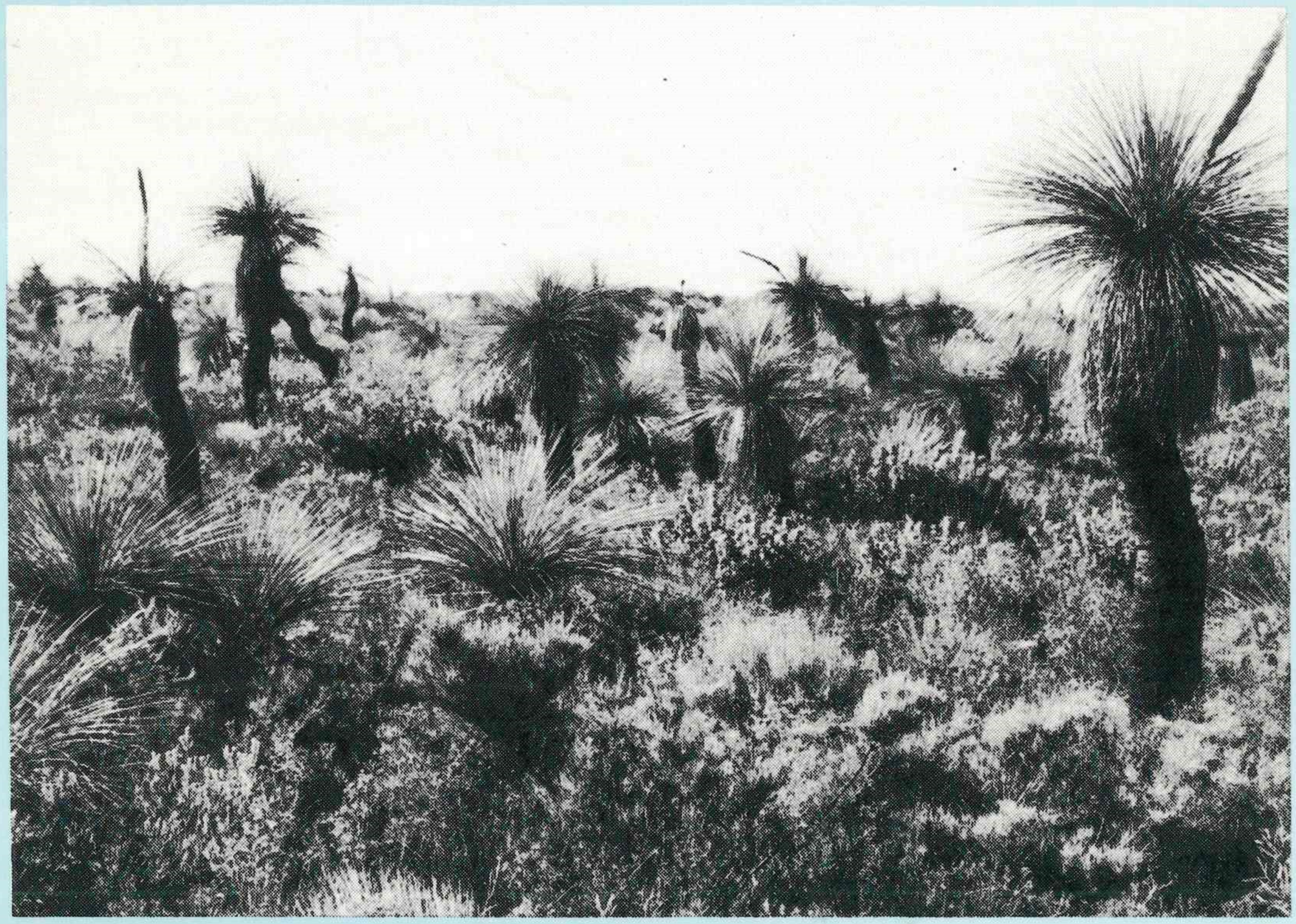
West. Aust. Nat. Reserve Manage. Plan No. 5

NATURE RESERVES OF THE SHIRE OF DANDARAGAN

VOLUME 1



by

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and
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This publ on constitutes the Working Plan for the Nature Reserves o e southern half of the Shire of Dandaragan in accordance h the provisions of the Wildlife Conservation Act 1950 (as amended).

Western Australian Nature Reserve Management Plan No. 5

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This Plan was adopted by the Western Australian Wildlife Authority on 12 December 1983 and approved by the Honourable H. D. Evans M.L.C., Minister for Fisheries and Wildlife, on 23 January 1984.

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DEPARTMENT OF FISHERIES AND WILDLIFE
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PART I—INTRODUCTION: THE SHIRE OF DANDARAGAN

The Shire of Dandaragan, which lies roughly midway between Perth and Geraldton, covers an area of 6 754 sq km, the western boundary of the Shire being the coast and the eastern one an irregular surveyed line passing some 10 km to the west of Moora. The northern and southern boundaries also follow surveyed lines (and the Moore River in the south-east), and these place the Shire more precisely between 120 and 220 km north of Perth (Fig. 1)*. The Shire of Dandaragan therefore forms a major part of the West Midlands agricultural region.

It also lies close to the southern end of an expanse of predominantly heathland vegetation, known as the northern sandplains, which extends from the Moore River as far north as Shark Bay.

The Shire supports a small population (1 960 persons) centred on the towns of Cervantes and Jurien on the coast and Badgingarra and Dandaragan itself inland. Other named centres referred to as landmarks in this plan include Cataby and Regans Ford. Together with Badgingarra these lie on the Brand Highway, which provides the main north-south route through the Shire. Dandaragan is located on a link road between the Brand Highway and Moora (Fig. 1).

*The Shire of Dandaragan also includes a number of small, offshore islands, several of which are Nature Reserves. These are not dealt with in this Management Plan. Management of the island Nature Reserves along the south-west coast of Western Australia, from Dongara to Safety Bay, are the subject of a further projected Management Plan in this series.

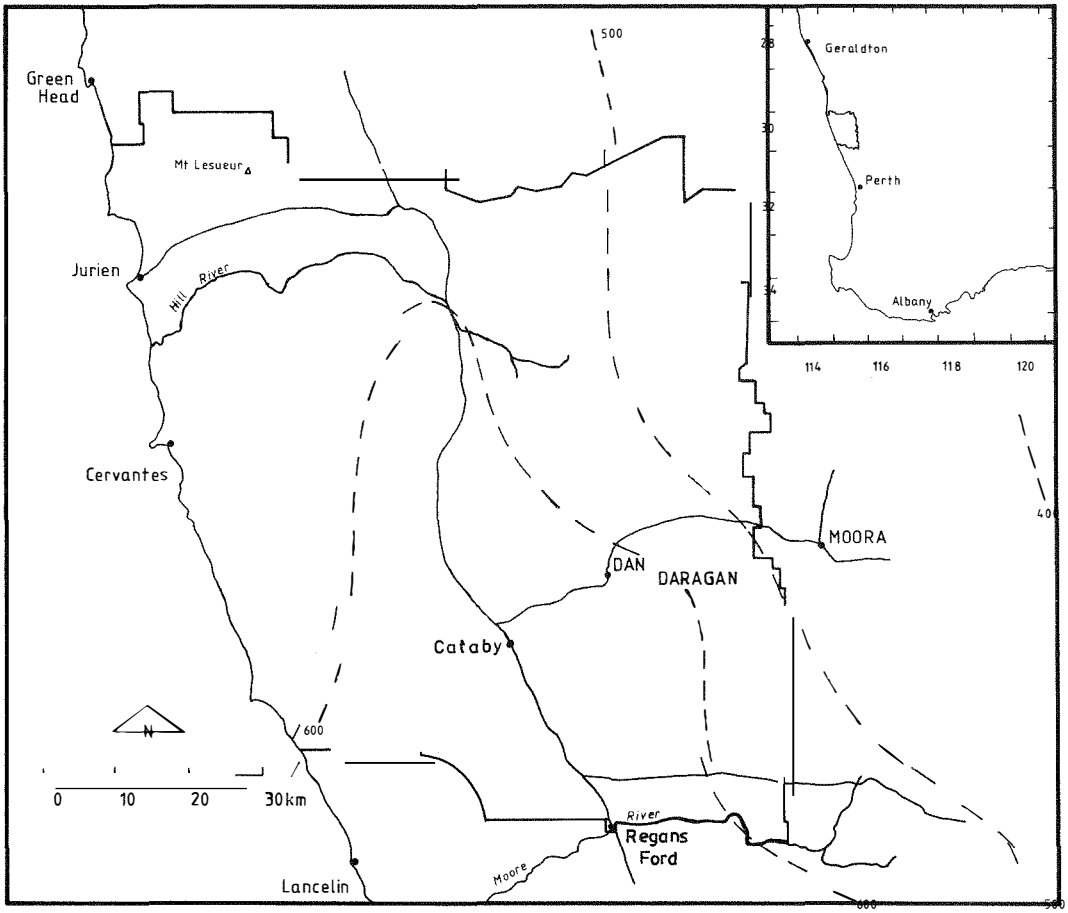

Figure 1. Location and major features of the Shire of Dandaragan including main roads, towns and rainfall isohyets.

The major industries of the Shire at this time are broad-acre agriculture (especially in the north and east—see Section 5: Land Use) and fishing, particularly for rock lobster, based on Jurien and Cervantes. Tourism and recreation, bee keeping, the wildflower industry and mining are of lesser but variously developing importance.

1. CLIMATE

Average annual rainfall in the Shire varies from about 500 mm on the coast, rising to 650 mm around Mt Lesueur and then decreasing inland, with local variations associated with topography, to 450 mm in the vicinity of Moora (Fig. 1). All significant rainfall occurs in the winter months, the summers being hot and dry. The overall climatic pattern is therefore Mediterranean in character with four to six "wet" months and six to eight "dry" ones. The season of plant growth is primarily defined by this rainfall pattern.

2. GEOMORPHOLOGY

Four physiographic units of major extent are represented in the Shire of Dandaragan. Figure 2 and the descriptions below follow

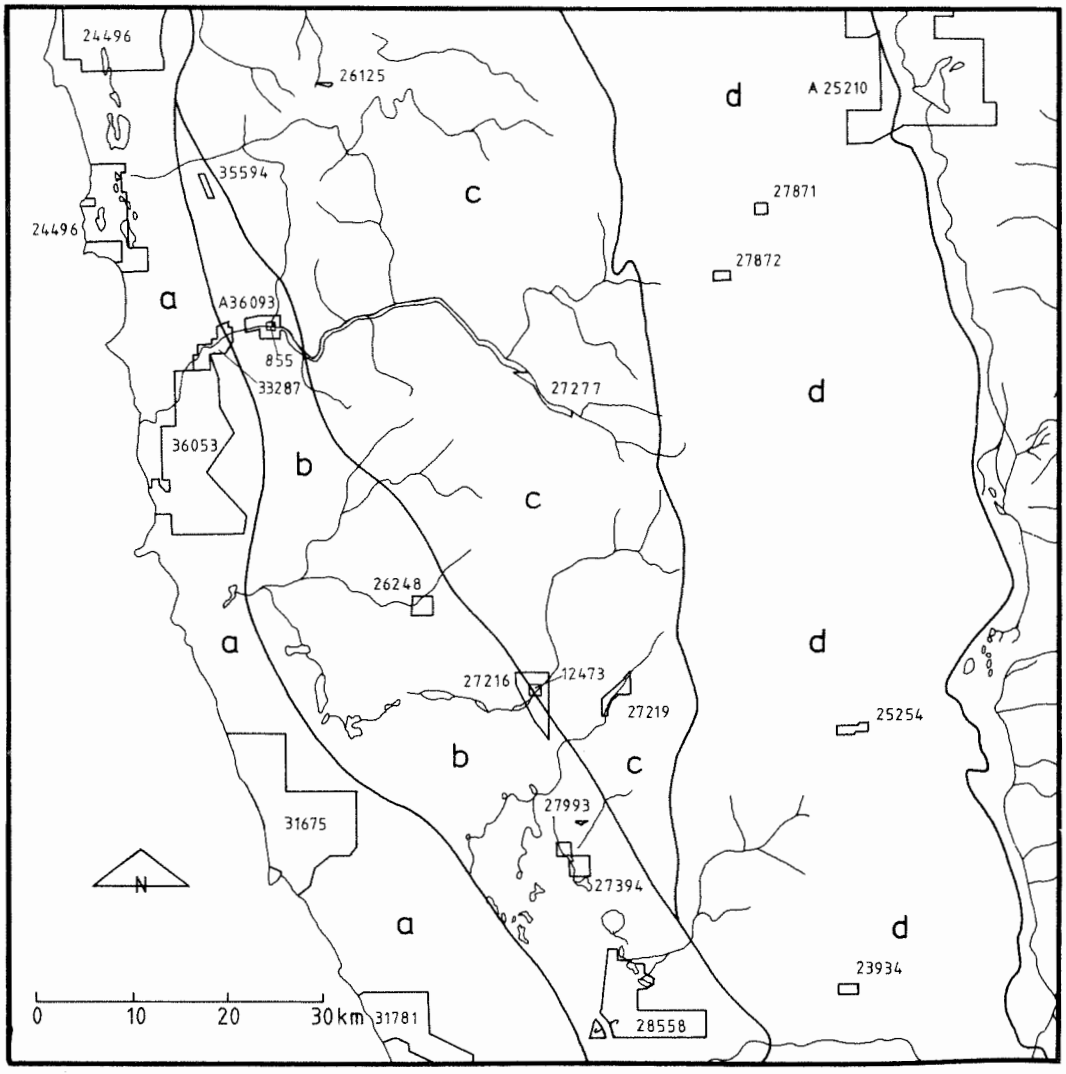

Figure 2. Geomorphology of the Shire of Dandaragan and surrounding area showing the distribution of Nature Reserves in relation to the major physiographic units represented, namely:

a. Coastal Belt b. Bassendean Dune System c. Dissected Region d. Dandaragan Plateau

the Geological Survey of Western Australia 1:250 000 Map Series, Sheet nos. SH50—5, 9 (Dongara—Hill River) and SH50—10 (Moora).

The Coastal Belt

The Coastal Belt consists of two sand-dune systems of geologically recent (Quaternary) age: the Quindalup system of fixed and mobile dunes and the somewhat older Spearwood system, in which the calcareous component of the sands has been lithified. The two are easily distinguishable from surface features. The Quindalup Dune System consists of deep, yellow sands forming soils with little or no structure. Mobile dunes, sparsely covered with plants or quite devoid of vegetation, which occur both on the coast and inland, are characteristic of this dune system. In the Spearwood dunes the sand is not so deep and is underlain by soft limestone. Outcrops of limestone, both in the form of "capstone" on ridges and as pinnacles in larger, flatter areas from which the surface sand has eroded, are a feature of the Spearwood dunes in the region. Considerable areas of both these dune systems, including coastal and inland mobile dunes, are represented within the Shire of Dandaragan in the Wanagarren Nature Reserve.

The Bassendean Dune System

The Bassendean Dune System, which was laid down in the Pleistocene and is therefore older than those of the Coastal Belt, occurs on the landward side of the coastal dunes. In the Dandaragan Shire it forms a strip running nearly parallel with the coast. It is about 20 km wide near the southern boundary of the Shire and narrows northwards to end close to the northern boundary of the Shire. The formation consists of low dunes of highly leached grey sands, poor in calcium and other minerals, excessively drained on the ridges and very poorly drained in interdunal depressions.

Dunelands of the Bassendean system occur along all of the Swan Coastal Plain, from Busselton, in the south to the Shire of Dandaragan in the north, a distance of more than 400 km. The drainage pattern and the poor soils of these dunes limit their use for agriculture, but the drainage pattern in particular gives them very high nature conservation value. The succession from poorly drained and winter-waterlogged soils at the bottoms of the depressions to over-drained and dry soils toward the dune summits is reflected in the diverse natural vegetation characteristic of the Bassendean dunes. The tendency for the inter-dunal swales to collect water has also resulted in the development of a chain of major and minor, seasonal and "permanent" wetlands along the whole length of the Bassendean Dune System. Many of these wetlands are Reserves of one kind or another. Others are privately owned. Several Nature Reserves in the Shire of Dandaragan are centred on Bassendean wetlands (see Section 6 : The Reserves). Together the wetlands of the Bassendean Dune System constitute one of the most important breeding habitats for waterfowl in the south-west of Western Australia.

The Dissected Region

The Dissected Region represents the variously eroded western edge of the Dandaragan Plateau. The Region is occupied by hills of sedimentary rocks overlain by frequently exposed caps of laterite. It is broadest in extent in the northern part of the Shire, where it lies inland of the Coastal Belt and the northern limits of the Bassendean Dune System. Further south it narrows to a point past which the Dandaragan Plateau rises directly out of Bassendean dunes along the line of the Gingin Scarp.

The Dissected Region encompasses some of the most spectacular landscapes in the Shire. In some areas, such as around Mt Peron and Mt Lesueur, the hill summits are parts of the original, virtually uneroded surface of the plateau from which the region was derived. In this area, particularly, the surrounding valleys are steep sided. The result is a striking example of mesa-form topography reminiscent of some of the drier regions of the American west. In the Dandaragan area, however, the hills are capped with laterite and fringed with breakaways, the result of erosion subsequent upon lateritisation of surface soils. East of Mt Lesueur the Cockleshell Gully Nature Reserve contains an area in which the laterite has formed on an already eroded and now strongly dissected surface. Here the hills, which have rounded or angular summits, are fringed with breakaways and bounded by steep-sided valleys.

In other parts of the Dissected Region the topography is more subdued, the valleys

broad and shallow, resulting in a landscape closely resembling the gentle succession of gravelly ridges and sand-plains more characteristic of the Dandaragan Plateau itself. Overall, however, the Dissected Region has a most varied topography, a factor which has certainly contributed to the remarkable richness of the flora of the area and possibly, in some degree, to the evolution of the very many endemic plants which occur there (see Section 4 Vegetation).

The Dandaragan Plateau

The Dandaragan Plateau is a laterite-capped plateau *ca.* 270 m a.s.l. The surface is undulating and mostly overlain with eluvial quartz sand. It contains isolated low hills of sedimentary rocks, frequently capped with exposed laterite (such as Jam Hill, the eastern slopes of which constitute the Jam Hill Nature Reserve). To the east, along the line of the Darling Fault, and for the most part outside the bounds of the Shire of Dandaragan, the Dandaragan Plateau is succeeded by the Darling Plateau. Here older Archaean rocks predominate, and the change is one of major significance in terms of soils and vegetation as well as geomorphology. It is along the line of the Darling Fault that the heathlands of the northern sandplain give way to the predominantly wooded vegetation of the western reaches of the wheatbelt.

For biological conservation purposes, therefore, Reserves which represent the habitats of the Dandaragan Plateau are important both for their own sake and for comparison with those of the topographically similar but geologically different Darling Plateau to the east.

3. SOILS

The soils of the region were mapped at a small scale (1:2 000 000) by Northcote, K.H. and collaborators (1967) in the "Atlas of Australian Soils" Sheet 5 : Perth—Albany—Esperance area. The map was published by the CSIRO, Melbourne, and shows the broad pattern of succession from unleached, calcareous sands near the coast (the Quindalup Dune System), through the siliceous sands of the Spearwood Dune System into the heavily leached sands of the Bassendean dunes. These dune system soils are in turn succeeded by the duplex soils of the Dissected Region (sandy at the surface with clayey subsoils) and the deep sands and sandy gravel soils of the Dandaragan Plateau both of which are somewhat more useful for agriculture.

4. VEGETATION

The vegetation of the Shire was mapped at a scale of 1:250 000 by Beard, J.S. (1978) "Vegetation Survey of Western Australia Moora and Hill River" Sheet SH50 9/10, Vegmap Publications, Perth (Fig. 3). In addition to areas of mobile dunes and salt lakes, Beard differentiated 21 major vegetation formations, as follows:

a. *Acacia/Melaleuca* heath
b. *Dryandra/Calothamnus* scrub/heath on limestone
c1. *Banksia* low woodland on limestone
c2. *Banksia* low woodland on white sand
d. Heath and scrub/heath mosaic on lateritic sandplain
e. Marri (*Eucalyptus calophylla*) woodland
f. *Banksia* low woodland
g. Tuart (*E. gomphocephala*) woodland
h. Flooded gum (*E. rudis*) woodland
j. *Dryandra* heath with scattered Marri
k. Marri/Wandoo (*E. wandoo*) woodland
m. *Hakea/Dryandra/Calothamnus* heath
n. Mixed eucalypt low woodland
p Marri/Wandoo/Powderbark (*E. accedens*) woodland
q. Wandoo woodland
r. *Banksia/Xylomelum* scrub/heath on sandplain
s. York Gum (*E. loxophleba*) woodland
t. *Banksia* low woodland with scattered eucalypts
u. Wandoo/Marri/Powderbark woodland in *Dryandra* heath
y. Wandoo and York Gum woodland
z. *Dryandra* heath on laterite.

The broad patterns of the vegetation mapped by Beard closely follow the physiographic features of the Shire. Heathlands are the predominant type of vegetation (though differing markedly in composition) both in the coastal dune systems and the Dissected Region. The Bassendean dunes in this area support a variety of heathlands and Paperbark (*Melaleuca* spp.) woodlands in lower lying

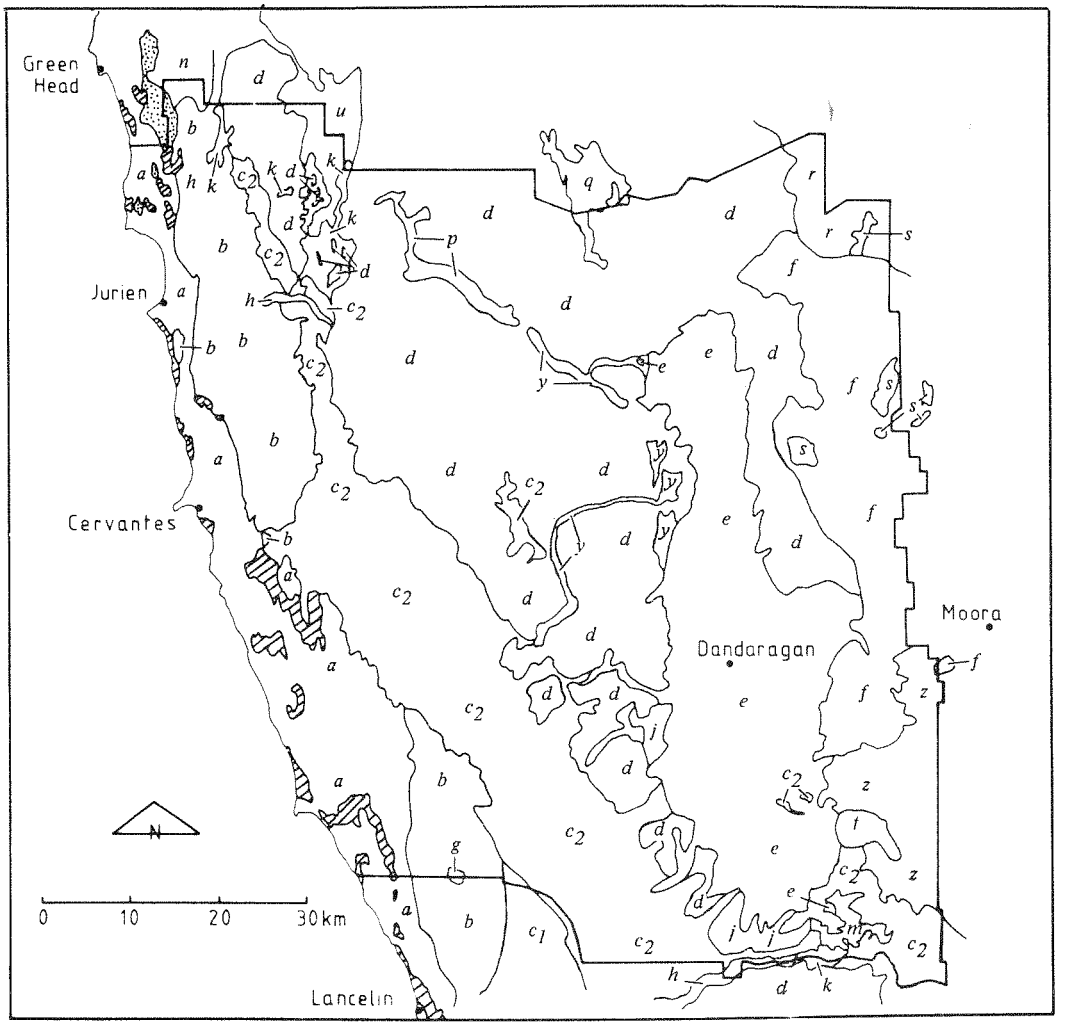

Figure 3. Vegetation of the Shire of Dandaragan (after Beard (1978)). The vegetation categories (a.b...) are described in the text. Mobile dunes are shown as hachured areas and salt lakes as stipled areas.

areas and low woodlands of *Banksia* spp. on drier sites. Woodland formations dominated by *Banksia* spp. and a variety of eucalypts including Marri (*Eucalyptus calophylla*) also occur throughout the Dandaragan Plateau where they are interspersed with large expanses of natural heath vegetation in which *Dryandra* and *Hakea* species are prominent.

Looking more generally at its vegetation, and comparing it with near coastal areas to the north and south, the Dandaragan Shire can be seen to occupy a transitional position between areas of higher rainfall in which woodland vegetation predominates and those of lesser rainfall where heathlands are the predominant vegetation type (the northern heathlands).

These northern heathlands are floristically very rich. On one survey in the Mt Lesueur area 67 different species of plants were recorded in an area of 500 sq m. Overall, the same study showed that the region between Eneabba in the north and Badgingarra in the south supports large numbers of species compared with heathlands in other parts of the south-west and Australia generally (67 (37-92) species per 500 sq m)*.

As well as their overall species-richness, the northern heathlands support many endemic

*George, A. S., Hopkins, A. J. M., and Marchant, N. G., (1979) "The Heathlands of Western Australia". In "Heathlands and Related Shrublands of the World". Specht, R. L. (Ed.) Elsevier Scientific Publishing Company, Amsterdam.

species (i.e. plants found nowhere else), plants which are rare and in need of special protection and many which are important to the wildflower industry in the State. Lying as it does near the southern end of this zone, the heathlands, and transitional woodlands, many of which have heathland understoreys, of the Shire of Dandaragan are of inestimable biological value, while their location near the main centres of population in the State adds emphasis to their potential value for amenity and education purposes and in both the wildflower and tourist industries.

5. LAND USE

Most land which has been developed for agricultural purposes in the Shire of Dandaragan lies in the belt of gravelly and sandy duplex soils of the Dissected Region and among the sandplains of the Dandaragan Plateau. Most of the Bassendean Dune System and the dune systems of the Coastal Belt, especially in the south, remain undeveloped and are probably not suitable for agricultural purposes (Fig. 4). As a result, substantial areas of the Shire remain uncleared. Some

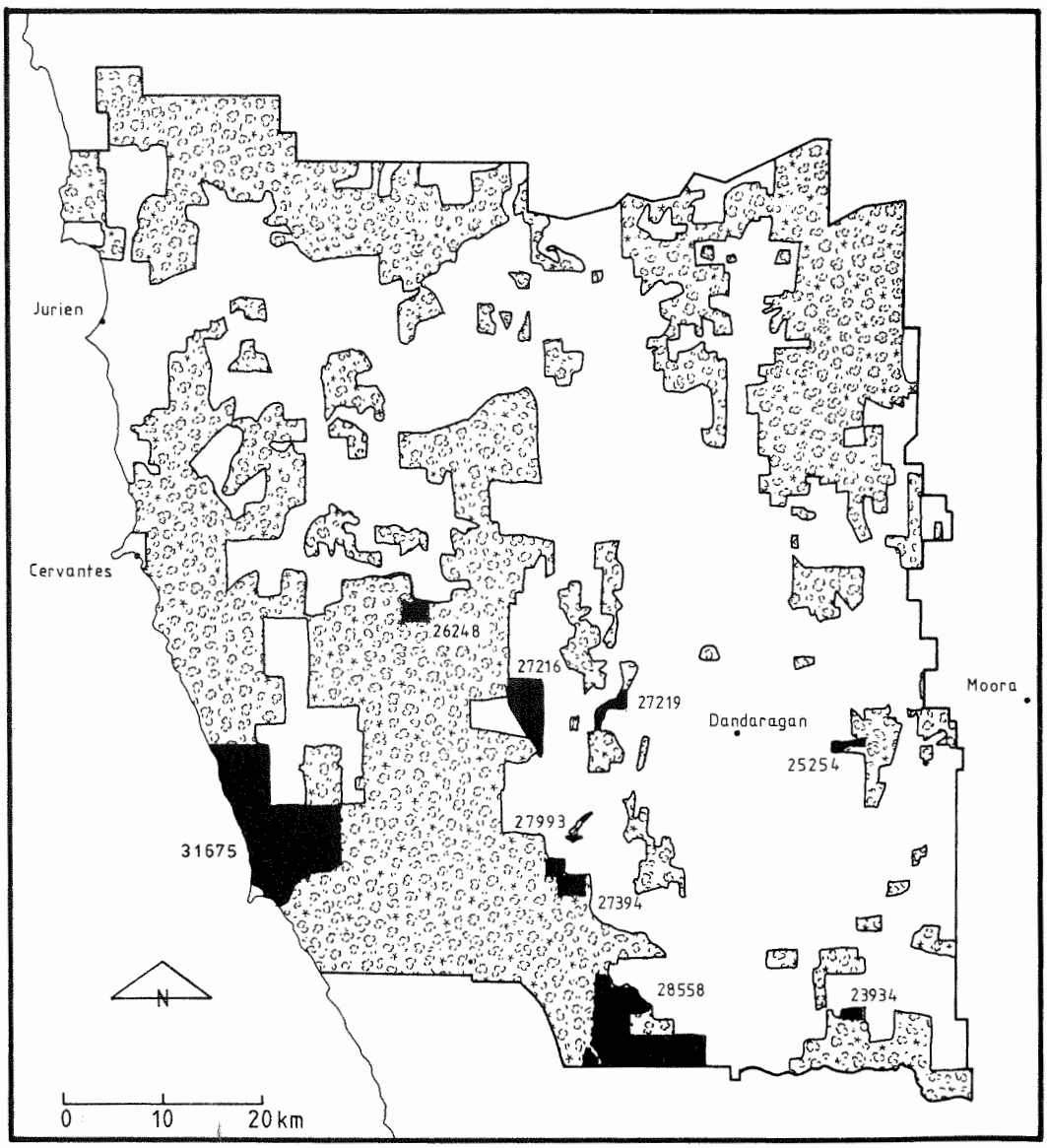

Figure 4. Pattern of land clearing (1979) in the Shire of Dandaragan and the surrounding area showing locations of Nature Reserves described in Volume 1 of this Plan (black areas).

parts of these areas are used by apiarists and the wildflower industry as sources of nectar, flowers, plants and seed. They also include three large and two smaller National Parks which are a focus for tourism and recreation in the Shire. In recognition of the biological importance of the region, a system of Nature Reserves has been established, the management of which is the subject of this Plan.*

* The Department of Fisheries and Wildlife maintains an office in Moora staffed by a Wildlife Officer whose duties include periodic inspections of the Nature Reserves in the Shire of Dandaragan. Cabinet approval has been obtained for the appointment of a regional reserves management team to be based in Wongan Hills. Until this appointment is made reserve management operations for the Nature Reserves in the area covered by this Plan are carried out by staff based in Perth.

6. THE RESERVES

Excluding offshore islands there are 19 Nature Reserves† wholly or partly within the Shire of Dandaragan (Table 1, Fig. 5). They cover an area of some 343 sq km or about five per cent of the total area of the Shire. The Reserves differ widely in size, the largest one wholly within the boundaries of the Shire being 11 138 ha* (Reserve No. 31675) and the smallest 3 ha. Five cover areas greater than 1 000 ha, and four are less than 100 ha. Two of the Reserves are vested in the Local Authority (Reserve Nos. 27216 and

†Nature Reserves within the meaning of the Wildlife Conservation Act 1950 (as amend.): i.e. Crown Reserves whose purpose includes the protection/ conservation of flora or fauna or both.

* A larger Reserve (No. 24496) of 70 013 ha occurs partly in the Shire of Dandaragan.

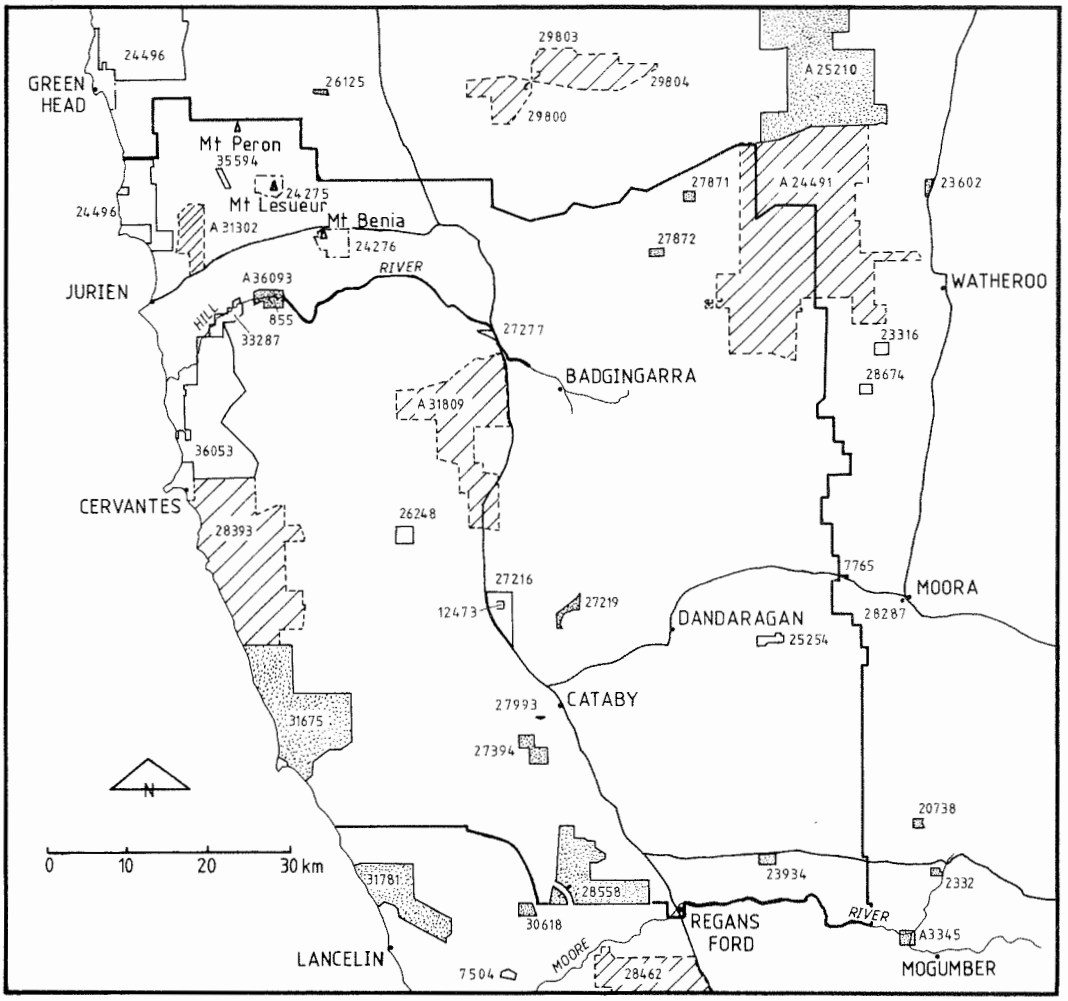

Figure 5. Conservation Reserves in the Shire of Dandaragan and surrounding areas including National Parks (diagonal hachured areas), Nature Reserves vested in the Western Australian Wildlife Authority (shaded areas) and Nature Reserves which are unvested or vested in other authorities (unshaded).

Table 1. The Nature Reserves of the Shire of Dandaragan (excluding islands).

Reserve No.	Name	Area (ha)	Purpose	Vesting
855		12	Camping and Flora	Local Authority
23934		212	Flora and Fauna	W.A.W.A.*
24496†		70013 (3600)†	Flora	
25254	Jam Hill	183	Flora	
26248	Wongonderrah	439	Flora	
27216		1576	Rec'n Camping and Flora	Local Authority
27219	Minyulo	200	Flora and Fauna	W.A.W.A.
27277	Twyata	131	Camping and Flora	
27394	Eneminga	741	Flora and Fauna	W.A.W.A.
27871		206	Flora and Fauna	W.A.W.A.
27872		202	Flora and Fauna	W.A.W.A.
27993		21	Flora and Fauna	
28558	Namming	5411	Flora and Fauna	W.A.W.A.
31675	Wanagarren	11138	Flora and Fauna	W.A.W.A.
33287	Hill River	293	Flora and Fauna	
35191		3	Flora	
35594		56	Flora	
36053		10854	Apiculture and Flora	
A36093		882	Flora and Fauna	W.A.W.A.

* Western Australian Wildlife Authority

†Reserve No. 24496 is mainly in the Shires of Carnamah, Coorow and Irwin. The area of the Reserve within the Shire of Dandaragan is given in parentheses.

855). Both of these have multiple purposes, "protection of flora" being the secondary purpose in each case. The primary purposes of these Reserves are "recreation and camping" and "camping" respectively.

Eight of the Nature Reserves in the Shire are vested in the Western Australian Wildlife Authority, thus coming under the purview of the Department of Fisheries and Wildlife as the managing agency for the Authority. The remaining nine are not vested.

This first volume of the Draft Management Plan for the Nature Reserves of the Shire of Dandaragan deals with the Reserves in approximately the southern half of the Shire. The nine Reserves concerned are Reserve Nos. 23934, 25254 (Jam Hill), 26248 (Wongonderrah), 27216, 27219 (Minyulo), 27394 (Eneminga), 27993, 28558 (Namming) and 31675 (Wanagarren). Of these nine Reserves, five which are shown shaded in Figure 5, namely Reserve Nos. 23934, 27219, 27394, 28558 and 31675, are vested in the Western Australian Wildlife Authority and will be considered in some detail.

Reserve No. 23934 (unnamed)

Reserve No. 23934 (212ha) is on the south side of the Gillingarra Road 12.5 km east of Brand Highway (Fig. 5). It consists of a central low-lying, wooded valley in which Wandoo *(Eucalytus wandoo),* Marri *(E. calophylla)* and Flooded Gum *(E. rudis)*** are prominent.

The valley is orientated roughly north—south and is fringed to the east and west by sand-laterite ridges supporting mainly heathland vegetation. Together with Jam Hill Nature Reserve (Reserve No. 25254 below), Reserve No. 23934 is one of a series of Nature Reserves which serve to represent some of the landforms, soils and vegetation of the Dandaragan Plateau in this general area (Fig. 2). The Reserve is vested in the Western Australian Wildlife Authority.

Reserve No. 25254, Jam Hill Nature Reserve

Jam Hill Nature Reserve (183 ha) takes in a narrow (*ca.* 1 km) strip of land on the eastern side of Jam Hill, 16 km west of Moora townsite. The western part of the Reserve consists predominantly of heathland vegetation on east-facing slopes of exposed laterite with pockets of sand. Toward the east (and south-east of Jam Hill itself)

**Flooded Gum *(Eucalyptus rudis)* and River Gum *(E. camaldulensis)* have been differentiated in this Plan on gross morphological grounds alone.

deeper yellow sands carry low woodlands in which Pricklybark *(Eucalyptus todtiana)* and *Banksia prionotes* are prominent. The Reserve is unvested.

Reserve No. 26248, Wongonderrah Nature Reserve

Reserve No. 26248 (439 ha), known as Wongonderrah, is one of a series of Nature Reserves in the Shire of Dandaragan situated on the Bassendean Dune System (Fig. 2). The Reserve is 25 km north-west of Cataby, its northern boundary being the Wongonderrah Road. The Reserve contains a broad cross-section of the vegetation found on Bassendean dunes in this area, from winter-wet swamps of Swamp Paperbark *(Melaleuca preissiana)* forest, through heathlands subject to varying degrees of winter flooding, to *Banksia* dominated woodlands of the dry dunes. The Reserve contains a number of uncommon plant species and others near the northern limits of their range. It is unvested.

Reserve No. 27216 (unnamed)

Reserve No. 27216 (1 576 ha), on the eastern side of the Brand Highway and 6 km north-west of Cataby, consists of undulating sandplain country near the western edge of the Dissected Region. The ridges, which are sandy gravels, support Blackboys (*Xanthorrhoea* spp.) over low heathlands, while the deeper sands in the hollows have woodlands of Pricklybark (*Eucalyptus todtiana*) and *Banksia* spp. The Reserve is vested in the Shire of Dandaragan.

Reserve No. 27219, Minyulo Nature Reserve

Reserve No. 27219 (200 ha) is 10.5 km north-north-east of Cataby and a similar distance west of Dandaragan. The Reserve follows the course of a seasonal stream, and the vegetation varies from Wandoo (*Eucalyptus wandoo*) and River Gum (*E. camaldulensis*) woodland on alluvial soils through an open woodland of Pricklybark (*E. todtiana*) to low, species-rich heathlands on sandy and gravelly soils. The Reserve is vested in the Western Australian Wildlife Authority.

Reserve No. 27394, Eneminga Nature Reserve

Eneminga Nature Reserve (741 ha) is west of the Brand Highway and 10 km south-west of Cataby. It is centred on a long and narrow system of lakes in Bassendean dunelands. Dry at the time of inspection (throughout 1980) the lakes are normally inundated every winter. They are surrounded by woodlands of *Melaleuca* spp. and River Gum (*Eucalyptus camaldulensis*) and, on the higher ground, the low *Banksia* woodlands typical of this dune formation. The Reserve is vested in the Western Australian Wildlife Authority.

Reserve No. 27993 (unnamed)

This is the smallest (21 ha) of the four Nature Reserves of Bassendean dunes in the Shire of Dandaragan. It is 5 km north of Reserve No. 27394 near the junction of the Brand Highway and the Dandaragan-Moora Road 30 km north of Regans Ford. The Reserve contains a small seasonal swamp covered in a thicket of *Melaleuca* spp. surrounded by a succession of woodland and heathland formations. The Reserve is unvested.

Reserve No. 28558. Namming Nature Reserve

Namming Nature Reserve is 5 411 ha in area and is situated on Bassendean dunelands 4 km west-north-west of Regans Ford. The southern boundary of the Reserve is also the southern boundary of the Shire of Dandaragan in this area. Most of the Reserve is of gently undulating topography and covered with woodlands of mixed *Banksia* spp. over low heaths. There are several seasonal, fresh-water swamps on the Reserve and these are surrounded by varying successions of wetland to dry-land vegetation types. The Reserve is noted for the presence of the Rose Banksia (*Banksia laricina*) and as a breeding ground for the Freckled Duck (*Stictonetta naevosa*). The Reserve is vested in the Western Australian Wildlife Authority.

Reserve No. 31675, Wanagarren Nature Reserve

This large Reserve (11 138 ha) lies on the coast between the Commonwealth controlled naval artillery range to the south and the Nambung National Park in the north. It consists of areas of both the Quindalup and Spearwood Dune Systems and includes both coastal and inland mobile dunes. The vegetation is predominantly low heathlands with stunted Christmas Trees (*Nuytsia floribunda*) scattered throughout. The heathlands are most diverse in species composition in areas of outcropping limestone on Spearwood dunes. Pockets of taller vegetation (to low woodlands) occur in moister situations throughout the Reserve. The Reserve is vested in the Western Australian Wildlife Authority.

PART 2. RESERVE No. 23934

1. INTRODUCTION

Reserve No. 23934 was originally set aside for the purpose of "timber" and was used from time to time as a source of gravel by the Shire of Dandaragan, and White Gum (Wandoo, *Eucalyptus wandoo*) by neighbouring farmers. Its potential value as a conservation area was pointed out to the Department in 1976 by residents of Moora, 36 km to the north-north-east. Being a refuge of woodland on the edge of a largely cleared and developed part of the Dandaragan Plateau (Fig. 4)*, it was set down for closer inspection.

The initial survey was carried out by the District Wildlife Officer in February 1977, who reported it to contain areas of "... open parkland with marrie, whitegum and blackbutt..." He concluded it to be "...a very interesting piece of land which has a very varied flora." (R. F. Dear *in litt.* to the Supervising Wildlife Officer, March 1977).

As a result of this favourable report the Department initially approached the Shire suggesting that an area containing part of the gravel resource on the Reserve, which had been mined from time to time for roading purposes, could be excised and, in view of the biological values of the area the remainder considered as a Nature Reserve. The Shire, however, objected to any change of purpose for the Reserve, stressing the importance of the White Gum, in particular, as a source of timber for fencing for local farmers.

A further and more detailed survey was carried out in December 1977. In this survey 47 plant species were recorded from the lower storeys of the vegetation over three distinct habitat types, namely breakaways, sand plains and lateritic sands (see Section 3 "Soils and Vegetation"). The survey showed the Reserve to represent "...a good cross-section of vegetation indigenous to this area." (Wildlife Officer B. Haberley *in litt.* to the Chief Wildlife Officer). Some deterioration in the values of the Reserve due mainly to rubbish dumping and timber-cutting was also noted.

*The remaining land to the west and south of the Reserve, shown as uncleared in Fig. 4, is now either cleared or in the process of development (see Section 2: "Physical Characteristics and Relationships").

As a result of the two surveys an application was made to the Under Secretary for Lands for a change of purpose of the Reserve to "Conservation of Flora and Fauna" and for it to be vested in the Western Australian Wildlife Authority. Both requests were granted and the changes Gazetted on 25 August 1979.

This Reserve is an example of one which, in the interests of arresting degradation of its values, was brought under the management control of the Western Australian Wildlife Authority and the Department of Fisheries and Wildlife without the agreement of all the local community. The objective remains, however, that the values of such a Reserve should ultimately be recognised by the whole of the community it serves. This is a primary aim of management, especially in the early years of the establishment of the Reserve.

2. PHYSICAL CHARACTERISTICS AND RELATIONSHIPS

Reserve No. 23934 (30° 55'S, 115° 49'E), which is 212 ha in area, lies in the south-west quadrant of the junction of Gillingarra Road and Capitela Road 12.5 km north-east of Regans Ford. (Fig. 5, Fig. 6). The Reserve is surrounded by privately owned land, most of which is either cleared or being developed for agricultural purposes.

The Reserve contains a broad, sandy gully running roughly north to south through its centre. The northern part, which is low-lying, is subject to seasonal flooding. This area supports the tall eucalypt woodlands which are such a feature of the Reserve. In the southern part of the Reserve the gully rises to form a low, sandy ridge.

The central gully is flanked on either side by laterite-covered plateaux, the junction between the two landforms being marked by steeply rising breakaways. This higher land supports a variety of low woodlands and heathlands characteristic of the sandplains of the region.

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3. SOILS AND VEGETATION

The soils of the Reserve are made up of whitish sands and sandy clays with pockets of laterite, especially on the higher ground. The vegetation has been differentiated into five major associations, which are mapped in Figure 6 and which correspond closely to areas of the main landscape units contained in the following descriptions. Areas 1 and 2 are the northern, lower portion of the gully on which the Reserve is centred. Area 3 takes in the low sandy ridge at its southern end, and areas 4 and 5 are situated on the higher ground on either side.

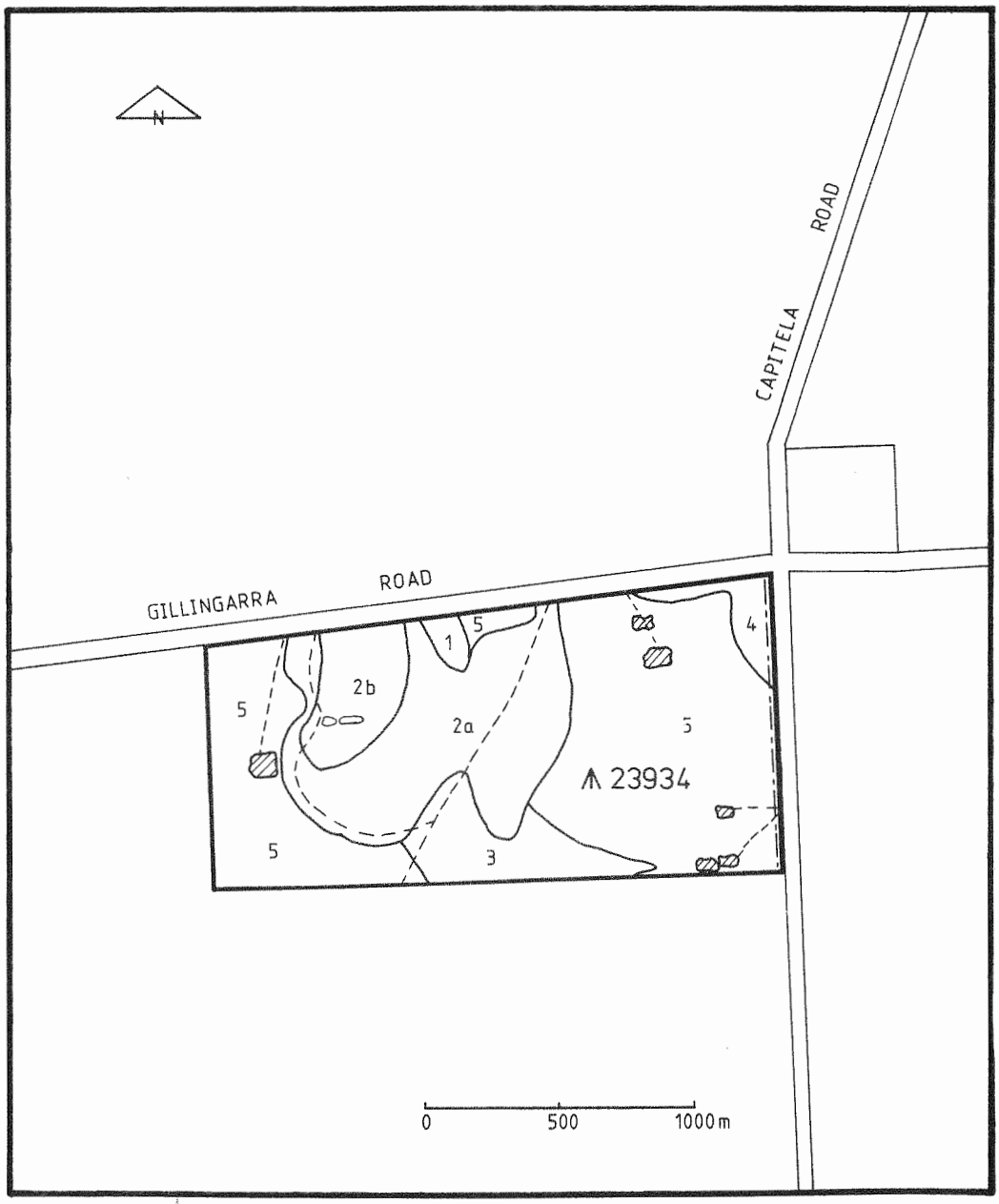


Figure 6. Reserve No. 23934 showing relationships with surrounding land. Tracks are shown as broken lines, disused gravel pits by diagonal hatching and two small seasonal swamps are stippled. Vegetation associations are identified by numbers (1.2.3. . .) and are described in the text.

1. Open Woodland* of Marri (*Eucalyptus calophylla*) 15-18 m, over Scrub made up mainly of the Swamp Cypress (*Actinostrobus pyramidalis*) (3-4 m) and Blackboys (*Xanthorrhoea* sp.) to 2 m. The ground cover in this area is Open Low Sedges.

2a. Woodland of mature Wandoo (*Eucalyptus wandoo*) 15-20 m with a sparse mid-storey made up of regenerating examples of the same species. The understorey is Dwarf Scrub C/Low Heath C dominated by *Hypocalymma* sp. and *Verticordia densiflora* both 1 m in height. Other less common components of the understorey include *Macrozamia riedlei, Calothamnus quadrifidus, Hakea trifurcata* and *Hakea* sp. The ground cover in this area is Open Low Grass and Open Low Sedges.

2b. Similar to 2a in general structure but the ground is frequently wet in winter. The Woodland is Wandoo (*Eucalyptus wandoo*) and Flooded Gum (*E. rudis*), 15-20 m in height, over a Thicket of *Melaleuca hamulosa* 3-4 m tall and Low Scrub A of *Hakea marginata* 1.5-2 m. The ground cover in this area is Open Low Grass and Open Low Sedges. (Occassional stands of Swamp Cypress to 4 m in height also occur in this area).

3. Low Woodland A of *Banksia attenuata* situated on the sandy ridge to the south of the moister part of the central gully. This formation is 5-7 m tall and has an understorey of Low Heath C/Low Heath D dominated by *Melaleuca scabra* (0.75 m) and *Eremaea pauciflora* (0.5 m). Occasional Christmas Trees (*Nuytsia floribunda*) and Pricklybark (*Eucalyptus todtiana*) to 8 m are also present.

4. Low Woodland A of *Banksia attenuata* 5-7 m. The understorey of this formation is a Thicket/Scrub of Woolly Bush (*Adenanthos cygnorum*) and *Banksia burdettii* to 3 m over Low Heath C/Low Heath D of varied composition including *Melaleuca scabra, Eremaea pauciflora, Dasypogon bromeliaefolius, Allocasuarina humilis, Conospermum stoechadis, Stirlingia latifolia* and sedges.

5. Vegetation in this area can be generally described as a variable and species-rich Heathland occasionally overtopped by Open Low Woodland of Pricklybark (*Eucalyptus todtiana*) and *Banksia attenuata*. In other areas there is an upper storey of taller shrubs (Thicket/Heath A) about 2 m tall in which *Hakea trifurcata, Banksia sphaerocarpa, Calothamnus quadrifidus, Hakea ruscifolia, Allocasuarina humilis* and Blackboys are prominent.

6. The main vegetation, however, is a Low Heath C/Low Heath D containing species such as *Hakea incrassata, H. baxteri, Allocasuarina humilis, Melaleuca* sp., *Calothamnus quadrifidus, Lambertia multiflora, Dryandra nivea, D. pteridifolia, Acacia pulchella, Daviesia pectinata, Eremaea pauciflora, Isopogon* sp., *Stirlingia latifolia* and *Patersonia occidentalis*. The ground cover of this association is Open Low Sedges.

Additional plant species recorded by Wildlife Officers during inspections prior to Gazettal of the area as a Nature Reserve include the following:

Lepidobolus chaetocephalus
Loxocarya fasciculata
Dianella revoluta
Conostylis aculeata
Conostylis aurea
Patersonia occidentalis
Dryandra armata
Hakea undulata
Petrophile linearis
Petrophile trifida
Sollya fusiformis
Daviesia preissii
Jacksonia decumbens
Jacksonia furcellata
Oxylobium capitatum
Comesperma acerosum
Comesperma confertum
Hibbertia acerosa
Hibbertia pachyrrhiza
Pimelea imbricata
Calytrix aurea
Calytrix fraseri
Leptospermum ellipticum
Melaleuca lateritia
Lysinema cilliatum
Dampiera juncea
Lechenaultia floribunda

*Structural vegetation categories follow Muir, B. G. (1977) Biological Survey of the Western Australian Wheatbelt. Part 2. Vegetation and Habitat of Bendering Reserve. Records of the Western Australian Museum Supplement No. 3. A summary of these categories is given in Appendix I.

4. FAUNA

Systematic surveys of the fauna of the Reserve have not been carried out, but sight records of mammals and birds were made during inspections preliminary to the preparation of this Plan. This list is contained in Appendix II.

5. PAST MANAGEMENT, USE AND FIRE HISTORY

Aerial photography flown in March 1960 shows that the eastern half of the Reserve had been burned shortly before that time and December-January 1969/70 photography shows a large, recent fire immediately to the west and south which affected a small area in the western part of the Reserve. There is no sign of fire having occurred on the Reserve subsequent to 1970. (Appendix III: Sketch-maps of the Fire Histories of Nature Reserves in the southern part of the Shire of Dandaragan).

The serial aerial photography and Landsat imagery of the northern sandplains that has become available since 1969 indicates that fire scars may remain detectable in heathland for 10 years or more. It therefore seems likely that this Reserve has suffered only one significant fire in the past 21-30 years, this having occurred sometime prior to 1960.

This uneventful fire history has taken place despite the lack of fire protection measures for the Reserve. There are no firebreaks on the Reserve itself*, and several internal tracks finish in dead ends and against fences and are of very limited use for fire control purposes.

Several of these tracks lead to old gravel quarry sites. The gravel, however, is apparently not of good quality for road-making purposes, and these sites have not been used in recent years. In the past, also, trees have been cut for fence posts and rubbish has been dumped in a few places.

Since its Gazettal as a Nature Reserve and vesting in the Western Australian Wildlife Authority management activity has been limited to clearing of rubbish and to contacting neighbouring landowners concerning the change in status of the land.

*There are well maintained firebreaks on private land adjacent the western and southern boundaries of the Reserve.

6. NATURE CONSERVATION VALUES

Reserve No. 23934 is one of two Nature Reserves on the Dandaragan Plateau in the southern part of the Shire. The second of the two is Jam Hill Nature Reserve, No. 25254 (see Part 8: The Unvested Reserves). Both are of similar size. A further group of three small Reserves north of Mogumber and near the eastern edge of the Plateau complete the series representing the habitats of this zone. Reserve No. 23934, however, is doubly valuable for the vartiety of vegetation and the tall eucalypt woodlands it supports. The Reserve contains a good cross-section of the local indigenous flora, and its diverse vegetation provides habitats for a variety of birds, mammals and reptiles. The Wandoo woodland, in particular, provides many nest sites for mammals and hollow-nesting birds.

This Reserve is deserving of key-site status as an area representing the habitats of this southern part of the Dandaragan Plateau. It is small but has the advantage of a compact shape. The Reserve is in good condition and is generally amenable to management. It has suffered only minor human interference and has not been affected by too-frequent fire. Given careful managment there is a good chance that the considerable values of the Reserve can be perpetuated.

7. MANAGEMENT PRIORITIES

Management of this Nature Reserve will be directed towards rehabilitation and maintenance of its nature conservation values and, as such a requirement becomes evident, toward facilitating its use as an amenity by the local community. Management provisions for these purposes will include the following:

Protection From Fire

To protect the assets of adjacent landholders and to take such measures as may be necessary to prevent or control the extent of wildfires which may occur on the Reserve.

Protection From Pests: Animal and Weed Control

To protect the Reserve and surrounding farmlands from damage as a result of infestation with such animals and plants as may be declared from time to time under the provisions of the Agriculture and Related Resources Protection Act.

Rehabilitation and Maintenance of the Natural Environment

To restore areas disturbed by gravel mining and refuse disposal, and to take such measures as may be necessary to curtail misuse of the Reserve, particularly rubbish dumping and the removal of trees for timber.

Use of the Reserve

To encourage the proper use of the Reserve for educational and interpretive purposes, as an objective of second priority under this plan.

8. MANAGEMENT—FIRE PROTECTION

Fire protection measures for the Reserve will include construction and maintenance of a system of perimeter and internal firebreaks and the provision for consultation between the Department, neighbouring landholders and the Shire concerning this and such other fire control measures as may be required from time to time.

Rationale

Prominent among the values to nature conservation of this Reserve is its long freedom from fire. This is not an unusual feature among smaller woodland and heathland Nature Reserves in the wheatbelt. Once the land around them is cleared the likelihood of fire, either as a result of land-clearing operations or from natural causes* is reduced. Because they have no recent history of fire, they are not perceived as a potential threat to property by surrounding landholders. They therefore provide good opportunities for maintaining representative areas of different vegetation as fire-free reference sites for long periods. Insofar as the normal range of intervals between "natural" fires in these vegetation types is not known it is desirable to adopt a conservative approach to their management, minimising the use and risk of fire while actively seeking knowledge of their fire ecology.

*The likelihood of fire from natural causes, such as lightning strike, is decreased because the area over which a fire can ignite and affect the Reserve is reduced as a side-effect of clearing. In areas of harsher Mediterranean climate farmland will not carry a fire for much of the fire danger period. Fires that start *outside* the Reserve are therefore less likely to burn into it once surrounding land is cleared than was the case beforehand. Risk from fires of this type is, to a much greater extent, a function of the likelihood of the point source of origin being on the Reserve itself. This likelihood is proportional to the Reserve area and is increasingly lower on smaller Reserves.

Firebreaks to be Constructed and Maintained

Six metre-wide firebreaks will be bulldozed around the perimeter of the Reserve, as close as practicable to existing fences on the western and southern boundaries and within 10 m of the boundaries of the Reserve and road reserves on its northern and eastern sides. At the same time, the existing internal track running north-east south-west through the central gully in the Reserve (Fig. 6) will be upgraded to a six metre-wide firebreak and access route. All firebreaks will be maintained to ensure they remain free of overgrowth and for access in case of fire.

Fire Suppression

As resources become available firefighting units of the Department of Fisheries and Wildlife will attend fires occurring on, or considered to be threatening the Reserve. Implementation of this provision and of a system of fire notification will be dependent upon appointment of the proposed Wongan Hills Reserves Management Team.

Adequacy of Control Measures

Owners of land in the vicinity of the Reserve are invited to draw the attention of the Director of Fisheries and Wildlife to what they consider to be inadequacies of fire protection. On receipt of such a complaint the Director will organise a joint inspection of the problem and take such other action as may be needed to remedy the situation.

Notifiable Authority

The Department of Fisheries and Wildlife shall be regarded as a Notifiable Authority in terms of the Bush Fires Act and Regulations in respect of Nature Reserve No. 23934.

9. MANAGEMENT— PROTECTION FROM PESTS: ANIMAL AND WEED CONTROL

Control of declared pest plants and animals may be necessary from time to time to protect fauna and flora and the environment of the Reserve generally, and as part of organised control of vertebrate pests or various weeds conducted in the vicinity of the Reserve.

Such arrangements as may be necessary in respect of organised pest control shall be made by consultation and co-operation between the Agriculture Protection Board and the Department of Fisheries and Wildlife.

Adequacy of Control Measures

As with the provisions for fire protection, owners of land in the vicinity of the Reserve are invited to draw the attention of the Director of Fisheries and Wildlife to what they consider to be inadequacies of control of pest plants and animals on the Reserve. On receipt of such a complaint the Director may organise a joint inspection of the problem or take such other action as may be necessary to remedy the situation.

10. MANAGEMENT— REHABILITATION AND MAINTENANCE OF THE NATURAL ENVIRONMENT

Gravel Pits to be Rehabilitated

At the same time as firebreaks are constructed on the Reserve the gravel pits shown in Fig. 6 will be surface-ripped to promote revegetation. The further use of tracks leading to these gravel pits will be discouraged.

Rubbish to be Removed

All remaining rubbish on the Reserve will be removed at the time of firebreak construction, and managment shall be generally directed toward minimising future mis-use of the Reserve.

11. MANAGEMENT— PUBLIC USE

Rationale

This Nature Reserve contains some particularly attractive bushland and is located close to Moora. Access, via Gillingarra Road, is easy, and the range of habitats on the Reserve offers a variety of opportunities for amenity use. The Reserve possesses no features likely to be damaged by passive recreational activity. There is every reason, therefore, to encourage the public, particularly the local community, to make use of the Reserve, and so enjoy the considerable attractions it offers, in ways appropriate to its primary status as a conservation area.

Naming

It is proposed that the name "Bundarra Nature Reserve" be submitted to the Nomenclature Advisory Committee of the Department of Lands and Survey for adoption and Gazettal as the official name for Reserve No. 23934. Bundarra is a local aboriginal word meaning "a copse of trees" the stand of Wandoo and other eucalypts near the centre of the Reserve being a most attractive feature.

Classification

The Reserve will not be classified under Section 12A of the Wildlife Conservation Act in the meantime, but part of it may be classified as a Limited Access Area during the currency of this Plan should vehicular use begin to prejudice either the nature conservation or amenity values of the area as a whole.

Wildlife Conservation Regulations to Apply

Apart from specific provisions which may be applied to the Reserve as a result of this Plan, public use will be managed as allowed for under the Wildlife Conservation Regulations.

Signs to be Erected

Signs identifying the Reserve and conforming to standard specifications for Department of Fisheries and Wildlife Nature Reserve signs will be erected near the main access to the Reserve from Gillingarra Road. This Plan also allows for the erection of such other signs as may be needed from time to time to facilitate the proper use of the Reserve by the public.

12. MANAGEMENT—GENERAL

During the currency of this Plan the Department of Fisheries and Wildlife may, with the approval of the Chairman of the Western Australian Wildlife Authority, undertake or authorise such other work as may be seen to be necessary or desirable to properly promote the stated objectives of management of the Reserve.

PART 3. RESERVE No. 27219, MINYULO NATURE RESERVE

1. INTRODUCTION

Originally set aside in August 1965 for "Government requirements", the purpose of this Reserve was amended to "recreation" in October 1971. The Reserve was not vested in any authority at this time.

In April 1978 the District Wildlife Officer at Moora reported on a series of visits he had made to the Reserve, and noted the considerable biological values of the area. He drew attention particularly to a stand of Wandoo woodland which lines the seasonal stream in the Reserve and to the populations of parrots the woodland supports:

> "... White-tailed Black Cockatoos, Corellas, ... Galahs and Twenty-eights (Port Lincoln Parrots) all nest in numbers in this area".
> (K. L. Miller *in litt.* to the Chief Wildlife Officer, Department of Fisheries and Wildlife, 24 April 1978).

As the Reserve was then little used for recreation and had little potential for development for that purpose alone, the Under-Secretary for Lands agreed to a request from the Director of Fisheries and Wildlife to recognise nature conservation as the predominant use, changing the purpose of the Reserve to "conservation of flora and fauna" and vesting it in the Western Australian Wildlife Authority. These changes were Gazetted on 19 January 1979, and the name Minyulo Nature Reserve was approved by the Nomenclature Advisory Committee the following year.

2. PHYSICAL CHARACTERISTICS AND RELATIONSHIPS

Reserve No. 27219 (30° 40'S, 115° 33'E, Figs. 5,7) lies roughly midway between Cataby and Dandaragan. It is irregular in shape, being elongated in a north-east to south-west direction to follow the stream bed on which it is centred. It has an area of 200 ha and a total perimeter of *ca.* 12 km. The western boundary of the Reserve is defined by a made gravel road as is its southern boundary and southern-western corner. Except for the short southern boundary, which adjoins uncleared land, the area is otherwise surrounded by developed farmlands.

The Reserve lies near the southern limit of the Dissected Region, close to the area where the Dandaragan Plateau and Bassendean Dune System converge (Fig. 2). Its topography is gentle and the range of soils includes a succession from red loams in the stream bed through an area of light sandy loams in the middle of the sequence to sandy, gravelly loams on the higher ground.

3. VEGETATION

Two distinct kinds of vegetation occur on the Reserve: mature Wandoo (*Eucalyptus wandoo*) woodland which occupies a narrow strip along all of the stream bed (Area 1, Fig 7) and a varied heathland, sometimes with a pricklybark (*Eucalyptus todtiana*) upper stratum, which occurs over all the drier lands and lighter sandy and gravelly soils (Area 2, Fig 7). The following detailed descriptions apply:

1. Low Woodland A made up almost exclusively of Wandoo (*Eucalyptus wandoo*) *ca.* 10-14 m in height, with scattered River Gum (*E. comaldulensis*) to *ca.* 12 m. The understorey is generally open with patches of Open Scrub to Open Low Scrub A made up of such species a *Acacia acuminata, Acacia* sp., *Hakea varia* and *Baeckea* sp. The ground cover is Open Low Grasses and Open Low Sedges.

2. Open Low Woodland B of Pricklybark (*Eucalyptus todtiana*) 4-5 m, over Heath A made up primarily of *Hakea trifurcata* to 2 m and *Banksia attenuata* to 2 m over a Low Heath C of several species including *Allocasuarina campestris, Hakea varia, Hakea incrassata, Conospermum stoechadis, Banksia* aff. *sphaerocarpa, Petrophile macrostachya, Calectasia cyanea, Acacia pulchella, Daviesia* spp., *Isopogon* sp., and *Calothamnus* sp. The ground cover in this area is generally Open Low Sedges in which two species of *Drosera* are also present.

On the eastern side of the river the upper stratum of Pricklybark (*E. todtiana*) and *Hakea trifurcata* almost disappears leaving Blackboys (*Xanthorrhoea preissii*) to *ca.* 2 m over a Low Heath D association characterised by the species mentioned above.

Note: Other species noted as common on the Reserve include the Christmas Tree (*Nuytsia*

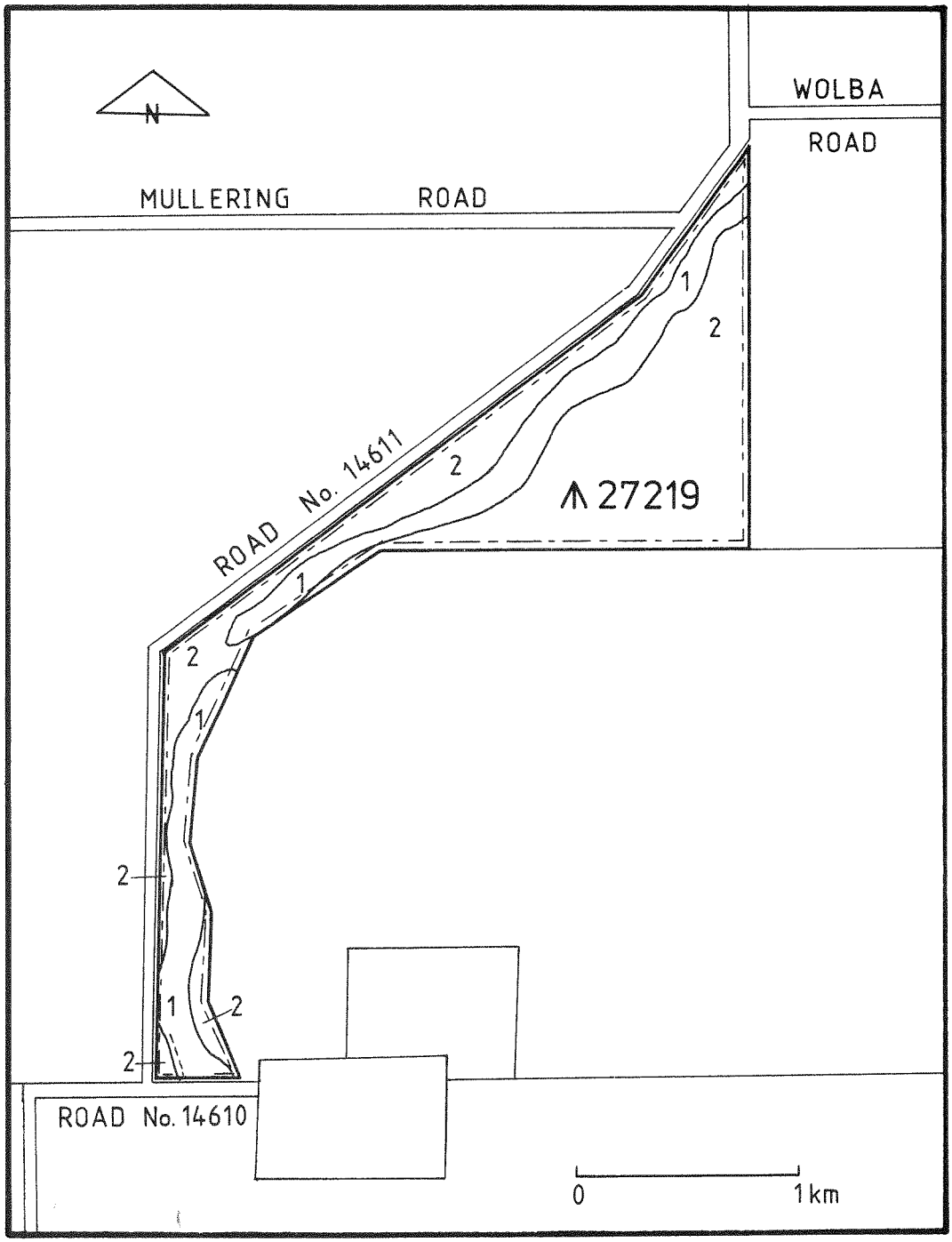


Figure 7. The Minyulo Nature Reserve. Firebreaks and tracks are shown as broken lines and vegetation associations are identified by numbers (1.2.) and are described below in the text.

floribunda), Marri (*Eucalyptus calophylla*) (small group on eastern side), York Gum (*E. loxophleba*) (as mallees in pockets growing alongside the watercourse) and Quandong (*Santalum acuminatum*).

4. FAUNA

No formal survey of the fauna has been carried out, but the sight records given in Appendix II (including breeding records for one species of cockatoo and two parrots) show the Reserve to support a varied fauna characteristic of the woodland and heathland habitats it contains.

5. PAST MANAGEMENT, USE AND FIRE HISTORY

Aerial photography shows that much of this Reserve was burned in a series of fires prior to 1960, but there is no indication of fire on the Reserve itself since that time. One or more clearing burns, particularly on the south-eastern side of the Reserve, took place between 1973 and 1976, and one of these may have had some affect on the heathlands in the north-eastern part. This would account for their appearance of having recently been burned. Most of the Reserve, however, has suffered no fires since shortly before 1960. (See Appendix III: Sketch-maps of the Fire Histories of Nature Reserves in the southern part of the Shire of Dandaragan).

All boundaries of the Reserve have six metre-wide ploughed firebreaks and, at some time in the past, prior to its Gazettal as a Nature Reserve, two small dams were constructed on the line of the stream, one near the northern and the other near the southern end of the Reserve. These do no detract from the biological values of the area. In general the Reserve has been little affected by past use, there having been some wood-cutting but no sign of rubbish-dumping or similar mis-use.

6. NATURE CONSERVATION VALUES

As well as presenting an attractive roadside strip of natural vegetation this Reserve provides a windbreak to neighbouring farms on both its eastern and western sides. Its principal value as a Nature Reserve, however, is as a feeding and breeding habitat for bush birds. Woodlands, in particular, are uncommon in the region and this Reserve is an important nesting area for a variety of parrots. As such it is fully deserving of wildlife refuge status in the Western Australian system of Nature Reserves.

7. MANAGEMENT PRIORITIES

Management of the Reserve will be directed toward maintaining its nature conservation values, while continuing to recognise its subsidiary uses as a source of water and as a windbreak to neighbouring farm properties. Provisions for management will include the following:

Protection from Fire

To protect the assets of adjacent landholders and the biological values of the Reserve and to minimise both the possibility of wildfires and the need for fuel reduction burning on the Reserve itself.

Protection from Pests: Animal and Weed Control

To protect the Reserve and surrounding farmland from damage as a result of infestation with animals and plants which are declared from time to time under the provisions of the Agriculture and Related Resources Protection Act.

Use of Water

To continue to provide neighbouring landholders with water in circumstances which do not detract from the nature conservation and aesthetic values of the Reserve.

8. MANAGEMENT—FIRE PROTECTION

Rationale

Because of its long boundaries adjacent to farmland frequent fire on this Reserve is likely to result in a large proportion of the heathland area being invaded to a greater or lesser degree by pasture, weed and crop species. Such an occurrence would detract

from the nature conservation values of the area as a whole and, in turn, heighten the risk of frequent fire. This Plan therefore provides for the minimisation of fire occurrence, both as wildfires and in fuel-reduction burning, using fire only for "biological" purposes, i.e. to facilitate regeneration of areas as the need to do so becomes apparent. Adoption of this management course is encouraged by the infrequent occurrence of fire in the past and the clear interest of neighbouring landholders in the Reserve.

Marginal Firebreaks to be Maintained

Arrangements will be made for the continuation of the maintenance of the firebreak system on the Reserve to its present standard.

Internal Firebreak to be Constructed

An internal east-west orientated firebreak bisecting the Reserve will be constructed and maintained during the currency of this Plan. This firebreak will inhibit any north-south movement of fire through the Reserve and together with the existing firebreak system will allow rapid access to all parts of the Reserve in the case of fire.

Fire Suppression

As resources become available firefighting units of the Department of Fisheries and Wildlife will attend fires occurring on, or considered to be threatening the Reserve. Implementation of this provision is dependent upon the appointment of the proposed Wongan Hills Reserves Management Team

Adequacy of Control Measures

The long boundaries of the Reserve, with farmland on the one side and public roads on the other, and the need to maintain the Reserve free of frequent fire require that special attention be paid to developing and maintaining good relationships with neighbours of the Reserve. As with provisions for fire suppression close neighbour contact requires the Wongan Hills Reserves Management Team to be in place. In the meantime, however, as with other Reserves in the Shire, this Plan includes a provision for Reserve neighbours to draw the attention of the Director of Fisheries and Wildlife to what they consider to be inadequacies in fire protection arrangements. On receipt of such a complaint the Director will organise a joint inspection of the problem and take such other action as may be needed to remedy the situation.

Notifiable Authority

The Department of Fisheries and Wildlife shall be regarded as a Notifiable Authority in terms of the Bush Fires Act and Regulations in respect of Nature Reserve No. 27219.

9. MANAGEMENT— PROTECTION FROM PESTS: ANIMAL AND WEED CONTROL

Control of declared pest animals and plants may be necessary from time to time to protect fauna and flora and the environment of the Reserve generally and as part of organised control of vertebrate pests or weeds in the vicinity of the Reserve.

Such arrangments as may be necessary in respect of organised pest control shall be made by consultation and co-operation between the Agriculture Protection Board and the Department of Fisheries and Wildlife.

Adequacy of Control Measures

As with the provisions for fire protection, Reserve neighbours are invited to draw the attention of the Director of Fisheries and Wildlife to what they see as inadequacies in the control of pest plants and animals on the Reserve. On receipt of such a complaint the Director may organise a joint inspection or take such other action as may be necessary to remedy the situation.

10. MANAGEMENT— PUBLIC USE

Rationale

This Reserve is not as well suited for development for amenity use as some others in the Shire, but it is of considerable value to neighbouring farmers, particularly as a source of water. Such water improvements as exist on the Reserve should be allowed to continue to be used under this Plan by virtue of their existence prior to Gazettal of the area as a Nature Reserve and by virtue of the

fact that they do not detract from its nature conservation values. Further development for water supply to adjoining properties is not envisaged.

Signs to be Erected

Signs identifying the status of the area as a Nature Reserve and which bear its name "Minyulo Nature Reserve" will be erected at one or more points along the road boundaries of the Reserve. The signs will comform to the standard specifications for Department of Fisheries and Wildlife Nature Reserve signs.

Classification

The Reserve will not be classified under Section 12A of the Wildlife Conservation Act.

Wildlife Conservation Regulations to Apply

Apart from specific exceptions concerning use of water, public use will be managed as allowed under the Wildlife Conservation Regulations.

Use of Water

The existing access of neighbouring landowners to water on the Reserve will be maintained under the provisions of this Plan. Neighbours will, however, be required to apply to the Director of Fisheries and Wildlife for express permission to modify existing arrangements or do any work, lay any pipelines or create or maintain any additional access routes which may be required on the Reserve.

11. MANAGEMENT—GENERAL

During the currency of this Plan the Department of Fisheries and Wildlife may, with the approval of the Chairman of the Western Australian Wildlife Authority, undertake or authorise such other work or action as may be seen to be necessary or desirable to properly promote the stated objectives of management of the Reserve.

PART 4. RESERVE No. 27394, ENEMINGA NATURE RESERVE

1. INTRODUCTION

Eneminga Nature Reserve, which is centred on a series of wetlands surrounding Eneminga Brook, was set aside in 1964. It was Gazetted initially as two Reserves, only the southern one being vested in the Western Australian Wildlife Authority*. "Water" was included with "conservation of fauna and flora" in the purpose of the northern one, and it remained unvested. The two Reserves were finally amalgamated in 1977 under a common purpose and vested in the Wildlife Authority.

This was an important step for several reasons. Firstly, the increase in area of the Reserve (from 481 to 741 ha) brought with it a potential for an increased carrying capacity for animals and therefore larger populations of the fauna it supports. Secondly, the northern part of the Reserve includes a normally permanent swamp of a type not represented in the southern section; and, thirdly, the increased diversity of habitats represented in the enlarged Reserve is likely to be accompanied by an increase in the range of wildlife species found there. Always known as a haven for waterfowl, the Eneminga Nature Reserve is recognised as a key site in the Western Australian Nature Reserve system both as a freshwater wetland and as a breeding ground for water birds.

2. PHYSICAL CHARACTERISTICS AND RELATIONSHIPS

The two blocks of land from which Eneminga Nature Reserve originated are evident from its present shape—two Locations joined at their south-east and north-west corners, respectively, with a short common boundary between them (Fig. 8). The Reserve (30° 48'S, 115° 30'E) has a total area of 741 ha and a perimeter of 14.6 km. It is located about 10 km south-west of Cataby and is isolated from public roads (Fig. 5), the northern and north-eastern sides adjoining fenced farmland while the southern and south-western sections are continuous with a large block of uncleared land (Fig. 4).

Eneminga Nature Reserve lies near the northern end of a depression in the Bassendean Dune System which broadens southwards to take in Lake Guraga and Namming Lake and which skirts the eastern side of Namming Nature Reserve (Fig. 2). At this northern end the inter-dunal depression is relatively narrow and occupied by Eneminga Brook. The stream bed runs through the Reserve from north-west to south-east and is characterised by a series of long, narrow, shallow lakes which hold water in the winter but which remain dry and devoid of vegetation for the remainder of the year.

To the east of Eneminga Brook in the northern part of the Reserve is Eneminga Swamp, which contains the only permanent or semi-permanent water in the Reserve. The remainder of the Reserve varies from heath-covered, winter-waterlogged lowlands to sandy ridges bearing stands of *Banksia* woodlands.

*Then the Fauna Protection Advisory Committee.

3. SOILS AND VEGETATION

Soils on the Reserve are grey quartz sands with dark, peaty sands in the low-lying, seasonally and permanently waterlogged areas. Seven vegetation associations have been described from the Reserve which are mapped in Figure 8 (Nos. 1 to 7). The descriptions of these associations are as follows:

1. (Lake beds along Eneminga Brook.) Bare soil supporting less than 2 per cent cover of *Halosarcia* sp. to *ca.* 0.2 m.

2. Low Woodland A of predominantly *Melaleuca rhaphiophylla* (6 to 10 m) over a Thicket, 2 to 4 m in height, of the same species, over scattered clumps of Tall Sedges (*Baumea articulata*) to *ca.* 2 m.

   Away from the watercourse this association merges into a mixed

Melaleuca rhaphiophylla/ River Gum (*Eucalyptus camaldulensis*)/ *Jacksonia sternbergiana* Thicket, 2 to 4 m in height, in which specimens of River Gum occur which are emergent to *ca.* 20 m. Small patches of *Acacia* sp. Thicket to 3 m occur along the lake edges.

3. Low Woodland A made up of *Banksia attenuata* and *B. menziesii* from 5 to 8 m, with *B. ilicifolia* and *B. prionotes* less dominant to *ca.* 7 m. Scattered examples of Pricklybark (*Eucalyptus todtiana*) and the Christmas Tree (*Nuytsia floribunda*) were also noted. Regenerating *Banksias* and *Adenanthos cygnorum* form a very sparse mid-storey element. Underlying the woodland is a complex shrub layer described as Open Dwarf Scrub C over Dwarf Scrub D, made up of many species including *Leptospermum erubescens, Allocasuarina*

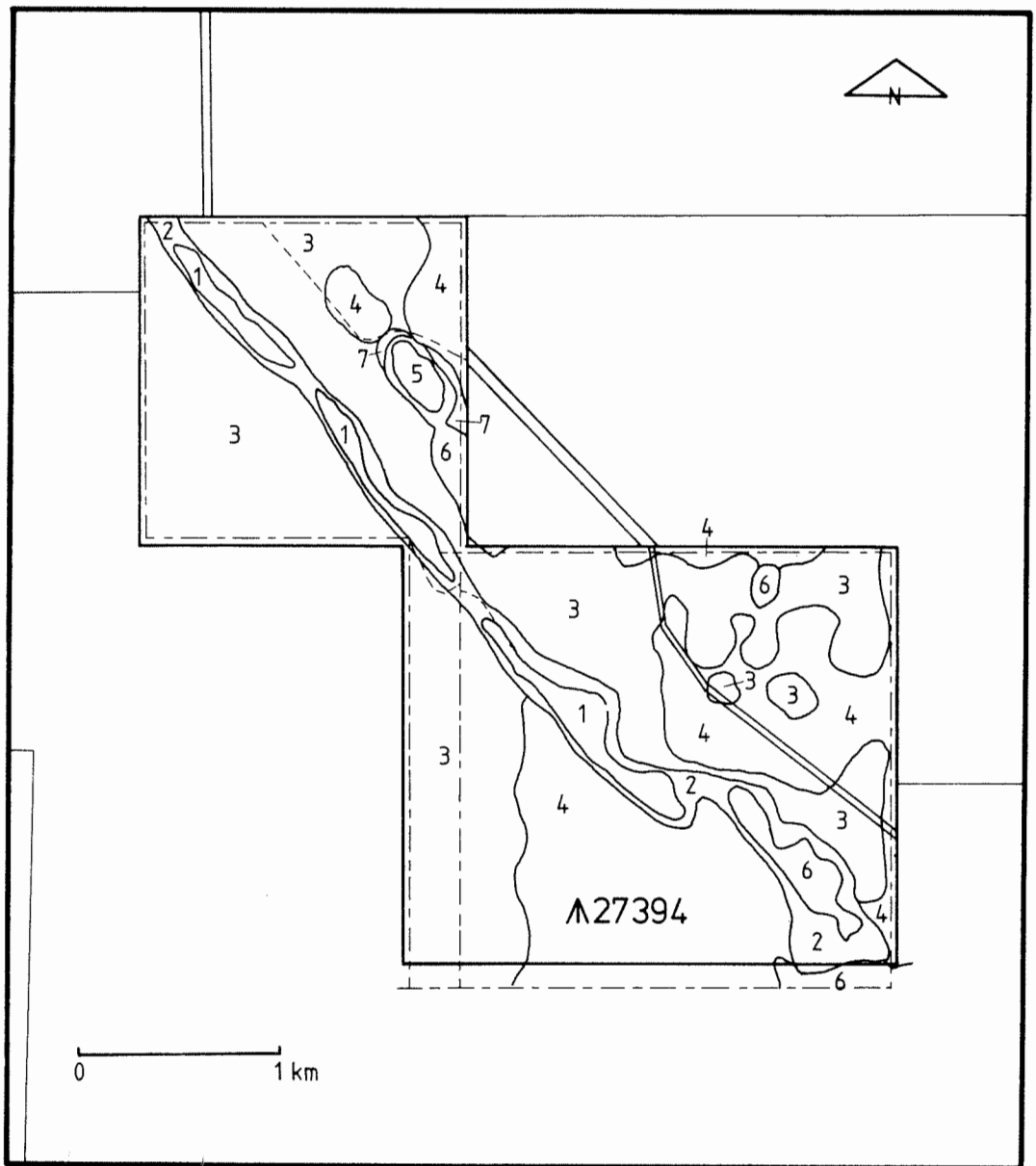


Figure 8. Eneminga Nature Reserve showing relationships with surrounding lands. Gazetted roads (which are undeveloped) are enclosed by double lines and tracks are indicated by broken lines. Vegetation associations are identified by numbers (1.2.3...) and are described in the following text.

humilis (to *ca* 1 m), *Eremaea pauciflora* (0.75 m and abundant), *Dasypogon bromeliaefolius* (0.3 m), *Calothamnus quadrifidus, Stirlingia latifolia, Acacia* sp. and *Conospermum* sp.

4. (Heath association with patches of *Banksia* woodland on higher ground). Heath B made up of such species as *Regelia ciliata, Beaufortia squarrosa, Allocasuarina humilis, Calothamnus quadrifidus, Banksia* aff. *sphaerocarpa* and *Hakea invaginata,* over Low Heath C to Low Heath D. Common species in the latter strata are *Banksia* aff. *sphaerocarpa, Calothamnus* sp., *Stirlingia latifolia, Verticordia plumosa* and *Dryandra nivea.*
5. Open Tall Sedges of Flag Rush (*Baumea articulata*) to *ca.* 1.5 m.
6. (Seasonal swamps with variable vegetation). Dense Thicket to Scrub of *Melaleuca* spp., 2.5 to 4 m in height, over an open understorey. In places this formation is superimposed by an Open Low Woodland A of *Melaleuca* sp. to 6 m in height.
7. Thicket of predominantly *Jacksonia sternbergiana,* 4 to 6 m.

4. FAUNA

Although no formal survey of fauna has been carried out on the Reserve, 37 bird species have been recorded during the course of routine inspections and on visits associated with the preparation of this Plan. This number, and the range of species involved, suggest that the Reserve supports a rich bird fauna. Such a finding would be quite in keeping with the diverse habitats it contains. The full list of birds and mammals found on the Reserve is contained in Appendix II.

5. PAST MANAGEMENT, USE AND FIRE HISTORY

Aerial photography and Landsat imagery (see Appendix III: Sketch Maps of the Fire Histories of Nature Reserves in the Southern Part of the Shire of Dandaragan) show there have been a number of fires on and in the vicinity of this Reserve since records started in 1960. The 1960 photography itself shows fire scars encroaching on the western boundary of the Reserve and the south-western and north-eastern corners of the southern block of the Reserve, although the body of the Reserve had clearly not been recently affected by fire at that time.

Between 1960 and 1969 a large fire burnt into the Reserve from the south, affecting the area to the south and west of the line of Eneminga Brook, an event nearly exactly repeated at some time between 1970 and 1973. Finally, in the summer of 1976-77, parts of the Reserve to the north and east of Eneminga Brook were burnt, the first fire to have affected that part of the Reserve in 15 years.

Cleared firebreaks, six metres wide, have been constructed around all the boundaries of the Reserve. The two blocks of the Reserve are separated by a similar break. Part of the firebreak system dates back to and includes two seismic lines cut by West Australian Petroleum Pty. Ltd. in the latter part of 1971. The first of these ran north to south along the eastern boundary of the northern block and through the southern block some 200 m inside the western boundary. The second ran east to west close to the northern boundary of the southern block (Fig. 8).

In 1971, also, the Reserve was classified as a "shooting and hunting area" under Section 12A of the Wildlife Conservation Act. This classification applies to all the Reserve, including the area vested in the Wildlife Authority in 1977.

Having no access by developed road this Reserve is subject to minimal public use, a situation not inappropriate to its status as a waterfowl breeding and hunting area. In view of the same factors past management has been conservative, aiming to minimise interference to the wetland areas.

6. MANAGEMENT SIGNIFICANCE OF FIRE HISTORY

Little knowledge is available of the effects of frequent fire on the *Banksia* woodland vegetation characteristic of the Bassendean Dune System. In areas closer to the Perth Metropolitan area, including the Thomsons Lake Nature Reserve, fires at intervals of four to five years have resulted in marked

deterioration of canopy trees, a reduction in canopy cover and the ingress of weed species, especially grasses (Crook, I. G. and Evans, T. (1981) Thomsons Lake Nature Reserve. *West. Aust. Nat. Reserve Manage. Plan* No. 2. Dept. Fish. & Wildl. Perth). The more northern woodlands in the series present a somewhat different situation, experiencing as they do lower rainfalls and having short growing seasons and therefore slower growth rates. Being close to the northern limits of the occurrence of *Banksia* woodlands those of Eneminga and other Nature Reserves on the Bassendean dunes in this area (such as Namming Nature Reserve—Part 5 of this Management Plan) might be expected to be even more vulnerable to the effects of too frequent fire than Reserves such as Thomsons Lake.

The vegetation of the Eneminga Nature Reserve, however, is in apparently good condition. It does not show signs of deterioration from too frequent burning, although the effects of the 1976-77 fire (Appendix III) are still evident in the heathlands of the north-eastern part of the Reserve. For lack of more precise indications, therefore, it would seem that intervals of 10—15 years or longer might be expected between naturally occurring fires in this kind of country.

7. NATURE CONSERVATION VALUES

Eneminga Nature Reserve is important as a waterfowl breeding area. The reed beds and dense thickets of *Melaleuca* spp. found around the swamps offer superb nesting sites for ducks. It is recognised as a key site in the Western Australian Nature Reserve System for this reason.

The Reserve contains substantial areas of a variety of habitats other than wetlands. These include *Banksia* woodlands and expanses of open heathland. With the wetlands the Reserve therefore contains a considerable diversity of habitats, so adding to its values, both directly and through the wildlife it supports.

Eneminga Nature Reserve is also a very attractive place. The Brook itself is especially beautiful when full of water, appearing as a series of shallow lakes, and the large number of plant species on the Reserve ensures a spectacular spring flowering.

Part of the attraction of this Reserve lies in the fact that it is somewhat remote and therefore little used by casual visitors. Its remoteness is, in itself, a value of some importance to the Reserve, and one that can be actively maintained.

In this respect Eneminga Nature Reserve should be considered as part of the system of Nature Reserves and other Crown Reserves in the southern part of the Dandaragan Shire. Such a Reserve system can, with sensitive management, cater for a wide range of user interests without conflict. In terms of public use it is appropriate that Eneminga Nature Reserve should continue to be regarded as a special use area for shooting waterfowl during open seasons. At other times it may serve well as a refuge for people who enjoy solitude and wish to seek out more remote areas of natural beauty.

8. MANAGEMENT PRIORITIES

The primary objective of management for the Eneminga Nature Reserve shall continue to be the maintenance of its values as a wetland and waterfowl habitat on the one hand, and as a representative area of the diverse habitats which characterise the Bassendean Dune System on the other. Inasmuch as public use can be maintained without conflict with the primary objectives of conservation, the Reserve will continue to cater for the specialist interests of shooters and naturalists, the natural division of the seasons of their interest allowing for a minimum of conflict between the two uses. Active management is expected to be required in the following fields during the course of operation of this Plan:

Protection from Fire

To protect the assets of adjacent landholders and to minimise the occurrence of wildfires on the Reserve.

Protection from Pests: Animal and Weed Control

To protect the Reserve and surrounding farmlands from damage as a result of infestation with such animals and plants as

may be declared from time to time under the provisions of the Agriculture and Related Resources Protection Act.

Public Use

To continue with the programme of conservative management with regard to public use which has been in operation during the last 10 years.

9. MANAGEMENT—FIRE PROTECTION

Rationale

The position of the Eneminga Nature Reserve adjacent to a large area of uncleared, vacant Crown land to the south and west makes it vulnerable to fire spreading from these directions. Two or three major fires which have occurred in the last 12-15 years (all of which started outside the Reserve) have come from this south-westerly direction.

On the other hand, the line of lakes which constitutes Eneminga Brook provides a valuable barrier to fire across the whole Reserve in a north-west to south-east direction. None of the fires known to have occurred here has crossed Eneminga Brook. The Reserve therefore does not constitute a major hazard to surrounding lands, either in itself or because of its location as a continuation of a large expanse of bushland.

This Plan therefore provides for fire protection measures which firstly minimise the risk of fire spreading into the Reserve from adjacent bushland (and farmland) and secondly for the maintenance of an effective system of natural and artificial firebreaks and barriers to fire spread.

South-Western Low-Fuel Buffer to be Constructed

Provided that future management options, including any which may stem from commitment of now vacant Crown land to use, are not unduly constrained thereby, the Bush Fires Board has agreed, as part of the regional fire protection scheme for the Shire of Dandaragan, to install a buffer, between 200 and 400 m in width, of frequently burned vegetation on vacant Crown land adjacent to the western and southern boundaries of this Nature Reserve. The buffer would employ the existing perimeter firebreaks on the Reserve as its eastern and northern limits.

Firebreaks to be Maintained

All existing perimeter firebreaks on the Reserve will be maintained to ensure they remain free of overgrowth and for access in case of fire. Internal tracks will be maintained to a lesser standard for access only. As a barrier to fire spread these need only supplement the natural firebreak provided by Eneminga Brook.

Fire Suppression

As resources become available firefighting units from the Department of Fisheries and Wildlife will attend fires occurring on, or considered to be threatening the Reserve. Implementation of this provision is dependent upon the appointment of the Wongan Hills Reserves Management Team.

Protective Burning

Unlike the smaller Reserves considered in previous parts of this Plan, Eneminga Nature Reserve lies in part of the Shire of Dandaragan which has been subject to regular fires during recent years. The natural barrier to fire provided by Eneminga Brook, however, minimises the risk to farmland from fire starting on or crossing the Reserve. This Reserve, therefore, presents an ideal opportunity to maintain an area of *Banksia* woodlands and asociated heathlands in the region free of fire for long periods. For these reasons protective buring will not be prescribed as part of the fire prtotection measures in this Plan.

Adequacy of Control Measures

In this respect special attention shall be paid to the feelings of Reserve neighbours and to establishing and maintaining effective contact with neighbours. As for other Reserves in the Shire, this Plan includes the formal provision for Reserve neighbours to draw the attention of the Director of Fisheries and Wildlife to what they consider to be inadequacies in fire protection arrangements for the Reserve. On receipt of such a complaint the Director will organise a joint inspection of the problem and take such other action as may be needed to remedy the situation.

Notifiable Authority

The Department of Fisheries and Wildlife shall be regarded as a Notifiable Authority in terms of the Bush Fires Act and Regulations in respect of Eneminga Nature Reserve.

10. MANAGEMENT— PROTECTION FROM PESTS: ANIMAL AND WEED CONTROL

Control of pest animals and plants may be necessary from time to time to protect fauna and flora and the environment of the Reserve generally and as part of the organised control of vertebrate pests or weeds in the vicinity of the Reserve.

Such arrangements as may be necessary in respect of organised control of declared animals and plants shall be made by consultation and co-operation between the Agriculture Protection Board and the Department of Fisheries and Wildlife.

Sheep to be Controlled

Although neighbouring farmlands are fenced off from the Reserve, sheep sometimes stray onto Eneminga Nature Reserve and cause significant damage to vegetation, particularly the herbaceous and soft-foliaged plants associated with wetland areas. Consultation will be maintained between the District Wildlife Officer and neighbouring landholders to minimise this problem.

Adequacy of Control Measures

As with the provisions for fire protection, Reserve neighbours are invited to draw the attention of the Director of Fisheries and Wildlife to what they see as inadequacies in the control of pest plants and animals on the Reserve. On receipt of such a complaint the Director may organise a joint inspection of the Reserve or take such other action as may be needed to remedy the situation.

11. MANAGEMENT— PUBLIC USE

Rationale

The following measures flow from existing provisions for the use of the southern part of the Reserve as a hunting and shooting area, the isolation of the Reserve and the desirability of maintaining a low level of general use of the area, both because of its value as a waterfowl breeding area and to ensure that suitable Reserves in the Nature Reserve system in Western Australia are maintained as places where beautiful environments can be enjoyed in conditions of near solitude.

Classification

The existing classification of the Reserve as a hunting and shooting area will be retained. It is not intended to declare any part of the Reserve a limited access area, although this provision may be reviewed by the Director of the Department of Fisheries and Wildlife should undeveloped roads in the vicinity of the Reserve be upgraded or opened to traffic.

Signs to be Erected

Signs identifying the area as Eneminga Nature Reserve shall be erected at the northern boundary of the Reserve close to the main point of access. The signs will conform to the standard specifications for Department of Fisheries and Wildlife Nature Reserve signs.

Wildlife Conservation Regulations to Apply

Apart from the specific provisions relating to shooting waterfowl, public use of the Reserve will be managed as allowed for under the Wildlife Conservation Regulations.

12. MANAGEMENT— GENERAL

During the currency of this Plan the Department of Fisheries and Wildlife may, with the approval of the Chairman of the Western Australian Wildlife Authority, undertake or authorise such other work or action as may be seen to be necessary or desirable to properly promote the stated objective of management of the Reserve.

PART 5. RESERVE No. 28558, NAMMING NATURE RESERVE

1. INTRODUCTION

The Wetland Area

The first, northern, part of Reserve No. 28558 was Gazetted for the purpose of conservation of flora and fauna on 12 May 1967. At this time the Reserve was unvested.

This northern section contains a series of shallow depressions which, at times of high rainfall, form part of the drainage system of Caren Caren Brook to the east. Namming Lake, after which the Reserve is named, and which is north-west of the Nature Reserve itself, and Lake Guraga (formerly "Salt Lake") are the major features of the drainage basin of this stream (Fig. 9). Some time in the past, however, the natural drainage pattern had been changed, bringing the swamps in the subsequently created Reserve No. 28558 into greater prominence as a wetland than might normally have been the case:

> "Apparently, the branch of Caren Caren Brook which flows into the swamp on Reserve 28558 . . . was originally diverted over 30 years ago to prevent flooding of the flat lands near Namming Lake. As a result of the diversion, water ponded in several swamps (on the Reserve) before overflowing into Namming Lake and the salt lake (Lake Guraga) from which there is no outlet". (Under Secretary for Works *in litt.* to the Director of Fisheries and Wildlife, 2 August 1972).

The new Reserve did not attract a great deal of attention between the time of its Gazettal and early 1972 when the Shire of Dandaragan built embankments across the southern branch of Caren Caren Brook. The object was to divert the water away from the minor swamps on the Reserve to flow directly into Namming Lake and Lake Guraga. The action of the Shire re-established the natural drainage pattern of the area. The diversion also followed a series of years of low rainfall during which the water level in the northern lakes fell substantially:

> "This (the diversion) was found to be necessary as the water level in the lake (Lake Guraga) had dropped to an alarmingly low height. This was causing inconvenience to persons wishing to use the lake for recreational purposes but also, and more important, appeared likely to seriously affect the large wildlife population of the lake."*
> (R. F. Taylor, Shire Clerk, Shire of Dandaragan, *in litt.* to the Director of Fisheries and Wildlife, 9 November 1973.)

The subsequent drying of the wetlands on Reserve 28558 was watched and recorded by Mr I. R. Anderson of Mt Lawley:

> "During a visit . . . on 11/1/72 I observed the water level . . . to be the lowest I have ever seen it since 1962. There were scores of dead and dying swamp tortoises . . . many were seen leaving the water. Several coots were seen apparently suffering from algal poisoning, and several dead coots were found . . . The total wild duck population, . . . was only about 50, being mainly teal with some black duck.
>
> . . . In normal circumstances I would estimate the wild duck population of these swamps, including Lake Namming, to be several thousand. There is evidence of extensive breeding and Freckled Duck have been seen by myself and others . . . (on the Reserve). However, as a result of . . . (the diversion) . . . there has been virtually no breeding at all this past season."
> (Mr I. R. Anderson, *in litt.* to the Director of Fisheries and Wildlife, 14 January 1972).

Mr Anderson's distress at the drying of the wetlands (an event which has occurred in many places during the past ten years and especially the last five years of drought in Western Australia) is understandable, and he was not aware that the northern course of Caren Caren Brook, directly into Namming Lake, was the normal one.

The re-diversion of the stream certainly resulted in the drying of wetlands on

*The effect of the re-diversion of Caren Caren Brook was only temporary. The dry years have continued and Lake Guraga has been without water for some time.

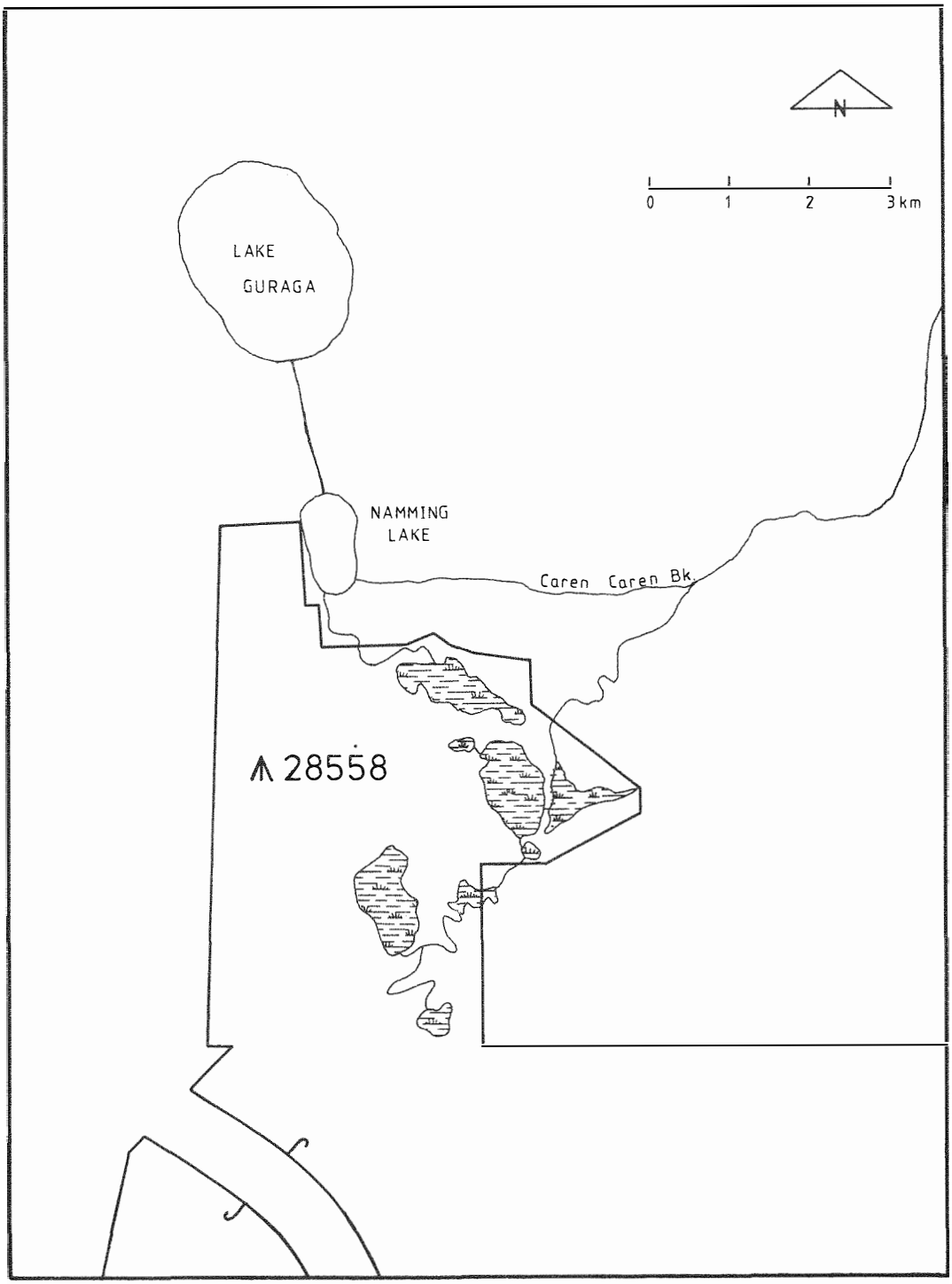


Figure 9. The drainage system of Caren Caren Brook showing the northern portion of Namming Nature Reserve and the seasonal wetlands in this area. Regulation of water flow into the southern branch of Caren Caren Brook and drainage channels cut between the wetlands on the Reserve have, in the past, provided the Local Authority with some control over the amount of water flowing into the Namming Lake/Lake Guraga system.

Namming Nature Reserve earlier than might otherwise have been the case, but of more far-reaching importance than the diversion itself, perhaps, is the intention of the Shire to reverse its action at some time in the future.

> "It is the intention of my council to maintain a reasonable level of water in the lake and to re-divert the water back to the swamp lands in the south from time to time".
> (R. F. Taylor *op. cit.*)

All these occurrences together demonstrate the need for the careful and integrated planning of the drainage management of wetland areas where agricultural, recreational and nature conservation interests are represented. This is especially so in the south-west of Western Australia where prolonged dry periods, interspersed with wet ones in which flooding occurs, is a "normal" rather than exceptional series of events.

The Discovery of *Banksia laricina* in the Vicinity of the Reserve

The Reserve, as Gazetted in 1964, remained unvested, and no further action was taken by the Department until 1978 when District Wildlife Officers P. Roberts and K. L. Miller inspected two adjacent blocks of Crown land (Melbourne Locations Nos. 3833 and 3834) the western one of which adjoins the southern boundary of the Reserve (Fig. 10). This inspection revealed the presence on the Reserve of *Banksia laricina*, the Rose Banksia, a plant with geographically restricted distribution so named because of the shape of its fruits. (These fruits are most sought after for dried flower arrangements.

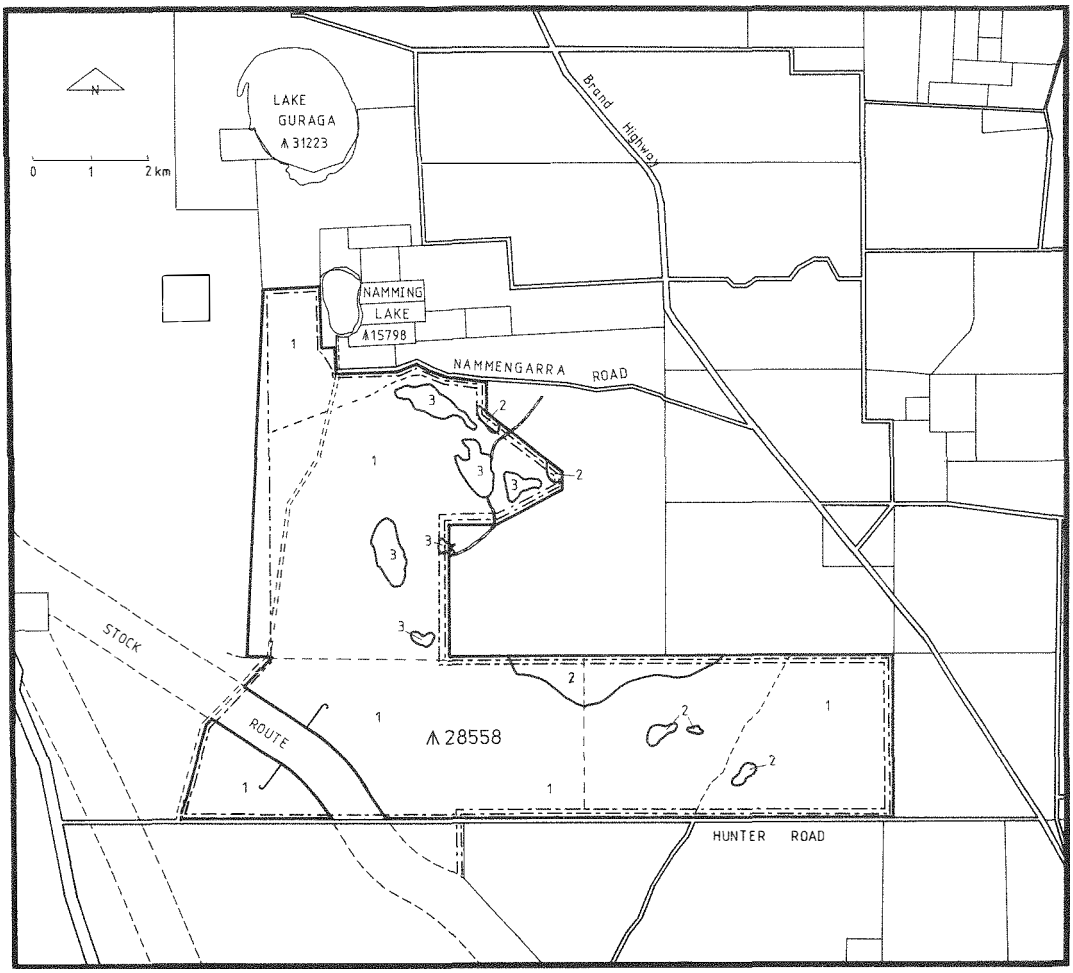


Figure 10. Namming Nature Reserve showing relationships with surrounding lands, firebreaks and tracks (dashed lines) and vegetation associations which are identified by numbers (1.2.3.) and described in the following text.

Without control, because it is so geographically restricted, exploitation could jeopardise the species).

As a result, application was made to the Under Secretary for Lands for the extension of Reserve 28558 to include the two locations to the south. The increase in area was Gazetted on 11 May 1979 and the whole area, now known as the Namming Nature Reserve, was vested in the Western Australian Wildlife Authority on 1 February 1980.

2. PHYSICAL CHARACTERISTICS AND RELATIONSHIPS

Namming Nature Reserve (30° 56'S, 115° 33'E, 5 411 ha) is irregular in shape with a total perimeter of some 50 km (Fig. 10). The southern boundary of the Reserve is also the southern boundary of the Shire of Dandaragan, the Reserve being on the western side of the Brand Highway 4 km west-north-west of Regans Ford.

At its north-west corner the Reserve adjoins Reserve No. 15798, set aside for the purpose of water, and which contains Namming Lake. Most of the eastern margins of the Reserve adjoin farm-land, but to the north and west, particularly, is a continuous expanse of vacant and uncleared Crown land (Fig. 4). In effect, Namming Nature Reserve lies at the south-eastern corner of a large expanse of uncleared land which includes Lake Guraga and Eneminga Nature Reserve to the north.*

Most of the Namming Nature Reserve is gently undulating, sandy country with a cover of *Banksia* woodlands. In shallow depressions throughout the reserve the woodlands give way to heathlands and there are a number of deeper, winter-wet swamps in the northern part of the Reserve.

Two gravel roads run for short distances along parts of the boundaries of the Reserve, namely Nammengarra Road in the north and Hunter Road in the south. There is also a Stock Route running through the Reserve at its south-western corner (Fig. 10).

3. SOILS AND VEGETATION

Grey Bassendean sands are the major soils to be found on the Reserve, these being admixed with some peat in poorly drained areas. The vegetation can be readily separated into three basic associations (Nos. 1-3 in Fig. 10 and below). There is, however, considerable variation within some of these groupings and a more detailed study would very likely produce more sub-divisions.

1. Low Woodland A of predominantly *Banksia attenuata* and *B. menziesii* from 5 to 8 m in height, with *B. ilicifolia* and *B. prionotes* less dominant to 7 m, and with scattered examples of Pricklybark (*Eucalyptus todtiana*) often emergent to 10 m. The understorey is a Low Heath D to Dwarf Scrub D made up of such species as *Stirlingia latifolia, Calothamnus quadrifidus, Beaufortia squarrosa, Acacia pulchella, Eremaea pauciflora* and *Hibbertia hypericoides.* A sparse mid-storey element is present in some areas, made up of regenerating *Banksia* spp., Blackboys (*Xanthorrhoea preissii*) and the Woolly Bush *Adenanthos cygnorum.*

   In the south-eastern section of the Reserve the understorey vegetation is taller, denser and more complex, and includes such species as *Verticordia nitens, Hakea obliqua, Hakea trifurcata* and *Allocasuarina humilis.* Isolated patches of the rare *Banksia laricina* to *ca.* 2 m in height occur along the southern boundary of the Reserve usually in moist areas. This species was severely affected by a fire which burned through the area in 1977, but regeneration from seed has now started to take place.

2. Widely scattered Christmas Trees (*Nuytsia floribunda*) (8 m) and Paperbarks (*Melaleuca preissiana*)

*These three major wetland areas, Namming Lake and its associated swamplands in the Nature Reserve, Lake Guraga, which lies within Reserve No. 31223 for the purpose of recreation, vested in the Shire of Dandaragan, and Eneminga Nature Reserve (see p. 35), are part of a single system of wetlands. They are all in the Bassendean system of dunes and are fed from small streams (Caren Caren Brook, Cataby Brook and Mimyto Brook) which rise on the edge of the Dandaragan Plateau to the east. The normal progress of these streams to the sea is blocked by the aeolian sands of the coastal dune systems to the west, causing the water to pond and accumulate in this low-lying part of the Bassendean dunes.

emergent to 7 m over Heath B (1.5 m) made up mainly of *Regelia ciliata, Hakea* sp. and *Melaleuca* sp. over Low Heath C to Low Heath D up to 1 m in height with species such as *Banksia* aff. *sphaerocarpa* and *Beaufortia squarrosa* over *Stirlingia latifolia, Patersonia occidentalis, Dryandra nivea* and assorted low sedges. This association is invariably found in depressions where the ground is susceptible to seasonal waterlogging.

3. This association covers a series of seasonal fresh water swamps which depend on annual winter rainfall and generally dry out in the summer months. The swamps form part of one drainage system, though in terms of their vegetation, they show considerable variation.

   The elevated margins of the swamps generally support narrow belts of Low Woodland A made up of *Melaleuca rhaphiophylla* (8 m) and/or *Melaleuca preissiana* (7 m). The woodland understorey is a Thicket to Heath A made up mainly of regenerating examples of the same species. In some areas River Gum (*Eucalyptus camaldulensis*) emergent to 14 m forms part of this association.

   The sandy-clay swamp beds support Open Low Woodland A made up of *Melaleuca rhaphiophylla* from 5 to 8 m over Open Scrub of *Melaleuca graminea* from 2 to 5 m with little ground cover except for sparse, very short grasses and odd clumps of sedges.

   In the two southern-most swamps which have dried out completely, the *Melaleuca* woodland has died, leaving behind a stark array of dead sticks.

   On sandy flats between the *Banksia* woodlands and the swamps is an intermediate zone which deserves mention. Here the vegetation is variable but usually fits the description of Dwarf Scrub C. Species recorded include *Acacia pulchella, Daviesia* aff. *brevifolia, Astroloma xerophyllum* and *Hibbertia* sp.

Other plant species previously recorded on Namming Nature Reserve by Wildlife Officer P. Roberts include *Conospermum stoechadis, Hypocalymma robustum, Drosera* (3 species), *Petrophile linearis, Darwinia neildiana, Byblis gigantea, Grevillea endlicheriana, G. leucopteris, Leptospermum* sp., *Anigozanthos viridis, A. manglesii, A. pulcherrimus, A. humilis, Verticordia grandiflora, V. picta, Acacia blakelyi, Melaleuca huegelii, Styphelia tenuiflora, Templetonia retusa, Calytrix flavescens* and *Dampiera spicigera.*

4. FAUNA

As with other Reserves in the Shire of Dandaragan, full surveys of the fauna of the Namming Nature Reserve have not been done. A list of birds and mammals recorded since visits to the Reserve began, however, is included in Appendix II. The total number of bird species is similar to that for the Eneminga Nature Reserve, but Namming Nature Reserve is best known for the occurrence of the Freckled Duck (*Stictonetta naevosa*). This species breeds on seasonal swamps in the Reserve during good years. The absence from lists compiled during the 1980 survey of this and a number of other waterbirds which might be expected to occur on the Reserve is attributable to the long drought from which the region has suffered.

5. PAST MANAGEMENT, USE AND FIRE HISTORY

There have been a number of fires on Namming Nature Reserve during the past 20-25 years (see Appendix III: Sketch Maps of the Fire Histories of Nature Reserves in the southern part of the Shire of Dandaragan). The first fires recorded preceded photography flown in 1960 and with the further fire tracks visible in the 1969/70 photography these indicate that very large fires burned over most of the Reserve during the late 1950s and 1960s.

There was another major fire in the north and west of the Reserve at some time between 1973 and 1976 and the remaining south-eastern area, unburnt since 1969 or earlier, was burnt out during early 1977. This is the section of the Reserve which supports *Banksia laricina*, some populations of which were seriously affected by the fire.

Apart from these major fires, smaller ones affected the northern and south-western corners of the Reserves between 1969 and 1973 and the northern extremity was burnt again during the summer of 1978-79.

All of the eastern boundaries of the Reserve have double boundary firebreaks 6 m wide and about 100 m apart. The western and northern boundaries, where the Reserve adjoins a large expanse of uncleared vegetation, have a single, six metre-wide cleared firebreak. The Reserve has also been divided into five compartments by internal firebreaks and tracks (Fig. 10).

Apart from maintenance of firebreaks the Reserve has had little active managment in the short period in which it has been vested in the Western Australian Wildlife Authority. The Reserve is also subject to little public use. Prior to its declaration as a Nature Reserve, wildflower pickers may have utilised the *Banksia laricina* populations in the southern part of the Reserve, and apiarists have occupied sites on the Reserve from time to time over a long period.

6. MANAGEMENT SIGNIFICANCE OF FIRE HISTORY

The fire history of the Namming Nature Reserve in recent years is similar to that of Eneminga Nature Reserve to the north: all of the Namming Nature Reserve has been burnt by at least one wildfire during the past 15 or more years. As with Eneminga Nature Reserve the vegetation does not show any apparent deterioration such as would be the case if the area had been subject to too frequent burning. The *Banksia laricina* populations, however, add a further dimension to the need for fire protection management for the Namming Nature Reserve. This species is known to be killed by fire. Seeds are the only means of survival and the young plants which germinate following a fire may take as long as 10 years to reach maturity and their full reproductive potential.* Obligate seeding species are among the most vulnerable to frequent burning. If subsequent fires occur at intervals shorter than required for these plants to reach maturity their populations will inevitably decline and become extinct.

In the absence of detailed knowledge of the minimum time interval between fires which will not cause long-term deterioration in the vegetation, a conservative approach needs to be taken to protective burning. It would seem from the history of the area that, for the Namming Nature Reserve, an interval of 10-15 years between fires may be both satisfactory from the biological viewpoint and an attainable target for management.

*This figure is an estimate based on knowledge of similar obligate-seeding *Banksia* spp. and the likely rate of growth of the plant in the heavier, and therefore moister, soils of this region on which it occurs (Mr A. Hopkins, Wildlife Research Centre, pers. comm.). The figure may need to be revised as knowledge of the life history of *B. laricina* increases.

7.

As it stands the major values of the Namming Nature Reserve are as a seasonal wetland and waterfowl breeding area for the populations of uncommon species, animal and plant, it supports (notably the Rose Banksia, *Banksia laricina,* and the Freckled Duck, *Stictonetta naevosa*) and finally as an expanse of considerable extent of the *Banksia* woodlands and mixed species heathlands characteristic of the Bassendean dunes. The Reserve is regarded as a key site for each of these qualities.

In a broader context, the system of wetlands of which this Nature Reserve forms a part, which includes Eneminga Brook, Lake Guraga, Namming Lake and swamps further west, is a most significant one and an important habitat for waterfowl. The values of the system as a whole are considerably greater than those of the individual wetland areas which are its parts. Great benefit would accrue from managing the entire area in an integrated way, with full consultation across the boundaries of tenure, the objectives being to advance the interests of all purposes to which it is dedicated.

The ideal of co-ordination of management of the wetlands in this area of south Dandaragan is a long-term objective, the furtherance of which will require appointment of the Wongan Hills Reserves Management Team. In the meantime

management of the Namming Nature Reserve will proceed with this objective in mind and will be directed toward maintaining and enhancing the natural values of the Reserve as an entity in itself. In addition, public use of the Reserve will be encouraged. Managment provisions for the Reserve will include active management in the following fields:

Protection from Fire

To protect the assets of adjacent landholders and to minimise the occurrence of wildfires on the Reserve.

Protection from Pests: Animal and Weed Control

To protect the Reserve and surrounding farmlands from damage as a result of infestation with animals and plants under the provisions of the Agriculture and Related Resources Protection Act.

Public Use

To encourage use of the Reserve by visitors, as resources become available, particularly during the wildflower season; all use to be subsidiary to maintaining the nature conservation values of the area.

9. MANAGEMENT—FIRE PROTECTION

Rationale

The position of the Namming Nature Reserve adjacent to a large area of uncleared and vacant Crown land to the west, north and south, presents problems of fire protection similar to those of Eneminga Nature Reserve (see Part 4 of this Management Plan). The Namming Nature Reserve, however, does not have the same natural barriers to fire as are provided by Eneminga Brook. The main objectives of fire protection provisions for the Namming Nature Reserve, therefore, are to minimise the likelihood of fire crossing into it from the vacant land to the west and from the Reserve into adjoining farmland to the east. Further, in the interests of the nature conservation values of the area, these objectives must be attained without recourse to frequent and expensive fuel reduction burning on the Reserve.

Low Fuel Buffer to be Constructed on Adjoining Vacant Land

Providing that future management plans, including any which may stem from commitment of now vacant land to use, are not unduly constrained thereby the Bush Fires Board will be requested, as part of the regional fire protection scheme for the Shire of Dandaragan, to install a buffer of frequently burned vegetation, 400 m in width, around all the boundaries of the Reserve adjoining vacant Crown land. It is envisaged that such a buffer would incorporate the existing boundary firebreaks of the Reserve, lying between them and a second series of parallel breaks to be constructed on the vacant land.

Provision for Additional Firebreaks

Provision shall be retained under this Plan for the construction of any additional firebreaks on the Reserve as may be indicated as being needed for fire management purposes.

Firebreaks to be Maintained

All existing perimeter firebreaks on the Reserve will be maintained by the Department to ensure that they remain free from overgrowth with vegetation and provide satisfactory access in case of fire. Internal firebreaks and tracks of significant fire protection value will be similarly maintained.

Provision for Burning Between Double Boundary Firebreaks Adjoining Farmland

For reasons of cost, the proportion of the total area of Reserves affected and the likelihood of weeds and grasses establishing in the frequently burned area (so ultimately heightening rather than reducing fire hazard), buffers of frequently burned vegetation are not generally installed on the boundaries of Nature Reserves adjoining farmland. In this particular case, however, prior to its vesting in the Western Australian Wildlife Authority, double boundary firebreaks had been cut along those boundaries of the Reserve adjoining private land. Provision shall be retained in this Plan for fuel reduction burning of the area between the double firebreaks at irregular intervals should this be required for fire protection purposes.

Protective Burning of the Body of the Reserve

This Plan will provide for the burning of this Reserve at intervals of about 15 years or such other period as increasing knowledge of the fire ecology of *Banksia* woodlands and associated heathlands in this area indicates would not be detrimental to the vegetation cover in the long term. Before decisions are made regarding which areas will be burnt and when, surveys of the Reserve are necessary to determine the location of representative samples of the region's flora, rare species and communities of special interest. Selected areas can then be managed accordingly, and fire excluded from areas of higher value, at least until more is known about the fire ecology of the species or community concerned. Therefore any prescribed burning required under the provisions of this Plan will need to await appointment of the Wongan Hills Reserves Management Team and subsequent surveys of the area.

Fire Suppression

As resources become available firefighting units from the Department of Fisheries and Wildlife will attend fires occurring on, or considered to be threatening, the Reserve. Implementation of this provision is dependent upon the appointment of the Wongan Hills Reserves Management Team.

Adequacy of Control Measures

In this respect special attention shall be paid to the feelings of Reserve neighbours and to establishing and maintaining effective contact with neighbours. As with other Reserves in the Shire, this Plan includes the formal provision for Reserve neighbours to draw the attention of the Director of Fisheries and Wildlife to what they consider to be inadequacies in fire protection arrangements for the Reserve. On receipt of such a complaint the Director will organise a joint inspection of the problem and take such other action as may be needed to remedy the situation.

Notifiable Authority

The Department of Fisheries and Wildlife, shall be regarded as a Notifiable Authority in terms of the Bush Fires Act and Regulations in respect of the Namming Nature Reserve.

10. MANAGEMENT— PROTECTION FROM PESTS: ANIMAL AND WEED CONTROL

Control of pest animals and plants may be necessary from time to time to protect fauna and flora and the environment of the Reserve generally and as part of organised control of vertebrate pests or weeds in the vicinity of the Reserve.

Such arrangements as may be necessary in respect of organised control of declared animals and plants shall be made by consultation and co-operation between the Agriculture Protection Board and the Department of Fisheries and Wildlife.

Adequacy of Control Measures

As with the provisions for fire protection, Reserve neighbours are invited to draw the attention of the Director of Fisheries and Wildlife to what they see as inadequacies in the control of pest plants and animals on the Reserve. On receipt of such a complaint the Director may organise a joint inspection of the Reserve or take such other action as may be needed to remedy the situation.

11. MANAGEMENT— PUBLIC USE

The Namming Nature Reserve lies within a few kilometres of the Brand Highway and access to the Reserve is available along either Nammengarra Road (to the wetland areas in the north of the Reserve) or along Hunter Road (to the southern part of the Reserve). A northward extension of Hunter Road, developed as a track on the Reserve, could be used as access onto the Reserve itself. For reasons of accessibility this Reserve presents a good opportunity for future development for public use.

Use by Apiarists

Once the permits for the apiary sites currently occupied on the Reserve expire they will not be renewed as, according to Wildlife Authority policy, beekeeping is excluded from any Nature Reserve containing rare flora. The *Banksia*

laricina population on Namming places the Reserve in this category.

Signs to be erected

Signs identifying the Reserve by name and complying to Department of Fisheries and Wildlife standard specification for Nature Reserve signs will be erected near the Hunter Road and Nammengarra Road accesses to the Reserve.

Classification

In the interests of possible future development of the Reserve for amenity purposes it will not be classified under Section 12A of the Wildlife Conservation Act in the meantime.

Wildlife Conservation Regulations to Apply

Public use of the Namming Nature Reserve will be managed as allowed for under the Wildlife Conservation Regulations.

12. MANAGEMENT—GENERAL

During the currency of this Plan the Department of Fisheries and Wildlife may, with the approval of the Chairman of the Western Australian Wildlife Authority, undertake or authorise such other work or action as may be seen to be necessary or desirable to properly promote the stated objectives of management of the Reserve.

PART 6. RESERVE No. 31675, WANAGARREN NATURE RESERVE

1. INTRODUCTION

The complex of coastal dunes in the southern part of the Shire of Dandaragan, and the Shire of Gingin to the south, is represented in two major Nature Reserves, namely Nilgen Nature Reserve (No. 31781), which is in the Shire of Gingin, and the Wanagarren Nature Reserve in the southern part of the Shire of Dandaragan. Of the two, Wanagarren is larger (11 138 ha) and is distinguished by the occurrence of large, inland and coastal mobile dunes of the Quindalup Dune System.

This Reserve was declared and vested in the Western Australian Wildlife Authority in late 1972, the boundaries being drawn to exclude an area in the vicinity of Wedge Point, the promontory leading to Wedge Island, used by fishermen as a settlement.

Since the Gazettal of the Reserve there has been a minor change to the southern boundary (between the Reserve and the Commonwealth controlled naval artillery range) and proposals for a road linking Wedge Point and Cataby and passing through the Reserve have been discussed but not undertaken. At present there are no Gazetted roads on the Reserve, and, as a result, settlers at Wedge Point make considerable use of undeveloped tracks for access purposes.

While they make management as a Nature Reserve the more difficult, these factors interfere with the long-term, nature conservation values of only a proportion of the area of the Reserve*. As a whole the Wanagarren Nature Reserve is regarded as a key site in the Western Australian Nature Reserve System representing the landforms and vegetation characteristic of the Quindalup and Spearwood series of coastal dunes in this area.

*The area most affected, however, includes the coastal dunes and the management problems caused mainly by uncontrolled use are serious ones (see Section 5: Public Use and Past Management).

2. LOCATION AND PHYSICAL FEATURES

Wanagarren Nature Reserve (30°46'S, 115°14'E — 11 138 ha, Fig. 11) lies on the coast between Wedge Island in the south and a point opposite the Green Islets in the north. With the exception of the promontory leading to Wedge Island, where the fishing settlement is located, the western boundary follows the line of the coast. The northern and southern boundaries adjoin the Nambung National Park and the Commonwealth controlled naval artillery range respectively. Most of the eastern boundary, which is in places ill-defined, especially in the north, adjoins largely undeveloped pastoral leasehold and privately owned land.

The topography of the Reserve varies from gently rolling plains and mobile dunes of the Quindalup Dune System to a succession of stable dunes and steeper hill country of the Spearwood Dune System further inland. Surface outcrops of limestone are a common feature of this landscape and adjacent to the coast erosion of surface sands has, in some areas, resulted in exposure of the underlying limestone with an accompanying increase in the ruggedness of coastal topography.

3. VEGETATION

The greater part of the Wanagarren Nature Reserve supports a low heath vegetation with stunted Christmas Trees (*Nuytsia floribunda*) scattered throughout. These heaths extend into the more rugged limestone hill country near the eastern boundary where *Banksia* woodlands are to be found in the upper valleys. The lower, drier reaches of the same valleys have numerous Blackboys (*Xanthorrhoea* spp.) emergent over low heath vegetation.

The coastal belt of dunes also supports a low heath vegetation in which *Acacia* and *Eremae* spp. are prominent except in the areas of mobile dunes where the vegetation cover is incomplete.

The vegetation of the Reserve can therefore be divided into five associations, distributed as shown in Figure 11, and which may be described as follows:

1. (Inland Heaths). Open Dwarf Scrub C made up mainly of *Melaleuca acerosa, Acacia cochlearis* and *Hakea prostrata,* over a Low Heath C to Low Heath D dominated by *Melaleuca acerosa, Acacia pulchella* and *Templetonia retusa.* Ground cover in this association consists of assorted Low Grass and Low Sedge communities in which *Lepidosperma* spp. are common.

   (Note: Due to fire over recent years much of this association has degenerated to the state of Low Heath D over Low Grass and Low Sedge, and on the steep slopes of stable sand ridges to Dwarf Scrub D over Open Low Grass.)
2. (Inland Woodlands). Open Low Woodland A of *Banksia attenuata* (4-6 m over Low Scrub B of mainly *Hakea prostrata, Calothamnus quadrifidus, Hakea trifurcata, Dryandra sessilis, Conospermum stoechadis* and *Melaleuca acerosa.* The ground cover consists of Open Low Grass and Open Low Sedge associations.

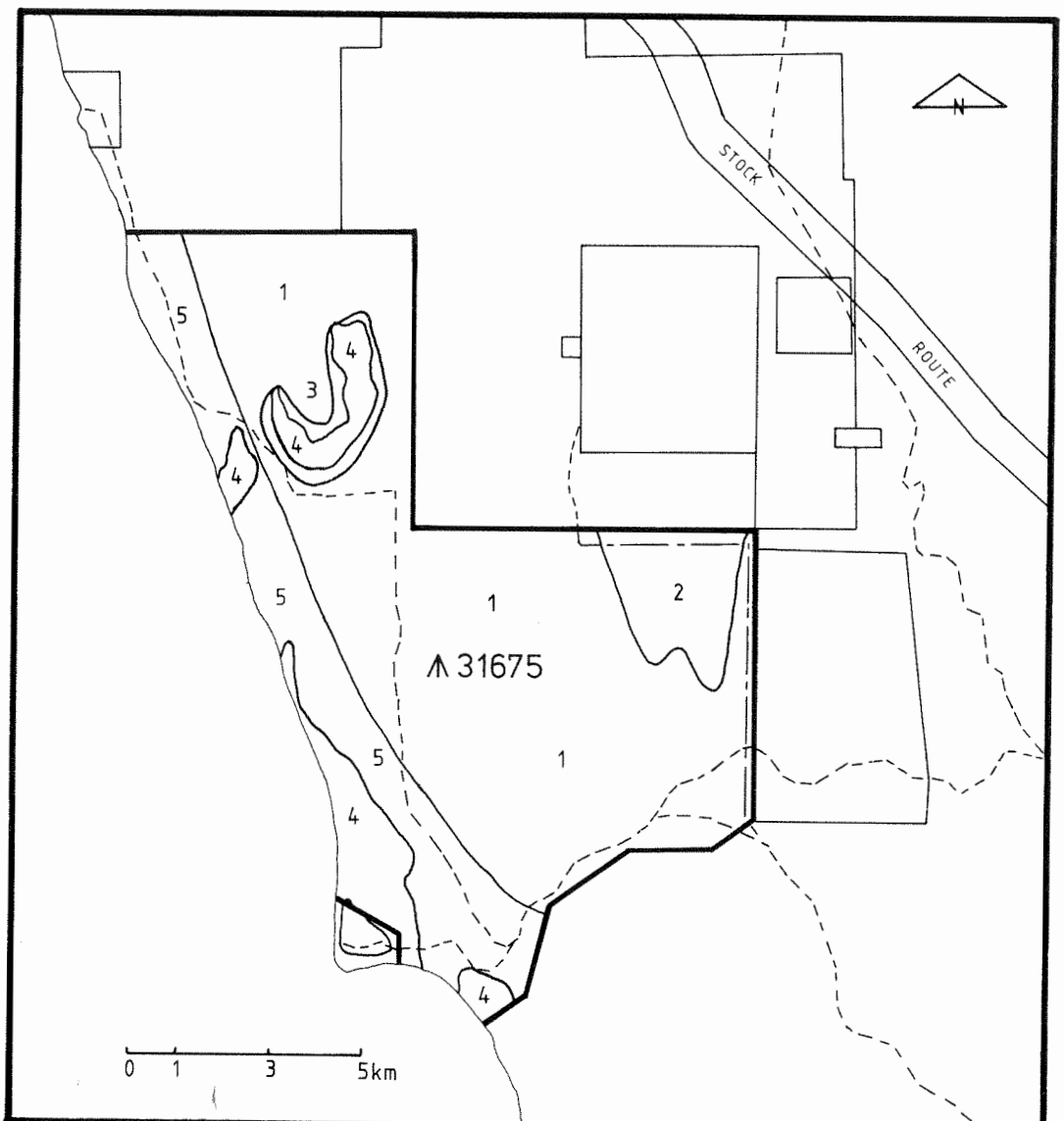


Figure 11. Wanagarren Nature Reserve showing relationships with surrounding lands, tracks (dashed lines) and vegetation associations which are numbered (1.2.3...) and described in the following text.

3. (Vegetation around the fringes of mobile dunes). Thicket dominated by *Allocasuarina campestris* (2.5 m) over *Melaleuca acerosa, Acacia pulchella* and *Acacia littorea*.

4. (Vegetation on parts of mobile dunes). Open Scrub of mainly *Olearia axillaris* to 2 m, *Acacia xanthina* to 2.5 m and *Atriplex isatidea* to 3 m.

5. (Coastal, variable heaths). Patches of Dense Thicket/Heath A dominated by such species as *Acacia xanthina, Eremaea beaufortioides, Olearia axillaris* and *Hakea trifurcata* over Low Heath C/Low Heath D in which *Melaleuca acerosa, Acacia pulchella, Acacia littorea,* and *Templetonia retusa* are common species. Low Grass and Low Sedge associations complete the ground cover.

4. FAUNA

Birds and mammals recorded during surveys preliminary to the preparation of this Plan are listed in Appendix II. As with other Reserves in the Shire, full surveys of the fauna of the Wanagarren Nature Reserve have not been carried out, and no conclusion can be drawn as to the faunistic values of the Reserve.

5. PUBLIC USE AND PAST MANAGEMENT

The very attractive and remote coastline of the Wanagarren Nature Reserve has a history of fairly intensive use by fishermen, holiday-makers and off-road vehicle enthusiasts. This pattern of use was well established before the declaration of the area as a Nature Reserve.

The fishing settlement of Wedge Point, which is located in an enclave of vacant Crown land outside the Reserve, provides a focus for some of the activity. A well-known coastal track between Lancelin and the Nambung National Park provides one access to the Wedge Point settlement and attracts large numbers of people who enjoy off-road travel. A second track links Wedge Point with roads to Cataby. Neither access is developed nor do they follow dedicated road reserves.

This activity is all "unofficial" and uncontrolled and therefore difficult to manage. Much of it is concentrated on the unconsolidated sands of the coastal dunes where track-making is easy and the erosion hazard considerable. Rubbish has accumulated around favoured campsites and some semi-permanent settlements. Motor vehicles have been abandoned at a number of sites and a proliferation of open camp-fires creates a fire hazard during the dry season.

The deterioration of nature conservation values of the coastal portion of the Wanagarren Nature Reserve, directly the result of uncontrolled public use, has not prompted management action in amelioration. The sources of the problem, particularly the settlement at Wedge Point and the developed patterns of access to and through the area are beyond the control either of the Department or the Wildlife Authority, while the effects of the resulting use of the Reserve are equally beyond the present resources of the Department to regulate effectively.

6. FIRE HISTORY

Aerial photography shows that, prior to 1970, the land on which the Wanagarren Nature Reserve is now located suffered infrequent fires (Appendix III: Sketch Maps of the Fire Histories of Nature Reserves in the Southern Part of the Shire of Dandaragan). Photography flown in March 1960 shows a small recent fire in the northern part of the Reserve and smaller spot fires in the eastern portion. Fire scarring of the vegetation is evident on photography flown in December 1969-January 1970 only on the northern boundary of the Reserve where a small fire had recently affected the southern part of the Nambung National Park. Landsat satellite imagery dating from 1973 to 1979 indicates that fire scars can be detected from remote-sensed data in these coastal lands for five years or longer after the occurrence of a fire. Assuming that earlier fire scars would be at least as easily detectable on large-scale, monochrome aerial photography as they are on Landsat imagery, the evidence of the 1960 and 1969-70 photography is that the area of the Reserve was subject to infrequent fires over this earlier period.

More recently, however, the situation appears to have changed. All inland parts of the Reserve have been burnt at least once since 1970, and some areas have had as many as three fires in the same period. One section of the Reserve between the coast, the inland mobile dunes in the north and the coastal mobile dunes to the south has, interestingly enough, remained unburnt.

The first of the recent, large fires started to the south of the Reserve in an area which is now the Naval artillery range and burnt northward to affect the eastern part of the Reserve. A second and larger fire, which also started to the south and which burned initially on a very narrow front, affected most of the eastern inland heathlands on the Reserve between 1973 and 1976. A third fire affected the eastern boundary areas during the summer of 1976-77. During the summer of 1977-78 a narrow strip on the western edge of the area burnt earlier and a second area adjacent to the nothern boundary were burnt over in a very large fire. This, most recent fire on the Reserve also affected a substantial part of the Nambung National Park.

7. MANAGEMENT SIGNIFICANCE OF FIRE HISTORY

The frequent fires which have affected this Reserve since 1970, all except one of which started outside the Reserve should, on the basis of the aerial photographic evidence, be regarded as an extraordinary series of events, possibly related to changing patterns of use of surrounding lands. It is apparent also that frequent fire has had a deleterious effect on the vegetation structure, particularly in the heathlands on the Reserve (see Section 3: Vegetation). Ideally, therefore, management for fire protection of the area should aim to reduce the incidence of fire to something more closely resembling the pattern prior to 1970. This might be achieved by inhibiting the inward spread of fires starting outside the Reserve. A system of buffers on strategic sections of the boundary of the Reserve might assist in this regard while having the additional effect of providing a degree of protection to surrounding lands from fires that might start inside the Reserve.

Construction of such a system of perimeter buffers would represent a departure from normal fire protection practice for the Department of Fisheries and Wildlife. The cost of the works in this particular case, however, would be justified by their strategic importance. In addition, the area affected in such a large Reserve would be a small proportion of the total and the stage of agricultural development of surrounding lands is generally not advanced enough to pose a weed invasion problem. These considerations would be sufficient to justify construction of perimeter buffers in this case.

The only fire of any extent to have started in the Reserve in recent years burned northwards from the Wedge Point track, and it would appear desirable to use this track as the centre line of a burnt buffer across the southern portion of the Reserve both to prevent further occurrences of fires of similar origin and as a second line of defence to fire spreading northwards from the area of the Naval artillery range.

8. NATURE CONSERVATION VALUES

Together with Nilgen Nature Reserve (Reserve No. 31781) to the south, which is in the Shire of Gingin and the subject of a separate Management Plan in preparation, the Wanagarren Nature Reserve is the major site of representation of the sequence of coastal ecosystems in this part of the northern sandplains*. It takes in good representative areas of both the Quindalup and Spearwood Dune Systems, including, in the former case, unconsolidated mobile dunes and, in both dune systems, limestone outcrops of a variety of kinds.

The second major value of this Reserve is for recreation activities associated with such as stretch of remote, undeveloped and rugged coastline. This feature cannot be

*Environmental Protection Authority Recommendation 5.7 (in Conservation Reserves for Western Australia, Systems 1, 2, 3 and 5, 1976), for an extensive Nature Reserve in the northern part of the Dandaragan Shire and extending into the Shire of Coorow, to represent the succession of ecosystems from the coast to the Dandaragan Plateau, also includes a substantial tract of similar coastal lands.

underestimated in any plan for the management of the area.

9. MANAGEMENT PRIORITIES AND RATIONALE

The primary objective of management for the Wanagarren Nature Reserve shall be to minimise the occurrence of fires on the Reserve resulting firstly from sources outside the Reserve and secondly from causes associated with public use, particularly of the track leading to Wedge Point from Cataby.* With the resources for management presently available to the Department there is little prospect of instituting a programme to regulate effectively the public use of the region nearer the coast. There also appears to be little prospect of any substantial development of lands around the Reserve, which makes the need for relational management action less important than is the case with most other Reserves in the region. Given adequate fire protection and the remoteness of the area the inland parts of the Reserve require little active management.

10. MANAGEMENT—FIRE PROTECTION

Low Fuel Buffers to be Constructed

To minimise the possibility of fire spreading into the Reserve from the Naval artillery range to the south, from private land in the south and east and from the National Park adjoining the northern boundary, this Plan will include provision for construction of buffers of frequently burned vegetation *ca.* 200 m in width between cleared firebreaks 6 m wide along the line of the Wedge Point-Cataby track and along sections of the southern parts of the eastern boundaries and the northern boundaries of the Reserve. The buffer parallel with the Wedge Point-Cataby track will have the further function of minimising the risk of fire starting as a result of public use of the track itself. The exact specification and parts of the boundaries where these buffers will be installed will be dependent on the practicability of heavy machinery movements and will be consistent with the long-term stability of areas of unconsolidated soils.

Construction of these buffers will be programmed as a matter of high priority upon adoption of this Plan.

Fire Suppression

As resources become available firefighting units from the Department of Fisheries and Wildlife will attend fires occurring on, or considered to be threating the Reserve. Implementation of this Provision is dependent upon the appointment of the Wongan Hills Reserves Management Team.

11. MANAGEMENT—PROTECTION FROM PESTS: ANIMAL AND WEED CONTROL

Control of pest animals and plants may be necessary from time to time to protect fauna and flora and the environment of the Reserve generally and as part of organised control of vertebrate pests or weeds in the vicinity of the Reserve.

Such arrangements as may be necessary in respect of organised control of declared animals and plants shall be made by consultation and co-operation between the Agriculture Protection Board and the Department of Fisheries and Wildlife.

12. MANAGEMENT—GENERAL

Following appointment of the Reserves Management team based in Wongan Hills, the management provisions for this Reserve will be reviewed. The review will include a detailed comparison of the natural features of Wanagarren and other Nature Reserves of coastal lands in the vicinity together with an assessment of the requirement at the time for use of parts of the Reserves for recreation purposes. As a result of this review a more detailed plan for management, including provisions for public use of the Reserve, will be prepared.

*Being nearly surrounded by mobile dunes the Wedge Point settlement itself appears to be of little trouble as a source of fire.

PART 7. A NATURE RESERVE WITH MULTIPLE PURPOSES VESTED IN THE LOCAL AUTHORITY (RESERVE No. 27216)

One Reserve in the area covered by this Plan is a Nature Reserve in the meaning of Section 6(1) of the Wildlife Conservation Act (i.e. it is a Crown Reserve set aside for the conservation of flora or fauna or both), but has purposes in addition to flora and fauna conservation and is vested in the Local Authority, the Shire of Dandaragan. The Reserve concerned is No. 27216 which is set aside for the purposes of recreation, camping and flora. The management of this Reserve is the responsiblility of the Shire of Dandaragan and flora conservation is a purpose secondary to recreation and camping. The Reserve is considered in this Plan, however, to review its biological features, to help alert the vesting Authority to its values for the conservation of native flora and to point out management measures that may be desirable to ensure its continuing value as a Nature Reserve.

1. INTRODUCTION, PHYSICAL CHARACTERISTICS & RELATIONSHIPS

Reserve No. 27216, which is unnamed, was Gazetted for its present purposes of recreation, camping and the conservation of flora on 17 September 1965. On 1 April 1977 the area was vested in the Shire of Dandaragan.

Reserve No. 27216 is irregular in shape with a total perimeter of 19.5 km and an area of *ca.* 1 576 ha. It is situated on the eastern side of the Brand Highway some six kilometres north-west of Cataby (Fig. 5). A 65 ha block in the centre of the Reserve is reserved separately (Reserve No. 12473) for the purposes of water and camping (Fig. 12).

The Brand Highway runs along the western and south-western sides of the Reserve, while the eastern edge borders on cleared farmland. About half of the northern boundary also borders on farmland, the remainder being still uncleared. Mullering Road cuts across the southern third of the Reserve from south-west to north-east. Firebreaks run around the perimeter although these have become overgrown in places. There are several vehicle tracks, the most noticeable of which have been marked on Figure 12. An underground gas pipeline runs north to south on the western edge of the Reserve.

2. SOILS AND VEGETATION

Reserve No. 27216 is of particular interest because it lies on the boundary between the sands of the Bassendean Dune System and the gravel-containing soils of the Dissected Region (Fig. 2).

The area is essentially undulating sandplain country. On the higher ground, however, the sand is mixed with significant amounts of laterite and supports Blackboys over low heath formations. The deeper sand in the hollows supports *Banksia* spp. and Pricklybark (*Eucalyptus todtiana*) dominated woodland. Mullering Brook flows through the northern part of the Reserve in a south-westerly direction and this watercourse is characterised by Marri (*E. calophylla*) and Flooded Gum (*E. rudis*) woodland. Areas around the watercourse which are susceptible to seasonal flooding generally support *Melaleuca* spp. and *Banksia* aff. *sphaerocarpa* dominated vegetation.

Five vegetation formations have been recognised on the Reserve, the distributions of which are shown in Figure 12.

1. Low Woodland B made up mainly of *Banksia attenuata* and Pricklybark (*Eucalyptus todtiana*) from 2 to 5 m. *B. menziesii* and *Nuytsia floribunda* are less common components of this association under which a Low Heath C/D of several species including *Eremaea pauciflora, Stirlingia latifolia, Dasypogon bromeliifolius, Allocasuarina humilis, Patersonia occidentalis, Dryandra* aff. *nivea, Calectasia cyanea, Blancoa canescens, Hibbertia hypericoides, Acacia* sp., *Conospermum* sp. and *Daviesia* sp. has developed. The ground cover consists of

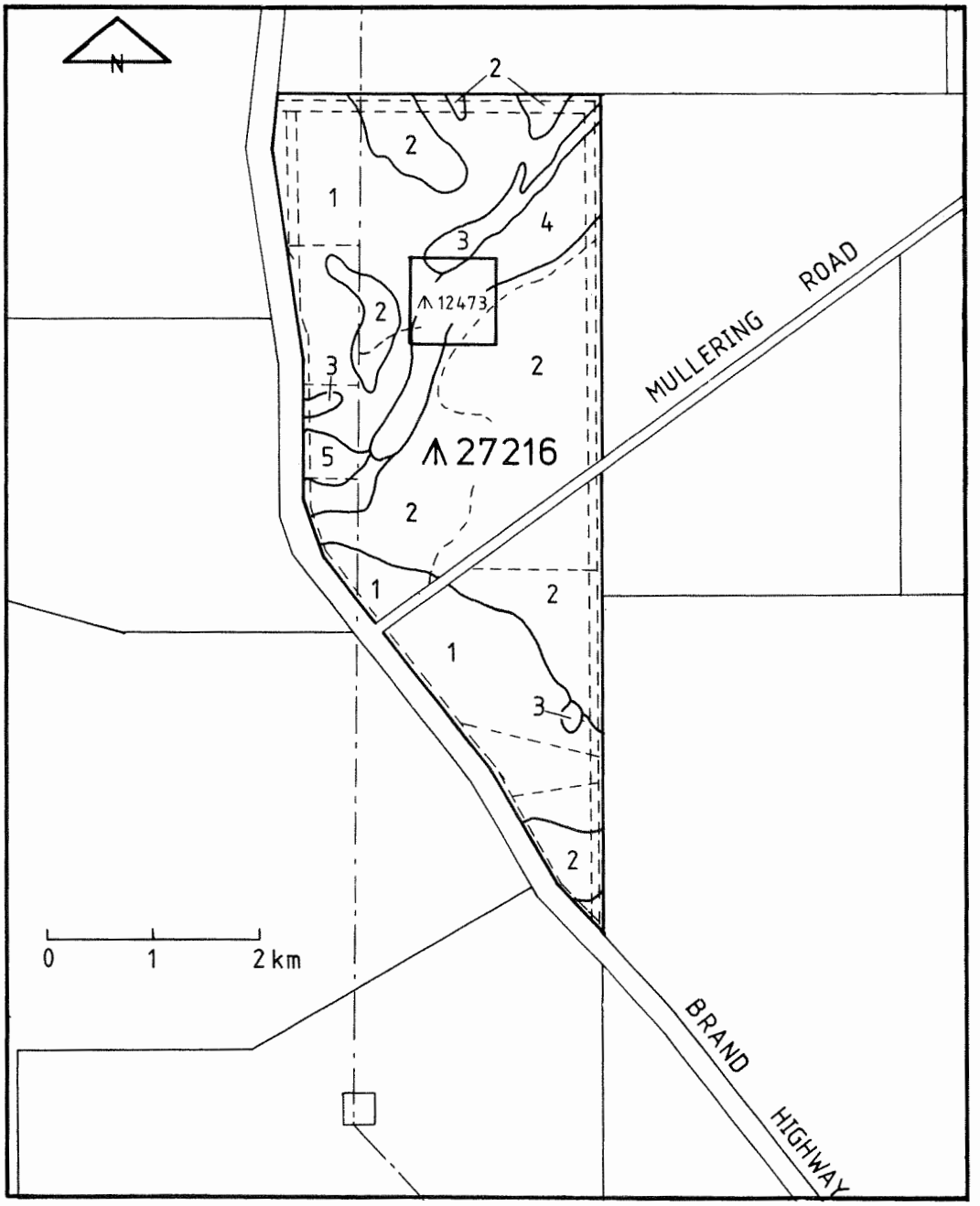


Figure 12. Reserve No. 27216 and the enclosed Reserve No. 12473 showing relationships to surrounding lands. Tracks and firebreaks on the Reserve are designated by dashed lines (the track of the gas pipeline being shown as a line of dashes and dots in sequence). Vegetation associations are identified by numbers (1.2.3 . . .) which correspond to those in the following text description.

Very Open Low Sedges and Very Open Herbs in which *Conostylis* spp., *Stylidium* spp. and *Drosera* spp. are common.

Note: In some areas Thicket of *Adenanthos cygnorum, ca.* 2 to 3 m in height, forms a recognisable intermediate stratum. In others the Thicket is absent.

2. Blackboys (*Xanthorrhoea preissii*) to *ca.* 2.5 m, 2 to 10 per cent canopy cover and interspersed with patches of *Eucalyptus gittinsii* and Mottlecah (*E. macrocarpa*) emergent from Low Heath C/D made up a large number of species but with no particular dominant. Species of common occurrence in this formation include *Hakea varia, Dasypogon bromeliifolius, Stirlingia latifolia, Banksia* aff. *sphaerocarpa, Banksia candolleana, Calectasia cyanea, Acacia pulchella, Conospermum stoechadis, Dryandra nivea, Blancoa canescens, Dryandra* sp., *Daviesia* spp., *Calothamnus* spp., *Grevillea* sp. and *Drosera* spp.

   Note: Banksia candolleana to *ca.* 0.75 m is most common along the edge of the *Banksia* woodland, while the Blackboys tend to be concentrated more on the laterite based soils on the higher ground.

3. Dense Thicket to Heath A of *Melaleuca* spp. *ca.* 2 to 3 m height with or without a Low Heath C understorey of *Verticordia* sp. to 1 m and *Calothamnus* sp. to *ca.* 0.75 m over Very Open Low Sedges and Grasses.

4. Woodland made up of Marri (*E. calophylla*), 15 to 18 m tall, and Flooded Gum (*E. rudis*) to 14 m over Open Scrub of predominantly *Jacksonia sternbergiana, Acacia* sp. and *Banksia grandis* to *ca.* 6 m. Isolated Blackboys (*Xanthorrhoea preissii*) form an understorey about 2 m high to this scrub layer and the groundcover is Open Low Sedges and Grasses.

5. Low Woodland A of Flooded Gum to 12 m (confined to stream bed) over Open Low Woodland B of *Jacksonia sternbergiana* to 4 m and *Melaleuca* sp. to 3 m. Beneath this stratum is a Thicket to Heath A 2.5 m tall dominated by *Hakea trifurcata.*

3. FAUNA

Twenty seven species of birds and evidence of good populations both of the Brush Wallaby (*Macropus irma*) and Western Grey Kangaroo (*M. fuliginosus*) were noted during surveys of the Reserve (Appendix II).

4. PAST MANAGEMENT, USE AND FIRE HISTORY

Reserve 27216 has been subject to a variety of uses in the past, none of which has seriously affected its natural features. There are numerous old tracks on the Reserve though many of these are becoming revegetated and are seldom if ever used. An underground gas pipeline which runs down the western side of the reserve has an access track maintained for inspection purposes. This acts as an additional firebreak to the ones put in along the Reserve boundaries. Mullering Road, which cuts through the southern part of the Reserve, is a public right of way. Two gravel pits are located alongside this road. There is some accumulation of rubbish along the Brand Highway, mainly cans and bottles. Near the eastern side of the Reserve there are two rubbish pits which are in active use. The block in the centre of the Reserve, which was set aside for camping and water is, in fact, an ideal camping area. Unfortunately frequent dumping of rubbish, including recently stripped car bodies, has somewhat degraded the natural attractions of the site.

The Reserve has been subject to a number of fires since aerial photographic coverage began in 1960. The 1960 photography itself shows a series of recent fire tracks over the southern and northern ends of the Reserve and the 1969 photography shows two recent fires, one in the north-western and the second in the southern corner of the Reserves. All these early fires were of small extent and none affected the central part of the Reserve.

Between 1969 and 1973, however, nearly all the Reserve was burnt in a single fire. Between then and 1978 there were at least three further fires again affecting the north-western and south-western parts of the Reserve where *Banksia* and *Eucalyptus todtiana* woodland formations are the predominant vegetation types. The entire Reserve was burnt out again during the summer of 1978-79.

Thus, there have been two occasions since 1969 in which nearly the entire Reserve has been burnt, these major fires being interspersed by a series of smaller ones, mainly affecting the woodland formation.

The effects of these frequent fires have not been determined except that the population of *Eucalyptus macrocarpa* in the southern woodland zone now consists entirely of mature individuals. These are regenerating from lignotubers following the most recent (1978-79) fire. The absence of young individuals from this and other frequently burnt populations of such a rare plant is of some concern and is indicative of the need to approach the question of fire frequency in heathlands and woodlands in this region with care.

5. NATURE CONSERVATION VALUES AND DIRECTIONS FOR MANAGEMENT

This Reserve is strategically located near the western edge of the Dissected Region and it is therefore not surprising that populations of species near the limits of their geographic range should occur there. Two eucalypts which fall into this category (*E. gittinsii* and *E. macrocarpa*) were indentified from the Reserve during the brief surveys preparatory to the preparation of this Plan. The *E. macrocarpa* population (totalling 68 individuals) is also important because of the overall rarity of the species. This northern form is under consideration for Gazettal as a rare species in terms of the Wildlife Conservation Act. The Reserve is therefore important for its location and the particular species of flora it supports. Under the management guidance of the Western Australian Wildlife Authority it would certainly be granted key site status in the Western Australian system of Nature Reserves.

In addition to these biological features are the equally clear attractions of parts of the Reserve for camping and the general potential of the area for recreational development. The Reserve is located at the junction of the Brand Highway and Mullering Road, and facilities for the public could be easily installed without jeopardising its biological values.

The area has had little management and could only benefit from measures to reduce the incidence of fires, rationalise the system of access tracks and prevent and repair unthinking degradation resulting from rubbish dumping.

PART 8. THE UNVESTED RESERVES

Three unvested reserves for the conservation of flora (Reserve Nos. 25254 (Jam Hill), 26248 (Wongonderrah) and 27993, unnamed) lie within the area covered by this Plan. These are also "Nature Reserves" in the meaning of Section 6 of the Wildlife Conservation Act, but, as they are unvested, the Department and the Western Australian Wildlife Authority have limited responsibilities for their management. The features and values of these Reserves are included in summary form in this Plan for comparative purposes.

1. RESERVE No. 25254, JAM HILL NATURE RESERVE

The Jam Hill Nature Reserve is located 16 km west of Moora Townsite and takes in the eastern slopes of the landscape feature known as Jam Hill (Fig. 13). It was originally designated as a Reserve for the purpose of gravel in 1959. In 1966 the purpose was changed to conservation of flora.

Reserve 25254 is irregular in shape with an area of 183 ha and a perimeter of about 8 km. It lies in undulating country and is surrounded by cleared or partially cleared farmland. The western end of the Reserve is dominated by a rocky lateritic ridge which gives way to yellow sandy country to the east—a succession of habitats typical of the Dandaragan Plateau. It can be approached along Lupin Valley Road which bisects the Reserve (Fig. 13).

Broadly speaking, the vegetation can be separated into two categories: (1) the Heathlands, which occur mainly on the exposed rocky ridge to the west, and (2) the Open Woodland and associated Scrub communities which occur on the yellowish sandy soils. The demarcation between these zones is not clear-cut, there being a tendency for one to merge into the other. There is also an interesting York Gum (*Eucalyptus loxophleba*) formation in the south-east corner (3) and some small patches of *Allocasuarina campestris* Dense Thicket (4) on the Reserve.

The Reserve is known to have been burnt twice in the past 20 years. Aerial photography flown in 1960 shows a fire scar of recent origin and satellite imagery from June 1976 shows that a second fire occurred between December 1973 and that time. Compared to areas further west, however, this Reserve has been relatively free of fire.

The Reserve is used by apiarists as it provides suitable habitat for bees during the winter and spring months.

This is valuable Reserve for several reasons. Although relatively small it supports a diverse flora not well represented in other Nature Reserves in the Shire. Together with Reserve No. 23934 this Reserve is one of two in the southern part of the Shire located on the Dandaragan Plateau. Four vegetation formations are recognized, although two of these are very limited in area. They provide suitable habitat for a number of birds and mammals. Numerous scrapings in the soil suggest a healthy Echidna population.

The area also has economic importance as a wintering site for bees. The change of purpose to conservation of flora, effected in 1966, was largely the result of submissions put forward by the Farmers Union of Western Australia concerning the value of the flora of the Reserve for bee-keeping.

Compared to the other physiographic units of the southern part of the Shire of Dandaragan the Dandaragan Plateau is quite poorly represented in the Nature Reserve system. For this reason alone the Jam Hill Nature Reserve deserves key site status. Although it is small in size the diversity of habitats it encompasses also adds considerably to its value as an area representative of the region.

2. RESERVE No. 26248, WONGONDERRAH NATURE RESERVE

Reserve 26248, Wongonderrah Nature Reserve, is situated about 25 km north-west of Cataby on Wadi Road (also known as Wongonderrah Road) (Fig. 5). The Reserve was set aside for conservation of flora in 1962. It is roughly square in shape with an area of 439 ha and a perimeter of about 8 km. To the north it borders on Wongonderrah Road, and to the east, south and west on

uncleared vacant Crown land. Wongonderrah Spring and its associated swampland occupies the lowest part of the Reserve where surface water is present into early summer (Fig. 14).

The vegetation can be separated into four basic associations. Running from the western end of the northern boundary towards the centre of the reserve is a Low Forest (1) of the Swamp Paperbark (*Melaleuca preissiana*). Along the edges this forest gives way to very much more open Woodland (1) with Blackboys and Grassboys over Tall Sedges forming the understorey. This is particularly prevalent to the west, though similar vegetation occurs where water runoff flows into the swamp from the east. In the centre of the Reserve to the south of the main swamp is a limited area of *Eucalyptus rudis* Forest (3).

West of the swampy belt is an expanse of Heathland (2) which is variable in

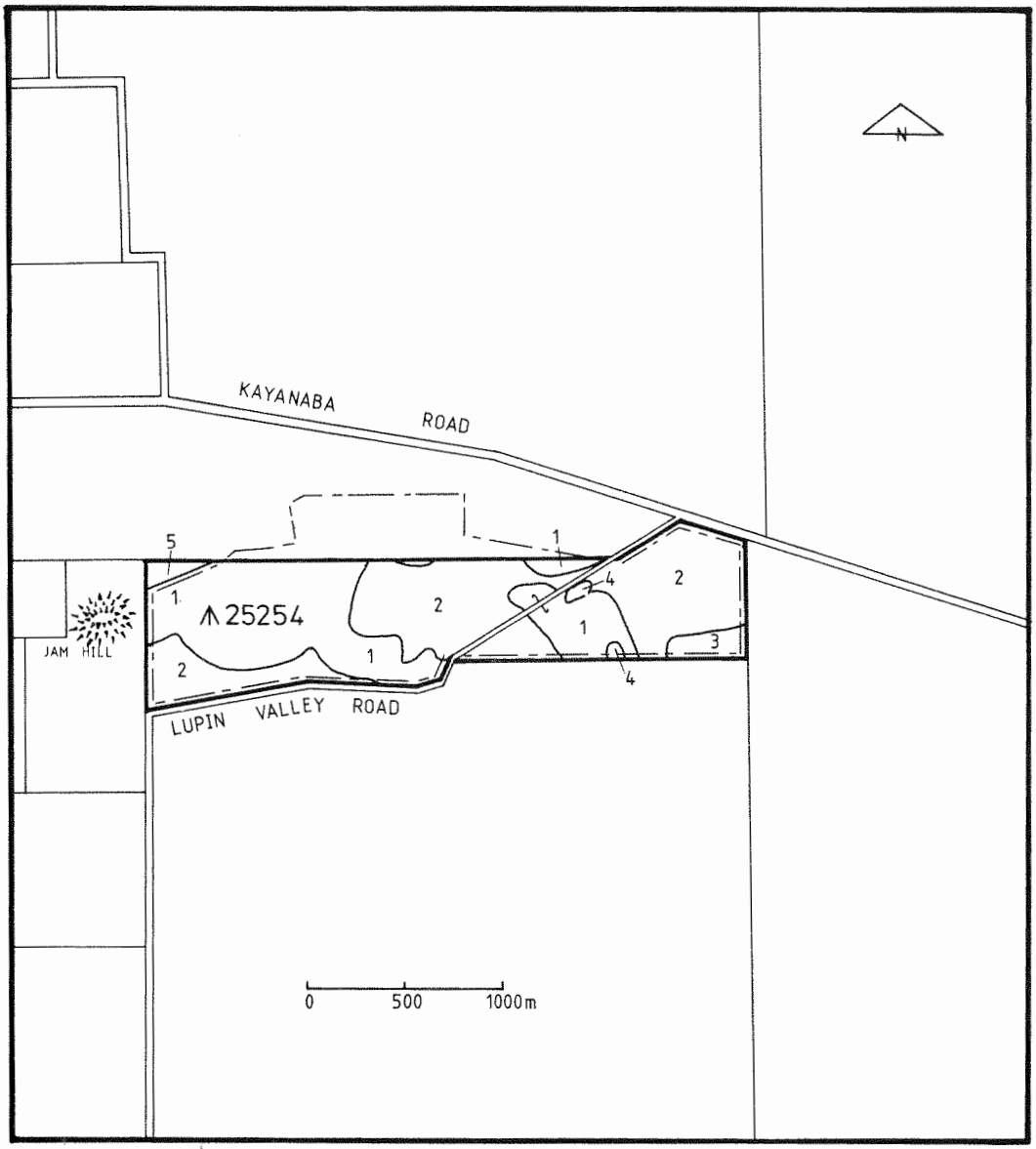


Figure 13. Jam Hill Nature Reserve showing relationships with surrounding lands. Lupin Valley Road cuts through the Reserve from south-west to north-east (double lines) and tracks are shown as broken lines. The vegetation associations identified by numbers (1.2.3...) are described in the text.

composition and rich in species. This area is susceptible to seasonal waterlogging.

To the east of the swamp a ridge of grey sand supports mixed *Banksia* dominated Woodland (4) typical of much of the northern coastal plain. This association extends across to a lower sandy ridge in the south and south-west of the Reserve.

The Reserve is therefore similar to the several other Reserves in the Shire situated on the grey sands of the Bassendean Dune System. Several uncommon plants have been recorded there, however, including species such as *Andersonia gracilis, Dryandra conferta, Calothamnus villosus, Lasiopetalum lineare* and an unidentified *Isopogon* sp. It also contains populations of

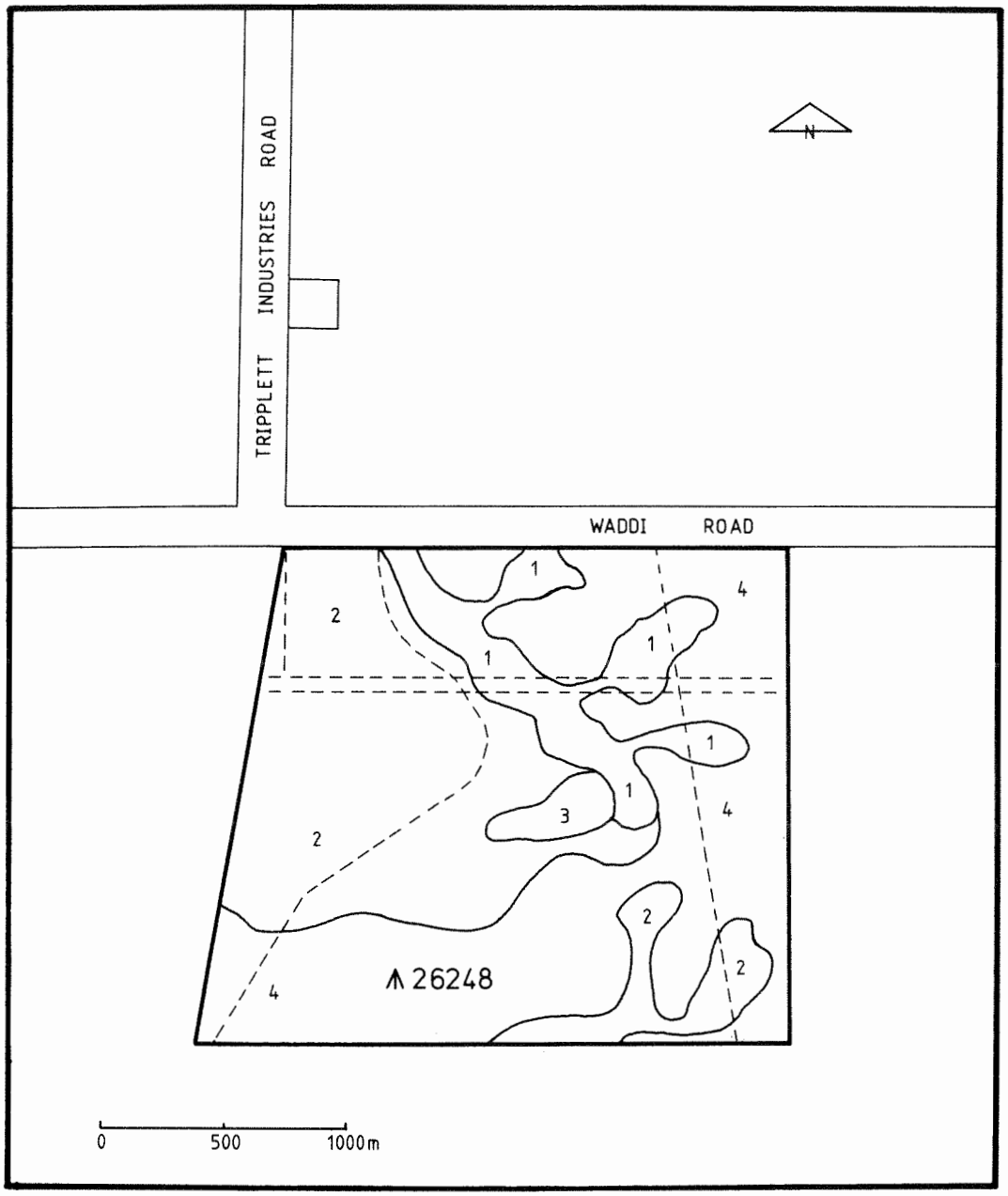


Figure 14. Wongonderrah Nature Reserve showing relationships to surrounding lands. Tracks on the Reserve are shown as broken lines and vegetation associations identified by numbers (1.2.3...) are described in the text.

plants close to the limits of their range, and it is the most northernly known locality of *Anarthria gracilis, Restio stenostachyus, Conostylis juncea, Pultenaea reticulata, Aotus ericoides, Calothamnus villosus* and *Banksia* aff. *sphaerocarpa.* It is therefore thoroughly deserving of key site status in the Western Australian Nature Reserve System.

This Reserve is also unusual among the Bassendean duneland Reserves because several mineral claims have been pegged there.

Examination of these claims by the Department of Conservation and Environment in 1976 resulted in recommendations that they should not be approved, as mining would have a detrimental effect on the values of the Reserve. Of particular concern is the likely effect any open cut mining operations would have on the perched water table of the swamp area of the Reserve.

There is, at present, no provision for management of the values of this Reserve. It lacks firebreaks and identification as a Reserve. No active management can be undertaken until the question of vesting is resolved.

3. RESERVE No. 27993

This area was originally gazetted as a Reserve for the conservation of flora and fauna on 25 February 1966. It was created on the recommendation of the surveyor when Mimegarra Road was deviated around the swamp which forms the centre of the Reserve. It has, however, remained unvested.

The Reserve is situated 2.5 km west of the Brand Highway on the Mimegarra Road (Fig. 5). It is irregular in shape, has an area of 21 ha and a perimeter of *ca.* 2.5 km. Its northern boundary is straight and runs in an east-west direction. The remaining sides follow the inside curve of a deviation on Mimegarra Road, and this gives the reserve a roughly semi-circular appearance. The soil is greyish-white sand, tending to sandy clay in the swamp (Fig. 15).

The area, though small, supports a variety of vegetation associations (Fig. 15). The central portion is dominated by a sandy ridge which supports *Eucalyptus todtiana* and *Banksia* dominated woodland. To the east of this is a *Melaleuca* spp. dominated swamp, partly surrounded by a belt of mature *E. rudis*. This, in turn, gives way to low heathland. On the western side about two hectares of the Reserve appears to have been fenced off into the adjoining farmland. This represents *ca.* 10 per cent of the total area.

This Reserve is very small, and although it contains several interesting vegetation associations and a substantial fauna no active management is envisaged.

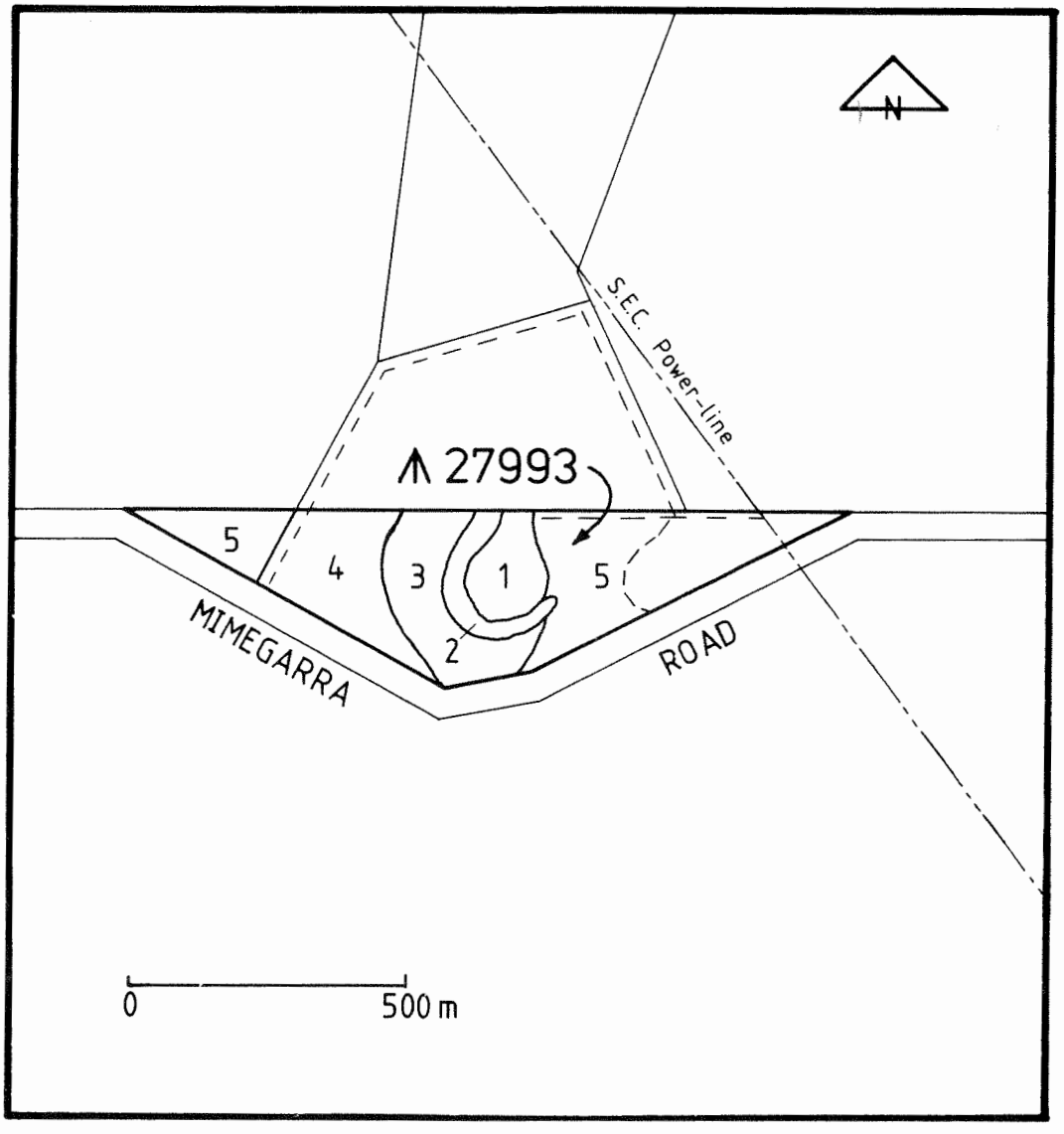


Figure 15. Reserve No. 27993 showing relationships with surrounding lands, tracks (broken lines) and vegetation associations as follows:

1. Dense Thicket of *Melaleuca* spp.
2. Low Woodland A of Flooded Gum (*Eucalyptus rudis*)
3. Low Woodland A of Pricklybark (*Eucalyptus todtiana*), *Banksia attenuata* and *B. menziesii.*
4. Species rich Dwarf Scrub D.
5. Area cleared and fenced into adjoining pasture land.

PART 9. GENERAL CONSIDERATIONS AND CONCLUSIONS

1. SUMMARY OF THE RESERVE SYSTEM

With the Nambung and Badgingarra National Parks the Nature Reserves in the southern part of the Shire of Dandaragan serve to represent several of the natural habitats in the area. The coastal belt and the Bassendean Dune System are particularly well represented while the agriculturally more useful Dissected Region and the Dandaragan Plateau itself have fewer Reserves which are also generally small in size (Table 2).

The provision of representative examples of such a succession of natural environments, which extends northward and southward into similar near coastal regions of lower and higher rainfall and eastwards onto the Darling Plateau and to the eucalypt woodlands of the wheatbelt, is a most important objective of the Nature Reserve System. In this respect it could be improved by the addition of further areas of the habitats characteristic of the more eastern parts of the Shire and, because of their high intrinsic value to waterbirds, of the wetlands, ephemeral and more permanent, of parts of the Bassendean Dune System.

In addition it should be noted that many of the plants of this region, particularly those which are scarce and endemic, are also very localised in their occurrence. An unknown but possibly significant number of these species may not be present in Reserves selected primarily as areas representative of broadly differing kinds of habitats. A similar situation may exist with some animals. For example, the burrowing skink (*Lerista christinae*) is known from a single specimen collected in Bassendean dunelands 22 km south of Badgingarra in November 1977. Further review of the Nature Reserves of the area will therefore be required as knowledge of biological factors (such as distribution of plant species) increases.

Table 2. Summary of the Nature Reserves of the Southern Part of the Shire of Dandaragan

Reserve No.	Area (ha)	Vesting	Geomorphological Zone	Status in W.A. Nature Reserve System
23934	212	W.A.W.A.	Dandaragan Plateau	key site, ecosystem
25254	183	Unvested	Dandaragan Plateau	key site, ecosystem*
26248	439	Unvested	Bassendean Dunes	key site, wetland
27216	1 576	Local Authority	Bassendean Dunes/ Dissected Region	key site, ecosystem
27219	200	W.A.W.A.	Dissected Region	key site, ecosystem
27394	741	W.A.W.A.	Bassendean Dunes	key site, ecosystem wetland, hunting area
27993	21	Unvested	Bassendean Dunes	wildlife refuge*
28558	5 411	W.A.W.A.	Bassendean Dunes	key site, ecosystem, wetland, rare species
31675	11 138	W.A.W.A.	Coastal Belt	key site, ecosystem

*The status of key site and wildlife refuge has management significance only for Nature Reserves vested in the Western Australian Wildlife Authority.

2. MANAGEMENT STRATEGY

Generally, until now, management of the Nature Reserve in this area has taken a most conservative direction, interference with natural processes being minimised except in pursuit of measures for fire control. This overall strategy is expected to continue with provision being made for the substantial upgrading of fire protection work and, as resources permit, for some future development of public uses of selected parts of the Reserve network.

On the question of fire protection there are already 198 km of firebreaks and access tracks on the Western Australian Wildlife Authority vested Reserves covered in this Plan. Under its provisions a further 23 km of perimeter breaks and 44 km of buffer strips are proposed. In addition the Plan recommends construction of 24 km of buffer strips on adjoing vacant Crown land and the prescribed burning of parts (2 128 ha) of the Namming Nature Reserve. This is considered to be a minimum development required to provide the basis for effective fire protection on these Reserves which is consistent with the needs of biological conservation.

Excluding the costs of the latter two measures (i.e. the buffers on the vacant Crown land and the prescribed burning of the Namming Nature Reserve) installation and maintenance of the proposed and existing works will entail an estimated expenditure of $1 600 per annum for each of the five vested Reserves named.

Apart from the purely financial aspects, it should be noted that appointment of the Reserves Management Team at Wongan Hills is a prerequisite to their success. The existing manpower resources of the Reserve Management Section of the Department are not adequate to undertake the increased programme of construction and maintenance required, nor is it feasible to provide other than a token fire fighting presence on Reserves in this area except through the establishment of a management team in the region.

APPENDIX I

STRUCTURAL VEGETATION CATEGORIES

LIFE FORM/HEIGHT CLASS	CANOPY COVER			
	DENSE 70-100%	MID-DENSE 30-70%	SPARSE 10-30%	VERY SPARSE 2-10%
Trees>30m	Dense Tall Forest	Tall Forest	Tall Woodland	Open Tall Woodland
Trees 15-30m	Dense Forest	Forest	Woodland	Open Woodland
Trees 5-15m	Dense Low Forest A	Low Forest A	Low Woodland A	Open Low Woodland A
Trees<5m	Dense Low Forest B	Low Forest B	Low Woodland B	Open Low Woodland B
Mallee Tree Form	Dense Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
Mallee Shrub Form	Dense Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
Shrubs>2m	Dense Thicket	Thicket	Scrub	Open Scrub
Shrubs 1.5-2.0m	Dense Heath A	Heath A	Low Scrub A	Open Low Scrub A
Shrubs 1.0-1.5m	Dense Heath B	Heath B	Low Scrub B	Open Low Scrub B
Shrubs 0.5-1.0m	Dense Low Heath C	Low Heath C	Dwarf Scrub C	Open Dwarf Scrub C
Shrubs<0.5m	Dense Low Heath D	Low Heath D	Dwarf Scrub D	Open Dwarf Scrub D
Mat Plants	Dense Mat Plants	Mat Plants	Open Mat Plants	Very Open Mat Plants
Hummock Grass	Dense Hummock Grass	Mid-Dense Hummock Grass	Hummock Grass	Open Hummock Grass
Bunch Grass>0.5m	Dense Tall Grass	Tall Grass	Open Tall Grass	Very Open Tall Grass
Bunch Grass<0.5m	Dense Low Grass	Low Grass	Open Low Grass	Very Open Low Grass
Herbaceous spp.	Dense Herbs	Herbs	Open Herbs	Very Open Herbs
Sedges>0.5m	Dense Tall Sedges	Tall Sedges	Open Tall Sedges	Very Open Tall Sedges
Sedges<0.5m	Dense Low Sedges	Low Sedges	Open Low Sedges	Very Open Low Sedges
Ferns	Dense Ferns	Ferns	Open Ferns	Very Open Ferns
Mosses, Liverwort	Dense Mosses	Mosses	Open Mosses	Very Open Mosses

APPENDIX II

FAUNA RECORDED ON NATURE RESERVES IN THE SOUTHERN PART OF THE SHIRE OF DANDARAGAN

BIRDS

	29394	25254	26248	27216	27219	27394	27993	28558	31675
NON-PASSERINES									
EMUS (DROMAIIDAE)									
Emu *Dromaius novaehollandiae*	X			X		X		X	X
GREBES (PODICIPEDIDAE)									
Australasian Grebe (Little Grebe) *Tachybaptus novaehollandiae*						X			
CORMORANTS (PHALACROCORACIDAE)									
Little Pied Cormorant *Phalacrocorax melanoleucos*						X			X
HERONS (ARDEIDAE)									
Pacific Heron (White-necked Heron) *Ardea pacifica*						X			
White-faced Heron *Ardea novaehollandiae*						X			
Rufous Night Heron (Night Heron) *Nycticorax caledonicus*						X			
DUCKS (ANATIDAE)									
Freckled Duck *Stictonetta naevosa*								X	
Australian Shelduck (Mountain Duck) *Tadorna tadornoides*					X			X	
Pacific Black Duck (Black Duck) *Anas superciliosa*						X			
Maned Duck (Wood Duck) *Chenonetta jubata*					X				

	29394	25254	26248	27216	27219	27394	27993	28558	31675
OSPREYS (PANDIONIDAE)									
Osprey *Pandion haliaetus*									X
LARGE RAPTORES (ACCIPITRIDAE)									
Black-shouldered Kite *Elanus notatus*								X	
Black-breasted Buzzard (Black-breasted Kite) *Hamirostra melanosternon*									
Whistling Kite *Haliastur sphenurus*						X			
Wedge-tailed Eagle *Aquila audax*				X		X		X	X
FALCONS (FALCONIDAE)									
Brown Falcon *Falco berigora*		X	X					X	
Australian Kestrel (Nankeen Kestrel) *Falco cenchroides*				X				X	X
QUAILS (PHASIANIDAE)									
Stubble Quail *Coturnix novaezelandiae*	X								
RAILS (RALLIDAE)									
Eurasian Coot (Coot) *Fulica atra*						X			
BUSTARDS (OTIDIDAE)									
Australian Bustard *Ardeotis australis*									X
SANDPIPER/CURLEW/GODWIT (SCOLOPACIDAE)									
Common Sandpiper *Tringa hypoleucos*									X
GULLS (LARIDAE)									
Silver Gull *Larus novaehollandiae*									X
Caspian Tern *Hydroprogne caspia*									X

	29394	25254	26248	27216	27219	27394	27993	28558	31675
Crested Tern *Sterna bergii*								X	
PIGEONS/DOVES (COLUMBIDAE)									
Common Bronzewing *Phaps chalcoptera*			X						
COCKATOOS (CACATUIDAE)									
White-tailed Black-Cockatoo *Calyptorhynchus baudinii*	X				X	X			X
Galah *Cacatua roseicapilla*	X			X	X		X	X	X
Long-billed Corella *Cacatua tenuirostris*					X		X		
PARROTS (PLATYCERCIDAE)									
Port Lincoln Ringneck *Barnardius zonarius*	X			X	X	X	X	X	
OWLS (STRIGIDAE)									
Southern Boobook (Boobook Owl) *Ninox novaeseelandiae*	X								
FROGMOUTHS (PODARGIDAE)									
Tawny Frogmouth *Podargus strigoides*						X			
TREE KINGFISHERS (ALCEDINIDAE)									
Laughing Kookaburra *Dacelo novaeguineae*	X		X	X	X	X	X		
Sacred Kingfisher *Halcyon sancta*	X					X			
BEE-EATERS (MEROPIDAE)									
Rainbow Bee-eater *Merops ornatus*	X					X		X	
PASSERINES									
SWALLOWS (HIRUNDINIDAE)									
White-backed Swallow *Cheramoeca leucosternum*								X	X
Welcome Swallow *Hirundo neoxena*				X	X			X	X

	29394	25254	26248	27216	27219	27394	27993	28558	3 5
Tree Martin *Cecropis nigricans*	X			X	X				
PIPITS (MOTACILLIDAE)									
Richard's Pipit *Anthus novaeseelandiae*				X	X	X		X	X
CUCKOO-SHRIKES (CAMPEPHAGIDAE)									
Black-faced Cuckoo-shrike *Coracina novaehollandiae*	X	X		X	X	X		X	X
ROBINS/WHISTLERS/MONARCHS/ FANTAILS (MUSCICAPIDAE)									
Scarlet Robin *Petroica multicolor*				X	X	X			
Red-capped Robin *Petroica goodenovii*								X	
Hooded Robin *Melanodryas cucullata*								X	
Rufous Whistler *Pachycephala rufiventris*				X	X				
Crested Bellbird *Oreoica gutturalis*								X	
Grey Fantail *Rhipidura fuliginosa*	X			X	X	X			
Willie Wagtail *Rhipidura leucophrys*	X			X	X	X	X	X	X
OLD WORLD WARBLERS (SYLVIIDAE)									
Brown Songlark *Cinclorhamphus cruralis*							X		
WRENS (MALURIDAE)									
Splendid Fairy-wren *Malurus splendens*	X	X			X			X	
White-winged Fairy-wren *Malurus leucopterus*						X			X
AUSTRALIAN WARBLER (ACANTHIZIDAE)									
White-browed Scrubwren *Sericornis frontalis*						X			
Weebill *Smicrornis brevirostris*					X	X			

	29394	25254	26248	27216	27219	27394	27993	28558	31675
Western Gerygone (Western Warbler) *Gerygone fusca*	X				X				
Inland Thornbill (Broad-tailed Thornbill) *Acanthiza apicalis*								X	
Yellow-rumped Thornbill *Acanthiza chrysorrhoa*	X		X	X	X	X		X	
HONEYEATERS (MELIPHAGIDAE)									
Red Wattlebird *Anthochaera carunculata*			X	X		X	X	X	
Yellow-throated Miner *Manorina flavigula*						X		X	
Singing Honeyeater *Lichenostomus virescens*				X		X		X	X
Brown Honeyeater *Lichmera indistincta*	X	X	X	X				X	X
New Holland Honeyeater *Phylidonyris novaehollandiae*								X	
Tawny-crowned Honeyeater *Phylidonyris melanops*	X			X			X		
Western Spinebill *Acanthorhynchus superciliosus*	X			X				X	
CHATS (EPHTHIANURIDAE)									
White-fronted Chat *Ephthianura albifrons*	X			X	X	X	X		
PARDALOTES (PARDALOTIDAE)									
Striated Pardalote *Pardalotus striatus*	X				X				
WHITE EYES (ZOSTEROPIDAE)									
Silvereye *Zosterops lateralis*					X	X			X
MAGPIE LARKS (GRALLINIDAE)									
Australian Magpie-Lark *Grallina cyanoleuca*					X	X	X	X	
WOODSWALLOWS (ARTAMIDAE)									
Black-faced Woodswallow *Artamus cinereus*		X	X	X	X			X	X

	29 94	25254	26248	27216	27219	27394	27993	28558	16 5
BUTCHERBIRDS (CRACTICIDAE)									
Grey Butcherbird *Cracticus torquatus*						X			
Australian Magpie *Gymnorhina tibicen*					X	X	X	X	
CROWS (CORVIDAE)									
Australian Raven *Corvus coronoides*	X	X		X		X		X	X

MAMMALS

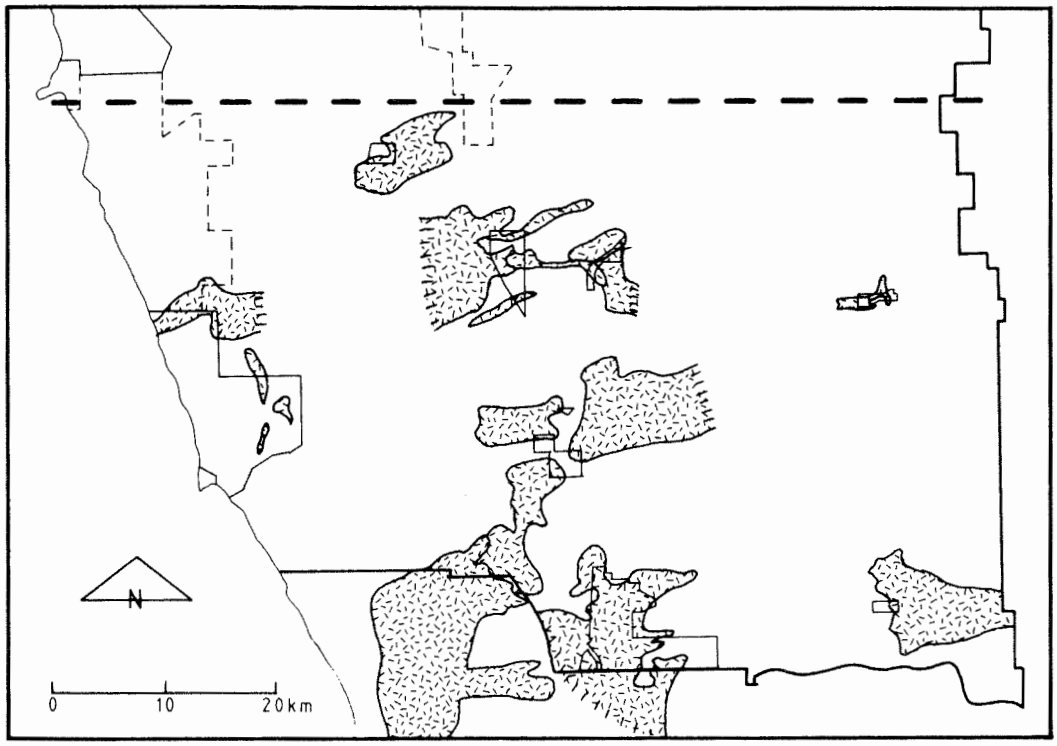
MONOTREMES									
Echidna *Tachyglossus aculeatus*		X							
WALLABIES/KANGAROOS									
Western Brush-Wallaby *Macropus irma*	X	X		X	X		X	X	
Western Grey Kangaroo *Macropus fuliginosus*	X	X	X	X	X	X		X	X
BATS									
White-striped Mastiff Bat *Tadarida australis*	X				X				
RABBITS									
European Rabbit *Oryctolagus cuniculus*	X		X	X	X	X	X	X	X
CARNIVORES									
Fox *Vulpes vulpes*				X		X	X	X	

APPENDIX III

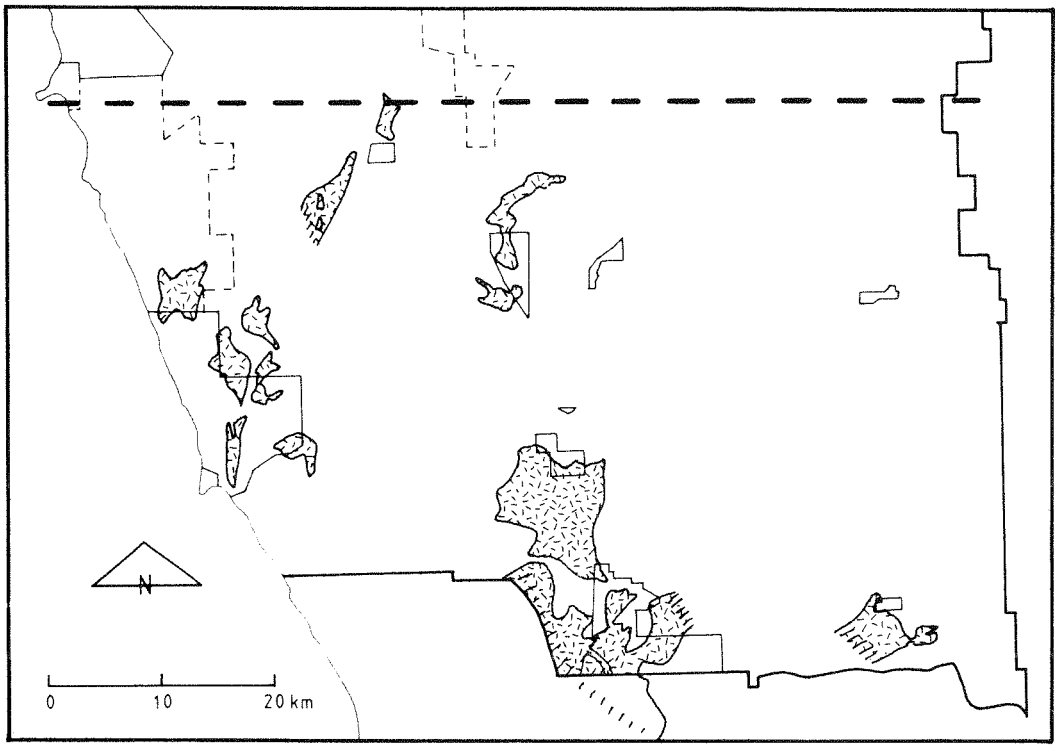
SKETCH MAPS OF THE FIRE HISTORIES OF NATURE RESERVES IN THE SOUTHERN PART OF THE SHIRE OF DANDARAGAN

These data are derived from aerial photography flown in March 1960 and December-January 1969-70 and from Landsat imagery dating from December 1973, June 1976, November 1977, August 1978 and October 1979.

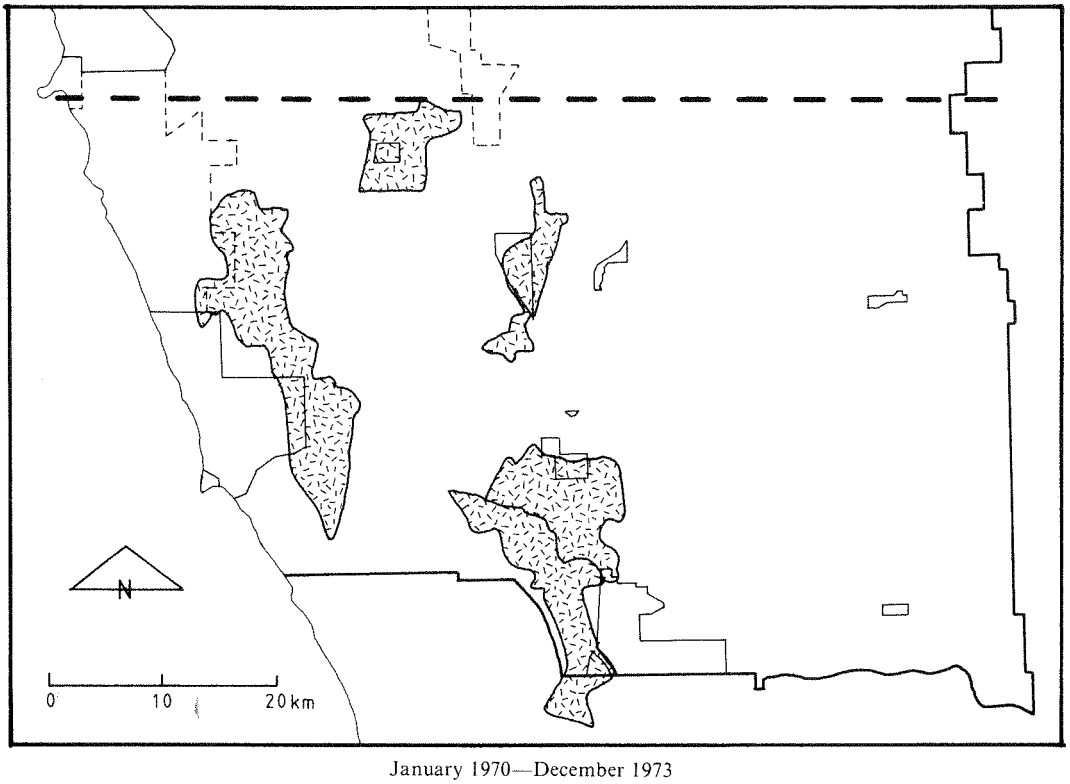
The periods referred to in the following captions are the intervals between the successive data sets. The data themselves represent the tracks of fires affecting Nature Reserves or in the immediate vicinity of Nature Reserves which were detectable on the later imagery referred to but which were not present on the preceding photography or Landsat image.



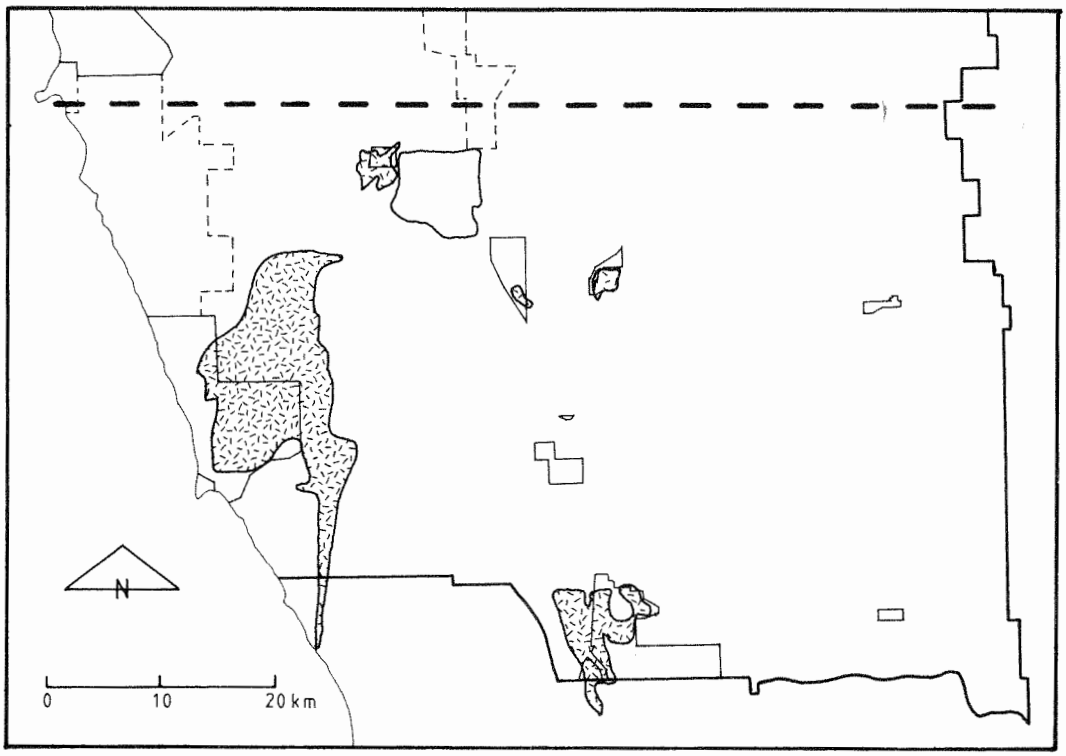
Pre March 1960



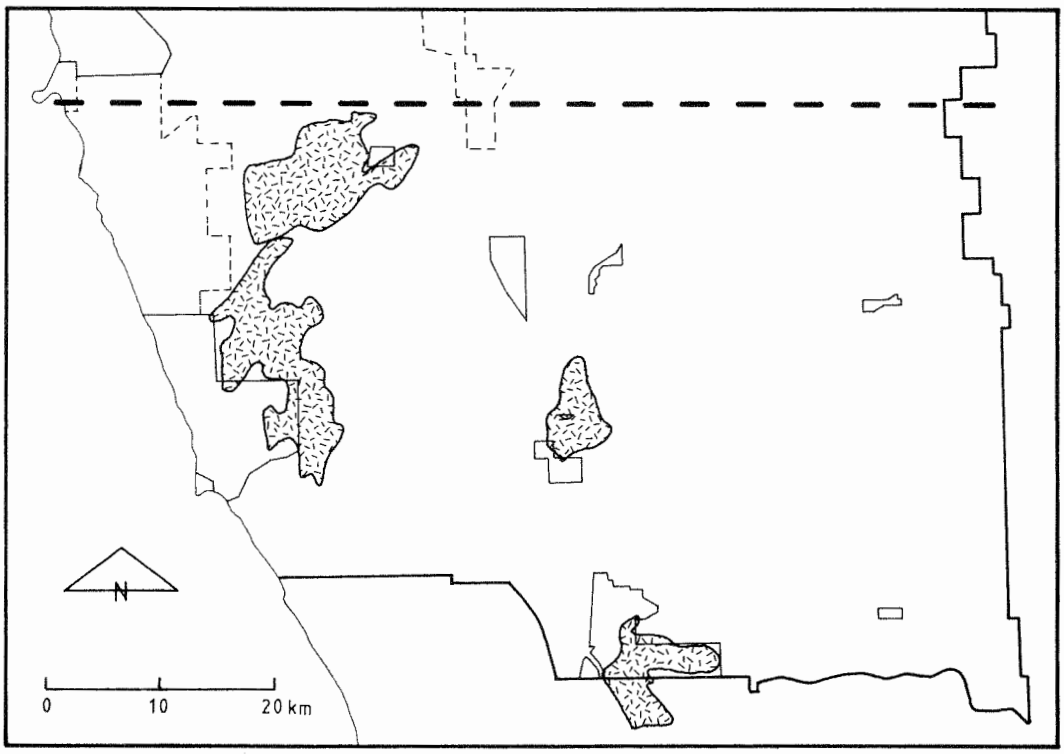
March 1960—January 1970



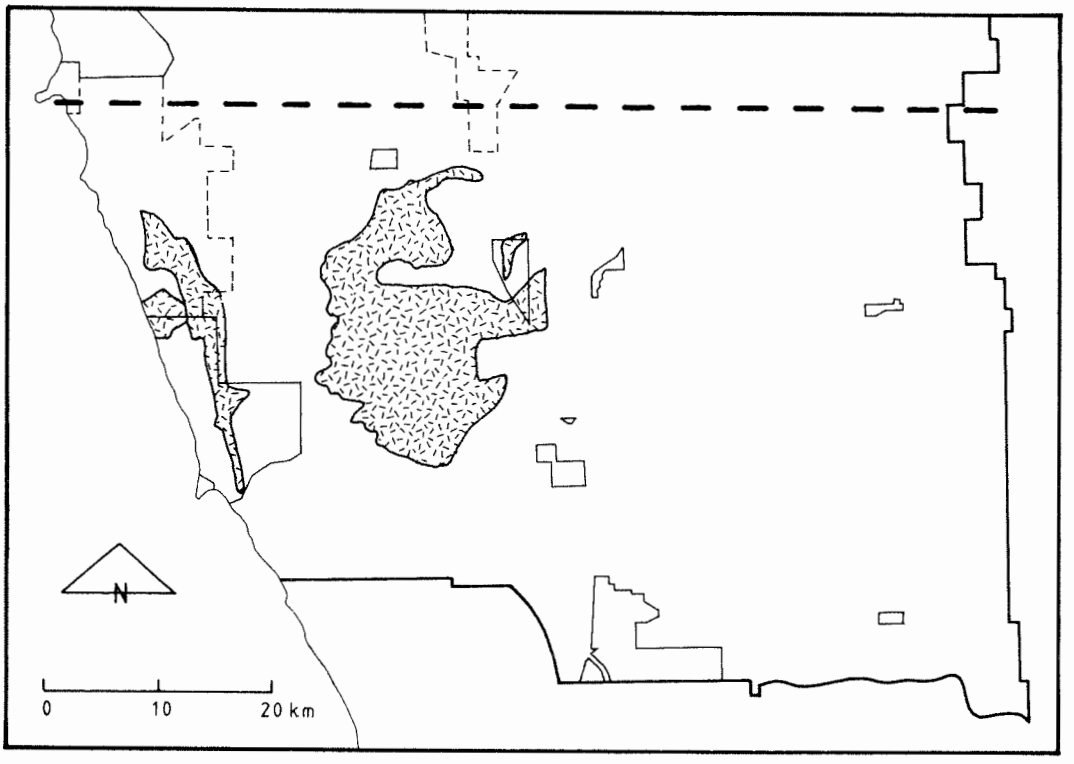
January 1970—December 1973



December 1973—June 1976



June 1976—November 1977



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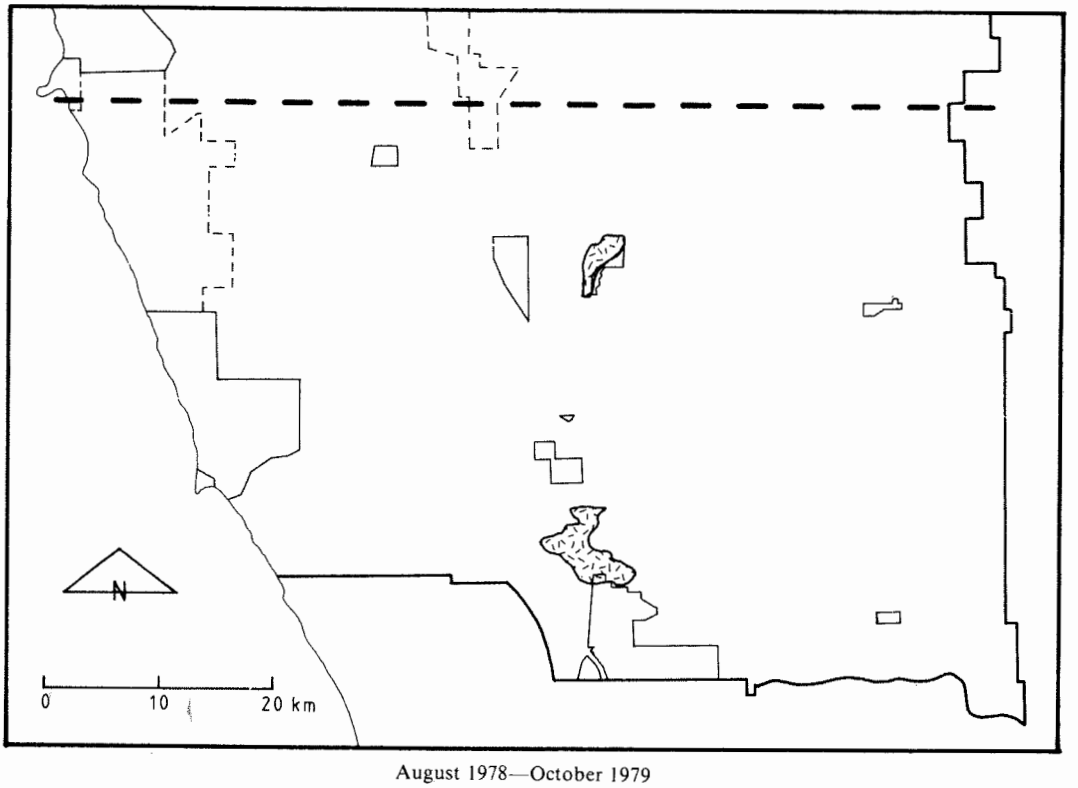

August 1978—October 1979