in the evening. It is not advisable to drink from waterholes. If you must do so, boil the water or use purification tablets. Flowing water in the creeks and rivers in the wet season is generally safe for human consumption.

The wildlife



- 'Mossies' are the greatest risk to health as at varying times throughout the year some may carry viruses (Ross River virus and others). There are no vaccines or cures, although medication can relieve symptoms.
- Again remember to slip, slop, slap. Cover up and slip into loose fitting clothing, slop on an effective insect repellent and slap up the mosquito net.

- For your own safety it is important not to enter water likely to contain saltwater crocodiles. Observe the warning signs; seek local or expert advice before swimming, boating, fishing or camping.

- Don't paddle, clean fish, prepare food or camp at the water's edge; stand at least a few metres back from the water's edge when fishing.
- Dispose of food scraps and other waste properly and away from your camp site; never feed crocodiles.

Don't feed native animals

- Over-friendly animals become demanding and menacing when food offerings cease. They are then a potential danger to visitors and may scratch and bite.
- Disruption of their normal diet can cause serious nutritional problems, along with contagious disease. Consistent feeding causes unnaturally high and unbalanced animal populations.

Risk management signs

In addition to the crocodile warning signs, CALM has a system of 'risk management' signs throughout Western Australia that are placed at sites of specific risk to visitors. The warning symbol calls for attention, the title identifies the risk; the nature of the risk is outlined and the appropriate behaviour is directed. Where a visitor risk situation cannot be managed through other means, these signs are used. Please see that visitors heed the warning on risk management signs.

Cliff Risk

Play safe

Whatever activities you pursue (walking, driving, boating, swimming, diving, caving), your safety is only as sure as your preparation for potential problems.

- Check that you have the necessary permits, licences and leases to operate the service and to access the resource.
- See that all equipment is in good working order and you have essential spare parts.
- Preferably travel with a H/F two-way radio capable of being tuned to the Royal Flying Doctor Service.
- Seek current local expert knowledge on conditions. Contact the nearest Tourist Bureau or Main Roads Department Office for current road conditions. Telephone 1800 013 314.
- Inform the responsible parties of your itinerary and expected time of return. And let them know when you do.
- In case of mechanical problems, stay with your vehicle. It provides shade and shelter and is more easily seen by rescuers than you are.

3.5

Licensing tour operations

Managing the natural resources of the Kimberley on a sustainable basis through protecting ecological processes and the diversity of life (biodiversity) is crucial to sustainable economic development in the tourism industry. CALM and the Kimberley Tourism Association (KTA) have a vested interest in the successful management of the tourism industry and the conservation of the lands, waters and wildlife upon which it depends in the Kimberley Region. Subsequently, all commercial operations on CALM estate, or involving native wildlife, are required to obtain a licence from CALM.

When is a licence required?

A licence is required for any commercial activity on all lands and waters managed by CALM and vested in the National Parks and Nature Conservation Authority (NPNCA)and the Marine Parks and ReservesAuthority (MPRA). The Conservation and Land Management Amendment Regulations, 1993 require all commercial operators to be licensed. The failure to obtain a licence to sell goods or services carries a penalty of $2000.

Why is a licence required?

In its role as manager of the public estate, CALM has two major responsibilities in relation to tourist activities; to protect the conservation values of the land and to ensure that visitors enjoy a safe and rewarding experience and develop a better understanding of the natural environment. CALM shares this second responsibility with tour operators who also want their clients to enjoy the experience. CALM also has a duty of care in reference to tour operators providing safe experiences.

The issuing of licences enables CALM to monitor access and use of lands and waters under its management and to ensure that the conservation values of these areas are maintained. By protecting these values the tour operator will be able to return to popular locations on many occasions and find them in an unspoiled condition.

What is a commercial operation?

A commercial operation is the selling of any product or service by any person, partnership, company or other organisation for reward or other consideration. Types of activities which may be conducted commercially on CALM lands include:

- vehicle tours or safaris
- guided walks
- adventure activities such as rock climbing and white water rafting
- minor facilities and services such as souvenir outlets
- charter tours

What type of licence is required?

CALM issues two types of licence depending on the nature of the commercial activity.

CLASS 'T' LICENCE

This is normally required when the activity is open to many operators. In these circumstances, environmental and visitor management objectives can be achieved simply through appropriate licence conditions. The majority of tour operators will fall into this category. Examples of class 'T' licences include the many 4WD operators that regularly visit Purnululu National Park

CLASS 'E' LICENCE

Class 'E' licences are licences which are limited. The reason for the restrictionof the licences is generally for the purposes of protecting a fragile or limited resource where unrestricted access or control is deemed to be adverse to this purpose. Expressions of interest are usually called for before class 'E' licences are issued

In the Kimberley region CALM currently has three commercial opportunities which are governed by class 'E' licences.

Purnululu National Park Fly/drive Licences

Suitable sites for camping areas are limited in the Park. It became evident that an opportunity existed for fly/drive tour operations at the Park. This was accommodated by renovation of an existing camping area (Bellburn) to be used exclusively for fly/drive tours. Four licences were granted. The operation has proved to be a viable concern for the companies involved and provides an alternative means for the public to access the Park and have a quality experience.

Purnululu National Park Helicopter Tours

Due to the remoteness and degree of difficulty in reaching the sandstone domes and deep gorges of the Bungle Bungle range, the scenic helicopter tours in the park enhance the range of experiences available to visitors. To ensure the helicopter tours have minimal impact to visitors of the park, one licence has been issued. Flight paths are also determined to ensure all visitors, both on ground and in air have a quality visitor experience.

Rowley Shoals Marine Park

The Rowley Shoals is a very fragile environment, which is receiving more attention each year as a prime tourism attraction for diving. A two tiered approach has been adopted to address the commercial access of tour operators to the Rowley Shoals. The two tiers adopted are the Full Season Commercial Charter Operator Licence, issued to a limited number of charter boat operators and the Single Visit Commercial Charter Operators Licence. Applications for the Single Visit licences will be subject to an assessment of expected visitation at the nominated time, meeting certain selection criteria and accepting the Single Visit licence conditions. Contact the CALM Broome office for further information and to obtain a Single Visit licence application form.

How to obtain a licence

- Contact the Park Policy and Toourism Branch of CALM [Phone (08) 9334 0207 or Fax (08) 9334 0253] for a commercial activity application form: CLM 149 for terrestrial activities and the Tour operator's Handbook or CLM 149M for marine activities and the Tour Operators handbook - Marine. Each Handbook will provide the operator with necessary information and the specific licence conditions for activities and parks. Where a submission is being made to an 'expression of interest' advertisement, information and requirements will be included in the guidelines to submissions prepared for each specific activity and/or location.
- Complete either the terrestrial and/or marine application form. The application form seeks information on activities, locations, type and number of proposed vehicles/vessels/craft etc., as well as other relevant information needed to assess the application.
- Forward the application(s) to the CALM Como Office with the information that is requested in the application checklists, including the prescribed application/ renewal fee currently $50.

- Departmental staff will assess your application ensuring all relevant information is supplied with the application (see the *Application Checklist*). Approval will be sought from the National Parks and Nature Conservation Authority (NPNCA) (the vesting body for National Parks and Reserves) and the Minister for the Environment to issue a licence. Approval from the Marine Parks and Reserves Authority (MRPA) (the vesting body for Marine Parks and Reserves) is not required to issue marine licenses.
- Following approval, your licence will be issued with a handbook, for each vehicle/ vessel in use as part of the licensed activity.
- Once a licence is issued the licence holder will be invoiced for the $250 licence fee.

What other requirements have to be met?

- If your activity includes the use of a motor vehicle or a boat, appropriate licences and certificates from the Department of Transport are necessary throughout the term of the licence. Contact the:

  Department of Transport
  PO Box 1993
  Broome 6725
  Telephone (08) 9193 5923
- A commercial operator must have Public Risk Liability Insurance with a minimum cover of $5 million before a licence is issued. This cover must note the Executive Director of CALM's interests.

A licence will not be issued until these requirements are met.

What if the activity covers a number of areas of W.A?

Operators whose activities cover a number of areas can generally include them on the one application and they are then approved on one licence. In cases where more than one park or reserve is visited each park or reserve involved must be identified separately on the application. All activities may not be permitted in all parks and reserves.

What if you don't want to be tied to a specific route or timetable?

Your licence allows flexibility for your tour.

What happens if you sell your business?

Tour Licences are not tangible assets and cannot be transferred to a new owner. Prior to any change of ownership of a business, the potential purchaser should enquire as to how a licence can be issued.

How long is a licence valid?

Class 'T' Licences are granted on an annual basis. Approvals are processed on a monthly basis.

Class 'E' Licences can be valid for one or more years (to a maximum of five years). The period is determined by CALM and will depend on the nature of the activity, the impact on the environment and the amount of capital investment made by the licence holder.

What are the fees used for?

Commercial tourist activities on CALM lands can involve the Department in significant additional management costs. Tour operators are also provided with a listing on CALM's naturebased website, a subscription to Landscope Magazine and a quarterly newsletter, Touring WA.

In the case of class 'E' licences, a portion of the financial returns from the activity can be considered as deriving directly from the use of these public lands and waters and involve a degree of protection from open competition. It is, therefore, considered appropriate that some fee be charged related to the use of the land or water for the commercial activity.

Fees

There is a non-refundable $50 application and renewal fee which is paid at the time of submitting your application for a licence or licence renewal to your nearest CALM office. Application and renewal fees are used to help cover the costs of processing the application / renewal.

Licence Charges

All other charges associated with a licence are directed toward the management of licence activities. Examples of management costs include:

- the establishment of monitoring programs to ensure the continued sustainability of tourist activities.
- the provision of information and interpretive material to enhance the quality of visitor experience and understanding of the natural environment.

Licence charges are vital to ensuring that tourist activities are environmentally sustainable.

Class 'T' Licence charges are a fixed annual amount. For 1998/99 licence charges are $250. This charge is payable at the time licences are issued.

Class 'E' Licence charges are linked directly to the level of activity of the licence and will generally be a percentage of gross receipts from licensed activities or a per head figure based on the number of passengers carried. Circumstances that require class 'E' licences often mean that intensive management and monitoring are required to ensure that the balance between use and conservation is maintained. The costs of such management can be substantial. Licence charges are used to help offset the costs of management and research activities necessary to ensure the continued sustainability of nature-based tourism activities. Charges are generally payable at quarterly intervals.

Park Entry and other Fees

Entrance and camping fees apply at a number of parks in Western Australia. These fees are levied in accordance with the National Parks Authority Regulations and are independent of commercial licence requirements. Fees collected are directed towards the provision and maintenance of facilities and services for the benefit of all park users. Where levied these fees apply to all visitors, private and commercial. Possession of a Commercial Licence does not negate the operator from paying the prescribed fees for clients of tours conducted by the operator. In certain circumstances credit facilities may be available for the payment of entrance and camping fees.

Who checks on licences?

CALM staff carry out random checks to ensure that commercial activities on CALM lands are covered by licences and that operators adhere to licence conditions. CALM can cancel or suspend licences if conditions are not complied with.

What are the benefits?

By safeguarding the beauty and diversity of Western Australia's natural environment and by complying with these requirements, you will be helping CALM to ensure that the beauty and diversity of Western Australia's natural environment and the natural attractions upon which your business is based are not diminished. CALM will also help you in any way it can to improve the experience of visitors on the land it manages.

3.6

About visitor fees on CALM lands and waters

Visitor fees apply to most national parks in Western Australia. The fees collected are re-invested in the parks to improve facilities for visitors and help offset the costs of management.

Park passes

A variety of park passes for day visits to national parks are available from CALM offices in the Kimberley. They do not cover camping fees.

- Four-week All Parks Pass
- Annual All Parks Pass
- Gold Star Pass
- Annual Local Parks Pass - Mirima and Purnululu

In the Kimberley day visitor fees apply at Purnululu and Mirima.

Camping fees

Camping fees are payable at Windjana Gorge, Silent Grove, and Purnululu.

Activities fees

Fees apply at Geikie Gorge for the boat tours.

Contact CALM offices for current prices.

Section 4

Section 4:

For Further Information

4.1

A Kimberley reading list

Further reading lists have been provided throughout this manual for specific information. The following publications concerning the Kimberley are available for loan or reference at local libraries.

General

The Australian Geographic Book of the Kimberley
D. McGonigal

The Kimberley: Horizons of Stone
Quentin Chester and Alasdair McGregor

North-West Bound
Department of Conservation and Land Management

Nature Conservation Reserves in the Kimberley
Department of Conservation and Land Management

The Land Beyond time: A Modern Exploration of Australia's North-West Frontiers
John Olsen et al

The Kimberley
Debbie Gallagher

Aboriginal

Land of Promises. Aboriginal People and Development in the East Kimberley
Edited by H.Coombs, H.McCann, H.Ross, N.Williams.

Aboriginal People in the Economy of the Kimberley Region
Greg Crough and Christine Christophersen

Aboriginal People and Diamond Mining: The Politics of Resource Development in the East Kimberley, Western Australia
M C Dillon and Roderick Dixon

Traditional Aboriginal Plant Resources in the Kalumburu Area
I M Crawford (Western Australian Museum)

The Art of the Wandjina. Aboriginal Cave Paintings in Kimberley, Western Australia.
I.M.Crawford

Bradshaws Ancient Rock Paintings of North-West Australia
Grahame L Walsh

Images of Power: Aboriginal Art of the Kimberley
Judith Ryan (National Gallery of Victoria)

Wirrimanu: Aboriginal Art from the Balgo Hills
James Cowan

Painting the Country: Contemporary Aboriginal Art from the Kimberley Region John E Stanton

Mythology in Northern Kimberley, northwest Australia
A. Capell

Aboriginal Culture in the Kimberley Region
Brian McKenna

Yirra, Land Law and Language: Strong and Alive
Kimberley Aboriginal Law and Culture Centre

Yorro Yorro: Everything Stand Up Alive: Spirit of the Kimberley
David Mowaljarlai and Jutta Malnic

History

The History of the North West of Australia
J S Battye

Kimberley: Dreaming to Diamonds
Hugh Edwards

Port of Pearls
Hugh Edwards

Pearls of Broome and Northern Australia
Hugh Edwards

Jandamarra and the Bunaba Resistance
Howard Pedersan and Banjo Woorunmurra

King of Kimberley: The Story of a Tragic Injustice
Rocky Marshall

Kimberley Scenes: Sagas of Australia's Last Frontier
Edited by Cathie Clement and Peter Bridge

Tales of the Overland, Queensland to Kimberley in 1885
G.H.Lamond

Fossil Downs, A Saga of the Kimberley
Gordon McKenzie

Discovery of the Kimberley Goldfields
E Playford and I Ruddock

The Oombulgurri Story
Neville Green

Forrest River Massacre
Neville Green

Kalumburu, The Benedictine Mission and the Aboriginal people 1908-1975
Fr Eugene Perez

Kalumburu War Diary
Fr Eugene Perez

Truscott: The Diary of Australia's Secret Wartime Kimberley Airbase 1943-46
John and Carol Beasy

The Koolama Incident
Bill Loane

Healing Hands: Memories and Milestones of the Derby Leprosarium
Sr Alphonsus Daly

The Long Road North
edited by F B Morony (Gasgoyne Trading)

Life Stories

North of the 26th
Edited by Helen Wheeler

North of the 26th Volume Two
Edited by Helen Wheeler

Kings in Grass Castles
Mary Durack

Sons in the Saddle
Mary Durack

Moola Bulla, In the Shadow of the Mountain
Edited by the Kimberley Language Resource Centre

Raparapa, Stories from the Fitzroy River Drovers
Edited by Paul Marshall

Nyibayarri. Kimberley Tracker
Jack Bohemia and Bill McGregor

Jilji, Life in The Great Sandy Desert
Pat Lowe with Jimmy Pike

Gularabulu Stories West Kimberley
Paddy Roe

Countrymen: The Life Histories of Four Aboriginal Men
as told to Bruce Shaw

My Country of the Pelican Dreaming: The Life of an Australian Aborigine of the Gadjerong Grant Ngabidj 1904-1977
as told to Bruce Shaw

When the Dust Come in Between: Aboriginal Viewpoints in the East Kimberley Prior to 1982
as told to Bruce Shaw

Above Capricorn: Aboriginal Biographies from Northern Australia
Strephen Davies

Joe Nangan's Dreaming
Joe Nangan and Hugh Edwards

The Rivers of Home: Frank Lacy - Kimberley Pioneer
Marion Nixon

Wiping out the Tracks: The Northern Odyssey
Leslie A Schubert

Save that Song: Conquering the Outback My Way
John N Hutchinson

With Rhyme and Reason
Norma Wainwright

Kimberley Cool
Mick Powell

First Cuts are Deepest
Pat Malcolm

Fiction

Lost River, An Adventurous Life
Joss Hardman

Heart of Light
Heather Grace

Tales from the NorthWest
Peter James

Photographic

The Kimberley, A Journey through Northwest Australia
Mike Leonard

Australia's Kimberley; Vision of a Lasting Wilderness
Col Roberts

The Kimberley: Australia's Unique North-West
Jocelyn Burt

Til She Dropped Her strides
Trish Ainslie and Roger Garwood

4.2

Matrix of CALM reserves, facilities and services

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4.3

Kimberley Tourism Association holiday planner

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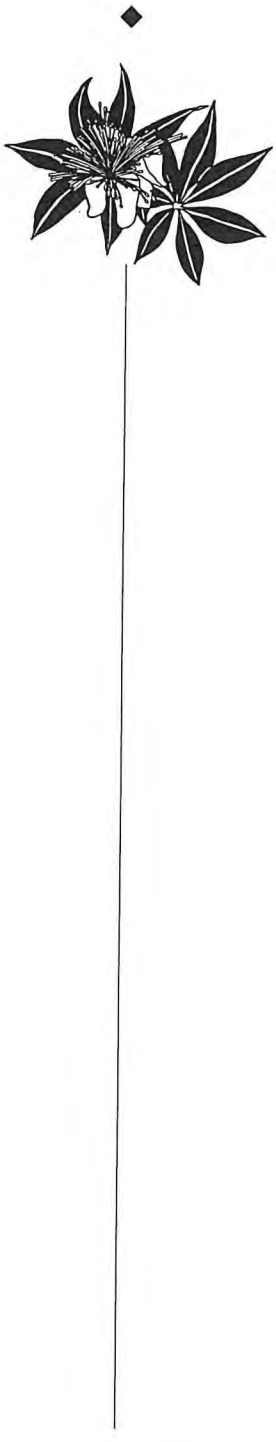


4.4

Kimberley Tourism Association

1999/2000

Membership Application Form

Name of Business: _____

Contact Name: _____

Kimberley Tourist bureau you are most affiliated with: _____

Postal Address: _____

_____

Phone: _____ Fax: _____

Email: _____ Website: _____

The nature of your operation: - _____

_____

_____

_____

_____

(E.g. 25 bed lodge....)

Number of Passenger seats, beds, etc. _____

PLEASE RUSH THIS TO THE KTA OFFICE

FAX: 008 9193 6662

Any queries, please call on 08 9193 6660

Photocopy this page and fax to 08 9193 6662

4.5

Code of practice for ecotourism operators

- Strengthen the conservation effort for, and enhance the natural integrity of, the places visited.
- Respect the sensitivities of other cultures.
- Be efficient in the use of natural resources (water, energy).
- Ensure waste disposal has minimal environmental and aesthetic impacts.
- Develop a recycling program.
- Support principals (i.e. hotels, carriers etc) who have a conservation ethic.
- Keep abreast of current political and environmental issues, particularly of the local area.
- Network with other stakeholders (particularly those in the local area) to keep each other informed of developments and to encourage the use of this code of practice.
- Endeavour to use distribution networks (eg. catalogues) and retail outlets to raise environmental awareness by distributing guidelines to consumers.
- Support ecotourism education and training for guides and managers.
- Employ tour guides well versed in and respectful of local cultures and environments.
- Give clients appropriate verbal and written educational material (interpretation) and guidance with respect to the natural and cultural history of the areas visited.
- Use locally produced goods that benefit the local community, but do not buy goods made from threatened or endangered species.
- Never intentionally disturb or encourage the disturbance of wildlife or wildlife habitats.
- Keep vehicles to designated roads and trails.
- Abide by the rules and regulations applying to natural areas.
- Commit to the principle of best practice.
- Comply with Australian safety standards.
- Ensure truth in advertising.
- Maximise the quality of experience for hosts and guests.

4.6

Fantastic Kimberley facts

- Many of the Kimberley's landscapes are among the oldest on Earth - parts date back almost 2 000 million years.
- The tidal ranges at some places on the Kimberley coast are amongst the highest in the world, at over 12m. Derby has the highest tidal range of any port in the southern hemisphere: 10.8m.
- Lake Argyle stores 18 times the volume of water in Sydney Harbour.
- The northwest coast of Western Australia is regularly visited by more than half a million migratory wader birds of more than 30 species - more than 30 per cent of the total number of migratory waders in the whole of Australia. It is ranked as the seventh most important wader site in the world.
- Argyle Diamond Mine is the world's largest diamond mine, producing more than 30 per cent of the world's diamonds.
- Derby was the terminus of the first scheduled aviation flight service in Australia. On December 5th, 1921 West Australian Airways flew between Geraldton and Derby, a year before Qantas began its service from Charleville to Cloncurry.
- The northwest Kimberley is one of few places in Australia with wildlife that is intact - there have been no recorded extinctions since European settlement.
- The Bradshaw rock paintings of the Kimberley have recently been dated as being at least 16,400 years old, making them the earliest definitely dated rock art style in Australia.
- Gogo station near Fitzroy Crossing is one of the world's most important fossil sites with the most diverse collection of Devonian age fishes in the world.
- and much more for you to add.

4.7

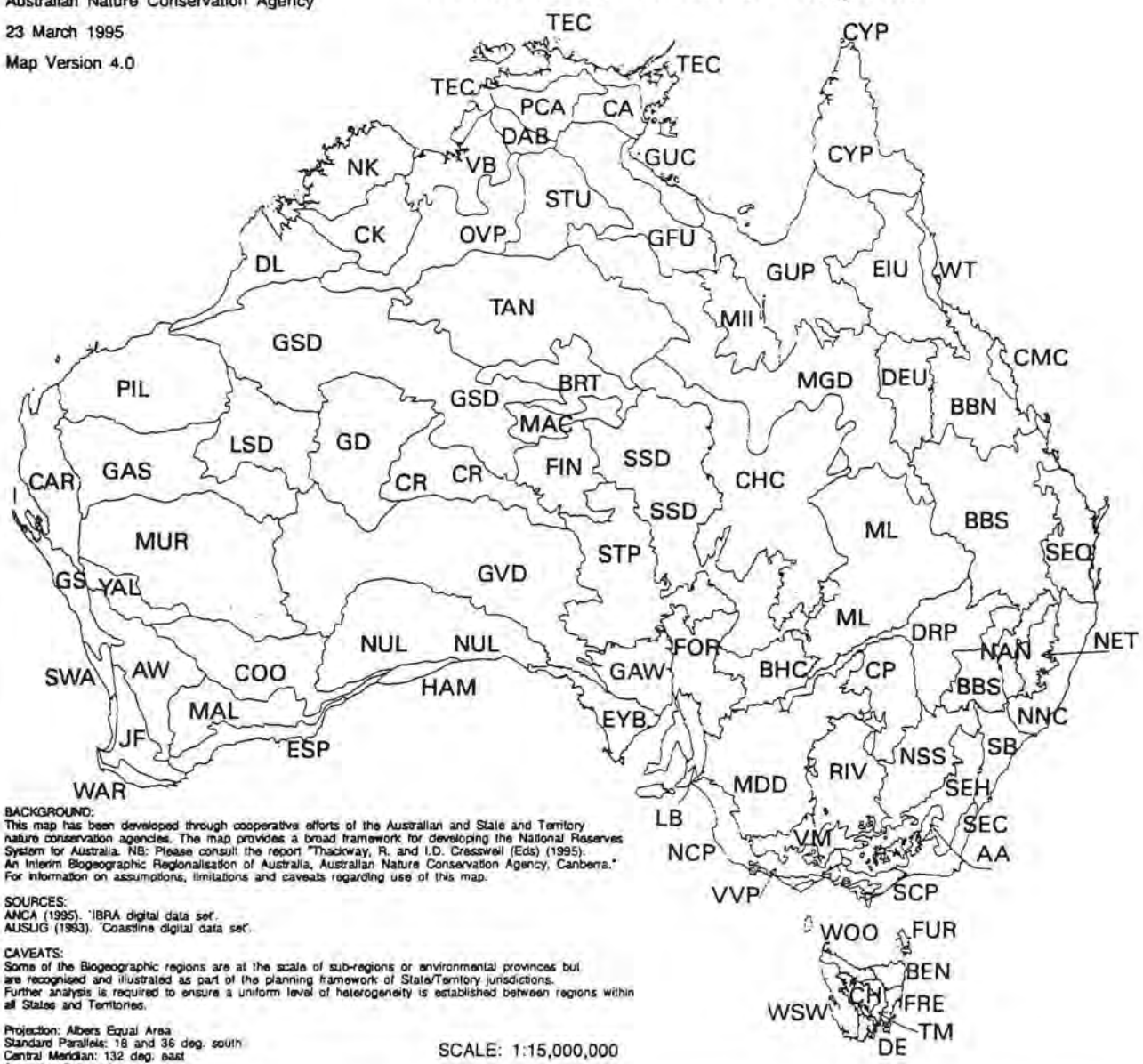
Kimberley Bioregions

Boundaries of IBRA Regions

Australian Nature Conservation Agency

23 March 1995

Map Version 4.0



BACKGROUND:
This map has been developed through cooperative efforts of the Australian and State and Territory nature conservation agencies. The map provides a broad framework for developing the National Reserves System for Australia. NB: Please consult the report "Thackway, R. and I.D. Cresswell (Eds) (1995). An Interim Biogeographic Regionalisation of Australia, Australian Nature Conservation Agency, Canberra." For information on assumptions, limitations and caveats regarding use of this map.

SOURCES:
ANCA (1995). 'IBRA digital data set'.
AUSLIG (1993). 'Coastline digital data set'.

CAVEATS:
Some of the Biogeographic regions are at the scale of sub-regions or environmental provinces but are recognised and illustrated as part of the planning framework of State/Territory jurisdictions. Further analysis is required to ensure a uniform level of heterogeneity is established between regions within all States and Territories.

Projection: Albers Equal Area
Standard Parallels: 18 and 36 deg. south
Central Meridian: 132 deg. east
Australian Spheroid

SCALE: 1:15,000,000

IBRA CODE: IBRA NAME
AA: Australian Alps
AW: Avon Wheatbelt
BBN: Brigalow Belt North
BBS : Brigalow Belt South
BEN: Ben Lomond
BHC: Broken Hill Complex
BRT: Burt Plain
CA: Central Arnhem
CAR: Carnarvon
CH: Central Highlands
CHC: Channel Country
CK: Central Kimberley
CMC: Central Mackay Coast
COO: Coolgardie
CP: Cobar Peneplain
CR: Central Ranges
CYP: Cape York Peninsula
DAB: Daly Basin
DE: D'Entrecasteaux
DEU: Desert Uplands
DL: Dampierland
DRP: Darling Riverine Plains
EIU: Einasleigh Uplands
ESP: Esperance Plains
EYB: Eyre and Yorke Blocks
FIN: Finke
FOR: Flinders and Olary Ranges
FRE: Freycinet
FUR: Furneaux
GAS: Gascoyne
GAW: Gawler
GD: Gibson Desert
GFU: Gulf Fall and Uplands
GS: Geraldton Sandplains
GSD: Great Sandy Desert
GUC: Gulf Coastal
GUP: Gulf Plains
GVD: Great Victoria Desert
HAM: Hampton
JF: Jarrah Forest
LB: Lofty Block
LSD: Little Sandy Desert
MAC: MacDonnell Ranges
MAL: Mallee
MDD: Murray-Darling Depression
MGD: Mitchell Grass Downs
MII: Mount Isa Inlier
ML: Mulga Lands
MUR: Murchison
NAN: Nandewar
NCP: Naracoorte Coastal Plain
NET: New England Tableland
NK: Northern Kimberley
NNC: NSW North Coast
NSS: NSW South western Slopes
NUL: Nullarbor
OVP: Ord-Victoria Plains
PCA : Pine-Creek Arnhem
PIL: Pilbara
RIV: Riverina
SB: Sydney Basin
SCP: South east Coastal Plain
SEC: South East Corner
SEH: South Eastern Highlands
SEQ : South Eastern Queensland
SSD: Simpson-Strzelecki Dunefields
STP: Stony Plains
STU: Sturt Plateau
SWA: Swan Coastal Plain
TAN: Tanami
TEC: Top End Coastal
TM: Tasmanian Midlands
VB: Victoria Bonaparte
VM : Victorian Midlands
VVP: Victorian Volcanic Plain
WAR: Warren
WOO: Woolnorth
WSW: West and South West
WT: Wet Tropics
YAL: Yalgoo

4.8

Kimberley Images

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◆

. . . a summary of themes, concepts and messages for promoting the values of the Kimberley

The following statements are taken from the text of this manual as a review of the essence of the Kimberley stories to be communicated to clients.

- The key Kimberley themes for interpretation are those identified in the contents of this manual:
  - (1) Sense of place,
  - (2) Cycles of change,
  - (3) Natural communities,
  - (4) Looking at Kimberley wildlife
  - (4) Getting to know Kimberley people
  - (5) Caring for the land,
  - (6) Places to go, things to know and do,
  - (7) Tourism in the Kimberley.
- Kimberley ecological concepts for understanding are change, diversity, community, interrelationships and adaptation.
- Change in sun, rain, wind and tide in the Kimberley has a significant effect on the lives of people, plants and animals.
- The Kimberley is a diversity of natural communities.
- The natural communities found in the Kimberley are the ranges, rainforests, woodlands, grasslands, arid lands, riverine and coastal wetlands and the ocean, islands and reefs.
- Natural communities are complexes of landscape, rocks, soil, water, plant and animal interrelationships.
- Wildlife (plants and animals) demonstrates adaptation to its environment in remarkable ways. However, adaptation is an evolutionary process over time.
- National parks and other conservation reserves are special kinds of land use that is ecologically sustainable; through tourism, they are economically viable; through public participation, they are socially acceptable.
- Know the Kimberley carers code - be careful, be clean, be kind, be wise, be cautious, be cool, be considerate.
- Aboriginal culture is diverse and complex although its traditional technology may be relatively simple. This simplicity epitomises the skilful adaptation and efficiency of use of resources for a hunter- gatherer lifestyle.
- Kimberley Aboriginal heritage is rich and varied.