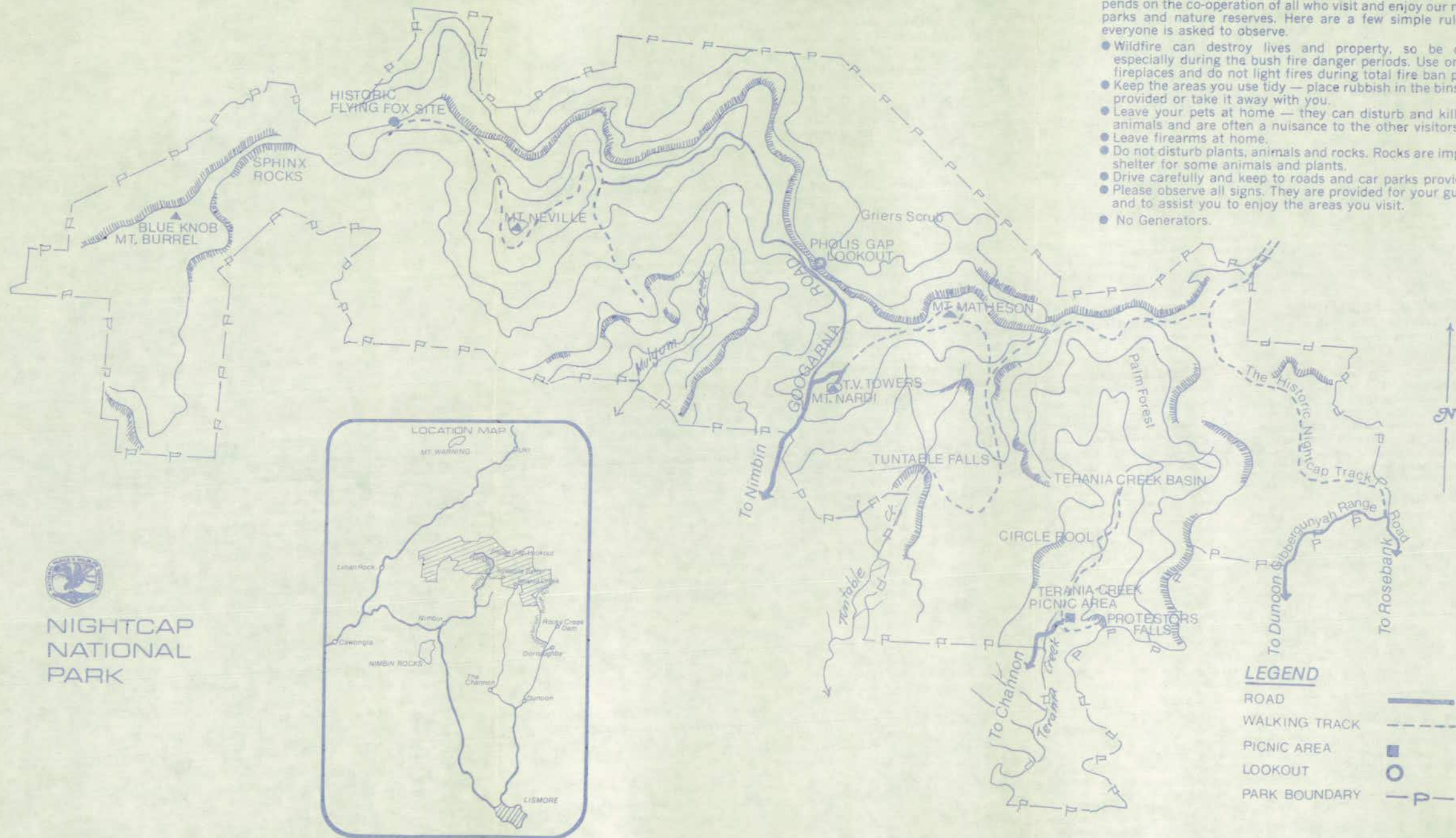


## NATIONAL PARKS AND WILDLIFE CODE

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- Wildfire can destroy lives and property, so be careful, especially during the bush fire danger periods. Use only safe fireplaces and do not light fires during total fire ban periods.
- Keep the areas you use tidy — place rubbish in the bins where provided or take it away with you.
- Leave your pets at home — they can disturb and kill native animals and are often a nuisance to the other visitors.
- Leave firearms at home.
- Do not disturb plants, animals and rocks. Rocks are important shelter for some animals and plants.
- Drive carefully and keep to roads and car parks provided.
- Please observe all signs. They are provided for your guidance and to assist you to enjoy the areas you visit.
- No Generators.



NIGHTCAP  
NATIONAL  
PARK



### LEGEND

- ROAD ————
- WALKING TRACK - - - -
- PICNIC AREA ■
- LOOKOUT ○
- PARK BOUNDARY - P -

# NIGHTCAP NATIONAL PARK

## ABOUT THE PARK

The Nightcap National Park is located in far north-eastern New South Wales, thirty kilometres north of Lismore and thirty kilometres south-west of Murwillumbah. Straddling the western half of the Nightcap Range, this park is a scenically spectacular massif of peaks, ridges and gullies delineating the southern caldera rim of the 20 million year old Mount Warning shield volcano.

This volcanic history, combined with the highest rainfall recorded in the State, has produced a lush subtropical flora. The most complex and best developed subtropical rainforest in N.S.W. occurs in the Nightcap.

This scenically magnificent rainforest is found in the higher altitude ridges and mountains as well as the lower altitude valleys and gullies, and reflects an underlying geology of rich basaltic lava flows.

The park's mid-slopes, derived from nutritionally poorer rhyolitic lava flows, support less complex warm temperate rainforest, and dense wet sclerophyll forest dominated by eucalypts and brush box.

The Nightcap National Park was reserved in 1983 by decision of the N.S.W. Government, after almost a decade of controversy over continued logging of the area which was then reserved as state forest.

## ACCESS AND FACILITIES

Road access to the park is based on four roads from the Richmond Valley to the South.

### MOUNT NARDI

A sealed road provides all weather access (12 km) from Nimbin to Mount Nardi. Mount Nardi is one of the higher peaks within the park and is the site of the ABC and RTN8 Television Towers. Lismore City Council maintains picnic facilities on the summit, and a viewing platform immediately south of the larger ABC tower provides panoramic views over the cleared farmlands of the Richmond Valley. A graded walking track links Mount Nardi (past the smaller RTN8 tower) to nearby Mount Matheson (1 km). A longer walk (8 km) links Mount Matheson with the historic Nightcap Track to the east.

### GOOGARNA ROAD

Googarna Road leaves the Mount Nardi Road some 500 metres before the summit. This gravelled road, wends its way westwards through the beautiful subtropical rainforest of the Nightcap Range. Pholis Gap lookout provides panoramic views of the scenic Tweed and Doon Doon Valleys. The road terminates on the eastern flanks of Mount Neville.

Visitors may walk from this terminus down an old logging road (Mulgum Road) to cliffs high above Mulgum Creek (2 km). A walk westwards along the old Flying Fox road (5 km) brings the visitor to the site of the historic old flying fox high above Kunghur Creek. This flying fox was used in the 1940's and 1950's to lower logs some 500 metres down from the rainforest of the Nightcap Range to a small sawmill on Kunghur Creek. In its day this flying fox was reported to be the largest in the southern hemisphere, with cables 1.6 km long.

### TERANIA CREEK

The Terania Creek road provides access from The Channon to the Terania Creek section of the park (14 km). This gravelled Shire road has three causeway crossings of Terania Creek. Care should be taken in crossing these causeways, especially during periods of wet weather. Special care should also be taken to dry brakes after crossing these causeways.

The first close encounter with the rainforest for any visitor travelling up the Terania Creek road from Lismore is approaching the

southern boundary of the national park adjacent to the Terania Rainforest Nursery. Dense dark green luxuriant rainforest assails the senses.

This experience is heightened for any visitor who has not previously encountered the tropical forests of the Richmond-Tweed and presents a sharp contrast to the extensively cleared farmlands further down the valley.

A walking visit to the main basin or for that matter just to the Protestors Falls will provide the visitor with a close encounter with dense rainforest including palm forest, and numerous large trees of strangler fig, brush box and yellow carabeen. The basin is an ideal area for an intimate experience with the tropical forest.

The National Parks and Wildlife Service has constructed a picnic area at the terminus of the Terania Creek road, and a new walking track provides an inviting 500 metre walk to the nearby Protestors Falls. Camping is permitted at the Terania Creek picnic area, but is restricted to one night only. Because of the high possibility of being marooned by flooded causeways, campers should pack and leave if heavy rains commence.

Currently access up the main Terania Creek Basin is via the old logging road. This road passes close to the beautiful circle pool, then leads onto a palm forest plateau where huge brush box and red cedar trees grow. These brush box trees have been carbon dated to 1200-1500 years old.

## NIGHTCAP TRACK

Access to the historic Nightcap Track is via Gibberungah Range road in the adjoining Whian Whian State Forest. The southern section of this road is incorporated in the Nightcap Forest Drive and is gravelled. However the northern section, beyond the Rummery road junction, is not gravelled and is impassible to a conventional vehicle in wet weather.

The Nightcap Track is a signposted graded walk through rainforest clad mountain escarpments. It was originally a pack horse track, constituting the first overland link between the Richmond and Tweed Valleys. Pioneering mailmen took three days to make the journey from Lismore to Murwillumbah. A graded walking track (9 kms) links the Nightcap track to Mount Nardi via Mount Matheson.

## "BITIES"

If your visit is in the right season you may encounter some of the park's "bities" — leeches, scrub ticks or stinging tree leaves.

A prior application of personal insect repellent around the feet and lower legs will help ward off leeches. If you do pick up a leech, just pull it off with your fingers, roll it into a little ball and throw it away. If you find this difficult or repulsive, common salt or insect repellent is also effective.

Ticks should be carefully pulled out with either fingers or tweezers.

The stinging tree leaf is large and round in shape and has many small fine hairs which when touched penetrate the skin and inject an irritating acid. The sting is similar to that of a stinging nettle, but a little more painful and longer lasting.

If you come into contact with any "bities" try not to rub the affected area as this increases the irritation. Application of an antiseptic cream may be helpful in the case of leech "bities" and antihistamine type creams for ticks or stinging trees.

## COOKING

Rainforests are often wet or damp, making the lighting of fires for barbecues difficult. If you intend cooking on your visit it is a wise precaution to bring a portable gas stove.



NIGHTCAP  
NATIONAL PARK

SPHINX ROCK



# TERANIA CREEK BASIN NIGHTCAP NATIONAL PARK

## GETTING THERE

Terania Creek basin is a narrow valley of subtropical rainforest and luxuriant eucalypt forest tucked under the cliffs and peaks of the Nightcap Range. The basin, which forms the eastern section of the Nightcap National Park, is located 35 kilometres north of Lismore in the northeastern corner of New South Wales.

Access to this section of the Nightcap is via Terania Creek Road, which turns off at The Channon, 25 kilometres north of Lismore via Dunoon. The road crosses a low-level creek causeway at the park entrance which can be flooded after several hours of rain. Extreme care should be taken in wet conditions and car brakes should be dried out after crossing.

## HISTORY

The area now known as the Nightcap National Park was previously reserved as State Forest and managed by the Forestry Commission of N.S.W., primarily for timber harvesting.

Interest by local councils and residents in a Nightcap National Park dates back to the 1930s, culminating in 1937 with the setting aside by the N.S.W. Government of an area within the State Forests on the Nightcap of 1,170 hectares, which would be "to all intents and purposes, a national park serving all time."

Logging of the Nightcap's State Forests continued until major anti-logging protests took place at Terania Creek in 1979 and Griens Scrub and Mount Nardi in 1982. Hundreds of protestors, timber workers and police were involved in these actions, prompting a N.S.W. Government review which led to the reservation of the Nightcap, and other rainforests, as national parks in 1983.

The facilities area at Terania Creek was a logging dump and served during the 1979 protest as a police camp. Nearby Protestors' Falls derives its name from these events.

## VISITOR FACILITIES

Basic picnic facilities including tables and toilets, car parking and a turning circle are provided at the road terminus in a glade next to the rainforest. As the name rainforest implies this area receives one of the highest rainfalls in the state. As such, firewood remains unlightable for long periods after rain. It is for this reason that no fireplaces are provided and intending visitors are requested to include a portable barbecue should they wish to cook.

## PROTESTORS' FALLS WALK

This 1.4 kilometre return walk follows Waterfall Creek to the base of Protestors' Falls. The walking track is sensitively constructed to blend with the environment and passes through a beautiful rainforest dominated by dense thickets of bangalow palms.

These palms are easily distinguished by their long leaves that sheath from smooth, ringed and slender trunks. Maiden's blush and blue quandong occur among the palms. The small walking stick palm is common along the walk. It bears edible, small red fruits on a single long spike and was used as a walking stick by early settlers as the slim trunk swells to a knob at its base, forming a natural handle.

Epiphytes such as staghorns, elk horns and bird's nest ferns can be observed clinging to tree trunks alongside the track. Various types of tree ferns can also be seen. Visitors should be aware that all plants in a national park are protected.

The short distance and quality of the walk, with its reward of a sheer waterfall tumbling into a dark pool, make Protestors' Falls one of the most accessible of the Nightcap's beauty spots.

## GEOLOGY

The Nightcap Range was formed by massive outpourings of molten lava from Mount Warning, then the central vent of a huge shield volcano, and the ensuing effect of 20 million years of erosion. The forces of erosion created the Tweed Valley with its near-circular caldera of steep-sided ranges. The Nightcap Range forms the southern rim of the caldera.

The lava flows were quite distinctive, and have been divided into three groups. The gentle slopes and creek basins are underlain by basalt, the first lava flow from the Mount Warning volcano. The basalt built up to considerable thickness, then eroded readily to form the fertile krasnozem and alluvial soils which support the rich subtropical rainforest in Terania Creek basin.

Enclosing the basin on three sides are sheer rhyolite cliffs. These Nimbin rhyolites flowed in a thick sequence of acid volcanics and have solidified to form material resistant to weathering. The soils derived from the rhyolites are of low fertility, mainly due to their high silica content, and support either wet sclerophyll eucalypt forest or warm temperate rainforest.

The third and final lava flow was again basalt, which now occurs only as small cappings on the peaks of the local mountains. The fertile soil derived from this basalt supports the lush subtropical rainforest of the high country.

## FLORA

The subtropical rainforest of the valley floor is characterised by a combination of white booyong, yellow carabeen, red cedar, purple cherry, sour cherry and strangler figs.

Many of these trees have peculiar flattened extensions from their trunks known as buttresses. The forest is dim and cool as the dense canopy overhead excludes most of the sunlight.

Huge brushbox trees grow on the poorer rhyolitic soils. These are prominent on the slopes above Terania Creek, and some of these trees have been dated at up to 1,500 years old. Well developed coachwood often forms part of the understorey beneath the towering brushbox.

## FAUNA

Despite its relatively small size, Terania Creek basin supports a rich and diverse animal population, including some rare and endangered species.

Pademelons and the southern brown bandicoot search for food on the forest floor, while the common ringtail possum prefers to feed on leaves and flowers in the branches. Carnivorous marsupials and other small mammals such as the brown antechinus and the fawn-footed tree rat are also present. Numerous blossom, fruit and insect-eating bats occur in the forest, including the rare Queensland tube-nose bat.

There have been no less than 130 species of birds recorded in Terania Creek basin, underlying the importance of this habitat. Among these are some rare or uncommon rainforest birds including the magnificently-coloured wompoo pigeon, marbled frogmouth, crested hawk, powerful and sooty owls and Albert's lyrebird.

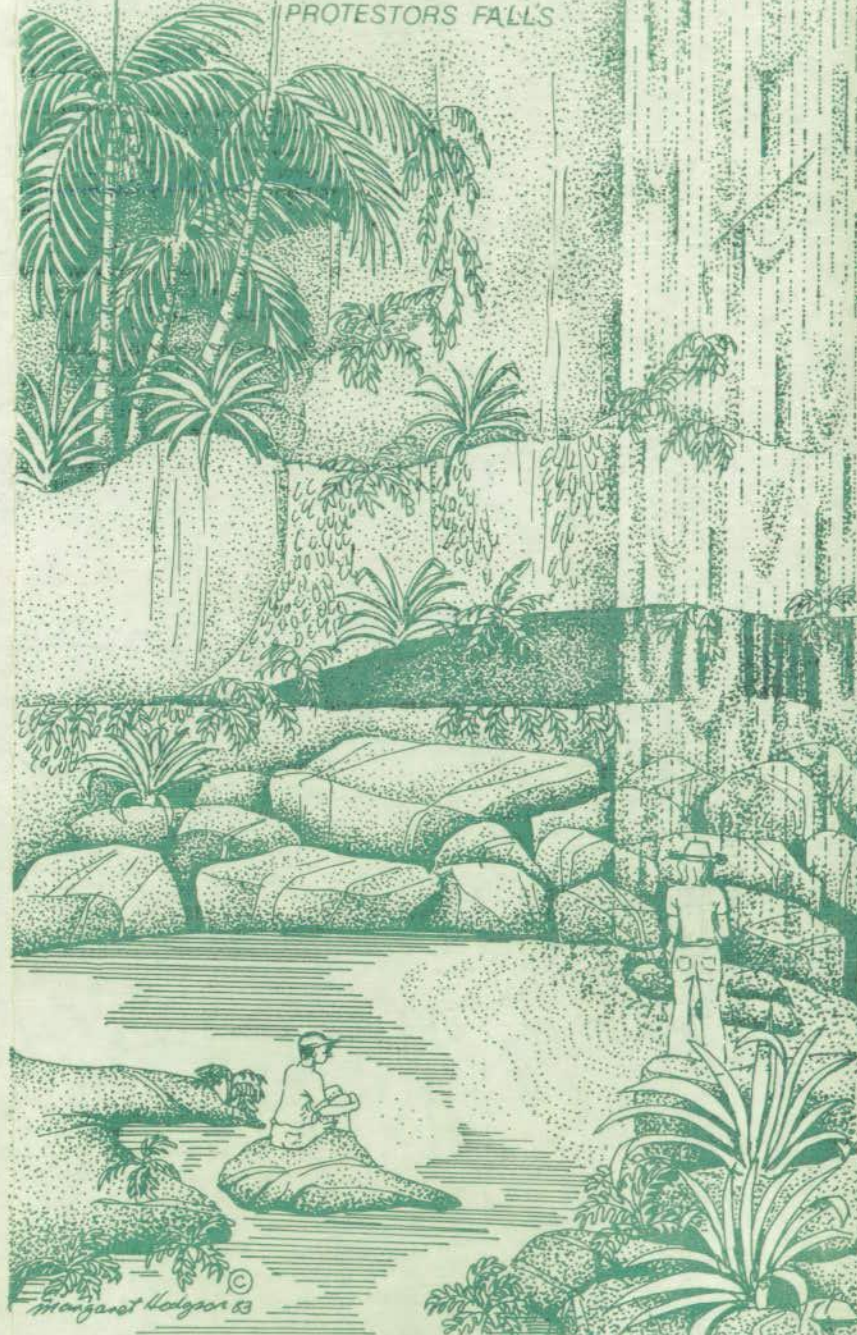
Most of the frogs in the rainforest are nocturnal and rarely seen during day visits. The tiny pouched frog is a rare amphibian recorded in the area. The males have pouches along their flanks where the eggs and larvae are brooded, an uncommon means of parental care as frog's eggs are usually left unattended in a pool.

Reptiles common to the area include the northern leaf-tailed gecko with its broad, flattened tail, the land mullet, lace monitor, long-necked tortoise and many small skinks. Snakes include the carpet python, tree snake, plus the venomous red-bellied black snake and rough-scaled snake.



# TERANIA CREEK BASIN NIGHTCAP NATIONAL PARK

## PROTESTORS' FALLS

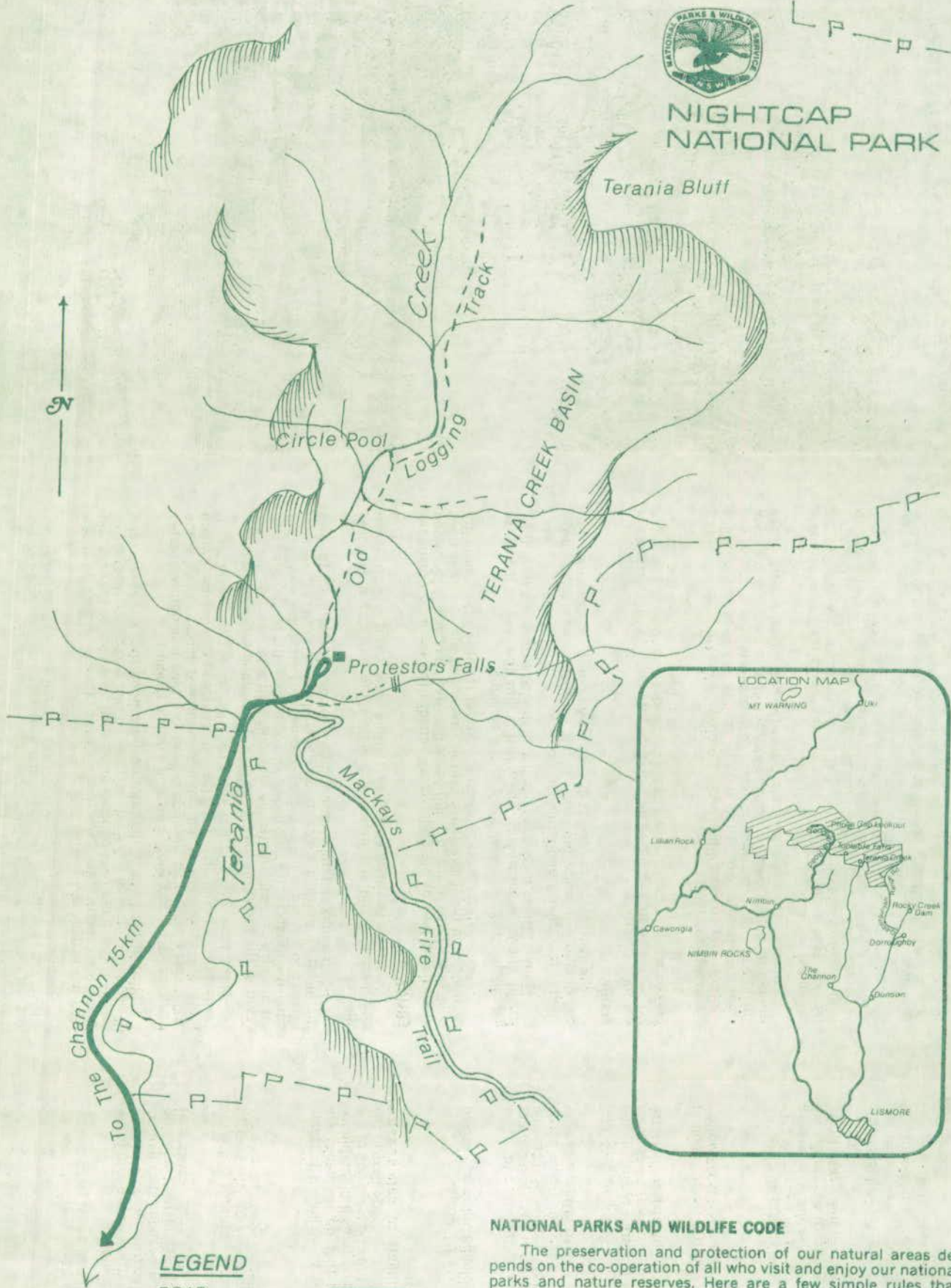


**FURTHER INFORMATION**

Additional information and associated pamphlets may be obtained from the Senior Ranger, National Parks and Wildlife Service, Lismore District, Colonial Arcade, Alstonville; telephone (066) 28 1177.



**NIGHTCAP NATIONAL PARK**



**LEGEND**

- ROAD
- WALKING TRACK
- PICNIC AREA
- SECONDARY RD
- PARK BOUNDARY

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# PHOLIS WALK

## NIGHTCAP NATIONAL PARK

Pholi's Walk is located in the Nightcap National Park, the southernmost of the rainforest parks found on the caldera rim of the ancient, eroded Mt. Warning Shield Volcano landform. It is reached by taking the road from Nimbin up Mt. Nardi (Newtons Drive—see map) to the carpark at the summit. The Mt. Matheson Loop Track leads off from behind the RTN-8 TV transmitter and you follow this for 600m to Pholi's Walk signpost. The walk leaves the Mt. Matheson Loop Track in a NW direction and descends along the caldera rim for a further 1.5 km to join Gogarna Road at the Pholi's Gap Lookout. If a vehicle cannot be arranged to meet you at this point it is advisable to return via the walk.

This walk is one of the most stimulating and educational short treks to be made in the caldera parks and is especially useful as a teaching aid in school excursions. A key to the rainforest trees would be a useful addition to your day pack on this walk. The forces of fire, wind and water which have worked in concert over the past 20 million years on the original volcanic lava flows are still dynamically and observably shaping the variety of habitats found along this walk.

Starting high on the ridgeline in cool subtropical rainforest, the track descends to the escarpment edge through warm temperate rainforest, passing a disturbed area where the processes of regeneration can be observed and emerges onto a ridge of open dry sclerophyll forest, dominated by fire-scarred New England Blackbutts.

A series of 9 numbered pegs is to be found along the walk, each of which is described in this pamphlet to help you in the understanding, not only of the total erosion caldera concept, but also of how the forces of nature have operated specifically in the particular habitat you are passing through.

## THE NUMBERED MARKERS — NOTES FOR YOUR SELF GUIDED NATURE WALK

**Peg 1.** In just the few metres you have walked, the silence has settled noticeably around you. The wind is muffled by the enclosing canopy of dense rainforest. Your footsteps fall softly on the deep leafy litter layer of the forest floor. As you proceed towards Peg 2 your attention may be caught by numerous piping birdcalls; flashes of red in the subdued filtered green light of vibrant new leaves, or the jewel-like fruit of walking-stick palms, *Linospadix monostachys*, or the shadowy, retreating form of a Scrub Turkey. And all around the profusion of majestic trees, the amazement of shape and texture in the diversity of rainforest plant species.

**Peg 2.** Through the rainforest giants there are tantalising glimpses of the valley views. Tree ferns, some with exquisite epiphytes including delicate filmy ferns abutt the track. High in the canopy overhead you may see flirting Bowerbirds, acrobatic Riflebirds or fruit eating pigeons.

This stretch of track to Peg 3 offers many opportunities to stop in a patch of sunlight to listen to the sounds of the rainforest.

**Peg 3.** This is a good stop to observe three large rainforest trees growing very close to each other on the lower side of the track. Each has distinctive differences in bark texture and colour. These are the Corkwood *Cauldcluvia paniculosa*, the Black Apple *Planchonella australis* and the Blue Cherry *Syzygium oleosum* (also known as *Syzygium coolminianum*). See if you can identify which is which from your rainforest key. How old do you think these trees are?

**Peg 4.** Here the track crosses an old jeep trail and a gully. Notice how the forest is responding to the disturbance and greatly increased light.

Very noticeable (in many ways) are the thorny, spikey plants which protect the pioneer tree seedlings you will see coming up everywhere under them. Think of the function of these heavily armed species, (native raspberry, wait-a-while palm, solanum, to name a few), in the protection of the regenerating gap in the canopy. How many different seedling tree species can you identify? As they mature they will help the next stage of more sensitive rainforest species to colonise.

The process from open space as you see it now to closed canopy rainforest, such as you have just passed through, will take hundreds of years, and maybe thousands, to achieve the climax rainforest habitat.

**Peg 5.** Here the forest is changing. You experience a transition zone, passing from the uphill subtropical rainforest on basalt-derived soils, to warm temperate rainforest situated on the downhill poorer rhyolitic soils.

You might think that as we descend in altitude we pass from cooler to warmer rainforest types. Not so! Here the usual process is reversed — we go from subtropical to temperate, as the governing factor is the parent rock: the basalt-rhyolite-basalt lava sandwich of the caldera rim.

**Peg 6.** Here the dominant species, of New England Blackbutts, Corkwood, Acacia and Geebung, are evidence of adaptation to climatic stresses close to the caldera rim, as well as the soils derived from the rhyolite parent rock. This is a dryer open sclerophyll forest subject to occasional fire and seasonal cyclonic winds.

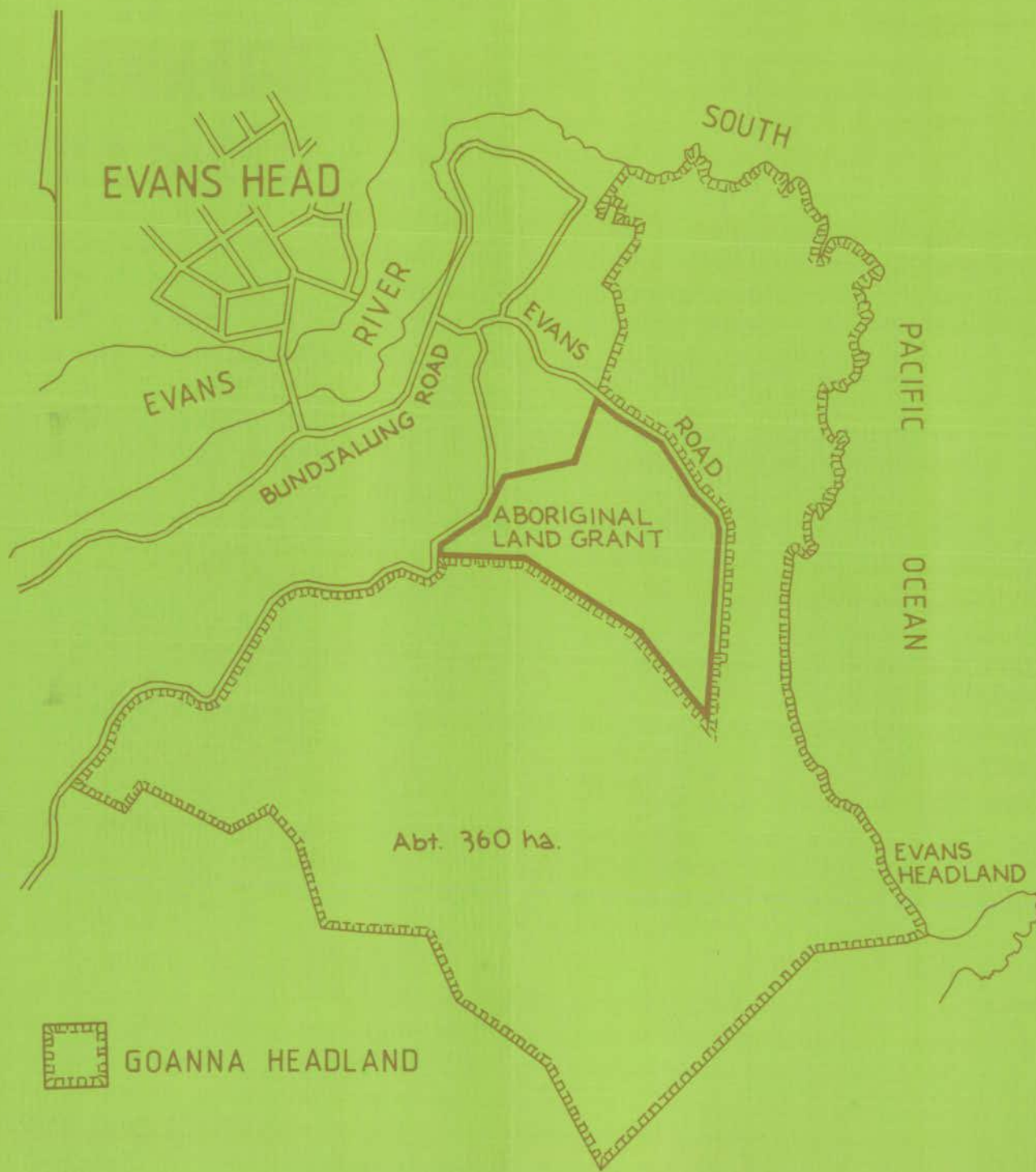
Can you see any ways the plants here have adapted to the dryness and fire?

**Peg 7.** The rainforest elements diminish as you emerge into the open forest along the escarpment rim. A gnarled New England Blackbutt provides a welcoming seat at a magnificent lookout from which you can view the rhyolite intrusion of Dougboy Mountain which rises from the centre of the Upper Doon Doon Valley before you. Behind this to the east is Mt. Jerusalem, the dominant silhouette on the caldera rim.

In the far distance to the north the indistinct range is Springbrook, the northern caldera rim, about 50km away.

You are standing on what used to be flowing lava slopes from the Mt. Warning Shield Volcano. Twenty million years of wind and water have carved out this huge caldera bowl before you.

**Peg 8.** The Walk-in Tree. Inspiring not only for fantasies of spirit-houses, gnomes or ents, but also an essay in the pure mechanics of survival.



## APPEAL

Whilst there are penalties and other constraints under the Crown Lands Consolidation Act, 1913, and the Recreational Vehicles Act, 1983, to misuse of the lands referred to and those penalties and constraints are clearly exhibited on the ground such are not laboured in this pamphlet. Rather an appeal is made to all users of this valuable resource to exercise constraint in those activities which may tend to degrade the land until proper planning measures can be undertaken and put in place.

## MANAGEMENT CONCERNS

The Headland has become an increasingly popular recreational area and the facilities have been inadequate to cater for demands. Uncontrolled off road vehicle use has disturbed the vegetation, caused sand blowouts and degradation and erosion of many areas. Similarly, uncontrolled camping has led to rapid degeneration of vegetation.

A plan of management is presently being drafted by the Crown Lands Office to address these management problems, to derive ways to overcome them and to prevent future problems arising.

## HOW YOU CAN HELP

There are many ways you can help prevent further degradation of the area;

- ☆ keep in mind the ecological and cultural values of the land and treat it accordingly;
- ☆ stay on the roads designated for use and park in formal parking areas;
- ☆ use the formalised beach accesses so that regeneration can occur along the other access tracks;
- ☆ take your rubbish home;
- ☆ do not remove artefacts or damage flora and fauna.

If you have any suggestions or comments which might help the Crown Lands Office in drafting the Plan of Management please send them to:

REGIONAL MANAGER,  
LANDS OFFICE,  
P.O. BOX 11,  
GRAFTON N.S.W. 2460.

# GOANNA HEADLAND

Goanna Headland, the popular name for the area illustrated on the diagram appearing herein, is an area of unspoiled bays, sandy and pebbly beaches with outcrops of coffee rock; of such diverse vegetation as wet, dry and dwarf heaths, sedgelands, mallees and woodlands; and is of great significance to Aboriginal culture and mythology. The land has been entered into the National Trust Register as the Goanna Headland Coastal Conservation Area.

## Reservation

The illustrated area was approved by the Minister for Natural Resources on 28th August, 1985, for notification as a Reserve for the Conservation of Aboriginal Culture and Heritage, Preservation of Fauna, Preservation of Native Flora and Public Recreation. A private trust is to be formed to control activities on the land.

## Mining

Late last century, alluvial gold mining was carried out. This period of occupation resulted in the naming of New Zealand Beach and Chinamens Beach, after the nationality of the miners who worked there.

More recently extensive beach mining for rutile and zircon occurred.

## Flora and Fauna

The vegetation of Goanna Headland forms a complex mosaic of communities with wet and dry heathland covering the largest proportion of the area. A community of note is the Christmas Bush mallee which is interesting because this species is at its most northerly limit at this location and its growth habit is as a low bush which is unusual. A number of other plant species in the area are considered rare, limited or of unusual distribution, on the north coast and some are listed as protected species under the National Parks and Wildlife Act (1974).

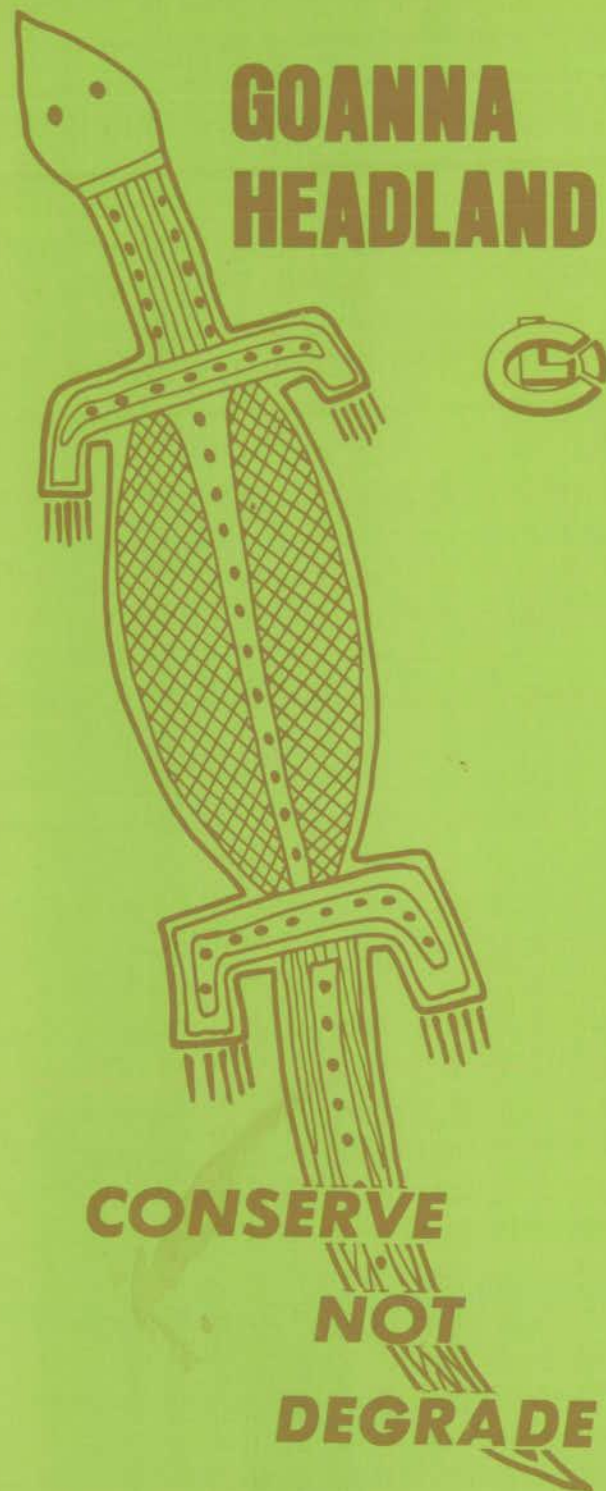
The wildlife too, includes rare species such as *Planigale mukulata* (a small carnivorous marsupial) as well as such threatened species as the Ground Parrot and Brolga. The Rainbow Bee-eater overwinters at Goanna Headland which is one of only a few locations in N.S.W.

## Mythology

Goanna Headland is a sacred place for the Bundjalung Aboriginal people. In Aboriginal mythology it is common to find beliefs involving animals and humans turning into stone during the dreamtime creation of the world. In this case the creation of the Headland began when a snake began tormenting a bird and Nimbin, a Bundjalung man with extra-ordinary powers, called out to the goanna to come and protect the bird. The goanna chased the snake from Bungawalbin, across to Woodburn and eventually found it near Evans Head. The goanna was slowed when the snake bit it on its head, and when it caught up again the snake headed out to sea and then doubled back to the Evans River and lay down thus creating Snake Island. The goanna reached the sea and lay down to wait for the snake to return. Thus Goanna Headland was created.

Other sites of spiritual importance include "The Old Lady Site", the Rain Cave and the Ceremonial Ground.

Important archaeological sites are also found in the area, e.g. at Red Hill and Snapper Point where stone artefacts have been discovered. Middens are scattered throughout the area.





# MANGROVES

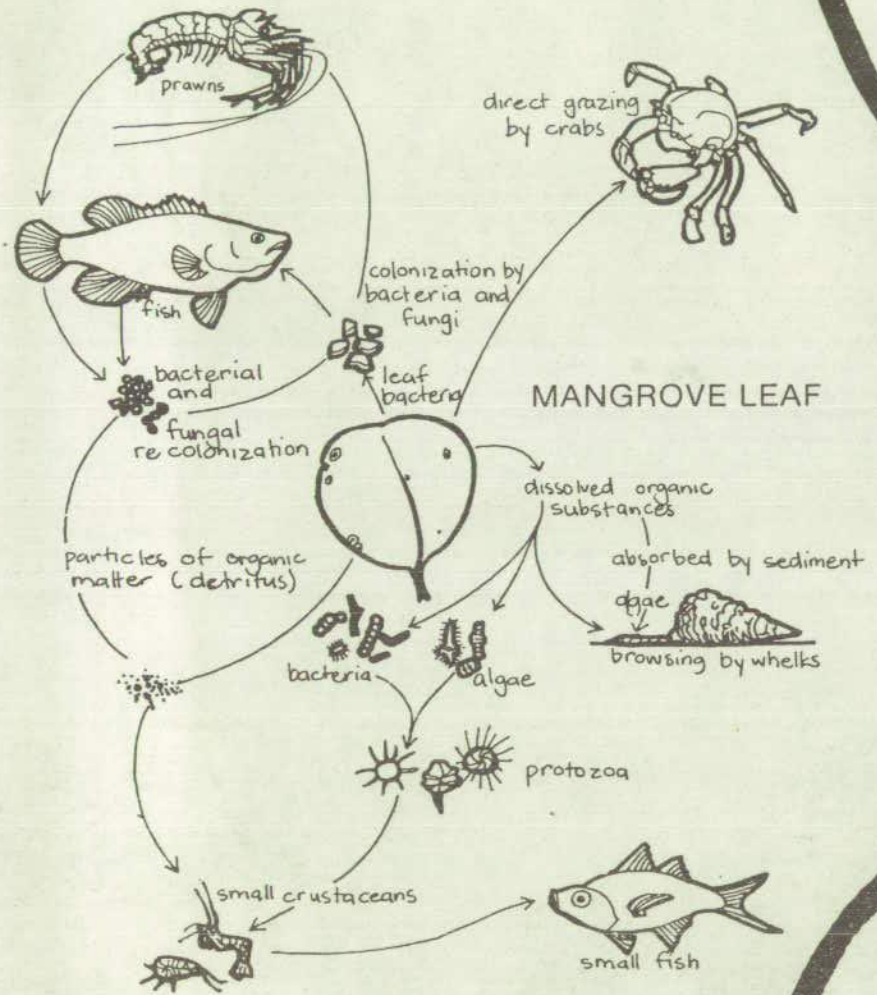
9 Until recently, mangrove swamps have been regarded by many as wastelands.

Consequently they have often been turned into rubbish dumps, or 'reclaimed', displaced by wharves, bridges and walls, or flooded with pesticides and industrial wastes.

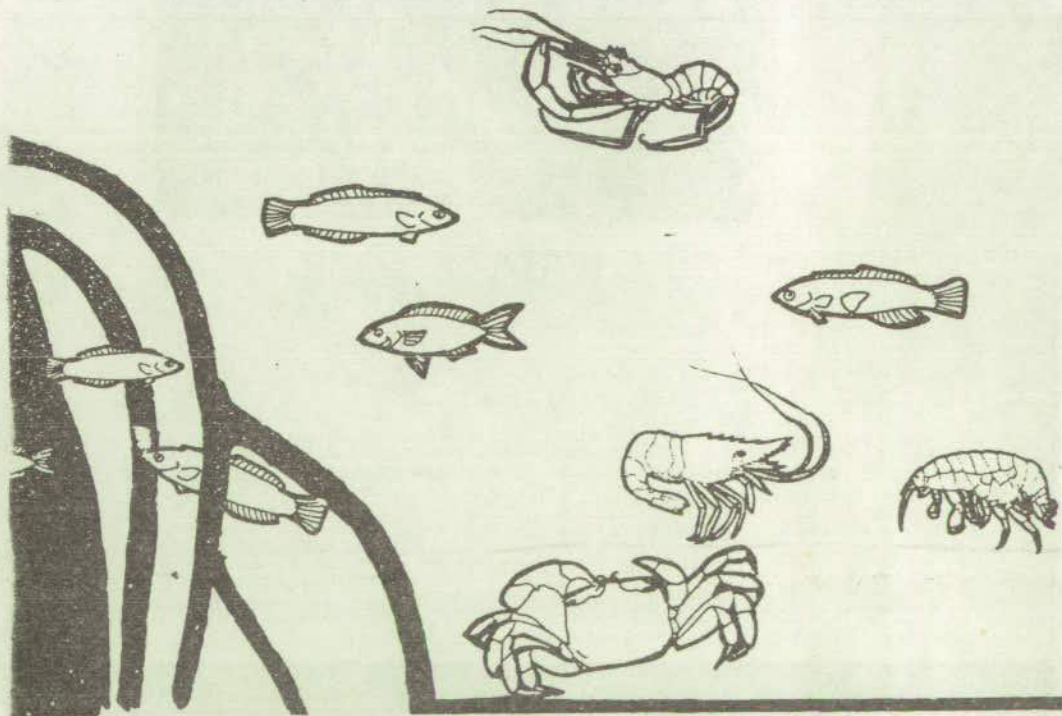
Mangrove trees are unique, with their leathery leaves, and asparagus-like aerial roots. Far from being 'dead' and ugly, mangrove swamps teem with life. More productive than almost any improved pasture; they act as nurseries, provide a safe harbour to countless small organisms, and are protected by a system of sand-bars and spits.

You might wonder how a tree can live on a regular diet of salt water and oxygen-depleted mud. In the Evans River estuary there are 2 species of mangrove; River Mangrove (*Aegiceras corniculatum*) and Grey Mangrove (*Avicennia marina*). Each lives within its own tidal zone, and is adapted to a particular degree of salinity, nutrient level and sand/mud type.

Their adaptations are intriguing . . . . Some have salt-excreting glands in their stems, and others a salt-intake prevention mechanism in their roots. Curious aerial breathing organs supply underground roots. Known as pneumatophores they poke up out of the mud like fingers and absorb oxygen at low tide. Other species have prop roots which arch out from the stems before reaching the mud, serving the same purpose.



THE PLACE OF MANGROVES IN A BASIC ESTUARINE FOOD CHAIN

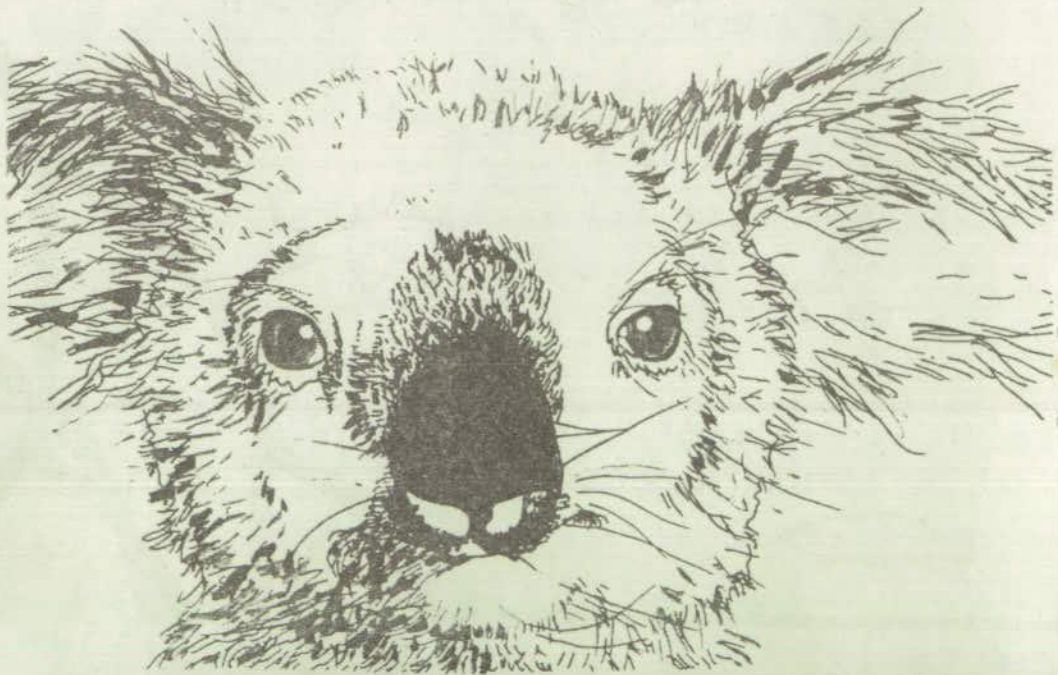


# KOALAS

10

The forest you see around you is dominated by Forest Red Gums (*E. tereticornis*) and Tallowwoods (*E. microcorys*). These eucalypts are amongst the favourite food for one of Australia's best known mascots, the Koala. The marsupials can sometimes be seen loafing in the foliage of their trees near here. At night, their presence is revealed by their calls which resemble the sound of a person being strangled!

The name Koala seems to be derived from the aboriginal word "koalah" meaning "does not drink water". Indeed this charming creature obtains all its water from the leaves it devours, about 600 grams per day.

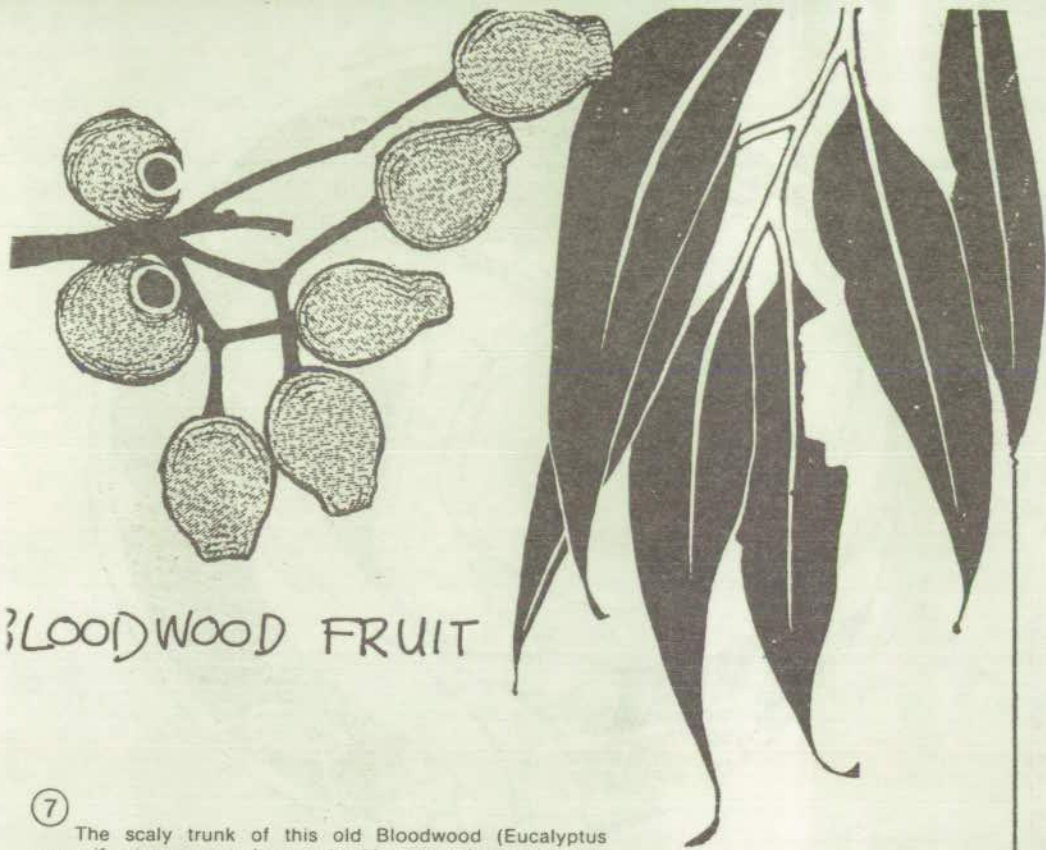


SWAMP BOX

8

This is a Swamp Turpentine (*Tristania suaveolens*) with bark resistant to bora and rot. The Aborigines have cut a long bark dish from it. This was made after Europeans had arrived with a revolutionary new tool, the steel axe.

You can still see the axe marks in its trunk.



## BLOODWOOD FRUIT

⑦ The scaly trunk of this old Bloodwood (*Eucalyptus gummifera*) appears to be awash with rusty coloured 'blood'.

Kino (gum) flows from wounded tissue and coagulates like blood forming a protective scab. A cross-section through an old Bloodwood, would show consecutive rings of dry kino, marking years of fire damage the tree has survived.

Bloodwoods are classified as primitive Eucalypts. They are known for their prolific kino production and it is this that you see on the trunk.

Can you find the Bloodwood fruit? Quite distinctive, being large and egg shaped, they recall a wine glass without a stem.

# ESTUARIES

⑪ Here land, river and sea meet. Estuaries are fertile and delicately balanced, incorporating salt marshes, mangrove swamps, mudflats and creeks and swamps.

One of the most fertile systems in the world, the estuary produces huge quantities of waste organic matter (detritus). With their warm shallows and the protection of sand bars, spits and mud islands they make great nurseries.

The two most important zones in an estuary are the mangrove swamps and seagrass beds. They drop about 4 tonnes and 100 tonnes an acre of detritus a year respectively.

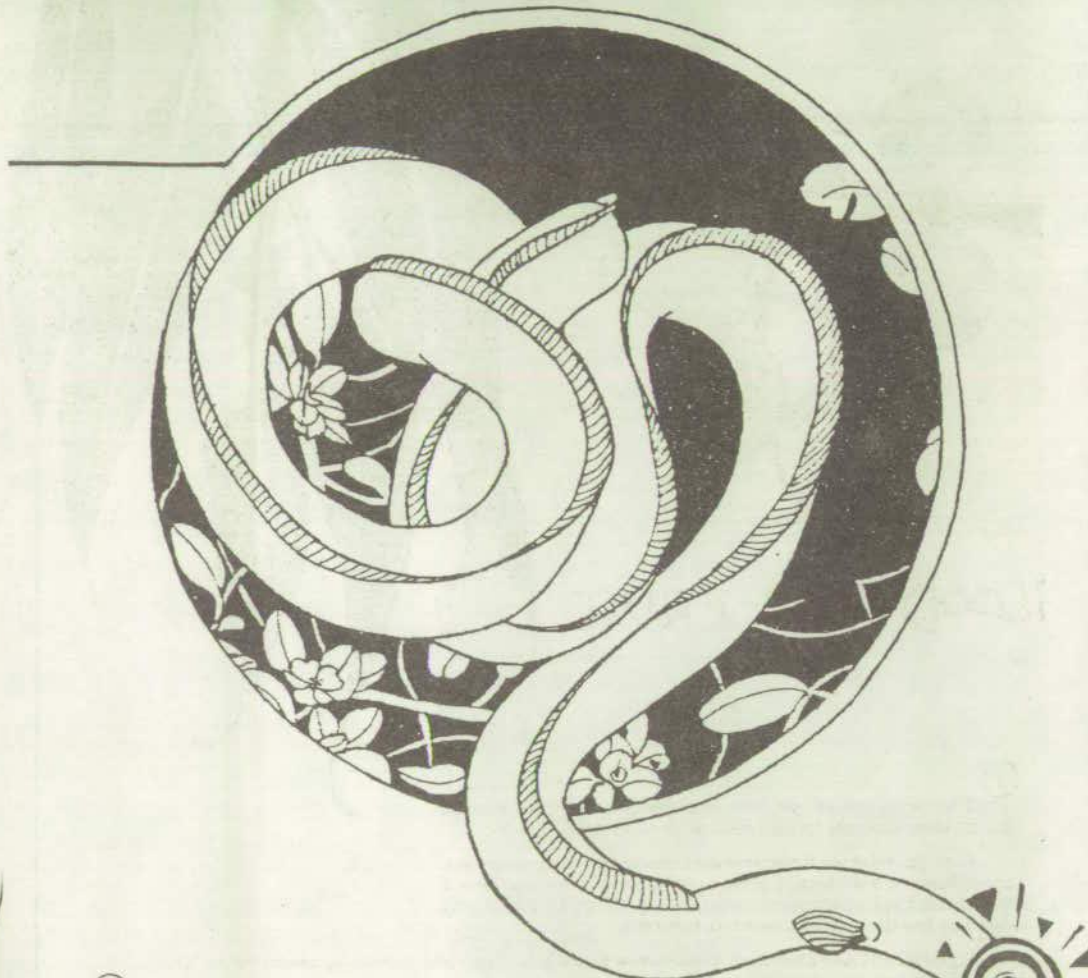
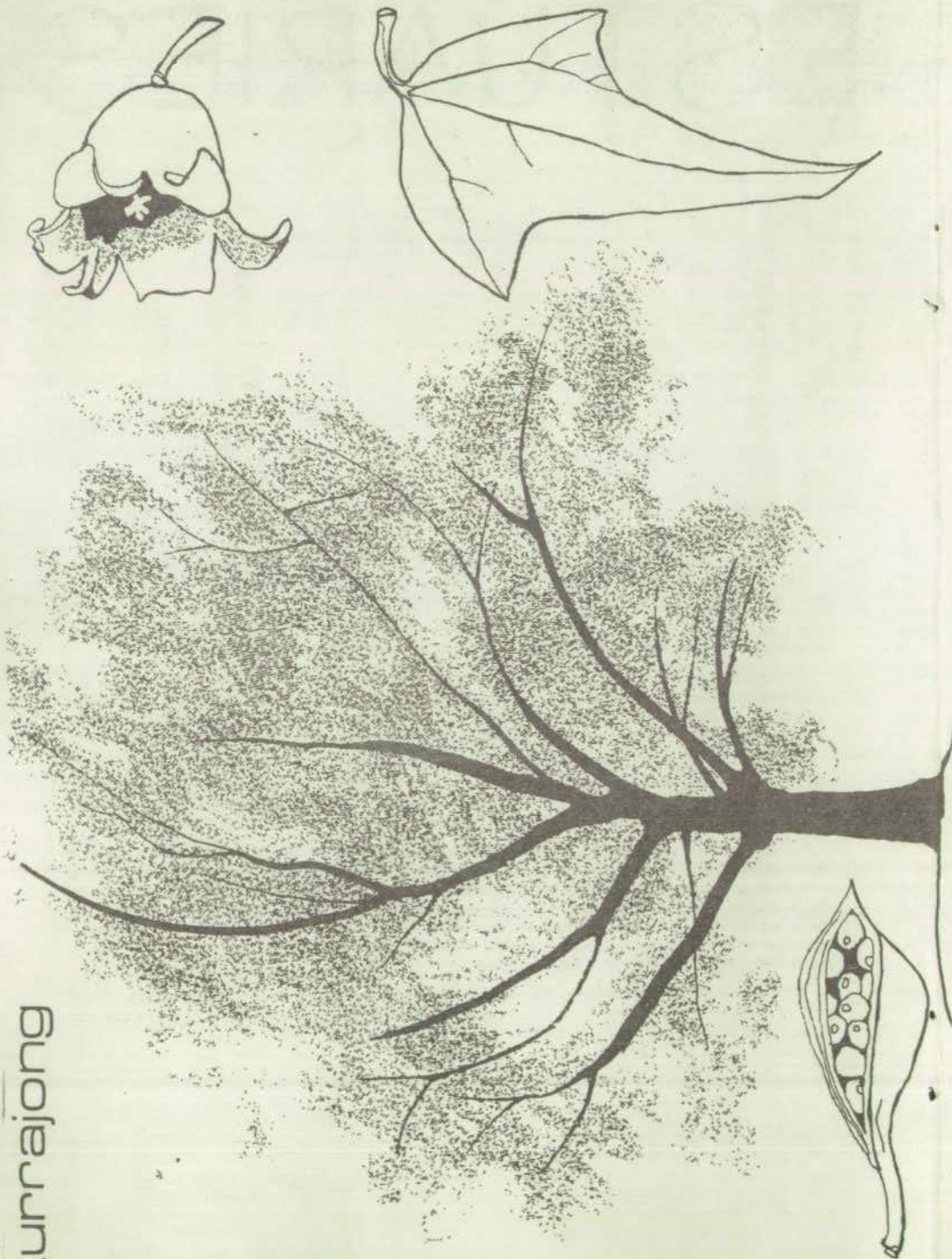
This cache of fertilizer decays slowly forming a rich "soup" with its associated fungi, bacteria, protozoa and microalgae. Fresh water deposits dissolved minerals — sunlight penetrates the shallows thus enabling photosynthesis, (producing oxygen and organic compounds) to take place. The result of which is of direct benefit to nature and man.

Of all commercial fish, molluscs and crustaceans, 70% are taken from or depend on estuaries. From here you can look towards Pelican Island and perhaps see waders and sea birds working over their feeding grounds. Further along the track is a tribute to thousands of generations of shell fish in the form of an aboriginal midden.

Estuarine plants and animals live in a stressful environment. They are subjected to salt and fresh water floods. Changes in rainfall alter the amount of dissolved minerals in the water. Ebbing and flowing tides mean regular exposure and submergence. These creatures and plants have been ingenious in their adaptations. . . To resist the force of the tide, grasses have developed deep roots. Mangroves have prop roots and pneumatophores supporting them which prawns, shrimps and other weak swimmers shelter amongst. Oysters which are attached, clam up to escape the heat and dry, and crabs burrow.

Estuaries are nutrient traps. They are also pollution traps and as such are vulnerable. Their actual location is such that they could receive all the industrial, residential and agricultural runoff and in the past have done so.

kurrajong



6

Have you ever been car sick? Chances are Corkwood (*Dubosia myoporoides*) has helped you. Its leaves contain alkaloids that are used extensively in motion-sickness tablets and dilating the pupils during eye-surgery. Although considered poisonous to stock, aborigines used it to produce an innoxious drink, and even to stupefy eels, making them easy to catch! The corkwood becomes common in regrowth areas following disturbances such as the fire we mentioned earlier, and is a rainforest indicator.

The tree next door is a Red Ash (*Alphidonia excelsa*). Its location here is typical. It usually occurs in the interface of open eucalypt forest and rainforest. Best known for its attractive orange-red timber, the Red Ash has become uncommon due to its popularity as a cabinet wood. In earlier times, it was prized by settlers for tool handles and bullock yokes by virtue of its strength and durability.

5

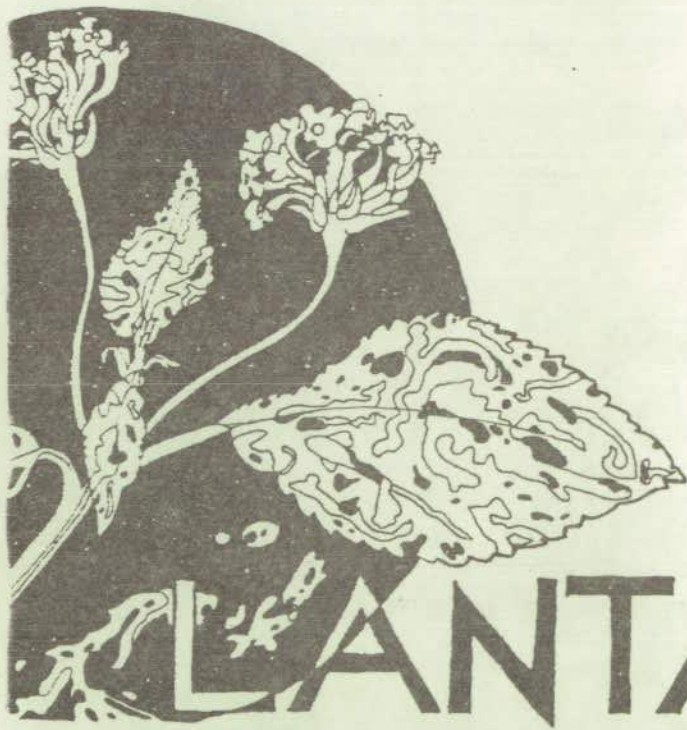
Lantana (*Lantana camara*) with its pretty pink and yellow flowers probably came to Australia from Central America to populate our gardens. But eastern Australian sun, rain and good soils have spurred it along. It is now a serious and rampant weed.

There is no Lantana back along the track because although it is sunny and receives moisture, the soil is poor. The same things which encourages hardy banksias, do not suit Lantana. As leaf litter on the track clues you in to the growing richness of the soil, so Lantana begins to appear. A track such as this breaks the rainforest upper canopy and lets sunlight through, completing the requirements for Lantana.

However this patch isn't doing so well, the leaves look chewed. They have been eaten by *Octotoma scabripennis* and *Uroplata girardi*, two forms of Lantana Beetle being used in Australia as biological controllers.

Both adults and larvae cause severe damage to leaves. Females lay eggs on the leaf surface, which hatch into larvae. These grubs mine out the middle (mesophyll) cells of the leaves. Pupae develop inside.

It is these mines, which you see as stripes and blotches, and the hole gnawed out by adult beetles which destroy Lantana, because they reduce the photosynthesizing surface of the leaf and weaken the plant. You can see young rainforest species growing up through the spindly branches, thanks to the Lantana Beetles.



# LANTANA

12

It is not hard to imagine daily life around this large midden. The debris from centuries of eating, trading and social gatherings have formed it. Fish, birds and animal bones along with shells, broken tools and weapons, vegetable matter, ash and charcoal all came to rest here.

Primarily an oyster midden, a metre and a half of debris and remains accumulated after 6000 years, but the midden used to be bigger.

## the midden

It has suffered the effects of two centuries of Europeans. In 1887 an ironstone bottleneck in the Evans River existed here. Known as the 'Iron Gates' it was blasted for flood mitigation purposes and a wide channel opened. A good portion of the midden was washed down stream. Nearly a hundred years later, during the flood of '74 a canvas dam on Tuckombil Canal was slashed. It deluged the estuary again and tore out even more of the midden.

But what remains still has a story to tell. Before Europeans came, this was an important meeting place where the Biriwan and the Western Bundjalung people met to trade. Seafood, salt and stone tools were exchanged for bunya nuts, Quondong and Kurrajong seeds.

Western Kurrajong (*Brachychiton populneum*) seeds rich in caffeine made a popular coffee-like drink and the branches provided food. The Kurrajong is regarded as a 'Tree of Life' and as a source of strength. Marriage ceremonies were conducted under its branches. On one occasion tribal elders travelled down to Iluka bringing some reluctant girls back from the Clarence to this midden, where they were married to equally reluctant local boys.

# the Story of Gumma Garra

Gumma Garra takes its name from an ancestor in dreamtime legend of the Bundjalung people's first landing near Evans Head. Three canoes carrying three brothers, their families and their old mother named Gummi put ashore. Gummi went into the sandhills and there she lay down to sleep off the rigours of the journey. Her children and grandchildren rested on the beach. Two of the families were to continue their journey, taking Gummi with them, while the third remained to settle the place of their landfall. But when it was time to put out to sea, try as they would, they couldn't find Gummi. Reluctantly, they left. Gummi finally awoke and, scrambling to the top of the headland, she was in time to see the two canoes heading through the Ballina Bar. Enraged at being left behind the old woman "called the waters" and the seas rose, swamping the boats on the bar.

Archeological evidence shows that the Biriwan (a sub group of the Bundjalungs) were camping at Gumma Garra 6000 years ago. The Bundjalungs are now scattered around the north coast. The Biriwan have disappeared completely and two differing explanations are given of their demise. One relates the story of a flood which killed many estuary fish.

The Biriwan ate the fish, fell suddenly ill and left Gumma Garra never to return. A second story tells of a visit to Gumma Garra by a Clarence tribe. On its way home the tribe killed sheep and cattle owned by local Europeans. But Queensland troopers shot the Biriwan, all except two children who never married.

The last of the Bundjalung tribespeople who used Gumma Garra camping ground died in the 1960's. Yet a rich tradition remains. Aboriginal people camped and lived at Gumma Garra for countless generations; drawn by the fertility of a place where estuary and rainforest meet.

While walking Gumma Garra turn your thoughts to the people who sat talking and eating at the midden and to the trees they planted there 300 years ago. The descendants of the Bundjalung say that the spirit of the Biriwan still inhabits the reserve protecting everyone who walks here from harm.

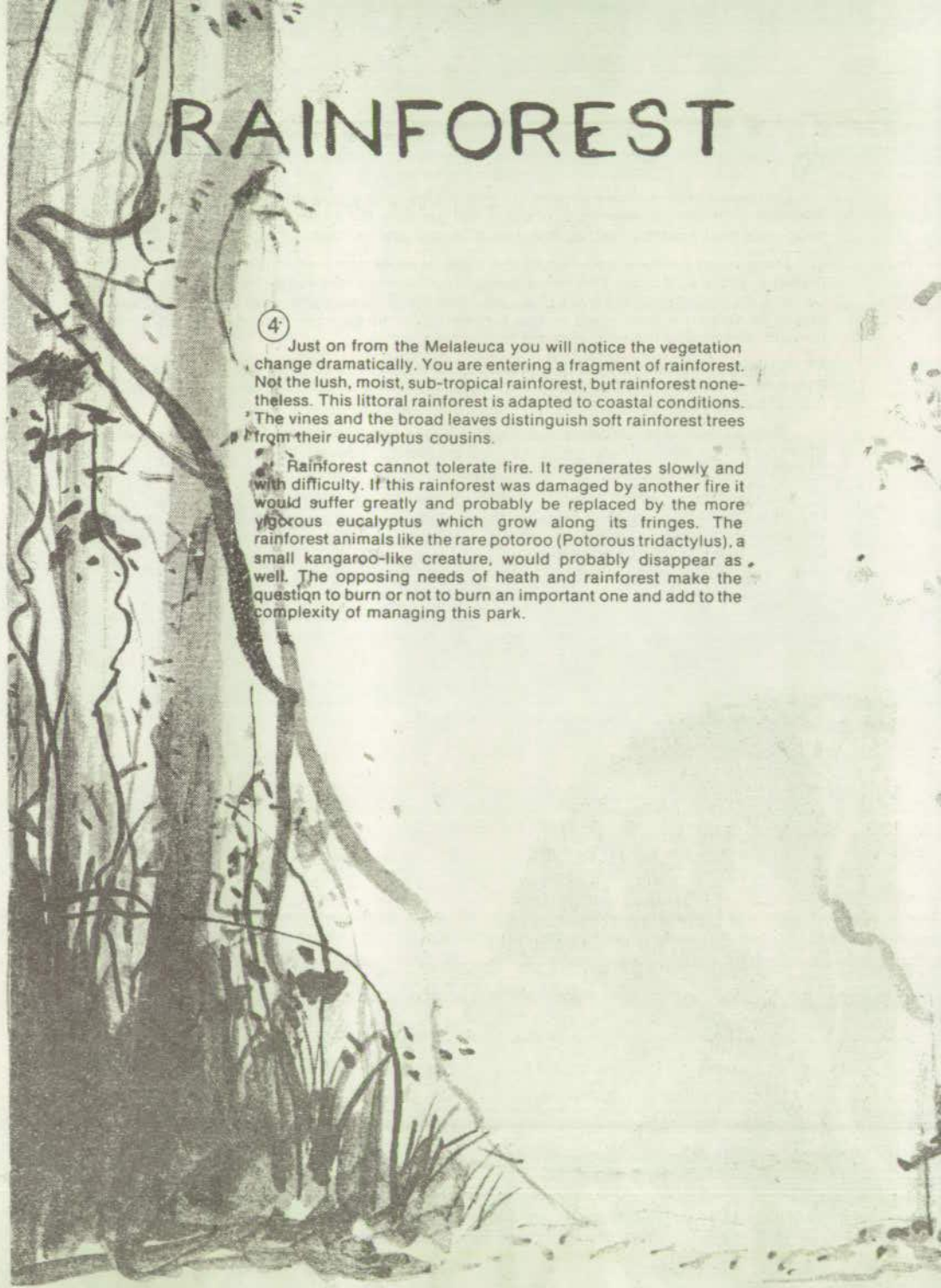


# RAINFOREST

4

Just on from the Melaleuca you will notice the vegetation change dramatically. You are entering a fragment of rainforest. Not the lush, moist, sub-tropical rainforest, but rainforest nonetheless. This littoral rainforest is adapted to coastal conditions. The vines and the broad leaves distinguish soft rainforest trees from their eucalyptus cousins.

Rainforest cannot tolerate fire. It regenerates slowly and with difficulty. If this rainforest was damaged by another fire it would suffer greatly and probably be replaced by the more vigorous eucalyptus which grow along its fringes. The rainforest animals like the rare potoroo (*Potorous tridactylus*), a small kangaroo-like creature, would probably disappear as well. The opposing needs of heath and rainforest make the question to burn or not to burn an important one and add to the complexity of managing this park.





2

Here it is hard to tell which are roots and which are branches. The tree is a broad-leaved paperbark (*Melaleuca quinquinerva*). They are usually found in poorly drained areas and can tolerate flooding for sustained periods. Unlike the nearby mangroves these trees have roots which extend into the soil above the high tide mark. As a go-between in the succession from mangroves to forest they represent an important stage in the stabilisation of estuaries.

3

A shallow cutting was part of the old dray track. Fishing parties intent on spending the day at Snapper Rock or Chinamans Beach, would set off in the morning from Woodburn Common. Reaching this spot at low tide the draught horses would set to pulling the dray over the mudflats, to the present road across Oyster Creek. These animals were immensely strong. On reaching the end of the track they would pull through sand for the last leg of the journey, from Evans Head Hill to Chinamans Beach.

13

On your left a Forest Red Gum and a White Mahogany (*E. acmenioides*) are curiously locked together.

Occasionally different Eucalypts species graft together at root level, transferring nutrients. Treatment of one with a deadly herbicide will also kill the other. However they never graft above ground level. In this case the two trees have 'collided' and are attempting to grow around each other.

The midden area was a place for eating, trading and socialising, the Biriwan campsite is a little way back along the track.

14

High above the worst of the sandflies and mosquitoes the family campsite commands views up and down the Evans River. Charcoal areas are still visible, indicating the positions of campfires for each family group. Stones were used to grind seeds, tough kangaroo meat was pounded then grilled on green sticks over white hot pebbles. The fact that the Birawan camped here for 6000 years says much about the way they treated the environment.

A second much smaller campsite in the area was used for boys who were taken from the family group at about the age of 12 for initiation and to await a wife the family would choose for them.

Now it's time to head back to the carpark through another of Gumma Garra's habitats — the heathland.



FROM "ABORIGINES SPEARING FISH"

# HEATH

15

Heaths appeared early in the evolution of flowering plants. In fact, fossil records suggest that heath originated in Australia and South Africa.

Adapted to our harsh conditions, they are 'sclerophyllous' meaning that they possess tough leaves, waxy cuticles and sunken stomata. They also contain oils, tannins and resins. These adaptations protect them from dangerous water loss.

The same adaptations, however, make heath highly flammable and it is rare to find heath in Australia that is older than about 12 years. Heath thrives on fire, unlike the rainforests we talked about earlier. Many heath plants, for example, the banksias, hakeas and some acacias need fire to burst their pods and to allow seed dispersal. Whereas most rainforests mammals breed slowly and expend much energy in rearing just a couple of offspring in response to their stable environment, most heathland mammals play the numbers game. In response to an unstable environment, they reproduce rapidly and in profusion when conditions are right.

So dependent of fire are some species in this park that the management of their populations is especially complicated. The rare, native mice (*Pseudomys*) prefer 2-3 year old heath, the endangered Ground Parrot, 7-8 and the honeyeaters go for the rich nectars of the older heath, say 10 years or more. It must burn frequently to preserve the habitat yet not as to damage the founding populations.

BLACK COCKATOO

FEATHER-TAILED GLIDER

GROUND PARROT



1

Under the bridge, the remains of an older bridge built by timbergetters in 1956 lies embedded in the mud. If you look carefully you will see that the old timbers are pocked with the holes of Cobra or Toledo worms. Aboriginies harvested these and ate them like oysters. The dense mud under the bridge contains lumps of red ochre, prized as body paint by Bundjalung "Clever Men".

During the 1940's oysters were harvested and bottled on site by a couple of locals. Evans River estuary oysters were famous in Sydney for their succulence, having fed so well on abundant plankton and detritus. (decaying organic matter).

The banks of the creek are still studded with oysters. At low tide you will see crabs delicately spooning detritus into their mouths with large claws. Crabs are very sensitive to vibration; tap your foot on the bridge and see them vanish in seconds.

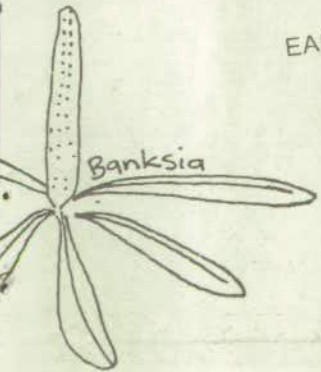
Oyster Creek is fed by a peaty swamp, rich in minerals and tannin, which give its waters the look of strong black tea. Turn right over the bridge. Stay alert; see if you can spot where one habitat gives way to another and the different wildlife each supports.

The track follows Oyster Creek to where it joins the Evans River. Note the banksias with their bottle brush flowers and nobbly seed pods. (Remember the Banksia Men in Snugglypot and Cuddlepie?). But resist the temptation to pick the pods. Everything in a national park is protected.

Mangroves line the creek and we will be telling you more about them later. The trees on your left beyond the banksia are aptly named paperbarks.







# LANDS

There are two types of heathland in Bundjalung and both are represented here. The wet heath grows on peat or shallow sand and is characterised by marsh grasses (sedges). The dry heath occurs on higher and deeper sands with few sedges. Both are adapted to the nitrogen and phosphorous deficient soils of Australia. The plant, Drosera, for example, drains nitrogen from the insects which it snares on its sugary, sticky leaves.

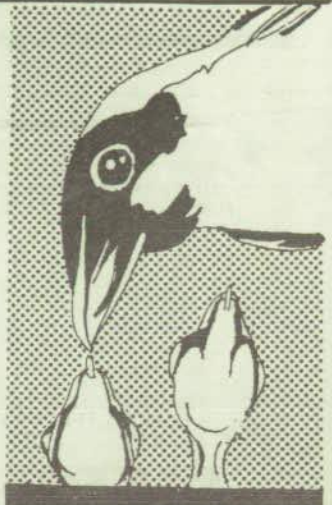
Balanced on a knife-edge, small changes in water balance or soil nutrients can markedly affect heathlands. Rubbish along roadsides has changed vegetation whilst the addition of phosphorous to the soil by bombs in the RAAF range nearby has possibly increased food plants for the Ground Parrot. Bundjalung is now one of the major strongholds for this endangered species.

With so many rare birds and animals and interesting adaptations, it is easy to see why heathlands are considered such an important habitat.

BLACK-WINGED FLYCATCHER

EASTERN PIGMY POSSUM

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As you stroll through the heath back to your starting point at the car park, you may care to ponder the wonders of natural creation. So many habitats, so different from each other, yet all part of an ecosystem supporting abundant life. And all this in such a small area. No wonder the Bundjalungs regarded Gumma Garra as a special place. We trust you do too.

TALLOWWOOD



PAPERBARK



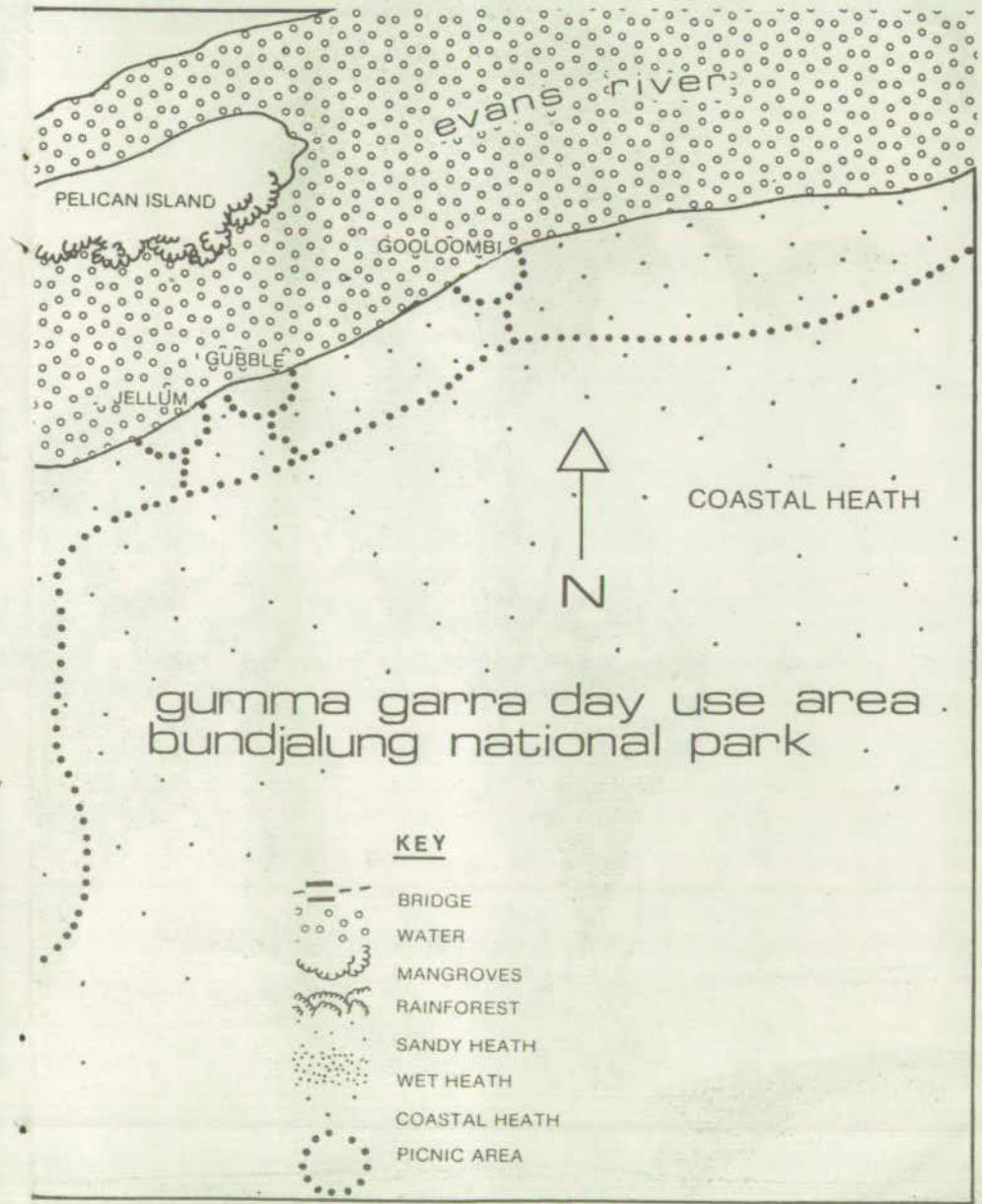
CORKWOOD



SCRIBBLEY GUM

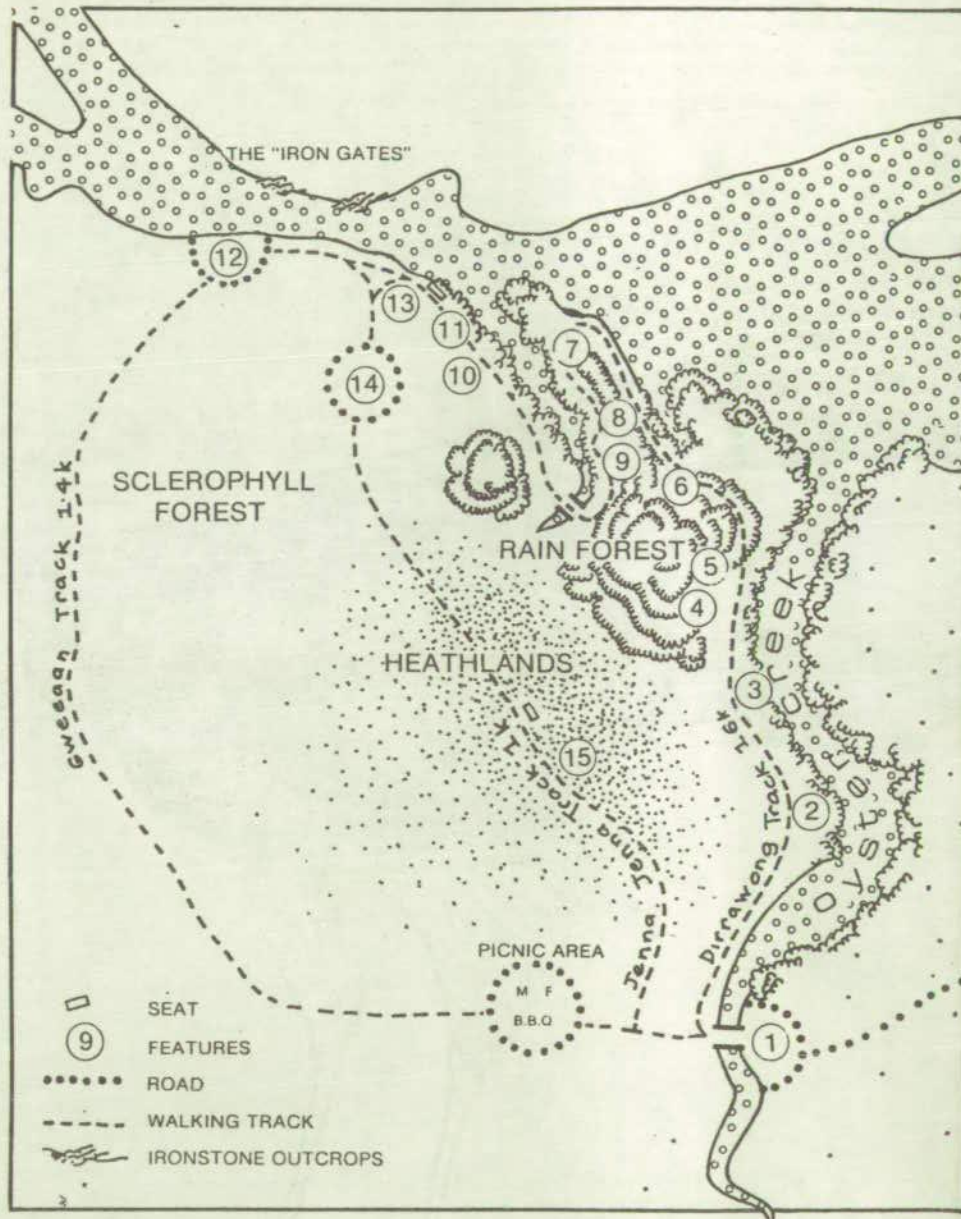


SWAMP MAHOGANY

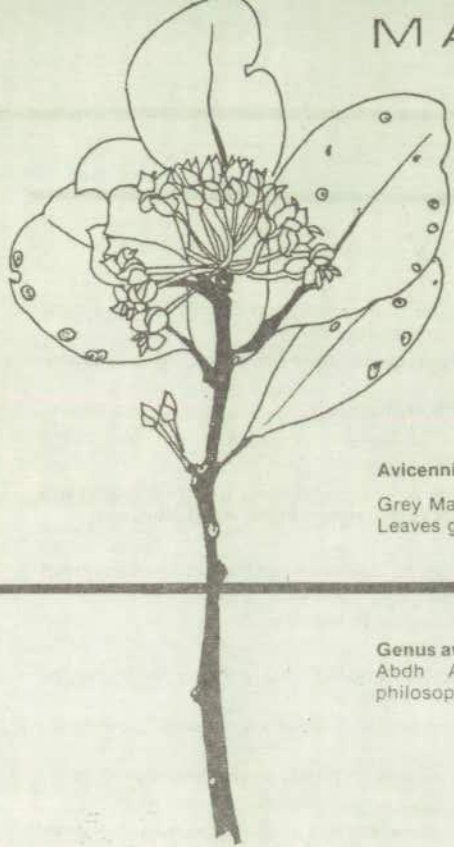


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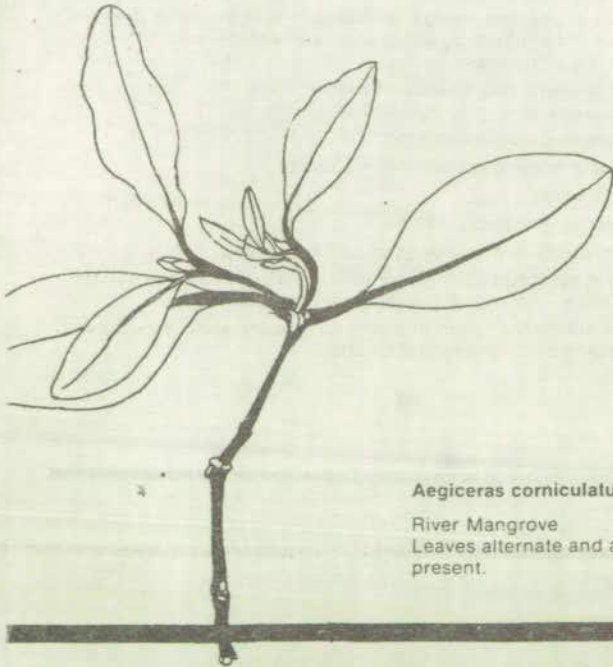
# MANGROVE KEY



*Avicennia marina*

Grey Mangrove  
Leaves gray on underside and opposite.

Genus *avicennia* was named in honor of Abu Ail Husain Ibn Abdh Allah, famous Persian physician naturalist, philosopher and mathematician.



*Aegiceras corniculatum*

River Mangrove  
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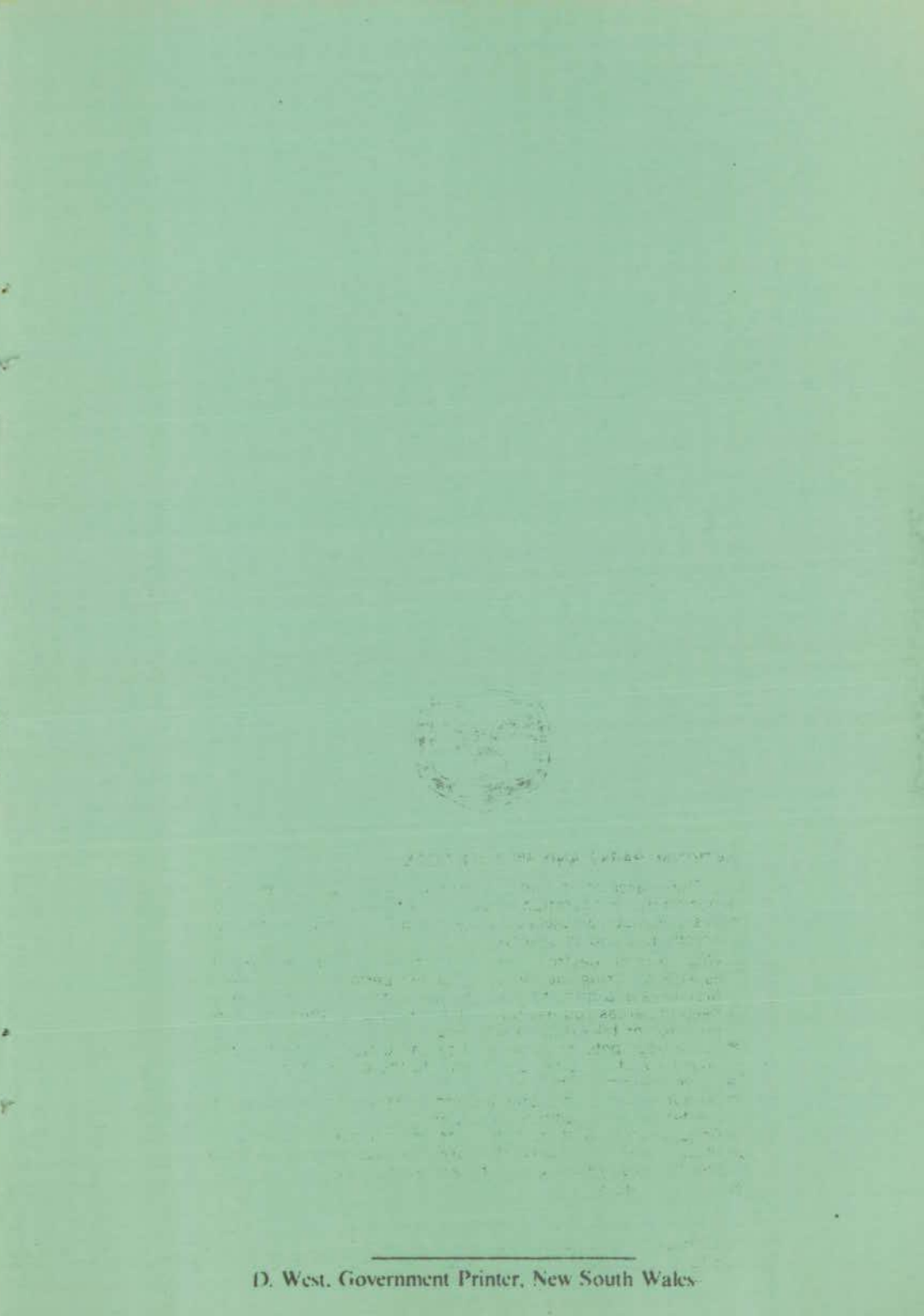
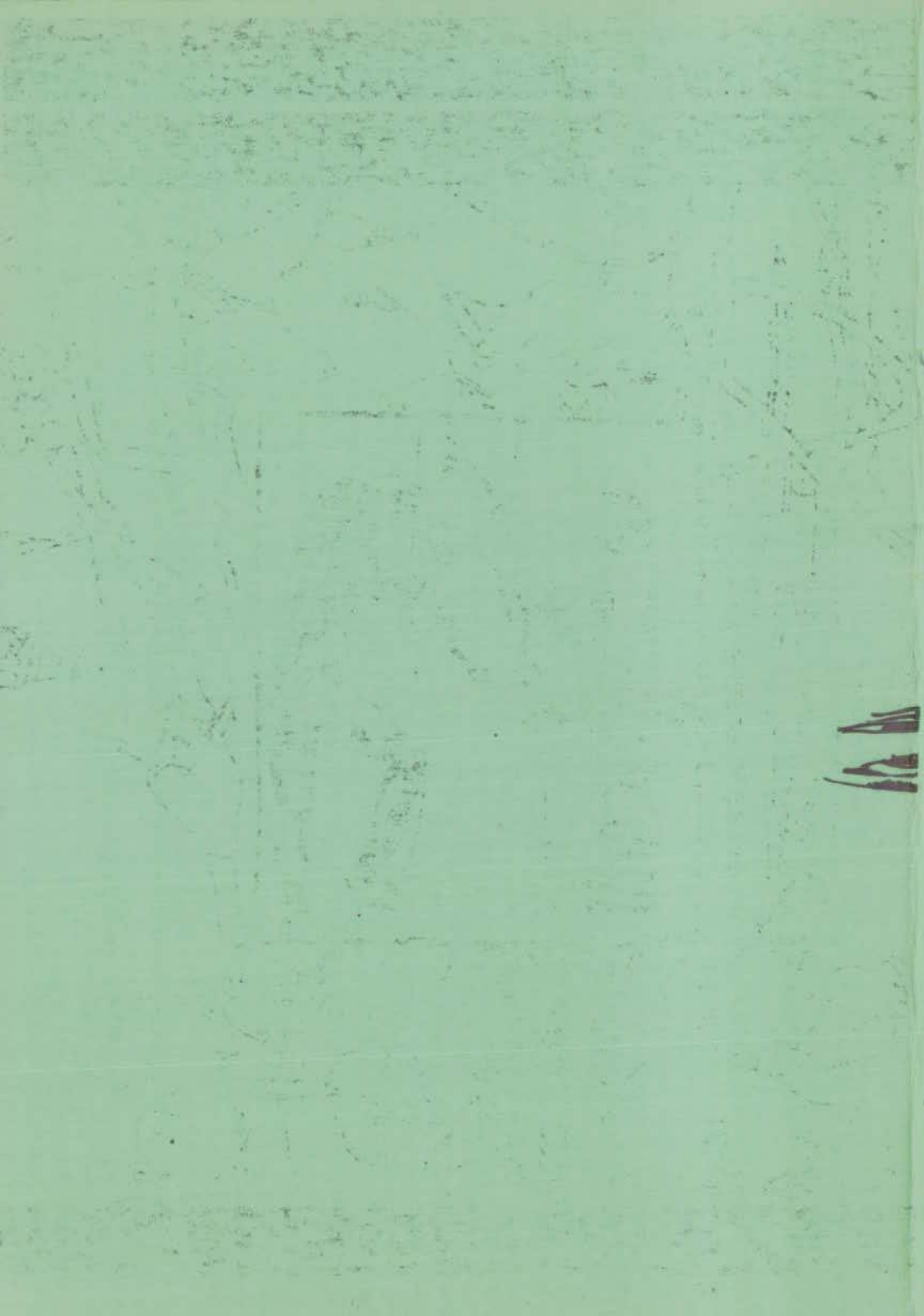
\* Welcome to Gumma Garra...<sup>00</sup>

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Let's begin right here at the bridge over Oyster Creek.



Text and artwork by Angela Gee



# Gumma Garra self-guiding nature walk

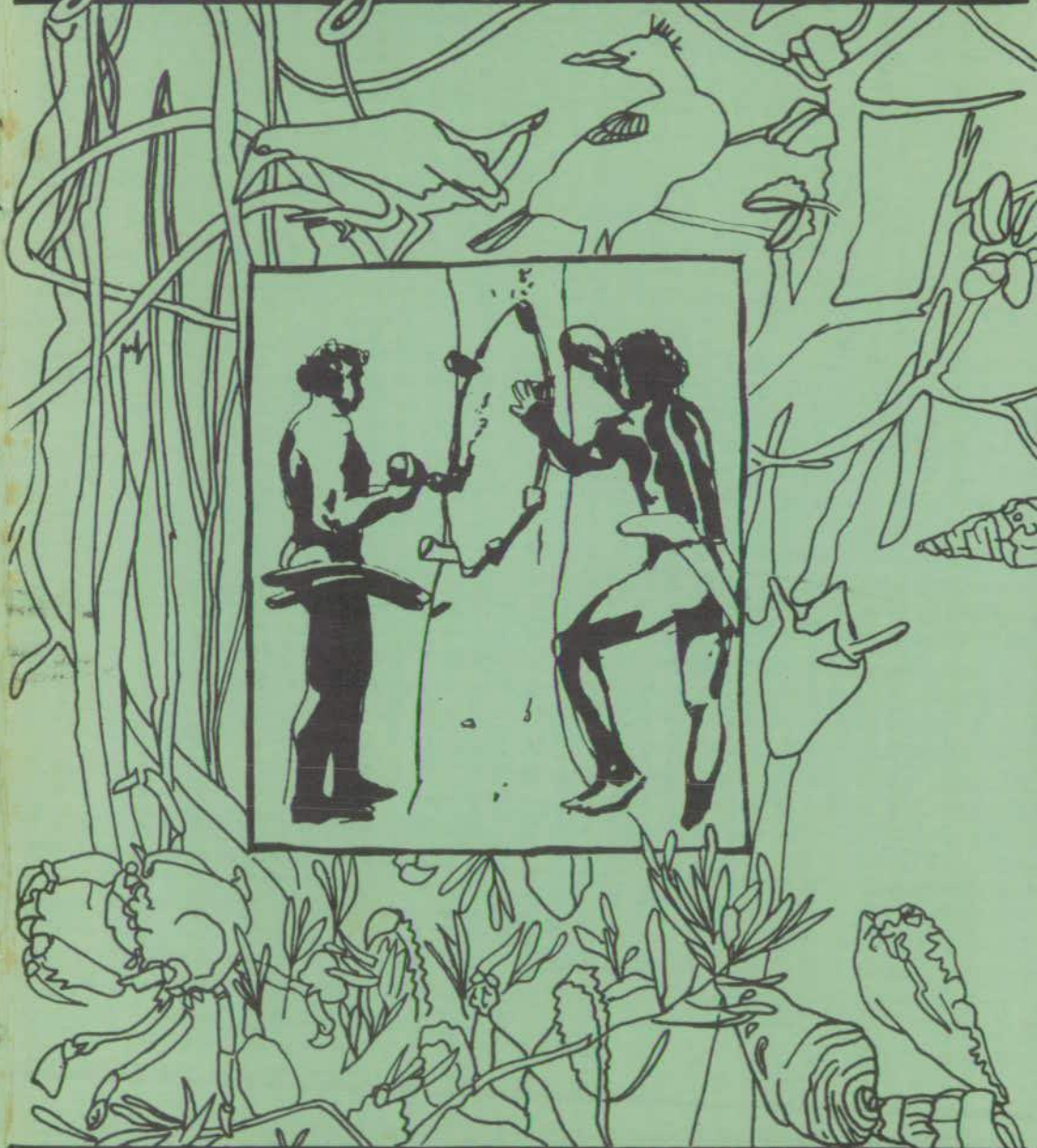


## NATIONAL PARKS AND WILDLIFE CODE

The preservation and protection of our natural areas depends on the co-operation of all who visit and enjoy our national parks and nature reserves. Here are a few simple rules that everyone is asked to observe.

- Wildfire can destroy lives and property, so be careful, especially during the bush fire danger periods. Use only safe fireplaces and do not light fires during total fire ban periods.
- Keep the areas you use tidy — place rubbish in the bins where provided or take it away with you.
- Leave your pets at home — they can disturb and kill native animals and are often a nuisance to the other visitors.
- Leave firearms at home.
- Do not disturb plants, animals and rocks. Rocks are important shelter for some animals and plants.
- Drive carefully and keep to roads and car parks provided.
- Please observe all signs. They are provided for your guidance and to assist you to enjoy the areas you visit.
- No Generators.

All enquiries may be directed to the Senior Ranger National Parks and Wildlife Service, P.O. Box 91, Alstonville 2477. Telephone (066) 28 1177.



# Bundjalung National Park

# Gurrua Garra self-guiding nature walk



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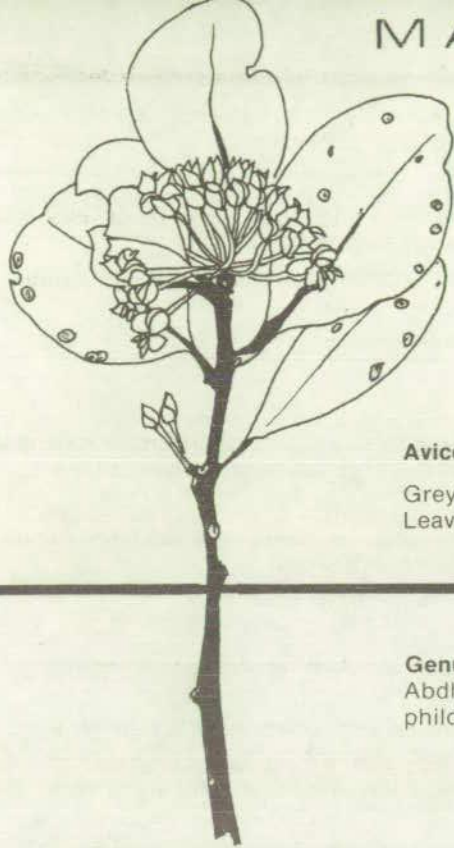


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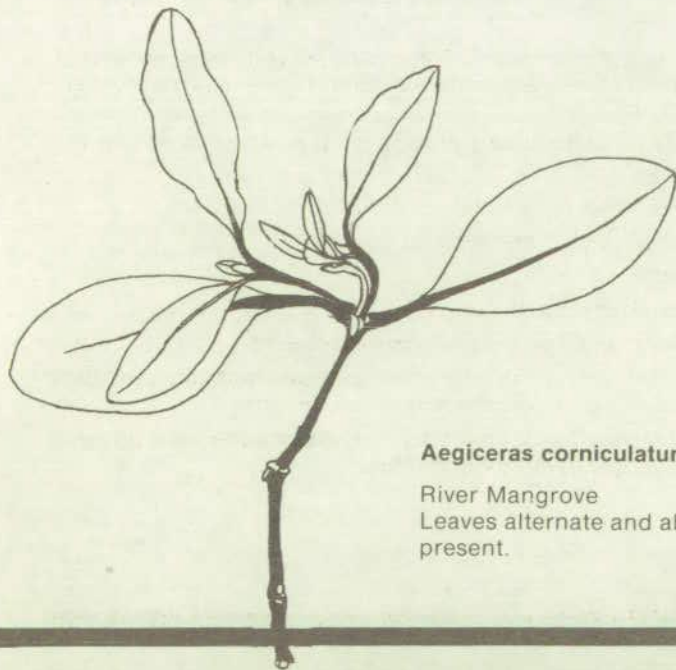
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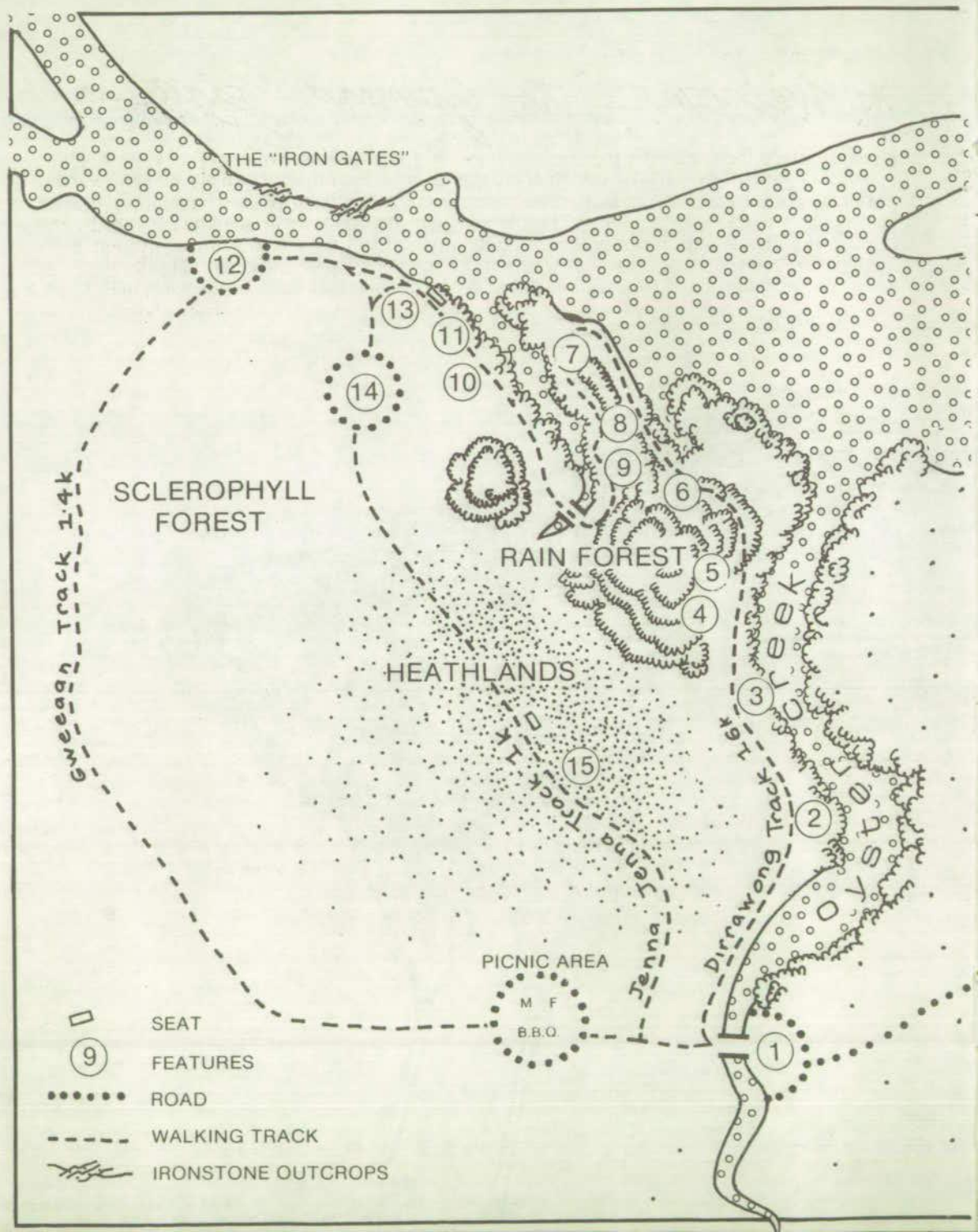
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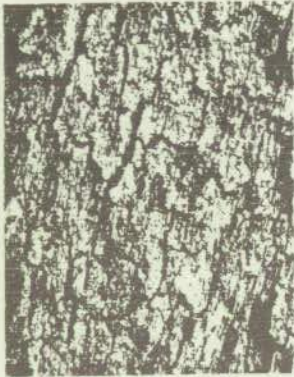


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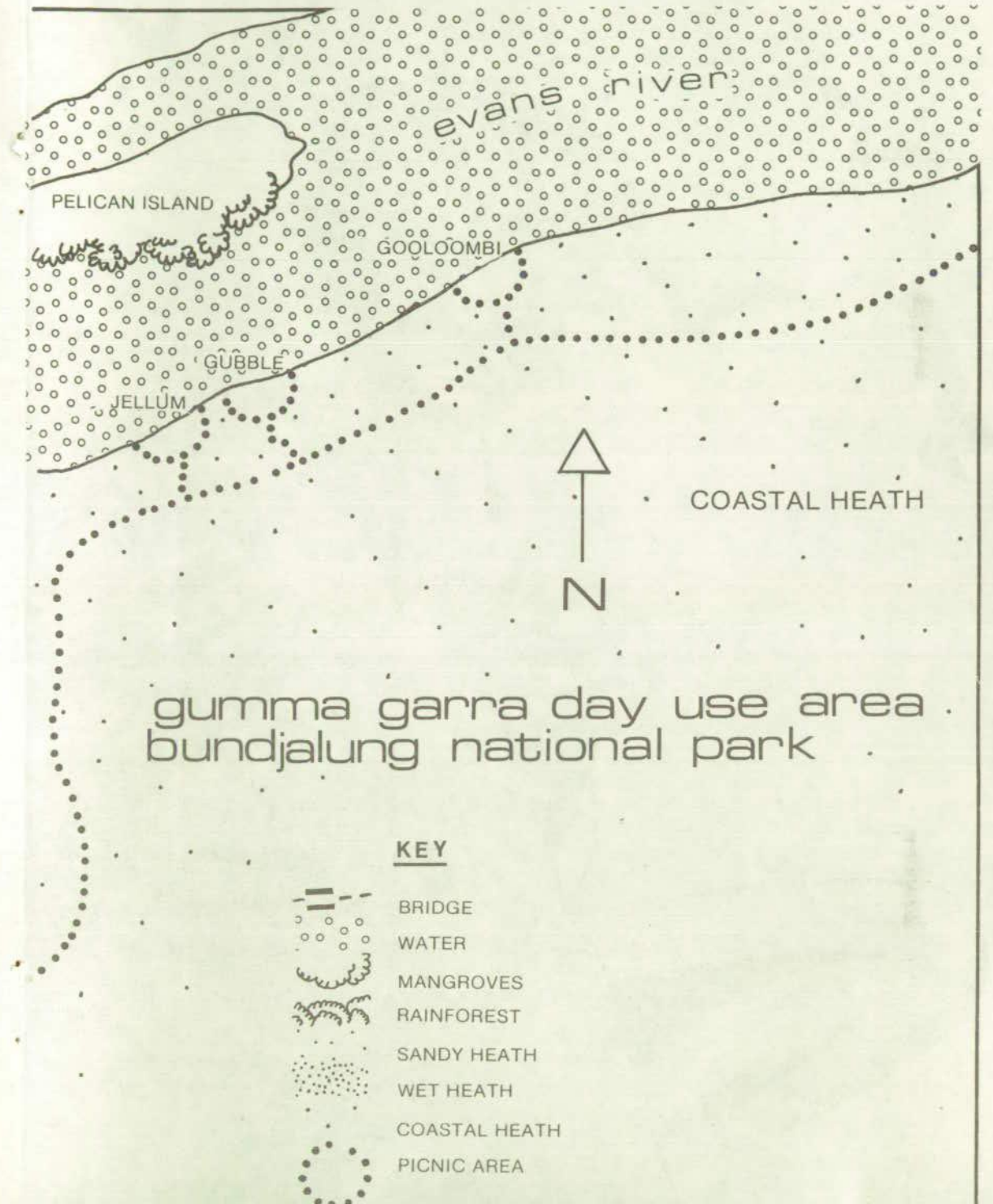
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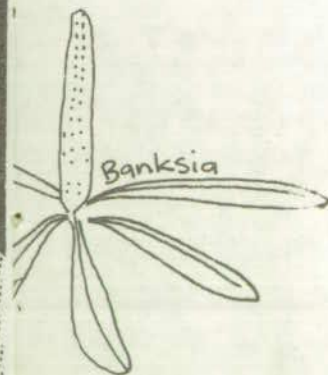


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During the 1940's oysters were harvested and bottled on site by a couple of locals. Evans River estuary oysters were famous in Sydney for their succulence, having fed so well on abundant plankton and detritus. (decaying organic matter).

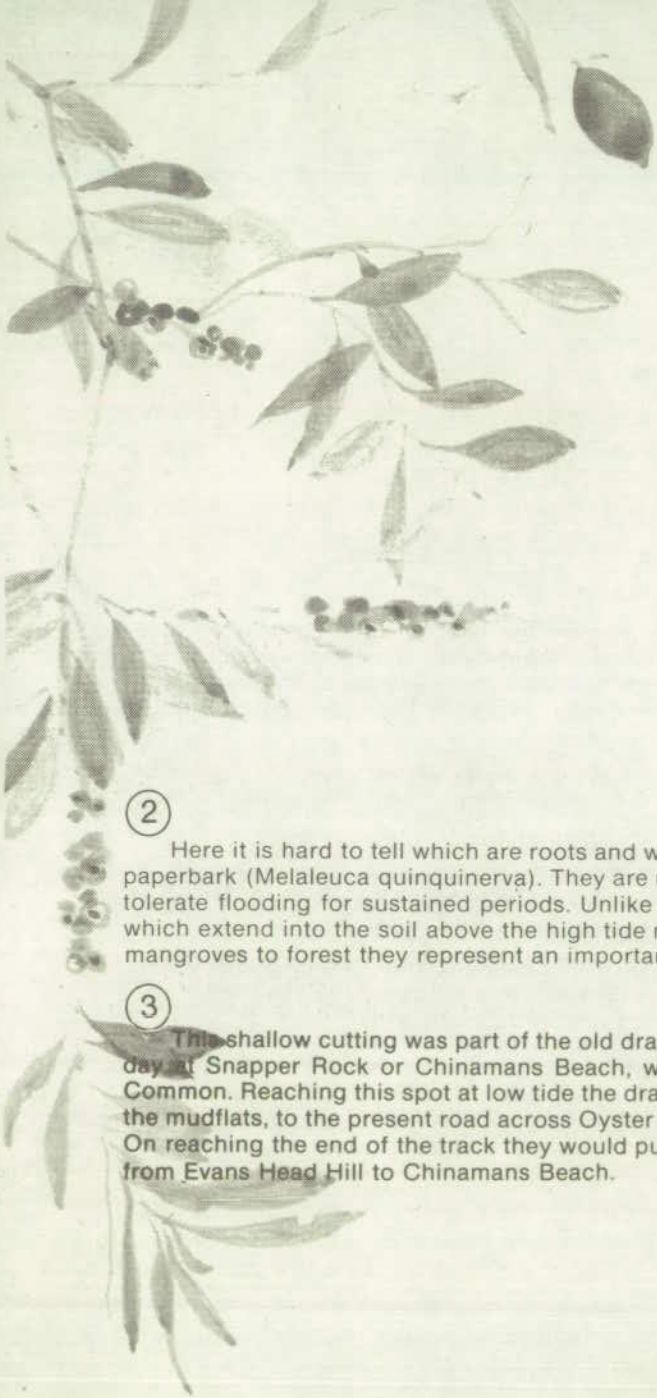
The banks of the creek are still studded with oysters. At low tide you will see crabs delicately spooning detritus into their mouths with large claws. Crabs are very sensitive to vibration; tap your foot on the bridge and see them vanish in seconds.

Oyster Creek is fed by a peaty swamp, rich in minerals and tannin, which give its waters the look of strong black tea. Turn right over the bridge. Stay alert; see if you can spot where one habitat gives way to another and the different wildlife each supports.

The track follows Oyster Creek to where it joins the Evans River. Note the banksias with their bottle brush flowers and nobbly seed pods. (Remember the Banksia Men in Snugglepot and Cuddlepie?). But resist the temptation to pick the pods. Everything in a national park is protected.

Mangroves line the creek and we will be telling you more about them later. The trees on your left beyond the banksia are aptly named paperbarks.





2

Here it is hard to tell which are roots and which are branches. The tree is a broad-leaved paperbark (*Melaleuca quinquinervia*). They are usually found in poorly drained areas and can tolerate flooding for sustained periods. Unlike the nearby mangroves these trees have roots which extend into the soil above the high tide mark. As a go-between in the succession from mangroves to forest they represent an important stage in the stabilisation of estuaries.

3

This shallow cutting was part of the old dray track. Fishing parties intent on spending the day at Snapper Rock or Chinamans Beach, would set off in the morning from Woodburn Common. Reaching this spot at low tide the draught horses would set to pulling the dray over the mudflats, to the present road across Oyster Creek. These animals were immensely strong. On reaching the end of the track they would pull through sand for the last leg of the journey, from Evans Head Hill to Chinamans Beach.

13

On your left a Forest Red Gum and a White Mahogany (*E. acmenioides*) are curiously locked together.

Occasionally different Eucalypts species graft together at root level, transferring nutrients. Treatment of one with a deadly herbicide will also kill the other. However they never graft above ground level. In this case the two trees have 'collided' and are attempting to grow around each other.

The midden area was a place for eating, trading and socialising, the Biriwan campsite is a little way back along the track.

14

High above the worst of the sandflies and mosquitoes the family campsite commands views up and down the Evans River. Charcoal areas are still visible, indicating the positions of campfires for each family group. Stones were used to grind seeds, tough kangaroo meat was pounded then grilled on green sticks over white hot pebbles. The fact that the Birawan camped here for 6000 years says much about the way they treated the environment.

A second much smaller campsite in the area was used for boys who were taken from the family group at about the age of 12 for initiation and to await a wife the family would choose for them.

Now it's time to head back to the carpark through another of Gumma Garra's habitats — the heathland.



FROM "ABORIGINALS SPEARING FISH"

# the Story of Gumma Garra

Gumma Garra takes its name from an ancestor in dreamtime legend of the Bundjalung people's first landing near Evans Head. Three canoes carrying three brothers, their families and their old mother named Gummi put ashore. Gummi went into the sandhills and there she lay down to sleep off the rigours of the journey. Her children and grandchildren rested on the beach. Two of the families were to continue their journey, taking Gummi with them, while the third remained to settle the place of their landfall. But when it was time to put out to sea, try as they would, they couldn't find Gummi. Reluctantly, they left. Gummi finally awoke and, scrambling to the top of the headland, she was in time to see the two canoes heading through the Ballina Bar. Enraged at being left behind the old woman "called the waters" and the seas rose, swamping the boats on the bar.

Archeological evidence shows that the Biriwan (a sub group of the Bundjalungs) were camping at Gumma Garra 6000 years ago. The Bundjalungs are now scattered around the north coast. The Biriwan have disappeared completely and two differing explanations are given of their demise. One relates the story of a flood which killed many estuary fish.

The Biriwan ate the fish, fell suddenly ill and left Gumma Garra never to return. A second story tells of a visit to Gumma Garra by a Clarence tribe. On its way home the tribe killed sheep and cattle owned by local Europeans. But Queensland troopers shot the Biriwan, all except two children who never married.

The last of the Bundjalung tribespeople who used Gumma Garra camping ground died in the 1960's. Yet a rich tradition remains. Aboriginal people camped and lived at Gumma Garra for countless generations, drawn by the fertility of a place where estuary and rainforest meet.

While walking Gumma Garra turn your thoughts to the people who sat talking and eating at the midden and to the trees they planted there 300 years ago. The descendants of the Bundjalung say that the spirit of the Biriwan still inhabits the reserve protecting everyone who walks here from harm.

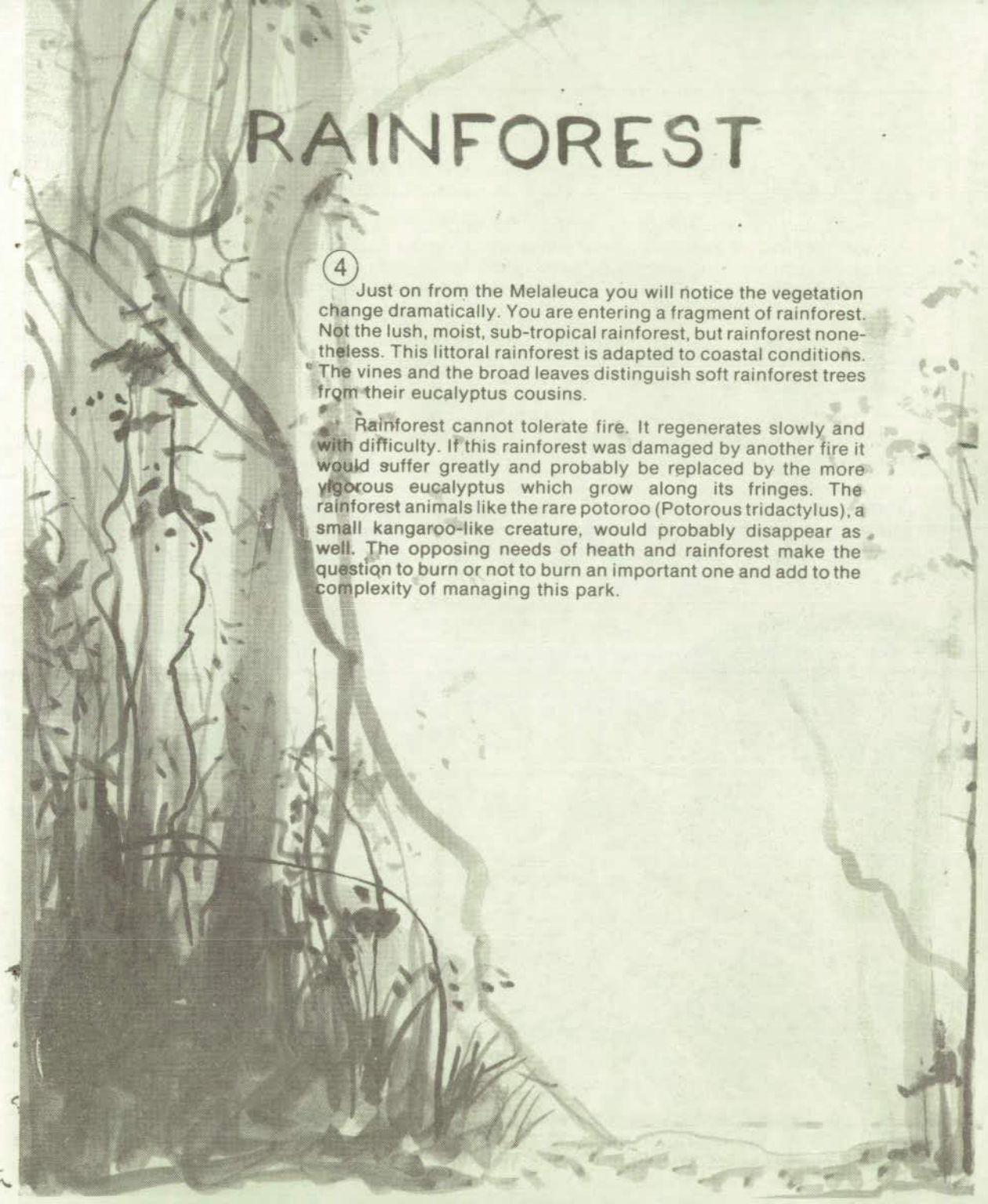


## RAINFOREST

4

Just on from the Melaleuca you will notice the vegetation change dramatically. You are entering a fragment of rainforest. Not the lush, moist, sub-tropical rainforest, but rainforest nonetheless. This littoral rainforest is adapted to coastal conditions. The vines and the broad leaves distinguish soft rainforest trees from their eucalyptus cousins.

Rainforest cannot tolerate fire. It regenerates slowly and with difficulty. If this rainforest was damaged by another fire it would suffer greatly and probably be replaced by the more vigorous eucalyptus which grow along its fringes. The rainforest animals like the rare potoroo (*Potorous tridactylus*), a small kangaroo-like creature, would probably disappear as well. The opposing needs of heath and rainforest make the question to burn or not to burn an important one and add to the complexity of managing this park.



5

Lantana (*Lantana camara*) with its pretty pink and yellow flowers probably came to Australia from Central America to populate our gardens. But eastern Australian sun, rain and good soils have spurred it along. It is now a serious and rampant weed.

There is no Lantana back along the track because although it is sunny and receives moisture, the soil is poor. The same things which encourages hardy banksias, do not suit Lantana. As leaf litter on the track clues you in to the growing richness of the soil, so Lantana begins to appear. A track such as this breaks the rainforest upper canopy and lets sunlight through, completing the requirements for Lantana.

However this patch isn't doing so well, the leaves look chewed. They have been eaten by *Ocotoma scabripennis* and *Uroplata girardi*, two forms of Lantana Beetle being used in Australia as biological controllers.

Both adults and larvae cause severe damage to leaves. Females lay eggs on the leaf surface, which hatch into larvae. These grubs mine out the middle (mesophyll) cells of the leaves. Pupae develop inside.

It is these mines, which you see as stripes and blotches, and the hole gnawed out by adult beetles which destroy Lantana, because they reduce the photosynthesizing surface of the leaf and weaken the plant. You can see young rainforest species growing up through the spindly branches, thanks to the Lantana Beetles.



12

It is not hard to imagine daily life around this large midden. The debris from centuries of eating, trading and social gatherings have formed it. Fish, birds and animal bones along with shells, broken tools and weapons, vegetable matter, ash and charcoal all came to rest here.

Primarily an oyster midden, a metre and a half of debris and remains accumulated after 6000 years, but the midden used to be bigger.

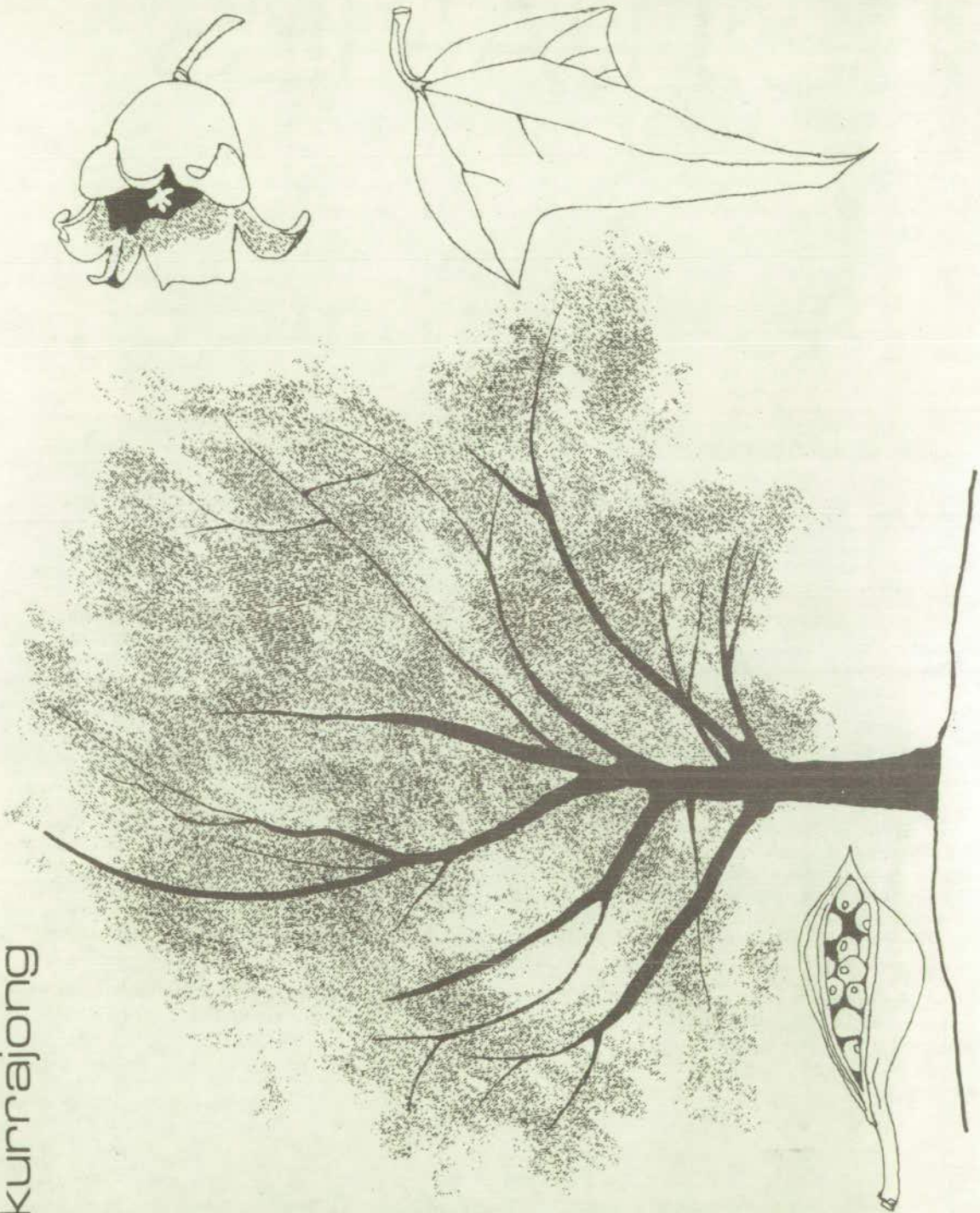
# the midden

It has suffered the effects of two centuries of Europeans. In 1887 an ironstone bottleneck in the Evans River existed here. Known as the 'Iron Gates' it was blasted for flood mitigation purposes and a wide channel opened. A good portion of the midden was washed down stream. Nearly a hundred years later, during the flood of '74 a canvas dam on Tuckombil Canal was slashed. It deluged the estuary again and tore out even more of the midden.

But what remains still has a story to tell. Before Europeans came, this was an important meeting place where the Biriwan and the Western Bundjalung people met to trade. Seafood, salt and stone tools were exchanged for bunya nuts, Quondong and Kurrajong seeds.

Western Kurrajong (*Brachychiton populneum*) seeds rich in caffeine made a popular coffee-like drink and the branches provided food. The Kurrajong is regarded as a 'Tree of Life' and as a source of strength. Marriage ceremonies were conducted under its branches. On one occasion tribal elders travelled down to Iluka bringing some reluctant girls back from the Clarence to this midden, where they were married to equally reluctant local boys.





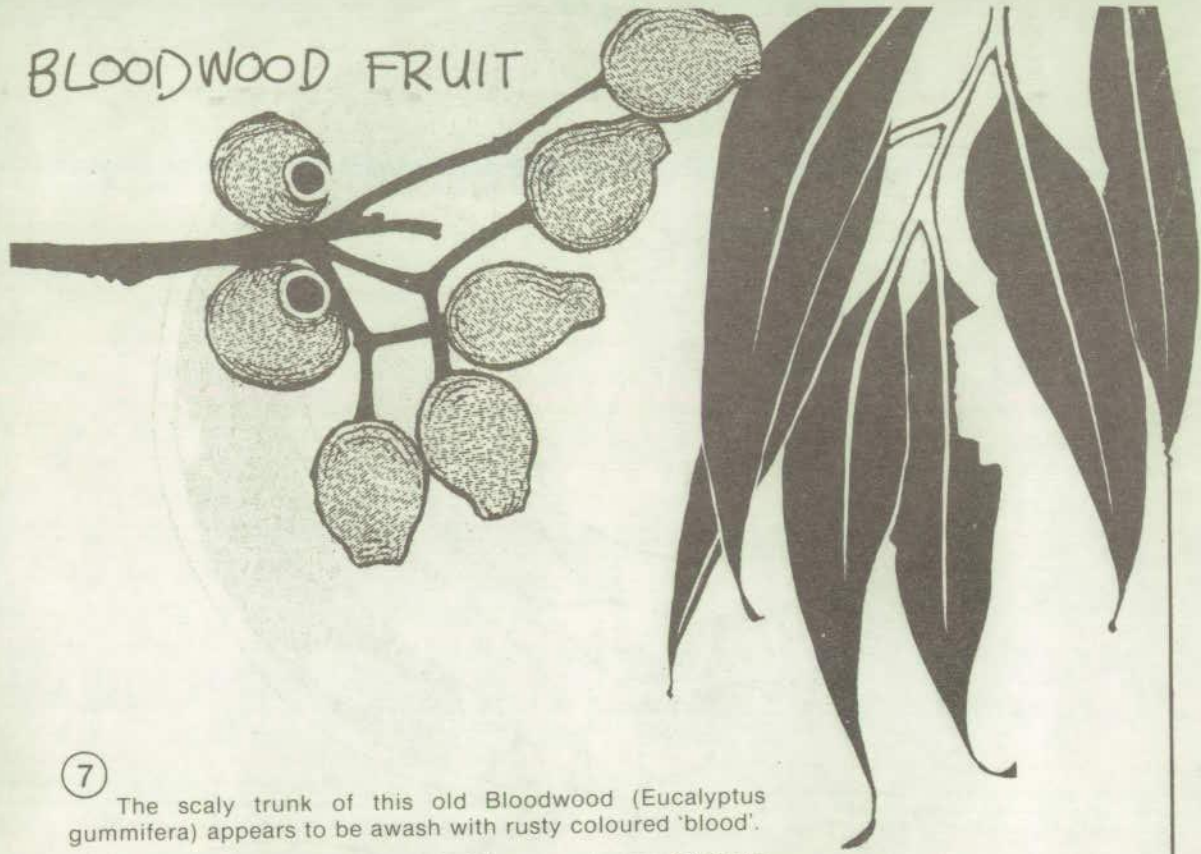
6

Have you ever been car sick? Chances are Corkwood (*Dubosia myoporoides*) has helped you. Its leaves contain alkaloids that are used extensively in motion-sickness tablets and dilating the pupils during eye-surgery. Although considered poisonous to stock, aborigines used it to produce an intoxicating drink, and even to stupefy eels, making them easy to catch! The corkwood becomes common in regrowth areas following disturbances such as the fire we mentioned earlier, and is a rainforest indicator.

The tree next door is a Red Ash (*Alphidonia excelsa*). Its location here is typical. It usually occurs in the interface of open eucalypt forest and rainforest. Best known for its attractive orange-red timber, the Red Ash has become uncommon due to its popularity as a cabinet wood. In earlier times, it was prized by settlers for tool handles and bullock yokes by virtue of its strength and durability.



## BLOODWOOD FRUIT



7

The scaly trunk of this old Bloodwood (*Eucalyptus gummifera*) appears to be awash with rusty coloured 'blood'.

Kino (gum) flows from wounded tissue and coagulates like blood forming a protective scab, a cross-section through an old Bloodwood, would show consecutive rings of dry kino, marking years of fire damage the tree has survived.

Bloodwoods are classified as primitive Eucalypts. They are known for their prolific kino production and it is this that you see on the trunk.

Can you find the Bloodwood fruit? Quite distinctive, being large and egg shaped, they recall a wine glass without a stem.

# ESTUARIES

11

Here land, river and sea meet. Estuaries are fertile and delicately balanced, incorporating salt marshes, mangrove swamps, mudflats and creeks and swamps.

One of the most fertile systems in the world, the estuary produces huge quantities of waste organic matter (detritus). With their warm shallows and the protection of sand bars, spits and mud islands they make great nurseries.

The two most important zones in an estuary are the mangrove swamps and seagrass beds. They drop about 4 tonnes and 100 tonnes an acre of detritus a year respectively.

This cache of fertilizer decays slowly forming a rich "soup" with its associated fungi, bacteria, protozoa and microalgae. Fresh water deposits dissolved minerals — sunlight penetrates the shallows thus enabling photosynthesis, (producing oxygen and organic compounds) to take place. The result of which is of direct benefit to nature and man.

Of all commercial fish, molluscs and crustaceans, 70% are taken from or depend on estuaries. From here you can look towards Pelican Island and perhaps see waders and sea birds working over their feeding grounds. Further along the track is a tribute to thousands of generations of shell fish in the form of an aboriginal midden.

Estuarine plants and animals live in a stressful environment. They are subjected to salt and fresh water floods. Changes in rainfall alter the amount of dissolved minerals in the water. Ebbing and flowing tides mean regular exposure and submergence. These creatures and plants have been ingenious in their adaptations. . . To resist the force of the tide, grasses have developed deep roots. Mangroves have prop roots and pneumatophores supporting them which prawns, shrimps and other weak swimmers shelter amongst. Oysters which are attached, clam up to escape the heat and dry, and crabs burrow.

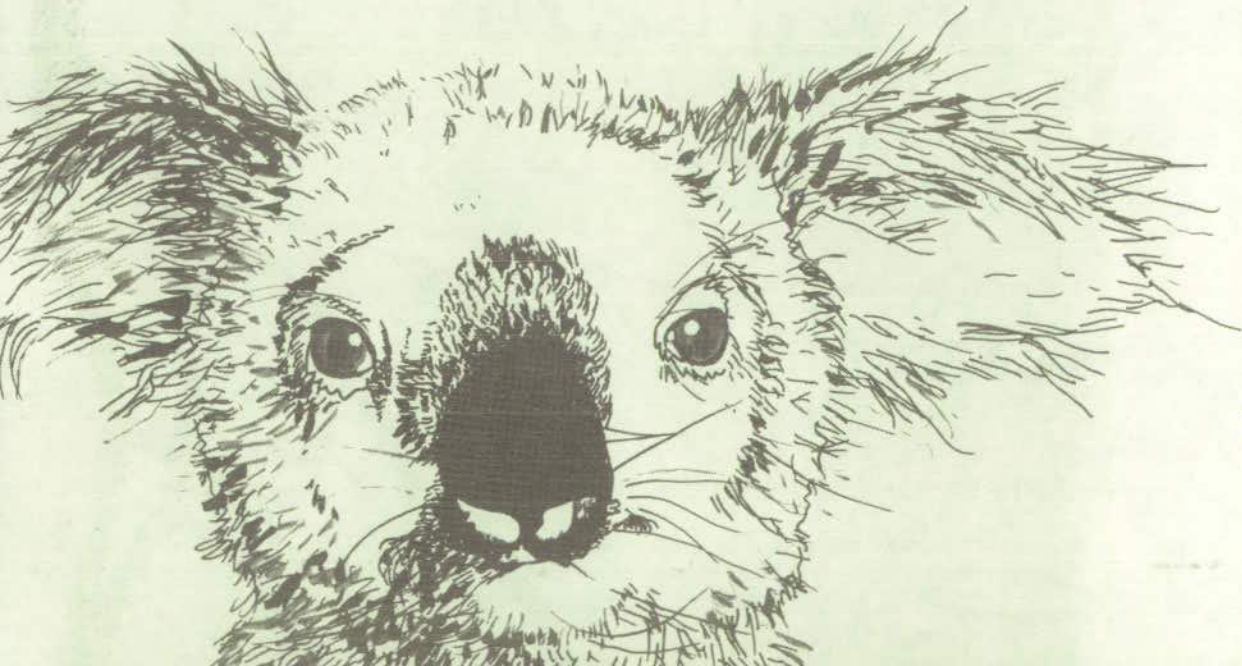
Estuaries are nutrient traps. They are also pollution traps and as such are vulnerable. Their actual location is such that they could receive all the industrial, residential and agricultural runoff and in the past have done so.

# KOALAS

10

The forest you see around you is dominated by Forest Red Gums (*E. tereticornis*) and Tallowwoods (*E. microcorys*). These eucalypts are amongst the favourite food for one of Australia's best known mascots, the Koala. The marsupials can sometimes be seen loafing in the foliage of their trees near here. At night, their presence is revealed by their calls which resemble the sound of a person being strangled!

The name Koala seems to be derived from the aboriginal word "koalah" meaning "does not drink water". Indeed this charming creature obtains all its water from the leaves it devours, about 600 grams per day.



SWAMP BOX

8

This is a Swamp Turpentine (*Tristania suaveolens*) with bark resistant to bora and rot. The Aborigines have cut a long bark dish from it. This was made after Europeans had arrived with a revolutionary new tool, the steel axe.

You can still see the axe marks in its trunk.

# MANGROVES

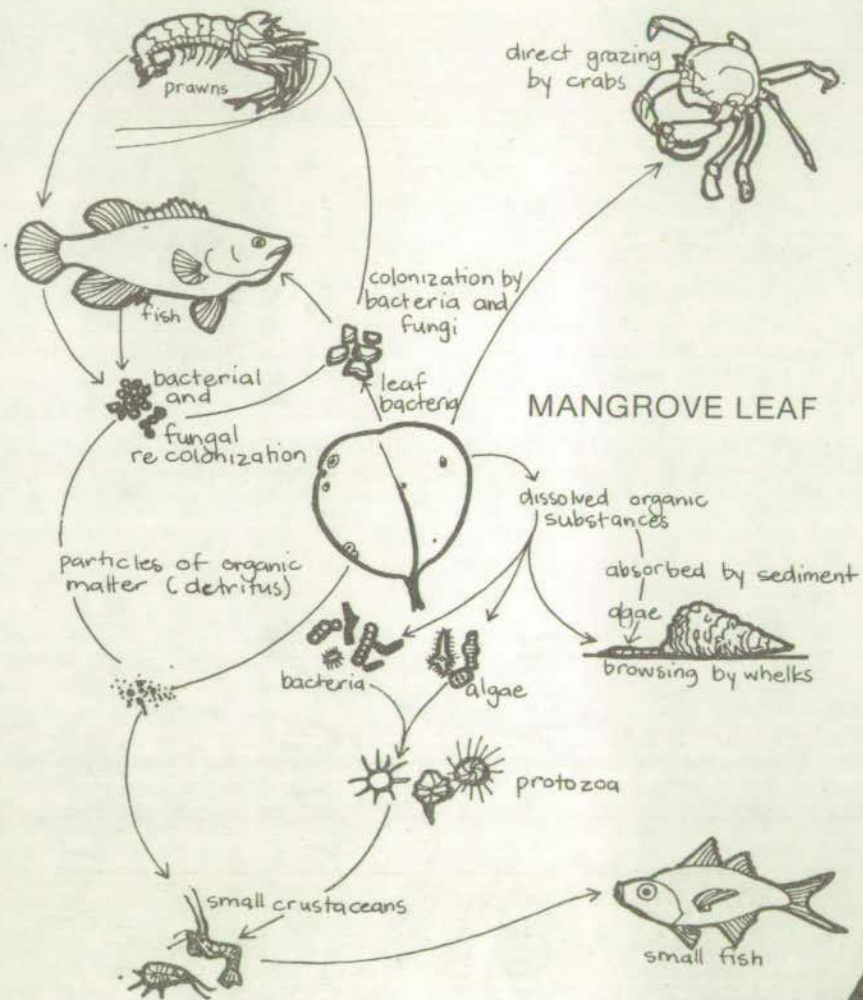
9 Until recently, mangrove swamps have been regarded by many as wastelands.

Consequently they have often been turned into rubbish dumps, or 'reclaimed', displaced by wharves, bridges and walls, or flooded with pesticides and industrial wastes.

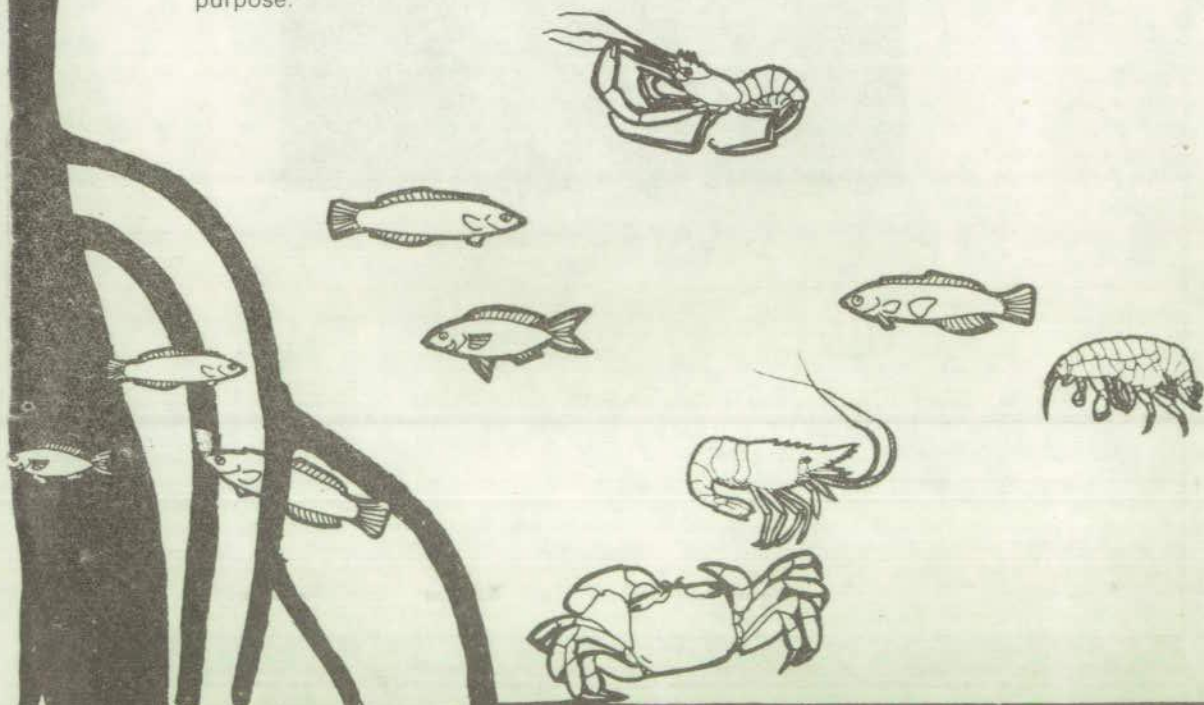
Mangrove trees are unique, with their leathery leaves, and asparagus-like aerial roots. Far from being 'dead' and ugly, mangrove swamps teem with life. More productive than almost any improved pasture; they act as nurseries, provide a safe harbour to countless small organisms, and are protected by a system of sand-bars and spits.

You might wonder how a tree can live on a regular diet of salt water and oxygen-depleted mud. In the Evans River estuary there are 2 species of mangrove; River Mangrove (*Aegiceras corniculatum*) and Grey Mangrove (*Avicennia marina*). Each lives within its own tidal zone, and is adapted to a particular degree of salinity, nutrient level and sand/mud type.

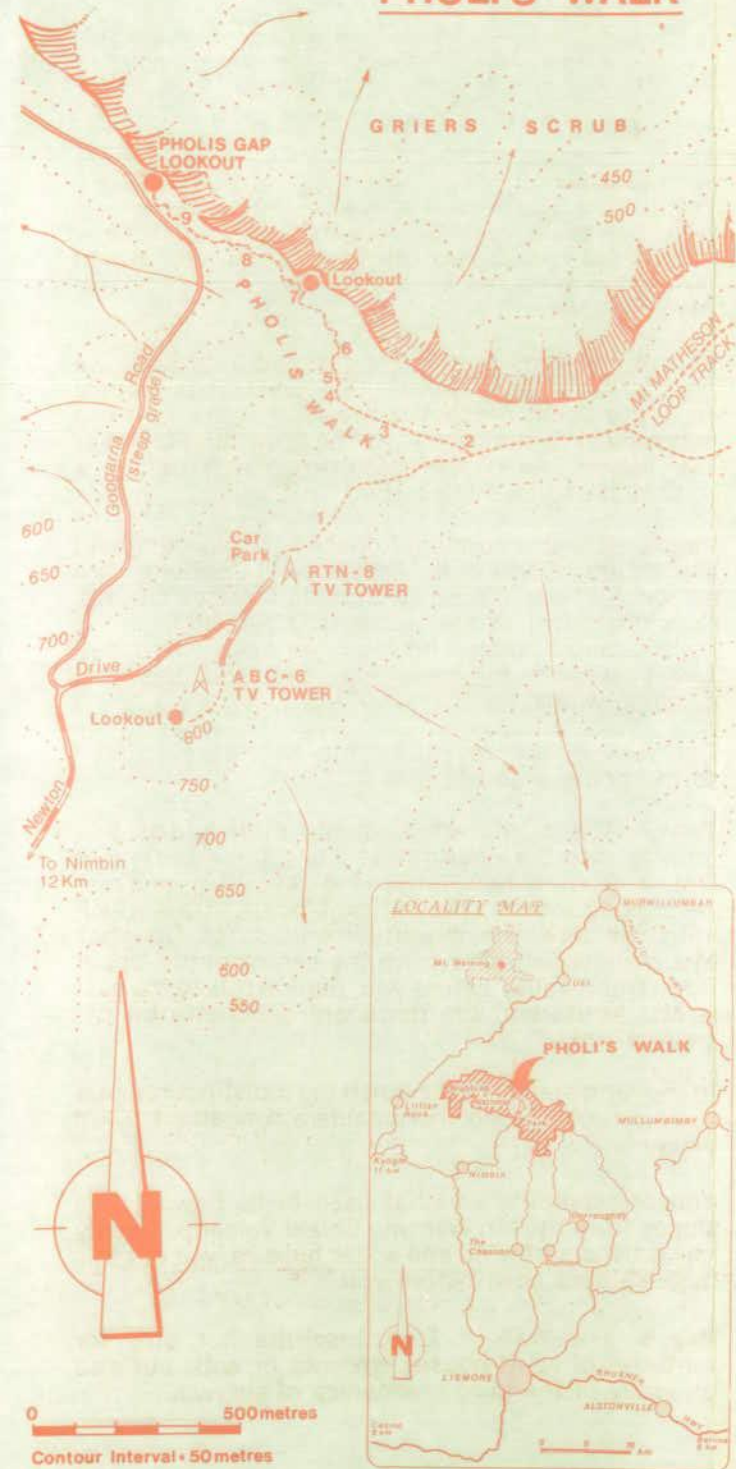
Their adaptations are intriguing . . . . . Some have salt-excreting glands in their stems, and others a salt-intake prevention mechanism in their roots. Curious aerial breathing organs supply underground roots. Known as pneumatophores they poke up out of the mud like fingers and absorb oxygen at low tide. Other species have prop roots which arch out from the stems before reaching the mud, serving the same purpose.



THE PLACE OF MANGROVES IN A BASIC ESTUARINE FOOD CHAIN



## PHOLI'S WALK



See how the trunk twists around its burnt-out heart, but it stands defiant against all the forces of fire and weather that would have destroyed it. Its huge roots thrust out like knees from the base of its trunk, penetrating deep into cracks in the rock, anchoring it, yet slowly breaking the rock apart — part of the soil making process.

**Peg 9.** From here the track descends to Pholi's Lookout through numerous awesome New England Blackbutts, and archaic Grass-trees. The air is fresh and stirs from the proximity of the escarpment cliffs.

At Pholi's Gap Lookout the view is an enlargement on the one you enjoyed up the track. Mt. Warning itself is now visible looming up out of the trees on the extreme left. Below you can see the lush palms of the lowland subtropical rainforest of Grier's Scrub.

### And who was Pholi?

Athol Pholi was killed by a falling tree in the course of his work in the area. The Gap, and subsequently the Track, were named in his memory.

This pamphlet is one of a series of the national parks of the Mount Warning Shield Volcano, which includes Mount Warning, Nightcap and Border ranges National Parks in N.S.W., and Lamington National Park in Qld.

For further information on these parks please contact:

The Lismore District office of the National Parks and Wildlife Service located in the Colonial Arcade, 75 Main Street, Alstonville, phone (066) 28 1177,

or,

our Kyogle Sub-district office located at 63 Summerland Way, Kyogle, phone (066) 32 2068.

## PHOLI'S WALK NIGHTCAP NATIONAL PARK



THE 'WALK-IN' TREE - A magnificent New England Blackbutt.

# PHOLIS WALK

## NIGHTCAP NATIONAL PARK

Pholi's Walk is located in the Nightcap National Park, the southernmost of the rainforest parks found on the caldera rim of the ancient, eroded Mt. Warning Shield Volcano landform. It is reached by taking the road from Nimbin up Mt. Nardi (Newtons Drive—see map) to the carpark at the summit. The Mt. Matheson Loop Track leads off from behind the RTN-8 TV transmitter and you follow this for 600m to Pholi's Walk signpost. The walk leaves the Mt. Matheson Loop Track in a NW direction and descends along the caldera rim for a further 1.5 km to join Googarna Road at the Pholi's Gap Lookout. If a vehicle cannot be arranged to meet you at this point it is advisable to return via the walk.

This walk is one of the most stimulating and educational short treks to be made in the caldera parks and is especially useful as a teaching aid in school excursions. A key to the rainforest trees would be a useful addition to your day pack on this walk. The forces of fire, wind and water which have worked in concert over the past 20 million years on the original volcanic lava flows are still dynamically and observably shaping the variety of habitats found along this walk.

Starting high on the ridgeline in cool subtropical rainforest, the track descends to the escarpment edge through warm temperate rainforest, passing a disturbed area where the processes of regeneration can be observed and emerges onto a ridge of open dry sclerophyll forest, dominated by fire-scarred New England Blackbutts.

A series of 9 numbered pegs is to be found along the walk, each of which is described in this pamphlet to help you in the understanding, not only of the total erosion caldera concept, but also of how the forces of nature have operated specifically in the particular habitat you are passing through.

### THE NUMBERED MARKERS — NOTES FOR YOUR SELF GUIDED NATURE WALK

**Peg 1.** In just the few metres you have walked, the silence has settled noticeably around you. The wind is muffled by the enclosing canopy of dense rainforest. Your footsteps fall softly on the deep leafy litter layer of the forest floor. As you proceed towards Peg 2 your attention may be caught by numerous piping birdcalls; flashes of red in the subdued filtered green light of vibrant new leaves, or the jewel-like fruit of walking-stick palms, *Linospadix monostachys*, or the shadowy, retreating form of a Scrub Turkey. And all around the profusion of majestic trees, the amazement of shape and texture in the diversity of rainforest plant species.

**Peg 2.** Through the rainforest giants there are tantalising glimpses of the valley views. Tree ferns, some with exquisite epiphytes including delicate filmy ferns abutt the track. High in the canopy overhead you may see flirting Bowerbirds, acrobatic Riflebirds or fruit eating pigeons.

This stretch of track to Peg 3 offers many opportunities to stop in a patch of sunlight to listen to the sounds of the rainforest.

**Peg 3.** This is a good stop to observe three large rainforest trees growing very close to each other on the lower side of the track. Each has distinctive differences in bark texture and colour. These are the Corkwood *Cauldcluvia paniculosa*, the Black Apple *Planchonella australis* and the Blue Cherry *Syzygium oleosum* (also known as *Syzygium coolminianum*). See if you can identify which is which from your rainforest key. How old do you think these trees are?

**Peg 4.** Here the track crosses an old jeep trail and a gully. Notice how the forest is responding to the disturbance and greatly increased light.

Very noticeable (in many ways) are the thorny, spikey plants which protect the pioneer tree seedlings you will see coming up everywhere under them. Think of the function of these heavily armed species, (native raspberry, wait-a-while palm, solanum, to name a few), in the protection of the regenerating gap in the canopy. How many different seedling tree species can you identify? As they mature they will help the next stage of more sensitive rainforest species to colonise.

The process from open space as you see it now to closed canopy rainforest, such as you have just passed through, will take hundreds of years, and maybe thousands, to achieve the climax rainforest habitat.

**Peg 5.** Here the forest is changing. You experience a transition zone, passing from the uphill subtropical rainforest on basalt-derived soils, to warm temperate rainforest situated on the downhill poorer rhyolitic soils.

You might think that as we descend in altitude we pass from cooler to warmer rainforest types. Not so! Here the usual process is reversed — we go from subtropical to temperate, as the governing factor is the parent rock: the basalt-rhyolite-basalt lava sandwich of the caldera rim.

**Peg 6.** Here the dominant species, of New England Blackbutts, Corkwood, Acacia and Geebung, are evidence of adaptation to climatic stresses close to the caldera rim, as well as the soils derived from the rhyolite parent rock. This is a dryer open sclerophyll forest subject to occasional fire and seasonal cyclonic winds.

Can you see any ways the plants here have adapted to the dryness and fire?

**Peg 7.** The rainforest elements diminish as you emerge into the open forest along the escarpment rim. A gnarled New England Blackbutt provides a welcoming seat at a magnificent lookout from which you can view the rhyolite intrusion of Dougboy Mountain which rises from the centre of the Upper Doon Doon Valley before you. Behind this to the east is Mt. Jerusalem, the dominant silhouette on the caldera rim.

In the far distance to the north the indistinct range is Springbrook, the northern caldera rim, about 50km away.

You are standing on what used to be flowing lava slopes from the Mt. Warning Shield Volcano. Twenty million years of wind and water have carved out this huge caldera bowl before you.

**Peg 8.** The Walk-in Tree. Inspiring not only for fantasies of spirit-houses, gnomes or ents, but also an essay in the pure mechanics of survival.

# BROKEN HEAD NATURE RESERVE

## THE RESERVE

Broken Head Nature Reserve, 80 hectares (approx.) in size, is located on the Far North Coast of New South Wales, six kilometres south of Byron Bay. The Nature Reserve encompasses a superb headland area of steep slopes covered by subtropical rainforest, sloping down to a number of secluded beaches between boulder-strewn headlands.

## ACCESS

Access to the Reserve is via the Seven Mile Beach road, a scenic gravel road which heads southwards from Broken Head Village. A sign-posted walking track leads from a parking area on this road, down through the rainforest, to King's Beach.

A second walking track, from the Broken Head Caravan Park, also provides access to King's Beach, along a dramatic cliff-top track.

## ACTIVITIES

The chief visitor attraction is probably the total experience of walking down through the lush rainforest-clad slopes of Broken Head to secluded King's Beach, followed by a refreshing surf and contemplation of the beauties of nature.

Broken Head is also a very popular fishing area, with mullet, bream and tailor caught in season as well as a variety of rock fish.

## FACILITIES AND ACCOMMODATION

Camping and day-use facilities are provided by Byron Shire Council at the Broken Head Caravan Park. Resort facilities are available at the nearby town of Byron Bay. Camping is not permitted in the reserve or on any of the beaches.

## THE RAINFOREST

Broken Head Nature Reserve was dedicated to ensure the preservation of the rainforest, an unusual occurrence of subtropical rainforest, right on the coast — a result of protection from salt spray by prominent headlands and enrichment of soils from past volcanic activity.

Rainforest in the Byron Bay area is today a rare resource, although originally the country between Byron Bay and Lismore contained the largest area of tall subtropical rainforest in Australia, known simply as "The Big Scrub". This rainforest, encompassing an area of 75,000 hectares, was almost totally destroyed for agriculture in the latter half of the 19th century. All that remains today are a few isolated remnants totalling 300 hectares in area — some 0.4% of the original area of the "Big Scrub". Although separated from the original "Big Scrub" by several kilometres of sclerophyll forest and swamp, the coastal subtropical rainforest of Broken Head contains many tree species which once occurred in the "Big Scrub" — trees such as White Booyong, Rosewood, Red Bean, Red Carabeen and Yellow Carabeen. It also contains the southern-most occurrence of the Smooth-seeded Kurrajong, and one of the two known occurrences of Stinking Cryptocarya in N.S.W. The moist sheltered gullies harbour Bangalow Palms and soft pink-leaved Maidens Blush, Hardy Brush Box and Native Elm, with its holly-like leaves, tower on the ridge tops above the low understorey of Burrawang Palms.

## FAUNA

The spectacular scenery of Broken Head Nature Reserve is often highlighted by the unexpected appearance of scrub and sea birds. White-breasted Sea Eagles and Brahminy Kites soar along the cliffs, occasionally plunging to the sea to snatch up a fish with their sharp talons, while within the rainforest gently cooing Green-winged Pigeons and Red-crowned Pigeons feed on the rich supply of fruit and berries. In the summer months the mournful call of the Koel rings eerily in the gullies and the loud whipcrack of the Eastern Whipbird is unmistakable. Both male and female Whipbirds work together producing a call resembling only one performer. It is amazing how many birds you can see or hear if you walk quietly in the rainforest.

## YOUR HELP IN THE PROTECTION OF BROKEN HEAD NATURE RESERVE

Bushfire is the greatest threat to this delicate rainforest reserve. Your personal care with picnic fires is essential. Firewood should **not** be collected from the rainforest, particularly the narrow band of bush between the Seven Mile Beach and the Caravan Park Road.

Please use the coastal track from the caravan park to King's Beach, or the track from the parking area on Seven Mile Beach road. Tracks on the cliff through the rainforest open up the forest to exposure from salt winds and erosion which could eventually destroy the area.

Help to care for and protect any young trees planted near the caravan park area. Rehabilitation of this section of rainforest, damaged from earlier clearing needs your assistance.

## NATIONAL PARKS AND WILDLIFE CODE

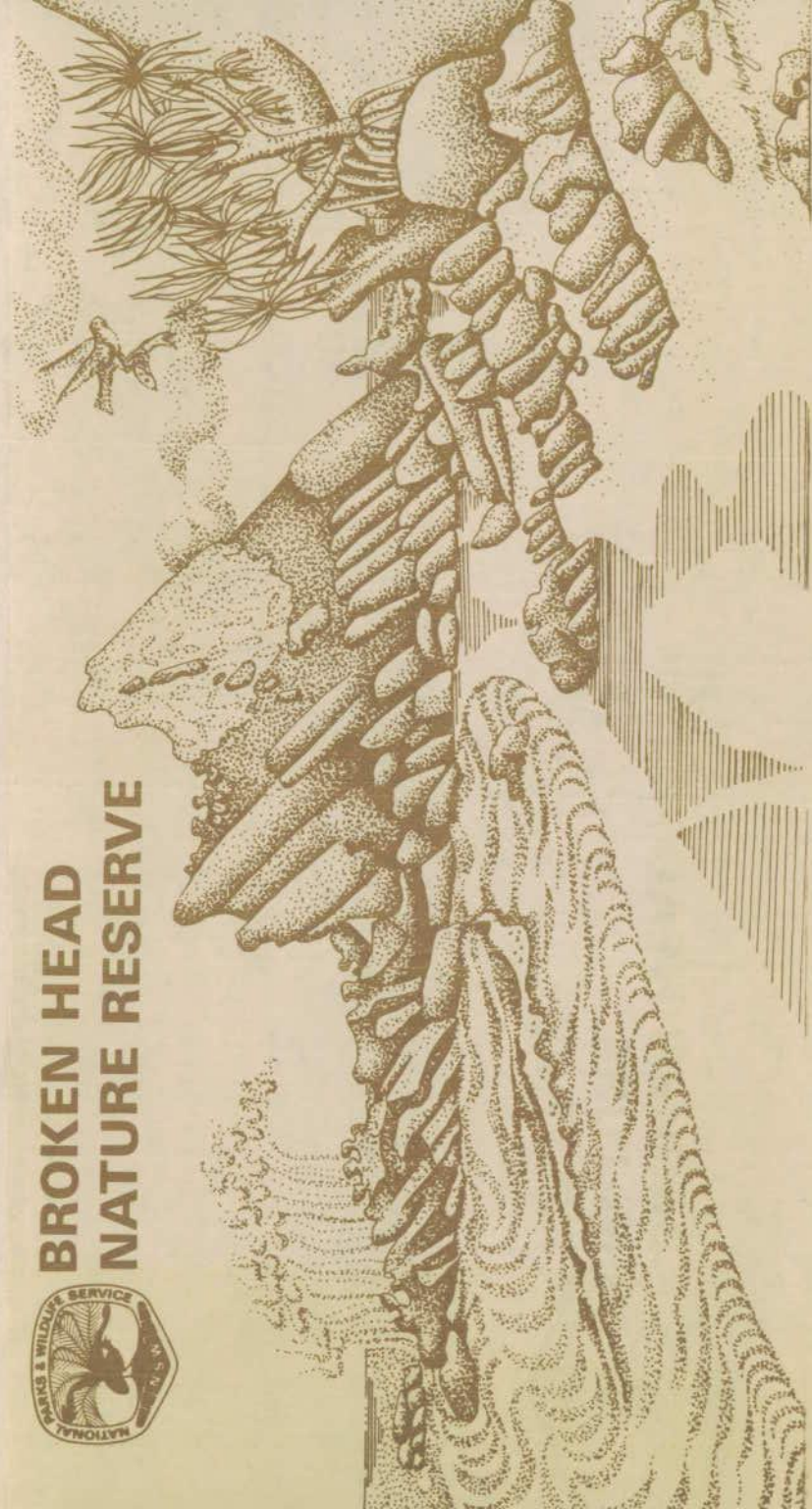
The preservation and protection of our natural areas depends on the co-operation of all who visit and enjoy our national parks and nature reserves. Here are a few simple rules that everyone is asked to observe.

- Wildfire can destroy lives and property, so be careful, especially during the bush fire danger periods. Use only safe fireplaces and do not light fires during total fire ban periods.
- Keep the areas you use tidy — place rubbish in the bins where provided or take it away with you.
- Leave your pets at home — they can disturb and kill native animals and are often a nuisance to the other visitors.
- Leave firearms at home.
- Do not disturb plants, animals and rocks. Rocks are important shelter for some animals and plants.
- Drive carefully and keep to roads and car parks provided.
- Please observe all signs. They are provided for your guidance and to assist you to enjoy the areas you visit.

All enquiries may be directed to the Senior Ranger, National Parks and Wildlife Service, P.O. Box 91, Alstonville 2477. Telephone: (066) 28 1177.

Broken Head Beach Caravan Park is administered by the Byron Shire Council, Lawson Street, Byron Bay.

For all camping enquiries contact the Resident Manager — (066) 85 6645.

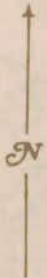


**BROKEN HEAD  
NATURE RESERVE**





# BROKEN HEAD NATURE RESERVE



To BYRON BAY  
Broken Head

OCEAN

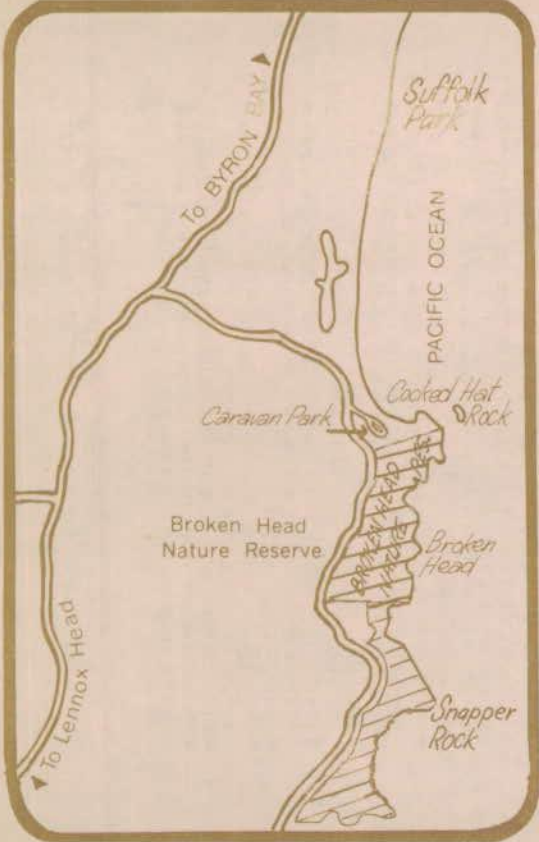
Broken Head Beach

caravan park

car park

Cocked Hat Rock

Location Map



Seven Mile Beach Road

Kings Beach

Kings Rock

Broken Head Nature Reserve

Tabletop

Razor back

Bray's Hole

Bray's Beach

PACIFIC

SCALE

1/2

1km



**LEGEND**

- SECONDARY RD
- PARK BOUNDARY
- WALKING TRACK
- CAMPING AREA
- SUB-TROPICAL RAINFOREST

Broken Head Nature Reserve

White's Beach

Jews Point

Seven Mile Beach



100 mg grid all. - top into  
vego.

Simon Fenner Arnold NPWS  
- mt Waring Nightcap  
Bader R. Rimpinwood Huka  
Munial f. d. g. new

National Parks

- Border Ranges
- Mount Waring
- Nightcap

CEP Bundle of work: 2 TAT - Baitbird monitoring → establish priorities for recovery.

- Works Programme
- Planning Programme -
- Bus access doc.
- Review of Major Plant Requirements

Nature Reserves

- Stotts Is.
- Victoria Park
- Broken Head
- Huka
- Numinbah
- Rimpinwood
- Wherabagh Island

thurs. May 1st } P.M. meeting  
August 7th } = Bundjalung am. meeting of  
Nov. 6th } Headwater committee

Flora Reserves

- Murray Scrub
- mt Nothofagus

Friday 14th April @ Tweed Stotts.  
mt Waring.  
26th June Lewis Plateau.  
25th Sept Western section Bader Range.

State Forest

- North Cherry Tree
- Richmond Range
- Toonumbah
- Donaldson
- Koreelah

RP:YK

# Valuer-General's Department

"NORTH COAST REGION"

Government Offices  
49 Victoria Street  
Grafton 2460



Mr P Thew  
Shire Clerk  
Kyogle Shire Council  
PO Box 11  
KYOGLE NSW 2474

Address all communications  
to the Regional Valuer  
P.O. Box 272, Grafton  
N.S.W. 2460

Our reference: GRA85/V/112

Your reference:

Telephone: (066) 42 0666  
Extension: 570

5 November 1985

Dear Sir

Attached is a copy of that section of the Valuation of Land Act that refers to wildlife districts, wildlife refuges and game reserves.

The National Parks and Wildlife (Valuation of Land) Amendment Act 1978 seeks to provide an incentive to land holders to co-operate with the National Parks and Wildlife Service in the conservation of the national estate.

Section 7F in the Valuation of Land Act requires the Valuer General to have regard to the provisions of the above act in determining rating values of land subject to orders or proclamations.

Rating and Taxing valuations are to be made on the assumption that the land "may be used only for the purpose of such a protected archaeological area" (wildlife refuge etc as the case may be).

It should be borne in mind however that the National Parks legislation does not exclude the using of the property by the owner of the land.

In measuring the value subject to the National Parks and Wildlife legislation the valuer is required to use his judgement as to what extent depreciation in value (if any) arises from any curtailment in the highest and best use of the land or from any loss in quiet enjoyment by reason of allowing other people access to the reserve or any other matters associated with the plan of management.

A new valuation subject to this act is issued to Council on receipt of a proclamation in the Government Gazette.

Yours faithfully

*Rex Poll*  
Rex Poll  
REGIONAL VALUER

*S/ Clerk*

enc

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*Valuation of Land.*

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**Protected archaeological areas, wildlife districts, wildlife refuges and game reserves.**

Ins. 1978 No. 137, Sch. 1 (1), Am. 1980 No. 137, s. 3 (1).

7F. (1) Without limiting the generality of section 19, the Valuer-General, on receipt of a copy of an order or revocation made under section 65 of the National Parks and Wildlife Act, 1974, or a proclamation made under section 67, 68 or 69 of that Act, shall make a valuation or valuations of the land or lands affected by the order, revocation or proclamation.

(2) Notwithstanding any other provision of this Act, the Valuer-General shall assume, in making a valuation for use by a rating or taxing authority of land, the whole or part of which comprises—

- (a) a protected archaeological area within the meaning of the National Parks and Wildlife Act, 1974—that the land so comprised may be used only for the purposes of such a protected archaeological area as at the date to which the valuation relates;
- (b) a wildlife district within the meaning of that Act—that the land so comprised may be used only for the purposes of such a wildlife district as at the date to which the valuation relates;
- (c) a wildlife refuge within the meaning of that Act—that the land so comprised may be used only for the purposes of such a wildlife refuge as at the date to which the valuation relates, or
- (d) a game reserve within the meaning of that Act—that the land so comprised may be used only for the purposes of such a game reserve as at the date to which the valuation relates.

**Department of Environment and Planning**

To: All City, Municipal and  
Shire Councils

Remington Centre  
175 Liverpool Street, Sydney 2000  
Box 3927 G.P.O. Sydney 2001  
DX. 15 Sydney

Telephone: (02) 266 7111 Ext.

Contact:

Our reference: 80/10408

Your reference:

CIRCULAR No. 95

12 December 1985

State Environmental Planning Policy No. 14 -  
Coastal Wetlands

The Minister for Planning and Environment, the Hon. R.J. Carr, M.P., has agreed to the making of State Environmental Planning Policy No. 14 - Coastal Wetlands. The Policy was gazetted today. A copy of the Policy is enclosed.

2. The Policy, which applies to the Cities, Municipalities and Shires with direct frontage to the Pacific Ocean (excluding those in the Sydney Metropolitan Area), is accompanied by a series of maps which identify the lands to which the Policy applies. The Policy makes the following developments designated developments, pursuant to Section 29 of the Environmental Planning and Assessment Act, 1979:-

- (a) Clearing of the land .
- (b) Constructing a levee on the land .
- (c) Draining the land.
- (d) Filling the land.

Development for these purposes will require the consent of the Council and the concurrence of the Director of Environment and Planning.

3. Under the Policy, a number of matters must be taken into consideration when a development proposal is considered. These include -

- (a) the environmental effects of the proposed development, including effect on plant and wildlife communities;
- (b) safeguards and rehabilitation measures which have been, or will be, made;

2.

(c) consistency with the objectives and major goals of the National Conservation Strategy for Australia; and

(d) whether any feasible alternative exists or has been considered.

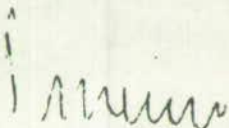
4. Failure to comply with the requirements of the Policy is subject to substantial monetary penalties under Section 126 of the Environmental Planning and Assessment Act.

5. Also enclosed for the information of each Council subject to the Policy are a copy of the maps of the affected lands in the Council's area and a brochure outlining the values of the wetland areas.

6. For the purpose of certificates under Section 149 of the Environmental Planning and Assessment Act, Councils may wish to use the following wording:-

State Environmental Planning Policy No. 14 - Coastal Wetlands provides that certain lands in coastal local government areas (except those in Sydney Metropolitan Area) shall not be cleared, drained or filled or have a levee constructed on them without the consent of the Council.

7. Any enquiries on the Policy should be directed to the Department's Regional Manager for the Council's area.



R.L. Pincini  
Secretary

STATE ENVIRONMENTAL PLANNING POLICY NO. 14.—  
COASTAL WETLANDS

HIS Excellency the Governor, with the advice of the Executive Council, and in pursuance of the Environmental Planning and Assessment Act 1979, has been pleased to make the State Environmental Planning Policy set forth hereunder in accordance with the recommendation made by the Minister for Planning and Environment

Minister for Planning and Environment.

**Citation**

1. This State Environmental Planning Policy may be cited as "State Environmental Planning Policy No. 14—Coastal Wetlands".

**Aims, objectives, etc.**

2. The aim of this policy is to ensure that the coastal wetlands are preserved and protected in the environmental and economic interests of the State.

**Interpretation**

3. In this policy, except in so far as the context or subject-matter otherwise indicates or requires—

"the Act" means the Environmental Planning and Assessment Act 1979;

"the map" means the series of maps marked "State Environmental Planning Policy No. 14—Coastal Wetlands" deposited in the office of the Department.

**Application of policy**

4. (1) Subject to subclause (2), this policy applies to the land outlined by heavy black edging on the map.

(2) This policy does not apply to land dedicated or reserved under the National Parks and Wildlife Act 1974 as an Aboriginal area, historic site, national park, nature reserve, state game reserve or state recreation area.

**Inconsistency between instruments**

5. Subject to section 74 (1) of the Act, in the event of an inconsistency between this policy and another environmental planning instrument, whether made before, on, or after the date on which this policy is made, this policy shall prevail to the extent of the inconsistency.

**Consent Authority**

6. The council of the local government area in which development described in clause 7 (1) (a), (b), (c) or (d) is proposed to be carried out shall be the consent authority having the function to determine a development application relating to that development.

**Restriction on development of certain land**

7. (1) In respect of land to which this policy applies, a person shall not—

- (a) clear that land;
- (b) construct a levee on that land;
- (c) drain that land, or
- (d) fill that land,

except with the consent of the council and the concurrence of the Director.

(2) In considering whether to grant concurrence under subclause (1), the Director shall take into consideration—

- (a) the environmental effects of the proposed development, including the effect of the proposed development on—
  - (i) the growth of native plant communities;
  - (ii) the survival of native wildlife populations;
  - (iii) the provision and quality of habitats for both indigenous and migratory species;
  - (iv) the surface and groundwater characteristics of the site on which the development is proposed to be carried out and of the surrounding area, including salinity and water quality;
- (b) whether adequate safeguards and rehabilitation measures have been, or will be, made to protect the environment;
- (c) whether carrying out the development would be consistent with the aim of this policy;
- (d) the objectives and major goals of the "National Conservation Strategy for Australia" (as set forth in the second edition of a paper prepared by the Commonwealth Department of Home Affairs and Environment for comment at the National Conference on Conservation held in June 1983, and published in 1984 by the Australian Government Publishing Service) in so far as they relate to wetlands and the conservation of "living resources" generally, copies of which are deposited in the office of the Department;
- (e) whether consideration has been given to establish whether any feasible alternatives exist to the carrying out of the proposed development (either on other land or by other methods) and if so, the reasons given for choosing the proposed development; and
- (f) any representations made by the Director of National Parks and Wildlife in relation to the development application.

(3) Pursuant to section 29 of the Act, development for which consent is required by subclause (1) is declared to be designated development for the purposes of the Act.

**Copy of application to be sent to Director of National Parks and Wildlife**

8. Where a council receives an application for consent to carry out development referred to in clause 7 (1), the council shall, within 7 days of its receipt of that application, forward a copy of the application to the Director of National Parks and Wildlife.

**Amendment of State Environmental Planning Policy No. 4—Development Without Consent**

9. State Environmental Planning Policy No. 4—Development Without Consent is amended by inserting in clause 10 (1) after the matter "clause 9" the words "or to land to which State Environmental Planning Policy No. 14—Coastal Wetlands applies".

## MANAGEMENT PLANNING

### Aim of Unit

This section is intended as an introduction to management planning for cultural resources. The situation which will be considered specifically is the one which is most common for people undertaking this course:- conservation of cultural resources on an area of land which also has other values, for conservation and/or recreation, for example, a National Park, a water catchment, or a State Recreation Area. The assumption, in this section, is that the management of the area of land is, on the whole, compatible with conservation of the cultural resources. Later we will look at management in a situation where this is not the case.

This is not necessarily an outline for a statutory Plan of Management, nor does it attempt to outline the general philosophy of land use planning - this is done in other subjects of the course - it's rather a checklist of factors to consider in management planning for cultural resources - some of which will be elaborated on in later units. To use with this unit are two examples of such plans - a section of the Kosciusko Plan of Management which deals with cultural resources and a section from the Biamanga management plan, which is a plan designed specifically to protect sites of significance to Aborigines. Neither of these documents follows the format set out below exactly; and neither are "perfect" examples; they are genuine, working documents, for critical consideration.

### A Cultural Resource Management Plan

These are the major areas which should be included when the manager is preparing a plan for cultural resource management.

1. Statement of legal responsibility, philosophy and general policy which will be the base for the plan. This may be a statutory responsibility - a cabinet directive (for example in the case of the Biamanga Plan) or an organisational policy (in NSW, the National Parks and Wildlife Service has a policy statement on management and conservation of historic areas - this will be the basis for Service management planning in NSW. It's included in your reading).

management practices it is important to strike a balance between too little detail:

- "historic features in the Park will be protected" and too much-
- "every archaeological site in the area will be located and recorded on form 266"

The first example gives too little information; the second is too restrictive, and probably too ambitious.

#### Headings for Management Practises

A. Recording/assessment/research. In most cases the data base is imperfectly known - a continuing data gathering and assessment programme is required (all the Kosciusko huts have been found, but not all the Aboriginal sites in Kakadu). Special provision for survey of sensitive areas before any proposed modification may also be required.

B. Maintenance and updating of records of the resource is an associated practice.

C. Appropriate Conservation Strategy. This may be:

- Preservation (Maintenance)
- Reconstruction
- Restoration or Adaptation

(You have already read a definition of these items in the Throsby Park Discussion Paper:- we will discuss them in more detail later in this unit).

D. Physical Protection - fences, grids, signs, noxious animal eradication - the necessity and appropriateness of such measures needs to be considered.

E. Monitoring of the resource, and also of the success of the management practices will provide feedback for future decisions and, if necessary, modification of the Plan.

F. Control of Research. Research into the resource is essential; but is sometimes inappropriate or poorly designed and/or destructive (see below page 105 ff).

G. Visitor Use/Interpretation Practices. Appropriate level of visitor use, and the main aim of any interpretation programme must be determined. What use will be made of visitors books, interpretative material, guided tours, restrictions, and permit systems? What about facilities, and access?

H. Control of impinging development or potentially conflicting management practices

- Provision of a buffer zone.
- Alteration of normal management practices (for example, re-routing a fire trail, or preservation of exotic vegetation or animals)
- Special care with possible disturbance of sub-surface deposits.

I. Salvage Procedures. If removal or destruction of cultural resources is to be allowed in some circumstances, or may occur accidentally, provision must be made for salvage and recording

- detailed recording
- excavation
- collection

(see below page 108)

J. Curation of Moveable Artifacts. Artifacts from the area being managed may need collection, or removal for safekeeping, or for display or interpretation. Standards of curation, display and documentation should be considered (see below page 115)

K. Consultation with, and/or involvement of, particular relevant groups. Refer to the section on Custodianship in Unit 4. It will usually be necessary, in the case of Aboriginal sites, to consult with the local Aboriginal community concerning ownership and arrangement of the sites. Often joint management agreements are worked out between the manager, and the original owners. This may be an important factor to be considered in management.

#### NOTES ON SPECIFIC MANAGEMENT PRACTICES

What now follows is a look in more detail at some of the principles and procedures of the management practices outlined above. Some of these have caused particular problems in the past, and require expansion and discussion.

#### CONSERVATION

Conservation is the "keeping" of sites, structures, and relics indefinitely. It is the process of looking after sites so as to retain their cultural significance. It is the all embracing term for the ongoing management of sites by any means which guarantee the continued existence of the cultural



2. Description of the resources, its assessment and a statement of significance. The necessity for this, and the methodology involved is described in units 3 and 4. A statement of significance, based on an assessment is of major importance, and if done properly, will solve some of the decision making problems commonly encountered in management planning. The actual statement of significance should be comprehensive but succinct - it is not necessary to include all the data which led to the statement, but it must be referred to and available. If the resource or its significance is incompletely known, survey and assessment will become a major management aim, to be carried out before major management decisions about the resource are put into operation, and the plan must be flexible enough to cope with the future outcome of the assessment of significance (see for example, the Kosciusko Plan).
3. Statement of how the cultural resource ranks with other values in the land area. The importance of the cultural resource compared with other values must be assessed and stated. This will vary within any large land area - see the Kosciusko Plan, or the Biamanga Plan.
4. Objectives of Management. The objectives will follow from and be compatible with (1), (2) and (3) above. The objectives are the major aims of the plan. They may be, for instance,
  - Active conservation of a sample of resources, and interpretation to the public
  - Reservation for the use of a particular group and in accordance with their wishes,
  - Facilitation of research
  - Sympathetic reuse of the resource.
 or, a combination of some of these. In the Biamanga Plan the main aim is to preserve the integrity and therefore the significance to Aborigines of the core area - so this subsumes other uses, such as logging, research, or public use and modifies other management practices such as fire control. In other areas within Biamanga, different aims are described. For instance, in some areas, facilitation of foresting use along with protection of the cultural resource is the main aim, so logging is allowed after archaeological survey, and suitable protection or salvage.
5. Definition and Zoning of Historic Areas. Cultural areas within a park/reserve/area of land can be defined in a certain way - as a historic zone as historic or prehistoric places, or as special features such as historic huts or archaeological areas or precincts. Statements of significance, comparative value of other

- resources, and objectives of management may vary from area to area; with consequently different management practices. A plan for a large area does not have to incorporate all the details of planning for each area. If a historic house or important Aboriginal art site exists in a larger area of land, it may be appropriate to commission a separate special study, and plan, for it and incorporate its recommendations as an objective of management in the longer plan.
6. Constraints. Often there are limits and checks on what would be ideal management practise. Some are obvious - there is never enough funding (except perhaps to conserve the Members Bar at Parliament House) - and rarely has the ideal amount of research been done, but it may be useful to examine and describe particular constraints and problems. This is sometimes difficult if the plan is to be a public document because there are political and community reasons for not identifying certain constraints, but the planner should be at least aware of them. Constraints may include:
    - Government policy (in Queensland, the relevant authority specifically excludes Aboriginal sacred sites and sites of significance from its brief)
    - Local pressure groups (can you find one, in the Kosciusko Plan?)
    - Severe lack of funding and resources.
    - Lack of expertise
    - Public hostility to the objectives of management.
  7. Major threats or problems particular to the area could also be identified; for example,
    - over-use
    - vandalism
    - hostile climatic conditions.
  8. Management Practices should put the objectives of management into practise. There follows a set of headings for management practices - neither comprehensive nor internally consistent - most are discussed in more detail later in this unit. All may not be appropriate for any one site. They are intended as an open-ended checklist. When the manager is actually designing the



## UNIT 2 READINGS AND RESOURCES

1. A list of all known major legislation in Australia.  
(This is at the end of this Unit).
2. G. Ward. Archaeology and legislation in Australia. In G. Connah (ed.) Australian Field Archaeology, A Guide to Techniques. Australian Institute of Aboriginal Studies, Canberra, 1983.
3. Copy of relevant acts and associated material (you should have obtained this).

### Further Reading and References

- Australian Heritage Commission, The National Estate in 1981, Australian Government Publishing Service, Canberra, 1982.
- Helen Temple. The Listing and Control of Archaeological Sites Under the N.S.W. Heritage Act. In Industrial and Historical Archaeology, National Trust of Australian, NSW, 1981.
- K. Sutcliffe. Cultural Resource Management in Queensland. In J.R. McKinlay and K.L. Jones, Archaeological Resource Management in Australia and Oceania. New Zealand Historic Places Trust, 1979.
- G.M. Bates. Environmental Law in Australia. Butterworth, Sydney, 1983 (Chapter 6, Preserving the National Estate).
- E. Walker (Hon). The Victorian Government and Conservation. In Heritage Australia. Vol. 2, No. 1, Winter 1983, pp. 32-35.

## LEGISLATION

### Major Relevant State Legislation

#### N.S.W.

Heritage Act 1977.  
National Parks and Wildlife Act, 1974  
Historic Houses Act, 1980

#### Queensland

The Aboriginal Relics Preservation Act of 1967-1976

Western AustraliaThe Aboriginal Heritage Act 1972-1980Northern TerritoryThe Native and Historical Objects and Areas Preservation Ordinance 1955-1960The Aboriginal Sacred Sites Act, 1978.South Australia

- (1) The South Australian Heritage Act, 1978 as amended
- (2) The Aboriginal and Historic Relics Preservation Act 1965 and
- (3) The Aboriginal Heritage Act, 1979

The situation with reference to these acts is complicated. (1) has partly replaced (2); and the historic site provisions of this act have been revoked; but (3) has not been gazetted, and so, for Aboriginal sites, (2) is still current.

VictoriaThe Archaeological and Aboriginal Relics Preservation Act (1972-1980)The Historic Buildings Act, 1981TasmaniaThe Aboriginal Relics Preservation Act, 1975The National Parks and Wildlife Act, 1970A.C.T.

The A.C.T. has no specific legislation, but some sites are protected under the Australian Heritage Commission Act 1975.

Australian legislationThe Australian Heritage Commission Act, 1975The World Heritage Properties Act, 1983Historic Shipwrecks Act, 1976

See the assistance list, at the end of the Subject Outline Booklet for addresses of relevant state and commonwealth authorities.



# NATIONAL PARKS AND WILDLIFE SERVICE

## **NORTHERN REGION AREA MANAGEMENT PLANNING PROGRAM 1986-1989**

### **The Status Quo**

The status quo for area management planning in the northern region is presented in the accompanying matrix reports and can be summarized as follows:

#### **One page area summaries**

Virtually non-existent.

#### **Management Guidelines**

Management guidelines are available in district blueprints for most Service areas in Lismore, Port Macquarie and Grafton districts. However as these were largely prepared in the late 1970's and have not been revised, the information is now dated. Management guidelines have also been prepared for some Service areas (other than in district blue prints) but not in a systematic manner or to a common format. Management guidelines for Washpool, Border Ranges and Nightcap National Parks were placed on exhibition in 1984.

#### **Plans of Management**

Plans of management have been adopted for Gibraltar Range and Mount Warning National Parks. A plan of management for Crowdy Bay National Park was placed on public exhibition in late 1983/early 1984. Public submissions have since been reviewed by the National Parks and Wildlife Advisory Council, who have made recommendations to the Minister on the final form of the plan to be adopted. The plan text is currently being rewritten by Port Macquarie district to the new 30 page format, prior to forwarding for Ministerial adoption.

A draft plan of management for New England National Park was forwarded to head office late in 1984 for approval to be placed on public exhibition. A number of editorial changes were required by the Assistant Director Field Management prior to this approval being given. These editorial changes have now been completed. Consideration will now need to be given to either placing this draft on public exhibition or to redrafting it in the new 30 page format.

In-Service drafts are available for both Dorrigo and Bundjalung National Parks. Neither plan has as yet proceeded to public exhibition.

Work towards preparation of a draft plan of management for Yuraygir National Park has been proceeding for a number of years now, with the following work having been undertaken:

- \* 1983 public exhibition of discussion paper on access and recreation.
- \* 1984 preliminary planning strategy, A.G. Davey - consultant.
- \* 1984 fire management resource data collection. Workshop proceedings.
- \* 1984 visitor information survey.
- \* 1985 analysis of submissions to position paper.
- \* 1985 analysis of visitor information survey.
- \* 1985 proceeding towards a fire management plan.

Grafton district is in a position to move quickly towards completion of a 30 page draft plan of management for Yuraygir National Park, along the following lines:

- \* Preparation of a position paper to provide the public with feedback on the initial discussion paper and public submissions to it, the visitor information survey and its analysis, an update on the Service's interim management and an outline of further work scheduled leading towards public exhibition of a draft plan. Preparation of this position paper is estimated to cost \$3,000 with the first draft to be available by the end of March 1986, ready for public release by the end of June 1986.
- \* Work is proceeding towards completion of a fire management plan for Yuraygir National Park by the end of March 1986, at an estimated cost of \$2,000. It is important that the fire management scenario for Yuraygir be completed before the draft plan is prepared and placed on public exhibition.
- \* Preparation of a 30 page draft plan over 1986, with the final draft to the Director at the end of 1986 for public exhibition in 1987.

## THE FUTURE

The matrix reports attached allocate a priority for the preparation of each area planning document within each district and within the region overall. Documentation required is split into categories of:

- \* plans of management,
- \* management guidelines released for public information and comment,
- \* management guidelines primarily for internal Service use
- \* one page area summaries.

Plans of management have been scheduled for completion over the next four financial years for the major Service areas in the region. A separate matrix schedule is attached listing these areas, indicating their regional priority, district priority, the financial year in which the draft plan text can be prepared and the necessary funding required. The schedule is based on the use of the new 30 page plan of management format. Resources are available within each district to write the draft plan text to the schedule indicated.

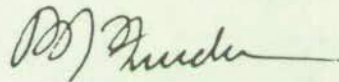
Funds are available from ANPWS for the preparation of the Caldera plan of management. Allocation of funds as indicated will be required for the preparation of the remaining plans of management, primarily for expenses involved in steering committee meetings, input by journalists to the plain English texts, and public consultation in the preparation of each draft plan of management.

This will see the preparation over the next four financial years of a 30 page draft plan of management for each of the major Service areas in the northern region. Please note that the scheduled timetable is for the preparation of the draft plan text at a stage to be submitted to the director for approval to be put on public exhibition. The actual placing of each plan on public exhibition will to be a later timetable.

At this stage the preparation and public exhibition of plans of management for the remainder of Service areas in the region is not regarded as either feasible or warranted. Public exhibition of a plan of management for a nature reserve is not a requirement under the National Parks and Wildlife Act. Nonetheless some Service areas within the region which are dedicated as nature reserves and which do not rate priority for preparation of a plan of management are of sufficient interest to the public that preparation and public release of management guidelines is warranted as indicated.

For the remainder of the Service areas which are of lesser public interest and a lesser priority, the preparation of management guidelines for internal Service use is envisaged, but as a lesser priority to the preparation of both the plans of management and management guidelines and public exhibition.

One page area summaries will be prepared by each district, for each area in each district. These summaries will indicate clearly the district O.I.C.'s intended management of each area for the forthcoming financial year and will be used as a guide in the allocation of funds. It will require annual revision and will need to be updated and forwarded to regional office by the end of September each year.



R.J. FRIEDERICH,  
REGIONAL PLANNING  
CO-ORDINATOR,  
NORTHERN REGION.

5/12/85

Regional Director.

	Regional Priority	District Priority	Resources Available Within District to Write Draft Plan T	Funds Allocated	Financial Year in Which Draft Plan Text Prepared	Funding Required for Draft Plan Preparation	COMMENTS
Crowdy Bay N.P.	1	1	N/A	N/A	N/A	N/A	Plan being represented in 30 page format for Ministerial adoption.
Border Ranges N.P.						\$34,000	Funding allocated by ANPWS.
Nightcap N.P.	2	1			85/86		
Limpinwood N.R.							
Numinbah N.R.							
Yuraygir N.P.	3	1			85/87	\$10,000	
Werrikimbe N.P.	4	1+2			86/87	\$5,000	Initial draft written as Management guidelines.
Dundjalung N.P.					86/87	\$5,000	
Brookwater N.P.	5	2+3					
Clunika N.R.							
Flat Head N.P.	6	5			86/87	\$5,000	
Washpool N.P.	7	1			87/88	\$5,000	
Braltar Range N.P.							
W England N.P.	8	1			86/87	\$5,000	Draft plan in old format completed.
Trigo N.P.	9	2			87/88	\$5,000	
Reburners Creek N.R.	10	6			87/88	\$5,000	
Wild Rivers ey N.P.	11	2			87/88	\$10,000	Timing of plan preparation depends on reservation progress.
See Beach N.R.	12	3			88/89	\$5,000	



LISMORE DISTRICT	The Past and Present						The Future							
	Management Guidelines			Plans of Management			Planning Priority		Documentation Required					
	One Page Area Summary	Blueprint	Other	Public Exhibition	In Preparation	In Service Draft	Public Exhibition	Plan Adopted	District	Region	Plan of Management	Management Guidelines Public release	Management Guidelines Internal Service Use	One Page Area Summary
Border Ranges N.P.									1	2				
Broadwater N.P.									3	5				
Bundjalung N.P.									2	5				
Mc Waring N.P.									-	-				
Nightcap N.P.									1	2				
Ballina N.R.									10	30				
Broken Head N.R.									4	16				
Brunswick Heads N.R.									7	20				
Bungawalbin N.R.									13	46				
Cook Is N.R.									11	47				
Davis Scrub N.R.									8	29				
Iuka N.R.									2	5				
Julian Rocks N.R.									17	50				
Lennox Head A.A.									14	39				
Limplwood N.R.									1	2				
Numindah N.R.									1	2				
Stotts Is N.R.									6	19				
Tuckean N.R.									9	23				
Tucki Tucki N.R.									12	40				
Tweed Heads H.S.									5	17				
Ukerebagh Is N.R.									5	17				
Alba N.R.									16	38				
La Park N.R.									15	48				



# NATIONAL PARKS AND WILDLIFE SERVICE

## FULL LIST OF PROTECTED PLANTS OF N.S.W.

FAMILY NAME	BOTANICAL NAME	COMMON NAME
<u>Seed Plants:</u>		
Apiaceae	✓ Actinotus helianthi	Flannel Flower
Arecaceae	✓ Archontophoenix cunninghamiana	Bangalow Palm
Liliaceae	Blandfordia cunninghamii	Christmas Bells
	Blandfordia grandiflora	"
	Blandfordia nobilis	"
Rutaceae	Boronia algida	Alpine Boronia
	Boronia anemonifolia	Sticky Boronia
	Boronia anethifolia	Narrow-leaved Boronia
	Boronia barkerana	Barker's Boronia
	Boronia bipinnata	.....
	Boronia deanei	Deane's Boronia
	Boronia falcifolia	Sickle-leaved Boronia
	Boronia floribunda	Pink Boronia
	Boronia fraseri	Fraser's Boronia
	Boronia glabra	Smooth Boronia
	Boronia granitica	Granite Boronia
	Boronia ledifolia	Ledum Boronia
	Boronia microphylla	Small-leaved Boronia
	Boronia mollis	Soft Boronia
	Boronia nana	Riverine Boronia
	Boronia parviflora	Swamp Boronia
	Boronia pinnata	Pinnate Boronia
	Boronia polygalifolia	Milkwort Boronia
	Boronia repanda	Repand Boronia
	Boronia rhomboidea	Rhomboid Boronia
	Boronia rigens	Stiff Boronia
	Boronia rubiginosa	Rust-coloured Boronia
	Boronia rupprii	Rupp's Boronia
	Boronia safrolifera	Safrol-scented Boronia
	Boronia serrulata	Native rose
	Boronia subulifolia	Awl-leaved Boronia
	Boronia thujona	Scented Boronia
	Boronia whitei	Surgeon-General White's Boronia
Orchidaceae	Bulbophyllum aurantiacum	.....
	Bulbophyllum bracteatum	.....
	Bulbophyllum crassulifolium	.....
	Bulbophyllum elisae	.....
	Bulbophyllum exiguum	.....
	Bulbophyllum globuliforme	.....
	Bulbophyllum minutissimum	.....
	Bulbophyllum pygmaeum	.....
	Bulbophyllum tuberculatum	.....
	Bulbophyllum weinthalii	.....
	Calanthe triplicata	Scrub Lily
	Calanthe veratrifolia	Christmas Orchid
Casuarinaceae	Casuarina cunninghamiana	River Oak
Cyperaceae	Caustis blakei	Curley Sedge
	Caustis flexuosa	Curley Sedge
	Caustis pentandra	Curley Sedge
	Caustis recurvata	Curley Sedge

FAMILY NAME	BOTANICAL NAME	COMMON NAME
Cunoniaceae	<i>Ceratopetalum gummiferum</i>	Christmas Bush
Papilionaceae	<i>Clianthus formosus</i>	Sturt's Desert Pea
Rutaceae	<i>Crowea exalata</i>	Crowea
	<i>Crowea saligna</i>	Crowea
Orchidaceae	<i>Cymbidium canaliculatum</i>	.....
	<i>Cymbidium madidum</i>	.....
	<i>Cymbidium suave</i>	.....
	<i>Dendrobium aemulum</i>	Ironbark Orchid
	<i>Dendrobium beckleri</i>	Pencil Orchid
	<i>Dendrobium cucumerinum</i>	Cucumber Orchid
	<i>Dendrobium delicatum</i>	.....
	<i>Dendrobium falcorostrum</i>	Beech Orchid
	<i>Dendrobium gracilicaule</i>	.....
	<i>Dendrobium gracillimum</i>	.....
	<i>Dendrobium kingianum</i>	Pink Rock Lily
	<i>Dendrobium linguiforme</i>	Tongue or Button Orchid
	<i>Dendrobium monophyllum</i>	Lily of the Valley Orchid
	<i>Dendrobium moorei</i>	.....
	<i>Dendrobium mortii</i>	.....
	<i>Dendrobium pugioniforme</i>	Dagger Orchid
	<i>Dendrobium schneiderae</i>	.....
	<i>Dendrobium speciosum</i>	Rock Lily
	<i>Dendrobium striolatum</i>	.....
	<i>Dendrobium tenuissimum</i>	.....
	<i>Dendrobium teretifolium</i>	Rat's Tail Orchid Bridal Veil Orchid
	<i>Dendrobium tetragonum</i>	Spider Orchid
	<i>Dipodium hamiltonianum</i>	.....
	<i>Dipodium punctatum</i>	Hyacinth Orchid
Agavaceae	<i>Doryanthes excelsa</i>	Giant Lily
	<i>Doryanthes palmeri</i>	Giant Lily
Rutaceae	<i>Eriostemon australasius</i>	Pink Wax Plant
	<i>Eriostemon brevifolius</i>	.....
	<i>Eriostemon buxifolius</i>	.....
	<i>Eriostemon difformis</i>	.....
	<i>Eriostemon hispidulus</i>	.....
	<i>Eriostemon linearis</i>	.....
	<i>Eriostemon myoporoides</i>	Native Daphne
	<i>Eriostemon obovalis</i>	.....
	<i>Eriostemon scaber</i>	.....
	<i>Eriostemon trachyphyllus</i>	Blunt-leaf Wax Plant
Orchidaceae	<i>Galeola cassythoides</i>	.....
	<i>Galeola foliata</i>	.....
	<i>Geodorum pictum</i>	.....
Proteaceae	<i>Grevillea aspleniifolia</i>	Fern-leaved Grevillea
	<i>Grevillea caleyi</i>	Caley's Grevillea
	<i>Grevillea longifolia</i>	Fern-leaved Grevillea
Orchidaceae	<i>Liparis coelogynoides</i>	.....
	<i>Liparis habenarina</i>	.....
	<i>Liparis reflexa</i>	Onion Orchid
	<i>Liparis simmondsii</i>	.....
Arecaceae	<i>Livistona australis</i>	Cabbage Tree Palm
Proteaceae	<i>Lomatia silaifolia</i>	Crinkle Bush
Podocarpaceae	<i>Microstrobos fitzgeraldii</i>	Dwarf Native Pine
Orchidaceae	<i>Oberonia muellerana</i>	Iris Orchid
	<i>Oberonia palmicola</i>	.....
	<i>Papillilabium beckleri</i>	.....
	<i>Parasarcophilus spathulatus</i>	.....
	<i>Parasarcophilus weinthalii</i>	.....
	<i>Peristeranthus hillii</i>	.....
Proteaceae	<i>Persoonia pinifolia</i>	Pine-leaved Geebung
Orchidaceae	<i>Phaius australis</i>	.....
	<i>Phaius tancarvilleae</i>	North Coast Swamp Lily

FAMILY NAME	BOTANICAL NAME	COMMON NAME
Orchidaceae	<i>Plectorrhiza erecta</i>	.....
	<i>Plectorrhiza tridentata</i>	Tangle Orchid
Restionaceae	<i>Restio tetraphyllus</i>	Native Rush
	<i>Rhinerrhiza divitiflora</i>	Raspy Root Orchid
Orchidaceae	<i>Sarcochilus australis</i>	Gem Orchid
	<i>Sarcochilus ceciliae</i>	Fairy Bells
	<i>Sarcochilus dilatatus</i>	.....
	<i>Sarcochilus falcatus</i>	Orange Blossum Orchid
	<i>Sarcochilus fitzgeraldi</i>	Ravine Orchid
	<i>Sarcochilus hartmannii</i>	.....
	<i>Sarcochilus hillii</i>	.....
	<i>Sarcochilus olivaceus</i>	.....
	<i>Schistotylus purpuratus</i>	.....
Epacridaceae	<i>Sprengelia incarnata</i>	Spengrelgia
Orchidaceae	<i>Taeniophyllum muelleri</i>	.....
Proteaceae	<i>Telopea mongaensis</i>	Waratah
	<i>Telopea oreades</i>	Waratah
	<i>Telopea speciosissima</i>	Waratah
	<i>Xylomelum pyriforme</i>	Woody Pear

Ferns and Fern Allies

Adiantaceae	<i>Adiantum aethiopicum</i>	Common Maiden Hair Fern
	<i>Adiantum diaphanum</i>	Filmy Maiden Hair Fern
	<i>Adiantum formosum</i>	Giant Maiden Hair Fern
	<i>Adiantum hispidulum</i>	Rough Maiden Hair Fern
	<i>Adiantum silvaticum</i>	Smooth Maiden Hair Fern
Aspleniaceae	<i>Asplenium falcatum</i>	.....
	<i>Asplenium australasius</i>	Bird's Nest Fern
Cyantheaceae	<i>Cyathea australis</i>	Tree Fern
	<i>Cyathea cooperi</i>	Tree Fern
	<i>Cyathea leichhardtiana</i>	Tree Fern
Davalliaceae	<i>Davallia pyxidata</i>	Hare's Foot Fern
Dicksoniaceae	<i>Dicksonia antarctica</i>	Tree Fern
	<i>Dicksonia youngiae</i>	Tree Fern
Lycopodiaceae	<i>Lycopodium deuterodensum</i>	Mountain Moss
Polypodiaceae	<i>Platycterium bifurcatum</i>	Elk Horn
	<i>Platycterium grande</i>	Stag Horn
Psilotaceae	<i>Tmesipteris billardieri</i>	.....
	<i>Tmesipteris ovata</i>	.....
	<i>Tmesipteris parva</i>	.....
	<i>Tmesipteris truncata</i>	.....
Osmundaceae	<i>Todea barbara</i>	Tree Fern

Mosses

Sphagnaceae	<i>Sphagnum</i> (all species)	Sphagnum Moss
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NOTE - This list includes all species of epiphytic and lithophytic orchids and *Sphagnum* indigenous to New South Wales.



#### "THE BIG SCRUB" EXPLAINED

Historically and botanically speaking, The Big Scrub was a complex ecosystem of subtropical lowland rainforest associations covering an area estimated to have been between 75,000 and 80,000 hectares.

It ran East from Lismore to the edge of the coastal plain inland from Ballina and the hills and slopes of Byron Bay. From the ridges above Meerschum Vale in the South, it once extended through Rous, Alstonville, Clunes and Bangalow to Goonengerry in the North.

Discovered in the 1840's by the first white men to enter the area - the Cedar getters- The Big Scrub or Red Scrub as it was sometimes known, was almost entirely cleared by the turn of the century.

Fearful of the unknown and anxious for land, the early settlers saw The Scrub as an obstacle to settlement and development. They burnt 60% of the timber, completely unaware that this was a highly evolved forest community dating back to the super-continent of Gondwanaland.

Today, The Big Scrub is represented by only a few small isolated reserves, 0.4% of its' former grandeur. Environmentalists working through The Centre, aim to revegetate much of the land that was inappropriately cleared by those first pioneers, healing the soil erosion and establishing a forested landscape once more.  
(More details available at The Centres' Library)

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88A Keen Street, Lismore, N.S.W. 2480.  
Phone (066) 21 3278



# NATIONAL PARKS & WILDLIFE SERVICE of New South Wales

Extract from

NATIONAL PARKS and WILDLIFE ACT, 1974.

#### SCHEDULE 12

#### ENDANGERED FAUNA

- Part 1 .... Fauna of Special Concern
- Part 2 .... Vulnerable and Rare Fauna
- Part 3 .... Threatened Fauna
- Part 4 .... Fauna in Imminent Danger of Extinction

#### SCHEDULE 12A

#### PROTECTED AMPHIBIANS

#### SCHEDULE 13

#### PROTECTED NATIVE PLANTS

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*National Parks and Wildlife.*


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SCHEDULE 13—*continued.*PROTECTED NATIVE PLANTS—*continued.*SEED PLANTS—*continued.*

<i>Phreatia</i> , all native species	..	..	Orchid.
<i>Restio tetraphyllus</i>	..	..	Restio.
<i>Rhinerrhiza divitiflora</i>	..	..	Orchid.
<i>Sarcochilus</i> , all native species	..	..	Orchid.
<i>Schistotylus purpuratus</i>	..	..	Orchid.
<i>Sprengelia incarnata</i>	..	..	Sprengelia.
<i>Taeniophyllum</i> , all native species	..	..	Orchid.
<i>Telopea</i> , all native species	..	..	Waratah.
<i>Xylomelum</i> , all native species	..	..	Woody Pear.

All native species of epiphytic and lithohyctic orchids not included elsewhere in this Schedule.

## FERNS AND FERN ALLIES

<i>Adiantum</i> , all native species	..	..	Maiden Hair Fern.
<i>Asplenium nidus</i>	..	..	Bird's Nest Fern.
<i>Asplenium falcatum</i>	..	..	.....
<i>Cyathea</i> , all native species	..	..	Tree Fern.
<i>Davallia pyxidata</i>	..	..	Hare's Foot Fern.
<i>Dicksonia</i> , all native species	..	..	Tree Fern.
<i>Lycopodium deuterodensum</i>	..	..	Mountain Moss.
<i>Platycterium</i> , all native species	..	..	Elk Horn and Stag Horn.
<i>Tmesipteris</i> , all native species	..	..	.....
<i>Todea barbara</i>	..	..	Tree Fern.

## MOSSES

<i>Sphagnum</i> , all native species	..	..	Sphagnum Moss.
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## National Parks and Wildlife.

## SCHEDULE 13.

(Secs. 5 (1), 115.)

## PROTECTED NATIVE PLANTS.

## SEED PLANTS

<i>Actinotus helianthi</i> .. .. .	Flannel Flower.
<i>Archontophoenix cunninghamiana</i> ..	Bangalow Palm.
<i>Blandfordia</i> , all native species .. ..	Christmas Bells.
<i>Boronia</i> , all native species .. .. .	Boronia.
<i>Bulbophyllum</i> , all native species .. ..	Orchid.
<i>Calanthe triplicata</i> .. .. .	Orchid.
<i>Casuarina cunninghamiana</i> .. .. .	River Oak.
<i>Caustis</i> , all native species .. .. .	Curly Sedge.
<i>Ceratopetalum gummiferum</i> .. .. .	Christmas Bush.
<i>Clianthus formosus</i> .. .. .	Sturt's Desert Pea.
<i>Crowea</i> , all native species .. .. .	Crowea.
<i>Cymbidium</i> , all native species .. .. .	Orchid.
<i>Dendrobium</i> , all native species .. .. .	Orchid.
<i>Dipodium</i> , all native species .. .. .	Orchid.
<i>Doryanthes</i> , all native species .. .. .	Giant Lily.
<i>Eriostemon</i> , all native species .. .. .	Wax Plant.
<i>Galeola</i> , all native species .. .. .	Orchid.
<i>Geodorum pictum</i> .. .. .	Orchid.
<i>Grevillea aspleniifolia</i> .. .. .	Fern-leaved Grevillea.
<i>Grevillea caleyi</i> .. .. .	Caley's Grevillea.
<i>Grevillea longifolia</i> .. .. .	Fern-leaved Grevillea.
<i>Liparis</i> , all native species .. .. .	Orchid.
<i>Livistona australis</i> .. .. .	Cabbage Tree Palm.
<i>Lomatia silaifolia</i> .. .. .	Crinkle Bush.
<i>Microstrobos fitzgeraldii</i> .. .. .	.....
<i>Oberonia</i> , all native species .. .. .	Orchid.
<i>Pandanus</i> , all native species .. .. .	Pandanus.
<i>Papillilabium beckleri</i> .. .. .	Orchid.
<i>Parasarcocochilus</i> , all native species .. ..	.....
<i>Peristeranthus hillii</i> .. .. .	Orchid.
<i>Persoonia pinifolia</i> .. .. .	Pine-leaved Geebung.
<i>Phaius tancarvilleae</i> .. .. .	Orchid.

## National Parks and Wildlife.

## SCHEDULE 12.

(Secs. 5 (1), 94.)

## ENDANGERED FAUNA.

## Part 1.

## FAUNA OF SPECIAL CONCERN.

## MAMMALS

<i>Ornithorhynchus anatinus</i> .. .. .	Platypus.
<i>Dasyurus maculatus</i> .. .. .	Spotted-tailed Quoll.
<i>Phascogale tapoatafa</i> .. .. .	Brush-tailed Phascogale.
<i>Dasyuroides byrnei</i> .. .. .	Kowari.
<i>Dasyercus cristicauda</i> .. .. .	Mulgara.
<i>Antechinus apicalis</i> .. .. .	Dibbler.
<i>Antechinus minimus</i> .. .. .	Swamp Antechinus.
<i>Planigale tenuirostris</i> .. .. .	Narrow-nosed Planigale.
<i>Planigale gilesi</i> .. .. .	Paucident Planigale.
<i>Sminthopsis longicaudata</i> .. .. .	Long-tailed Dunnart.
<i>Sminthopsis psammophila</i> .. .. .	Sand Hill Dunnart.
<i>Sminthopsis hirtipes</i> .. .. .	Hairy-footed Dunnart.
<i>Sminthopsis douglasi</i> .. .. .	Julia Creek Dunnart.
<i>Sminthopsis butleri</i> .. .. .	Carpentarian Dunnart.
<i>Thylacinus cynocephalus</i> .. .. .	Thylacine.
<i>Mymecobius fasciatus</i> .. .. .	Numbat.
<i>Nyctoryctes typhlops</i> .. .. .	Marsupial Mole
<i>Isoodon auratus</i> .. .. .	Golden Bandicoot.
<i>Perameles gunni</i> .. .. .	Eastern Barred Bandicoot.
<i>Perameles eremiana</i> .. .. .	Desert Bandicoot.
<i>Macrotis leucura</i> .. .. .	Lesser Bilby.
<i>Wyulda squamicaudata</i> .. .. .	Scaly-tailed Possum.
<i>Pseudocheirus peregrinus occidentalis</i> ..	Western Ringtail Possum.
<i>Pseudocheirus dahli</i> .. .. .	Rock Ringtail Possum.
<i>Gymnobelideus leadbeateri</i> .. .. .	Leadbeater's Possum.
<i>Acrobates pygmaeus</i> .. .. .	Feathertail Glider.
<i>Cercartetus nanus</i> .. .. .	Eastern Pygmy Possum
<i>Cercartetus lepidus</i> .. .. .	Little Pygmy Possum.
<i>Phascolarctos cinereus</i> .. .. .	Koala.
<i>Potorous tridactylus gilberti</i> .. .. .	Gilbert's Potoroo.
<i>Potorous platyops</i> .. .. .	Broad-faced Potoroo.

## National Parks and Wildlife.

## SCHEDULE 12—continued.

## ENDANGERED FAUNA—continued.

<i>Potorous apicalis</i> .. .. .	Southern Potoroo.
<i>Potorous longipes</i> .. .. .	Long-footed Potoroo.
<i>Bettongia pencillata tropica</i> .. .. .	Brush-tailed Bettong.
<i>Caloprymnus campestris</i> .. .. .	Desert Rat-kangaroo.
<i>Lagorchestes conspicillatus</i> .. .. .	Spectacled Hare-wallaby.
<i>Lagorchestes hirsutus</i> .. .. .	Rufous Hare-wallaby.
<i>Lagostrophus fasciatus</i> .. .. .	Banded Hare-wallaby.
<i>Onychogalea lunata</i> .. .. .	Crescent Nailtail Wallaby.
<i>Petrogale concinna</i> .. .. .	Narbarlek.
<i>Petrogale persephone</i> .. .. .	Proserpine Rock-wallaby.
<i>Petrogale burbidgei</i> .. .. .	Warabi.
<i>Thylogale billardieri</i> .. .. .	Red-bellied Pademelon.
<i>Macropus eugenii</i> .. .. .	Tammar Wallaby.
<i>Macropus greyi</i> .. .. .	Toolache Wallaby.
<i>Macropus robustus isabellinus</i> .. .. .	Euro (Barrow Island).
<i>Macroderma gigas</i> .. .. .	Ghost Bat.
<i>Hipposideros galeritus</i> .. .. .	Fawn Horseshoe-bat.
<i>Hipposideros semoni</i> .. .. .	Wart-nosed Horseshoe-bat.
<i>Hipposideros stenotis</i> .. .. .	Lesser Wart-nosed Horseshoe-bat.
<i>Rhinonicteris arantius</i> .. .. .	Orange Horseshoe-bat.
<i>Taphozous saccolaimus</i> .. .. .	Naked-rumped Sheathtail-bat.
<i>Taphozous mixtus</i> .. .. .	Troughton's Sheathtail-bat.
<i>Myotis adversus</i> .. .. .	Large-footed Myotis.
<i>Murina florium</i> .. .. .	Tube-nosed Insectivorous-bat.
<i>Xeromys myoides</i> .. .. .	False Water-rat.
<i>Mesembriomys gouldii</i> .. .. .	Black-footed tree-rat.
<i>Zyzomys pedunculatus</i> .. .. .	Central Rock-rat.
<i>Pseudomys praeconis</i> .. .. .	Shark Bay Mouse.
<i>Pseudomys novaehollandiae</i> .. .. .	New Holland Mouse.
<i>Pseudomys fumeus</i> .. .. .	Smoky Mouse.
<i>Pseudomys occidentalis</i> .. .. .	Western Mouse.
<i>Pseudomys fieldi</i> .. .. .	Alice Springs Mouse.
<i>Pseudomys shortridgei</i> .. .. .	Heath Mouse.
<i>Pseudomys chapmani</i> .. .. .	Pebble-mound Mouse.
<i>Notomys fuscus</i> .. .. .	Dusky Hopping-mouse.

## National Parks and Wildlife.

## SCHEDULE 12—continued.

## MAMMALS—continued.

<i>Leporillus conditor</i> .. .. .	Greater Stick-nest Rat.
<i>Leporillus apicalis</i> .. .. .	Lesser Stick-nest Rat.
<i>Pseudomys gouldii</i> .. .. .	Gould's Mouse.
<i>Pseudomys australis</i> .. .. .	Plains Mouse.
<i>Pseudomys desertor</i> .. .. .	Desert Mouse.
<i>Pseudomys oralis</i> .. .. .	Hastings River Mouse.
<i>Notomys mitchelli</i> .. .. .	Mitchell's Hopping-mouse.
<i>Notomys longicaudatus</i> .. .. .	Long-tailed Hopping-mouse.

## REPTILES

<i>Leiopolisima lichenigera</i> .. .. .	Lord Howe Island Skink.
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## BIRDS

<i>Pedionomus torquatus</i> .. .. .	Plains Wanderer.
<i>Tricholimnas sylvestris</i> .. .. .	Lord Howe Island Woodhen.
<i>Psittaculirostris diophthalma</i> .. .. .	Double-eyed Fig Parrot.
<i>Psephotus pulcherrimus</i> .. .. .	Paradise Parrot.
<i>Manorina melanotis</i> .. .. .	Black-eared Miner.
<i>Strepera graculina crissalis</i> .. .. .	Lord Howe Island Currawong.
<i>Amytornis textilis</i> .. .. .	Thick-billed Grasswren.

## SCHEDULE 12A.

(Secs. 5 (1), 94A.)

## PROTECTED AMPHIBIANS.

<i>Litoria brevipalmata</i> .. .. .	Green-thighed Frog.
<i>Litoria flavipunctata</i> .. .. .	.....
<i>Litoria glandulosa</i> .. .. .	.....
<i>Litoria jervisesis</i> .. .. .	Jervis Bay Tree Frog.
<i>Litoria maculata</i> .. .. .	.....
<i>Litoria pearsoniana</i> .. .. .	.....
<i>Assa darlingtoni</i> .. .. .	Pouched Frog.
<i>Kyarranus loveridgei</i> .. .. .	Loveridge's Frog.
<i>Kyarranus sphagnicolus</i> .. .. .	Sphagnum Frog.
<i>Pseudophryne australis</i> .. .. .	Red Crowned Toadlet.
<i>Pseudophryne corroboree</i> .. .. .	Corroboree Frog.
<i>Lechriodus fletcheri</i> .. .. .	Fletcher's Frog.



## National Parks and Wildlife.

## SCHEDULE 12—continued.

## ENDANGERED FAUNA—continued.

## BIRDS

<i>Pterodroma leucoptera</i>	..	..	..	Gould's Petrel.
<i>Stictonetta naevosa</i>	..	..	..	Freckled Duck.
<i>Leipoa ocellata</i>	..	..	..	Malleefowl.
<i>Ardeotis australis</i>	..	..	..	Australian Bustard.
<i>Burhinus magnirostris</i>	..	..	..	Bush Thick-knee.
<i>Pezoporus wallicus</i>	..	..	..	Ground Parrot.
<i>Sterna Albifrons</i>	..	..	..	Little Tern.
<i>Podargus ocellatus</i>	..	..	..	Marbled Frogmouth.
<i>Pachycephala rufogularis</i>	..	..	..	Red-lored Whistler.
<i>Amytornis striatus</i>	..	..	..	Striated Grasswren.
<i>Dasyornis brachypterus</i>	..	..	..	Eastern Bristlebird.
<i>Xanthomyza phrygia</i>	..	..	..	Regent Honeyeater.

## Part 4.

## FAUNA IN IMMINENT DANGER OF EXTINCTION.

## MAMMALS

<i>Dasyurus viverrinus</i>	..	..	..	Eastern Quoll.
<i>Dasyurus geoffroii</i>	..	..	..	Western Quoll.
<i>Phascogale calura</i>	..	..	..	Red-tailed Phascogale.
<i>Myrmecobius fasciatus</i>	..	..	..	Numbat.
<i>Perameles bougainville</i>	..	..	..	Western Barred Bandicoot.
<i>Macrotis lagotis</i>	..	..	..	Greater Bilby.
<i>Chaeropus ecaudatus</i>	..	..	..	Pig-footed Bandicoot.
<i>Lasiorninus krefftii</i>	..	..	..	Northern Hairy-nosed Wombat.
<i>Bettongia penicillata</i>	..	..	..	Brush-tailed Bettong.
<i>Bettongia gaimardi</i>	..	..	..	Tasmanian Bettong.
<i>Bettongia lesueur</i>	..	..	..	Burrowing Bettong.
<i>Lagorchestes leporides</i>	..	..	..	Eastern Hare-wallaby.
<i>Onychogalea fraenata</i>	..	..	..	Bridled Nailtail Wallaby.
<i>Petrogale xanthopus</i>	..	..	..	Yellow-footed Rock-wallaby.
<i>Myotis australis</i>	..	..	..	Small-footed Myotis.
<i>Rattus tunneyi</i>	..	..	..	Pale Field-rat.
<i>Conilurus albipes</i>	..	..	..	Rabbit-eared Tree-rat.

## National Parks and Wildlife.

## SCHEDULE 12—continued.

## ENDANGERED FAUNA—continued.

## MAMMALS—continued

<i>Notomys macrotis</i>	..	..	..	Big-eared Hopping-mouse.
<i>Notomys amplus</i>	..	..	..	Short-tailed Hopping-mouse.
<i>Notomys aquilo</i>	..	..	..	Northern Hopping-mouse.
<i>Dugong dugon</i>	..	..	..	Dugong.
<i>Arctocephalus forsteri</i>	..	..	..	New Zealand Fur-seal.
<i>Balaena glacialis</i>	..	..	..	Right Whale.
<i>Balaenoptera musculus</i>	..	..	..	Blue Whale.
<i>Megaptera novaeangliae</i>	..	..	..	Humpback Whale.

## REPTILES

<i>Crocodylus johnstoni</i>	..	..	..	Freshwater Crocodile.
<i>Crocodylus porosus</i>	..	..	..	Saltwater Crocodile.
<i>Dermochelys coriacea</i>	..	..	..	Leathery Turtle.
<i>Pseudemysdura umbrina</i>	..	..	..	Western Swamp Turtle.
<i>Amphibolurus yinneathara</i>	..	..	..	.....
<i>Ctenotus delli</i>	..	..	..	.....
<i>Ctenotus youngsoni</i>	..	..	..	.....
<i>Ctenotus lanceolini</i>	..	..	..	.....
<i>Egernia stokesii badia</i>	..	..	..	.....
<i>Egernia stokesii stokesii</i>	..	..	..	.....
<i>Lerista christinae</i>	..	..	..	.....
<i>Lerista humphriesi</i>	..	..	..	.....
<i>Lerista lineata</i>	..	..	..	.....
<i>Menetia amaura</i>	..	..	..	.....
<i>Tiliqua adelaidensis</i>	..	..	..	.....
<i>Aspidites ramsayi</i>	..	..	..	Woma.
<i>Liasis childreni</i>	..	..	..	Children's Python.
<i>Liasis olivaceous barroni</i>	..	..	..	Pilbara Olive Python.
<i>Python carinatus</i>	..	..	..	.....
<i>Python spilotes</i>	..	..	..	Carpet and Diamond Python.
<i>Brachyaspis atriceps</i>	..	..	..	.....
<i>Vermicella calonotus</i>	..	..	..	.....

## National Parks and Wildlife.

## SCHEDULE 12—continued.

## ENDANGERED FAUNA—continued.

## BIRDS

<i>Diomedea exulans</i> .. .. .	Wandering Albatross.
<i>Calonectris leucomelas</i> .. .. .	Streaked Shearwater.
<i>Puffinus pacificus</i> .. .. .	Wedge-tailed Shearwater.
<i>Puffinus griseus</i> .. .. .	Sooty Shearwater.
<i>Puffinus tenuirostris</i> .. .. .	Short-tailed Shearwater.
<i>Oceanites oceanicus</i> .. .. .	Wilson's Storm-Petrel.
<i>Oceanodroma leucorhoa</i> .. .. .	Leach's Storm-Petrel.
<i>Sula abbotti</i> .. .. .	Abbott's Booby.
<i>Sula sula</i> .. .. .	Red-footed Booby.
<i>Sula dactylatra</i> .. .. .	Masked Booby.
<i>Sula leucogaster</i> .. .. .	Brown Booby.
<i>Fregata andrewsi</i> .. .. .	Christmas Island Frigatebird.
<i>Fregata minor</i> .. .. .	Great Frigatebird.
<i>Fregata ariel</i> .. .. .	Least Frigatebird.
<i>Phaethon rubricauda</i> .. .. .	Red-tailed Tropicbird.
<i>Phaethon lepturus</i> .. .. .	White-tailed Tropicbird.
<i>Ardeola ibis</i> .. .. .	Cattle Egret.
<i>Egretta alba</i> .. .. .	Great Egret.
<i>Cereopsis novaehollandiae</i> .. .. .	Cape Barren Goose.
<i>Tadorna radjah</i> .. .. .	Radjah Shelduck.
<i>Anas querquedula</i> .. .. .	Garganey.
<i>Haliaeetus leucogaster</i> .. .. .	White-bellied Sea-Eagle.
<i>Megapodius reinwardt</i> .. .. .	Orange-footed Scrubfowl.
<i>Rallus pectoralis</i> .. .. .	Lewin's Rail.
<i>Irediparra gallinacea</i> .. .. .	Comb-crested Jacana.
<i>Pluvialis squatarola</i> .. .. .	Grey Plover.
<i>Pluvialis dominica</i> .. .. .	Lesser Golden Plover.
<i>Charadrius hiaticula</i> .. .. .	Ringed Plover.
<i>Charadrius Mongolus</i> .. .. .	Mongolian Plover.
<i>Charadrius leschenaultii</i> .. .. .	Large Sand Plover.
<i>Charadrius veredus</i> .. .. .	Oriental Plover.
<i>Arenaria interpres</i> .. .. .	Ruddy Turnstone.
<i>Numenius madagascariensis</i> .. .. .	Eastern Curlew.
<i>Numenius phaeopus</i> .. .. .	Whimbrel.

## National Parks and Wildlife.

## SCHEDULE 12—continued.

## ENDANGERED FAUNA—continued.

## VULNERABLE AND RARE FAUNA.

## BIRDS—continued.

<i>Neophema pulchella</i> .. .. .	Turquoise Parrot.
<i>Ninox strenua</i> .. .. .	Powerful Owl.
<i>Tyto novaehollandiae</i> .. .. .	Masked Owl.
<i>Tyto longimembris</i> .. .. .	Eastern Grass Owl.
<i>Tyto tenebricosa</i> .. .. .	Sooty Owl.
<i>Halcyon chloris</i> .. .. .	Collared Kingfisher.
<i>Menura alberti</i> .. .. .	Albert's Lyrebird.
<i>Atrichornis rufescens</i> .. .. .	Rufous Scrub-bird.
<i>Coracina lineata</i> .. .. .	Yellow-eyed Cuckoo-shrike.
<i>Monarcha leucotis</i> .. .. .	White-eared Monarch.
<i>Cinlosoma cinnamomeum</i> .. .. .	Chestnut-breasted Quail-thrush.
<i>Amytornis barbatus</i> .. .. .	Grey Grasswren.
<i>Strepera versicolor melanoptera</i> .. .. .	Black-winged Currawong.
<i>Peophila cincta</i> .. .. .	Black-throated Finch.

## Part 3.

## THREATENED FAUNA.

## MAMMALS

<i>Antechinomys laniger</i> .. .. .	Kultarr.
<i>Potorous tridactylus</i> .. .. .	Long-nosed Potoroo.
<i>Petrogale penicillata</i> .. .. .	Brush-tailed Rock-wallaby.
<i>Pseudomys gracilicaudatus</i> .. .. .	Eastern Chestnut Mouse.

## REPTILES

<i>Gonocephalus spinipes</i> .. .. .	Southern Angle-headed Dragon.
<i>Echiopsis curta</i> .. .. .	Bardick.
<i>Hoplocephalus bungaroides</i> .. .. .	Broad-headed Snake.
<i>Hoplocephalus stephensi</i> .. .. .	Stephen's Banded Snake.
<i>Simoselaps australis</i> .. .. .	Coral Snake.

## National Parks and Wildlife.

## SCHEDULE 12—continued.

## ENDANGERED FAUNA—continued.

## REPTILES

<i>Aprasia parapulchella</i>	..	..	..	..	..
<i>Aprasia pseudopulchella</i>	..	..	..	..	..
<i>Egernia frerei</i>	..	..	..	..	Major Skink.
<i>Cacophis krefftii</i>	..	..	..	..	Dwarf Crowned Snake.

## BIRDS

<i>Pterodroma solandri</i>	..	..	..	..	Providence Petrel.
<i>Puffinus carneipes</i>	..	..	..	..	Flesh-footed Shearwater.
<i>Xenorhynchus asiaticus</i>	..	..	..	..	Black-necked Stork.
<i>Anseranas semipalmata</i>	..	..	..	..	Magpie Goose.
<i>Pandion haliaetus</i>	..	..	..	..	Osprey.
<i>Aviceda subcristata</i>	..	..	..	..	Pacific Baza.
<i>Lophoictinia isura</i>	..	..	..	..	Square-tailed Kite
<i>Hamirostra melanosternon</i>	..	..	..	..	Black-breasted Buzzard.
<i>Haliastur indus</i>	..	..	..	..	Brahminy Kite.
<i>Erythrotriorchis radiatus</i>	..	..	..	..	Red Goshawk.
<i>Falco subniger</i>	..	..	..	..	Black Falcon.
<i>Falco peregrinus</i>	..	..	..	..	Peregrine Falcon.
<i>Falco hypoleucos</i>	..	..	..	..	Grey Falcon.
<i>Turnix melanogaster</i>	..	..	..	..	Black-breasted Button-quail.
<i>Gallinula olivacea</i>	..	..	..	..	Bush-hen.
<i>Grus rubicundus</i>	..	..	..	..	Brolga.
<i>Burhinus neglectus</i>	..	..	..	..	Beach Thick-knee.
<i>Haematopus longirostris</i>	..	..	..	..	Pied Oystercatcher.
<i>Haematopus fuliginosus</i>	..	..	..	..	Sooty Oystercatcher.
<i>Charadrius rubicollis</i>	..	..	..	..	Hooded Plover.
<i>Larus dominicanus</i>	..	..	..	..	Kelp Gull.
<i>Ptilinopus magnificus</i>	..	..	..	..	Wompoo Fruit-Dove.
<i>Petrophassa scripta</i>	..	..	..	..	Squatter Pigeon.
<i>Callocephalon fimbriatum</i>	..	..	..	..	Gang-gang Cockatoo.
<i>Cacatua leadbeateri</i>	..	..	..	..	Pink Cockatoo.
<i>Polytelis swainsonii</i>	..	..	..	..	Superb Parrot.
<i>Polytelis anthopeplus</i>	..	..	..	..	Regent Parrot.

## National Parks and Wildlife.

## SCHEDULE 12—continued.

## ENDANGERED FAUNA—continued.

## BIRDS—continued.

<i>Numenius minutus</i>	..	..	..	..	Little Curlew.
<i>Tringa glareola</i>	..	..	..	..	Wood Sandpiper.
<i>Tringa brevipes</i>	..	..	..	..	Grey-tailed Tattler.
<i>Tringa incana</i>	..	..	..	..	Wandering Tattler.
<i>Tringa hypoleucos</i>	..	..	..	..	Common Sandpiper.
<i>Tringa nebularia</i>	..	..	..	..	Greenshank.
<i>Tringa stagnatilis</i>	..	..	..	..	Marsh Sandpiper.
<i>Tringa terek</i>	..	..	..	..	Terek Sandpiper.
<i>Gallinago hardwickii</i>	..	..	..	..	Latham's Snipe.
<i>Gallinago stenura</i>	..	..	..	..	Pin-tailed Snipe.
<i>Gallinago megala</i>	..	..	..	..	Swinhoe's Snipe.
<i>Limnodromus semipalmatus</i>	..	..	..	..	Asian Dowitcher.
<i>Limosa limosa</i>	..	..	..	..	Black-tailed Godwit.
<i>Limosa lapponica</i>	..	..	..	..	Bar-tailed Godwit.
<i>Calidris canutus</i>	..	..	..	..	Red Knot.
<i>Calidris tenuirostris</i>	..	..	..	..	Great Knot.
<i>Calidris acuminata</i>	..	..	..	..	Sharp-tailed Sandpiper.
<i>Calidris melanotos</i>	..	..	..	..	Pectoral Sandpiper.
<i>Calidris bairdii</i>	..	..	..	..	Baird's Sandpiper.
<i>Calidris mauri</i>	..	..	..	..	Western Sandpiper.
<i>Calidris ruficollis</i>	..	..	..	..	Red-necked Stint.
<i>Calidris subminuta</i>	..	..	..	..	Long-toed Stint.
<i>Calidris ferruginea</i>	..	..	..	..	Curlew Sandpiper.
<i>Calidris alba</i>	..	..	..	..	Sanderling.
<i>Tryngites subruficollis</i>	..	..	..	..	Buff-breasted Sandpiper.
<i>Limcola falcinellus</i>	..	..	..	..	Broad-billed Sandpiper.
<i>Philomachus pugnax</i>	..	..	..	..	Ruff.
<i>Phalaropus fulicarius</i>	..	..	..	..	Grey Phalarope.
<i>Phalaropus lobatus</i>	..	..	..	..	Red-necked Phalarope.
<i>Glareola maldivarum</i>	..	..	..	..	Oriental Pratincole.
<i>Stercorarius maccormicki</i>	..	..	..	..	South Polar Skua.
<i>Stercorarius parasiticus</i>	..	..	..	..	Arctic Jaeger.
<i>Stercorarius pomarinus</i>	..	..	..	..	Pomarine Jaeger.
<i>Stercorarius longicauda</i>	..	..	..	..	Long-tailed Jaeger.

## National Parks and Wildlife.

## SCHEDULE 12—continued.

## ENDANGERED FAUNA—continued.

## BIRDS—continued.

<i>Chilodnius leucoptera</i>	..	..	..	White-winged Tern.
<i>Chilodnius niger</i>	..	..	..	Black Tern.
<i>Hydroprogne caspia</i>	..	..	..	Caspian Tern.
<i>Sterna hirundo</i>	..	..	..	Common Tern.
<i>Sterna sumatrana</i>	..	..	..	Black-naped Tern.
<i>Sterna anaethetus</i>	..	..	..	Bridled Tern.
<i>Anous stolidus</i>	..	..	..	Common Noddy.
<i>Anous tenuirostris</i>	..	..	..	Lesser Noddy.
<i>Ptilinopus regina</i>	..	..	..	Rose-crowned Fruit-dove.
<i>Chalcophaps indica</i>	..	..	..	Emerald Dove.
<i>Petrophassa smithii</i>	..	..	..	Partridge Pigeon.
<i>Calyptrorhynchus lathami</i>	..	..	..	Glossy Black-cockatoo.
<i>Polytelis alexandrae</i>	..	..	..	Alexandra's Parrot.
<i>Cyanoramphus novaezelandiae cookii</i>	..	..	..	Norfolk Island Parrot.
<i>Geopsittacus occidentalis</i>	..	..	..	Night Parrot.
<i>Psephotus chrysopterygius</i>	..	..	..	Golden-shouldered Parrot.
<i>Psephotus dissimilis</i>	..	..	..	Hooded Parrot.
<i>Northiella haematogaster narethae</i>	..	..	..	Naretha Blue Bonnet.
<i>Neophema chrysogaster</i>	..	..	..	Orange-bellied Parrot.
<i>Neophema splendida</i>	..	..	..	Scarlet-chested Parrot.
<i>Cuculus saturatus</i>	..	..	..	Oriental Cuckoo.
<i>Ninox rufa</i>	..	..	..	Rufous Owl.
<i>Ninox squamipila natalis</i>	..	..	..	Christmas Island Owl.
<i>Ninox novaezelandiae royana</i>	..	..	..	Norfolk Island Boobook.
<i>Hirundapus caudacutus</i>	..	..	..	White-throated Needletail.
<i>Apus pacificus</i>	..	..	..	Fork-tailed Swift.
<i>Merops ornatus</i>	..	..	..	Rainbow Bee-eater.
<i>Pitta iris</i>	..	..	..	Rainbow Pitta.
<i>Artichornis clamosus</i>	..	..	..	Noisy Scrub-bird.
<i>Hirundo rustica</i>	..	..	..	Barn Swallow.
<i>Mortacilla flava</i>	..	..	..	Yellow Wagtail.
<i>Coracina tenuirostris</i>	..	..	..	Cicadabird.
<i>Zoothera dauma</i>	..	..	..	White's Thrush.
<i>Drymodes superciliaris</i>	..	..	..	Northern Scrub-robin.

## National Parks and Wildlife.

## SCHEDULE 12—continued.

## ENDANGERED FAUNA—continued.

## BIRDS—continued.

<i>Microeca flavigaster</i>	..	..	..	Lemon-bellied Flycatcher.
<i>Microeca tormenti</i>	..	..	..	Kimberley Flycatcher.
<i>Poecilodryas superciliosa</i>	..	..	..	White-browed Robin.
<i>Falcunculus frontatus</i>	..	..	..	Crested Shrike-tit.
<i>Rhipidura rufifrons</i>	..	..	..	Rufous Fantail.
<i>Psophodes nigrogularis</i>	..	..	..	Western Whipbird.
<i>Cinlosoma punctatum</i>	..	..	..	Spotted Quail-thrush.
<i>Pomatostomus temporalis</i>	..	..	..	Grey-crowned Babbler.
<i>Malurus coronatus</i>	..	..	..	Purple-crowned Fairy-wren.
<i>Malurus leucopterus</i>	..	..	..	White-winged Fairy-wren (Dirk Har- tog Island and Barrow Island races).
<i>Amytornis dorotheae</i>	..	..	..	Carpenterian Grasswren.
<i>Amytornis goyderi</i>	..	..	..	Eyraen Grasswren.
<i>Dasyornis longirostris</i>	..	..	..	Western Bristlebird.
<i>Dasyornis broadbenti</i>	..	..	..	Rufous Bristlebird.
<i>Pardalotus quadragintus</i>	..	..	..	Forty-spotted Pardalote.
<i>Zosterops albogularis</i>	..	..	..	Norfolk Island Silvereye.
<i>Emblema oculata</i>	..	..	..	Red-eared Firetail.
<i>Lonchura flaviprymna</i>	..	..	..	Yellow-rumped Mannikin.
<i>Chlamydera maculata</i>	..	..	..	Spotted Bowerbird.
<i>Lichenostomus melanops cassidix</i>	..	..	..	Helmeted Honeyeater.

## Part 2.

## VULNERABLE AND RARE FAUNA

## MAMMALS

<i>Planigale maculata</i>	..	..	..	Common Planigale.
<i>Sminthopsis leucopus</i>	..	..	..	White-footed Dunnart.
<i>Cercartetus concinnus</i>	..	..	..	Western Pygmy-possum.
<i>Burrarnys parvus</i>	..	..	..	Mountain Pygmy-possum.
<i>Macropus parma</i>	..	..	..	Parma Wallaby.
<i>Macropus dorsalis</i>	..	..	..	Black-striped Wallaby.
<i>Phoniscus papuensis</i>	..	..	..	Dome-headed Bat.
<i>Mastacomys fuscus</i>	..	..	..	Broad-toothed Rat.
<i>Leggadina forresti</i>	..	..	..	Forrest's Mouse.
<i>Pseudomys pilligaensis</i>	..	..	..	Pilliga Mouse.
<i>Melomys burtoni</i>	..	..	..	Grassland Melomys.

A Description of Coastal Heath at  
North Head, Sydney Harbour National Park:  
Impact of Recreation and other  
Disturbance since 1951

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Abstract

The current status of heath growing at North Head, Sydney Harbour National Park, and the way in which the vegetation has been altered by recreation and other factors since 1951, were assessed by field survey and interpretation of aerial photographs.

Pattern analysis showed that mature (10 years since last fire) heath could be divided into two areas based on the mutual exclusiveness of *Leptospermum laevigatum* on the one hand and *Restio fastigiatus* and *Leucopogon microphyllus* on the other. *Leptospermum* heath tended to be found on relatively deep sandy soil, whereas *Restio-Leucopogon* heath was found on shallow soil with subdued local relief. The delimitation of heath types could not be accounted for by differences in fire history.

*Leptospermum* heath was floristically less rich than *Restio-Leucopogon* heath (13 of 26 species), and both types were less rich than heath that had been burnt 1-5 years previously (36 species). Regrowth in the recently burnt heath comprised species that regenerated from seed stored in persistent capsules (8%), those that regenerated from soil-stored seed (< 67%), and those that had vegetative means of regeneration (28%). A large proportion (67%) of those species in the second category were rare or absent in mature heath, whereas all of those in the first were dominant in 10-year-old heath.

*Restio-Leucopogon* heath has been burnt approximately every 10 years since 1951, and this interval between burns should be retained to maximize floristic diversity. *Leptospermum* heath has been burnt only once in the same period. This type of heath would need to be burnt every 10-20 years to increase floristic diversity of vegetative plants and to reduce canopy height, although species present as dormant viable seeds would not be eliminated by a less frequent burning program.

Substantial areas of heath have been removed by earthworks, and heath and topsoil have been stripped from the lower parts of the Head by run-off from compacted and sealed surfaces. Pedestrian and vehicle traffic has not had a serious impact on the vegetation. In the absence of further disturbance, heath plants have colonized ground when topsoil material has been left *in situ*.

Introduced grasses have become established at the junction of parking areas and paths with the heath. This has probably been assisted by nutrient enrichment via imported fill material.

Introduction

When several pieces of the rugged foreshore of Sydney Harbour were designated as Sydney Harbour National Park, the State Government of New South Wales acknowledged the value of this land, which has long been appreciated by the public for its outstanding scenery and accessibility.

Some parts of the new National Park carry stands of essentially natural vegetation. These are of botanical importance for their representativeness and their rarity on the central coast of the State. At a time of increasing fuel cost and scarcity, there is likely to be an intensification of visitor pressure on such areas in the Sydney Metropolitan Area (Anon. 1975). Numerous studies (e.g. Liddle 1975; Cole 1978) have shown that typical responses of natural vegetation to recreation use are: change in structure and species

composition; increase in plant cover as species resistant to trampling become established; or the complete removal of plant cover under intense pressure.

The closed heath and scrub of the North Head Peninsula, which forms the northern shore at the entrance to Sydney Harbour, is now part of Sydney Harbour National Park. The present study was conducted to ascertain how visitor pressure and other disturbance had affected the natural vegetation in the recent past, and to provide data on the status of the North Head vegetation to aid in the formulation of management proposals. A series of aerial photographs dating from 1951 was used to estimate the changes in heath cover that had taken place since that time, and to construct a fire history map for the last 30 years.

Quantitative surveys of plant cover were carried out in areas of mature heath which had been burnt 10 years previously. Sample sites were classified and the contributions of each species to group formation were assessed using the information statistic program MULTBET and the diagnostic program GROUPE, respectively (Milne 1976). Vegetation pattern was examined in the light of supplementary soil sample data and fire history. Species occurring in recently burnt heath (1.5 years since last fire) and their mode of regeneration were recorded. Results have been discussed with special reference to other studies of coastal heath (Specht *et al.* 1958; Groves and Specht 1965; Burrell 1969; Siddiqi *et al.* 1972; 1976; Russell and Parsons 1978), and of fire as a management tool in the maintenance of floristic diversity and vigour (Hanes 1971; Parsons 1976; Gill 1977).

The study was confined to the open headland of approximately 8.5 ha area at the tip of the North Head Peninsula (Fig. 1). This plateau has received the greatest visitor pressure in the past and is delimited by 70-m cliffs dropping to the Pacific Ocean to the south and east, by a boundary wall to the north, and by sharply falling terrain to the west. Such a study may indicate protective measures needed in other areas of the Peninsula which (unlike the Head itself) have been protected from heavy visitor pressure in the past by military and quarantine authorities.

#### Methods

##### *Aerial Photographs*

Copies and enlargements were obtained of the following black and white, vertical projection aerial photographs (Department of Lands, N.S.W.) of the North Head locality: Sydney, 468-74, Run 10 (May 1951); Sydney, N.S.W., 233 510Y, Run 19 (1.i.1956); Cumberland 1961 Series, N.S.W., 1050 5079, Run 31 (28.vi.1961); Cumberland 1970 Series, N.S.W., 1911 5028, Run 15 (7.vii.1970); County of Cumberland 1978, N.S.W., 2707 167, Run 14 (11.iv.1978).

Examination of the photographs allowed the study area to be divided up into zones of contrasting fire history. Interpretation of approximate dates of burning (to the nearest year) was aided by inspection on the ground of areas in the locality of known recent fire history. Because of the extremely fragmented nature of the plant cover (Fig. 1), small (< 5 m diameter) clumps of heath may not have been burnt at the time when all surrounding vegetation was burnt. It was not practicable to map such small areas accurately because of gross changes in the overall cover of vegetation over the last 30 years.

From enlargements of photographs for 1951 and 1978, overlay maps at a scale of 1:1000 were drawn which enabled a composite map to be prepared showing changes in the extent of heath, grassland and bare ground. Additional data on disturbance due to



Fig. 1. Aerial photograph of the study area at North Head flown on 11.iv.78. (a) Metalled access road and parking area. (b) Access points currently used by vehicles moving off the parking area. (c) Metalled pedestrian footpath. (d) Lookout to Sydney and Harbour. (e) Military installations (disused). Reproduction by permission of the Department of Lands, New South Wales.

military installations prior to 1951 were obtained by personal communication with armed forces personnel.

Topographic information was obtained from a 1979 1:2000 orthophotomap (North Head U2752-43 New South Wales).

#### Field Survey

Vegetation was sampled in 33 quadrats, each 2 m square. Each contained 50 regularly spaced point quadrats which enabled cover repetition scores to be recorded for each species present. The quadrats were set out in the heath that had been burnt last in 1969, which made up approximately 70% of the study area. They were distributed at 15-m centres between five transects (Fig. 2).

The 33 sample quadrats were classified by the agglomerative polythetic program MULTBET (Milne 1976) on the basis of the presence or absence of species with greater than 10% constancy. An initial subjective classification (Mueller-Dombois and Ellenberg 1974), and consideration of the total number of quadrats making up the sample population led to the limitation of the number of final groups in the hierarchy to four. The contribution of each species to information gain with each group-group fusion was determined by the GROUPER program (Milne 1976).

The vegetation regenerating after the fire of January 1978 on the western edge of the study area was surveyed within a grid 16 m by 16 m (Fig. 2). The size of the grid was determined by preliminary investigations with nested quadrats, and the grid was positioned in part of the regeneration area judged to be representative of the whole. Species presence and the mode of regeneration were recorded. Species that had flowered and set seed were noted. No data were available on the species composition of this area prior to the 1978 fire.

Subsequently, vegetation and soils were sampled at 7-m intervals along three parallel transects (Fig. 2) run in an east-west direction through the heath that had regenerated after the 1969 fire. Soil cores (150 mm diameter) were augered to bedrock at each sample site and field assessments made of particle size, texture and colour. Within a circle of 2 m radius from each auger hole, the presence or absence was recorded of *Leptospermum laevigatum*, *Banksia ericifolia*, *Casuarina distyla* and/or other dominant species. There was a total of 57 sample sites in this soil and vegetation survey. No attempt was made to auger areas of bare ground adjacent to the access road since this had ostensibly been built up with introduced fill material.

All field survey work was carried out between June and September 1979. The history of burning (Fig. 2) includes the fire that burnt out a large part of the study area in December 1979. Vegetation was not sampled in the minor area at the northern edge of the study area that had not been burnt since before 1950.

#### Results

##### Changes in Plant Cover

Major disturbance of the vegetation at North Head began in the period 1936-40 when three observation posts were installed in the cliff-face (Fig. 1) as part of the Coastal Defence System. There remained in 1951 a swath of apparently unvegetated ground 25-75 m in width extending from close to the three observation posts across the northern boundary of the study area to gun emplacements set back from the cliff-top.

Much of this cleared ground was subsequently used as a car park and has therefore

remained in an unvegetated state, but it is significant that approximately 0.40 ha near the vehicle turning circle once more supported heath by 1961 (Fig. 3). No data are available on the degree of disturbance caused by the operations of

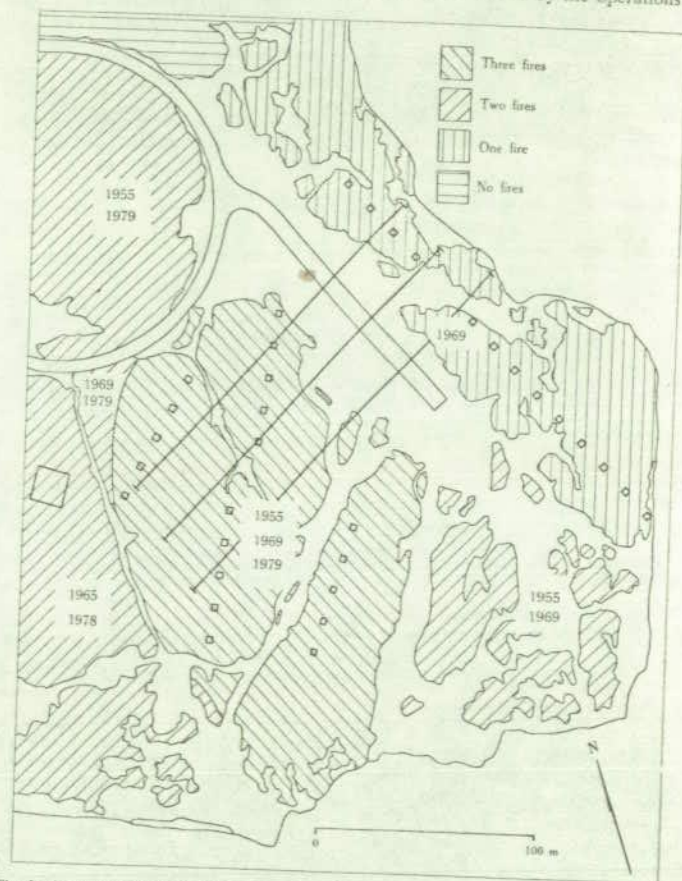


Fig. 2. Fire history for heath showing approximate dates of burning since 1951. Also shown are locations of 33 quadrats, each 2 m square, the single 16-m-square quadrat, and three parallel soil survey transects. (See Methods for explanation.)

1936-40. However, observation of topsoil depths in the newly colonized area suggested that disturbance was limited to the stripping of top growth. No rehabilitation of bare ground took place following disturbance. The heath therefore made a remarkable natural recovery in the period 1940-61. Natural colonization may

have taken place in as little as 10 years between 1951 and 1961 depending on the amount of continuing disturbance that occurred between 1940 and 1951.

Overall changes in plant cover in the period 1951–78 (Fig. 3) show that substantial areas of heath have been denuded of all vegetation (0.36 ha), or have been replaced by a cover of grassland (0.17 ha). Of the two major areas of newly created bare ground, that adjacent to the access road and vehicle parking area (Fig. 1) was formed between 1956 and 1970. Some heath clearance took place between 1956 and 1961, and since the access road (and walkway to the lookout not shown in Fig. 3) was surfaced at this time, it is reasonable to suppose that the remaining heath was cleared by earthmoving equipment.

The second large area of new bare ground (Fig. 3) that runs south-west from the end of the access road had assumed its present dimensions by 1970. A relatively narrow but continuous erosion channel developed in the heath between 1956 and 1961, the time when some deliberate heath clearance took place farther up the slope in the parking area. Its widening between 1961 and 1970 was coincident with the surfacing of the access road. Unsurfaced pedestrian footpaths had not increased in width in the last 30 years.

The species found in the grassland that fringed areas of established heath were *Stenotaphrum secundatum* (buffalo grass), *Cynodon dactylon* (couch) and *Pennisetum clandestinum* (Kikuyu grass).

From the aerial photograph for 1951, it appeared that grass cover was negligible, but the presence of introduced grasses at that time could not be dismissed. It was not practicable to map in Fig. 3 individual plants and small (< 5 m<sup>2</sup>) areas of grass that were observed in the present study growing amongst heath plants in a number of locations, e.g. close to the lookout (Fig. 1).

In 1978, the coverage of heath on the headland accounted for only 5.14 ha of the total surface area, i.e. 60%. Based on this figure the amount of heath that has been replaced by bare ground and grassland since 1951 is approximately 10%.

#### Vegetation and Soils

Pattern analysis (Fig. 4) suggested that for practical purposes a major division of the 33 sample quadrats could be made on the basis of the presence of *Leptospermum laevigatum* and absence of *Restio fastigiatus* and *Leucopogon microphyllus*, or vice versa. All of the 10 members of Final Group I contained *Leptospermum* and, of these, none contained *Restio* and only two contained *Leucopogon*.

Interestingly, when the data had been examined initially for species constancy and differentiating species after the method of Mueller-Dombois and Ellenberg (1974), *Leptospermum* on the one hand and *Restio* and *Leucopogon* on the other, had been recognized as species on which a major division could be based. Moreover, two quadrats were recognized as borderline 'relevés' since they contained all three supposedly differentiating species. These two quadrats were classified within the *Restio-Leucopogon* group in the agglomerative procedure despite the fact that they also contained *Leptospermum*.

A remarkable feature of the analysis was the pattern of quadrat distribution that arose between those of Final Group I and those of the other Groups. The 10 members of Final Group I were confined totally to the eastern side of the access road (Fig. 2). Of the remaining three quadrats in this area, two were the borderline cases mentioned above (which contained *Leptospermum* among other species), and one which did not contain *Leptospermum*. It was therefore reasonable to divide the heath which was last

burnt in 1969 (and thus the vegetation of the majority of the study area) into two vegetation types which may be termed *Leptospermum* heath and *Restio-Leucopogon* heath. All but three of the sample quadrats representative of the latter type were to the west of the access road (Fig. 2).

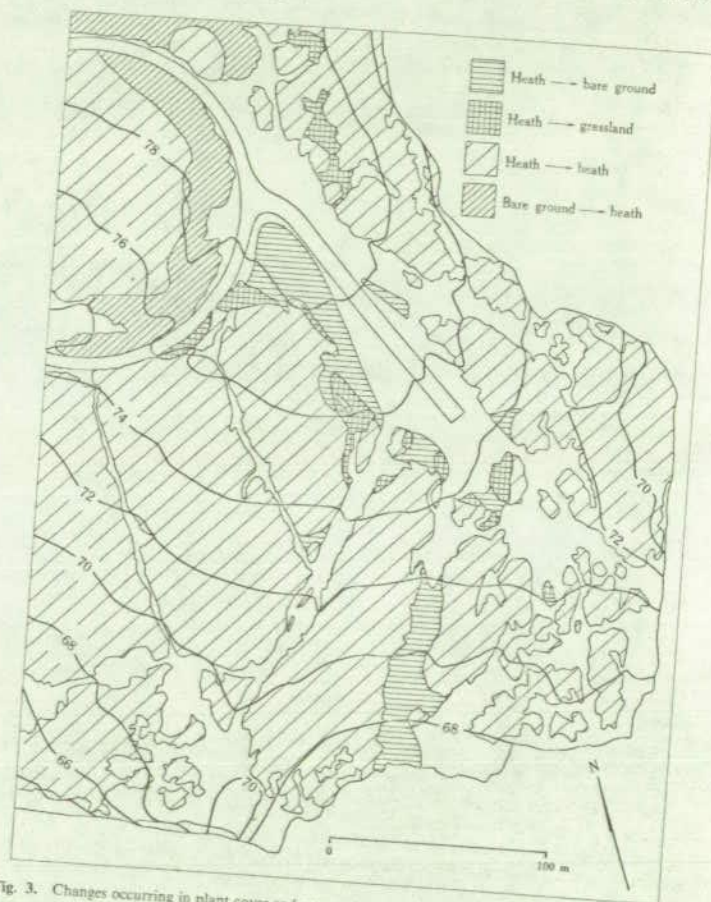


Fig. 3. Changes occurring in plant cover and extent of bare ground between 1951 and 1978. Unshaded areas were not vegetated at either time. Contour interval 2 m.

A division of the *Restio-Leucopogon* heath could be made on the basis of the mutual exclusiveness of *Baeckea imbricata* and *Epacris microphylla*. The former could be divided again into those that did contain, and those that did not contain, *Xanthorrhoea*



*australis*. The three Final Groups of the *Restio-Leucopogon* heath (2, 3 and 4 of Fig. 4) contained quadrats that were apparently randomly distributed.

Table 1 shows the species observed in the *Leptospermum* and in the *Restio-Leucopogon* heaths with the mean cover repetition scores per quadrat of the most prominent species ranked in order of constancy. The former was characterized by a relatively low species richness, the canopy being dominated by *Leptospermum laevigatum* and *Banksia ericifolia*. This was in contrast with the relatively species-rich *Restio-Leucopogon* heath in which 15 species occurred with over 25% constancy despite the dominant position occupied by *Banksia ericifolia*. In addition to *B. ericifolia*, the four species *Darwinia fascicularis*, *Calytrix tetragona*, *Casuarina distyla* and *Lepidosperma viscidum* were important components of both heaths and did not feature as indicator species in the pattern analysis.

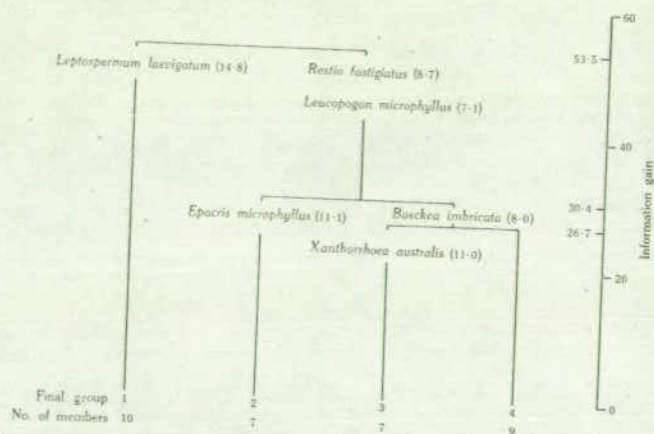


Fig. 4. Hierarchy of 33 members of sample population from the agglomerative program MULTBET. Named species at the head of groups are those occurring principally in those groups and which made the greatest contribution to information gain on fusion (values shown in parentheses).

Despite the fact that the *Leptospermum* heath and *Restio-Leucopogon* heath had been burnt previously at the same time (1969), there was a marked difference in the mean canopy heights in the two areas. The latter, to the west of the access road, was a typical heath as defined by Specht (1970) with a dense plant cover (90.3%) dominated by shrubs of mean height 1.2 m. The area of *Leptospermum* 'heath' more closely approximated closed scrub with a dense cover (94.6%) of plants of 2.7 m mean height. There was, however, considerable variability in canopy height in this area, with some quadrats comprising plants of relatively small stature. The term 'heath' has therefore been retained below.

Soil samples taken in the three additional transects running across the 1969 regeneration area (Fig. 2) showed the presence of two distinct soil types. The first was a shallow, sandy soil resting on Hawkesbury Sandstone bedrock at depths ranging from 0.1 to 0.5 m. Beneath a thin surface litter layer was 0.05-0.10 m of fine, dark grey

sand. This changed to a lighter, grey-brown coarse sand which gave way to a yellow-brown coarse sand just above bedrock. Small pebbles (up to 20 mm in diameter) and gravel were typically distributed throughout the coarse sand layer. Apart from the thin layer of fine sand at the top of the profile, the profile corresponded with that given by Walker (1960) for skeletal soils of the Hawkesbury Sand Series.

Table 1. Floristic composition of 10-year-old *Leptospermum* and *Restio-Leucopogon* heaths (a) Mean cover repetition scores per quadrat for species with greater than 25% constancy. (b) Species with less than 25% constancy, arranged alphabetically. Species marked \* occurred in one heath type only

<i>Leptospermum</i> heath <sup>a</sup>			<i>Restio-Leucopogon</i> heath <sup>b</sup>		
Species	%	Score	Species	%	Score
(a) Species with > 25% constancy					
* <i>Leptospermum laevigatum</i>	100	20.3	<i>Banksia ericifolia</i>	96	25.5
<i>Darwinia fascicularis</i>	100	9.4	<i>Leucopogon microphyllum</i>	87	6.0
<i>Banksia ericifolia</i>	70	11.3	* <i>Restio fastigiatum</i>	70	7.7
<i>Casuarina distyla</i>	60	8.0	<i>Calytrix tetragona</i>	70	5.2
<i>Calytrix tetragona</i>	50	1.6	<i>Darwinia fascicularis</i>	65	4.5
<i>Lepidosperma viscidum</i>	40	0.6	<i>Baeckea imbricata</i>	57	3.6
			<i>Casuarina distyla</i>	48	5.0
			<i>Lepidosperma viscidum</i>	44	1.7
			<i>Xanthorrhoea australis</i>	44	1.2
			<i>Persoonia lanceolata</i>	39	2.0
			<i>Platysace lanceolata</i>	39	0.7
			<i>Grevillea speciosa</i>	35	1.4
			* <i>Epacris microphylla</i>	35	1.0
			* <i>Pultenaea elliptica</i>	30	1.1
			* <i>Leptospermum squarrosum</i>	26	0.7
(b) Species with < 25% constancy					
<i>Baeckea imbricata</i>			* <i>Banksia sp.</i>		
* <i>Epacris longiflora</i>			* <i>Cuscuta australis</i>		
<i>Grevillea speciosa</i>			* <i>Epacris pulchella</i>		
<i>Leucopogon microphyllum</i>			* <i>Goodenia bellidifolia</i>		
<i>Persoonia lanceolata</i>			* <i>Hakea teretifolia</i>		
<i>Platysace lanceolata</i>			* <i>Kunzea capitata</i>		
<i>Xanthorrhoea australis</i>			* <i>Leptospermum juniperinum</i>		
			* <i>Melaleuca nodosa</i>		
			* <i>Pinelaea linifolia</i>		
			* <i>Woollya pungens</i>		
			* <i>Zieria laevigata</i>		

<sup>a</sup>13 species. <sup>b</sup>26 species.

The second soil type has arisen principally from wind-blown sand deposits which take the form of low, cliff-top dunes at North Head, and was characterized by a light grey fine sand layer ranging from 0.2 to 0.7 m in depth. This layer sometimes rested on yellow-brown coarse sand and gravel, presumably derived from the underlying Hawkesbury Sandstone, which was encountered at depths of from 0.2 m to over 1.3 m. The coarse sand and gravel were of varying thickness, and at some sample sites were absent, the fine sand directly overlying the bedrock. Clay was recorded in only 3 out of the 57 sample sites and it was not present in sufficient quantity to impede vertical drainage.

The distribution of the two soil types was closely correlated with the two major types of heath vegetation described above, the relatively deep sandy soil being found to the east of the access road (*Leptospermum* heath), and the shallow soil derived from Hawkesbury Sandstone being found to the west (*Restio-Leucopogon* heath).

Recordings of the most prominent species within 2 m of each auger hole largely confirmed the findings of the preliminary survey that *Leptospermum laevigatum* was confined to the east of the study area, although this species was found at 6 out of the 42 soil sample sites to the west.

In a  $\chi^2$  Goodness-of-Fit test, the presence of *Leptospermum* was found to be highly correlated ( $P \leq 1\%$ ) with a deep ( $\geq 0.15$  m) surface layer of fine sand (Table 2). The mean depth of fine sand at all sites at which *Leptospermum* was present was 0.29 m, with an underlying coarse sand and pebble layer 0.15 m in thickness. In contrast, at soil sample sites at which *Leptospermum* was absent, soils were of the first type described above with a mean depth of fine sand of only 0.05 m overlying coarse sand of 0.23 m average thickness.

Table 2. Contingency table showing the correlation between the presence of *Leptospermum laevigatum* and a fine sand topsoil  $\geq 0.15$  m in depth at 57 sample sites  
 $\chi^2 = 29.6$ , significant at the 1% level

	Deep sand ( $\geq 0.15$ m)	Shallow sand ( $< 0.15$ m)
<i>Leptospermum</i> present	15	4
<i>Leptospermum</i> absent	3	35

The presence of other species was not correlated with soil characteristics, nor was the presence of *Leptospermum* correlated with depth to rock.

Not surprisingly, sampling of the vegetation regenerating in the area that had been burnt 1.5 years previously showed (Table 3) a mixture of species prominent in the neighbouring mature heath stands, and species which were rare or absent from these areas and which could be classed as relatively short-lived pioneer species. Of the species listed in Table 1(a), i.e. those dominating the canopy of 10-year-old heath, all but *Pultenaea elliptica* and *Leptospermum squarrosum* were observed.

The floristic composition of heath that had regenerated naturally following clearance in the period 1940–51 (see above) was similar to that of the *Leptospermum* heath. *Leptospermum laevigatum* and *Banksia ericifolia* dominated a canopy approximately 2.5 m in height. However, the presence was noted of *Banksia marginata*, a species not recorded elsewhere in this study.

#### Fire History

A fire history for the heath at North Head (including the fire of December 1979) is shown in Fig. 2. Since 1949–50, no part of the heath has been burnt more than three times, and the shortest interval between burns was approximately 10 years.

The area which had been burnt only once since 1951 (1969) to the east of the access road corresponds with the occurrence of *Leptospermum* heath on relatively deep sandy soil. The vegetation described above as *Restio-Leucopogon* heath growing on shallow soil to the west of the access road had been burnt twice prior to data collection (1955 and 1969), and again in 1979.

#### Discussion

Two distinct vegetation types have long been recognized in studies of coastal heath in south-eastern Australia, viz. 'wet' and 'dry' or 'sand' heaths (Groves and Specht 1965). Heath nearly always occurs on podzolized, sandy soils (Groves 1980). In wet heath the sandy A horizon is relatively shallow (0.25–0.50 m) and overlies an impermeable B horizon or bedrock. Seasonal waterlogging and drought are features of the soil environment. In contrast, sand heath has a deep (up to or greater than 1.5 m) A

Table 3. Mode of regeneration of species occurring in 1.5-year-old heath that were either (a) abundant or (b) absent or rare in 10-year-old heath

See Table 1. Species marked * had set seed		
Regeneration from seed stored in capsules	Regeneration from soil-stored seed	Vegetative regeneration
(a) Species abundant in 10-year-old heath		
<i>Banksia ericifolia</i>	<i>Baeckea imbricata</i>	<i>Lepidosperma viscidum</i>
<i>Casuarina distyla</i>	<i>Calytrix tetragona</i>	* <i>Platyrase lanceolata</i>
<i>Leptospermum laevigatum</i>	<i>Darwinia fascicularis</i>	<i>Restio fastigiatum</i>
	<i>Epactis microphylla</i>	<i>Xanthorrhoea australis</i>
	<i>Grevillea speciosa</i>	
	<i>Leucopogon</i> sp.	
	<i>Persea lancolata</i>	
	* <i>Platyrase lanceolata</i>	
(b) Species absent or rare in 10-year-old heath		
	* <i>Acacia suaveolens</i>	* <i>Angophora hispida</i>
	* <i>Actinopus helianthi</i>	* <i>Hacmodorum planifolium</i>
	* <i>Actinopus minor</i>	<i>Hypolaena fastigiatum</i>
	<i>Banksia heterophylla</i>	<i>Melaleuca</i> sp.
	<i>Crocea saligna</i>	<i>Restio complanatum</i>
	<i>Cuscuta australis</i>	* <i>Stypandra umbellata</i>
	<i>Cyperus polystachyos</i>	
	<i>Eriostemon buxifolius</i>	
	* <i>Gonolobus bellidifolius</i>	
	* <i>Hibbertia fasciculata</i>	
	<i>Kunzea capitata</i>	
	* <i>Mitrasacme polymorpha</i>	
	<i>Opercularia aspera</i>	
	* <i>Pimelea limfolia</i>	
	<i>Woolhia purgens</i>	
	<i>Zieria laevigata</i>	

horizon which buffers the vegetation from the extremes of waterlogging and drought (Groves and Specht 1965). The two heath formations identified at North Head are further examples of the wet and sand types, i.e. *Restio-Leucopogon* and *Leptospermum* heaths, respectively. The contrast between the two heaths was particularly marked at North Head because a gradational change was no longer observable, the access road and car park (Fig. 1) having been constructed on what once must have been the boundary between the shallow Hawkesbury Sandstone soil and the relatively deep soil derived from aeolian material. Such a gradational change between the two extreme heath types was reported by Osborn and Robertson (1939) for vegetation at Myall Lakes, and Groves and Specht (1965) recognized that the two 'ecosystems' often intergraded within the heath formation at Wilson's Promontory.

In the latter study the dominant species were essentially the same in the wet and the sand heaths. There were floristic similarities between *Leptospermum* and *Restio-Leucopogon* heaths at North Head (Table 1), notably in the important position occupied by *Banksia ericifolia*, a species which has been shown (Siddiqi and Carolin 1976) to be tolerant of a wide range of soil types and soil moisture regimes. The observed difference in the mean dominant shrub canopy height between *Leptospermum* heath and *Restio-Leucopogon* heath probably reflects a difference in shoot biomass between wet and sand heath as has been reported by Groves and Specht (1965).

Coastal heath growing at Mourawaring Point 60 km north of Sydney has been classified in studies by Siddiqi *et al.* (1972, 1976). *Leptospermum* heath growing on relatively deep sand at North Head corresponds with the 'wet sand heath' of Siddiqi *et al.* (1976) who describe the soil profile under this heath type as being 'sandy with a water table 60–150 cm deep'. *Banksia ericifolia* and *Casuarina distyla* were prominent species in *Leptospermum* heath at North Head and in wet sand heath at Mourawaring Point.

The indicator species of sand heath at Mourawaring Point was *Banksia serratifolia*, but this species was not observed initially in the present study. One might expect *Leptospermum* to be replaced by *B. serratifolia* or other deep-rooting species in more sheltered situations in the neighbourhood of North Head. Deeper (> 2 m) cliff-top dunes probably occur in less exposed sites and these could support vegetation more closely resembling the 'dry sand heath' of Siddiqi *et al.* (1976) in which *B. serratifolia* was dominant. Following the fire of December 1979, a single plant of *B. serratifolia* was observed regenerating vigorously from a sunken lignotuber.

Siddiqi *et al.* (1976) make reference to 'North Head', stating that residents had probably 'subjected (the heath) to periodic burning (approximately every two years)', and that *Banksia asplenifolia* was a feature of the vegetation. It can only be concluded that this observation was made of vegetation growing at some distance from the present study area, since no *B. asplenifolia* was observed and fires at the Head itself demonstrably did not occur as frequently as every 2 years (see below). Moreover, local authority officials report that fires on the peninsula of North Head have not been deliberately lit in recent years.

The *Restio-Leucopogon* heath of the present study corresponds with the 'ground water heath' at Mourawaring Point, the impermeable clay layer at 0.2–0.5 m depth observed by Siddiqi *et al.* (1972) being provided by bedrock of subdued relief at North Head. Siddiqi *et al.* (1972) observed that *Banksia ericifolia*, *Casuarina distyla* and *Hakea teretifolia* were prominent species in almost all of their species groups in this vegetation type. At North Head only the first two of these were prominent although *Hakea* was present.

The recognition of a subgroup of quadrats within the *Restio-Leucopogon* heath based on the presence of *Baeckea imbricata* and absence of *Epaeris microphylla* suggests that local variations of soil depth or subsurface rock formation have given rise to areas of more pronounced waterlogging within the ground water heath. *Baeckea* was the dominant swamp species within the ground water heath at Mourawaring Point. No explanation can be forwarded for the division of the *Baeckea* heath sites on the basis (largely) of the presence or absence of *Xanthorrhoea australis*.

Specht (1970) observed that *Leptospermum laevigatum* can develop into stands of closed scrub on coastal sand dunes in south-east Australia. No study of the growth requirements of *Leptospermum laevigatum* has been published. However, it must be

assumed that this species is confined to the relatively deep sand at North Head because it grows as, or more, successfully than other species present in this soil environment; and because it cannot compete successfully with other species in wet heath.

Burrell (1969) showed that 10 ppm phosphorus in the topsoil was necessary to prevent the stunted growth of *Leptospermum* seedlings, and that this level was reached when heath growing on deep sandy soil was burnt approximately once in 12 years. However, Siddiqi *et al.* (1972) found that build-up of phosphorus in above-ground plant parts was likely to be less pronounced in wet heath than in sand heath, such that soil phosphorus levels might reach only 1–5 ppm after burning of the former. Thus seedlings of *Leptospermum* regenerating in wet heath areas would be stunted and less able to compete with species better adapted to low phosphorus stress, e.g. *Banksia ericifolia*.

The delimitation of *Leptospermum* and *Restio-Leucopogon* heaths was confounded with fire history (Fig. 2). The former was burnt only once in 30 years (1969), whereas the latter was burnt in 1955 and 1969. However, the observed difference in floristics between the heath types could not have been caused by the difference in fire history. The indicator species *Leptospermum laevigatum* can be eliminated from heath by two fires spaced at an interval of less than 4–5 years because of its fire sensitivity and its inability to set seed in this time (Burrell 1969; Specht 1980). Such a double burn of the area currently carrying *Restio-Leucopogon* heath, which would account for the absence there of *Leptospermum*, has not taken place since 1951 (Fig. 2). Nor is it likely that a double burn or more frequent burning of the *Restio-Leucopogon* heath occurred for many decades prior to 1951, since the species currently dominant in this heath type also would have been seriously depleted. *Banksia ericifolia*, which can also be eliminated by two closely spaced fires (Siddiqi *et al.* 1976), would not have achieved its dominant position in the canopy if this had been the case.

The confounding of heath type with fire history was unavoidable given the limited area under study. In view of the fact that a large section of the *Restio-Leucopogon* heath was again burnt in December 1979 (Fig. 2), further investigations may show that wet heath is more prone to burning than sand heath owing to the severe droughting experienced by the vegetation over the early summer months.

The proportion (approximately 80%) of species regenerating from seed alone 1–5 years after a fire was in sharp contrast with findings of other studies of sclerophyllous vegetation. For heath at Wilson's Promontory, 73% of regeneration was by means of fire-resistant rootstocks (Russell and Parsons 1978); all but three of the shrubby understorey species in eucalypt forest, Black Mountain, Canberra, regenerated by vegetative means after fire (Purdie 1977a); and 44% of regeneration was from rootstocks in Californian chaparral vegetation (Hanes 1971).

Russell and Parsons (1978) noted no obvious decline in species richness 10 years after fire because of the persistence of vegetative organs of most of the species and the essentially self-replacing response to fire. A reflection of the low proportion of species reliant on vegetative means of regeneration at North Head was the sharp decline in floristic richness with time since last fire (Tables 1 and 3). There was a drop from 36 species in 1–5-year-old heath to 26 species (28% reduction) in the relatively species-rich *Restio-Leucopogon* heath. The *Leptospermum* heath contained only 13 species representing a reduction of 64%. Heath at Dark Island (Specht *et al.* 1958) contained 36 species immediately after fire and this declined by 16 species in 25 years (a 44% reduction).

A decline in floristic diversity was observed in chaparral vegetation (Parsons 1976),

with a predominantly herbaceous cover immediately after fire giving way to less diverse shrub cover after 14 years, which in turn degenerated to chaparral dominated by one species after 35 years. The use of fire in the maintenance of floristic richness and vegetative 'vigour' in chaparral has been stressed (Hanes 1971; Parsons 1976).

Gill (1977) and Purdie (1977b) pointed out that, in order to formulate sound policy for the use of fire in heath management, greater attention should be paid to species present in the dormant state, i.e. as soil-stored viable seeds. The proportion of species germinating from soil-stored seed after fire at North Head (Table 3) which were not prominent in more mature heath (67%) gives an indication of the importance of such data. A danger has been recognized (Gill 1977) that vegetation may be repeatedly and frequently burnt if a declining trend in floristic richness is observed with time since fire. As has been pointed out above, such a policy would eliminate fire-sensitive woody species if their seedlings failed to produce seed before the next fire.

Of the species listed in Table 3, only three (8%) regenerated from seed stored on the parent plants, although these had some of the highest cover values in mature heath (Table 1); at least 24 (67%) were fire-sensitive species that regenerated from soil-stored seed; and 10 (28%) were able to regenerate vegetatively after fire. It seems likely that some of the species in this last category also would have regenerated from seed, although this was observed only in *Platysace lanceolata*. It is interesting to note (Table 3) that many of the species that were rare or absent in mature heath had ensured their perpetuation by setting seed less than 1.5 years since the last fire.

To maintain vegetative floristic diversity at North Head, both the *Leptospermum* heath and *Restio-Leucopogon* heath should be burnt approximately every 10–20 years. This interval would be sufficiently long for dominants with above-ground seed storage to build up seed reserves. It would also maintain heath 'vigour' (Hanes 1971) and prevent the heath from becoming dominated by a limited number of the taller-growing species (Specht *et al.* 1958; Russell and Parsons 1978). *Restio-Leucopogon* heath has burnt spontaneously with this time interval since 1951 (Fig. 2), and may continue to do so in the future, whereas *Leptospermum* heath may require deliberate firing. If the latter heath type were burnt less frequently, scrub would develop (Specht 1970) which would be undesirable for recreational purposes. However, species diversity would be perpetuated in soil-stored seed of short-lived species. It is unlikely that *Banksia ericifolia* or *Casuarina distyla* would be completely suppressed by *Leptospermum laevigatum* in the absence of fire for 30–40 years.

The most serious causes of the loss of heath cover at North Head have been, firstly, deliberate clearance for the construction of roads and parking space and, secondly, the gradual erosion of plants and topsoil by run-off from compacted or sealed surfaces. In the former case the disturbance has taken place over a limited period of time and the potential for heath regrowth has been demonstrated when conditions for recolonization have been favourable, i.e. the absence of traffic and the retention of topsoil material. The close proximity of the seed source in undisturbed heath would also have assisted regeneration (Thatcher and Westman 1975). The presence of *Banksia marginata* in *Leptospermum* heath regenerating following the disturbance of 1940–50 was unusual since this species has been found to regenerate almost always by vegetative means (Specht *et al.* 1958).

It is likely that vehicles have accelerated heath erosion in some places but their effect has been of secondary importance compared to that of deliberate heath clearance and run-off damage. Foot pressure has not had an appreciable effect on path width, probably because the sclerophyllous nature of the plant cover has tended to prevent

casual straying, and the sandy soil and exposed rock provide an ideal walking surface for visitors. This is somewhat surprising in the light of the findings of such workers as Liddle (1975) and Cole (1978).

If the stripping of heath (largely of the *Restio-Leucopogon* type) and soil from the lower parts of the Head were prevented and visitor pressure were controlled, natural colonization of bare ground would occur. However, the capacity for regrowth has been greatly reduced by the loss of seed-rich soil and by the creation of unfavourable seed beds, making a policy of allowing natural regeneration to occur a long, but not necessarily unacceptable, course of action. The erection of fences to prevent access of visitors to regeneration areas would inevitably concentrate foot pressure in certain areas, e.g. perimeter paths. Present indications are that this would not cause accelerated erosion provided the paths were not impermeable.

A cause of serious concern in positive efforts to reinstate the former cover of heath is the danger of the introduction of nutrients and genetic material from outside the immediate locality. It is likely that nutrients (especially phosphorus) have been imported to North Head in the past in fill material used to surface paths and the parking area. While these have probably not been added in sufficient quantity and in a way that would cause the direct decline and mortality of heath plants (Hedde and Specht 1975), grasses (also imported) have been able to colonize ground where formerly only heath plants would have been able to grow. A similar effect has been observed by Specht *et al.* (1977) when heath soils, which are notoriously poor in nutrients (Groves 1980), have been artificially fertilized. Perhaps of more fundamental concern than the establishment of obviously alien weed species would be the risk of introduction from elsewhere in the Sydney Region of seeds or plant material of the same or similar species as those already occurring at North Head. Thus, the elaborate methods adopted for the regeneration of heath disturbed by industrial operations, e.g. following 'coastal sandmining' (Coaldrake 1979), or recreational impact (Bayfield 1976), could be inappropriate and unnecessary in the circumstances.

#### Acknowledgments

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#### References

- Anon. (1975). 'Sydney Region Open Space Survey.' (New South Wales Planning and Environment Commission: Sydney.)
- Bayfield, N. (1976). The use of grasses in revegetating disturbed ground in semi-natural areas. In 'The Next Decade in Amenity Grassland', ed. C. E. Wright, pp. 93–8. (Institute of Biology: Belfast.)
- Burrell, J. P. (1969). The Invasion of Coastal Heathlands of Victoria by *Leptospermum laevigatum*. Ph.D. Thesis, University of Melbourne.
- Coaldrake, J. E. (1979). Coastal sandmining and landscape rehabilitation in eastern Australia. *Land, Plann.* 6, 359–74.
- Cole, D. N. (1978). Estimating the susceptibility of wildland vegetation to trailside alteration. *J. Appl. Ecol.* 15, 281–6.
- Gill, A. M. (1977). Management of fire-prone vegetation for plant species conservation in Australia. *Search* 8, 20–6.
- Groves, R. H. (1980). Heathland soils and their fertility status. In 'Heathlands and Related Shrublands of the World. B. Analytical Studies', ed. R. L. Specht, pp. 143–50. (Elsevier: Amsterdam.)
- Groves, R. H. and Specht, R. L. (1965). Growth of heath vegetation. I. Annual growth curves of two heath ecosystems in Australia. *Aust. J. Bot.* 13, 261–80.

- Hanes, T. L. (1971). Succession after fire in the chaparral of southern California. *Ecol. Monogr.* **41**, 27-52.
- Heddie, E. M., and Specht, R. L. (1975). Dark Island Heath (Ninety-Mile Plain, South Australia). VIII. The effect of fertilizers on composition and growth, 1950-1972. *Aust. J. Bot.* **23**, 151-64.
- Liddle, M. J. (1975). A selective review of the ecological effects of human trampling on natural ecosystems. *Biol. Conserv.* **7**, 17-35.
- Milne, P. W. (1976). The Canberra programs and their accession. In 'Pattern Analysis in Agricultural Science', ed. W. T. Williams, pp. 116-23. (CSIRO: Melbourne.)
- Mueller-Dombois, D., and Ellenberg, H. (1974). 'Aims and Methods of Vegetation Ecology.' pp. 177-93. (Wiley: New York.)
- Osborn, T. G. B., and Robertson, R. N. (1939). A reconnaissance survey of the vegetation of the Myall Lakes. *Proc. Linn. Soc. N.S.W.* **64**, 279-96.
- Parsons, D. J. (1976). The role of fire in natural communities: an example from the southern Sierra Nevada, California. *Environ. Conserv.* **3**, 91-9.
- Purdie, R. W. (1977a). Early stages of regeneration after burning in dry sclerophyll vegetation. I. Regeneration of the understorey by vegetative means. *Aust. J. Bot.* **25**, 21-34.
- Purdie, R. W. (1977b). Early stages of regeneration after burning in dry sclerophyll vegetation. II. Regeneration by seed germination. *Aust. J. Bot.* **25**, 35-46.
- Russell, R. P., and Parsons, R. F. (1978). Effects of time since fire on heath floristics at Wilson's Promontory, southern Australia. *Aust. J. Bot.* **26**, 53-61.
- Siddiqi, M. Y., and Carolin, R. C. (1976). Studies in the ecology of coastal heath in New South Wales. II. The effects of water supply and phosphorus uptake on the growth of *Banksia serrata*, *B. asplenifolia* and *B. ericifolia*. *Proc. Linn. Soc. N.S.W.* **101**, 38-52.
- Siddiqi, M. Y., Carolin, R. C., and Anderson, D. J. (1972). Studies in the ecology of coastal heath in New South Wales. I. Vegetation structure. *Proc. Linn. Soc. N.S.W.* **97**, 211-24.
- Siddiqi, M. Y., Carolin, R. C., and Myerscough, P. J. (1976). Studies in the ecology of coastal heath in New South Wales. III. Regrowth of vegetation after fire. *Proc. Linn. Soc. N.S.W.* **101**, 53-63.
- Specht, R. L. (1970). Vegetation. In 'The Australian Environment', ed. G. W. Leeper, pp. 44-67. (CSIRO: Melbourne.)
- Specht, R. L. (1980). Conservation: Australian heathlands. In 'Heathlands and Related Shrublands of the World. B. Analytical Studies', ed. R. L. Specht, pp. 235-40. (Elsevier: Amsterdam.)
- Specht, R. L., Connor, D. J., and Clifford, H. T. (1977). The heath-savannah problem: the effect of fertilizer on the sand heath vegetation of North Stradbroke Island, Queensland. *Aust. J. Ecol.* **2**, 179-86.
- Specht, R. L., Rayson, P., and Jackman, M. E. (1958). Dark Island Heath (Ninety-Mile Plain, South Australia). VI. Pyric succession: changes in composition, coverage, dry weight, and mineral nutrient status. *Aust. J. Bot.* **6**, 57-88.
- Thatcher, A. C., and Westman, W. E. (1975). Succession following mining on high dunes of coastal south-east Queensland. In 'Managing Terrestrial Ecosystems', eds J. Kikkawa and H. A. Nix, *Proc. Ecol. Soc. Aust.* **9**, 17-33.
- Walker, P. H. (1960). 'A Soil Survey of the County of Cumberland, Sydney Region, New South Wales.' Soil Survey Unit Bulletin No. 2. (New South Wales Department of Agriculture.)

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## Regeneration of Native Plants on Abandoned Mallee Farmland in South-eastern Australia

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### Abstract

The vegetation is described on 12 sites from which mallee vegetation has been cleared and which have since been left undisturbed for periods from 1 to 39 years. Comparisons are made with three virgin stands. Early regeneration in paddocks is dominated by annual herbs but shrubs, especially *Acacia*, *Dodonaea* and *Cassia*, usually become dominant. Wind-dispersed or soil-stored seed allows species to occur after severe site disturbance. Rabbit grazing effects on native plants appear not to be catastrophic at present. The only site studied in detail where mallee eucalypt seedlings were seen was along a firebreak recently cleared through virgin mallee. Minimal competition from older eucalypts is an important factor for eucalypt seedling establishment. No eucalypt seedlings were found more than 10 m from a seed source. Such regeneration is facilitated by seed release following fire or felling. Competition from shrubs and lack of an adequate seed source may well mean that eucalypts will no longer dominate the climax vegetation in many areas, their place being taken by formerly seral species of *Acacia* and *Dodonaea*. The findings have features of both the tolerance and inhibition models of succession of Connell and Slatyer.

### Introduction

In semi-arid southern Australia before European settlement, large areas were dominated by multistemmed, lignotuberous eucalypts 2-10 m high ('mallee scrub'). Large nature reserves now exist in some areas unsuitable for agriculture. However, in areas which can be used for cereal growing, nature reserves are small and widely scattered (Victoria: Land Conservation Council 1974). In most regions, large areas now occur where native vegetation is mainly confined to narrow, shrinking remnants along roadsides. Although some old stands of mallee eucalypts can still be seen in paddocks, they are almost invariably accessible to grazing by domestic stock, the understorey is usually dominated by woody aliens, and regeneration of the eucalypts or any other native shrubs is usually absent. The roadside remnants are often in a similarly degraded state.

While it is clear that native vegetation is disappearing over large areas, it is still important to learn as much as possible about the regeneration of the native plants present, both to assist in the management of existing reserves and to find out under what circumstances, if any, cleared land is able to revert to stands of native plants. One practical point which needs to be established is whether small reserves can be increased in size by acquiring adjacent cleared land and allowing such reversion to take place. Further, it needs to be established to what extent grazing of seedlings by the introduced rabbit will prevent the native vegetation from returning to its pre-European settlement condition, given the catastrophic effects of rabbit grazing in areas drier than the Mallee (Hall *et al.* 1964). The present paper describes introductory work designed to define these problems better by field studies at a number of contrasting sites.

NATIONAL PARKS ASSOCIATION OF NSW  
STATE COUNCIL MEETING DECEMBER 5, 1987  
HUNTER BRANCH REPORT AND NOTICE OF MOTION

Hunter Branch has been mainly concerned with Barrington Tops National Park due to the impending draft plan of management and the ongoing problem of Scotch Broom.

Barrington Tops N.P. Plan of Management

Poor weather forced cancellation of the proposed PMC/Hunter Branch inspection of the BTNP plateau on 24-25 October. However, NPWS held an informative briefing for PMC/Hunter Branch on 26th October.

Main proposals are -

- i) large areas of wilderness declared under the NP & W Act,
- ii) improved 2WD access to park periphery and to Eremeran Lookout,
- iii) more camping and picnic facilities,
- iv) reduced 4WD access and remnant 4WD access to be on a "controlled access" basis through locked gates.

PMC and Hunter Branch are to make preliminary submissions to NPWS based on information available to date.

Scotch Broom

On the initiative of the BTNP Advisory Committee, a Barrington Tops Broom Council was formed early 1987. The Council's long-term aim is to control and minimise the extent of Broom infestations. To this end, the Council is seeking to -

- i) maintain a database relating to Broom at Barrington Tops and elsewhere,
- ii) monitor the spread of infestations,
- iii) raise the level of public awareness of the problem,
- iv) co-ordinate current control programs,
- v) obtain funding for research into biological control.

The accompanying letter and information sheet from the Council indicate the seriousness of the problem, particularly in view of the existence of Broom in other national parks such as Blue Mountains and Kosciusko where, as yet, it has caused little concern and attracted little, if any, management action.

The Broom Council has been advised that the CSIRO would be interested in carrying out research into biological control subject to external funding (approx. \$1m. for a 5 year program). To date the Council has been unable to attract this funding.

Hunter Branch considers that NPA should assist the Council where possible and to this end gives notice of the following motion to be put to the December 5, 1987, State Council meeting.

MOTION

"That State Council refers the following recommendations to the Executive Committee for detailed consideration and action -

- i) request NPWS to allocate increased funds and staff resources to preventing the spread of Scotch Broom at Barrington Tops and other infested national parks,
- ii) increase public and NPWS awareness of the current and potential problem,
- iii) seek funding from government and other sources (e.g. NP & W Foundation, ACF, WWF or a public appeal) for research into biological control."

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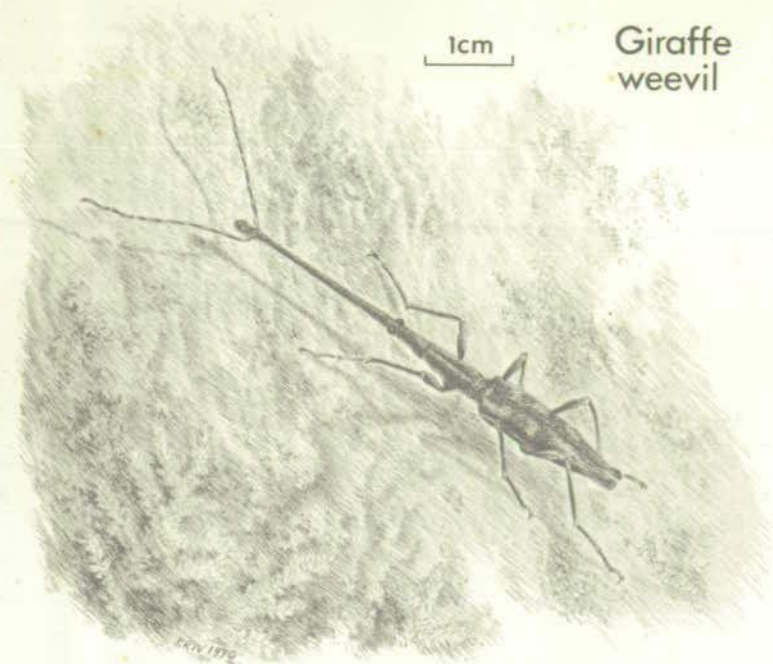


# PUKATEA WALK

Abel Tasman National Park



If tempted to handle plants remember that there are other visitors coming after you who will want to see them undamaged.



The giraffe weevil *Lasiorrhynchus barbicornis* may occasionally be found on trees along the walk. The male (shown above) is larger than the female, being sometimes almost four inches in length. The feelers are near the tip of the proboscis in the male and about mid-way in the female.

Prepared for the Abel Tasman National Park Board by Botany Division, D.S.I.R.  
Text by A. E. Esler. Illustrated by K. R. West.

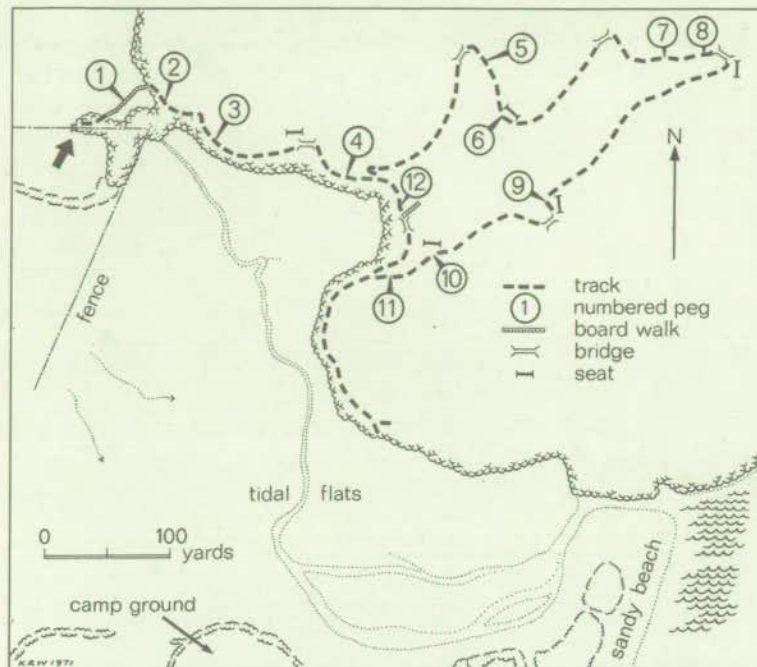
Track designed by J. Wildermoth, Senior Ranger, Abel Tasman National Park.

Printed by The Caxton Press, Christchurch. 1971.

## Botanical Names.

Botanical names can be a little bothersome if you are unfamiliar with them. However, for some purposes they are necessary. If you wish to read more about the plants mentioned here, botanical names will help you find references more readily.

Toetoe	<i>Cortaderia toetoe</i>
N.Z. flax	<i>Phormium tenax</i>
Kiekie	<i>Freycinetia banksii</i>
Shining broadleaf	<i>Griselinia lucida</i>
Nikau	<i>Rhopalostylis sapida</i>
Supplejack	<i>Ripogonum scandens</i>
Kidney fern	<i>Trichomanes reniforme</i>
Bracken	<i>Pteridium aquilinum</i> var. <i>esculentum</i>
Wheki	<i>Dicksonia squarrosa</i>
Mamaku	<i>Cyathea medullaris</i>
Silver tree fern	<i>Cyathea dealbata</i>
Pate	<i>Schefflera digitata</i>
Five-finger	<i>Neopanax arboreum</i>
Lancewood	<i>Pseudopanax crassifolium</i>
Manuka	<i>Leptospermum scoparium</i>
Kanuka	<i>Leptospermum ericoides</i>
Hard beech	<i>Nothofagus truncata</i>
Black beech	<i>Nothofagus solandri</i> var. <i>solandri</i>
Kamaha	<i>Weinmannia racemosa</i>
Putaputaweta	<i>Carpodetus serratus</i>
Pukatea	<i>Laurelia novae-zelandiae</i>
Northern rata	<i>Metrosideros robusta</i>
Matai	<i>Podocarpus spicatus</i>
Kahikatea	<i>Podocarpus dacrydioides</i>
Rimu	<i>Dacrydium cupressinum</i>



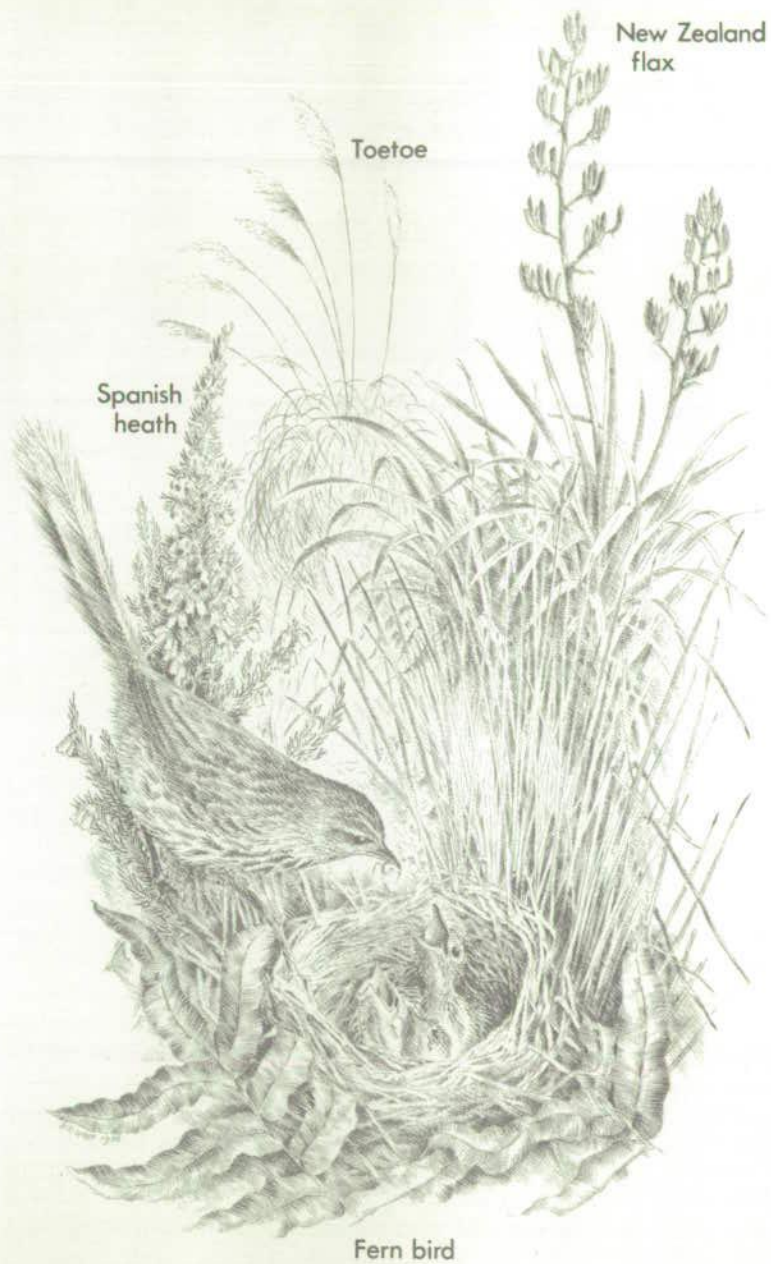
Adapted from original supplied by Lands and Survey Department, Nelson.

## THE PUKATEA WALK, TOTARANUI

The Tataranui headland has a patchwork of vegetation reflecting strong contrasts between moist gullies and dry facings and ridges. The walk takes you through the extremes of wet and dry habitats and for most of its length the path lies on the boundary between them. To add further to the interest there are, at one extreme, fragments of forests which may never have been burnt and, at the other, patches of shrubland on the way to becoming forest again.

This variety of habitats supports a wide range of species. A few are restricted to their specific habitats, others demonstrate the versatility of many New Zealand species by growing as well in one environment as in another.

**Peg 1.** In the swamp at the start of the walk there are good examples of this adaptability. The manuka, toetoe, New Zealand flax, *Coprosma robusta* and the exotic Spanish heath are as much at home here as in fairly dry habitats. However, the three species of *Carex* sedges and the two rush-like *Cladium* species are more truly wetland species. So too is the shy fern bird whose chirping "U-tick" call can frequently be heard here.



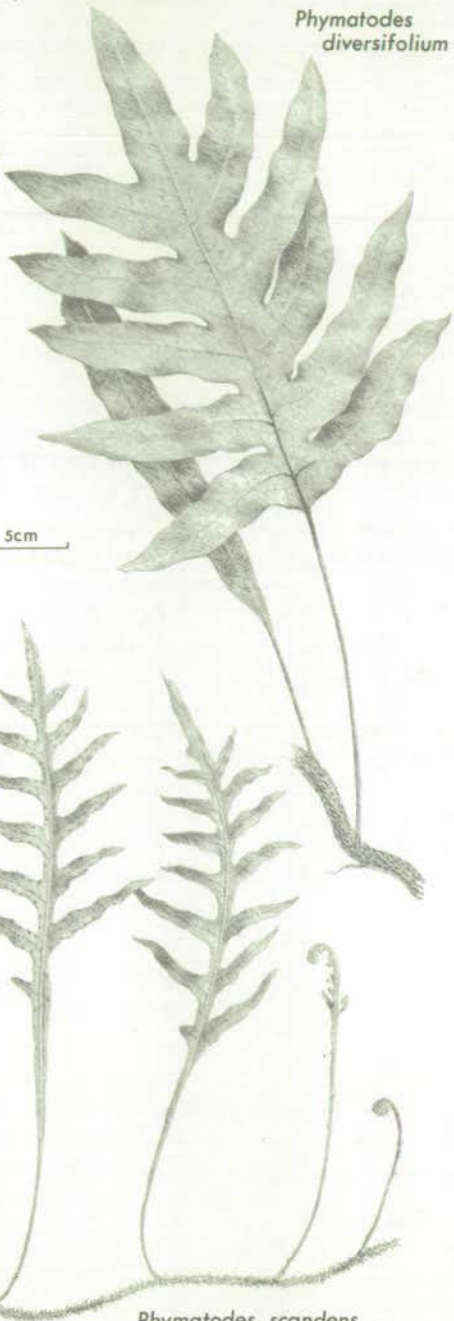
Fern bird

2

*Blechnum*  
*discolor*



*Phymatodes*  
*diversifolium*



*Phymatodes scandens*

15

The path now turns sharply to the right and crosses a small bridge. An offshoot directs attention to a fine stand of pole pukatea. These trees, together with the two small kahikatea at the end of the guided walk at **peg 12**, promise the perpetuation and development of this luxuriant forest. Try to recall where you have viewed a forest like this before. These scenes are now rare because most lowland swampy areas have been cleared and drained for farming. National Parks have been created to preserve scenery such as this.

Rimu  
*Dacrydium cupressinum*  
(pole stage)

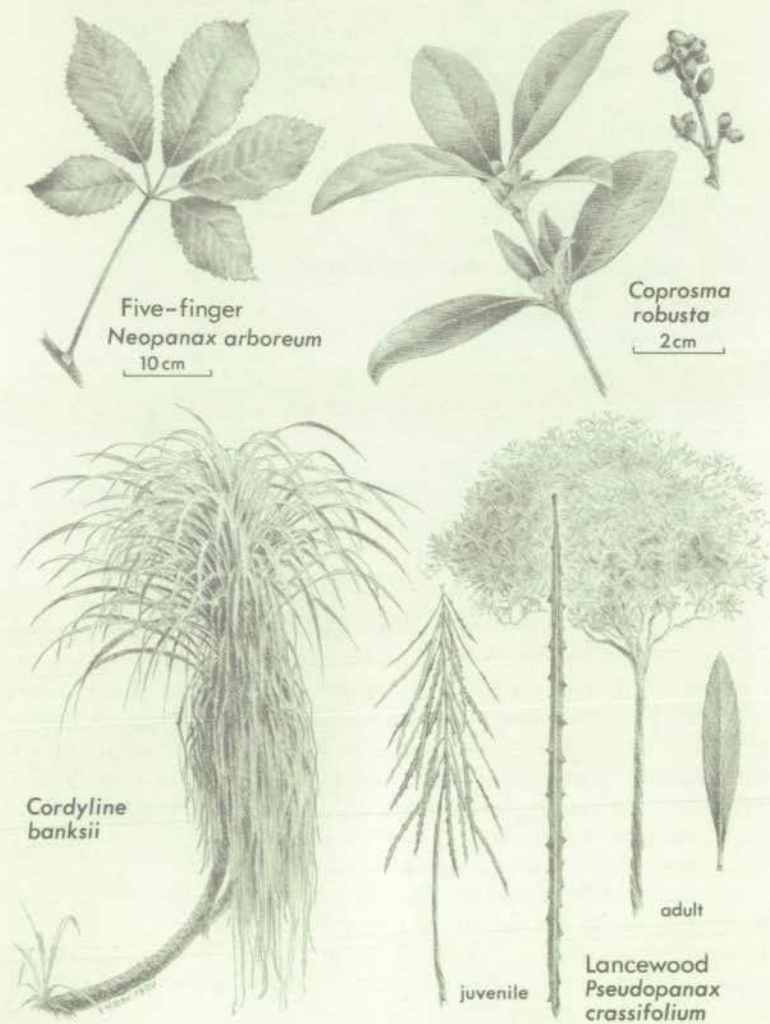


14

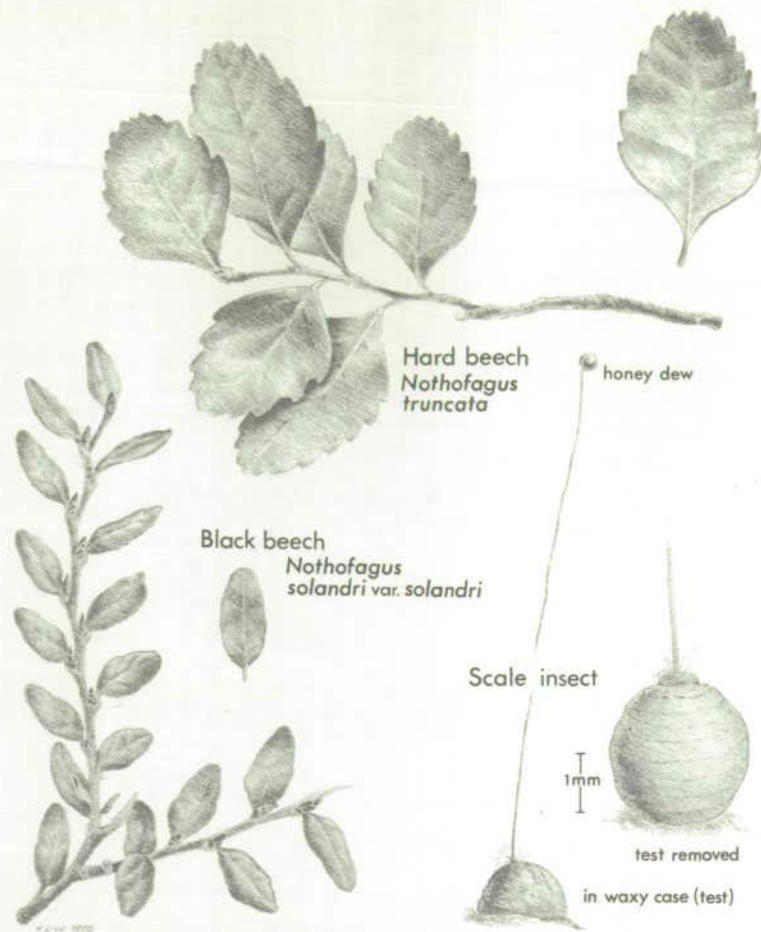
**Peg 2.** At this point gorse, manuka and bracken fern represent an early stage in forest regeneration after fire. This community is typical of much of the vegetation of the lower slopes of hills in the Totaranui catchment as it was in the 1950's. On these hills now five-finger, *Cordyline banksii*, *Coprosma robusta* and many others are replacing the gorse, manuka and bracken. Most of the same species grow here.

**Peg 3.** Near the peg both juvenile and adult forms of lancewood grow together.

Looking westwards the margins of some of the fires which swept the hills can still be discerned; and above the path several stages of regeneration to beech forest are represented.



3



Hard beech  
*Nothofagus truncata*

Black beech  
*Nothofagus solandri* var. *solandri*

Scale insect

1mm

test removed

in waxy case (test)

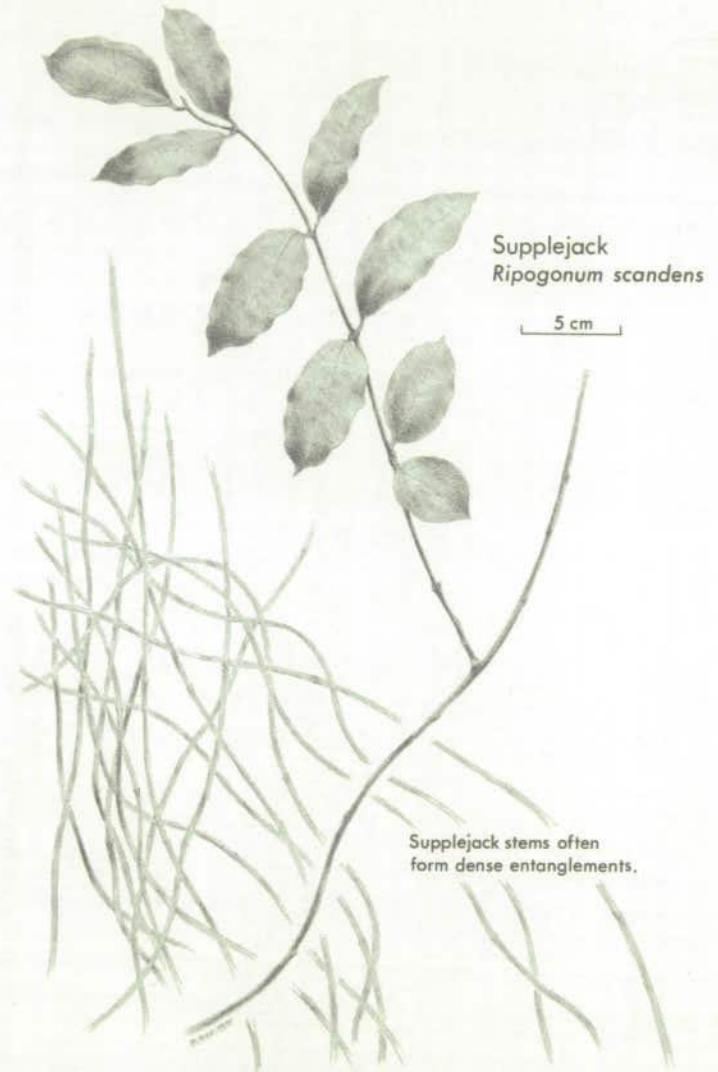
A little further on there are taller trees of hard beech (with toothed leaves), black beech (with entire leaves) and possibly some hybrids between them. The trunks of many are smeared with sooty mould nourished by honey dew exuded by parasitic scale insects nestled in crevices of the bark. The honey dew is collected from the tips of the white hairlike tubes by birds and insects but much of it is washed or blown off. This honey dew gives a distinctive sweet smell to forests where the scale is present and to stands of blighted manuka where a similar host plant-scale-fungus relationship exists.

On banks in beech forest *Dianella* and *Libertia* frequently occur together. *Dianella* has flax-like leaves folded at the base, insignificant flowers but conspicuous drooping white to blue berries. *Libertia*, a native iris, has narrower flat leaves, very handsome white flowers and hard, erect seed capsules.

that this species was cut out for timber in the early days of settlement.

**Peg 10.** The next stop is in a grove of kanuka and black beech poles which have grown up after a burn. Eventually, the kanuka will be replaced by beech just as it replaced manuka, its shorter relative, in the earlier stages of succession.

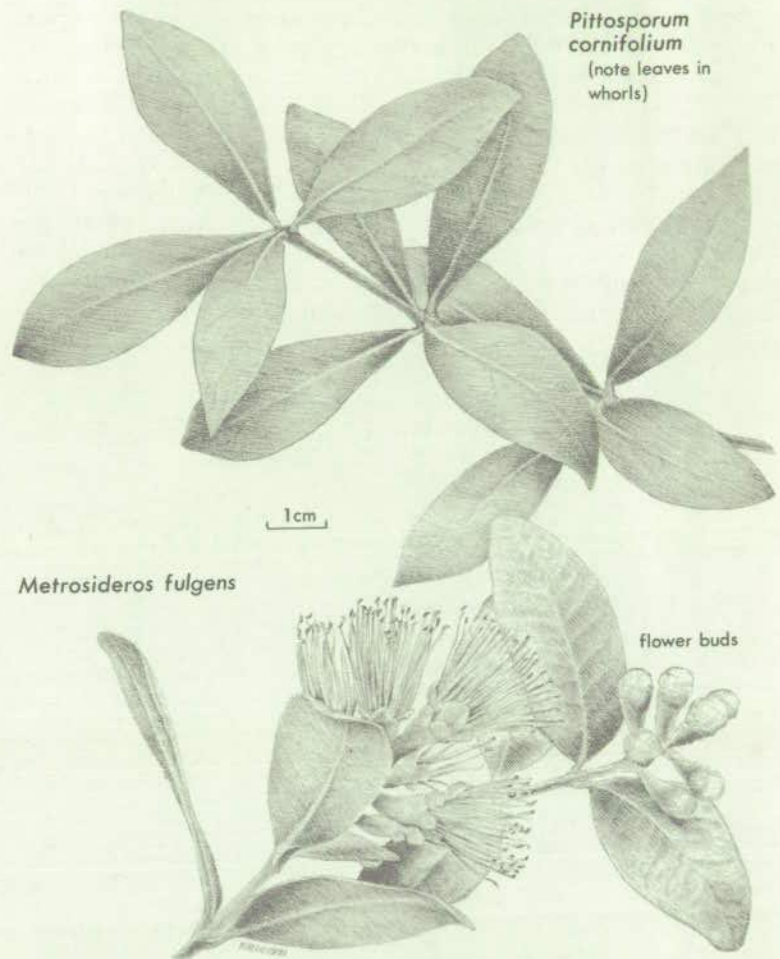
**Peg 11.** Here rimu is forming the new forest. Groups of rimu seedlings, saplings and poles are quite common on the margins of beech forest but few can equal the beauty of this grove of New Zealand's most graceful tree.



Supplejack  
*Ripogonum scandens*

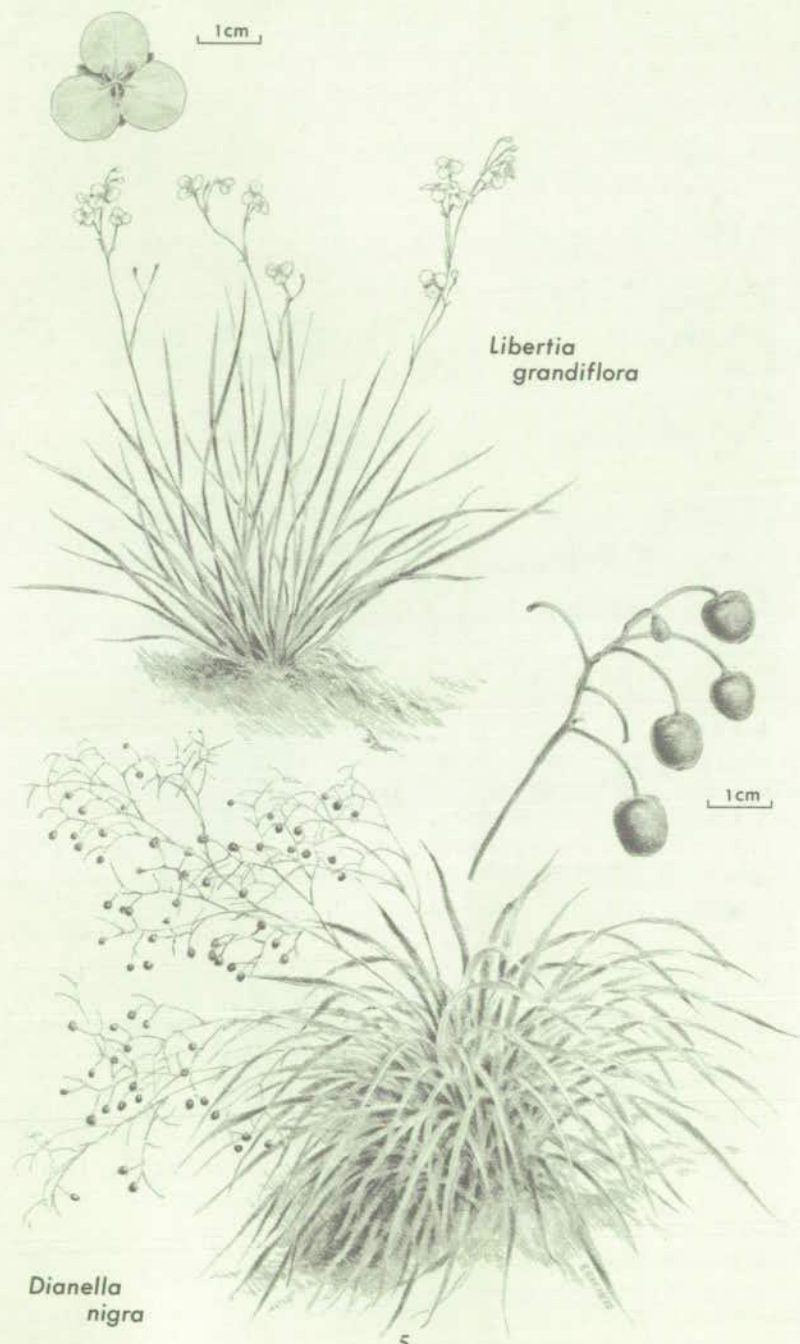
5 cm

Supplejack stems often form dense entanglements.



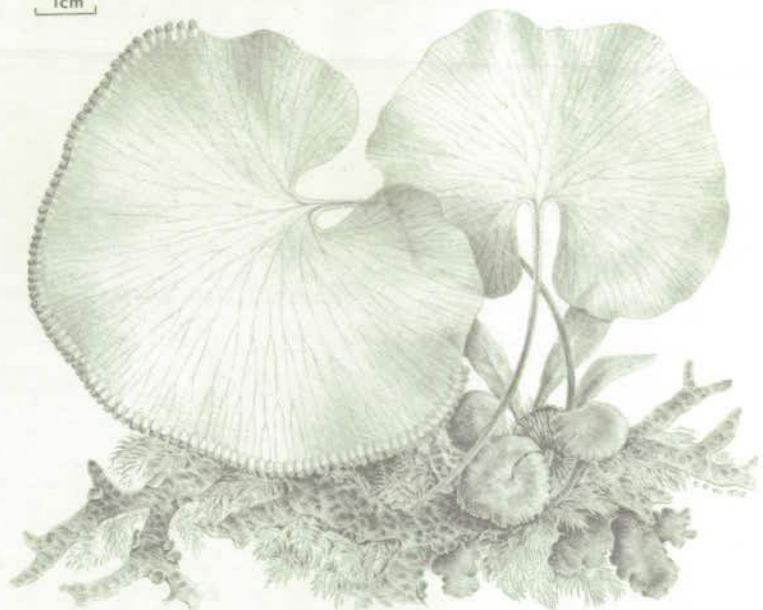
**Peg 9.** This large northern rata is typical of many thousands in the Park. Its peculiar contorted butt and spreading surface roots distinguish it readily from other forest trees. Many begin their lives perched high on other trees but become self-supporting when their roots reach the ground, coalesce and form a trunk around the hapless supporting tree. Some northern rata in the Park reach to about 150ft and overtop all other species. Other rata species found along the track include the woody climber *Metrosideros fulgens* illustrated above. The rather straggly plant growing from the bottom layer of *Collosporum* is *Pittosporum cornifolium*.

From the seat there is a view into the swamp forest with pukatea and their collars of *Collosporum*. Only tall kahikatea is needed to complete the picture of a typical swamp forest community. It is likely



Kidney fern  
*Trichomanes reniforme*

1cm

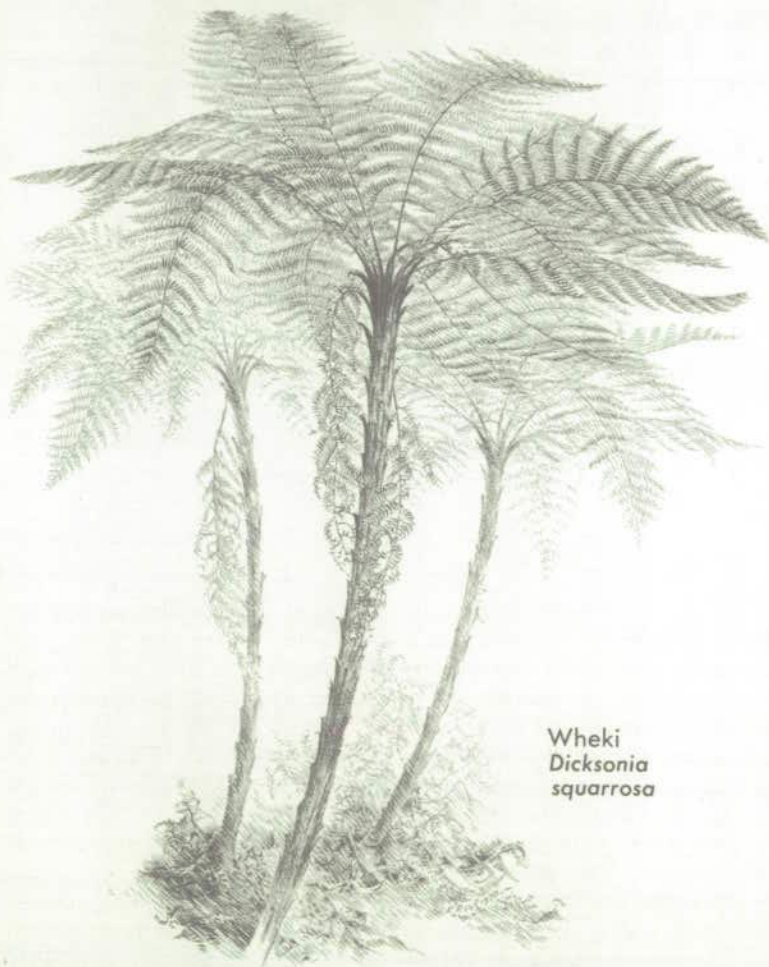


Peg 4. At this point the influence of increased shelter and moisture is apparent as more species of moister habitats make their appearance. The kidney fern here is good evidence of this. Kiekie, *Collospermum* and *Astelia* flourish too. Kiekie is akin to Pandanus and a large number of other tropical species but has no near relatives in New Zealand. It is readily distinguished by its long stems which carry the plant across the ground and to considerable heights up some trees. Watch for other specimens along the walk. *Collospermum* and *Astelia* are epiphytes (perching plants) without any root connection with the ground but are not parasites. They eke out an existence utilising the nutrients and moisture that come their way. *Collospermum* has fan-shaped clusters of wide leaves with black bases. The leaves of *Astelia* are more slender and are whitish on the undersurface.

These perching plants in turn provide a foothold for other epiphytes. This is the typical habitat of *Pittosporum cornifolium* (also at peg 9) but a few individuals grow on rocks on the Totaranui Headland not far above high tide mark. The whorled leaves and orange inner faces of the capsules give this species a very distinctive appearance.

The path then climbs a little and turns up a wide gully. Note the change from beech to kamahi above the track as it becomes more shaded and more moist.

Peg 8. Nikau palms of all ages flourish here and give a tropical atmosphere to the forest. It is the only palm of more than 2000 species to extend to New Zealand. Contrary to popular belief the stem does not have a single ring scar each year. More frequently two or three are formed annually but there is considerable variation in number. This is related to the number of fronds which fall as each scar represents the place of attachment of a frond which has been shed. In adult nikau palms the flower cluster which forms within the dilated frond base is exposed when the frond falls. By the following summer the fruits are fully grown, change from green to red and are eaten by pigeons or fall to the ground. Germination is not impaired by passage through the digestive tract of pigeons.

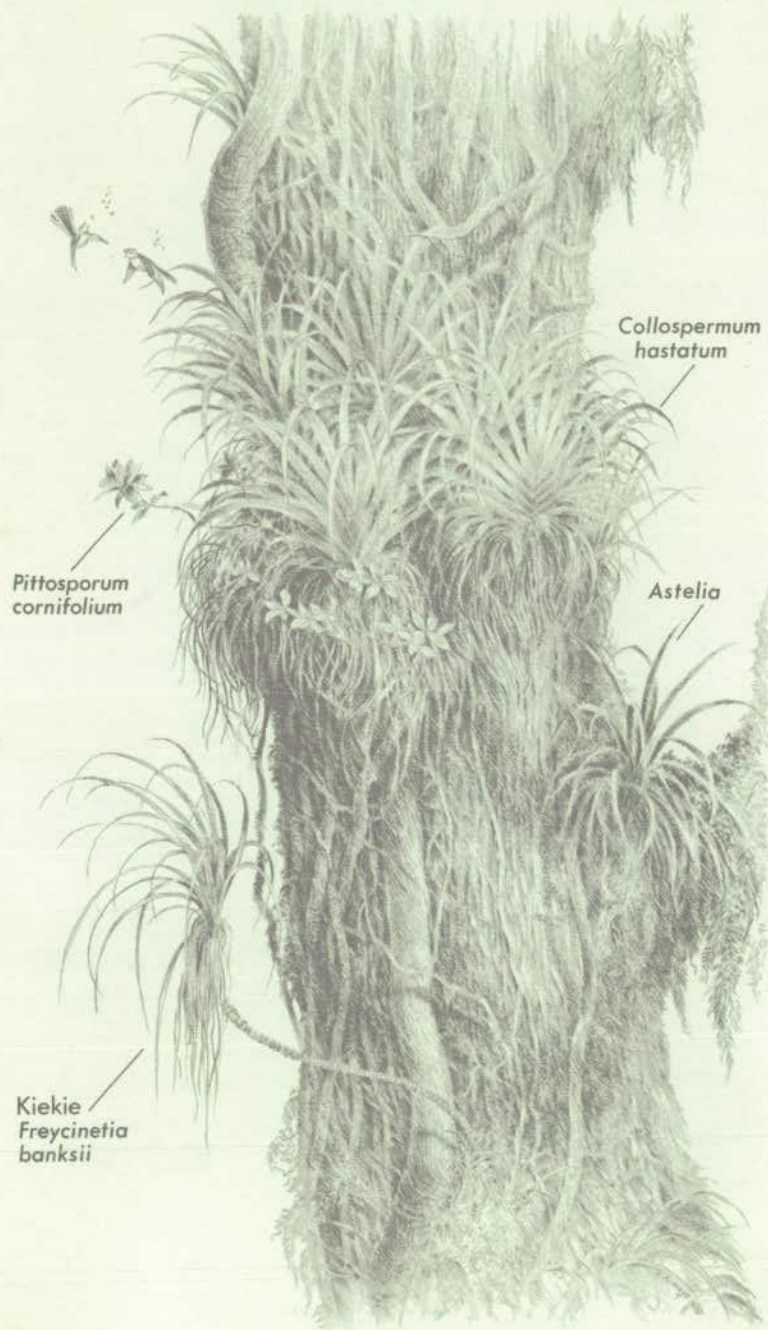


Wheki  
*Dicksonia*  
*squarrosa*



Nikau  
*Rhopalostylis sapida*

10



*Collospermum  
hastatum*

*Pittosporum  
cornifolium*

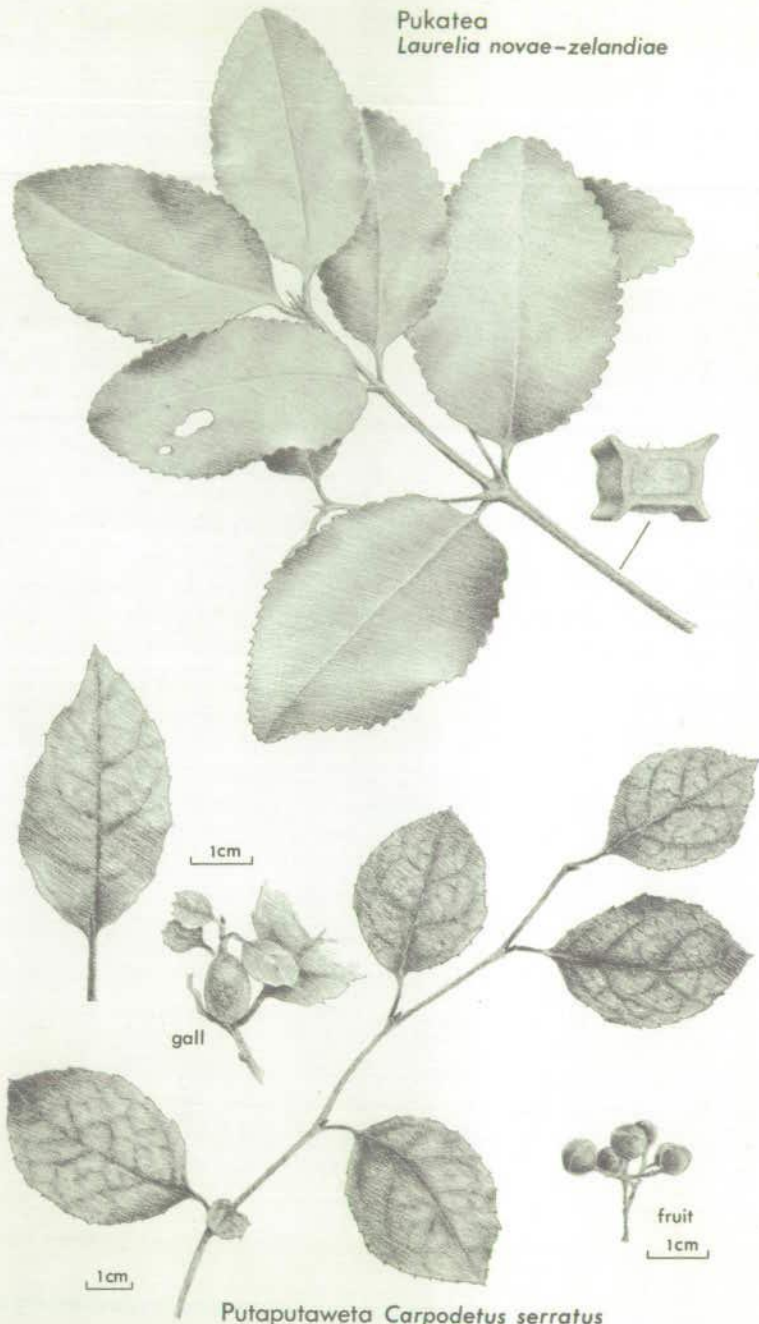
*Astelia*

*Kiekie  
Freycinetia  
banksii*

7



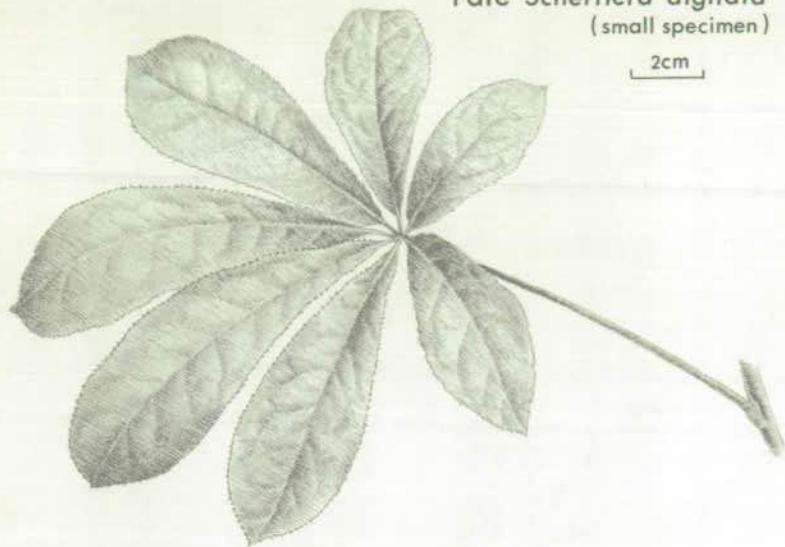
Pukatea  
*Laurelia novae-zelandiae*



Putaputaweta *Carpodetus serratus*

8

Pate *Schefflera digitata*  
(small specimen)



Peg 5. The tall swamp forest tree with radiating plank buttresses is pukatea, one of the few native species able to thrive in such a wet place. Supplejack normally grows with it.

Openings in the canopy encourage species which normally occur in the earlier stages of forest development. Pate and putaputaweta have made an appearance here.

On the margin between swamp forest and beech forest some other native trees find ideal habitats.

Peg 6. Looking from the seat a large matai is seen to the right. This species produces a hard wearing timber favoured for flooring. Note the stout root of shining broadleaf perched high in this tree.

To the left, the rimu like most other large trees in the forest, was probably several centuries old when Tasman passed along this coast more than 300 years ago. In general, large individuals are older than small individuals of the same species but age cannot be estimated from size with accuracy because of wide variations in growing conditions. Rimu is still the most important native timber tree but the versatile exotic pine timber has taken its place for many purposes. The climbing fern on this rimu is *Blechnum filiforme*.

Peg 7. This group of wheki tree ferns shows the distinctive features of the species. Note the straight trunks with old frond bases still clinging, the very rough fronds and the brownish-black hairs at the base of the fronds. Compare it with the stocky silver tree fern and the tall mamaku with its black bent trunk and stout arching fronds. The wheki normally occur in groups because new shoots are constantly being produced at the tips of the numerous underground runners.

9



# GUIDELINES FOR THE PLANNING CONSTRUCTION & MAINTENANCE OF TRAILS

## 1. INTRODUCTION

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These roads tend to follow the natural landform of the land closely. Construction usually consists of minimum earthworks and culverting. The natural road surface is rarely gravelled. Maintenance following initial construction is minimal, and usually left until the surface has severely eroded and access is restricted.

By constructing the roads with crossfall drainage and trafficable cross banks, it is possible to minimize erosion damage and the need for maintenance. Establishment and maintenance of vegetation on the roads further reduces erosion.

These guidelines outline the principles which apply in planning, constructing and maintaining trails to minimise soil erosion and control runoff.

It must be recognised that erosion can :

- (a) contribute to inferior water quality and the siltation of streams;
- (b) be a major factor in destroying trafficability of trails;
- (c) cause serious safety problems.

Consideration of erosion control measures at the planning and construction stage will reduce the cost and increase the effectiveness of trail maintenance programmes.

The guidelines are based on the understanding that there is a very wide variation of geology, soils, topography, vegetation and climate over the State and even within the length of a single trail. Such variations make it impossible to provide recommendations which can be applied to all situations. Where special erosion problems occur on specific trails, the Soil Conservation Service should be consulted.

Definitions of terms used in the guidelines have been included at the end of this leaflet.



Figure 1 Trafficability is seriously impaired when undrained low standard roads become eroded.

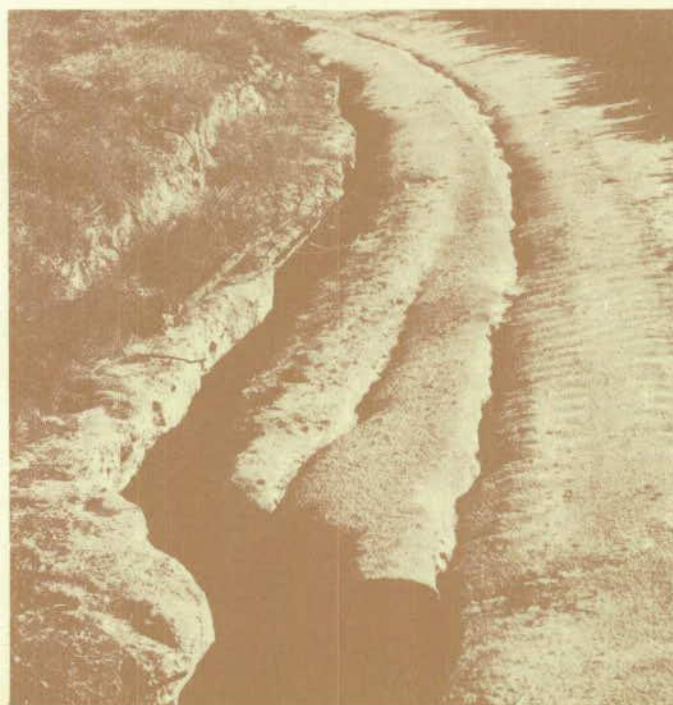


Figure 2 Deep rill erosion caused by inadequate drainage.

## 2. PRE-PLANNING

Erosion of low standard roads can very quickly destroy the trafficable surface of the roads and yield significant volumes of silt to streams. At the planning phase, careful consideration of the following points will ensure that the trail construction will minimise erosion and reduce maintenance requirements.

- The purpose of the trail.
- Type and volume of traffic.
- Possible use by unauthorised vehicles and consequent problems.
- Soil erosion hazards present along the trail.
- Drainage lines and other trail crossings.
- Topographic restrictions (steep slopes, rock outcrops, swampy areas, etc.).
- Potential mass movement areas.
- Vegetation type, density and size.
- Feasibility of proposed construction – should an alternative site be examined?

Alternative routes to the proposed trail should be assessed in the office and the field using all available information. Selection of the route should aim to minimise soil and vegetation disturbance. Wherever possible the trail should be constructed simply by slashing or blading the surface vegetation. Blading of soil should only occur where it is necessary to build a “trail bench” on sideslopes, to form drainage line approaches or make rough surfaces trafficable.

## 3. LOCATION

Trails should be located to minimise the risk of sediment entering drainage lines and generally, should be kept well above flood levels. They should be far enough from a stream to provide an effective vegetative buffer to contain any sediment flowing from the trail.

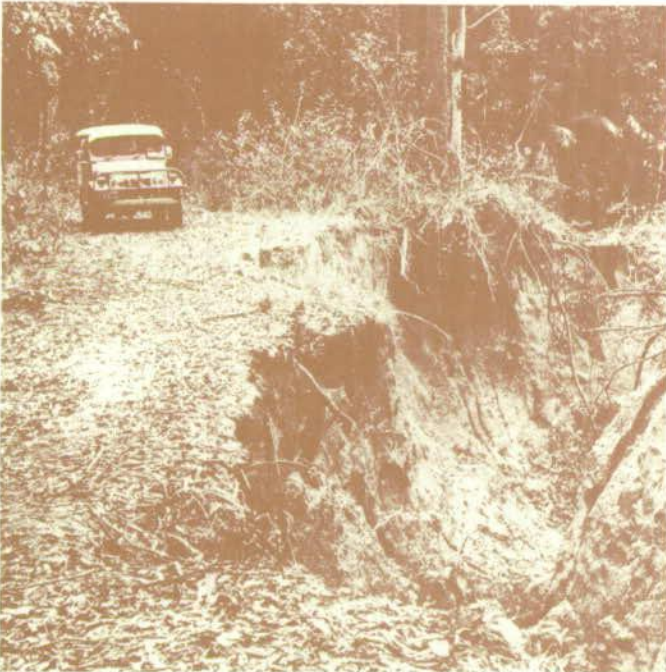


Figure 3 Gully erosion affecting access as a result of poor trail location.

Avoid physical features which may indicate the possibility of mass movement problems, such as:

- High “erosion hazard” soils – Class C and Class D (refer Section 13 – Definitions).
- Slopes with steps, clay beds, humocky topography.

Crossing at mid-slope of long, steep unstable gradients especially where bed rock is highly weathered is not recommended. Also avoid opening up moisture laden toe slopes to form a cut batter.

## 4. GRADES

Gradients limiting effective trail drainage are reached well before those limiting the passage of most four-wheel drive vehicles. Sections of ineffectively drained trails can quickly become untrafficable, especially if located on Class B, C and D soils.

Generally speaking, the grade of a trail should be less than  $10^\circ$ . However, short lengths of steeper grade may be needed to negotiate difficult sections, or to take advantage of favourable terrain and are acceptable.

In designing sections with grades exceeding  $10^\circ$  it will be noted that effective, trafficable cross banks can only be built on trails to approximately  $12^\circ$  grade. Consequently, sections steeper than  $12^\circ$  will require special drainage works.

Trails on Class D soils should not be built on sloping land nor should they be formed mechanically.

Where it is necessary for grades to exceed  $15^\circ$  on Class A and B soils and  $12^\circ$  on Class C soils, surface preparation (gravelling) and more sophisticated road drainage will be required.

## 5. SURFACE DRAINAGE

### 5.1 Crossfall Drainage

Crossfall drainage is often sufficient to ensure control of runoff. This form of drainage reduces runoff along the road to a minimum, as runoff is directed across the road surface and over the road batter. The low profile fill batters associated with this standard of road can withstand the dispersed flow of crossfall drainage. To ensure effectiveness of the crossfall, any earth windrow which develops at construction on the downslope side of the road

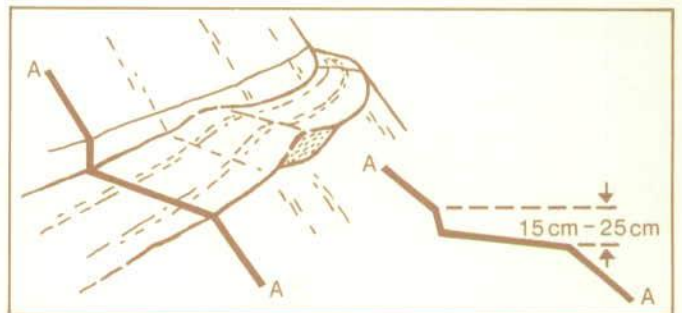


Figure 4 Crossfall surfacing of the road should be used instead of infalling.

should be removed. Care should be taken to overcome wheel rutting which can lead to concentration of water and resultant erosion.

There are two forms of crossfall drainage: outfall and infall (refer Section 13 Definitions). Outfall drainage is preferred and should be used except when:

- Fill batters are unconsolidated and likely to erode.
- Fill batters exceed 1.5 m in height.

In these situations infall drainage should be used and table drains, drop down drains and culverts will also be required. Without adequate culverts, table drains quickly erode, often endangering the trafficability of the road.



Figure 5 Gullying of table drains is a serious erosion problem and a danger to road users.

### 5.2 Cross Banks

Where runoff cannot be controlled by crossfall drainage, cross drains or cross banks may be used. Trafficable cross banks are recommended. Correctly located and built these banks provide effective, cheap, long term, low maintenance road drainage. Cross banks are more likely to be required immediately following construction, when disturbed areas are unconsolidated. They are most efficient if constructed at right angles to the trail. However, diagonal banks may be required to:

- Obtain sufficient gradient.
- Direct water to the most suitable outlet.

In choosing sites for cross banks common sense will dictate the most suitable outlet in the vicinity of the recommended location.

On new trails, or those affected by erosion, cross banks should be constructed at the spacing indicated below.

Cross Bank Spacing			
Road Grade	Soil Class A	Soil Class B	Soil Class C
Up to 8°	70 to 90 m	60 to 70 m	20 to 30 m
8° to 12°	60 to 70 m	50 to 60 m	●
12° to 16°	40 to 60 m	●	●
16° to 20°	30 to 40 m	●	●
20° to 22°	20 to 30 m	●	●

Note (1) ● Indicates that trails should not be constructed on these soil types within the slope range.

Note (2) Where trails are constructed on slopes exceeding 12°, only light and infrequent traffic should be permitted.

Notwithstanding the above guidelines the stability of the trail in operation will eventually dictate the need for, and location of, cross banks.



Figure 6 Trafficable cross banks can be comfortably negotiated and provide effective drainage when sited and built correctly.

## 6. CROSS BANK CONSTRUCTION

A suitable outlet point must be selected for the bank, one that is not blocked by a stump or rock. The outlet should be located so that water will spill into undisturbed vegetation and can't flow back onto the road. The roadline should be ripped to a depth of 20 to 30 cm for a length of one or two tractor lengths back from the chosen outlet point. If loose earth is pushed down the roadline into a bank, commence at the uphill side of the road and work towards the outlet side. Sufficient loose earth must be used to give the required dimensions after shaping and compaction. Depending on the size of the machine being used, up to eight blade-

### Erosion Classes in Relation to Soil Types

Class A — Low Soil Erodibility	Brown and red soils derived from finer sediments and metasediments.
Class B — High Soil Erodibility	Red soils on fine granites, fine sandstones and basalt.
Class C — Very High Soil Erodibility	Grey and yellow soils derived from granites, sediment and metasediment, especially coarse grained types.
Class D — Extreme Soil Erodibility	Unconsolidated sediment. As a general rule, trails should not be built on Class D soils.

### Mitre Drain

A drain to conduct runoff from the shoulders of a trail to a disposal area away from the road alignment.

### Table Drain

The side drain of a road running adjacent and parallel to the shoulders, and comprising part of the road formation.

### Trail

A road of minimal construction standards which closely follows the natural landform and is constructed with a minimum of culverts and earthworks. The surface is rarely gravelled and, following initial construction, receives little maintenance. Construction standards provide for intermittent, but reliable, loaded four-wheel drive travel in fair weather conditions and generally at low speeds. More extensive use, or use during wet conditions, may lead to rapid deterioration of the trail.

## 14. ADDITIONAL INFORMATION

For further advice and assistance, the Head Office and Regional Offices of the Soil Conservation Service of N.S.W. are listed below:

### Head Office

3rd Floor, Export House, 22 Pitt Street,  
Box R201, Royal Exchange Post Office,  
SYDNEY. N.S.W. 2000  
Phone: 27 7235 or 27 9551 (STD 02)

### Northern Region

Parry Shire Building, 468-472 Peel Street,  
P.O. Box 601,  
TAMWORTH. N.S.W. 2340  
Phone: 66 1988 (STD 067)

### Eastern Region

Soil Conservation Service Office,  
Cnr. Guernsey and Susan Streets,  
P.O. Box 130,  
SCONE. N.S.W. 2337  
Phone: 45 1344 (STD 065)

### South East Region

N.S.W. Government Offices,  
159 Auburn Street, P.O. Box 390,  
GOULBURN. N.S.W. 2580  
Phone: 23 0600 (STD 048)

### Western Region

Hay Street, P.O. Box 77,  
CONDOBOLIN. N.S.W. 2877  
Phone: 95 2033 (STD 068)

### Riverina Region

N.S.W. Government Offices,  
43-45 Johnston Street, P.O. Box 10,  
WAGGA WAGGA. N.S.W. 2650  
Phone: 23 0400 or 23 0475 (STD 069)

### Macquarie Region

Cnr. Anson and Kite Streets, P.O. Box 53,  
ORANGE. N.S.W. 2800  
Phone 63 8278 (STD 063)

### North East Region

Cnr. Clyde and Forth Streets, P.O. Box 177,  
KEMPSEY. N.S.W. 2400  
Phone: 62 1391 or 62 1392 (STD 065)

### Acknowledgements:

R.J. Cathcart C.J. Marshall K.J. O'Neill-Fuller

fuls of earth may be required.

A grade across the road of approximately 1:20 will ensure that water does not pond in the channel of the bank. The bank can be shaped with the blade, and the entire length of the bank should be track or wheel rolled to obtain maximum compaction and a smooth, even bank. A sweep with the blade will clean the channel of the bank. The small bank of earth resulting at the outlet end can be left to act as a silt trap and water spreader. This should be pushed far enough so that draining water can clear the road effectively.

If an eroded table drain has to be filled to build a bank, the bank at that point must be well compacted with extra earth to allow for slumping and to cope with the concentration of runoff in the table drain.

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Trail construction should be done with minimum disturbance of soil and vegetation both on, and adjacent to, the trail.

Trails should follow the contour of the land as much as possible to minimize the amount of cut and fill and soil disturbance.

Batters to 1.5 m height should be cut vertically to minimise the area of disturbed soil exposed. Batters to this height may suffer from initial slumping but will generally stabilize with follow-up maintenance.

Fill batters on all soil classes should be no steeper than 2:1 and flatter where possible to encourage effective revegetation naturally or by reseeded. Batters higher than 1.5 m on Class B, C and D soils may require special stabilization works such as drop-down drains, hay mulching etc.

No vegetative debris should be incorporated in fill batters as this results in poor compaction with hollows and slumping occurring as the vegetation rots.

"Borrow" areas should not, for preference, be located near drainage lines or creeks because of the danger of sediment polluting the stream. When necessary, "borrow" areas should be limited in size, worked in such a way to reduce the danger of sediment leaving the borrow pit and revegetated progressively as the pit is worked out.

Wherever practicable, topsoil and litter (free of timber debris) should be stockpiled – in a recoverable position for respreading over disturbed areas. This material contains valuable seed and nutrients which will greatly assist revegetation.

## 8. TIMBER DESTRUCTION

Clearing should be limited to 0.5 m either side of the trail.

## 9. DRAINAGE LINE CROSSING

Crossing of drainage lines should be via fords, culverts or bridges. Log crossings should

not be used as they obstruct flood flows and often create turbulent flow and consequent erosion.

Fords are preferable to culverts or bridges as their associated works are minimal. They should not be used where the creek has a deep cross section which requires considerable excavation to provide the approach to the crossing.

Culverts should never be used where debris blockages are likely.

Culverts should be laid as close as possible to the natural alignment of the drainage line, to avoid diverting the flow into the stream banks or creating scour of the drainage line.

Soil and vegetation disturbed during construction of drainage line crossings should be kept to a minimum. Such disturbed areas may need to be reseeded and protected from erosion.

Timber, scrub, soil or debris should not be dumped in drainage lines but stacked well above flood level.

Corduroy or stone paving should be used on low slope, boggy soft soil areas, to avoid excessive soil disturbance and maintain a trafficable surface.

THE PROVISIONS OF SECTION 26D OF THE WATER ACT AS THEY REFER TO THE DESTRUCTION OR INJURY OF TREES IN THE BED OR WITHIN 20 METRES OF THE BANKS OF PRESCRIBED STREAMS APPLIES.

## 10. REVEGETATION

The degree of revegetation required on disturbed areas may apply as follows:

- No revegetation required – forest litter and native flora will provide natural vegetation and stabilisation.
- Short term revegetation – provided by annual grasses (e.g. wimmera ryegrass) or cereals (e.g. rye corn, oats or japanese millet) and fertilizer. Long term stability will be provided by forest litter and native flora.
- Long term revegetation – using perennial grasses and clovers, with or without a cover crop such as oats, cereal rye corn, japanese millet and fertilizer.
- Use of sod or other vegetative material in specialised situations.
- Use of shrubs and trees such as some silver leafed poplars and shrub willows in situations such as those requiring de-watering or affected by unstable soils.

When revegetation is considered necessary it should be carried out immediately following the disturbance while the soil is still loose, irrespective of the growing seasons.

It may be necessary to apply a maintenance dressing of fertilizer.

## 11. MAINTENANCE

It is essential that a sound cover of vegetation and/or forest litter develops on the surface of the

trail, on batters and the approaches to drainage line crossings.

Frequent maintenance is essential, especially in the early years after construction, to ensure effective erosion control and trail stability.

All trails should be inspected at least annually and following heavy traffic usage, or exceptionally heavy rainfall, to determine maintenance requirements.

Destruction of vegetation should be restricted to the removal of excess vegetation preferably by slashing or spraying. Unnecessary grading or blading should be avoided to minimise soil disturbance.

*Crossfall drainage should be encouraged by removing any windrow along the outside edge of the trail.*

The location, spacing and size of cross banks should always be studied when considering the maintenance programme. A sound guide to bank spacing will be indicated by the distance of water run on a trail before rilling commences. Cross bank outlets should permit the free flow of water.

The outlet of culverts, drains, etc. should be examined at each maintenance inspection and, if necessary, problems corrected.

Material slumping from cut batters should be left untouched if it does not unduly restrict the operating width of the trail. If it is necessary to remove material, care should be taken to avoid undercutting the toe of the batter.

The removal of timber and scrub should be the minimum necessary to maintain safety on the trail. Timber should be felled and wherever practicable stumps left intact instead of being bulldozed. This is especially important above cut batters and adjacent to, and in, drainage lines.

No timber, scrub, soil or debris should be dumped in drainage lines but should always be stacked well above flood level.

Debris deposited near drainage line crossings should be removed during maintenance.

The use of crossfall surfacing and cross banks largely eliminates the need for blading the surface of the road, itself a disturbance and creator of an erosion hazard. The stabilized road surface and protective vegetative cover on the bank outlets combine to provide a reduction in road erosion.

## 12. CONCLUSION

By applying the principles of these guidelines to design and maintenance of trails, access should be available at all times.

The use of crossfall surfacing and trafficable cross banks offers a cheap and easy method of controlling runoff and erosion on low standard roads. Their use will help ensure that roads remain trafficable and that vehicles are not hindered or halted by surface rilling and table drain gullying.

## 13. DEFINITIONS

### **Batter**

The face of an embankment or cutting, produced as a result of earthmoving operations involving cutting and filling.

### **Batter Drop-Down**

A constructed and stabilized drain to carry runoff down the trail batters, typically down the line of greatest slope.

### **Cross Bank**

A hump of earth constructed across a trail so that runoff is effectively diverted from it.

The cross bank is formed by digging a trench up to 20 to 30 cms deep on a graded line across the trail, using the excavated earth to form a bank on the down slope side.

The gradient of the trench should be enough to provide adequate drainage. If the gradient is too steep it will speed the flow of water and this can cause erosion. A gradient of approximately 1:20 is recommended.

The formed bank must be consolidated and with batters shaped no steeper in relation to the trail surface than 1:5.

Cross banks are designed to handle larger anticipated flows than cross drains.

### **Cross Drain**

A drain of various form that baulks the flow of water down a trail and diverts it across the trail's surface. The capacity of the drain is defined by its cross-section.

Cross drains are designed to handle smaller anticipated flows than cross banks but larger flows than can be controlled by crossfall drainage.

### **Crossfall Drainage**

Drainage which occurs when the surface of a trail has sufficient cross slope to cause water to flow across and off the surface, rather than along it. Where the water flows into the hillside it is termed INFALL, and where flow is away from the hillside it is termed OUTFALL.

The minimum cross slope required to achieve such crossfall drainage is 1:25. For safety reasons the maximum crossfall used should generally not exceed 1:10.

### **Culvert**

A pipe or similar structure used to direct water under the trail.

### **Earth Windrow**

A longitudinal ridge of soil created due to spillage at the edge of a bulldozer blade during earthmoving operations. Windrows may build up along the edges of trails during their construction and maintenance. This may prove useful in directing runoff to a stable outlet in which case it is called a WINDROW DRAIN. However, in other circumstances it may prevent runoff leaving the trail, causing erosion.



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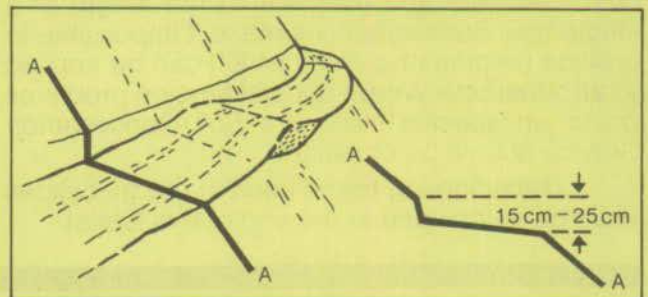


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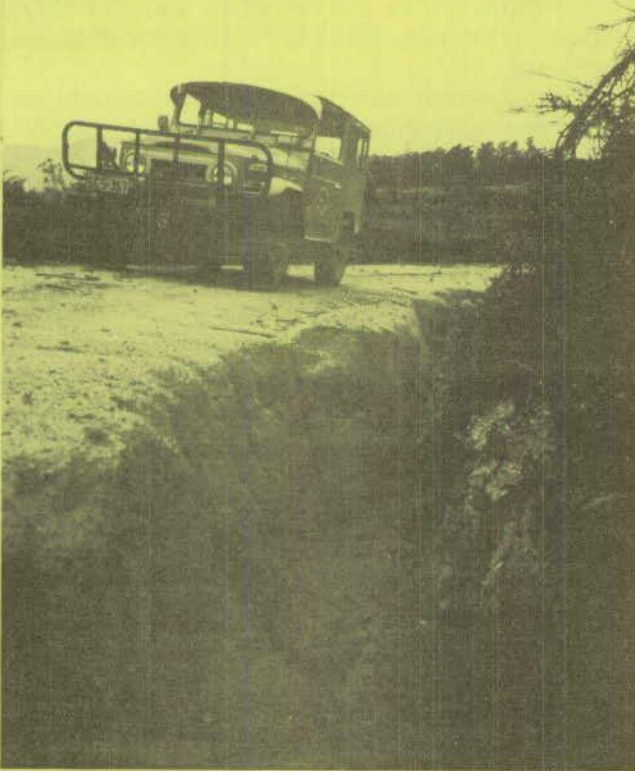


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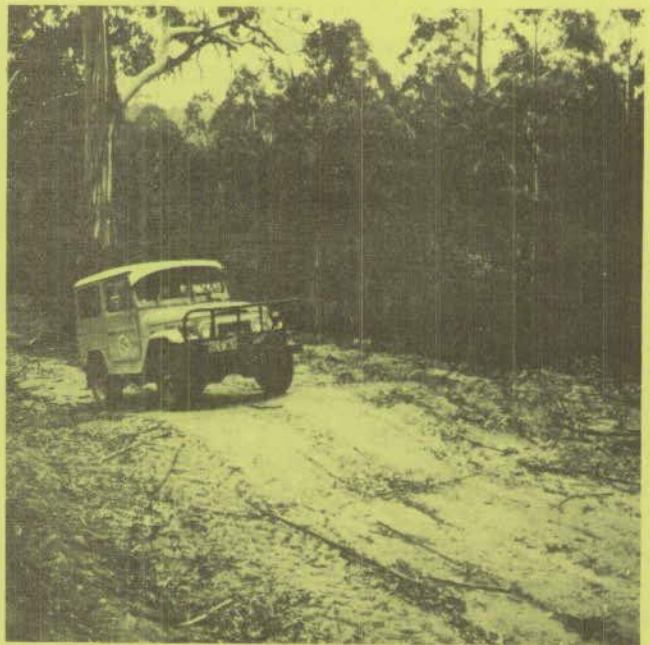


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No vegetative debris should be incorporated in fill batters as this results in poor compaction with hollows and slumping occurring as the vegetation rots.

"Borrow" areas should not, for preference, be located near drainage lines or creeks because of the danger of sediment polluting the stream. When necessary, "borrow" areas should be limited in size, worked in such a way to reduce the danger of sediment leaving the borrow pit and revegetated progressively as the pit is worked out.

Wherever practicable, topsoil and litter (free of timber debris) should be stockpiled – in a recoverable position for respreading over disturbed areas. This material contains valuable seed and nutrients which will greatly assist revegetation.

## 8. TIMBER DESTRUCTION

Clearing should be limited to 0.5 m either side of the trail.

## 9. DRAINAGE LINE CROSSING

Crossing of drainage lines should be via fords, culverts or bridges. Log crossings should

not be used as they obstruct flood flows and often create turbulent flow and consequent erosion.

Fords are preferable to culverts or bridges as their associated works are minimal. They should not be used where the creek has a deep cross section which requires considerable excavation to provide the approach to the crossing.

Culverts should never be used where debris blockages are likely.

Culverts should be laid as close as possible to the natural alignment of the drainage line, to avoid diverting the flow into the stream banks or creating scour of the drainage line.

Soil and vegetation disturbed during construction of drainage line crossings should be kept to a minimum. Such disturbed areas may need to be reseeded and protected from erosion.

Timber, scrub, soil or debris should not be dumped in drainage lines but stacked well above flood level.

Corduroy or stone paving should be used on low slope, boggy soft soil areas, to avoid excessive soil disturbance and maintain a trafficable surface.

THE PROVISIONS OF SECTION 26D OF THE WATER ACT AS THEY REFER TO THE DESTRUCTION OR INJURY OF TREES IN THE BED OR WITHIN 20 METRES OF THE BANKS OF PRESCRIBED STREAMS APPLIES.

## 10. REVEGETATION

The degree of revegetation required on disturbed areas may apply as follows:

- No revegetation required – forest litter and native flora will provide natural vegetation and stabilisation.
- Short term revegetation – provided by annual grasses (e.g. wimmera ryegrass) or cereals (e.g. rye corn, oats or japanese millet) and fertilizer. Long term stability will be provided by forest litter and native flora.
- Long term revegetation – using perennial grasses and clovers, with or without a cover crop such as oats, cereal rye corn, japanese millet and fertilizer.
- Use of sod or other vegetative material in specialised situations.
- Use of shrubs and trees such as some silver leafed poplars and shrub willows in situations such as those requiring de-watering or affected by unstable soils.

When revegetation is considered necessary it should be carried out immediately following the disturbance while the soil is still loose, irrespective of the growing seasons.

It may be necessary to apply a maintenance dressing of fertilizer.

## 11. MAINTENANCE

It is essential that a sound cover of vegetation and/or forest litter develops on the surface of the

trail, on batters and the approaches to drainage line crossings.

Frequent maintenance is essential, especially in the early years after construction, to ensure effective erosion control and trail stability.

All trails should be inspected at least annually and following heavy traffic usage, or exceptionally heavy rainfall, to determine maintenance requirements.

Destruction of vegetation should be restricted to the removal of excess vegetation preferably by slashing or spraying. Unnecessary grading or blading should be avoided to minimise soil disturbance.

*Crossfall drainage should be encouraged by removing any windrow along the outside edge of the trail.*

The location, spacing and size of cross banks should always be studied when considering the maintenance programme. A sound guide to bank spacing will be indicated by the distance of water run on a trail before rilling commences. Cross bank outlets should permit the free flow of water.

The outlet of culverts, drains, etc. should be examined at each maintenance inspection and, if necessary, problems corrected.

Material slumping from cut batters should be left untouched if it does not unduly restrict the operating width of the trail. If it is necessary to remove material, care should be taken to avoid undercutting the toe of the batter.

The removal of timber and scrub should be the minimum necessary to maintain safety on the trail. Timber should be felled and wherever practicable stumps left intact instead of being bulldozed. This is especially important above cut batters and adjacent to, and in, drainage lines.

No timber, scrub, soil or debris should be dumped in drainage lines but should always be stacked well above flood level.

Debris deposited near drainage line crossings should be removed during maintenance.

The use of crossfall surfacing and cross banks largely eliminates the need for blading the surface of the road, itself a disturbance and creator of an erosion hazard. The stabilized road surface and protective vegetative cover on the bank outlets combine to provide a reduction in road erosion.

## 12. CONCLUSION

By applying the principles of these guidelines to design and maintenance of trails, access should be available at all times.

The use of crossfall surfacing and trafficable cross banks offers a cheap and easy method of controlling runoff and erosion on low standard roads. Their use will help ensure that roads remain trafficable and that vehicles are not hindered or halted by surface rilling and table drain gullying.

## 13. DEFINITIONS

### **Batter**

The face of an embankment or cutting, produced as a result of earthmoving operations involving cutting and filling.

### **Batter Drop-Down**

A constructed and stabilized drain to carry runoff down the trail batters, typically down the line of greatest slope.

### **Cross Bank**

A hump of earth constructed across a trail so that runoff is effectively diverted from it.

The cross bank is formed by digging a trench up to 20 to 30 cms deep on a graded line across the trail, using the excavated earth to form a bank on the down slope side.

The gradient of the trench should be enough to provide adequate drainage. If the gradient is too steep it will speed the flow of water and this can cause erosion. A gradient of approximately 1:20 is recommended.

The formed bank must be consolidated and with batters shaped no steeper in relation to the trail surface than 1:5.

Cross banks are designed to handle larger anticipated flows than cross drains.

### **Cross Drain**

A drain of various form that baulks the flow of water down a trail and diverts it across the trail's surface. The capacity of the drain is defined by its cross-section.

Cross drains are designed to handle smaller anticipated flows than cross banks but larger flows than can be controlled by crossfall drainage.

### **Crossfall Drainage**

Drainage which occurs when the surface of a trail has sufficient cross slope to cause water to flow across and off the surface, rather than along it. Where the water flows into the hillside it is termed INFALL, and where flow is away from the hillside it is termed OUTFALL.

The minimum cross slope required to achieve such crossfall drainage is 1:25. For safety reasons the maximum crossfall used should generally not exceed 1:10.

### **Culvert**

A pipe or similar structure used to direct water under the trail.

### **Earth Windrow**

A longitudinal ridge of soil created due to spillage at the edge of a bulldozer blade during earthmoving operations. Windrows may build up along the edges of trails during their construction and maintenance. This may prove useful in directing runoff to a stable outlet in which case it is called a WINDROW DRAIN. However, in other circumstances it may prevent runoff leaving the trail, causing erosion.

### **Erosion Classes in Relation to Soil Types**

Class A— Low Soil Erodibility	Brown and red soils derived from finer sediments and metasediments.
Class B— High Soil Erodibility	Red soils on fine granites, fine sandstones and basalt.
Class C— Very High Soil Erodibility	Grey and yellow soils derived from granites, sediment and metasediment, especially coarse grained types.
Class D— Extreme Soil Erodibility	Unconsolidated sediment. As a general rule, trails should not be built on Class D soils.

#### **Mitre Drain**

A drain to conduct runoff from the shoulders of a trail to a disposal area away from the road alignment.

#### **Table Drain**

The side drain of a road running adjacent and parallel to the shoulders, and comprising part of the road formation.

#### **Trail**

A road of minimal construction standards which closely follows the natural landform and is constructed with a minimum of culverts and earthworks. The surface is rarely gravelled and, following initial construction, receives little maintenance. Construction standards provide for intermittent, but reliable, loaded four-wheel drive travel in fair weather conditions and generally at low speeds. More extensive use, or use during wet conditions, may lead to rapid deterioration of the trail.

## **14. ADDITIONAL INFORMATION**

For further advice and assistance, the Head Office and Regional Offices of the Soil Conservation Service of N.S.W. are listed below:

#### **Head Office**

3rd Floor, Export House, 22 Pitt Street,  
Box R201, Royal Exchange Post Office,  
SYDNEY. N.S.W. 2000  
Phone: 27 7235 or 27 9551 (STD 02)

#### **Northern Region**

Parry Shire Building, 468-472 Peel Street,  
P.O. Box 601,  
TAMWORTH. N.S.W. 2340  
Phone: 66 1988 (STD 067)

#### **Eastern Region**

Soil Conservation Service Office,  
Cnr. Guernsey and Susan Streets,  
P.O. Box 130,  
SCONE. N.S.W. 2337  
Phone: 45 1344 (STD 065)

#### **South East Region**

N.S.W. Government Offices,  
159 Auburn Street, P.O. Box 390,  
GOULBURN. N.S.W. 2580  
Phone: 23 0600 (STD 048)

#### **Western Region**

Hay Street, P.O. Box 77,  
CONDOBOLIN. N.S.W. 2877  
Phone: 95 2033 (STD 068)

#### **Riverina Region**

N.S.W. Government Offices,  
43-45 Johnston Street, P.O. Box 10,  
WAGGA WAGGA. N.S.W. 2650  
Phone: 23 0400 or 23 0475 (STD 069)

#### **Macquarie Region**

Cnr. Anson and Kite Streets, P.O. Box 53,  
ORANGE. N.S.W. 2800  
Phone 63 8278 (STD 063)

#### **North East Region**

Cnr. Clyde and Forth Streets, P.O. Box 177,  
KEMPSEY. N.S.W. 2400  
Phone: 62 1391 or 62 1392 (STD 065)

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# QUANTITATIVE STUDIES OF THE EFFECTS OF HUMAN TRAMPLING ON VEGETATION AS AN AID TO THE MANAGEMENT OF SEMI-NATURAL AREAS

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## INTRODUCTION

The increasing demand in recent years for public outdoor recreation has resulted in a need for the study of its impact on the semi-natural environment. It has become apparent that positive management steps must be taken if the character of such areas is not to deteriorate when subjected to intense or prolonged trampling. Considerable attention has been given to the socio-economic aspects of outdoor recreation, with studies of the attitude and awareness of the public towards the countryside, the money they spent, the distances they travelled and the facilities they expected (Mutch 1968; Smith & Kavanagh 1969; Sillitoe 1969), but there has been little study of the precise effects of recreation on the vegetation and soils of semi-natural areas. As a consequence of the lack of data on the effects of recreation pressure, management proposals have frequently been of an *ad hoc* nature, based on the subjective assessment of the condition of intensively used areas. Management techniques are all too often applied after signs of deterioration have become obvious, such as the loss of ground vegetation and soil erosion, by which time the environment to which people were initially attracted may have been severely damaged and recovery made more difficult. Detailed quantitative studies of the effects of trampling on the vegetation and soils of different sites enables the prediction of environmental changes for given intensities of pressure. More effective management policies could be based on such predictions and so avert environmental deterioration. This paper seeks to outline the nature of the changes caused by human trampling in the soils and ground vegetation of semi-natural areas, to discuss quantitative methods for relating these changes to the intensity of use, and to suggest how these data might be applied in the formulation of management policies for recreation areas.

## THE RELATIONSHIP BETWEEN THE INTENSITY OF TRAMPLING PRESSURE AND ITS ENVIRONMENTAL EFFECTS

### *Carrying capacity*

A precise definition of 'vegetational deterioration' is not simple, but examples exist where appropriate management has been lacking or applied too late and, in consequence, the vegetation cover has been removed by excessive use and soil erosion has followed (Schofield 1967; Watson 1967; Corbett 1968; Lloyd 1970). Deterioration may be less extreme involving such effects as the loss of an attractive flowering species or the formation of permanent puddles in areas of locally concentrated pressure, such as around gateways.

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It follows that the amount of use an area can receive without deterioration of the vegetation occurring is dependent upon the declared management objectives for that site and the degree of 'naturalness' it is felt necessary to preserve. This limiting level of use is frequently called the carrying capacity of the area. Thus the same area might have a series of carrying capacities; a low level of recreational use which would preserve a rare, sensitive species, a higher one which would preserve an acceptable degree of flowering of a ground species, a higher one again which would preserve a complete grass cover, and yet a higher level in which a complete grass cover was dependent on artificial fertilization, seeding and watering. These considerations lead us to define carrying capacity as the maximum intensity of use an area will continue to support under a particular management regime without inducing a permanent change in the biotic environment maintained by that management.

As Wagar (1964) put it, '... final definitions of recreational carrying capacity must be of an administrative nature.'

#### Trampling induced changes

The effect of a given intensity of recreation pressure is dependent upon the nature of the physical and biotic environment, e.g. the geology, soil type, slope, aspect, species composition, the past management regime, and the weather conditions during the period of recreational use. In order to establish the relationship between detailed measurements of intensity of use and observed effects on the environment, it is important that these two aspects be studied concurrently. Speight (1966) attempted this approach in his investigation of recreation in the New Forest. Other workers have tended to treat the 'cause' (trampling intensity) and the 'effect' (vegetational destruction) in isolation (Bates 1935; Ripley 1962). Lloyd (1970) has described a number of the environmental changes that can be attributed to recreational activities. In what is primarily a desk study, covering a considerable number of different habitats, he has outlined the ecological effects of recreation but has not provided any quantitative data relating the use to the effects.

La Page (1967) reports observations made over three years on a newly-opened camp site in New Hampshire, U.S.A. In the first year he found that the logarithm of pressure, measured in camper-days, was related to the logarithm of the percentage loss of vegetation cover. Large plants suffered most, whereas narrow-leaved grasses survived best, and 50% of the lost vegetation cover was regained during the winter. The following season the loss of vegetation was not as great but fewer species were present owing to the elimination of those more sensitive to pressure. After the third season, although more campers used the area in the third summer, the vegetation cover was greater than at the end of the first season, owing to the establishment of resistant species such as bent grass (*Agrostis*) and bluegrass (*Poa*) [sic]. Hence one method of management of heavily-used areas is to encourage the growth of resistant species by seeding, fertilizing and watering. On dry sites, watering not only promotes growth but reduces the desiccation and death of crushed vegetation (Wagar 1965). Ripley (1962) used multiple regressions to relate eight dependent and eighteen independent variables in a survey of forty-two American picnic and camp sites. Although having little data on use of the sites, he concluded that the amount of bare ground exposed on a picnic site was directly related to an estimate of the intensity of use and to the completeness of the overstorey canopy.

Schofield (1967) estimated that the complete loss of the vegetation cover of mature salt-marsh would be caused by the passage of 7500 people per season. A similar number walking over yellow dunes was shown to cause dune erosion and the elimination of

*Ammophila arenaria* (L.) Link, *Agropyron junceiforme* (A. & D. Löve) A. & D. Löve and *Salsola kali* L. Recovery occurred in 4 years if the area was protected. On a grey dune, local exposure of sand and soil was caused by 4000 people, but details of the area concerned, the frequency of trampling and the season involved are not reported. In the Netherlands, Westhoff (1966) has observed that calcareous dunes used for recreation are less liable to erosion than are acid dunes.

A zonation of path vegetation was observed in Britain by Bates (1935). Bare ground, flanked by *Poa pratensis* L. formed the central zones, which he assumed to be the most heavily trampled, with *Trifolium repens* L. and *Lolium perenne* L. on the outer edges. He suggested that resistance to trampling was related to life form, noting that resistant species frequently possessed flat leaves and a conduplicate stem. Many of the resistant species were cryptophytes, bearing perennating buds at or below ground level. Bates suggested that the physical bruising of vegetation and the puddling caused by trampling has a greater effect on the vegetation than the indirect effect of soil compaction. Wagar (1965) found beneficial effects of watering. During hot, dry weather on the Ranmore nature trail (Burden 1970, and below) bruised vegetation was quickly dried by the sun and, together with the dry, dusty, surface soil, was scattered by further trampling and easily blown away by the wind.

A falling tarp was used by Wagar (1964) to simulate trampling for a short part of the growing season. Using regression analysis he discovered 'that grasses and such woody vines as trailing raspberry are less damaged by trampling than are dicotyledonous herbs'. He did not, however, attempt to relate his experiment to any field situation. Bayfield (1971a) has conducted greenhouse experiments with S.50 Timothy (*Phleum pratense* L.), an important constituent of the reseed mixtures on Cairngorm ski areas. At the same time he has conducted controlled trampling of field sites. Whilst these methods provide useful data on the immediate effects of trampling, it should be remembered that the long term effects of continued trampling may be quite different.

#### Beneficial trampling

In certain situations, low levels of trampling may be acceptable and even desirable in order to maintain the character of the environment. Above this level, deterioration will ensue unless the vegetation is artificially maintained, or access restricted at times when it is vulnerable. In the management of areas heavily used for outdoor recreation it is important to be able to predict with accuracy the intensity of recreation pressure at which permanent deterioration (in the sense in which it has been defined above) begins. Sankey & Mackworth-Praed (1969) conducted regular trampling of *Brachypodium sylvaticum* (Huds.) Beauv. for a season on a chalk grassland and found a reduction in the height of the grass and in the setting of its seed, and areas of bare ground appeared. With further trampling the bare ground increased and the broad-leaved herbaceous species were damaged more than the grass. They concluded that *B. sylvaticum* could be kept in check by trampling but that excessive levels of trampling eliminated many of the attractive herbaceous species for which chalk grassland is noted. Westhoff (1966) points out that many species of botanical interest occur in areas of light or medium trampling pressure, and so trampling is not always detrimental.

#### THE MEASUREMENT OF RECREATION PRESSURE

The measurement of the intensity of recreation pressure on an area involves a consideration of the number of people, their distribution and their activities as well as the season of

the year and the length of time for which the pressure is applied. The length of time for recovery of the vegetation between periods of trampling must also be considered. For example, the effect of a hundred people spread through a season may be slight, that of ten per day for ten days may be greater and severe damage may result from a hundred in the space of 1 hour. The intensity of pressures applied for a given length of time varies with different activities but it is extremely difficult to establish quantitative relationships between the different effects on the vegetation and soil caused by, for example, picnicing, walking, and playing football. Our studies conducted on paths and discussed below, are concerned only with the activity of walking.

Hammond (1967) and Schofield (1967) simply counted the numbers of people passing along a path. La Page (1967) assessed the intensity of recreation pressure on a camp site in terms of cumulative number of camper-days over a period of time. Bayfield (1971b) obtained a relative measure of the lateral distribution of trampling intensity across paths. In our field studies we have used a measure of the number of walkers per metre of each defined unit or zone of vegetation over a given period, or in unit time. This measure provides data on the numbers of people and their distribution. It was possible to calculate the physical pressure exerted per unit area of ground per unit time, having regard to the weight, size of boot, length of pace and frequency of the visitors.

#### THE MEASUREMENT OF THE EFFECTS OF TRAMPLING PRESSURE

The study of the relationship between the intensity of recreational use and environmental change may be approached in two ways. Firstly, the course of edaphic and floristic changes may be observed when an area is exposed to recreational use for the first time, or as the intensity of recreational use increases. Secondly, an established system can be investigated, in which the vegetation and the trampling are assumed to be in equilibrium, and changes with time are minimal. Within the first approach, depending on the rate of change of the intensity of pressure, the rates of change in the environment will be slow and gradual, or rapid and intense. Hence the time scale of the study will be correspondingly long or short.

##### *Approach 1(a): observation of the course of change; long term*

Changes in the vegetation and soil are recorded over a period of years at specific sites, and related to the changes in the observed intensity of use. This method provides data which can be used to predict the course of change of similar sites. It has the disadvantage that a long time is required for collecting the data, during which period irreversible deterioration of the site may occur. The sacrifice of the site may, however, be justified if successful management schemes are derived from the data obtained, and are applied to the conservation of other sites under pressure.

##### *Approach 1(b): observation of the course of change; short term*

Changes in the vegetation and soils are recorded over a short period during which the pressure upon a site is rapidly or suddenly increased. If this increase is not great and the new level of trampling is maintained indefinitely, a new equilibrium between the trampling and plant growth will be reached and the vegetational change will cease. More commonly, situations are encountered where a very intense pressure is applied for a short time on a previously unused area such as a known number of people attending a county show or nature trail. The effects on the environment and its subsequent recovery after the event are then studied in the light of the level of pressure and the time for which it was

applied. This approach is dependent upon conditions specific to the site and the weather. Information gained from this kind of study in conjunction with a knowledge of the past recreational use of an area, may be used to predict the effects of a given recreation pressure when this intensity is to be applied to an area for the first time, whether or not this level of pressure is to be maintained.

##### *Approach 2: investigation of an established system at equilibrium*

This type of investigation measures the environmental characteristics of a series of sites each of which is subjected to a known intensity of recreation pressure. The fieldwork occupies a matter of days rather than months. The floristic composition and soil parameters are assumed to be determined principally by the particular intensity of trampling at each site. Taking into consideration the variation of environmental factors, comparisons between sites are made in order to assess the effect of increasing intensities of trampling. As in approach 1(a), measurements of both pressure and environment can be made accurately within a small study area, especially if a number of replicate samples is taken. Intensities of trampling may thus be related to known effects such as the elimination of a particular species. It is assumed that the levels of trampling pressure for some time prior to the investigation have been constant, so that the vegetation and soil characteristics are in equilibrium with them. Data are obtained quickly with this method but, as with approach 1(b), the results are dependent upon specific factors such as current weather conditions. In both approaches, the extrapolation of results to predict environmental effects for levels of pressure outside the range of those actually measured is a procedure open to criticism.

#### FIELD STUDIES

To demonstrate the application of these approaches in the field, one example of approach 1(b), an event causing short-term changes, and two examples of approach 2, studies of established equilibrium systems, are described.

##### *(A) The investigation of the environmental effects of an event (approach 1b)*

During the period of 13-20 July 1969, the Surrey Naturalists' Trust organized a nature trail at Ranmore on the North Downs near Dorking. One of us (R.F.B.) investigated the effects of the unidirectional passage of 7729 people round the trail (an average intensity of 966 per day), which included previously untrampled areas of woodland on clay-with-flints as well as chalk grassland (Burden 1969, 1970). Having regard to the path width, the weight, size of foot, length of pace and frequency of the visitors, a pressure figure for a path 1 m wide of  $62 \text{ kg cm}^{-2}$  was calculated for the total period of 8 days. The movement of visitors was more haphazard on the picnic area at the start of the trail and hence the pressure was more dispersed. A daily survey of the trail was made, path widths measured and photographic records made. The weather was dry and sunny during the whole week.

##### *Soil*

A comparison was made of the depth of needle litter under the larches, *Larix decidua* Mill. at the picnic area before and after the week, using two methods. The litter depth in replicated soil cores, and the heights of tree stumps above the litter surface, were measured. A statistically significant difference was found only with the soil cores.

On alternate days, path profiles were recorded by means of a level, consisting of a



perforated bar, and a vertical scale, which was placed across the path, and rested on permanent pegs. The clay-with-flints soil under hazel coppice showed only a little overall compression. This was probably due to smearing of the uppermost clay layer, exposing the more resistant flints and tree roots.

In the beech wood, a higher compression of the chalky soil was recorded, 50% of which occurred within the first two days. The friable soil of the chalk grassland slope, rather than undergoing compaction, was broken up and kicked down the slope. Although the duration of the event was short, this method detected small changes in the level and shape of the paths.

The assumption was made that soil structure is affected by trampling, hence samples were taken from trampled and untrampled areas of a series of sites, to estimate changes in pore space and soil compaction. A series of soil cores of a constant known volume was taken and each core shaken up with a known volume of water in a measuring cylinder. The change in volume recorded is equal to the combined volume of the soil particles and soil water. The volume of air-filled pores is then the difference between the former and the volume of the core. As no rain fell during the week, the soil water content was probably constant and hence the proportion of air-filled pores which this method measures is here taken as an estimate of soil compaction. A second method was modified from that employed by civil engineers (British Standards Institute 1963). The volume of core samples was determined by filling the remaining hole with a measured volume of dry sand. After wet and dry weighing, the soil particle volume of the core was determined by the displacement of water from a specific gravity bottle. This method allows air-filled, water-filled and total pore spaces to be calculated. The results showed that the effect of trampling was to decrease the total pore space and the proportion of air-filled pores, and to increase the proportion of water-filled pores. This suggests that increasing soil compaction is effected by the obliteration of air-filled pores and in consequence, the soil becomes proportionately wetter. The two methods give comparable results although the first method is quicker and simpler.

#### Vegetation

In both the woodland and chalk grassland, point quadrats were taken and also vegetation and surface litter in 25-cm<sup>2</sup> and 1-m<sup>2</sup> quadrats respectively were collected from trampled and untrampled areas, for subsequent comparisons.

A reduction in the standing crop of *Hedera helix* L. by a factor of more than four occurred on the path in the beech wood. On the south-facing chalk scarp exposed to the sun, the quantity of vegetation litter increased as plants became flattened, broken and dried. However, in the hazel and oak woodland with virtually no understorey vegetation or leaf fall, the broken, crushed leaf litter decreased.

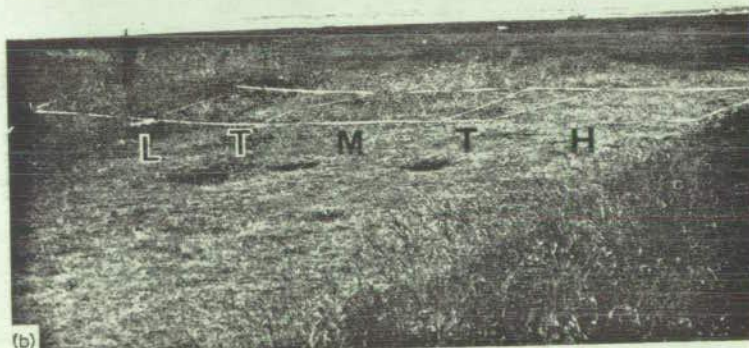
The trail showed a typical reaction as trampling progressed. As the path became wider, the centre became worn, and eventually bare of vegetation (Plate 1a, b). Paths aligned across slopes became over-widened on the lower side, whereas paths up or down slopes showed the greatest amount of erosion of vegetation and soil. Species differed in their resistance to trampling. *Mercurialis perennis* L. and *Viola hirta* L. soon disappeared whereas the stems of some of the more substantial plants such as *Senecio jacobea* L., *Pastinaca sativa* L., *Centaurea scabiosa* L. and *Agrimonia eupatoria* L., remained up-standing. *Hedera helix* soon lost its leaves, but the runners were more resistant. Tussocks of vegetation became eroded only on the side from which people approached. More resistant species, which occurred on previously established paths, such as *Plantago*



(a) Part of the Ranmore Nature Trail after the passage of twenty people. (b) The same place after the passage of 7899 people over 9 days.



(a)



(b)

(a) The zonation of *Bellis perennis* across a footpath at Old Grimsby, Tresco, Scilly. Note the gradient of trampling pressure and the transect markers. (b) The Norfolk study site showing the three zones of trampling pressure: H = high, M = medium, L = low; T = transitional zone.

*lanceolata* L., *P. media* L., *Bellis perennis* L., *Lolium perenne* and *Cynosurus cristatus* L., survived the subsequent trampling. The presence of resistant species on established paths of the chalk scarp was similar to the zonation of species on paths described by Bates (1935). It is of interest that the flower heads of these grasses, many of which remained erect after the week, measured 25 cm in height, compared with the 70 cm of susceptible species such as *Holcus lanatus* L. and *Bromus erectus* Huds. on untrampled areas.

#### Recovery

Three weeks after the end of the trail, a survey showed shoots of *Pteridium aquilinum* (L.) Kuhn and *Holcus lanatus* emerging from the bare ground of the picnic area. Growth of *Viola hirta*, *Hedera helix* and the flattened grasses of the chalk slope was noted, presumably due to the underground stems and roots having escaped damage.

#### (B) Isles of Scilly short-term investigation (approach 2)

##### Visitor : vegetation survey

During May 1969, a team of eight postgraduates and four staff from University College London carried out a 10-day survey on the impact of recreation pressure on the ecology and amenity of the Isles of Scilly (Anon 1969; Goldsmith, Munton & Warren 1970). As part of a large-scale survey, the vegetation of the five major islands was mapped, and this was related to the numbers and distribution of visitors on these islands. These data were obtained from questionnaire-maps completed by a very high proportion of visitors while making the return boat journey after a visit to the island concerned. It must be remembered, especially at this scale, that the distribution of people over an area is determined as much by the nature of the vegetation as is the vegetation by the distribution of people. Thus visitors distribute themselves on areas of short grass sward rather than areas of bracken and by doing so prevent invasion of bracken by their trampling. This feedback effect is principally seen on the large scale, although it applies also on the small scale to footpaths, which tend to be self-perpetuating.

Detailed ecological studies were made of nineteen specific sites, having regard for ecological gradients resulting from such factors as exposure to salt spray. Sites were selected where zones of varying trampling intensities were evident and having a nearby vantage point from which the numbers and distribution of people on the site could be observed. Many of the chosen sites were on footpaths around the coast where the untrampled vegetation was a maritime heath or maritime grass sward. Quadrats were placed along transect lines either at regular intervals or in positions which spanned the whole gradient of trampling pressure. For all species present, cover was recorded as a percentage and on the 1 to 5 Domin scale, and records were made of the mean height of each species, presence of flowers, soil depth to bedrock, pH, conductivity, percentage of organic matter, and the distribution of particle sizes in the soil.

##### Distribution of people

The numbers of people crossing a site were recorded by simple observation, or by photo-electric counters where the site was close to a suitable position for their operation and concealment. Observations were made of the distribution of people crossing the sites, using stones or driftwood markers placed along the transects. A more objective method was the use of 35-mm cameras at fixed positions overlooking the transects. A 'base photograph' of the site was necessary, which included marker poles, pegs and tapes to

define the sample areas. In a situation where the passage of people across a site is continuous, photographs can be taken at regular intervals to obtain a sample of the distribution. Where people are less frequent, as on Scilly, it is necessary to take a photograph whenever someone crosses the site. By this method, a permanent, accurate record of the total number and distribution of people was obtained. It is essential that the positioning and alignment of the camera be identical for each picture. The film was later projected on to a paper screen, and cumulative distribution diagrams plotted which were related to data of the vegetation and soil. The methods of observation and of camera recording are very time consuming, and a method of automatic photography was tried.

#### Time-lapse photography

To fulfil the requirement of a large film capacity, and automatic shutter release and film advance, we used a 16-mm cine camera with single frame facility, driven by a 12 V d.c. battery via an electronic timer, and loaded with black-and-white reversal film of sufficient latitude to render automatic exposure control unnecessary. The camera was positioned on a lighthouse at a height of about 20 ft, overlooking an area of maritime grassland crossed by a number of paths. A 'base photograph' was taken with a regular grid of poles and tapes laid out on the site. This grid, which allows the subsequent accurate location of people, was preferred to the overlay grid on the site pictures suggested by Goodier (1967) which takes no account of distance and perspective in the picture. Time intervals of 4 minutes, and of 30 seconds were tried, but there was insufficient power in the battery to operate the mechanism regularly, and mains power was not available on the site. However, sufficient film was obtained to demonstrate the potential of this technique, particularly at sites where large numbers of people are involved. The rigid camera position, looking down on the site, enabled accurate plots of the positions of people to be made on the grid, which could be accurately related to vegetation data. One of us (R.F.B.) is currently investigating the use of a photo-electric counter to activate the shutter release of a clockwork-powered, single exposure cine camera. This will enable the technique to be used with greater efficiency, especially on sites where the passage of people is relatively infrequent or irregular. The transects across the chosen sites were divided into homogeneous vegetation units and the distribution of people along the transects expressed in terms of numbers per metre of each vegetation unit for the total counting period. This gives a comparative measure of trampling pressure within a single transect. For comparison of different transects it is necessary to consider the length of time and the time of day during which the observations were made.

#### Results

It was found that certain species occurred more frequently in the trampled zones, indicating a tolerance of high levels of pressure. In the untrampled areas, however, these species appear to be at a competitive disadvantage and are overgrown by the trampling-sensitive species of the untrampled community. These resistant species may be termed indicator species in just the same way as other species are indicators of acidic conditions or high levels of soil nitrate. On Scilly, the indicator species included *Plantago coronopus* L., *P. lanceolata*, *Bellis perennis*, *Armeria maritima* (Mill.) Willd., *Agrostis tenuis* Sibth., *A. stolonifera* L., *Scilla verna*, Huds., and to a lesser extent, *Potentilla erecta* (L.) Rausch, *Festuca rubra* L., and *Poa annua* L. Certain species may be indicators of pressure by showing modification of their growth form. Thus *Armeria maritima* occurs as tussocks on non-trampled areas of maritime grassland, whereas trampling has the effect of suppressing

both tussock formation and flowering, although the cover afforded by the individual plants remains relatively high.

Plate 2(a) shows the effect on the flowering of *Bellis perennis*, caused by a wide path in which two bands of higher pressure were observed. In a rather different environment, the mountain tundra of the Cairngorms, Watson, Bayfield & Moyes (1970), have observed that *Calluna vulgaris* (L.) Hull and *Trichophorum caespitosum* (L.) Hartmann are good indicators of trampling and show characteristic changes in growth form and cover.

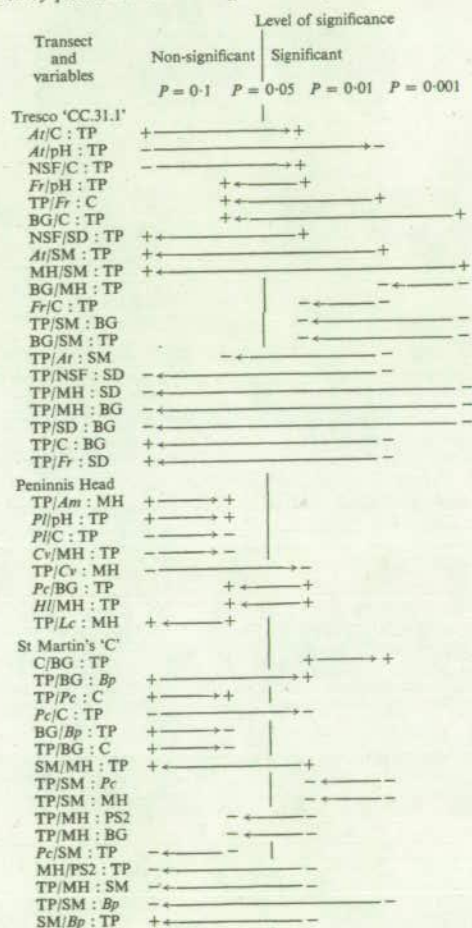
#### Correlation analysis

To demonstrate the distribution of species in relation to trampling in quantitative terms, correlation coefficients were calculated from the data, showing the relationships of all the factors measured, both human and environmental. It proved instructive to relate the abundance of each species to the level of trampling pressure, and then, by the calculation of the partial correlation coefficient, to exclude from this certain environmental effects such as soil depth, conductivity, and moisture. In the majority of cases there was no significant change in the correlation after exclusion of the effect of a third factor. For example *Calluna vulgaris* retained its significant negative correlation with trampling after exclusion of the effect of pH, soil moisture, conductivity, or soil depth, whereas the correlation between *Agrostis stolonifera* and trampling remained non-significant after exclusion of the same factors. However, in several cases, examples of which are given in Table 1, changes in the level of significance were observed, indicating that the species concerned possessed some complex relationship involving both trampling and one or more of the environmental factors. Several species were found to lose their significant correlations with trampling pressure when the effect of an environmental factor was removed, or *vice versa*, indicating their sensitivity or resistance, depending on the sign of the correlation, to the intensity of trampling. For example, *Festuca rubra*, *Agrostis tenuis*, *Holcus lanatus*, *Plantago coronopus*, *Bellis perennis*, maximum height of vegetation and number of species in flower all show this kind of relationship with trampling and such factors as soil moisture, depth and particle size distribution, pH, conductivity or the amount of bare ground. In many cases, the change occurs as a result of the exclusion of trampling pressure, e.g. *Plantago coronopus* ceases to be correlated with bare ground when the factor of trampling is excluded. In some cases, correlations increased their significance after the exclusion of a third factor, e.g. *Agrostis tenuis*, *Plantago coronopus* and the number of species in flower, with pH or conductivity, after the exclusion of the trampling factor. Examples of changes are also shown which do not cross the significance boundary of  $P = 0.05$ , but indicate that relationships with trampling probably exist. This method provides a simple means of investigating the relative effects of trampling and other environmental factors on the growth of particular species but in many cases, the interrelations are too complex to be analysed adequately. There is also the criticism that the data are not entirely suitable for the calculation of correlations, as the occurrence of species may be zero in several samples, e.g. for a sensitive species in the centre of a path. However, such samples may not be excluded from the calculation as this would substantially alter the correlation by reducing the range of trampling pressures over which it was assessed.

#### Ordination analysis

Ordination provides a method of extracting the principal axes of vegetational variation and relating these to different environmental factors to determine which factors govern

Table 1. Examples of the correlations between two variables and the changes in significance and sign of the correlation when the effect of a third variable is removed by partial correlation coefficient analysis; three transects, Scilly



Arrows to the right show increases in significance, to the left, decreases.

Key: X/Y : Z partial correlation between X and Y, excluding the effect of Z.

TP	Intensity of trampling pressure	Fr	<i>Festuca rubra</i>
SM	% soil moisture	At	<i>Agrostis tenuis</i>
BG	Bare ground	Cv	<i>Calluna vulgaris</i>
C	Conductivity	Hl	<i>Holcus lanatus</i>
SD	Soil depth	Lc	<i>Lotus corniculatus</i>
MH	Maximum vegetation height	Am	<i>Armeria maritima</i>
NSF	Number of species in flower	Pc	<i>Plantago coronopus</i>
PS2	% soil particle size (medium range 0.002-0.2 mm)	Pl	<i>P. lanceolata</i>
		Bp	<i>Bellis perennis</i>

the distribution of the vegetation. Ordinations were performed on the vegetation data of three transects using the principal components analysis of a variance-covariance matrix; an R technique designed to give equivalent results to the Q analysis of a weighted similarity coefficient matrix (Orloci 1966). The principal axes obtained were correlated with data for the vegetation, trampling and environmental factors and the results are given in Table 2.

Table 2. Correlations of floristic and environmental variables with ordination axes for two transects on Scilly (significance and sign of the correlations are shown)

Transect and variable	Axis 1	Axis 2	Axis 3
Tresco 'CC.31.1'			
<i>Calluna vulgaris</i>	***+		
<i>Erica cinerea</i>	***+		***+
<i>Festuca rubra</i>	**+		
<i>Agrostis tenuis</i>	***-	***+	
<i>Plantago coronopus</i>		***-	-
<i>Aira praecox</i>		**-	*-
<i>Rubus fruticosus</i>			***+
<i>Pteridium aquilinum</i>			*+
Max. height of veg.	***+		***+
No. of spp. flowering	**-		*-
Bare ground	***-	***-	
pH	***+		
% soil moisture	***+	**+	
Conductivity	***-	**+	
Soil depth	**+		+
Trampling pressure	*-	*-	
St Martin's 'C'			
<i>Plantago lanceolata</i>	***+	Correlations with 2nd and 3rd axes omitted as no environmental factors were involved	
<i>P. coronopus</i>	*+		
<i>Lotus corniculatus</i>	**+		
<i>Euphrasia officinalis</i>	**+		
<i>Jasione montana</i>	*+		
<i>Erodium cicutarium</i>	**+		
<i>Bellis perennis</i>	*+		
<i>Trifolium campestre</i>	*+		
<i>Ononis repens</i>	*-		
<i>Anthoxanthum odoratum</i>	***-		
<i>Aira praecox</i>	**+		
<i>Hypnum cupressiforme</i>	***+		
<i>Pelligera</i> sp.	*+		
Max. height of veg.	**-		
No. of spp. flowering	*+		
% soil moisture	**-		
% particle size (medium)	*+		
Trampling pressure	**+		

\*\*\*,  $P < 0.001$ ; \*\*,  $P = 0.01-0.001$ ; \*,  $P = 0.05-0.01$ ; blank spaces,  $P = 0.1-0.05$ , i.e. just below significance.

The first two axes of the Tresco transect both involve trampling pressure. The data show that at high intensities of trampling, high values would be expected for bare ground, number of species in flower, *P. coronopus* and *Aira praecox*, but low values for soil depth, soil moisture, pH, maximum height of vegetation, *Calluna vulgaris*, *Erica cinerea* and *Festuca rubra*. The results for conductivity and *Agrostis tenuis* are contradictory, indicating that their relationship with trampling is not a simple one, and demonstrating the difference between the first and second axes of variation. In the St Martin's transect, the principal ordination axis is strongly related to trampling pressure. Thus positive relationships are held between trampling and % silt particles (0.002–0.2 mm), number of species in flower, and several species including *Plantago lanceolata*, *P. coronopus* and *Bellis perennis* whereas negative relationships are held with soil moisture, maximum height of vegetation and susceptible species such as *Anthoxanthum odoratum*. It is surprising that both transects show negative relationships between trampling and soil moisture, when examined by both partial correlation and ordination, but this probably results from the lack of waterlogging due to the well-drained soils and the sloping ground. Interpretation of the ordination results is easier than those of partial correlation, but both methods give reliable indications of the species affected by trampling and the relative importance of other environmental factors. In both cases the situation is inevitably oversimplified because no distinction is made between the direct effect of trampling on vegetation, the indirect effect via the modifications of soil characteristics and the effect of independent variation in the soil parameters of the site. These effects could only be separated by the selection of an 'ideal' site which was homogeneous in all respects except trampling pressure.

#### (C) Norfolk short term investigation (approach 2)

##### Method

During July 1969 one of us (P.F.R.) undertook a survey of the environmental effects of trampling on a sand-covered shingle ridge community on Morston Marsh, Norfolk (Randerson 1969). Above the level of the highest normal tides, the ridge supports a closed sward of grasses and herbs, and is crossed by a path varying between 3 and 4 m in width. A site was chosen where a clear distinction could be made between zones of high, low and intermediate trampling, on the basis of the height of the vegetation (Plate 2b). Replicated measurements were made in each zone of the height of the vegetation and the standing crop, both above and below ground. The method used was to cut out 25-cm<sup>2</sup> turves and clip off the aerial parts. The species present were placed in one of four groups according to their growth form, a characteristic strongly related to trampling pressure, as follows.

- (1) Rosette plants: *Plantago coronopus*.
- (2) Cushion plants: *Armeria maritima*.
- (3) Plants straggling along the surface and between other species: *Silene maritima* With., *Cerastium semidecandrum* L.
- (4) Erect plants: *Festuca rubra* var. *arenaria* Fries, *Poa pratensis* L., *P. subcaerulea* Sm., *Agrostis stolonifera*, *Ammophila arenaria*, *Agropyron pungens* (Pers.) Roem. & Schult.

The root mat of each turv was treated as a unit, after separation from the soil. The plant fractions were oven-dried and weighed, and measures of the pH, moisture content, loss

on ignition, percentage of organic matter, and distribution of particle size were made on samples of the soil. Soil compaction was estimated on the basis of the dry weight of replicate soil cores of constant volume. The number of people, totalling 511, and their distribution on the three zones was recorded by simple observation during a day representative of peak visitor usage.

##### Results

The differences between the three zones for all the characters measured were assessed by the calculation of Student's *t* for the differences between the sample means. Significant differences were found to exist between the zones, for the standing crops of all the plant groups and the roots. The cushion plants and straggling plants showed a reduction, whereas the rosette plants and the roots showed a higher standing crop with increasing trampling pressure. Similarly, the soil cores were significantly heavier at high than at low

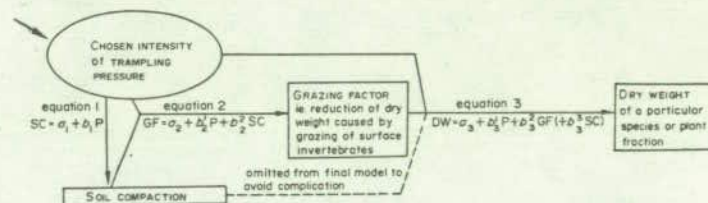


FIG. 1. Diagram representing the predictive model obtained by regression analysis in the Norfolk study. P = intensity of trampling pressure, SC = soil compaction, GF = grazing factor, DW = dry weight, *a* and *b* are calculated regression coefficients.

pressure. The weights of grasses were greatest at low, and least at medium pressure, this complex relationship resulting from the differing reactions to trampling of the various species composing the 'grass' complex; a result similar to that observed by Bates (1935). This result may also indicate that the level of pressure is increasing and hence is not in true equilibrium with the vegetation. In this situation the medium pressure zone would be expected to be the most affected and show the greatest loss of standing crop, before the resistant species become established. In order to assess the effect on the standing crop of grazing by surface invertebrates, replicate plots were treated with insecticide and harvested after a 4-week growth period. Significant differences in the standing crop were obtained in several cases, and from these data a grazing factor was calculated for each group of species at each level of pressure. Similar conclusions were obtained when an analysis of variance was performed on the results.

##### Predictive model

Regression techniques were used to establish quantitative relationships between trampling pressure as the independent variable, and the dependent variables of soil compaction, grazing factor and standing crop of a particular species. These regression relationships are based on only three measurements of the independent variable, corresponding to the three pressure zones. Hence linear regressions only were calculated and conclusions drawn from them are tentative. Although the level of trampling pressure was shown by the values of the regression coefficients to have a significant effect only upon soil compaction and

the standing crop of all species, in further calculations, the nonsignificant variables were included to demonstrate the operation of the model in more complex situations. By linking the regression equations in sequence, a simple linear model was formed and used to predict the value of each of the dependent variables from a given value of the independent variable, trampling pressure (Fig. 1). By extrapolation of the model, the level of trampling pressure at which the standing crop becomes zero was found, and termed the 'trampling capacity' of that component of the sward. The overall trampling capacity of the sward is composed of the trampling capacities of several species and may be much greater than that for particular individual species, depending on their sensitivity. It can be argued that the variables may not bear the same relationship outside the range investigated in the field and hence extrapolation outside the range is invalid. However, in the absence of further data, this method allows a tentative prediction to be made of the levels of trampling pressure at which deterioration of the sward is likely to begin.

#### DISCUSSION AND CONCLUSIONS

Owing to the urgent need for data on the ecological effects of recreation activities, our field studies have concentrated upon those methods yielding more rapid results. The three examples have all attempted to relate the observed environmental differences and changes to the measured intensity of trampling. The Ranmore study recorded absolute numbers of people per day using the trail, whilst the Scilly and Norfolk surveys utilized comparative levels of trampling across the study areas.

##### Ranmore

The study of the rapid changes resulting from the trampling of previously unused areas at Ranmore demonstrated that species, such as *Mercurialis perennis* and *Viola hirta*, were soon destroyed whilst others, such as *Senecio jacobea*, *Pastinaca sativa* and *Centaurea scabiosa*, were more resistant. Changes in the vegetation litter occurred, which would presumably lead to changes in the organic matter content of the soil. Soil compaction and erosion of the paths were found to be related to the amount of trampling. The process of widening of the path from about  $\frac{1}{2}$  m to a maximum of 4 m, depending on the slope of the ground, was related to the number of people that had passed. The species present on established paths, such as *Plantago lanceolata*, *Bellis perennis*, *Lolium perenne* and *Cynosurus cristatus*, were notably more resistant to trampling. Rapid recovery from trampling was shown by *Pteridium aquilinum*, *Holcus lanatus* and *Hedera helix*, which possessed persistent roots or underground stems.

##### Scilly

The two surveys of established systems demonstrated different points. The distribution of people on the islands was related to the vegetation types and places of interest on Scilly. The map-questionnaire, a new technique, made a major observational survey of the visitors' distribution and activities unnecessary. A large amount of data was obtained quickly and cheaply in comparison with, for example, an aerial photographic survey, and the method is limited only by the respondents' abilities of orientation and interpretation of the map. Together with the proportion of visitors interviewed, these factors will vary with the situation in which the technique is used.

Species showing sensitivity and resistance to trampling in terms of cover or growth form were identified. In particular, tussocks of *Armeria maritima* were replaced by a flattened

sward on trampled areas. *Plantago coronopus*, *P. lanceolata* and *Bellis perennis* were important constituents of the paths, but not *Calluna vulgaris* or *Pteridium aquilinum*.

The relative importance of trampling and other environmental factors has been assessed by the use of partial correlation and ordination, and the limitations of the methods have been considered. The results of the ordination proved to be easier to interpret and gave a clearer overall picture of the factors determining the distribution of the vegetation, whereas the partial correlation results were potentially more detailed, but in practice were more difficult to interpret and gave a more fragmentary picture. Both techniques showed such species as *Plantago coronopus*, *P. lanceolata* and *Bellis perennis* to be resistant, and *Calluna vulgaris*, *Erica cinerea* and *Anthoxanthum odoratum* to be sensitive to trampling pressure. An unexpected negative relationship between trampling and soil moisture was presumed to be due to the well-drained soils of those particular transects. However, partial correlation showed that moisture was also related to bare ground, to the cover of several species and to maximum height of the vegetation, suggesting that an evapo-transpiration factor may be important in the soil-water relationship of trampled areas. Differences between transects may be accounted for by the differences in the habitat and range of intensities of trampling involved. Thus *Lotus corniculatus* survives best at medium levels of trampling, being shaded out by tall grasses, but sensitive to a high level of pressure. Hence this species was found to be uncorrelated with trampling on a heavily-used path but positively correlated on two paths of lower intensity.

##### Norfolk

The Norfolk study examined the reactions of species of different growth forms to different intensities of trampling. As found before, the standing crop of cushion plants and straggling plants, e.g. *Armeria maritima*, *Silene maritima* and *Cerastium semidecandrum*, was reduced, and that of rosette plants, e.g. *Plantago coronopus*, was increased by higher intensities of trampling. The complex reaction of the grasses, whereby the standing crop is lower at medium trampling than even in the most highly trodden areas of the site, results from the differing resistances and competitive abilities of the species involved. Thus the onset of trampling at 'medium' intensity greatly reduced some species (*Ammophila arenaria*, *Agropyron pungens* and *Agrostis stolonifera*), whereas, with increased trampling, more resistant species such as *Poa pratensis* and *Festuca rubra* are at a competitive advantage and are able to produce a higher standing crop. At even higher intensities of trampling, it may be assumed that the standing crop would again diminish as the resistant species deteriorated.

##### Predictive model

The relationships between trampling and its dependent environmental variables were examined by means of the regression analysis of replicated measurements of the vegetation and soil in the three zones of trampling intensity, and were used as a basis for the construction of a simplified predictive model of the situation. The data supplied by such a model would be of value as a basis for the formulation of a management policy to avoid vegetational loss from the area.

##### Comparison of techniques

Our results are in accordance with those of Bates (1935) that some species, e.g. *Poa pratensis* and *Plantago* spp., are resistant to trampling owing to a particular morphology.

Bates' other resistant species, e.g. *Lolium perenne* and *Trifolium repens*, were not encountered owing to habitat differences. Studies involving the relationship between trampling and vegetation over a period of time (La Page 1967) indicate how different are the effects of sudden increases in trampling from those of sustained trampling. Similarly the controlled trampling experiments of Wagar (1964) and Bayfield (1971a) demonstrate the different effects of transient and prolonged trampling, but are not directly applicable to field situations.

Although treated separately, it can be seen that the two approaches to the investigation of the effects of recreation pressure on the semi-natural environment are complementary, and should be used in conjunction. In the one case, absolute numbers of people, constituting an increased intensity, are known, and related to immediate effects on the soil and vegetation. This applies equally to sudden decreases in use, such as the recovery phase following the Ranmore nature trail. In the other case, relative numbers of people are measured and assumed to reflect a constant level of past use. Data obtained from both approaches are of value in the understanding of the reaction of the particular biotic and physical environment to trampling, and hence in the formulation of management proposals. As such data is frequently required within a short time, we advocate the use of short-term surveys in most instances rather than lengthy permanent plot studies.

Our observations suggest that trampling acts both directly upon the vegetation by bruising and crushing, and indirectly by changing such soil characteristics as air-filled pore-space and water content. These soil changes in turn have an effect on the vegetation in the longer term. Vegetational changes appear, therefore, to be more sensitive indicators of the intensity of recreational use than soil characters, and are more easily measured, but soil parameters should be measured wherever possible in future studies and built into a model of the system.

#### Recreation management

The methods used for the management of semi-natural areas to accommodate recreation depend upon the initial objectives, whether it is desired to conserve an area as a nature reserve, as a piece of 'natural' countryside or whether the provision of facilities for recreation is the primary aim. The basic strategy of management will be modified by the topography and climate of each individual area. It is not our intention to discuss here the details of management methods, but broadly two approaches may be adopted: firstly, the concentrating, channelling and attraction of people away from vulnerable areas; and secondly, the dispersal and diffusion of use over a wide area so that no part becomes unacceptably altered. Management of the environment may include the artificial manipulation of drainage, watering, seeding and fertilizing, as well as the provision of durable hard surfacing. In sensitive areas where these methods are inappropriate or ineffective, strict rotation of use may be practised so that regrowth may occur in 'rested' areas. Hence it is desirable to know the rates of recovery of certain communities after different periods of trampling at particular intensities. Quantitative data of the kind collected in the studies described above allow the calculation of acceptable levels of use and facilitate the formulation of a definitive management policy to maintain an area in a particular desired condition, whilst at the same time allowing for maximal recreational use.

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#### SUMMARY

The available literature on the environmental effects of public recreation is critically reviewed, and this reveals a need for detailed quantitative studies to relate the intensity of recreation pressure to its effects on the vegetation and soils of semi-natural areas. The nature of the effects of trampling and the considerations necessary to determine the carrying capacity of an area are discussed.

Two basic approaches to the problem of relating trampling intensity to environmental change are proposed.

(1) Direct recording at selected sites of such effects of trampling as changes in species composition and soil parameters, over a period of changing, usually increasing, pressure. Such environmental effects may be manifest in either the short or long term depending on the rate of change of the trampling intensity.

(2) Comparative studies using a range of sites subject to different intensities of trampling where it may be assumed that the environment is in equilibrium with the intensity of recreational use. Data collected from such sites are suitable for analysis by multivariate methods such as the analysis of variance, principal component analysis, partial correlation and partial regression.

It is argued that the first approach is more appropriate where the intensity of trampling is obviously increasing, and the second approach where the situation is relatively static, but they are complementary and ideally an investigation should involve both. The two approaches may be used to indicate a number of thresholds of trampling pressure at which vegetation species composition shows abrupt changes, and these intensities of use may be considered a series of carrying capacities of an area.

These two basic approaches have been illustrated using field examples. The study of the Ranmore nature trail exemplifies the dynamic system changing in the short term due to a sudden, transient increase in the level of trampling intensity. Changes in path widths and profiles, soil compaction, litter and ground vegetation were measured as they occurred over the week, in relation to the precise numbers of people using the trail. The studies of trampled areas on Scilly and in Norfolk show the application of the second approach, where areas are considered to be in balance with the intensity of pressure upon them. On Scilly, the distribution of people on the islands was examined in relation to vegetation types and features of interest by means of map-questionnaires on which visitors traced their movements. Objective photographic methods were used to record the distribution of people on the chosen sites, which included a range of intensities of trampling. The vegetational cover of the sites was examined, and such soil parameters as pH, conductivity, moisture and compaction were measured. These data were then related using multivariate methods. Similarly, in the Norfolk study, measurements of pressure in three defined zones were related by regression to replicated measurements of the standing crop of groups of species with different growth forms and to soil compaction. A simple model of the effects

of trampling was formulated and, within limitations, used to predict intensities of trampling at which particular species would disappear from the sward.

The effectiveness of these methods of study for relating trampling pressure to environmental effects in different situations, and for predicting carrying capacity levels, is discussed. The need for quantitative investigations of this kind cannot be overemphasized as a preliminary to the formulation of management policies for any semi-natural area that is to be used for recreation.

## REFERENCES

- Anon (1963). *Methods of Testing Soils for Civil Engineering Purposes*. British Standards Institute, London.
- Anon (1969). *The Impact of Tourism on the Ecology and Amenity of the Isles of Scilly*. Unpublished report of the Conservation Course, University College London.
- Bates, G. H. (1935). The vegetation of footpaths, sidewalks, cart-tracks and gateways. *J. Ecol.* 23, 470-87.
- Bayfield, N. G. (1971a). *The Scientific Management of Animal and Plant Communities for Conservation* (Ed. by E. Duffey and A. S. Watt), pp. 469-85. Blackwell Scientific Publications, Oxford.
- Bayfield, N. G. (1971b). A simple method for detecting variations in walker pressure laterally across paths. *J. Appl. Ecol.* 8, 535-5.
- Burden, R. F. (1969). *The effects of people on the nature trail at Ranmore*. M.Sc. thesis, University College, London.
- Burden, R. F. (1970). Some effects of people on the nature trail at Ranmore, Surrey. *The Surrey Naturalist: Annual Report for 1969*, 14-22.
- Corbett, K. F. (1968). *The Need for the Conservation of Frensham Common, Surrey, with Reference to the Sand Lizard Population*. Unpublished report, University College, London.
- Goldsmith, F. B., Munton, R. J. C. & Warren, A. (1970). The impact of recreation on the ecology and amenity of semi-natural areas: methods of investigation used on the Isles of Scilly. *Biol. J. Linn. Soc.* 2, No. 4, 287-306.
- Goodier, R. (1967). Human pressures on the mountain environment of Snowdonia. *The Biotic Effects of Public Pressure on the Environment* (Ed. by E. Duffey), pp. 46-53. The Nature Conservancy, Monks Wood Symposium No. 3.
- Hammond, R. C. (1967). Visitor pressure at Wye and Crundale Downs National Nature Reserve. *The Biotic Effects of Public Pressure on the Environment* (Ed. by E. Duffey), pp. 127-33. The Nature Conservancy, Monks Wood Symposium No. 3.
- La Page, W. (1967). Some observations on camp ground trampling and ground cover response. *U.S. Forest Service Research Paper*, NE-68.
- Lloyd, R. (1970). *Countryside Recreation. The Ecological Implications*. Lindsey County Council.
- Mitch, W. E. S. (1968). *Public Recreation in National Forests*. Forestry Commission Booklet, No. 21.
- Orlaci, L. (1966). Geometric models in ecology. I. The theory and application of some ordination methods. *J. Ecol.* 54, 193-215.
- Randerson, P. F. (1969). *A quantitative investigation of the effects of public pressure*. M.Sc. thesis. University College, London.
- Ripley, T. H. (1962). Recreation impact on Southern Appalachian camp grounds and picnic sites. *U.S. Dept. of Agriculture, Forest Service. South-eastern Forest Experimental Station, Station paper*, N. 153.
- Sankey, J. & Mackworth-Praed, H. (1969). Headley Warren Reserve in 1968. *The Surrey Naturalist: Annual Report for 1968*.
- Schofield, J. M. (1967). Human impact on the fauna, flora and natural features of Gibraltar Point. *The Biotic Effects of Public Pressures on the Environment* (Ed. by E. Duffey), pp. 106-11. The Nature Conservancy, Monks Wood Symposium, No. 3.
- Sillitoe, K. K. (1969). *Planning for Leisure*. H.M.S.O., London.
- Smith, R. J. & Kavanagh, N. J. (1969). The measurement of benefits of trout fishing; preliminary results of a study at Grafham Water, Great Ouse Water Authority, Huntingdonshire. *J. Leisure Research*, 1(4), 316-32.
- Speight, M. (1966). *A study of recreational use of the New Forest*. M.Sc. thesis, University College, London.
- Wagar, J. A. (1964). *The carrying capacity of wildlands for recreation*. Forest Science Monographs, 7. Washington D.C.
- Wagar, J. A. (1965). Cultural treatment of vegetation on recreation sites. *Proceedings of the Society of American Foresters Meeting, Detroit: Forest Resource Decisions in a Changing Power Structure*. 37-39.
- Watson, A. (1967). Public pressures on soils, plants and animals near ski lifts in the Cairngorms. *The Biotic Effects of Public Pressures on the Environment* (Ed. by E. Duffey), pp. 38-45. The Nature Conservancy, Monks Wood Symposium, No. 3.
- Watson, A., Bayfield, N. & Moyes, S. (1970). Research on damage and rehabilitation of Scottish mountain tundra, soils and animals. *Productivity and Conservation in Northern Circumpolar Lands* (Ed. by W. J. Fuller & P. G. Kevan), pp. 256-66. I.U.C.N. New Series 16, Morges.
- Westhoff, V. (1966). The ecological impact of pedestrian, equestrian, and vehicular traffic on vegetation. *Proceedings and Papers of the Tenth Technical Meeting of I.U.C.N.*, Morges. 218-23.

(Received 4 March 1971)



IMPORTANT NOTICE.CUTS TO/ABOLITION OF LEGAL AID BENEFITS.

Recent rumours have been heard concerning possible cuts to or abolition of legal aid for environmental groups - this will presumably mean cuts to/abolition of legal aid for environmental matters generally.

It is important to lobby politicians now before any firm decision is made.

Please contact your local M.P. to express your concern and write/ring:-

The Hon. Nicholas Greiner  
Premier  
Ministerial Office  
Premier's Dept. 8th Floor  
State Office Block  
Philip Street  
SYDNEY NSW 2000  
TEL: 28 5239  
Electorate Office  
844 Pacific Highway  
GORDON 2072  
TEL: 498 4109

The Hon. John Dowd,  
Attorney General  
Ministerial & Electorate Office  
20th Level,  
Goodsell Building  
Chifley Square,  
SYDNEY NSW 2000  
TEL: 228 7339

The Hon. David Hay M.B.E.  
Minister for Planning &  
Local Government  
Ministerial Office  
37th Level, Legal & General House  
8-18 Bent Street  
SYDNEY NSW 2000  
TEL: 221 3244  
Electorate Office  
Suite 14, Pacific Pt. Arcade  
4-10 Sydney Road  
MANLY 2095  
TEL: 977 7655

The Hon Timothy Moore LL.B.  
Minister for the Environment  
Ministerial Office  
10th floor, 139 Macquarie St. 8-18 Bent St  
SYDNEY NSW 2000  
Electorate Office  
844 Pacific Highway  
GORDON 2072  
TEL: 498 3257

# TASMANIA'S FORESTS CONTINUED

The inquiry has failed to do this. The areas identified by Commissioners Hellsham and Wallace contain 0.5 percent of Tasmania's sawlogs and only 0.3 percent of Tasmania's pulpwood. All the Commissioners agreed that many of the alternatives put to them by conservationists are prudent and feasible. But cited that much of the information arrived too late for them to assess thoroughly or that much of the information was inaccurate, including data from the forestry commission.

Before 17th June, the Federal Government must decide whether to extend the ban on logging, adopt the Hellsham Report or stand firmly behind the Hitchcock Report. Unless the Federal Government adopts the report of Commissioner Hitchcock immediately, this superb wilderness faces destruction.

Senator Graham Richardson on the 8th May said "I am listening but so far the roar isn't deafening, when it is then I am sure we can take the action you all want".

Writing letters to Mr. Hawke and Mr. Richardson, C/ Parliament House, Canberra. A.C.T. 2600 is still the most effective response. Or you could write to your local newspaper calling on the Federal Government to nominate Western Tasmania Stage 2 for World Heritage listing. I am personally interested in forming a local Tasmanian Wilderness Action Group. Anyone wishing to help with this project please contact Bradley Williams, C/ Big Scrub Environment Centre Mondays and Wednesdays only.

The Federal Government is making it quite clear that the final decision is being left to you!, Remember we have till the 17th June, so write those letters NOW.....BRADLEY WILLIAMS



## Second Ballina Bridge?

Hundreds of submissions are needed to stop massive environmental destruction which will occur if Ballina Council have their way and build a \$6 million bridge through wetlands on North Creek. These wetlands, zoned mainly for environmental protection, are mainly covered by mature mangroves and are the habitat of a rich diversity of wildlife. Their loss will further deplete the marine life of the area, and greatly reduce the wading bird feeding area.

The Councils proposed 'compensatory' creation of wetlands is nothing more than the hole left behind after they have taken out the fill for the approaches. Natural regeneration will take many, many years and will in no way replace the mature mangroves destroyed.

Ballina Environmental Society has opposed this bridge site for the past 8 years because it is environmentally damaging and a blatant waste of taxpayers money.

The proposal will also disturb the peace and quiet of the retirement villages, with the southern approach directly adjoining the Crowley Retirement Village.

An alternative site at North Creek Road is preferred and if the council would fairly assess this alternative a large amount of money could be saved.

The E.I.S. is on sale at the Council emporium in Cherry St and can be purchased for \$25, which effectively limits the range of its distribution! Please write to Ballina Council by June 29 stressing the value to fishing resources of the mangroves and the LESS COSTLY ALTERNATIVE of a second crossing at the old North Creek site.

Address for submissions -  
Ballina Council  
40 Cherry St  
Ballina.

For more information contact -  
Max Mosig 866679

Caldera not ratified

Bundjalung : within 1 month.

Broadwater } Dred management  
Big Scrub } for selected public  
exhibition Sept/Oct.



NEW SOUTH WALES  
MINISTER FOR PLANNING AND ENVIRONMENT  
NAPAWI

NEWS RELEASE

May 28, 1986

COASTAL CONSERVATION PACKAGE FOR BYRON COAST  
-----

The Minister for Planning and Environment, Mr. Bob Carr, today announced a major conservation package for the Byron Coast on the far north coast of New South Wales.

Mr. Carr said the conservation package of Crown Land comprised two new nature reserves and additions to two existing reserves all located on the coastline in Byron Shire.

"Centrepiece of this conservation package is the new 750 hectare Tyagarah Nature Reserve which itself has about eight kilometres of magnificent beachfront between Byron Bay and Brunswick Heads.

"When you add these eight kilometres to the seven kilometres of beachfront in the existing reserves and today's additions, it means that about 15 kilometres of coastline - OR 42 PERCENT OF THE TOTAL COASTLINE IN BYRON SHIRE - is now permanently protected under the National Parks and Wildlife Act."

Mr. Carr said the second new nature reserve, and the two additions to existing reserves, all contained littoral rainforest. "They represent a flow-on from the earlier

announced Government initiative to protect all of the state's coastal rainforest."

The three rainforest areas are the new Cape Byron Nature Reserve at Byron Bay, an addition to Brunswick Heads Nature Reserve, and an addition to Broken Head Nature Reserve south of Byron Bay.

Mr. Carr said Tyagarah Nature Reserve incorporated mainly pristine coastal heath, woodland, forest and wetland.

"Tyagarah Nature Reserve is a product of the local community and state Government working together.

"The local community environmental group BEACON (Byron Environmental and Conservation Organisation) has studied the natural history in great detail. Beacon workers have even discovered a local population of the rare and endangered potoroo - a rabbit sized animal of the kangaroo family."

Mr. Carr said he was pleased to see that Tyagarah had such good public support at the local level - including Byron Shire Council.

"The reserve package for the Byron coast is further evidence of the Wran Government's commitment to consolidate its coastal conservation programmes. There is strong community support for preventing Gold Coast development spreading the

length of the New South Wales north coast.

"The State Government recognises the need for tourist development on the north coast. We must ensure development does not spoil the natural beauty of the far north coast, which is its natural appeal."

Mr. Carr said that the new reserves, whilst mainly serving a conservation and environmental education function, will have provision for public access such as limited vehicular access and walking tracks.

"What will appeal to most visitors are the numerous beaches which are now assured of protection from unsightly development. There will be no high rise buildings

overshadowing these or any other beaches on the Byron Coast."

NEW CAPE BYRON NATURE RESERVE AT BYRON BAY

Mr. Carr said the new reserve of about 40 hectares is located about three kilometres north east of the town of Byron Bay.

"The reserve, although small, has significant conservation value because of its subtropical littoral rainforest. It also has an unusual palm like plant, *Lepidozamia peroffskyana*, a member of the ancient cycad family.

"Littoral rainforest is of particular importance as it is one of the last remaining rainforest types in New South Wales which, until recently, had not received adequate protection.

"Littoral rainforest is unique as it is found in exposed conditions on coastal headlands and on sand dunes. It consists mainly of tree species whose leaves are salt and wind tolerant.

"During recent times, a large percentage of this rainforest type has been decimated by sandmining, urbanisation, destruction for tourist facilities, and mismanagement."

Mr. Carr said Cape Byron Nature Reserve offered excellent environmental education opportunities, being so close to the township of Byron Bay.

#### ADDITION TO BRUNSWICK HEADS NATURE RESERVE

Mr. Carr said the 10 hectare addition to the 74 hectare Brunswick Heads Nature Reserve was located on the southern extremity of the New Brighton Peninsula.

"This littoral rainforest addition is vital as it contains two rare and endangered tree species, the Stinking Cryptocarya (*Cryptocarya foetida*), and a population of White Yiel Yiel (*Grevillea hilliana*) which can only be preserved in this area.

"Other important rainforest species include the Dusky Flame Tree (*Brachychiton discolor*), White Bean (*Ailanthus triphysa*), and Yellow Boxwood (*Planchonella pohlmanniana*), all of which were previously only recorded in the upper Richmond River area.

"This isolated occurrence on the headland, which represents the southern limit of these species, is of special interest to plant ecologists and geographers.



"This magnificent addition will provide a reference area of great value in itself, as well as complementing the ecological and geographical significance of the rest of the reserve.

"The Service's established policies recognise the need to control and, if possible, eliminate any populations of noxious and exotic plants and animals occurring on this and all other nature reserves. Wherever possible control programmes are co-ordinated with programmes organised on neighbouring lands."

Mr. Carr said the Service in its management of the addition will take into account the traditional recreational usage of the southern tip of the peninsula and of the breakwall.

#### ADDITION TO BROKEN HEAD NATURE RESERVE SOUTH OF BYRON BAY

Mr. Carr said the 10 hectare addition to this 8 hectare nature reserve also contained important stands of littoral rainforest.

"The 10 hectares is of great value for educational purposes. It is a superb example of how this density of vegetation protects the adjoining rainforest by deflecting the potentially damaging salt laden winds up,

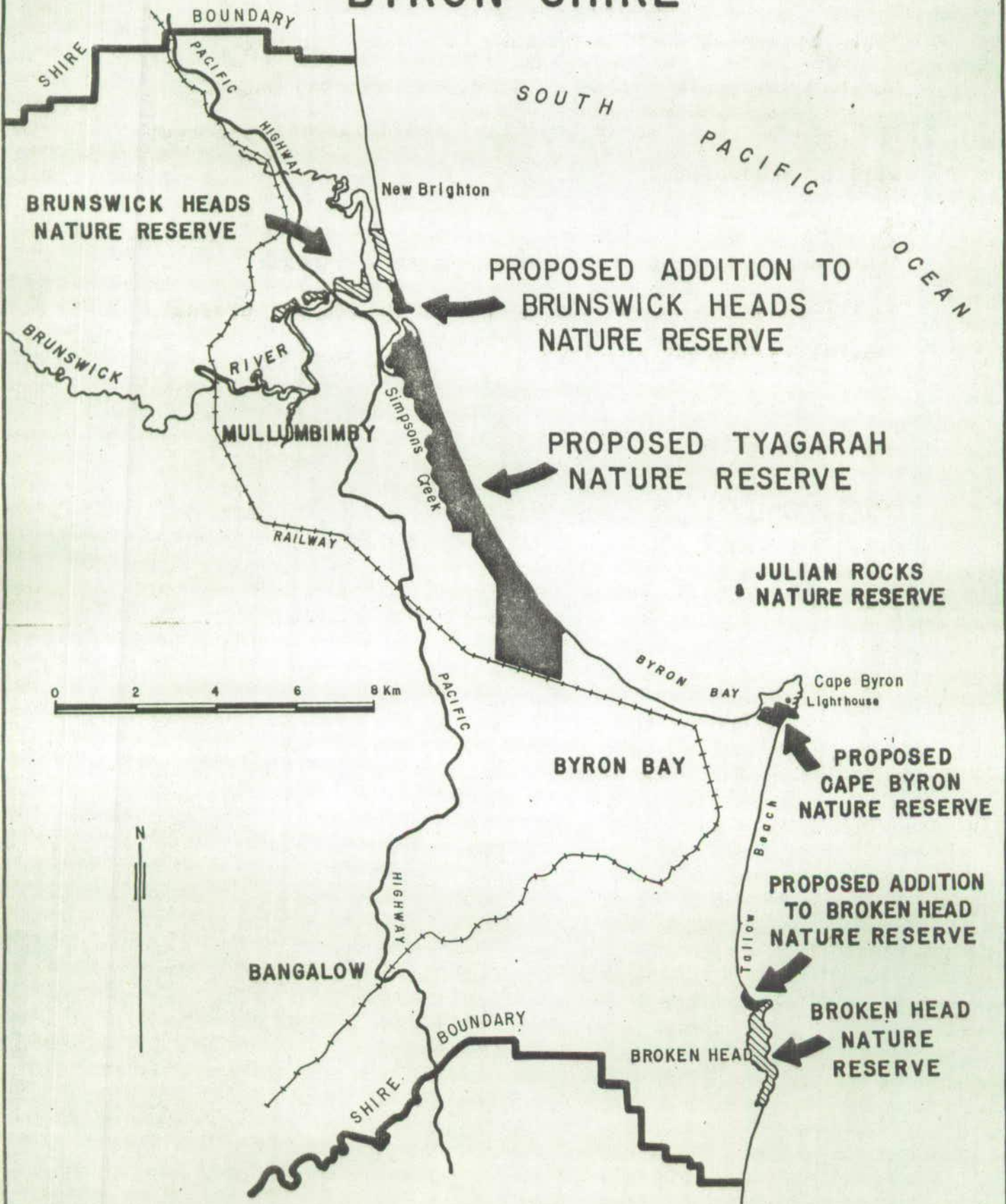
rather than allowing the salt into the rainforest.

"The rainforest will be managed to ensure that no further damage is caused to it by an expanded use of the caravan park. Where possible, the damaged rainforest will be regenerated.

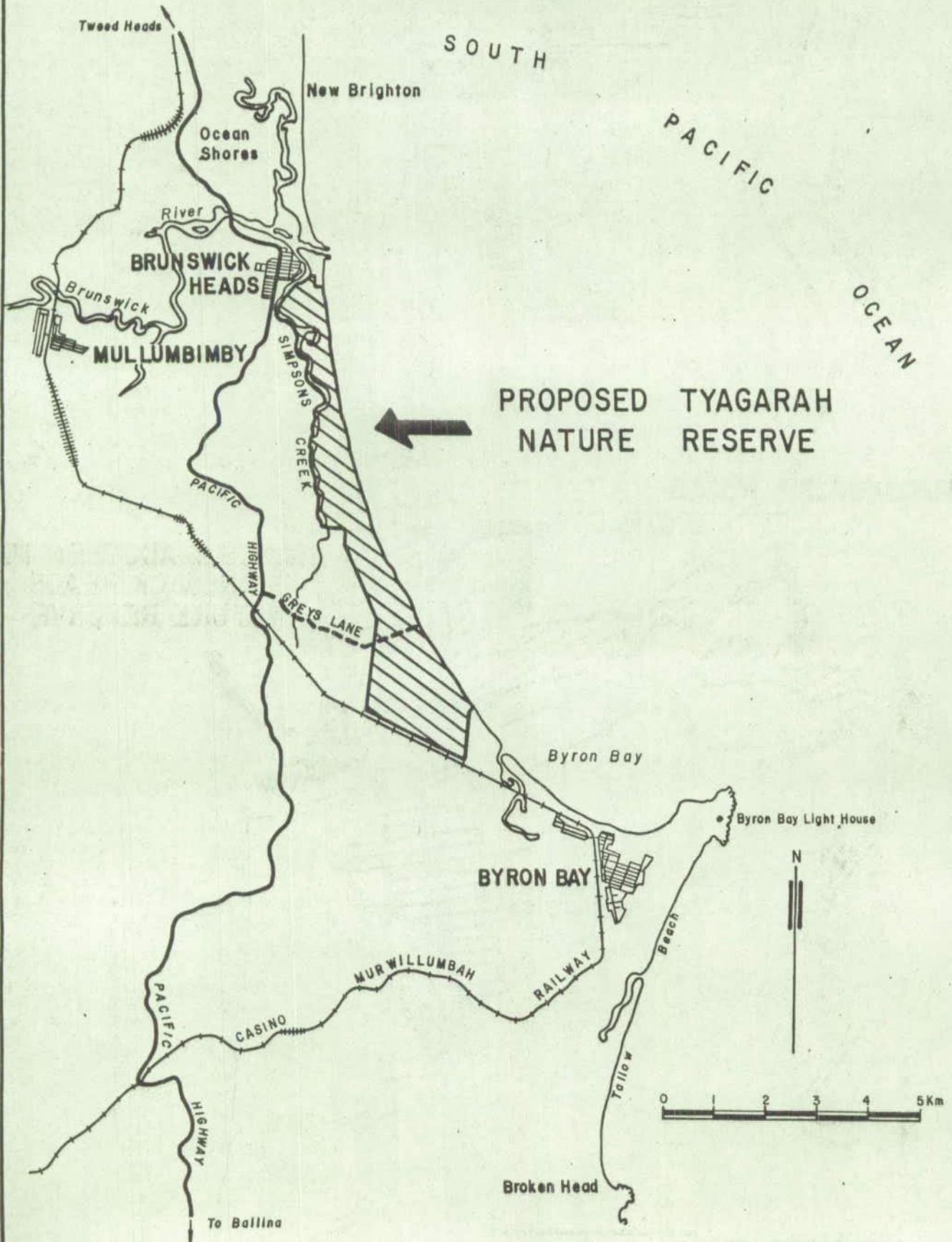
"This addition to Broken Head makes an important contribution to one of the most interesting and unusual coastal rainforest reserves in New South Wales."

Media enquiries: Berkeley Wiles (02) 237 6925

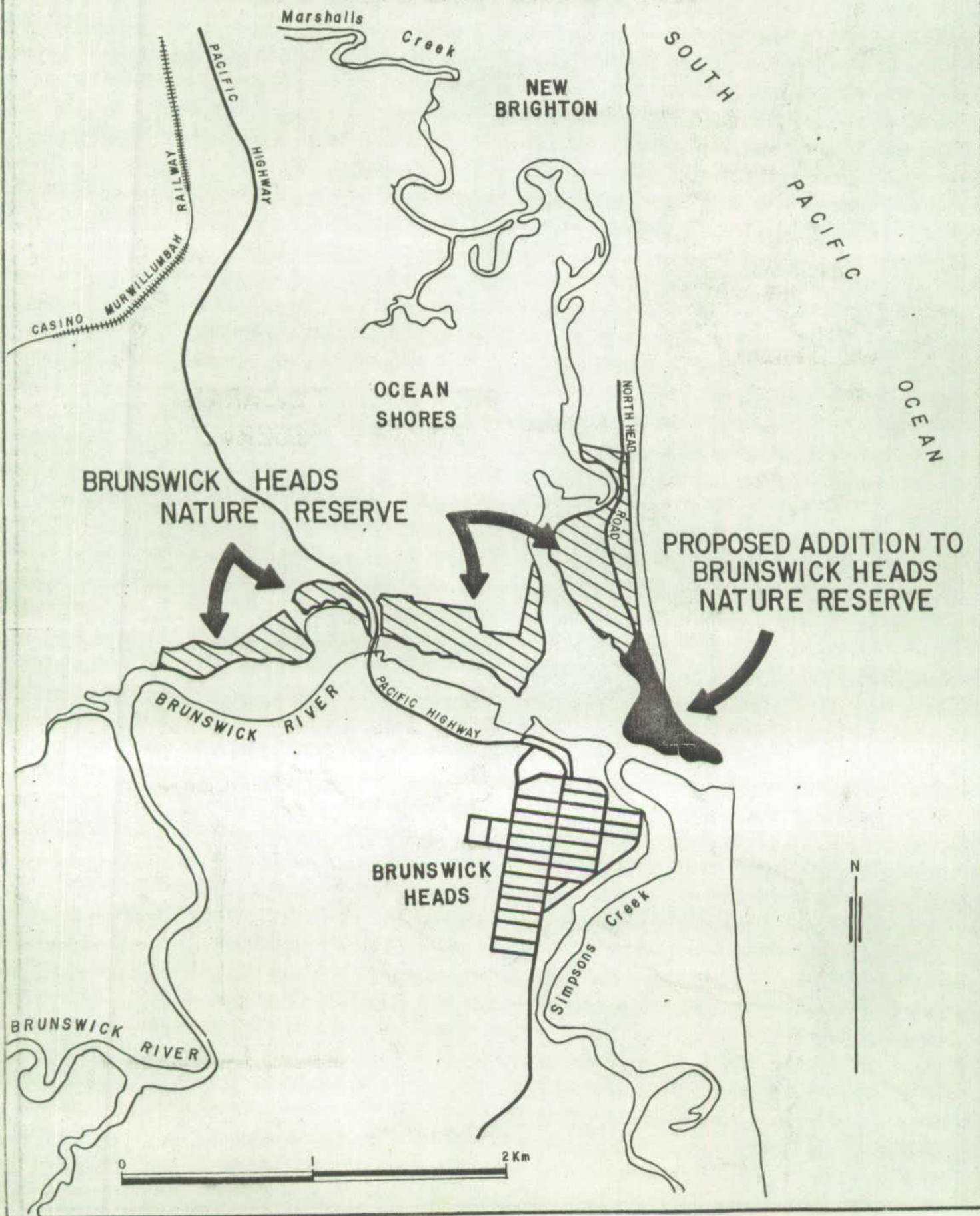
# LOCALITY DIAGRAM for BYRON SHIRE



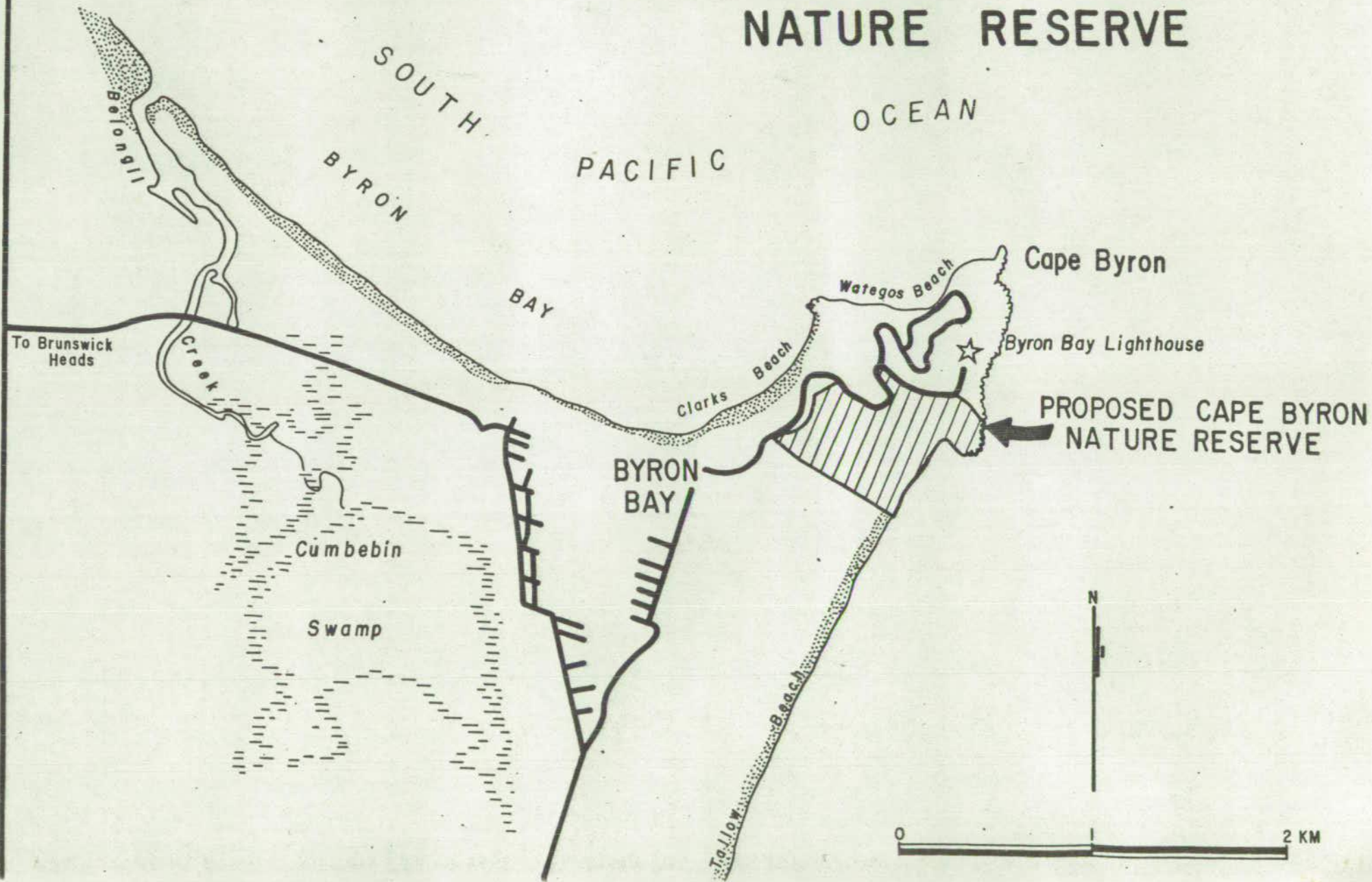
# PROPOSED TYAGARAH NATURE RESERVE



# BRUNSWICK HEADS NATURE RESERVE ADDITIONS



# PROPOSED CAPE BYRON NATURE RESERVE



New South Wales Government  
On Her Majesty's Service



Ms. E. White,  
BERTON RD.  
TIGGI.  
VIA LISMORE.  
2480.

Mt Matheson debacle - any further  
developments.

Land valuation

Sign posting

Graying in Border Ranges - progress  
enormous 1.01 Reversed by the Quality  
legal problem

Review capital works. Reassess valuation

Map 1  
Looking for environmental sensitivity?  
appropriate <sup>permissible</sup> levels.

Survey identifying present use  
patterns & limitations,  
use characteristics  
use



W warning National Lab  
Plan of management  
P 52. MINING

What happened to the proposal to  
Tweed Shire Council. P 72

P 78 Provision of picnic & parking  
facilities

P.O. BOX 174  
KYOGLÉ 2474





# NATIONAL PARKS AND WILDLIFE SERVICE

## NATIONAL PARKS AND WILDLIFE ACT 1974 MOUNT WARNING NATIONAL PARK AMENDMENT TO PLAN OF MANAGEMENT

In pursuance of Section 75 of the National Parks and Wildlife Act, 1974, it is hereby notified that an amendment to the Plan of Management for Mount Warning National Park has been prepared.

The amendment to the plan will be on public display between 12th February and 14th March, 1988. Copies of the Plan may be inspected during office hours at:

Lismore District Office,  
National Parks and Wildlife Service,  
Suite 9,  
Colonial Arcade,  
ALSTONVILLE 2477

Northern Region Office,  
49 Victoria Street,  
GRAFTON 2460

Head Office,  
189 Kent Street,  
SYDNEY 2000

During the display period, representations on Plan amendment may be made to the Director, c/o Lismore District office, P.O. Box 91, Alstonville, 2477.

*JFW*  
J.F. WHITEHOUSE,  
DIRECTOR.

DRAFT AMENDMENT TO THE PLAN OF MANAGEMENT FOR  
MOUNT WARNING NATIONAL PARK

Draft amendment to replace section 9.12 on pages 66 and 67 of the existing plan.

"9.12 An arrival platform will be established immediately below and to the east of the summit area at the terminus of the walking track. A walkway leading from the arrival platform will encircle the summit area and incorporate three viewing platforms and fencing.

Degraded areas will be replanted with species native to the summit area.

Camping and the lighting of fires not be permitted in the summit area."



# NATIONAL PARKS AND WILDLIFE SERVICE

## **Explanation of the draft amendment to the plan of management for Mount Warning National Park Background**

The plan of management for Mount Warning National Park recognised the special significance of the summit area of Mount Warning. In particular it recognised the unique natural features, the significance to Aborigines and the attraction for visitors of the summit. Over 60,000 are estimated to have visited the summit in 1986.

The plan also recognised that visitor use had damaged the natural features of the summit and that visitor numbers and the extent of damage had increased in recent years. The most damaging aspect of visitor use was;

- \* the use of fires and firewood collection in the summit area
- \* vegetation and soil compaction
- \* track making and vegetation removal by visitors seeking vantage points around the summit.

Public safety was also identified in the plan as of concern because of the use of unsatisfactorily formed tracks and exposed vantage areas on the summit.

The plan outlined measures to improve the protection of the natural features, visitor facilities and visitor safety in the summit area. Because of the significance of the site the measures were identified in detail in the plan.

## **Amended development proposal**

Subsequent to the adoption of the plan and in accordance with the requirements of the Environment and Planning Assessment Act, the Service undertook a review of the environmental effects of implementing the measures. The review found unacceptable environmental effects would result from implementing the measures identified in the plan of management. In particular the introduction of paving material and the establishment of only one viewing area would add to continued damage of the natural features.

Further evaluation of problems associated with the summit area has resulted in a new proposal for development of the summit area which minimises site disturbance and satisfies environmental constraints.

The proposed developments are depicted in the accompanying concept design and incorporate construction of a central platform at the trackhead immediately below the summit. The central platform will be linked by a circular elevated walkway to three separate viewing platforms, below the summit and providing a complete panorama of the surrounding landscape.

The central platform, viewing platforms and linking walkways will be prefabricated and lifted onto established footings by helicopter. Each of the structures where necessary will incorporate fencing to improve visitor safety.

## Public comment

The new development proposal requires amendment to the existing plan of management for Mount Warning National Park.

The draft amendment is proposed to replace section 9.12 on pages 66 and 67 of the existing plan.

The draft amendment to the plan of management for Mount Warning National Park is released for public comment.

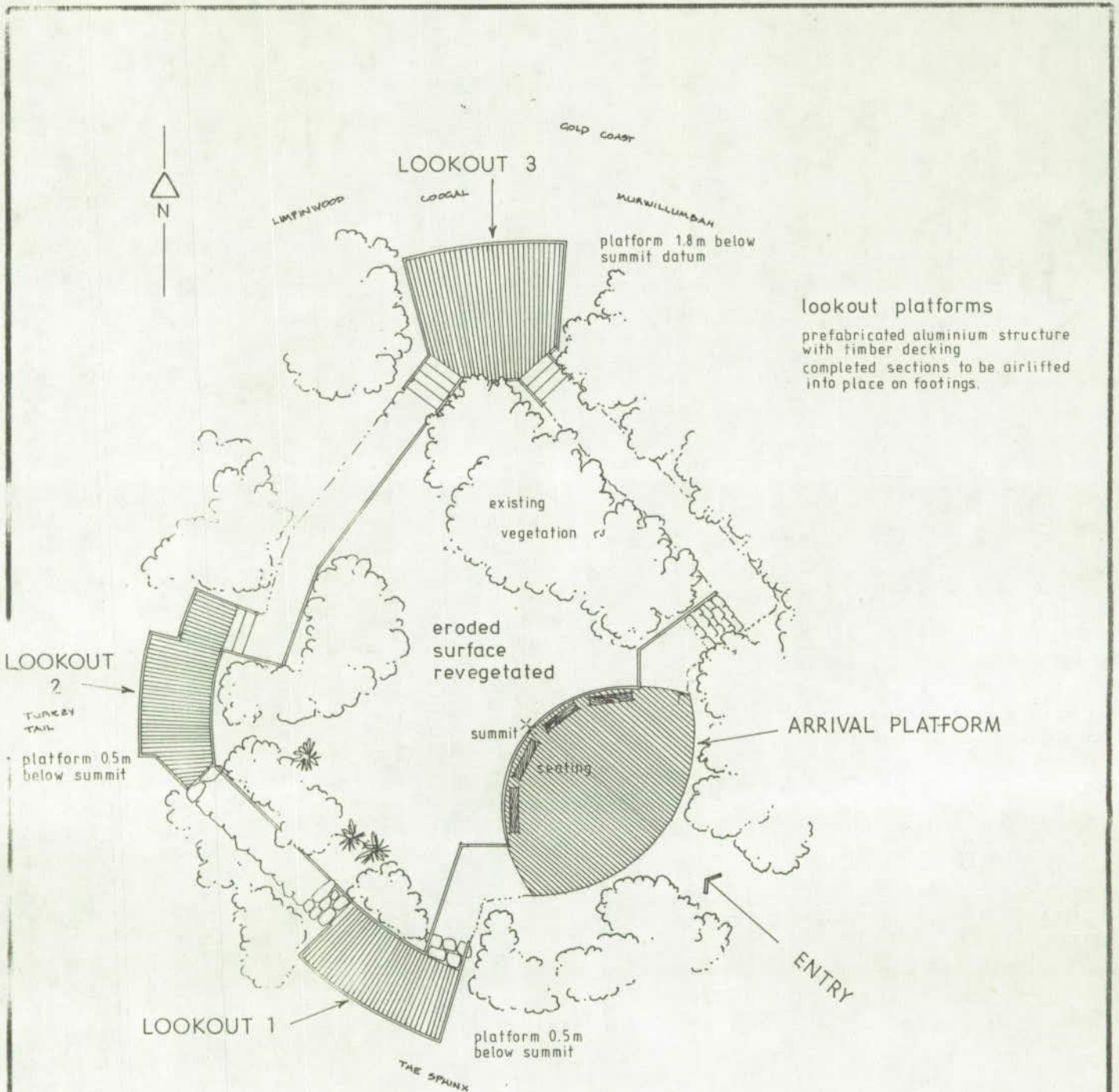
Any person or group may, during the period of exhibition make a submission on the draft amendment by writing to:

The Superintendent,  
Lismore District,  
N.P.W.S.,  
P.O. Box 91,  
ALSTONVILLE 2477

Phone (066) 281177

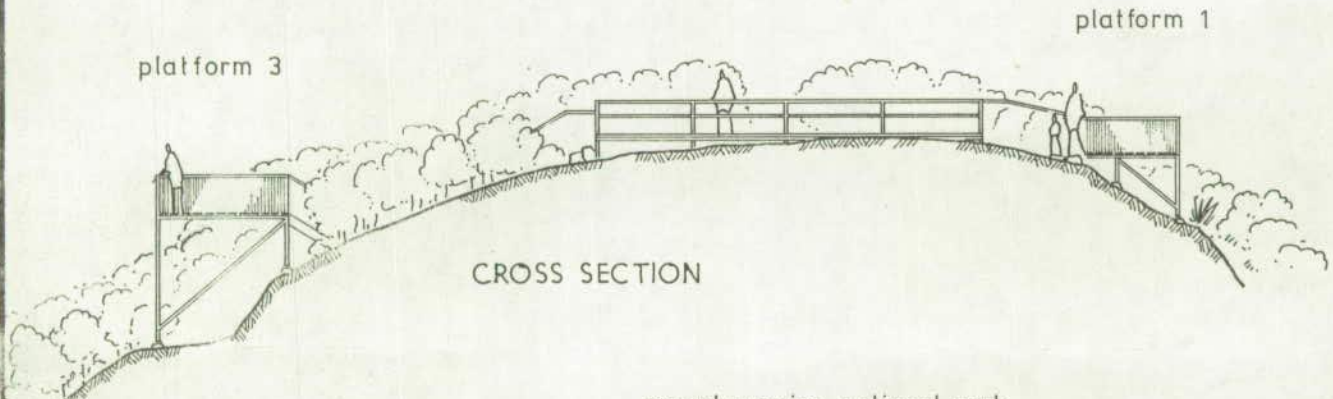
The closing date for public comment on the draft amendment is:

THE 14th OF MARCH 1988.....



lookout platforms  
 prefabricated aluminium structure  
 with timber decking  
 completed sections to be airlifted  
 into place on footings.

SITE PLAN



CROSS SECTION

mount warning national park  
 SUMMIT RESTORATION - concept design  
 scale: 0 1 2 3 metres  
 s gorrell architect  
 october 1987



National Parks Association of NSW

State Council  
275c Pitt Street, Sydney NSW 2000  
Telephone (02) 264 7994

February 5, 1988

MEMO: Clarence Valley Branch  
Far North Coast Branch

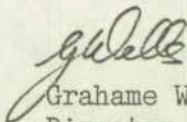
SUBJECT: Draft Plan of Management for Bundjalung

As you know Bundjalung Draft Plan is moving towards publication date.

Please gear up your members for its release by inspections, slides and talks if possible.

Issues which should be addressed are:

- \* off-road vehicles
- \* vehicles off road
- \* powerlines
- \* caravans
- \* Bitou bush

  
Grahame Wells,  
Director.

£2.00  
NPA.

PROPOSAL  
for a  
NIGHTCAP NATIONAL PARK

Being extracts from a submission to the NSW  
Governments Inquiry into the proposed logging  
of Terania Creek with an additional list of  
species of birds known on the Nightcap Range.

BY

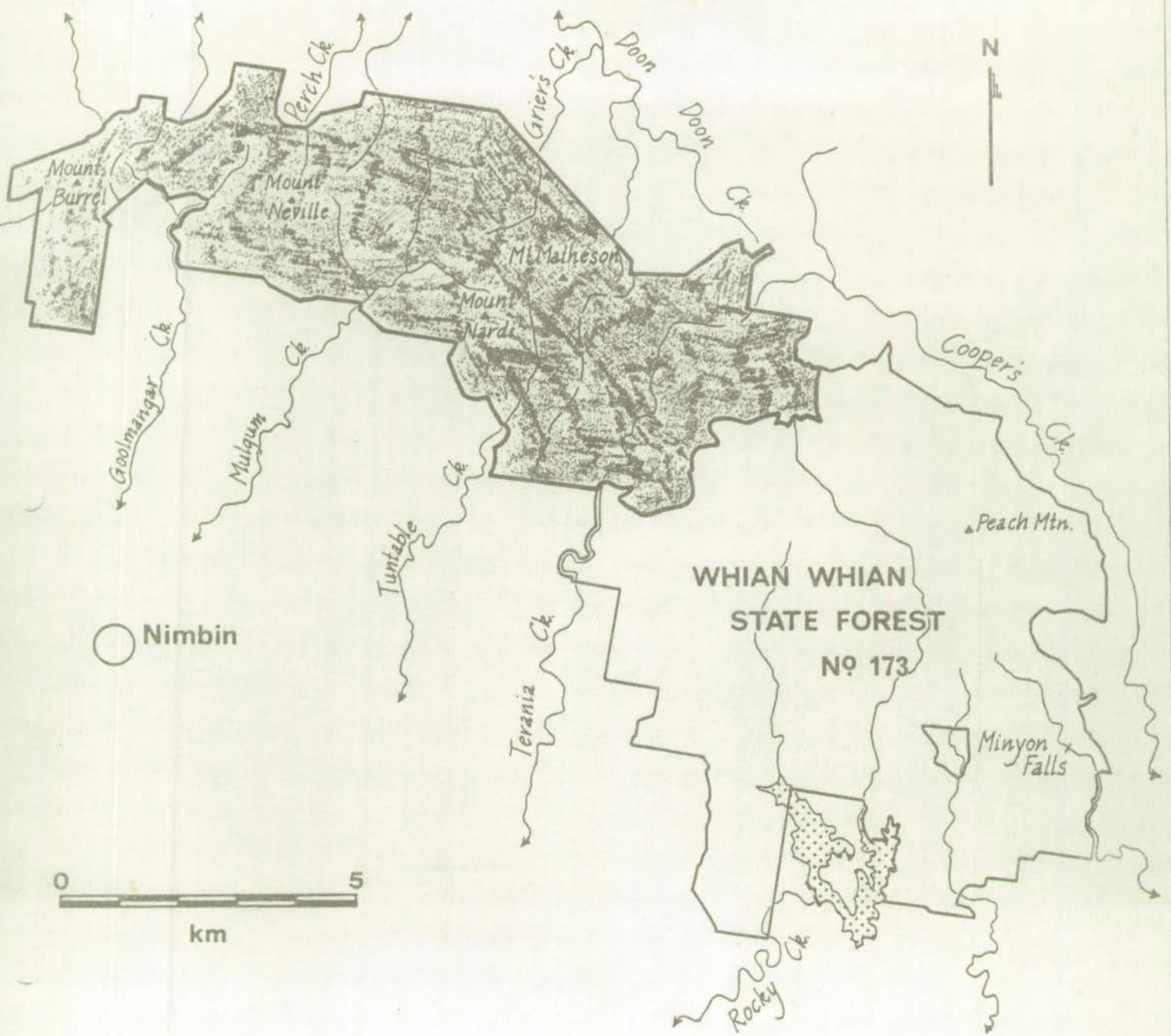
The National Parks Association of N.S.W.

399 Pitt St. NSW 2000 (02) 233 3618

22 Terania St. North Lismore 2480 (066) 213278

Proposal dated February 29, 1980

This edition February 8, 1982



## NIGHTCAP NATIONAL PARK PROPOSAL

Proposed parklands





## 2.0 GEOLOGY

- 2.1 The proposed national park is situated entirely on basaltic and rhyolitic lavas. These lavas are approximately 20 million years old and form part of the Mount Warning Shield volcano.

The great Mount Warning Shield is 4,700 square kilometres in area. With its centre at Mount Warning and its rim comprising the McPherson, Tweed and Nightcap Ranges, the radius of the caldera is about 50 kilometres.

- 2.2 The Nightcap Range is composed of three distinct volcanics of Tertiary age (McElroy 1963):

- (a) The Lismore Basalt
- (b) The Nimbin Rhyolite
- (c) The Blue Knob Basalt.

- 2.3 The Lismore Basalt contains some conglomerates and shales. It reaches a maximum thickness of 180 metres.

- 2.4 The Nimbin Rhyolite overlies the Lismore Basalt and is a thick formation reaching its maximum of 400 metres between Minyon Falls and Peates Mountain. The Nimbin Rhyolite is composed of acid volcanics, including fluidal, lithoidal and porphyritic glassy rhyolites, obsidian, tuff and agglomerate. It is this sequence which forms the prominent cliffs of the eastern part of the Nightcap Range.

- 2.5 The Blue Knob Basalt overlies the Nimbin Rhyolite and forms the higher parts of the Nightcap Range. It is thought to reach its maximum thickness of about 240 metres at Blue Knob.

- 2.6 Underlying the region are sedimentary rocks of Triassic age, consisting mainly of shales and sandstones. These do not outcrop at all within the proposed park area, which consists of the much more recently formed volcanic rocks. Near Nimbin some limited mining of coal seams in the Triassic sediments has occurred.

### References

- \* Geol. Survey Sheet
- \* F.C. Statement Dec. 14. 1980
- \* McElroy, C.T.

### 3.0 PHYSIOGRAPHY

- 3.1 The proposed park takes in an area of marked local relief. The highest point is Mount Burrell (Blue Knob) at 933 metres, compared with low valley elevations of between 200 and 300 metres on Goolmangar, Mulgum, Tuntable and Terania Creeks.
- 3.2 The Nightcap Range declines in height towards the east, the elevations of the main peaks ranging from Mt. Burrell's 933 metres, to 600 metres at Peach (or Peats) Mountain. Within the proposed park are also Mt. Neville (919 metres), Mt. Nardie (812 metres) and Mt. Matheson (804 metres). The peaks are quite distinct, their steep slopes evidencing the readily erodable nature of the Blue Knob Basalt which forms the highest parts of the Range.
- 3.3 The Nimbin Rhyolite is a more resistant rock and is responsible for shelf formations on the sides of the mountains. Massive rockfalls have produced cliff faces of up to 90 metres relative height. Within Terania Basin and on its northern rim are dramatic pinnacles of rhyolite rock.
- 3.4 Terania Creek Basin is bounded on the east, west and north by prominent, discontinuous clifflines composed of rhyolite. In places there is an upper and lower line of cliffs.
- 3.5 The lowest and most readily erodable of the volcanic strata, the Lismore Basalt, has weathered away to form the gentler, lower slopes of the Nightcap Range, and the creek basins.

Soil description by Haigh, Hurlingham

Method as per Mac@ Univ. Earth Sciences  
(T.R. Paton Soil Scientist)

5

#### 4.0 SOILS

- 4.1 Three basic soil types are found in the proposed park area, two deriving from the basalts and one from the rhyolite. A distinction needs to be drawn between soils derived from the Blue Knob basalt on the one hand, the the Lismore basalt on the other, not only because of differences in the parent rocks, but also because of the influence of the intervening Nimbin Rhyolite.
- 4.2 The Blue Knob Basalt occurs only on the higher elevations of the Nightcap Range, generally above 520 metres. Because of this height and steepness, few sites are offered for soil formation. Soils derived from this basalt can be described as dark-coloured blocky clays with a few areas on the mountain summits of residual subplastic clays. The downslope transportational sites might have a fabric contrast soil showing the different origins of the upper horizon derived from material transported from above, while the lower horizon has developed in situ. Fabric contrast soils have a dark clay layer overlying a much brighter yellowish or reddish brown clay with a dense matrix fabric.
- 4.3 The Nimbin Rhyolite is rich in free silica and produces a quite different soil. The rhyolite occurs mostly on transportational or hillslope sites. At the head of Terania Creek, the Nimbin Rhyolite constitutes the ridge line, and in the absence of overlying Blue Knob Basalt to provide a source of downwashed material, it might be expected that the soil in this locality would have a more sandy texture and fabric than elsewhere.

The rhyolite derived soil is probably of an earthy fabric with a field texture grade of five, sandy loam lying over a clay subsoil. It would have a marked break in its profile, the upper horizon being transported from above, while the lower horizon developed in situ.

One would expect considerable variations in this soil, reflecting the different proportions of material derived from the Blue Knob Basalt and from the Nimbin Rhyolite, from place to place. A greater proportion of clay material from the upslope basalt would increase the earthiness of the fabric and texture, and decrease the sandiness of this soil type.

- 4.4 Beneath the Nimbin Rhyolite is the Lismore Basalt. The soil produced by this rock would be similar to that derived from the Blue Knob Basalt except for its different geomorphic location which causes it to be markedly influenced by soils originating from above. This soil occurs in transportational and depositional sites on the lower slopes of the Nightcap Range and in the valleys. It forms a dark-coloured blocky clay on the slopes and a harsh depositional clay in the valleys. The contribution of material from the rhyolite upslope gives varying degrees of sandy fabric and texture to these clays. Where the vegetation has been removed from steep slopes composed of this soil type, large land slips have occurred as a consequence of heavy rain.

## 5.0 CLIMATE

- 5.1 The Nightcap Range is located in a region of humid sub-tropical climate with local variations caused by physiography and particularly by elevation.

Climatic data has been drawn from the following meteorological stations :

Nimbin  
Lillian Rock  
Whian Whian  
Lismore

- 5.2 The Richmond-Tweed region lies within a transitional zone between the steady trade winds to the north and the anticyclone belt to the south. The anticyclone belt oscillates seasonally northward and southward over the region. This oscillation causes distinct wet and dry seasons.

The anticyclone belt lies to the south of the region at the beginning of the year and moves northward from April, usually lying over the region, or slightly to the north of it from July to September.

The winter season is relatively dry. Light winds and clear skies associated with the descending air masses of the anticyclones may be conducive to frost formation.

As the anticyclone belt moves southward it brings warm humid conditions. These conditions, associated with south-easterly trade winds, are experienced in the summer season from November to March.

From January to April, tropical cyclones may occur.

- 5.3 The Nightcap Range has a considerable modifying effect on climate, locally. Regional average rainfall varies from 975 mm in the vicinity of Tabulam, to over 2545 mm near Springbrook. The Nightcap Range forces winds from the south-east to converge and rise, and consequently is a high rainfall area. Jerusalem Mountain, just to the north-east of the Nightcap Range, receives over 2286 mm annually. The Nightcap Range itself receives a range of annual rainfall of 1651 mm in the west to 2032 mm in the east. About 65% of the annual rainfall occurs in the summer months, the wettest months being February and March, and the driest August and September.

Altitude increases precipitation on the windward side of the mountains because of increased uplift and cooling of air masses. This is most pronounced on the Nightcap Range during the summer months when prevailing winds are from the south-east, and encounter no very high land after crossing the coast until the range is reached. A comparison

of rainfall at Lismore and Whian Whian (elevations of 16 metres and 381 metres respectively) gives an altitudinal effect of 529 mm/km for January, 186 mm/km for July and an annual effect of 2120 mm/km.

The region often experiences short periods of very heavy rain. At Springbrook daily totals of 685 mm have been recorded. The average number of raindays per year is between 112 and 120, the largest number occurring in the month of March.

- 5.4 Temperatures in the region reach a maximum of about 38°C in December or January and a minimum in July of about 7 or 8 degrees Celsius.

On the Nightcap Range temperatures are modified by altitude, such that it can be expected to be about 10°C cooler than at Lismore when summer temperatures approach the maximum. Winter minimum temperatures are also moderated, such that in July it can be expected to be about 2°C warmer on the Nightcap Range than at Lismore, when temperatures approach the minimum. This moderation of winter temperatures may be explained by cold air drainage to the lower elevations, and the effect of the mountains' forest cover in contrast to the cleared country below.

- 5.5 Frosts occur in the region, but again the Nightcap Range escapes severe exposure. Sheltered lowlands may experience up to 50 days of frost per annum, compared to one or two mild frosts on the Range.
- 5.6 Tropical cyclones occur from December to April along the east coast of Australia, with about three events each season. These cyclones can affect the Richmond/Tweed region, but normally the threat is limited to one occurrence for every two cyclone seasons.

Severe local storms accompanied by strong winds, hail, torrential rain and even tornadoes, affect the region. These cause widespread damage and are very irregular in occurrence.

- 5.7 Winds during November to April come most frequently from the north-east to south-east, and during June, July and August from the north-west to south-west. During other months of the year, there is a transitional phase when no clear prevailing wind direction is ascertainable.

Webb,  
Williams,  
Floyd,

Saw  
Fox (NAT. HERBARIUM)

## 6.0 FLORA

6.1 The rainforest of Terania Creek Basin has been described by Webb (see Appendices) as classifying into two main types :

"(a) The Booyong and Palm type on red volcanic soil along the creek and on the lower slopes;

(b) The Coachwood type, which is generally mixed with other species including those of the Booyong-Palm type. The Coachwood type extends upslope on brown and grey volcanic soils of relatively low fertility, and becomes increasingly mixed with Brushbox, Flooded Gum, and eventually Blackbutt on upper slopes. These tree species, which are also commercial species, were able to regenerate in the past as a result of wildfires. In moister areas downslope where fires have not penetrated for several hundred years, the Brushbox trees that are emergent above the developing rainforest become senile, then collapse and disappear, thus leaving pure Coachwood type rainforest."

6.2 Webb notes that the Booyong and Palm type rainforest along the creek and lowest slopes of Terania Basin (also described by him as 'warm subtropical seasonal wet type') occurs as "an attenuated extension of the 'Big Scrub' on the narrow alluvial floor of the valley", but rapidly grades upslope into another type (described by him as the "cool subtropical cloudy wet" type). This lowest Booyong and Palm type rainforest would have been more extensive, according to Webb, further down the valley at lower altitudes, before clearing took place. It is characterised by the combination of White Booyong, Red Cedar, White Beech, Silver Quandong, Bumpy Ash, *Eugenia crebrinervis*, *E. corynantha*, *Pithecellobium muellerianum*.

6.3 Further upslope, Webb discriminates within his "Booyong and Palm" rainforest type a forest characterised by many Bangalow Palm patches growing on the basaltic soils of the lower slopes of the Basin in combination with Black Booyong, Yellow Carabeen, *Elaeocarpus kintonii*, *Ackama paniculata*, *Doryphora sassafras*, *Acradenia euodiformis*, *Orites excelsa*. This type is described by him as the cool subtropical cloudy wet type.

6.4 Further upslope still, occurs the Coachwood rainforest or "cool subtropical cloudy wet type" again, but now on soils derived from rhyolite with some basaltic enrichment. This forest is characterised by the dominance of Coachwood at the mature or climax stage, but Crab Apple, *Qhintinia sieberi*, *Eugenia coolminiana*, *Anopterus macleayanus*, *Callicoma serratifolia*, *Canarium australasicum*, *Endiandra introrsa*, *Cryptocarya glaucescens*, are also common.

- 6.5 Webb states that the two variants of "cool subtropical cloudy wet" rainforest (described in paragraphs 6.3 and 6.4 above) are the result of differences in soil mineral nutrient availability. The low fertility variant of "cool subtropical" rainforest is equivalent to the "warm temperate rainforest" of Baur and Floyd. Webb rejects their classification because, according to him, "it is meaningless to classify two different rainforests side by side in the same climatic zone by the use of different climatic types, especially when it is agreed that the differences are correlated with soils".
- 6.6 The lower and higher soil fertility variants of "cool subtropical..." rainforest, although quite distinct types, become mixed on the mixed soils of gullies. Webb states that as a result they have been termed "gully rainforest" by Baur and Floyd.
- 6.7 The low fertility variant of "cool subtropical..." rainforest is mixed with Brush Box, and occasional Sydney Blue Gum and Flooded Gum characterise convex stony slopes and spurs with shallower soils.
- 6.8 Webb, in discussing the interrelationships of rainforest and sclerophyll vegetation, states that their segregation is rarely absolute. He states that unless the disturbance of the rainforest which allowed the sclerophyllous tree species to infiltrate the rainforest margins originally, is repeated, affecting both the forest canopy and the forest floor, sclerophylls do not regenerate under a developing rainforest canopy. He states that intermittent sclerophyll regeneration in practically all cases is the result of the intrusion of fires.

In its "Statement" on the Terania logging, the Forestry Commission states (p.37) that the rainforest's

"...expansion and dominance has been limited by rhyolitic soils of low fertility and thus the hardwood stands have been able to maintain their ecological integrity. These stands do not form a physical buffer to the rainforest stands as may occur in other localities but are in equilibrium with them."

Yet in Baur ("Nature and Distribution of Rainforests in NSW, 1978") it is made quite clear that the rainforest type immediately adjacent to the Brush Box stands in Terania Basin (Ceratopetalum - Schizomeria association of Baur) grows well on soils of low fertility. Indeed, Baur states (p.27) that :

"The Ceratopetalum-Schizomeria association in northern New South Wales and the wet sclerophyll forests which were studied are on soils with much lower levels of ... nutrients, both communities occurring over the same range of values. The dry sclerophyll forest and wet mallee soils are even lower in nutrients."

Baur goes on to say (p.28) that :

"...at Lamington National Park the Ceratopetalum rainforest can border directly on to the Mallee formation, without any intervening wet sclerophyll forest band".

The statements of Webb and Baur support a conclusion that in the absence of disturbance, the rainforest understorey now in association with the Brush Box stands in Terania Creek Basin, will, as the hardwoods die out, become dominant, and that the low fertility of the rhyolitic soils are no barrier to the eventual development of this pure rainforest.

In his submission to the Terania Inquiry, Mr. J.B. Williams, Senior Lecturer in Botany, University of New England, states that much of the forest typed by the Forestry Commission as Brush Box does in fact fit the Commission's own definition of rainforest. He goes on to say :

"...Many ecologists, including myself, would regard it as a light type of rainforest with emergent trees of the sclerophyll Brush Box. In some Brush Box stands (away from Terania Creek) there is no doubt that the community is a sclerophyll forest, but in the Terania Basin much of the Brush Box vegetation is certainly rainforest. Characteristic growth forms of rainforest are plentiful in the area logged in August 1979 - including large vines, buttressed trees, palms and, on certain of the trees, large loads of epiphytic staghorns and bird's nest ferns.

"The above is not meant to imply that the Brush Box stands are the same as the gully rainforests (to be excluded from logging) - they are not. But the (Forestry Commission) Statement is in error in maintaining in various places (e.g. p.5) that none of the Brush Box stands are to be considered as part of the set of rainforest communities of the Terania Basin".

- 6.9 The rainforest of Terania Creek Basin contains some outstanding individual trees. The most notable of these is a White Beech 59 metres high and of 2.65 metres girth. This compares favourably with the largest tree of that species known to the Forestry Commission in 1979, the height of which is recorded to be a mere 48 metres.

J.B. Williams, in his submission to the Terania Inquiry, states that there are significant large trees in Terania Basin, including the 15 medium to large Red Cedars, additional very large White Beech to the specimen mentioned previously, and large specimens of Strangler Figs and Giant Stingers. Williams also records a Red Ash tree 40 metres tall which he regards as most unusual and believes to be one of the largest known trees of this species. Williams also states that many

\* Turners  
Soil Fertility  
Index NAT.  
\* See also  
HERB. PT.



of the Brush Box and Flooded Gums are very large impressive trees which have escaped cutting during previous logging episodes in the Basin.

Floyd states (Appendix 5, Forestry Commission Statement) that Terania Basin is a "compact area of much vegetational interest, particularly as regards the mixture of plant communities". He draws attention to the significance of the Palm rainforest which he believes to be "surely... the greatest area of this type in New South Wales".

In contrast, the ecological significance and interest of the Terania Basin vegetation appears to be constantly under-rated in the body of the Forestry Commission Statement.

- 6.10 On the top of Nightcap Range, within Goonimbar State Forest, on soils derived from the Blue Knob Basalt, occurs subtropical rainforest of a type differing from that in Terania Creek Basin. The dominant species are Booyong, White Booyong, Yellow Carabeen and Red Carabeen.

This rainforest becomes mixed with and eventually gives way to a forest dominated by sclerophyllous species as rhyolitic soils are encountered at lower elevations on the Range. The hardwood forest is dominated by Brush Box and Flooded Gum, with some of the drier sites dominated by Blackbutt. As the edges of the rhyolite cliffs are approached, the forest becomes more open and its rainforest understorey less well developed.

From the foot of the cliffs Brush Box stands penetrate varying distances down the slopes, but the rainforest soon dominates again. As the basaltic soils are encountered on the lower slopes of the range, so also is rainforest of the Booyong and Palm type as found in Terania Creek Basin.

Within Whian Whian State Forest most of the original forest has been clear-felled and the area planted to Flooded Gum and Blackbutt. This portion of the Nightcap Range is not within the proposed park area.

See Milledge  
(summary)  
(Conclusions)

## 7.0 FAUNA

- 7.1 Variations in altitude and topography, together with the conjunction of rainforest and sclerophyll forest, should make the proposed park area worthy of reservation as a habitat for diverse species of fauna.
- 7.2 In a survey of mammals in the upper Richmond and Clarence Rivers by J.H. Calaby (CSIRO) in 1965, 45 indigenous species were found, the richest mammal fauna so far discovered in Australia.

This was  
stated  
before  
Milledge  
Report  
published

Adequate surveying of the mammals of the Nightcap Range has yet to be carried out. The Wildlife Research Group (Queensland) in October 1976, (see Appendices) recorded five species but commented that "the very little time available for spotlighting renders this list totally inadequate and one would expect a much greater variety of mammals to occur there. One quite possible occurrence is the Tiger Cat (*Dasyurus maculatus*), a species which is rapidly becoming increasingly rare and localised throughout its distribution".

Mammals recorded by the Wildlife Research Group (Queensland) were the Platypus, Pademelon, Short-nosed Bandicoot, Common Ringtail and Grey-headed Flying Fox. These findings are reproduced in the Forestry Commission's Statement on "Proposed Logging of Terania Creek" in Appendix 6, headed "Fauna Lists for Terania Creek Section of Whian Whian and Goonimbar State Forests". The implication might be drawn from this that this is the full extent of the mammalian fauna, which is not likely to be the case.

- 7.3 The Wildlife Research Group (Queensland) found a "rich and varied" avifauna in this area. Some rare and localised species, such as the Albert Lyrebird, were found in very good numbers. Spine-tailed Logrunners were also "extraordinarily common" and the records of Powerful and Sooty Owls, both rare species, were considered to be of particular interest. These researchers were also interested to note some characteristics of the avifauna of Whian Whian and Goonimbar State Forests which are quite different from most rainforest localities in south-eastern Queensland and north-eastern New South Wales. In particular, several species of predominantly northern origin (such as the Spectacled Flycatcher) were found to be common in this area but quite rare elsewhere in New South Wales. The researchers also noted that Whian Whian and Goonimbar State Forests constitute one of the very few localities where the Plumed Frogmouth (*Podargus plumiferous*) has been recorded. This bird, possibly subspecific to the Marbled Frogmouth, is extremely rare and records extremely scarce.

Many birds are nomadic in their use of rainforests. The seven species of pigeon which feed in rainforests each has its own particular pattern

of movement through the forests, corresponding with the availability of various tree fruits. These birds are not dependent upon a few tree species in a small area, but upon many species at different times and in different places over a wide area. H.J. Frith (Wildlife Conservation, 1973) has said that the nomadic fruit pigeons might be preserved if enough rainforest can be retained in a series of reserves throughout their range. Fruit pigeons are to the casual visitor the most obvious birds in the Terania Creek rainforest.

Various observers, as noted in Appendix 6 of the Forestry Commission Statement on "Terania", have recorded a total of 137 species of birds in Terania Creek Basin and the Nightcap Range. Of these, at least 130 were recorded from Terania Creek.

- 7.4 Reptiles and Amphibians are listed in Appendix 6 on the Forestry Commission "Statement" without comment. Once again, the source is the Report of the Wildlife Research Group (Queensland), October 1976. However, the researchers' comments must qualify their list of 10 species if the reader is not to be misled.

In respect of their list of 4 reptiles, they said :

"The very little time available for reptile collecting did not allow for compilation of a truly representative list. However, the area is an interesting zoogeographical zone, being both the southern and northern limit of many species. The record of *Anomalopus truncatus*, however, is very significant, as this species has not previously been recorded outside of south-eastern Queensland".

In respect of their list of 6 Amphibians, they said, inter alia :

"On wet summer nights it is expected that a good number of additional species would be recorded."

- 7.5 The Wildlife Research Group concluded that the faunal values of the Nightcap Range are such as to commend at least the western half for reservation as a national park :

"It is the opinion of this organisation that a suitably extensive national park should be created in this region as soon as possible. It is considered that a minimum park should include the greater part of Goonimbar State Forest and the north-western one-third section of Whian Whian State Forest".

## 8.0 ABORIGINAL INFLUENCE

- 8.1 McBride states that aboriginal culture in the region exhibits an early industry of flake and core artefacts dominated by uniface pebble tools. This industry dates back to the mid fifth millenium B.C. About 2000 B.C. it was succeeded by a more diverse tool kit including backed blade and ground edge artefacts; the manufacture and presumed use of these in composite tools and attached to a wooden handle, reflect fundamental changes in aboriginal technology. The pebble tools continued in use throughout the period.

McBride presumes from the evidence that this change was not a sudden or complete one, but rather a reflection of greater changes occurring elsewhere. She believes it to represent the adoption of new tool types rather than the arrival of some new group of people with a completely new range of utensils.

Little is known of the aboriginal significance of the Nightcap Range or the proposed park area. The area falls within the territory of the Bundjalung tribe, and historical records suggest that there was seasonal movement by the Aborigines between the coast and the foothills of the Nightcap Range, probably in response to the availability of different foods.

As elsewhere in New South Wales, the Bundjalung Aborigines had a subsistence economy featuring hunting, fishing and food gathering.

A large rock overhang at the base of the lower rhyolite cliffline at the eastern edge of the Terania Basin has been claimed by local Aborigines as a site of significance to the Bundjalung tribe. Apparently, investigations have indicated a probability of aboriginal occupation at some time in the past.

## 9.0 HISTORY

- 9.1 The Richmond-Tweed district of NSW was not settled until quite late in the history of the Colony. 1839 saw the arrival of the first settlers and cedar-getters. The search for new cedar stands following the exhaustion of the resources of the Hunter and Manning valleys, further south, was one of the main reasons for the opening up of this new country, which was still largely a blank on the maps of that time.

The cedar-cutters began the tradition of overcutting of forests which is still honoured, where possible, in the region today, and which has, to a significant extent, contributed to the public controversies surrounding forest management in the Border Ranges and on the Nightcap Range.

Squatter-pastoralists came to the lower and middle Richmond Valley in the 1840s and settled in the woodland and eucalypt forest country.

In the 1860s, with the passage of Sir John Robertson's land laws allowing free selection before survey, many new settlers came to the Richmond Valley and took up farms. Many of them selected small holdings in the Big Scrub, the largest tract of tall subtropical rainforest in Australia. Within thirty years this fabulous timber resource had been almost totally cut down and burnt to make way for farms.

The 1870s saw the climax of the region's trade in cedar and pine. With the decline in its resources of these most valuable timbers, the industry turned increasingly to hardwood milling to supply the timbers for railway, bridge and wharf construction. As the accessible forests were cut out, the loggers moved into the more remote and mountainous areas.

The farmers who established dairies on a grass cover of *Paspalum dilatatum* where the Big Scrub had once stood, prospered for a generation. Since then, declining soil fertility, loss of markets and the depressed socio-economic position of dairying in the region, has led to much farmland falling into a derelict and weed-infested condition. This downward trend was particularly evident in the years after World War II.

Beef production and tropical fruit growing have today replaced dairying on many holdings.

The region has come to rely much more on tourism, although most of the income and activity generated by this industry is concentrated along the coastal strip.

During the 1970s the availability of cheap farmland in the Richmond Valley, combined with the attraction of a warm climate, has led to the movement of new settlers into the district. Terania Creek Valley and Tuntable Creek Valley are today particularly identified with the 'new settlers' who tend to be young, educated people who have left city life in the hope of finding a lifestyle which gives greater value to environmental quality, personal development and satisfaction, and physical and mental wellbeing. To some extent the conflict at Terania Basin is purely a social one arising out of the different value judgments arrived at by many of the new settlers, compared with a section of the traditional community. The two groups tend to view native forests, and particularly rainforests, in a different light.

- 9.2 Settlement of the Richmond Valley necessitated communications with Brisbane to the north, the nearest commercial port. By the 1850s there were three roads to the north, one hugging the coast and two inland routes passing west of the Nightcap Range.

In the 1870s the need for a more direct route to the Tweed Valley led to the exploration and survey of a track over the Nightcap Range. Construction of the road commenced about 1878. This road, little more than a bridle track, was used for the carriage of mail and by light travellers such as Bishop Doyle of Lismore, local settlers, public servants and others.

A section of the track is preserved today within the Nightcap Track Flora Reserve in Whian Whian State Forest, to the north-east of Terania Basin.

To the north-west of the same Basin, on the divide between Tuntable and Terania Creeks, is a short section of an old track starting and ending in scrub. This was thought to be of aboriginal origin, but has now been confirmed as the work of Surveyor Arthur Gracie, who had his men construct the section of road while he was absent in Murwillumbah. Surveyor Gracie realised, even while the Nightcap Track was under construction, that it would be too steep to adequately serve traffic between the Richmond and Tweed Valleys. His alternative line, known as 'Gracie's Mistake', came to nothing however, because both it and the Nightcap Track were superseded by a road passing through Brunswick to the east.

- 9.3 The name 'Nightcap' is thought to be a corruption of 'night camp'. The locality of a prominent rock peak along the track over the range was made by the District Surveyor his main camp. This peak assumed the name 'Night Camp', evolving to 'Nightcap', and in time this name was applied to the whole range. An alternative explanation has been suggested by L.J. Webb, who believes the name to be a reference to the frequent cloud-capping of the summits of the range.

9.4 With the reservation of Whian Whian State Forest in 1914 and Goonimbar State Forest in 1917, much of the Nightcap Range came under the management control of the Forestry Commission. Lesser areas in the vicinity of the Blue Knob Range, on the northern slopes of Mount Burrell, and in the vicinity of Tuntable Falls, have been made Reserves for the Protection of Flora and Fauna by the Lands Department.

9.5 Interest in the establishment of a national park on the Nightcap Range was first expressed at least 47 years ago when a number of the councils in the region, and local residents, made representations to the NSW Government for the establishment of such a reserve. Notable among those pressing for the park was a Mayor of Lismore, E.J. Eggins, who sought the dedication of an area centred on the old Nightcap Track.

These representations were not entirely unsuccessful. Although no national park, as at Port Hacking and Ku-ring-gai, was established by special legislation, the NSW Government did respond. On May 15th, 1937, the Hon. Roy Vincent, MLA, Minister for Mines and Forests, declared under the Forestry Act, 1916, 'The Nightcap National Forest', incorporating Whian Whian, Goonimbar and two other State Forests (see Appendices).

The Minister in his declaration stated that the management plan for the national forest would provide for "what is, to all intents and purposes, a National Park serving all time", protecting a section of the range around the Nightcap Track. This national park consisted of 2,665 acres on the higher part of the range, and smaller areas of 120 acres about Peat's Mountain, 120 acres around Boggy Crossing, and 4 acres at an indeterminate locality, all within Whian Whian State Forest. The total park area was 2,909 acres.

The national forest declaration was not simply a response to conservation demands. Nightcap was the second such national forest created following amendments to the Forestry Act in 1935 which provided for such a designation. The difference between a state forest and a national forest is their security; state forests can be revoked by a simple notice in the Government Gazette at the instance of the Minister, while a national forest revocation is not usually possible without an Act of Parliament. During the 1930s there was considerable pressure on the Government to revoke Whian Whian, Goonimbar and adjacent state forests to allow for selection and settlement. The national forest declaration acted to counter such pressure.

9.6 Management of the Nightcap National Forest and its contained 'national park' has not been notably sympathetic to the preservation of forest values other than wood production, nor have the fair words of the Hon. Roy Vincent concerning recreation, wildlife (and even including

a quote from Emerson) been much heeded. Most of Whian Whian's natural forest cover has been clear-felled and planted to Blackbutt and Flooded Gum. The areas "to all intents and purposes, a National Park serving all time" have for the most part been lost to intensive forestry (and even to bananas), although 375 hectares are retained unlogged in the Nightcap Track Flora Reserve.

Much of Goonimbar State Forest, as yet unlogged, is to be intensively harvested between 1980 and 1986 to provide the bulk of the supply for the Murwillumbah working 'circle'.

The Forestry Commission have explained their failure to preserve the 'Nightcap National Park' in terms of war-time exigencies, which required the sacrificing of nature preservation in order to provide rainforest timbers for armament and aircraft construction. Closer examination of records is required to confirm the point, but it seems unlikely that the 2,665 acre section of the 'national park' on the highest and least accessible part of Whian Whian State Forest would have been harvested for the war effort when other sources of supply could have been more easily obtained in the vicinity.

The Commission's explanation of its failure to re-assert national park management objectives in the area since the war is difficult to accept. The 1937 plans for a 'national park' are said to have been 'overlooked' and 'effectively obliterated', yet the basic documentation can be found in the Commission's Head Office library.

Although the Forestry Commission has pointed to other areas "preserved" in Whian Whian and Goonimbar State Forests, it must be said that a number of these (Minyon Falls Flora Reserve, Boomerang Falls Flora Reserve, Last Valley Preserved Area) are inaccessible and would have been preserved, as well as the 'park', in any case. The so-called "Preserved Areas" are a designation unknown to the Forestry Act, and appear to have no real security from logging. The Big Scrub Flora Reserve (and presumably the adjacent "Preserved Area"?) has been logged in the past. The Gibbergunyah Roadside Preserved Area is a linear strip a few trees wide in a clear-felled forest; it has some aesthetic appeal but little conservation value.

- 9.7 An interesting logging episode in Goonimbar State Forest commenced in 1944 with the construction of a sawmill on Kunghur Creek, on the Tweed side of the range. In 1948 a flying fox was constructed, the line connecting the mill with the top of the range, a distance of almost two kilometres, and a difference in elevation of more than 500 metres.

Using this device to transport logs to the mill (a brake slowed the descending log), the rainforests on the crest of the Nightcap Range in that locality were logged. Apparently almost all of the timber went to make banana cases.



The logged area is now weed infested, and regeneration of the rainforest has been poor. The mill at Kunghur Creek ceased operations in 1955.

- 9.8 In 1963 the Minister for Lands made representations to the Minister for Conservation seeking the reservation of part of Whian Whian State Forest as national park. On advice from the Forestry Commission, the Minister rejected this proposal.
- 9.9 In 1976 the Wildlife Research Group (Queensland) (see Appendices) published a report of a fauna survey of Whian Whian and Goonimbar State Forests and recommended :

"...that a suitably extensive national park should be created in this region as soon as possible. It is considered that a minimum park should include the greater part of Goonimbar State Forest and the north-western one-third of Whian Whian State Forest".

Also in 1976, there appeared a nature reserve proposal encompassing Terania Basin. This was advanced by N. Nicholson and given publicity in the National Parks Journal, March/April issue, of that year.

It can be seen from the foregoing that the present proposal for a national park incorporating parts of Whian Whian and Goonimbar State Forests is not a novel one, and that, indeed, community interest in a national park on the Nightcap Range has quite a long history.

see p. 33

8.1

See PP 17-29  
NP&WS Submission

ALSO BAUR (1964) 20  
"FUTURE OF  
RAINFORESTS  
IN N.S.W."  
- F.C. QUOTED  
IN WEBB EVIDENCE  
21.4.80 PP. 57, 58.

## 10.0 RECREATION

Rec. Usage  
See  
PIP NCCC  
SUBMISSION

10.1 The proposed Nightcap National Park would serve as a very significant recreational and tourist resource for the Richmond-Tweed region, being centrally located between the major population centres of Lismore and Murwillumbah, and providing a contrast and additional attraction to the area's mainly coastal tourist assets. A Nightcap National Park would be more easily accessible than the Border Ranges National Park announced by the Government in 1978, and can be expected to take some of the pressure from the now heavily used Mount Warning National Park to the north.

Section 1 of the proposed park, comprising Terania Creek Basin and the Nightcap Track Flora Reserve, is a particularly valuable unit and can be expected to attract a disproportionate share of tourist use and interest in the larger proposed park area.

Within a small area of about 1200 ha, the visitor can experience a very beautiful rainforest environment featuring Bangalow Palms and outstanding individual specimens of rainforest and hardwood trees. Within the Basin there are also waterfalls, pools, rock pinnacles and, of course, the associated rainforest fauna, the most obvious examples of which are the fruit pigeons. From the top of the upper cliffline there are quite extensive views into the Basin and over the edge of the Nightcap Range to the north.

Around the head of Terania Basin there exists a walking track system including the historic Nightcap Track. From the Nightcap Track it is possible at the present time to walk around the northern rim of the Basin and eventually a system of tracks linking the Nightcap Track with Mount Nardi might be formed.

Section 2 of the proposed park area, comprising the most rocky sections of Goonimbar State Forest and equally inaccessible Crown land, will provide limited opportunities for hardy recreation and perhaps some climbing. From Blue Knob and the Sphinx there are extensive views over the Richmond-Tweed region.

Section 3 of the proposed park area, comprising the greater part of Goonimbar State Forest, provides some opportunities for the touring motorist, as dry weather roads have already been constructed by the Forestry Commission. The high altitude subtropical rainforests along the higher parts of the Nightcap Range in this section of the proposed park are not unlike those in the Border Ranges, but more easily accessible to the centres of population and less distant from the main tourist roads.

Aesthetics  
see NP&WS  
P36 8.4.4.

## 11.0 COMPETING LAND USES

- 11.1 Natural resources within the proposed park area appear not to be under any significant competing claims apart from demands from the timber industry.
- 11.2 The proposed park is considered in three sections, because of the different effects on the timber industry which will flow from dedication as national park of each of the three areas (see map).

### 11.3 Section 1

This section comprises the 740 hectares of Terania Creek Basin, plus the 375 hectares of the Nightcap Track Flora Reserve, together with further smaller areas intended to protect a narrow strip above the upper clifflines around the edges of the Basin.

The Forestry Commission's Statement on Terania Creek places considerable emphasis on the impact of supplies to the Mullumbimby and Murwillumbah Working Circles if Terania Creek's contribution is no longer available. This concern is greatly exaggerated, as can be shown by using data from the Forestry Commission's Statement :

	<u>Mullumbimby</u> <u>Sustained Yield</u> 1979-2006		<u>Murwillumbah</u> <u>Not Sustained Yield</u> 1979-1986
<u>Logging Cycle</u>	27 years		7 years
<u>Annual Net Volume</u>	7000 m <sup>3</sup>		9970 m <sup>3</sup>
<u>Total Net Volume of Cycle</u>	189000 m <sup>3</sup>		69790 m <sup>3</sup>
		Thinnings (say) 3,000 m <sup>3</sup> over 20 yrs.	60000 m <sup>3</sup>
			<u>130000 m<sup>3</sup></u>
<u>Terania Proportion</u>			
Compartments No. 46N	2800 m <sup>3</sup>	Goonimbar '75	450
Nos. 46S, 49	2700 m <sup>3</sup>	" '76	450
	<u>5500 m<sup>3</sup></u>		<u>900</u>
Gross to Nett-22%	1200 m <sup>3</sup>	-22%	<u>200</u>
Net	<u>4300 m<sup>3</sup></u>		<u>700 m<sup>3</sup></u>
			<u>6400</u>
			<u>1400</u>
			<u>5000 m<sup>3</sup></u>

Percent of Annual Volume     $\frac{4300}{7000} = 60\%$  or 7 months     $\frac{700}{9970} = 7\%$  or 25 days

Percent of Total Volume    27 yrs =  $\frac{4300}{189000} = 2.3\%$      $\frac{700}{130000} = .05\%$

20 yrs =  $\frac{4300}{1400000} = 3\%$

But describing, as the Forestry Commission has, the importance of Terania Creek timber to the Mullumbimby Working Circle volume as "essential in relative terms", and the loss to the Murwillumbah Working Circle as "major", is unwarranted exaggeration. On page 42 of the Statement, the effect is described in more realistic terms as a reduction of 150 m<sup>3</sup> per annum spread over 3 mills in the case of the Mullumbimby Working Circle, and a "marginal" effect in the case of the Murwillumbah Working Circle of 25 days' less supply than the expected 7 years.

The Association makes no alterations to its submissions at this stage, apart from page 22 of the submission of February 29, where paragraphs 3 and 4, beginning respectively "The Terania Basin" and "From the above", are deleted and replaced by the following paragraph :

"From the above it can be appreciated that the removal of the timber allocation represented by Section 1 of the proposed park area, need not result in any undue hardship to any sawmill proprietor or lead to any unemployment in the timber industry."

From the above, the removal of the timber allocation represented by Section 1 of the proposed park area, spread over a time period of six years, need not result in undue hardship to any sawmill proprietor or lead to unemployment in the timber industry.

It is misleading of the Forestry Commission to mention in their Statement the withdrawal in 1978-79 from Standard Sawmilling Pty. Ltd. of their quota of 9610 m<sup>3</sup> as a result of the Border Ranges National Park decision, without also mentioning that that Company was paid a lump sum in compensation by the NSW Government in 1978 of \$750,000. It should be noted that although the prime reason for this ex gratia payment by the Government was to ensure the continuation of local employment through the importation of more expensive timber from Western Samoa, actual employment in Standard's Murwillumbah mill has, nevertheless, declined from 120 in 1978 to a present total of 93. This has been achieved by not replacing staff who have resigned or retired.

The possibility that Standards may decide to close their Murwillumbah mill as a result of decreasing economy of scale as a consequence of further reduction in their quota, is a most unlikely one. A potential cut of 3%, which might in fact not eventuate, however, is not likely to cause such a drastic step, as the Company's profits could only be reduced marginally.

\* STANDARDS = STANDARD SAWMILLING CO PTY LTD  
NSW = ROBB & BROWN

*Remove  
- No further  
needed.*



The fact that James Hurford's mill at Lismore is being rebuilt despite their quota being reduced to 1430 m in 1977, is an indication that economies of the scale would not be a major factor in sawmilling profitability under the circumstances being considered here.

#### 11.4 Section 2

Section 2 of the proposed park area comprises a Reserve for Public Recreation R.50987, vacant Crown land and the westernmost part of Goonimbar State Forest in the vicinity of Blue Knob and the Sphinx. Forests on these lands were not taken into account in the Forestry Commission's assessment of timber volumes due to their inaccessible nature, and in the case of the public reserve, inappropriate tenure.

Consequently, the dedication of Section 2 of the proposed park should have no effect on the timber industry.

#### 11.5 Section 3

Section 3 of the proposed park area comprises the greater part of Goonimbar State Forest. This State Forest was assessed by the Forestry Commission in 1972 as containing 81,200 m<sup>3</sup> net timber volume.

Goonimbar State Forest is to provide 96% of timber supply for the Murwillumbah Working Circle between 1980 and 1986. Prescribed yield of 9970 m<sup>3</sup> net per annum is to be directed to Standard Sawmilling Company at Murwillumbah (5770 m<sup>3</sup> net per annum) and to Robb & Brown at Murwillumbah (4200 m<sup>3</sup> per annum).

After 1986, the Forestry Commission's Statement forecasts a substantial reduction in timber supply to the Murwillumbah Working Circle because harvesting mature and over-mature stands will have been completed. The level of yield will then be dependent upon the ability of the industry to utilise thinnings from regrowth stands.

The as yet largely unlogged Goonimbar State Forest will therefore in seven years cease to be a source of hardwoods and rainforest timbers for a considerable time. In the case of hardwoods, this State Forest is not expected to contribute to mill supplies again until 2006. In the case of rainforest timbers under the Forestry Commission's present policy (which calls for phasing out of general purpose rainforest logging), Goonimbar will cease to be a supplier in the foreseeable future.

Section 3 of the proposed park is put forward for dedication simultaneously with Sections 1 and 2. It is recognised, however, that the dedication of Section 3 poses problems in respect of maintaining timber supply to the Murwillumbah Working Circle over the next seven years.

The Murwillumbah Management Plan produced by the Forestry Commission shows that 35% of Goonimbar's assessed timber volume will be derived from rainforest timbers. The pure rainforest occupying the highest parts of the Nightcap Range within Goonimbar State Forest is as yet largely unlogged.

This Association urges the Terania Inquiry to examine the resource position closely in order to establish whether the hardwood regrowth stands upon which the Murwillumbah Working Circle must rely after 1986 can in fact be brought into use earlier than 1986. If this is the case, the pure rainforest component of Goonimbar State Forest at least might be protected from logging in the proposed park without affecting mill supplies and employment.

If it is found that logging of the hardwoods in Goonimbar State Forest must continue, this might be continued as a phasing out operation within Section 3 of the proposed national park, and ought not necessarily lead to a delay in the dedication of the proposed park or to the dedication of a lesser area than that proposed.

## 12.0 ACKNOWLEDGEMENTS

The National Parks Association is most grateful for the assistance given by various individuals and organisations in the preparation of this submission.

The Association is particularly indebted to Tony Haigh, Peter Den Exter, Hugh and Nan Nicholson, Michael Murphy, Len Webb and John Williams.

The Association also acknowledges the assistance of the Richmond River Historical Society, the librarian at the NSW Forestry Commission, and the Wildlife Research Group, (Queensland).

REFERENCES

- Baur, G.N. "Nature and Distribution of Rainforests in NSW" 1978.
- Bureau of Meteorology "Climatic Survey Richmond-Tweed Region 1 NSW" Nov. 1972.
- Forestry Act, 1916, NSW.
- Forestry Commission of NSW, "Declaration of the Nightcap National Forest", May 15, 1937. (see appendices).
- Forestry Commission of NSW, "Murwillumbah Management Plan".
- Forestry Commission of NSW, "Proposed Logging of Terania Creek", Dec.14, 1979.
- Frith, H.J. "Wildlife Conservation", 1973.
- McBride, Isabel. "The Prehistory of New England", S.U.P., 1976.
- McElroy, C.T. "The Geology of the Clarence-Morton Basin." Mem. Geol. Surv. NSW 9. 1963
- Richmond River Herald "Nightcap National Park. Memories of the Pioneers." May 11 and 14, 1937.
- Richmond River Historical Society. "Flying Fox - Kunghur Creek."
- Webb, L.J. "Statement." Feb.1980, (see appendices).
- Webb, L.J. "Problems of Rainforest Classification in a specific Locality." Feb.5, 1980. (see appendices).
- Webb, L.J. "The Ecological Relations of the Terania Rainforests." Feb.8, 1980, (see appendices).
- Wildlife Research Group (Queensland). "Report of a Fauna Survey, Whian Whian - Goonimbar State Forests." October 1, 1976. (see appendices).
- Williams, J.B. "Submission to the Inquiry into Proposed Logging of Terania Creek." Feb. 1980.



WILDLIFE RESEARCH GROUP (QUEENSLAND),

P.O. Box 867,  
FORTITUDE VALLEY QLD. 40061 OCTOBER, 1976REPORT OF A FAUNA SURVEYWHIAN-WHIAN - GOONIMBAR STATE FORESTS

Wildlife Research Group (Qld.) conducted a fauna survey of an Whian State Forest (S.F.173, Night Cap National Forest No. 2, County of Rous, Land Districts - Lismore & Murwillumbah, Forestry District - Casino, Tweed & Terania Shires) and Goonimbar State Forest (S.F. 344, Night Cap National Forest No. 2, County of Rous, Land District of Lismore, Forestry District - Casino, Tweed & Terania Shires) between 10 and 12 September, 1976.

11 Closed Forest and Tall Open Forest (Specht, R. L. 1970. Vegetation, pp. 44-67 in 'The Australian Environment'. 4th ed. I.R.O. Melbourne: Uni. Press) were investigated. Activities included early morning bird-watching sessions, from censuses and nocturnal spotlighting. Camp was based on Terania Creek.

An annotated list of mammals, birds, reptiles and amphibians recorded is presented.

MAMMALIAMONOTREMATA

Platypus (Ornithorhynchus anatinus)

MARSUPIALIA

Pademelon (Thylogale sp.).

Short-nosed Bandicoot (Isodon obesulus).

Common Ringtail (Psephocheirus peregrinus).

CHIROPTERA

Grey-headed Flying Fox (Pteropus poliocephalus).

Comments The very little time available for spotlighting renders this list totally inadequate and one would expect a much greater variety of mammals to occur there. One quite possible occurrence is the Tiger Cat (Dasyurus maculatus), a species which is rapidly becoming increasingly rare and localised throughout its distribution.

AVESPELECANIFORMES

Black Cormorant (Phalacrocorax carbo).

Little Black Cormorant (P. sulcirostris).

Little Pied Cormorant (P. melanoleucos).

CICONIIFORMES

White-faced Heron (Ardea novaehollandiae).

FALCONIFORMES

Crested Hawk (Aviceda suberistata).  
 Grey Goshawk (Accipiter novaehollandiae).  
 Brown Goshawk (A. fasciatus).  
 Edgetailed Eagle (Aquila audax).  
 Banken Kestrel (Falco sephchroides).

ALLIFORMES

Wattle-necked Turkey (Alectura lathamii).

CHARADRIIFORMES

Lesser Frigatebird (Venellus novaehollandiae).

COLUMBRIFORMES

Rock Dove (Macropygia phasianella).  
 New Zealand Pouter (Geopelia humeralis).  
 Rock Dove (Ptilinopus magnificus).  
 Rock Dove (Lopholaimus antarcticus).

PSITTACIFORMES

Yellow-tailed Black Cockatoo (Calyptorhynchus funereus).  
 White Cockatoo (Cacatus galerita).  
 Crimson Rosella (Platycercus elegans).  
 King Parrot (Alisterus scapularis).

BUCULIFORMES

Sooty Owl (Tyto tenebricosa).  
 Boobook Owl (Ninox novaeseelandiae).  
 Powerful Owl (N. strenua).

CAPRIMULGIFORMES

Tawny Frogmouth (Podargus strigoides).  
 Owllet-Nightjar (Aegotheles cristatus).

CORACIIFORMES

Azure Kingfisher (Ceyx azureus).  
 Laughing Kookaburra (Dacelo gigas).

PASSERIFORMES

Noisy Pitta (Pitta versicolor).  
 Albert Lyrebird (Menura albertii).  
 Welcome Swallow (Hirundo neoxena).  
 Tree Martin (Petrochelidon pigricans).  
 Black-faced Cuckoo-Shrike (Coracina novaehollandiae).

Varied Triller (Lalage leucomela).  
 Australian Ground-Thrush (Zoothera dauma).  
 Spine-tailed Logrunner (Orthonyx temminckii).  
 Blue Wren (Malurus cyaneus).  
 Variegated Wren (M. lamberti).  
 Brown Warbler (Gerygone mouki).  
 Striated Thornbill (Acanthiza lineata).  
 Brown Thornbill (A. pusilla).  
 White-browed Scrub-Wren (Sericornis frontalis).  
 Large-billed Scrub-Wren (S. magnirostris).  
 Yellow Robin (Eopsaltria australis).  
 Pale-yellow Robin (E. capito).  
 Rose Robin (Petroica rosea).  
 Grey Fantail (Rhipidura fuliginosa).  
 Rufous Fantail (R. fufifrops).  
 Willie Wagtail (R. leucophrys).  
 Spectacled Flycatcher (Monarcha trivirgata).  
 Golden Whistler (Pachycephala pectoralis).  
 Grey Shrike-Thrush (Colluricincla harmonica).  
 Eastern Shrike-tit (Falcunculus frontatus).  
 Eastern Whipbird (Psophodes olivaceus).  
 White-throated Treecreeper (Climacteris affinis).  
 Red-browed Treecreeper (C. erythrops).  
 Mistletoe-bird (Dicaeum hirundinaceum).  
 Spotted Pardalote (Pardalotus punctatus).  
 Black-headed Pardalote (P. melanocephalus).  
 Eastern Silvereye (Zosterops lateralis).  
 Lewin Honeyeater (Meliphaga lewinii).  
 Yellow-faced Honeyeater (M. chrysops).  
 White-naped Honeyeater (Melithreptus lunatus).  
 Eastern Spinebill (Acanthochaera chrysoptera).  
 Little Friarbird (Phelemon citreogularis).  
 Noisy Friarbird (P. corniculatus).  
 Southern Figbird (Sphecotheres vieillotii).  
 Mudlark (Grallina cyanoleuca).  
 Pied Butcherbird (Cracticus nigrogularis).  
 Grey Butcherbird (C. torquatus).  
 Black-backed Magpie (Gymnorhina tibicen).  
 Pied Currawong (Strepera graculina).  
 Green Catbird (Ailuroedus crassirostris).  
 Satin Bowerbird (Ptilonorhynchus violaceus).  
 Paradise Riflebird (Ptiloris paradiscus).  
 Australian Crow (Corvus ceciliae).

Comments A rich and varied avifauna is represented in this area. It is interesting to note some characteristics of the region which are quite different from most rainforest localities in south-eastern Queensland and north-eastern New South Wales, particularly the latter since the clearing of the 'big scrub'. Several species of predominantly northern origin (such as the Spectacled Flycatcher) are common here but quite rare elsewhere in New South Wales.

Some generally rare and localised species (such as the Albert Lyrebird) are in very good numbers in the area. Spine-tailed Logrunners were also extraordinarily common. Of particular interest were the records of Powerful and Sooty Owls, both considered rare species.

The Whian Whian - Goonimbar Forest is one of the very few localities where the Plumed Frogmouth (Podargus plumiferus) has been recorded. This bird, possibly subspecific to the Marbled Frogmouth, is extremely rare and records extremely scarce.

#### REPTILIA

##### SQUAMATA

Yellow-bellied Legless Skink (Anomalopus truncatus).  
 Grass Skink (Lampropholis guichenoti).  
 Common Legless Skink (Sphenomorphus scrutirostrum).  
 Water Dragon (Psylgnathus leseurii).

Comments: The very little time available for reptile collecting did not allow for compilation of a truly representative list. However, the area is in an interesting zoogeographical zone being both the southern and northern limit of many species. The record of Anomalopus truncatus, however, is very significant as this species has not previously been recorded outside of south-eastern Queensland.

#### AMPHIBIA

##### ANURA

Marsupial Frog (Assa darlingtoni).  
 Tusked Frog (Adelotus brevis).  
 Giant Barred River Frog (Mixophyes iteratus).  
 Brown Marsh Frog (Limnodynastes peroni).  
 Common Froglet (Ranidella signifera).  
 Pearson Tree-Frog (Literia pearsonianna).

Comments: The occurrence of the Marsupial Frog is of much interest. This species, with a unique form of parental care which involves raising the tadpoles in small pouches on the side of the male, has been recorded from very few localities and never at such a low altitude. The Giant Barred River Frog is another uncommon and localised species. On wet summer nights, it is expected that a good number of additional species would be recorded.

#### General Comments:

"The remaining rainforests of Australia are of international significance as ancient and isolated reservoirs of a great variety of plant and animal species."

(Report of the Committee of Enquiry into the National Estate, 1974. Aust. Govt. Publ. Service, p.55).

There exists in the Whian Whian - Goonimbar State Forests extensive tracts of rainforest. It is not unreasonable that we should expect that these authorities concerned in New South Wales should strive to afford appropriate protection to those tracts of rainforest still in existence, particularly in view of the relentless destruction of this habitat that has occurred in recent history in this State.

The rainforest and associated habitats of this area provide refuge to large numbers of some species of wildlife generally considered to be rare and localised throughout their ranges, such as the Sooty and Powerful Owls and Albert Lyrebird. It is significant that in the course of such a short period of time, the known ranges of two species of vertebrate, one of which is extremely localised in distribution, should be extended.

It is also of considerable interest that some species of chiefly northern origin were common here. An extraordinary representation of both predominantly highland and predominantly lowland species was noted to an extent not previously recorded in similar habitats by the researchers.

It is the opinion of this organisation that a suitably extensive national park should be created in this region as soon as possible. It is considered that a minimum park should include the greater part of Goonimbar State Forest and the north-western one-third section of Whian Whian State Forest.

The Wildlife Research Group expresses its strong support and encouragement to those residents in Terania Creek Valley and other individuals who have so appropriately sought protection for the region surveyed.

(G. J. Roberts) 1  
Secretary.

1. Participants in Survey

C. Corben (Qld. Uni.), R. Raven (Qld. Museum), G. Roberts (Qld. Uni.),  
A. Smyt (Bris. Library), D. Smyth (Qld. Uni).

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## MOUNT WARNING NATIONAL PARK PLAN OF MANAGEMENT

A plan of management for Mount Warning National Park has been prepared by the National Parks and Wildlife Service of New South Wales. Public exhibition of the plan took place between 27th March and 29th May, 1981, and in all 23 responses were received.

These submissions had been reviewed by the National Parks and Wildlife Advisory Council and a report to the Minister subsequently made.

On 24th April, 1985, the Minister adopted the Mount Warning National Park Plan of Management.

Please find attached a copy of the plan for your information and use. If further copies are required they are available for purchase using the attached coupon.

*T. Smallwood*  
J. F. Whitehouse,  
Director.



National Parks Association of NSW

State Council  
275c Pitt Street, Sydney NSW 2000  
Telephone (02) 264 7994

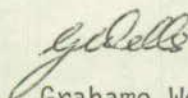
January 29, 1988

MEMO: Far North Coast Branch  
Three Valleys Branch  
Clarence Valley Branch  
Mid North Coast Branch

SUBJECT: North Coast Regional Environmental Plan

The Minister for Planning and Environment, Mr Bob Carr, made the North Coast Regional Environmental Plan on 18th December 1987. The Plan was gazetted on 15/1/88.

I presume copies will be available in due course from the DEP.

  
Grahame Wells,  
Director.



**RAINFOREST NATIONAL  
PARKS OF THE  
FAR NORTH COAST  
INTERIM MANAGEMENT  
JUNE 1984**







*The peace and tranquility of a rainforest stream.*

## **RAINFOREST NATIONAL PARKS OF THE FAR NORTH COAST INTERIM MANAGEMENT**

### **INTRODUCTION**

This paper has been prepared by the National Parks and Wildlife Service to provide you with information on:

- \* The recent decision of the New South Wales Government to conserve rainforest areas in new national parks and nature reserves.
- \* The new national parks themselves.
- \* Management policies of the National Parks and Wildlife Service which are relevant to the three new northern rainforest parks: Border Ranges, Nightcap and Washpool.
- \* Interim management proposals for the three new northern rainforest parks.

### **The National Parks and Wildlife Service and the New Rainforest National Parks**

Since it was established in 1967, the National Parks and Wildlife Service has been responsible for nature conservation in New South Wales.

The main functions of the Service are to provide a full range of natural habitats and to ensure the continued survival of all our native plants and animals.

National parks are also popular places for outdoor recreation. So popular that last year nearly 15 million people visited national parks in New South Wales.

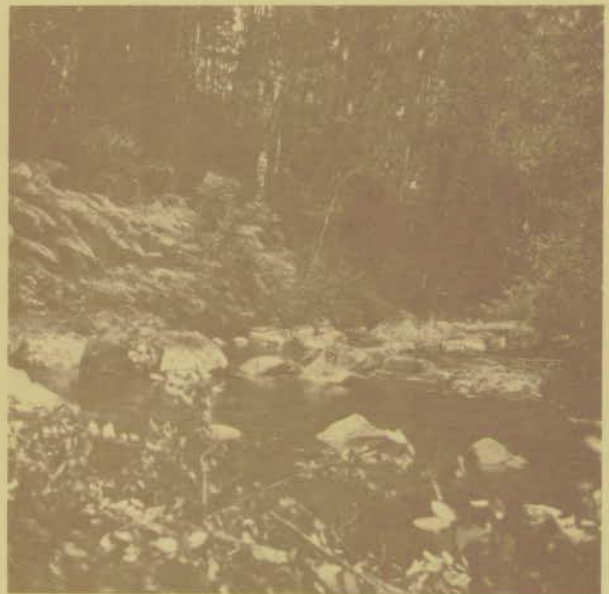
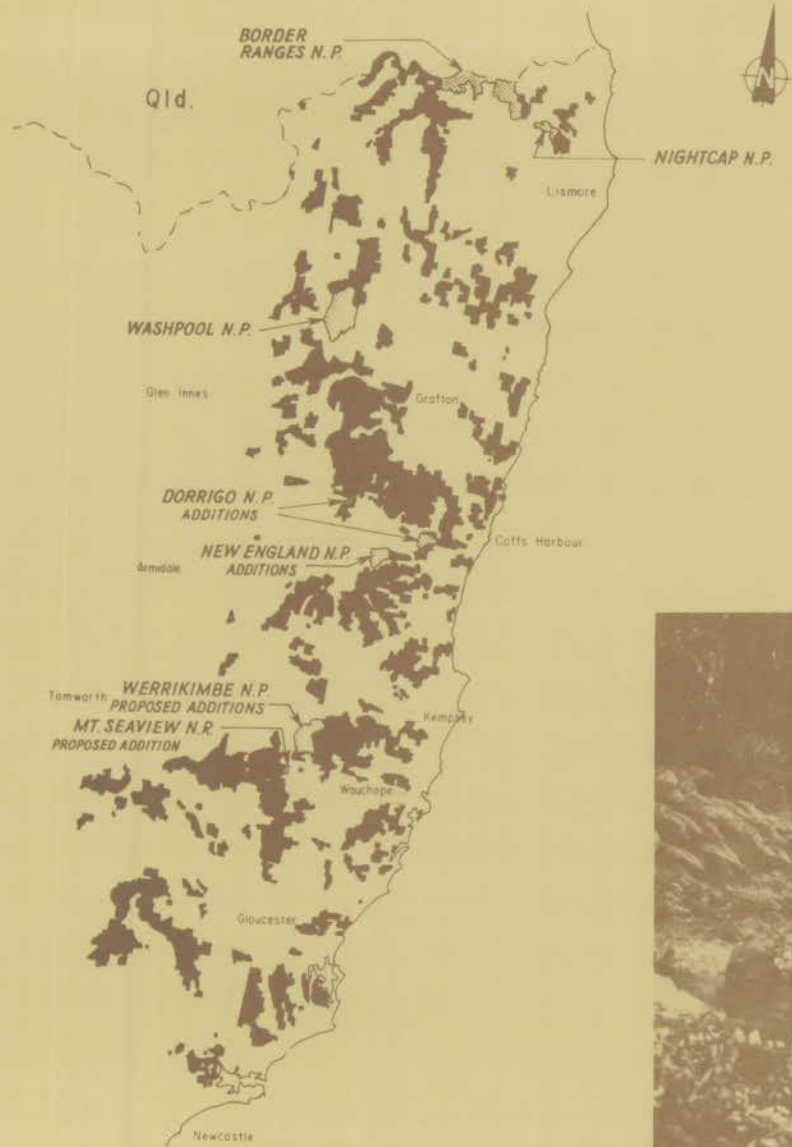
Recent years have seen a growing awareness of the environment, both in Australia and overseas. One of the ways in which the New South Wales Government has responded to this has been by setting aside a number of new national parks and reserves.

Some of the most important of these are the new rainforest parks of the far north coast – the Washpool, Border Ranges and Nightcap National Parks.

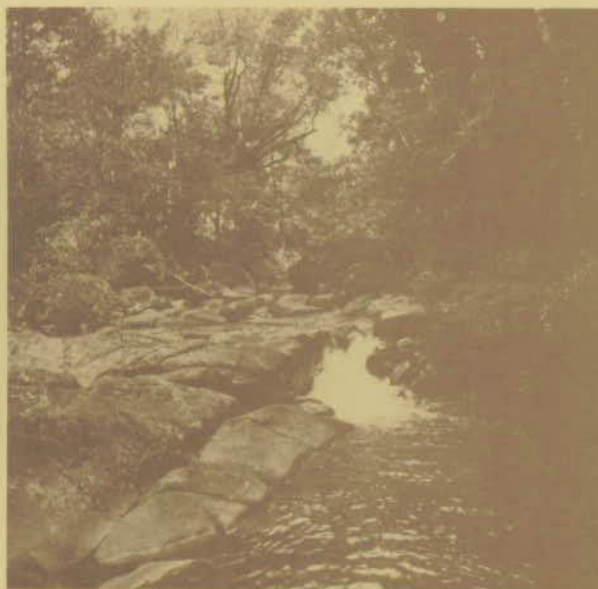
In 1982, following an exhaustive investigation of important rainforest areas on the north coast, the Government adopted a policy which identified six major rainforests for preservation in 90,000 hectares of new national park.

The State Premier even more recently pledged his Government would nominate rainforest national parks in New South Wales for inclusion on the World Heritage list.

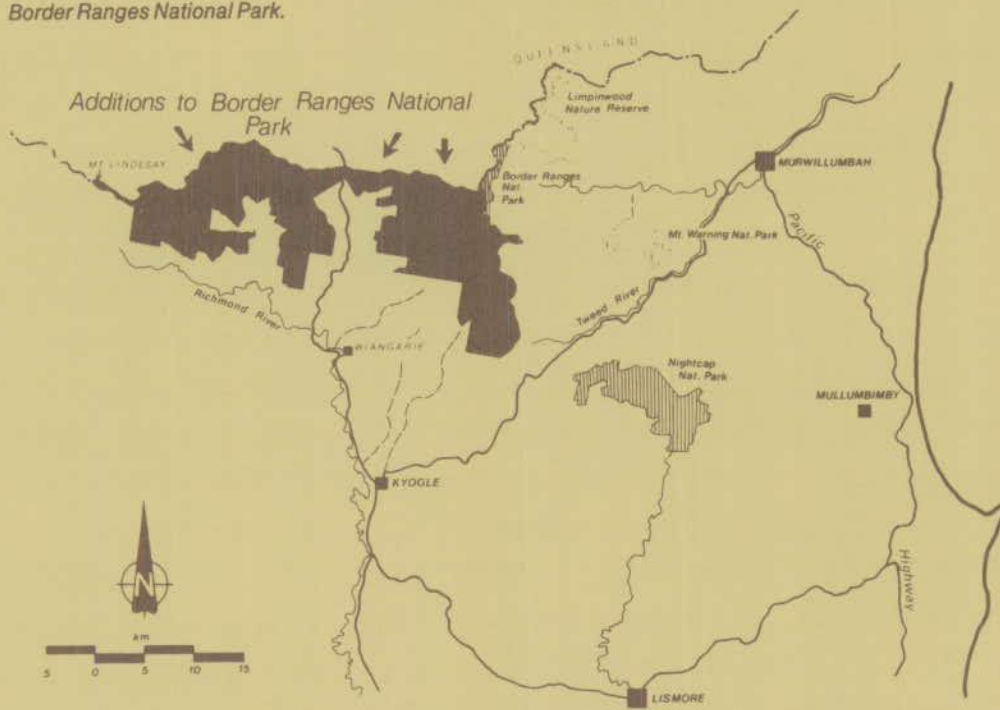
Locality map showing positions of the three new Rainforest National Parks.



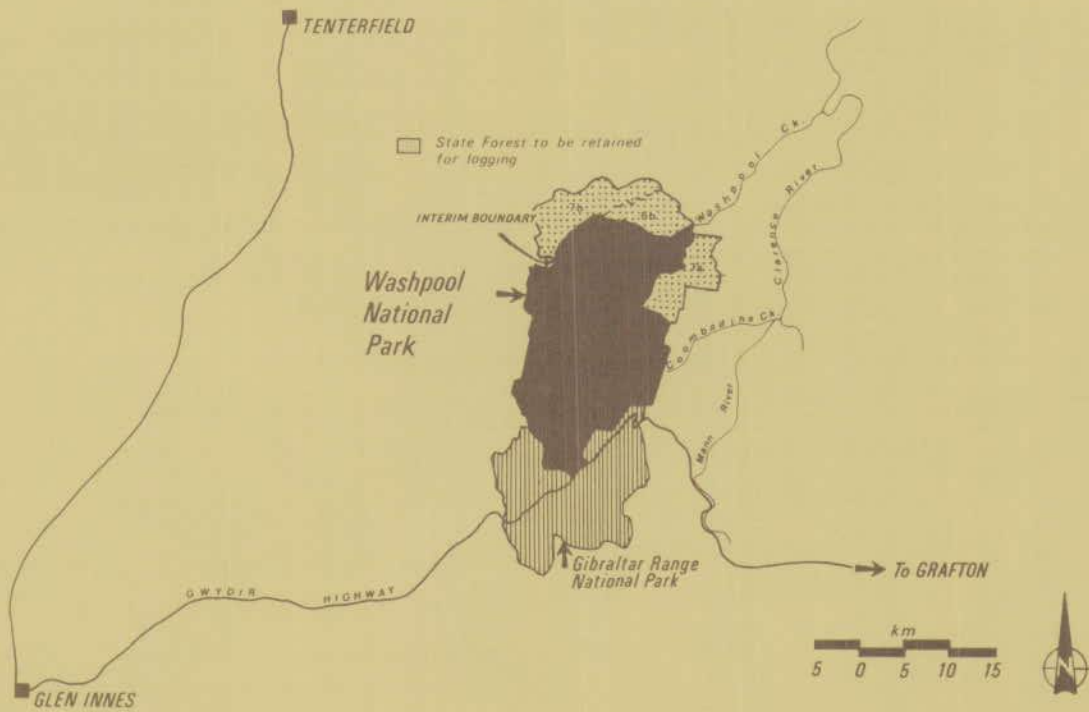
Washpool National Park.



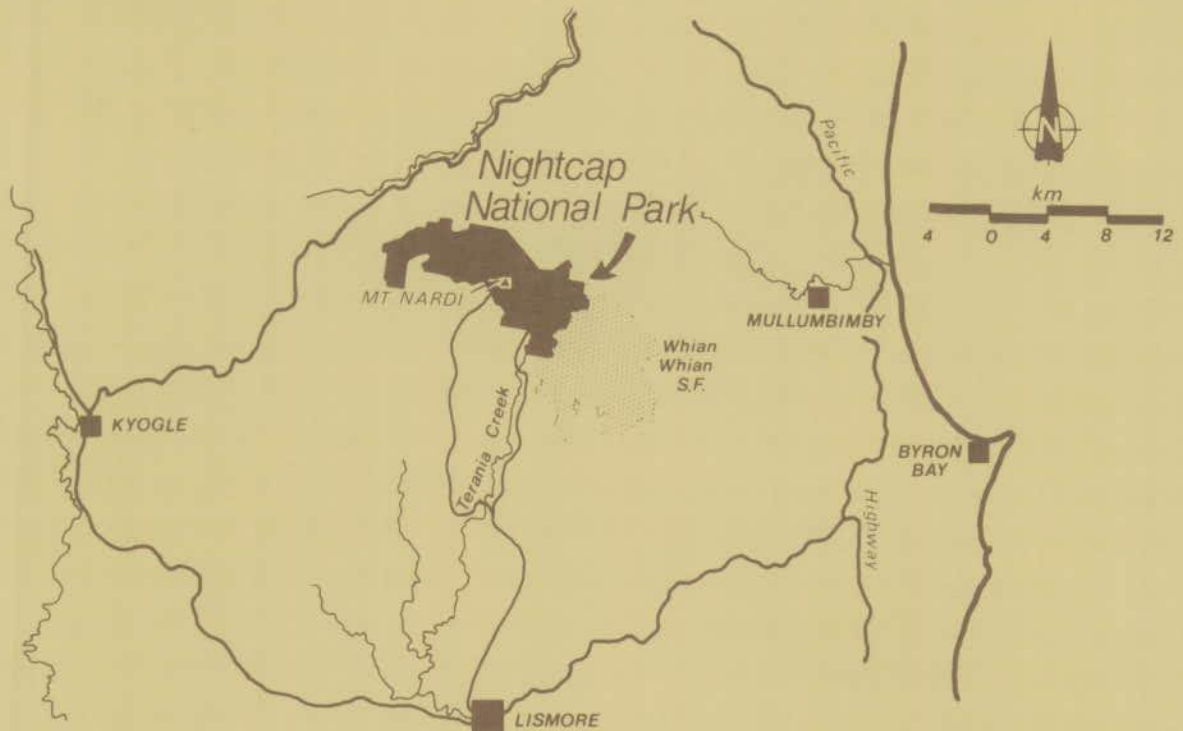
**Border Ranges National Park.**



**Washpool National Park.**



### Nightcap National Park.



### Planning in the rainforest parks

The Service is now faced with the complex task of planning for the management of these important areas.

The Service believes that the public should be involved in this planning as much as possible.

A major avenue for this is provided by local advisory committees. The committees, whose members are usually local people with special skills related to park management, representatives of park user groups, local authorities and adjoining landholders, are appointed by the Minister for Planning and Environment.

Committee members play a valuable role in providing information from the community to the National Parks and Wildlife Service, and from the Service to the community.

A new Advisory Committee has been formed to advise on the rainforest parks in the Service's Lismore District (i.e. Border Ranges, Mount Warning and Nightcap National Parks).

The Service is required to prepare plans of management for all areas under its control. Plans of management will be prepared for the rainforest national parks. The Service will exhibit these and invite public comment and suggestions before each plan is adopted.

The preparation of a plan of management for a national park is a lengthy business. Many groups and individuals have contributed to previous plans and it is the Service's job to try to resolve their often conflicting interests.

On past experience we must expect that

management plans for the rainforest parks will take some time as the complex problems are studied and various community views are sought and carefully considered.

While the planning process is underway, the Service believes that interim management actions must be taken to protect the rainforests against degrading influences such as erosion and to provide safe visitor access to and facilities within the new parks.

These interim actions can be reversed if that is recommended by the adopted plan of management.

### THE THREE NEW NORTHERN RAINFOREST PARKS -

#### A BRIEF DESCRIPTION

#### **Border Ranges National Park**

The Border Ranges National Park is situated in far north-eastern New South Wales on the Queensland border, 30 kilometres west of Mullumbimby and 30 kilometres north of Kyogle.

The park is predominantly rainforest and encompasses some 30,000 hectares of the rugged McPherson Range, from the Tweed Range in the east to Mount Lindesay in the west.

Much of the Border Ranges are clothed in luxuriant subtropical rainforest, while some of the higher, moister parts of the Tweed Range support cool temperate rainforest dominated by Antarctic beech.

Dry rainforest predominates over much of the lower country towards the western end of the McPherson Range.

The mammal fauna of the Border Ranges is probably richer than in any other part of New South Wales and possibly Australia.

About a quarter of the total bird species present in Australia have been recorded in the vicinity of the Border Ranges. Likewise, the invertebrate groups which have been studied there have been found to be extremely diverse.

It has generally been concluded that the Border Ranges are home to a treasure trove of undescribed species.

The Tweed Range Scenic Drive from Lillian Rock to Wiangaree is a spectacular round trip through the eastern Tweed Range section of the park. Facilities include a rest area for short-term camping, picnic spots, lookouts and walks.

The lookouts provide breathtaking views of the rim or caldera of the Mount Warning shield volcano, with the Mount Warning volcanic plug in centre stage.

Lamington National Park across the border to the north and the Nightcap Range to the south are set off by the Pacific Ocean on the eastern horizon.

The western Roseberry section provides a more remote style of recreation, with perimeter roads providing a base for day walks and wilderness walks to places like Levers Plateau.

The Lions Road passes through the narrow central section of the park, providing travellers with glimpses of rugged, rainforest-clad ranges to the east and west. Picnic and lookout facilities provided by the Lions Club along this road add to its beauty and charm.

### **Nightcap National Park**

The Nightcap National Park is located near the Border Ranges in far north-eastern New South Wales, 30 kilometres north of Lismore and 30 kilometres south-west of Murwillumbah.

Straddling the eastern half of the Nightcap Range, this park is made up of a scenically spectacular series of peaks, ridges and gullies.

The park features one of the best developed subtropical rainforests in New South Wales. This rainforest is found on the higher mountains and ridges as well as the lower altitude valleys and gullies and reflects an underlying geology of rich basaltic lava flows.

The park's midslopes support less complex warm temperate rainforest and dense wet sclerophyll forest dominated by eucalypts and brush box.

The park is situated in the closely settled Richmond/Tweed district. It has a diverse and scenic environment and is readily accessible by road from the Richmond and Tweed Valleys, the Gold Coast and Brisbane.

The Nightcap offers both residents and tourists the opportunity of day walks in an ancient and beautiful rainforest.

### **Washpool National Park**

Washpool National Park is situated in northern New South Wales on the eastern escarpment of the New England Tablelands.

It is 670 kilometres north of Sydney midway between Grafton and Glen Innes and adjoins the Gibraltar Range National Park to the south.

Washpool National Park is of national significance for its permanent reservation of a major complex of warm temperate rainforest with its associated mosaic of open hardwood forests.

It also provides outstanding wilderness recreation opportunities.

### **SERVICE POLICIES AND INTERIM MANAGEMENT ACTIONS FOR THE RAINFOREST PARKS**

The National Parks and Wildlife Service is actively involved in managing resources in its care so that they can be enjoyed by the community and preserved for future generations.

This management is guided by Service policies.

There are a number of these policies which are relevant to the new rainforest parks. Broadly, these aim to protect each park's nature conservation, scenic, scientific, cultural and recreational values by:

- \* eliminating, to the greatest possible extent, the influence of non-native plants and animals.
- \* providing positive management of fire based on ecological requirements and the need to protect adjoining communities and land.
- \* providing for appropriate public recreation.

This section outlines policies which are relevant to the new rainforest and outlines interim actions that the Service will take in each park.

These actions are seen as essential in the period prior to the preparation of plans of management for each park. Works outlined are limited and maintain the range of management options to allow public debate and assessment during the plan of management process that will follow.

The policies and actions cover the following areas:

### **RECREATION AND PUBLIC ACCESS**

National parks serve two main functions. They preserve habitat for native plants and animals.

They also preserve areas for outdoor recreation. In managing national parks, the Service must walk a delicate line between protecting habitat which often means excluding people, and providing public access, which means impact on the environment.

The Service believes that people who visit national parks do so to experience a natural environment in safety and relative comfort.

Therefore the Service does not consider it appropriate to construct large scale or intrusive visitor facilities.

It aims instead to provide facilities appropriate to each individual park. Bird observatories, for instance, are most appropriate in wetland parks. Viewing platforms are suitable to mountain parks with panoramic views.

The Service generally limits its provision of visitor facilities to the basics – access roads to points in the park which are of interest in themselves; where visitors may park their cars and walk along graded walking tracks; through natural landscape; picnic areas; fireplaces; drinking water and toilets.

These are constructed from natural materials and designed to blend into the environment. Tracks are signposted with distance and average walking times.

The Service has identified the appropriate recreational role of each of the new rainforest parks and a number of specific actions considered necessary.

These works are primarily designed to meet visitor needs and to protect the parks from further environmental damage, such as erosion. In other words, the Service will manage some areas for bushwalker access, including closing many kilometres of existing logging roads, and open other areas for vehicle based recreational use.

These measures are interim. If the adopted plan of management for the park decides they should be modified, they will be.



*Walking tracks are being developed to allow visitors to appreciate the beauty of the rainforest.*

### **Nightcap National Park**

The Nightcap National Park provides outstanding recreation opportunities, especially for close appreciation of a rainforest environment.

The Service sees low key development of the park, with construction of walking tracks and picnic areas, as being complementary to the Border Ranges and Washpool National Parks which will be less accessible to the public.

The park will also help to relieve visitor pressures on the smaller Mount Warning National Park where the steep terrain restricts the provision of parking and recreational facilities.

### **\* Terania Creek**

The popularity of Terania Creek reflects a decade of interest and promotion as Lismore's own beautiful rainforest.

To cater for the existing high use, the Service has provided all-weather access to a delightful creekside picnic area.

A graded walking track has been constructed from the picnic area to Protestors' Falls.

The Service proposes to complete the picnic area to construct a two-kilometre graded circuit walk through the subtropical rainforest of the Terania Creek Basin. This walk will depart from the picnic area and will replace the existing walk along an old logging track.

### **\* Mount Nardi**

The summit of Mount Nardi, accessible by sealed road from nearby Nimbin, is girded by largely undisturbed subtropical rainforest and is the most logical visitor destination in this section of the Nightcap National Park.

The summit area has been heavily cleared to construct two television transmitting towers and associated roads, power lines and buildings.

The land between the towers is managed by Lismore City Council as a picnic area.

The Service believes that little can be done to soften the overpowering impact of these developments on the Mount Nardi summit.

While an excellent existing walking track departs from the summit, the Service believes Mount Nardi has been so altered that it does not offer the visitor a high quality rainforest experience.

It therefore proposes to maintain Googarna Road to its junction with Mulgum and Flying Fox Roads in the belief that this former forestry road offers a rainforest drive of exceptional quality and beauty.

A picnic area and turn-around, with parking for nineteen cars, will be constructed at this junction and Mulgum and Flying Fox Roads will be closed to vehicle use. Karawatha Road in Griers Scrub will also be closed.

The Service proposes to construct a viewing platform at Pholis Gap lookout so that visitors can safely enjoy the view from this spectacular vantage point on Googarna Road.

Mulgum and Flying Fox Roads will be converted to walking tracks to features of interest such as the flying fox at the head of Kunghur Creek.

Careful interim management of the logging roads inherited with the Nightcap National Park is crucial. This park has the highest recorded rainfall in New South Wales – when it rains it pours. Roads must be either well maintained or closed and rehabilitated or they are destroyed by landslips and washaways. This damages the forest and community town water supply reservoirs on Doon Doon and Mulgum Creeks.

Because the continued presence of Mulgum, Flying Fox and Karawatha Roads threatens the environmental integrity of the rainforests of the Nightcap, the Service proposes to close and rehabilitate them. This will involve digging cross drains to stop water from washing any more of the roads away, and by ripping their gravel surfaces so that natural revegetation can proceed quickly.

The management of Googarna Road will involve road grading, clearing roadside drains and directing run-off water. This will minimise damage to the forest by roadslip and erosion and will maintain future options.

\* Nightcap Track and Mount Matheson Loop Track

The Service will maintain these walking tracks for day-walkers.

### **Border Ranges National Park**

The eastern Tweed Range section of the park provides the opportunity for day use, short-term camping and wilderness exploring in a scenic rainforest environment.

The central Lions Road section offers day use opportunities. An important secondary role of this section is the access provided by Lions Road to wilderness areas along the Queensland/New South Wales border to the east and west.

The eastern Tweed Range section of the park is popular with visitors, reflecting a decade of community interest and the provision of recreational facilities by the Forestry Commission.

The Service has continued to maintain these facilities, which include the Tweed Range Scenic Drive, picnic areas, lookouts, graded walks and a rest area for short-term camping and day use.

Additional picnic facilities have been provided by the Service on Bar Mountain and graded walks from these facilities through the Bar Mountain rainforest to scenic outlooks are progressing.

The existing rest area at Forest Tops is small and often shrouded in mist and rain because of its high elevation. The Service proposes to build a new rest area on Sheep Station Creek.

The Service is also investigating a scenic rim walk along the escarpments of the Mount Warning volcanic caldera commencing at Numinbar Gap north of Murwillumbah and then around the McPherson, Tweed and Nightcap Ranges.

### **Washpool National Park**

This park offers long wilderness walks in rugged forest-clad mountain ranges and creeks.

An important secondary role is day use and short-term camping in the southern and northern edges of the wilderness.

The Washpool is complemented by the long-established Gibraltar Range National Park which adjoins it to the north.

Management of the Washpool by the Service must aim to protect the important wilderness value identified by the Government's rainforest policy.

The Service has inherited a wilderness area of national significance with established visitor destinations and increasing use based on old logging roads.

Service management aims to provide all-weather access to facility areas on the edge of the park with the early closure and rehabilitation of roads which compromise wilderness values.

### \* Roads

**Coombadjha Road:** Will be retained from the Gwydir Highway to Coombadjha Creek as the principal access road to the park. Road repair and regravelling will be undertaken as soon as practicable. A picnic area is to be constructed on Coombadjha Creek and will provide an appropriate terminus. The road beyond this point will be retained as a walking route.

**Moogem Road:** The section of this road between Coombadjha Road and Dundarra Gully requires extensive repair. A functional terminus for public vehicular use will be provided at Dundarra Gully. Beyond this point Moogem Trail and Northwest Trail will be retained for fire management purposes only.

**Granite Road:** This road, which provides access to Granites Lookout, will be upgraded to all-weather standard.

**Cedar Road:** Is currently in poor condition and not trafficable. It will remain closed to vehicles and its long-term future will be reviewed when a draft plan of management is prepared.

### \* Wilderness

The whole of the park north of Coombadjha Creek and east of Moogem Road/Trail will be declared wilderness under Section 59 of the National Parks and Wildlife Act.

### \* Recreation facilities

**Coombadjha Rest Area:** An attractive area above Coombadjha Creek has been carefully assessed and designed for both day use and short-term camping. About 50 campsites will be provided along with parking for buses and caravans. A graded walking track system will be constructed through an unlogged coachwood/banksia forest. A graded walking track system will link the Coombadjha rest area to the existing Hakea picnic area and associated walks in the adjoining Gibraltar Range National Park.

### **FIRE**

The National Parks and Wildlife Service is responsible for the management of fire on lands under its control.

Rainforest normally does not burn, due to its moist, humid environment. However, fire does occur in the sclerophyll forests which often buffer rainforests.

These fires have traditionally been associated with spring burns for cattle grazing.

Rainforest flora is very sensitive to and can be badly damaged by fire. So the Service seeks to keep fire out of rainforest and to reduce the frequency of fire in neighbouring forests by excluding cattle where legally possible and excluding prescribed burning in buffer zones.



*Ferns abound in the moist rainforest environment.*

### **Washpool National Park**

The Washpool has a long history of fire in its western boundary sclerophyll forests, usually associated with grazing on adjoining leasehold lands.

Moogem Road, Moogem Trail and Northwest Trail will be maintained for fire control, with access restricted to Service and bush fire control vehicles.

### **All three national parks**

The Service will prepare fire management plans for the three parks separate from the plans of management.

These will outline the service philosophy on fire, address questions such as "to burn or not to burn" and make detailed recommendations.

### **WEEDS**

Lantana and crofton weed are the main weeds present in the new rainforest parks.

These weeds are widespread throughout the north coast of New South Wales, particularly on mountainous land with fertile soils and high rainfall.

Their growth in rainforest parks is limited to disturbed or open areas and generally their presence is minor compared to adjoining lands.

Their expansion is limited by the rainforest canopy which screens out direct sunlight.

Control or eradication of these weeds from the rainforest parks or the north coast generally is believed to be not technically or economically possible.

Specific control measures will not be implemented. As the rainforest parks regenerate, the presence of these two weeds will diminish.

The release of insects for biological control is reducing the vigour of lantana. Future insect releases are expected to further reduce its growth.



*The management of fire is an important aspect of park management.*

Groundsel bush also occurs to a very limited extent in the new parks.

Groundsel is a declared noxious plant and is removed as a matter of priority. Ultimately, biological control may prove successful and the Service is participating in the release of various insects in co-operation with the Allan Fletcher Research Station in Queensland and the New South Wales Department of Agriculture.

### **REHABILITATION OF LOGGED AREAS**

The Service believes there is no need to replant logged areas within the new parks as the forests are quite capable of regenerating themselves.

Previous rainforest reforestation experience indicates that, where sufficient seed banks are present, natural processes in high rainfall areas are usually sufficient to begin the restoration of damaged areas.



The Service is concerned to protect the genetic integrity of the rainforest parks and would not introduce seed from outside the forests.

Replanting is not considered necessary in the light of the abundant seed sources within the forest and methods evolved by rainforest to close gaps in its continuous canopy.

## GRAZING

Cattle grazing is normally not permitted in national parks in New South Wales.

Apart from the physical damage they cause, cattle represent an indirect fire threat as graziers traditionally burn in spring to provide green pick for their animals.

An important strategy in fire management of national parks is to exclude cattle.

However, when control passes from the Forestry Commission to the Service with the reservation of former state forests as national parks, the Service often inherits long-standing grazing leases.

The Service recognises that to immediately revoke those leases would cause the lease-holding graziers economic hardship.

The Service will consider the circumstances associated with existing leases. It is committed however to the long-term phasing out of cattle grazing in national parks.

## Border Ranges and Washpool National Parks

These two parks have long histories of grazing under either Crown lease or Forest leases. Crown leases are held in perpetuity and Forest leases, which were previously issued by the Forestry Commission, are renewable over varying periods of time.

The Service plans no immediate action to cancel these leases and cattle grazing will therefore continue in the Washpool and Border Ranges National Parks for some time.

## Nightcap National Park

No grazing leases were inherited with the Nightcap and this park will be maintained free of cattle.

## BEEKEEPING

Beekeeping is not regarded by the Service as an appropriate activity in national parks for the following reasons:

- \* The honey bee is not native to Australia.
- \* Beekeeping is mainly an agriculture-related industry which depends on a system of roads and tracks.
- \* Bee hives can degrade the natural scenic beauty of a national park.
- \* In mountainous country, such as the new rainforest parks, sites for bee hives often compete with public recreation facilities from available flat land.

There is a developing concern that introduced bees "rob" native flowers without effecting pollination thus affecting seed set and seed availability.

Because of the conflict between beekeeping and nature conservation, beekeeping is generally permitted in national parks only where bee sites are inherited and where no serious conflict with national park values exists.

## Border Ranges and Nightcap National Parks

The rainforest flora of these two parks is not suited to beekeeping. No sites were previously licensed in either park, nor will they be.



Buttresses are a distinctive feature of some rainforest trees.

## Washpool National Park

Since the 1960s, the Forestry Commission has licensed seven bee sites in the Washpool. This number was extended to 15 following the construction of Coombadjha Road into the wilderness core in 1979/80.

The Service has historically maintained five bee sites in the adjoining Gibraltar Range National Park.

Eleven of the 15 inherited Washpool bee sites depend for access upon the retention and upgrading of Coombadjha Road. The penetration of this road to the wilderness area seriously prejudices the important wilderness values of the Washpool.

The road is currently in poor condition and eroding seriously. The Service proposes to close this road to public use beyond Coombadjha Creek, and to prevent further erosion by cross-draining the road beyond this point.

Prior to this work, hives from the 11 affected bee sites will have to be moved.

The Service has approached the Forestry Commission to see if these sites can be given priority when new logging roads are constructed in the state forest adjoining the Washpool to the north.

The four sites which remain unaffected by the closure of Coombadjha Road will be retained, and their long-term future reviewed when a draft plan of management for the Washpool is prepared and placed on public exhibition.



*Thick woody vines are common in rainforest areas.*



*A variety of plant species is a feature of the rainforest.*

## **PLANS OF MANAGEMENT – PUBLIC INVOLVEMENT**

The Service is obliged under the National Parks and Wildlife Act, 1974, to prepare a plan of management for every national park under its control.

The Service is further required to place these plans on public exhibition in draft form for a minimum of one month and to seek public comment.

The Service seeks the fullest public participation during the exhibition of these draft plans. It invites submissions from any individual or group who wishes to express a view on the future management of the park.

These submissions are forwarded, along with the draft plan of management, for consideration by the National Parks and Wildlife Advisory Council and, in turn, the Minister for Planning and Environment, who determines and adopts the final plan of management.

Once adopted, the plan becomes the blueprint for the development and management of the park.

In many instances, national park advisory committees such as the one formed to advise on the Border Ranges, Nightcap and Mount Warning National Parks, contribute substantially to the process of preparing a management plan.

It is a process of public involvement which can take some time. Interim management actions which the Service concludes are necessary in the meantime have been outlined in this paper.

People wishing to comment on these interim actions, or to contribute to the plans of management of the three new rainforest parks, are invited to contact:

The Regional Director,  
National Parks and Wildlife Service,  
P.O. Box 97,  
Grafton, 2460.

Whatever your views, we would like to hear from you. Please feel free to seek more information on or to discuss any aspect of this paper with Service staff.

Contact:

### **Border Ranges and Nightcap National Parks**

The Senior Ranger,  
Lismore District,  
National Parks and Wildlife Service,  
Colonial Arcade,  
Alstonville, 2477.  
Phone: (066) 28 1177  
8.30 a.m.-4.30 p.m. Monday-Friday.

### **Washpool National Park**

The Senior Ranger,  
Glen Innes District,  
National Parks and Wildlife Service,  
Grey Street,  
Glen Innes, 2370.  
Phone: (067) 32 1177  
8.30 a.m.-4.30 p.m. Monday-Friday.

### **Or for all three parks**

The Regional Director,  
Northern Region,  
National Parks and Wildlife Service,  
P.O. Box 97,  
Grafton, 2460.  
Phone: (066) 42 0593  
8.30 a.m.-4.30 p.m. Monday-Friday.



A Publication of the New South Wales Government  
**NATIONAL PARKS AND WILDLIFE SERVICE**  
189 Kent Street, SYDNEY 2000



Summerland Printers, Ballina

## Service eyes park at Old Grevillia

A small park at Old Grevillia has attracted the interest of the National Parks and Wildlife Service.

The service wants to take over Moore Park, which now is under the control of the Kyogle Shire Council.

The park, about three hectares, is along a creek's bank.

Cr J Pollard said that the park contained a number of rare species of trees.

He said that for many years, the National Parks and Wildlife Service had wanted to take over control of the park.

He said that local residents should have a say in the future of the park.

The park has barbecue facilities and the council spends about \$1250 in annual maintenance costs.

The National Parks and Wildlife Service propose to take over the maintenance work and carry out additional weed control and tree planting, and to build walking tracks to the river.

The proposal allows for the continuation of the council's gravel extraction activities.

No cattle would be permitted on the reserve.

The council voted to advertise the proposal for public comment.

10-10-86

## New reserves approved

Two new reserves have been approved for North Coast State Forests.

They are a rainforest at Mount Clunie and a 185 ha flora reserve at Wilson's Peak in the Koroelah State Forest, near Urbenville.

The reserves were announced this week by the Minister for Lands and Agriculture, Mr Hallam.

Mt Clunie is located near the western peak of the McPherson Range, 16 kilometres north of Urbenville on the Queensland border.

The reserve will include hardwood stands, cliff and rock plant communities and rainforest.

The flora reserve is 25 kilometres north-west of Urbenville.

18-10-86



# National Parks and Wildlife Service



## LISMORE DISTRICT

26th August, 1986.

Suite 9  
Colonial Arcade  
Main Street  
P.O. Box 91  
Alstonville, N.S.W. 2477

Our reference: *F/008*

Your reference: *MB: CP*

Telephone: 28 1177  
STD: 066

### BUNDJALUNG BROADWATER ADVISORY COMMITTEE MEETING

TIME : SEPTEMBER 9th 1986 AT 7.30p.m.

LOCATION : EVANS HEAD RECREATION HALL.

1. Removal of powerline - Jerusalem Creek.
2. Woody Head Development
3. Black Rocks Plans
4. Seasonal Ranger Programme
5. Annual Conference of Advisory Committee Chairpersons.
6. N.P.W.S. Organisational Review update
7. Johnson's Lane, Iluka - Caravan Park proposal.
8. Report re. Ultra-light aircraft legislation from Andrew Henderson.
9. Joint Advisory Committee Field trip to Nightcap National Park.
10. Amalgamation of Advisory Committees (Bundjalung-Broadwater and (Rainforest) to form a District Advisory Committee.

Malin Blazejowski

Lismore District  
For the Director

C.C. Seasonal Ranger Programme  
Black Rocks Plans.

Copy notes & maps x6

1 to file 72/5 / 1 for my use

Bundjalung National Park

BLACK ROCKS REST AREA

DESIGN CONCEPTS FOR UPGRADING



## 1. INTRODUCTION

This report is a preliminary discussion document on design options for the re-organization of Black Rocks Rest Area. The two main issues are :-

- 1.01 Closure of Jerusalem Creek 4WD tracks and provision of associated track head facilities.

Factors Where should closure be?

Are there any suitable camping nodes north of ~~Area 2~~ Area 2?

The need to prevent vehicle access to the proliferation of 4WD tracks alongside Jerusalem Creek is also an important consideration.

- 1.02 Extension and Upgrading of Rest Area facilities generally.

Factors A combination of increasing popularity and limited site areas has led to a situation of overcrowding at peak times, with resultant management problems and increasing site degradation (eg felling of trees)

It is felt that the present management problems can only be addressed by provision of a greater number of sites of a quality usually identified with a National Park experience.

Drawing 1 lists existing conditions and problems.



## 2. DESIGN OPTIONS

### CREEK

#### 2.01 JERUSALEM TRACK CLOSURE

In choosing the best location for closure and track head facilities, two major factors are:-

- At what point is closure of main tracks easiest to defend, and, at what point is access to the various 4 wd tracks along Jerusalem Creek easiest to defend?
- Is there any worthwhile gain in rest area sites the further north the road is extended before closure?

Drawing 2 shows three possible options. ~~xxx~~

#### 2.02 OPTION A - furthest north

allows for limited parking facilities and provides for up to 10 Rest Area sites back in Area 1. However this is a limited area and the low heath west of the track makes the closure of the 4 wd tracks difficult to defend.

#### 2.03 OPTION B - Area 1

Would provide a generous track head facility (12-15 cars) but would probably negate the site for Rest Area use, or at least reduce potential sites to 5-6. The heath remains a defense problem.

#### 2.04 OPTION C

Recognizes that Area 2 provides limited Rest Area sites at the moment. Instead the area would be converted to a track head facility with parking for 12-15 cars.

The waterlogged ground west of the road (melaleuca forest) would make closure of all tracks to the north easier to defend.

Camping sites negated would be more than replaced by <sup>the</sup> Rest Area reorganization proposed below.

## 2.04 REST AREA UPGRADING

As noted the limited site area available for camping has resulted in competitiveness over sites and environmental degradation. In assessing the best approach to site re-organization, the following are major factors for consideration

## 2.05 ENVIRONMENTAL

In locating land suitable for Rest Area extensions, the following desirable elements relevant to the site are:-

- (a) Dry terrain, unaffected by waterlogging
- (b) Reasonable shade cover with protection from salt exposure for existing vegetation
- (c) Stable ~~soil~~ pedestrian beach access over dunes.

As shown on dwg 1, ~~the~~ the area <sup>clearing 4</sup> west of ~~the~~, and a second area west of clearing 6, south of Black Rocks, both appear to fulfil these requirements.

## 2.06 USAGE

The congestion at Black Rocks during peak times is created by a number of concurrent conflicting activities, viz..

- (a) arrival point for both campers and day visitors.
- (b) popular camping area
- (c) 4wd vehicle beach access point.

As these activities are currently taking place on a limited site area, the confusion can only be amended by either

- (i) increasing the area to allow for greater separation of activities, OR
- (ii) at least one of the activities should be re-sited

Accordingly, the recommendations for upgrading are as follows...

### 3 UPGRADE PROPOSALS

clearing 4

- 3.01 That (Yabbarra) should be consolidated by expansion to the west to form a Rest Area of approximately 25 sites. As no additional access roading is required this could be constructed as a Stage 1 with provision only of minimal "interval" hard stand.
- 3.02 That a second Rest Area node be created west of clearing 6 for up to 30 sites. This area contains dry, well shaded land with a canopy of banyan, well protected from salt spray by a high dune, and with well protected beach access.  
The site would require approximately 350 metres of 2 way gravel road plus 500 metres one way loop road.
- 3.03 That Black Rocks become a day visitor and camper arrival and information point only. (4wd vehicle beach access for stay)
- 3.04 More detailed site investigations will be needed to design specific Rest Area layouts. A brief is also needed to designate site numbers required.

### 4. FUTURE EXPANSION

- 4.01 There appears suitable terrain for extending the southern Rest Area northwards, as long as an adequate buffer zone is left between it and Black Rocks

Note: It is felt that provision of an increased number of well identified sites may help in alleviating many of the present management problems. However the Service should note that

- (i) it is not generally feasible to provide sites for all campers at peak times
- (ii) there may be some initial user resistance to changes in traditional usage patterns.

A. E. Farrell  
Architect  
10/6/86.

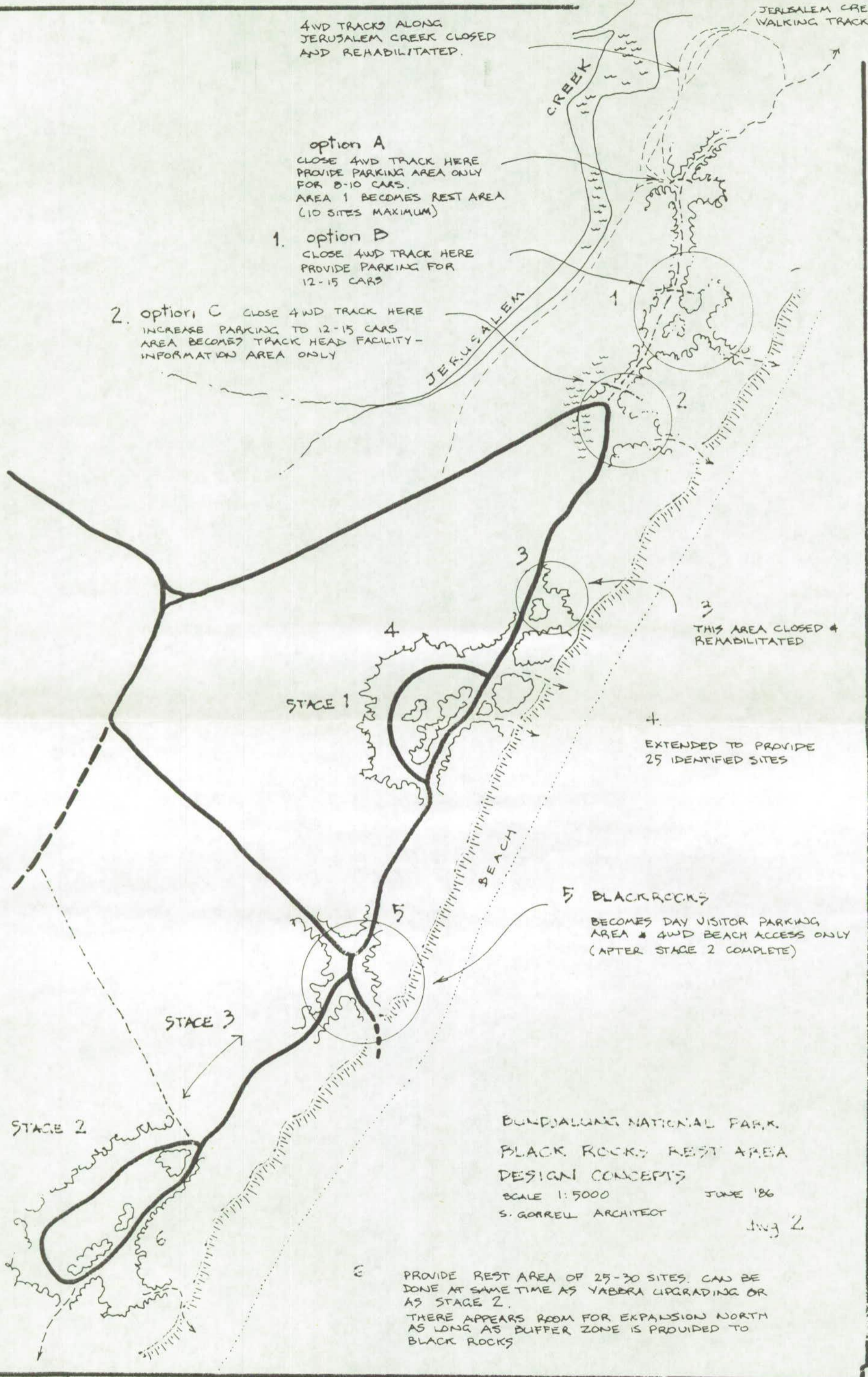
4WD TRACKS ALONG  
JERUSALEM CREEK CLOSED  
AND REHABILITATED.

JERUSALEM CREEK  
WALKING TRACK

option A  
CLOSE 4WD TRACK HERE  
PROVIDE PARKING AREA ONLY  
FOR 8-10 CARS.  
AREA 1 BECOMES REST AREA  
(10 SITES MAXIMUM)

1. option B  
CLOSE 4WD TRACK HERE  
PROVIDE PARKING FOR  
12-15 CARS

2. option C CLOSE 4WD TRACK HERE  
INCREASE PARKING TO 12-15 CARS  
AREA BECOMES TRACK HEAD FACILITY -  
INFORMATION AREA ONLY



3 THIS AREA CLOSED &  
REHABILITATED

4  
EXTENDED TO PROVIDE  
25 IDENTIFIED SITES

5 BLACK ROCKS  
BECOMES DAY VISITOR PARKING  
AREA & 4WD BEACH ACCESS ONLY  
(AFTER STAGE 2 COMPLETE)

BUNDJALUNG NATIONAL PARK  
BLACK ROCKS REST AREA  
DESIGN CONCEPTS  
SCALE 1:5000 JUNE '86  
S. GARRELL ARCHITECT

Jug 2.

E PROVIDE REST AREA OF 25-30 SITES. CAN BE  
DONE AT SAME TIME AS YABBERA UPGRADING OR  
AS STAGE 2.  
THERE APPEARS ROOM FOR EXPANSION NORTH  
AS LONG AS BUFFER ZONE IS PROVIDED TO  
BLACK ROCKS

4WD TRACKS ALONG  
JERUSALEM CREEK CLOSED  
AND REHABILITATED.

option A  
CLOSE 4WD TRACK HERE  
PROVIDE PARKING AREA ONLY  
FOR 8-10 CARS.  
AREA 1 BECOMES REST AREA  
(10 SITES MAXIMUM)

1. option B  
CLOSE 4WD TRACK HERE  
PROVIDE PARKING FOR  
12-15 CARS

2. option C CLOSE 4WD TRACK HERE  
INCREASE PARKING TO 12-15 CARS  
AREA BECOMES TRACK HEAD FACILITY -  
INFORMATION AREA ONLY

JERUSALEM CREEK  
WALKING TRACK

CREEK

JERUSALEM

BEACH

STAGE 1

STAGE 3

STAGE 2

3 THIS AREA CLOSED &  
REHABILITATED

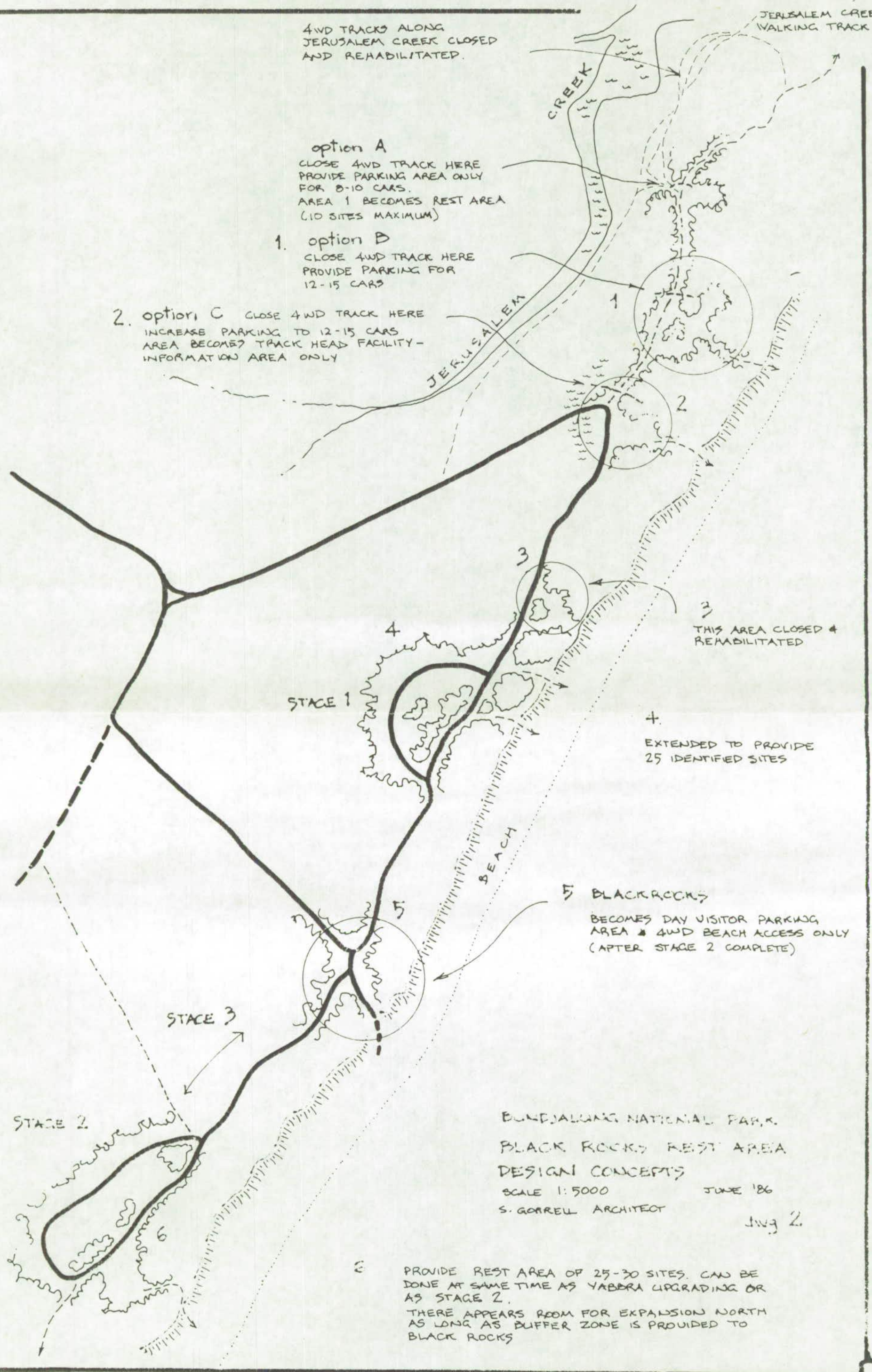
4 EXTENDED TO PROVIDE  
25 IDENTIFIED SITES

5 BLACK ROCKS  
BECOMES DAY VISITOR PARKING  
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BUNDJALUNG NATIONAL PARK,  
BLACK ROCKS REST AREA  
DESIGN CONCEPTS  
SCALE 1:5000 JUNE '86  
S. GARRELL ARCHITECT

July 2

6 PROVIDE REST AREA OF 25-30 SITES. CAN BE  
DONE AT SAME TIME AS YABBARA UPGRADING OR  
AS STAGE 2.  
THERE APPEARS ROOM FOR EXPANSION NORTH  
AS LONG AS BUFFER ZONE IS PROVIDED TO  
BLACK ROCKS



NATIONAL PARKS ASSOCIATION OF N.S.W.

\*

Submission to  
National Parks and Wildlife Service

\*

Some comments on the Management planning of  
Border Ranges National Park

\*

February 6th, 1985

## INTRODUCTION

The creation of a new national park provides an opportunity to preserve natural areas for posterity and to improve facilities for the public. The National Parks Association of NSW is made up of citizens who have a professional or amateur interest in the conservation of wildlife and the enjoyment of recreational pursuits not incompatible with this aim.

The NPA regards equity of access as an important principle in the planning of a national park. Most people who visit parks drive ordinary vehicles suitable for ordinary roads; those who wish to travel away from the road should be prepared to walk. The service should not provide facilities for special interest groups such as the owners of four-wheel-drive machinery, trail bikes, horses and the like. Even if no extra facilities are provided for these minority groups the cost of repairing the resulting damage is likely to be borne by the NPWS. Therefore in national parks there should be no vehicular roads open to the general public unless suitable for conventional vehicles.

Public demand for access to the Border Ranges National Park for the purposes of recreation and inspection can be met by:

- the control and management by the NPWS of facilities previously provided by the Forestry Commission of NSW, and
- the provision of a limited range of facilities at selected locations elsewhere in the park.

Except where indicated, all places mentioned in this report were visited by a delegation of the NPA park management committee in September 1983. This report also includes comments of the NPA Far North Coast Branch as at December 1984.

## CONSERVATION OF WILDERNESS

It is proposed that the following areas be managed as wilderness zones in accordance with S.59 of the National Parks and Wildlife Act:

- a. The Gradys Creek valley west of Gradys falls (those upstream from the landslip north of Isaksson Ridge): Although not inspected by the delegation, it is understood that there are pure littoral stands of Antarctic Beech, approximately 1.3 metre diameter and 40 metres high, on Gradys Creek which should be included in the designated wilderness area. Southern border to be the K-line road, the west border to be a line from trig station 783 running south down the ridge line to the boundary. This area might be described as the Upper Gradys Valley Wilderness.
- b. The land to the south of the loop road, boundaries to be Collins Creek, the Tweed Range Road and the Wiangaree Forest Rd: This area might be described as the Collins Creek Wilderness.
- c. The John Lever Wilderness: the northern boundary to be the NSW/QLD border, southern boundary the loop road from Terrace Creek and Roseberry Forest Drive, western boundary from Terrace Creek loop road west at the 600 metre contour to the border west of Glennies Chair, the eastern boundary is 1 km west of the main railway line and from 615 spot height to Mt. Chinghee NP (Qld.) south to the kink in the boundary. This includes all of the former Roseberry state forest.

These zones include land that has been severely disturbed on their periphery by roading, logging and the resulting introduction of noxious woody weeds, fire and feral animals. The NPA is of the opinion that the survival of the remaining native species is unlikely to be enhanced by further development in the core of these areas.

#### PROPOSED DEVELOPMENT

Tickys Hut - This area of former grazing land at the junction of Old Highway Road and Sandy Hill Road is suitable for day use and camping and offers a fine view of Mt. Lindesay. Car access should be maintained by the Old Highway Rd. This drive should be maintained to the minimum standard to permit ordinary two wheel drive cars to proceed to Tickys Hut.

Roseberry Nursery - Ideally, this former Forestry Commission nursery and rest park would be re-established for the propagation of rainforest species. However, in view of the limited resources of the service, this area could well be operated as a caravan park and picnic and car camping area. A national park information and interpretation centre could be provided.

Sawpit Creek - This is another area of disused grazing land and is eminently suitable for the establishment of a picnic and camping area. The area should be set out in two sections, one for camping near vehicles, the other for pack-camping away from cars.

Long Creek - The creek flat just beyond the crossing where the tramway route begins its ascent to the plateau is weed infested but appears suitable for development as a walk-in camp site. Part of this development might include a foot bridge over the creek. Private vehicles should be restricted to parking on the other bank, that is, at the end of the road from the south.

It is understood that there is a proposal to reconstruct the Long Creek timber tramway as a tourist railway. The NPA does not object to this proposal provided that no new roads are built in the Long Creek or Levers Plateau area.

Whether or not the tramway proposal proceeds, strong action should be taken to prevent this route being used by trail bike riders to gain access to the plateau.

Border Loop - The Lookout area is frequently visited and reasonably developed. It should be retained as a facilities area but the toilets should be brought up to NPWS standards. It is understood that the service is aware of this problem. This site could be further upgraded by the provision of a pedestal plaque and other sources of interpretive information.

Roads in the eastern part of the park - NPA proposes that the Brindle Creek loop road be closed to vehicles between Negrohead Beech and Brindle Creek. Alternatively, if it is found to be impractical to mark out the existing road at Brindle Creek for parking and turning then the road should be made one-way west bound from Negrohead Beech to Brindle Creek. This should reduce the cost of maintenance and environmental damage caused by grading.



It is proposed that Airdrop, K-line and Reserve Roads be closed to public vehicles forthwith. NPA strongly opposes use of this area by the Army. These roads should be permitted to revegetate and be used as walking tracks only.

All roads in the park north and east of Green Pigeon that can be reached from Green Pigeon should be closed to vehicles and converted to walking tracks.

Sheepstation Creek - This proposed camp site is quite appropriate. Dry Sclerophyll forest types and lantana prevail on this disused farm land. The NPA is in favour of the construction of a camping area generally in accordance with the NPWS architect's drawings made available for our inspection. As with the Green Pigeon proposal, this site provides ample space for camping with and without cars, there is running water, some firewood and reasonable road access for conventional vehicles.

The NPA is of the opinion that the nearby former Sheepstation Creek Flora Reserve be suitably signposted to reflect the foresight of the Forestry Commission in preserving at least this area of rain forest.

Green Pigeon - The NPA is of the opinion that a large camp site could be developed in this area. Portion 123, parish Warrazambil at Fawcetts Creek (grid reference 084506, CMA map Brays Creek) provides a large area of open forest close to water and to a reasonable road. This area is a pleasant destination for car tourists and is also suitable as a base for those wishing to walk north and east into the park. While caravans should not be permitted in this area there would appear to be scope for a privately managed caravan park in the nearby village of Green Pigeon, possibly on the site of the abandoned sawmill.

Forest Top - This site should be designated for day use and camping limited to 24 hours. It can be expected that the demand for camping in this area will diminish following the opening of the Sheepstation Creek facilities.

Brindle Creek - Brindle Creek rest area provides an excellent introduction to the rain forest. These facilities should be maintained.

Barkers Vale - There appears to be scope for a camping area at the saddle in the Tweed Range Road near the Barkers Vale park entrance. Map reference 115475, CMA map Brays Creek. The requirements of open forest and closeness to an existing road are met, however a water tank would be needed.

Pumpenbil Creek - The Service should investigate a possible facilities area on Pumpenbil Creek, where South Pumpenbil Creek enters the Park within Portion 77, Parish Tyalgum (near "Pinnacle View", grid reference 132598 CMA Brays Creek). This would be very convenient to visitors driving from Murwillumbah. (The NPA delegation did not inspect this site.)

#### OTHER PICNIC AREAS AND LOOKOUTS

Negrohead Beech should be retained as a picnic site and as a turning area. The high degree of existing disturbance and the presence of fascinating views north to Flinders Peak (Ipswich) and the Heights of Lamington (Bithongabel) and Limpinwood are grounds for the construction of a timber tower to tree top level.

The Tweed Valley Lookout is spectacular but there is very little room for parking for southbound traffic here.

The Blackbutts rest area is suitable for day use only.

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