The vegetation of the Fitzgerald River National Park, Western Australia

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Abstract

Aplin, T.E.H. and Newbey, K.R. The vegetation of the Fitzgerald River National Park, Western Australia. Kingia 1(2): 141-153 (1990). A vegetation map of the Fitzgerald River National Park which accompanies this paper shows 12 major plant communities. A brief account of each of these plant communities depicted in that map is provided. The vegetation formations range from woodland to heath, with the predominant formation being tall shrubland. Notes on the physical environment are also included.

Introduction

The Fitzgerald River National Park (Park), of 244,677 ha, lies in the central south coast of Western Australia, between the towns of Bremer Bay and Hopetoun along the coast and Jerramungup and Ravensthorpe inland (Figure 1). The Park was gazetted a "C" class reserve for the preservation of flora and fauna in 1954, and in 1973 was made an "A" class reserve and vested in the National Parks Authority of Western Australia. It is registered as an International Biosphere Reserve with the United Nations Educational Scientific and Cultural Organization, the first to be so approved in Western Australia.

In 1970 a botanical survey was conducted by the Western Australian Herbarium to obtain an assessment of the botanical resources in the Park. The vegetation map which accompanies this paper was compiled by Aplin in the course of that survey. Since then Newbey (1979) undertook a study of the vegetation of the central south coastal region and some of his results have been incorporated in this paper. This is the first of a series of three papers on the vegetation and flora of the park. Accounts of the flora are published separately (Aplin and Newbey 1990, Newbey 1990).

Historical Notes

West, Middle and East Mount Barren, three prominent features in the Park, were named by Matthew Flinders in 1802. Their names indicate his descriptions of them. In 1841, during his historic overland journey, E.J. Eyre traversed the Park. He described it as "barren, worthless country". Eyre recorded the presence of Australian aborigines at Culham Inlet.

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Figure 1. Map showing location of Fitzgerald River National Park

Many of the physical features of the Park, including the Fitzgerald River were named by the surveyor J.S. Roe who visited the area in 1847. Roe reported the presence of good grazing land along the Gairdner River to the north-west of the Park. This was taken up as a pastoral lease by J. Hassell in 1849. Hassell named the property Jarramungup Spring, from the aboriginal word "yarra-moitch" which means "moitch on high ground", "moitch" being *Eucalyptus occidentalis*.

The overland telegraph line which ran more or less parallel to the coast was completed in 1877 and remained in use until 1927. Following the discovery of gold and copper at Ravensthorpe, the Phillips River Goldfield was declared in 1900. Ravensthorpe, and its port, Hopetoun, were designated town sites in 1901. Their connecting rail link, opened in 1909, remained in use until 1936. In 1902, to prevent the westward movement of rabbits, the Number Two Rabbit Proof Fence which traversed the western portion of the Park inland to the coast was constructed. It was maintained until 1955.

Large areas of vacant Crown Land along the south coastal region were released for agricultural development in the 1950's and 1960's. The main reason why the area of land occupied by the Park was not taken up for farming was its harsh terrain.

Botanical collecting in the Park commenced in 1829 but the first vegetation map of the area was published at 1:250,000 scale using photo-mosaics (Beard 1972). Prior to that, most accounts of the vegetation of the area were sketchy (Gardner 1944, Anon. 1965).

Grazing by introduced livestock in the Park has been confined to small areas along the Phillips, Fitzgerald and Hamersley Rivers. As a consequence most of the vegetation in the Park has remained relatively undisturbed and has not been invaded by alien plant species.

Mining activities in the Park have been mainly exploratory. These reached their peak in 1969-70 when about 31,200 ha or 13% of the area of the Park was pegged for mineral exploration. At that time it was proposed to open-cut mine lignite in the Fitzgerald River valley. Fortunately, subsequent drilling tests proved the lignite deposit to be uneconomic (Cockbain and Van de Graaff 1972). Actual mining operations in the Park have involved the mining of copper at West River from 1908 to 1909 (Sofoulis 1958) and the quarrying of spongolite at Twertup Creek from 1965 to 1978. Exploratory shafts have been sunk at Naendip, for copper, and at Coppermine Creek, for manganese.

A Field Studies Centre was established in 1981 at Twertup Creek by the Fitzgerald River National Parks Association.

There are three resident National Park rangers who maintain the facilities in the Park, and reside in the Park.

Physical Environment

Geology

The geology of south-western Australia was reviewed by Johnstone *et al.* (1973), and it is essentially from this work that the following account on the geology of the Park has been taken.

The Archaean Yilgarn Block is represented along the northern portion of the Park. Composed of gneisses and migmatites, with minor infolded belts of metasediments with different grades of regional metamorphism, it has a general north-west strike. Along the southern margin of the Yilgarn Block the Proterozoic metamorphics of the Albany-Esperance Block trend north-east to south-east and east to west, almost at right angles to the Yilgarn Block. The gneisses, granites and metasediments of the Albany-Esperance Block are dated at about 1,150 million years. The variation in mineral association and metamorphic grade is matched exactly by similar east-west trending rocks in eastern Antarctica, providing one of the strongest pieces of evidence for the geological fit of Australia and Antarctica in the reconstruction of Gondwanaland.

No sediments of Triassic to Neocomian age are known from the south coast, although evidence obtained from east of the Eucla Basin show that rift valley formation commenced as early as late Jurassic. These rift valleys were the precursors of the spreading which separated Australia from Antarctica, and stratigraphic evidence points to a pronounced marine gulf during the Late Cretaceous. Australia became isolated from Antarctica by the uppermost Cretaceous with only a tenuous link joining Tasmania to Antarctica along a transform fault.

The absence of warm water indicators in the Late Cretaceous faunas could be due to water circulation, as it is unlikely that warm waters from the Indian Ocean could have circulated freely in the narrow gulf until at least the middle Eocene. Marine sediments of late Eocene age, of the Plantagenet Group, which are well represented in the Park, consist of fine sandstone, mudstone, siltstone, spongolite and minor limestone up to 100 m thick with a fauna attesting to warm water sedimentation. This marine transgression extends up to 270 km inland from the present coast line. Old beach levels associated with this cycle of sedimentation are now at about 150 m.

Laterization of the Late Eocene Plantagenet Group probably occurred in the Oligocene and Early Miocene, as Middle Miocene sandstones in the adjoining Eucla Basin are not laterized.

A wide variety of Quaternary units developed around the coastal margin, with the dune system of the south coast tentatively referred to the Pleistocene.

The geology of the Ravensthorpe area has been dealt with by Thom *et al.* (1977) while Sofoulis (1958) has discussed the mineral deposits of the Phillips River Goldfield.

Topography

The Park lies within Swanland of Jutson (1950) and the South Coast Drainage System of Bettenay and Mulcahy (1972). The topography of the Central South Coastal Region was reviewed by Newbey (1979) and the following account is extracted from his work.

The southern portion of the Park is dominated by peaks and ridges of quartzite and phyllitic schist, which rise from 300 to 450 m above sea level. They include West, Middle and East Mount Barren, Mount Bland, Woolbernup Hill and the Whoogarup and Eyre Ranges, with Thumb Peak rising to 457 m. The peaks and ridges have slopes ranging from 7° to 30°, the steeper slopes becoming rockier. The coastline backed by these ranges is steep and rugged. There is an extensive wave-cut platform about 60 m above sea level. Away from the ridges the coastline has a narrow dune system.

To the north of the ranges is an extensive slightly elevated plain with the margins draining into the river systems. Drainage on the plain is local into scattered ephemeral swamps or, if unco-ordinated, gilgais. The swamp floors are approximately 2 m below the general level of the plain.

The two major watercourses, the Fitzgerald and Hamersley Rivers, each meander in a general north to south direction in narrow channels in broad flat-floored gorges walled by spongolite cliffs, or steep rubble slopes, 10 to 50 m high. Small mesas and buttes are present in the gorges. The Phillips, West, Gairdner and Bremer Rivers each also traverse parts of the Park. All of the rivers are intermittently flowing and saline; all terminate in inlets which are frequently cut off from the Southern Ocean by sand bars.

The Stirling Scarp, consisting of a steep to a more gentle granite slope, marks the boundary of the Yilgarn and the Albany-Esperance Blocks. To the north of the scarp are gently undulating uplands.

Soils

The various soil types in south-western Australia have been described by Northcote *et al.* (1967) and Mulcahy (1973). The following account is taken from Newbey (1979), with nomenclature following Northcote (1971).

Bare rock or shallow skeletal soils cover the ranges. The soils are sandy on quartzite and sandy loam on schist. Colluvial deposits have developed at the bases of the ranges. When derived from schist the deeper profiles of the moderately developed gradational soils have a clay loam "B" horizon.

The three main soils types on the elevated plain are: 1) truncated laterite, sometimes overlain with sand, 2) duplex soil, 700 mm to 1 m thick, developed over spongolite and consisting of sand to sandy loam overlying clay to sandy clay, and 3) duplex soil, developed over spongolite in drainage sumps and consisting of a shallow "A" horizon which ranges from a self-mulching clay loam in gilgais to loamy sands on the swamp floors.

Stony loams and skeletal soils overlying spongolite occur on the steep slopes of gorges and bedrock exposures.

On the gorge floors soil profiles range from gradational to duplex, the "B" horizon which is developed *in situ*, ranging from sandy to clay loams, whereas the "A" horizon, which frequently includes colluvial material, varies in texture from sand to clay loams.

Along the major drainage lines the alluvial soils are saline and frequently waterlogged or damp to within 200 to 500 mm of the surface. Fossil river flats, 2 to 4 m above the stream level, have finer texture soils.

Siliceous and calcareous sands occur on the narrow coastal dune systems.

To the north of the Stirling Scarp the soils have a duplex profile, the "A" horizon of sand or sandy loam, 100 to 200 mm in depth, overlying a mottled sandy clay zone and lower pallid clay zone up to or more than 5 m thick.

Apart from the alluvial soils, the nutrient content in each of the soil types is low. The pH levels range from 6.5 for sand, through 8.0 for clays, to in excess of 8.5 for calcareous sands.

Climate

There are no weather recording stations in the Park and data presented in Table 1 have been extrapolated. The climate, according to the classification of Papadakis (1975), is Marine Mediterranean. The bulk of the rainfall is received from May to October. The marine influence diminishes as the distance inland increases, with isotherms and isohyets running more or less parallel to the coastline.

Table 1. Range of climatic variation in the Fitzgerald River National Park

Figures have been extrapolated from recordings taken at Bremer Bay, Jerramungup, Ravensthorpe and Hopetoun, that were obtained from the Western Australian Regional Office of the Bureau of Meteorology.

Attribute	Coastal	Northern boundary
Average annual rainfall	650 mm	360 mm
Average break to season	Early March	Late April
Growing season	8.1 months	5.9 months
Anticipation of 7-month dry spell years	1 in 20 years	1 in 3 years
Average annual evaporation	1,000 mm	1,270 mm
Mean winter temperature	12.2°C	10.5°C
Mean summer temperature	20.5°C	29.4°C

Classifying the Vegetation

The classification system used follows Specht (1970) as shown in Table 2.

Table 2. Vegetation structural formations after Specht (1970)

Life-form and height of tallest stratum	Projected foliage cover of tallest stratum, as %	Description	Reference Code
Trees over 30 m	70-100	High closed-forest	A1
	30-70	High open-forest	A2
	10-30	High woodland	A3
	Under 10	High open-woodland	A4
Trees 10-30 m	70-100	Closed-forest	B1
	30-70	Open-forest	B2
	10-30	Woodland	B3
	Under 10	Open-woodland	B4
Trees under 10 m	70-100	Low closed-forest	C1
	30-70	Low open-forest	C2
	10-30	Low woodland	C3
	Under 10	Low open-woodland	C4
Shrubs over 2 m	70-100	Closed-scrub	D1
	30-70	Open-scrub	D2
	10-30	High shrubland	D3
	Under 10	High open-shrubland	D4
Shrubs under 2 m	70-100	Closed-heath	E1
	30-70	Open-heath	E2
	10-30	Low shrubland	E3
	Under 10	Low open-shrubland	E4
Herbs	70-100	Closed-herbland, closed-grassland, closed-sedgeland, etc.	F1
	30-70	Herbland, grassland, sedgeland, etc.	F2
	10-30	Open-herbland, open-grassland, open-sedgeland, etc.	F3
Hummock grasses	10-30	Hummock grassland	G3
	Under 10	Open-hummock grassland	G4

Subsequent to the vegetation map being published, the shrub categories, under 2 m, were further subdivided into:

1.	Shrubs 1 to 2 m	70-100% cover	Closed-heath
		30-70%	Open-heath
		10-30%	Shrubland
		Under 10%	Open-shrubland
2.	Shrubs under 1 m	70-100%	Low closed-heath
		30-70%	Low open-heath
		10-30%	Low shrubland
		Under 10%	Low open-shrubland

These categories are mentioned in the text.

Mapping the Vegetation

The vegetation map published at 1:250,000 scale, which accompanies this paper, was based upon aerial-photointerpretation of black and white stereo-pairs taken at 1:40,000 scale. These photographs were taken in 1968 and 1969. Unfortunately large areas of vegetation in the Park were burnt just prior to the photographs being taken, while further areas were burnt between then and the time of the survey in 1970. This made aerial-photointerpretation extremely difficult, and as a consequence, other data such as soils and topography were used to assist in delineating boundaries of vegetation types.

Plant Communities

Twelve major plant communities were recognised at the mappable scale. Species that occur in the Park are listed in Aplin and Newbey (1990) and Newbey (1990).

Woodland (B3)

1. Ys. *Eucalyptus occidentalis* - *E.* spp. woodland; confined to the banks and flats of major watercourses and to larger swamps, varies in structural formation from woodland (B3) to low open-woodland (C4).

The understorey high open-scrub layer includes species of *Acacia*, *Allocasuarina*, *Alyogyne*, *Banksia*, *Dodonaea*, *Hakea*, *Labichea*, *Leptospermum*, *Melaleuca*, *Santalum* and *Viminaria*, while the low open shrub layer includes species of *Acacia*, *Allocasuarina*, *Anthocercis*, *Astroloma*, *Brachysema*, *Cassia*, *Dampiera*, *Diplolaena*, *Dodonaea*, *Enchylaena*, *Eutaxia*, *Glischrocaryon*, *Grevillea*, *Guichenotia*, *Hakea*, *Halgania*, *Hibbertia*, *Myoporum*, *Olearia*, *Petrophile*, *Phyllanthus*, *Pimelea*, *Rhagodia* and *Templetonia*. Tufted plants, climbers, ground cover plants and herbs are represented by *Amphipogon*, *Carpobrotus*, *Cassytha*, *Gahnia*, *Isolepis*, *Juncus*, *Kennedia*, *Lepidosperma*, *Patersonia*, *Pelargonium*, *Senecio* and *Tricostularia*, together with members of the Droseraceae, Orchidaceae and Stylidiaceae.

Low closed-forest (C1)

2. Ep. *Eucalyptus platypus* - *E. gardneri* low closed-forest; wrongly depicted on the vegetation map as closed-scrub, whereas in fact the dominant stratum consists of trees, not shrubs, occurs on the face of the scree-slopes of the spongolite cliffs on clayey loam soils. *Eucalyptus platypus* is found towards the base of the cliffs while *E. gardneri* occurs on the upper slopes and the tops of the cliffs. Other tree species present include *Eucalyptus annulata*, *E. astringens*, *E. lehmannii* and

E. transcontinentalis. The low open shrub layer is made up of *Acacia glaucoptera, Boronia ternata, Daviesia benthamii* subsp. *benthamii, Dodonaea concinna, Melaleuca cucullata, M. undulata, Phebalium rude* subsp. *amblycarpum* and *Styphelia intertexta.*

Closed-scrub (D1)

3. Ea. *Eucalyptus angulosa - E. platypus* var. *heterophylla - Melaleuca nesophila* closed-scrub; occurs on coastal sand dunes. Other high shrubs present are *Eucalyptus decipiens, E. falcata* and *E. tetragona.* Ea closed-scrub merges with Ag closed-scrub and the two are synonymous with coastal scrub (Beard 1972).

4. Ag. *Agonis flexuosa* closed-scrub; occurs on coastal sand dunes, and in some areas develops into a low forest. High shrub species present include *Acacia cyclops, A. ligulata, A. rostellifera, A. saligna* and *Exocarpos sparteus.* The low shrub stratum is made up of *Acacia littorea, Acrotriche cordata, Adriana quadripartita, Anthocercis littorea, Hibbertia cuneiformis, Leucopogon parviflorus, Olearia axillaris, Spyridium globulosum* and *Templetonia retusa* together with species of *Agonis, Allocasuarina, Andersonia, Banksia, Beaufortia, Boronia, Bossiaea, Burtonia, Calothamnus, Comesperma, Dryandra, Grevillea, Guichenotia, Gyrostemon, Hakea, Isopogon, Logania, Melaleuca, Opercularia, Pelargonium, Petrophile, Phebalium, Phyllanthus, Phymatocarpus, Pimelea, Pultenaea, Scaevola, Sphaerolobium, Stirlingia, Thomasia* and *Velleia.* Tufted plants, climbers, ground cover plants and herbs include species of *Amphipogon, Anarthria, Carpobrotus, Cassytha, Clematis, Conostylis, Drosera, Isolepis, Kennedia, Lepidosperma, Loxocarya, Mesomelaena, Patersonia, Poa, Stylidium* and *Trachymene.*

Open-scrub (D2)

5. Eg. *Eucalyptus gardneri - E. conglobata - E. nutans* open-scrub; occurs predominantly on the lower slopes of broad valleys. Other high shrub species present include *Eucalyptus annulata, E. celastroides* subsp. *virella, E. incrassata, E. leptocalyx, E. platypus, E. redunca, E. transcontinentalis, E. uncinata, Acacia cyclops, Banksia media, Hakea laurina* and *Santalum acuminatum.* The low closed shrub stratum includes species of *Acacia, Acrotriche, Astroloma, Baeckea, Boronia, Bossiaea, Chamelaucium, Chorizema, Comesperma, Coopernookia, Daviesia, Dodonaea, Eriostemon, Exocarpos, Glischrocaryon, Gompholobium, Grevillea, Hakea, Halgania, Helichrysum, Hibbertia, Isopogon, Leptospermum, Melaleuca, Nematolepis, Olearia, Oxylobium, Persoonia, Petrophile, Phebalium, Pimelea, Platysace, Prostanthera, Santalum* and *Synaphea.* Tufted plants, climbers, ground cover plants and herbs include species of *Amphipogon, Billardiera, Cassytha, Laxmannia, Lepidosperma, Mesomelaena, Sollya* and *Wilsonia.*

6. DH. *Dryandra* spp. - *Hakea* spp. - *Allocasuarina* spp. open-scrub; is found on shallow sandy loam, which is often moderately laterized, overlying spongolite. The high shrub stratum includes *Allocasuarina trichodon, Banksia lemanniana, B. media, Dryandra falcata, D. quercifolia, Eucalyptus gardneri, E. leptocalyx, E. nutans, E. redunca, E. tetragona, E. uncinata, Hakea crassifolia, H. ferruginea, H. laurina, H. marginata, H. trifurcata* and *H. varia.* The low closed shrub stratum includes species of *Acacia, Acrotriche, Agonis, Allocasuarina, Andersonia, Astroloma, Baeckea, Beaufortia, Boronia, Brachysema, Burtonia, Calothamnus, Chorizema, Comesperma, Coopernookia, Dampiera, Dodonaea, Dryandra, Gompholobium, Grevillea, Hakea, Isopogon, Kunzea, Lambertia, Leucopogon, Logania, Lysinema, Melaleuca, Opercularia, Persoonia, Petrophile, Pultenaea, Sphaerolobium, Stackhousia, Verticordia* and *Xanthorrhoea.* Tufted plants, climbers, and herbs include species of *Amphipogon, Anarthria, Cassytha, Drosera, Gahnia, Lepidosperma* and *Mesomelaena* as well as members of the Orchidaceae.

High shrubland (D3)

7. Eu. *Eucalyptus uncinata* - *E. redunca* - *E. incrassata* - *E. tetragona* high shrubland; which merges with Eg open-scrub, is found on the gentle upper slopes of the broad valleys. Other high shrub species present include *Eucalyptus conglobata*, *E. eremophila*, *E. falcata*, *E. gardneri*, *E. lehmannii*, *E. leptocalyx*, *E. nutans*, *E. oleosa* and *E. xanthonema*, *Acacia saligna*, *Allocasuarina campestris* subsp. *campestris*, *A. huegeliana*, *A. trichodon*, *Alyogyne hakeifolia*, *A. huegelii*, *Callitris drummondii*, *Exocarpos sparteus*, *Hakea laurina*, *Labichea lanceolata* subsp. *brevifolia*, *Melaleuca elliptica* and *Santalum murrayanum*. Many of the genera present in the low shrub stratum of both Eg and DH open-scrub are found in Eu high shrubland. Additional genera are *Anthocercis*, *Astartea*, *Brachyloma*, *Callistemon*, *Calytrix*, *Choretrum*, *Commersonia*, *Cryptandra*, *Darwinia*, *Jacksonia*, *Kennedia*, *Lechenaultia*, *Logania*, *Microcorys*, *Mirbelia*, *Phymatocarpus*, *Spyridium*, *Styphelia*, *Templetonia* and *Thomasia*. Tufted plants, climbers, ground cover plants and herbs include those genera found in both Eg and DH open-scrub, as well as *Chamaescilla*, *Conostylis*, *Dianella*, *Disphyma*, *Juncus*, *Lomandra*, *Patersonia*, *Sollya*, *Stylidium*, *Thysanotus* and *Wurmbea*. Eg open-scrub and Eu high shrubland are synonymous with shrubland mallee (Beard 1972).

High open-shrubland (D4)

8. Et. *Eucalyptus tetragona* - *E. buprestium* - *Banksia baxteri* - *B. attenuata* high open-shrubland; occurs on the gently sloping or undulating lightly stripped lateritic soils of the elevated plain. The soils are hard-setting, neutral, mottled sandy loams overlying sandy clay, with a mantle of sand from 200 mm to 2 m in depth. On the deeper sands *E. tetragona* is associated with *B. baxteri* and *B. attenuata*, whereas on shallow sandy soils *E. tetragona* is associated with other *Eucalyptus* species such as *E. decipiens*, *E. falcata*, *E. incrassata*, *E. leptocalyx*, *E. nutans* and *E. redunca*. Other tall shrub species found are *Banksia coccinea*, *B. media*, *B. speciosa*, *Lambertia inermis*, *Nuytsia floribunda*, *Hakea laurina*, *H. victoria*, *Grevillea tripartita* and *Exocarpos sparteus*. The low shrub stratum is similar to those in PL open-heath. Et high open-shrubland is synonymous with mallee heath (Beard 1972).

Closed-heath (E1)

9. PM. Proteaceae - Myrtaceae mixed closed-heath; which occurs on the Proterozoic quartzite, phyllitic schist of the Barren Ranges, is a mixture of vegetation formations, predominantly closed-heath but also attaining the structure of closed-scrub or open-scrub. Proteaceous and myrtaceous elements predominate. Species of *Eucalyptus* endemic to this vegetation type, and in the Park, are *E. coronata*, *E. burdettiana* and *E. sepulcralis*. Other plant taxa endemic in the Park, in this vegetation type, are *Acacia argutifolia*, *A. cedroides*, *A. phlebopetala* var. *pubescens*, *Adenanthos dobagii*, *A. ellipticus*, *A. labillardierei*, *A. venosus*, *Anthocercis fasciculata*, *Baeckea ovalifolia*, *Calothamnus validus*, *Calycopeplus marginatus*, *Coopernookia georgei*, *Goodenia stenophylla*, *Grevillea fistulosa*, *G. infundibularis*, *Hakea hookeriana*, *Jacksonia compressa*, *Lechenaultia superba*, *Melaleuca citrina*, *Regelia velutina*, *Stylidium albomontis* and *S. galioides*. Undescribed species of *Acacia*, *Agonis*, *Grevillea*, *Hibbertia* and *Monotoca* found in this vegetation type are probably restricted to it (Newbey 1990). Shrub species present include *Banksia attenuata*, *B. baueri*, *B. baxteri*, *B. coccinea*, *B. lemanniana*, *B. nutans* var. *nutans*, *B. oreophila*, *B. violacea*, *Dryandra falcata*, *D. plumosa*, *D. pteridifolia* and *D. quercifolia*. Also present are species of *Acrotriche*, *Allocasuarina*, *Andersonia*, *Beaufortia*, *Bossiaea*, *Chamelaucium*, *Chorizema*, *Comesperma*, *Conospermum*, *Conothamnus*, *Dampiera*, *Darwinia*, *Daviesia*, *Eutaxia*, *Exocarpos*, *Gompholobium*, *Hypocalymma*, *Isopogon*, *Kunzea*, *Lambertia*, *Lasiopetalum*, *Leptomeria*, *Leptospermum*, *Nuytsia*, *Persoonia*, *Petrophile*, *Platysace*, *Pomaderris*, *Pseudanthus*, *Rhadinothamnus*, *Scaevola*, *Siegfriedia*, *Sphenotoma*, *Spyridium*, *Stachystemon*, *Tetratheca* and *Thomasia*. Tufted plants, climbers and herbs

include species of *Anarthria, Athrixia, Billardiera, Conostylis, Dasypogon, Drosera, Isolepis, Kennedia, Lepidosperma, Patersonia, Sollya* and *Thelymitra.*

10. LM. Leguminosae - Myrtaceae mixed closed-heath; which occurs on the pediments adjacent to the coast, is wind-pruned to a height barely exceeding 1 m and is therefore a low closed-heath. The low shrub layer includes species of *Acacia, Acrotriche, Banksia, Calothamnus, Daviesia, Eucalyptus, Guichenotia, Hakea, Hibbertia, Leptomeria, Leptospermum, Melaleuca, Olearia, Phebalium, Pimelea, Pultenaea, Rhagodia, Scaevola, Templetonia* and *Westringia.*

Open-heath (E2)

11. PL. Proteaceae - Leguminosae - Myrtaceae mixed open-heath; found on the gently undulating elevated plain, usually in exposed situations, mostly in the northern portion of the Park, is synonymous with heath (Beard 1972). This formation is difficult to differentiate from Et high open-shrubland, with which it merges, after severe fires, as the only structural form that separates these two is the presence of a tall open shrub layer in the high open-shrubland. The mid-dense to dense low shrub layer in PL and Et are floristically rich and similar in species composition. Both contain species of *Acacia, Acrotriche, Actinodium, Adenanthos, Andersonia, Astartea, Astroloma, Baeckea, Banksia, Beaufortia, Boronia, Brachysema, Burtonia, Calectasia, Chamelaucium, Comesperma, Coopernookia, Cryptandra, Dampiera, Darwinia, Dasypogon, Daviesia, Dryandra, Eriostemon, Eutaxia, Franklandia, Gastrolobium, Glischrocaryon, Gompholobium, Goodenia, Grevillea, Hakea, Helichrysum, Hibbertia, Hovea, Hypocalymma, Isopogon, Jacksonia, Kunzea, Lasiopetalum, Latrobea, Lechenaultia, Leptomeria, Leptospermum, Leucopogon, Logania, Lysinema, Melaleuca, Microcorys, Monotoca, Oligarrhena, Opercularia, Persoonia, Petrophile, Phymatocarpus, Pimelea, Platysace, Pultenaea, Sphaerolobium, Spyridium, Stachystemon, Stackhousia, Stirlingia, Styphelia, Synaphea, Templetonia, Verticordia* and *Xanthorrhoea.* Tufted plants, climbers and herbs include species of *Agrostocrinum, Amphipogon, Anarthria, Anigozanthos, Billardiera, Cassytha, Caustis, Chamaescilla, Conostylis, Cyathochaeta, Dianella, Diuris, Drosera, Gahnia, Haemodorum, Hypolaena, Johnsonia, Laxmannia, Lepidosperma, Lomandra, Loxocarya, Lyginia, Lyperanthus, Mesomelaena, Patersonia, Restio, Schoenus, Sollya, Stylidium* and *Tricostularia.*

Closed-herbland (F1)

12. S. Sedgelands and Swamp Complexes; occur in and around shallow intermittent lakes and swamps on the undulating elevated plain and the sandy plain. The grey silty surface soils are underlain by brown or mottled clay. Several plant communities make up the vegetation complexes, and of these the sedge component consisting of species of *Anarthria, Baumea, Caustis, Cyathochaeta, Gahnia, Isolepis, Lepidosperma, Lyginia, Mesomelaena* is most consistently represented. *Eucalyptus occidentalis* woodland and *Melaleuca cuticularis* low woodland may be present in and around the larger swamp complexes. The shrub stratum is made up of species of *Acacia, Chorizema, Coopernookia, Hakea, Isopogon, Kunzea, Leptospermum, Petrophile and Pultenaea.* The prostrate *Wilsonia humilis* is often the only ground-cover species on otherwise bare areas. *Halosarcia pergranulata* subsp. *pergranulata* is present in saline depressions.

Minor plant communities

Plant communities present in the Park as non-mappable units include granite complexes which occur in the northern portion of the Park and which range from lichen-encrusted rocks, through clumps of very low *Borya constricta* in small pockets of soil, *Melaleuca elliptica - Calothamnus quadrifidus* closed-heath in shallow soils, to *Melaleuca uncinata - Allocasuarina campestris* subsp.

campestris open-scrub in deeper soils away from granite exposures. *Allocasuarina campestris* subsp. *campestris* high shrubland, with a mixed heath understorey forms a continuum between the *Melaleuca uncinata* - *Allocasuarina campestris* subsp. *campestris* open-scrub and Et high open-shrubland.

A summary of the relationships between plant communities and the physical environment in the Park is shown in Table 3.

Table 3. Relationships between plant communities and the physical environment in the Park

Plant communities	Physical environment		
	Soils	Geology	Topography
PM, LM	Skeletal soils and shallow sandy loam	Proterozoic quartzite and phyllitic schist	Ranges
PL	Colluvial sand		
Eu	Colluvial loam		
Et	Truncated laterites	Proterozoic gneisses and migmatites	Elevated plain
PL	Colluvial sand		
Eu, DH	Duplex soils	Eocene spongolite	
Ys, S	Swamp soils	Both bedrock types	
Et	Truncated laterites	Archaean gneisses and migmatites	Northern plain
PL	Colluvial sand		
Eu	Drainage line colluvium		
Granite complex	Skeletal soils		
Eu	Duplex soils	Eocene spongolite	Gorge and valley floors
Eg, Ep	Colluvial loam		
Ys	Alluvium		
Ea, Ag	Siliceous sand	Recent sands	Coastal dunes
Ea	Calcareous sand		

Discussion

The only plant community restricted in its distribution to the Park is the PM mixed closed-heath which occurs on the Ranges.

In general terms communities which develop greater amounts of biomass, such as Ys woodland, Ep low closed-forest and Eg open-scrub, occur on the valley floors and lower slopes, whereas shrubland and mixed heath communities, which develop lesser amounts of biomass, are present on the upper slopes and on the elevated plains. The dominant genus in the woodland and shrubland communities is *Eucalyptus*, although in deeper sandy soils it is replaced by *Banksia*. The mixed scrub and heath communities have predominantly Proteaceous, Myrtaceous and Leguminous elements.

Sclerophyllous scrub, shrubland and heath communities, often collectively referred to locally as sandplain, sandheath or Kwongan (Beard 1976), which develop on nutrient-poor soils in a

Mediterranean climate, usually have a high species richness and a high degree of endemism (Raven 1971). Two factors responsible for this rapid genetic differentiation and speciation, applicable in south-western Australia, are the existence of complex edaphic mosaics and the stresses brought about by major climatic changes and year to year fluctuations (Hopper 1979). The high species richness and endemism in the flora of the Park has been dealt with separately (Aplin and Newbey 1990).

Milewski (1983), who compared the ecosystem of the Barrens with that of a similar nutrient-poor ecosystem in South Africa, found that in both regions, plants in general live long, have parts that grow slowly, have much of their biomass underground, are woody and unpalatable, and are associated with underground fungi. He also found that the plants attracted warm-blooded pollinators, were able to recycle nutrients, survive damage by consumers and fire, and set few seeds. Some striking discrepancies between the two ecosystems were the much taller vegetation, the more prickly, resinous or toxic nature of the leaves of shrubs and the paucity of fleshy rhizomatous plants in the Western Australian ecosystem.

Pate and Dixon (1982) showed that underground fleshy storage organs in Western Australian plants were associated with all life forms. They listed 204 species possessing underground storage organs; of these, 66 species were recorded in this survey in the Park with 33 species, or 30% of this number in the Orchidaceae, 8 species in the Droseraceae and 6 species in the Liliaceae. These organs are important structures for the plant's ability to regenerate after fire or to evade drought conditions.

A Raunkerian life form spectrum of the elements in the Park showed that phanerophytes made up 68% of the total number of species of which 85% or nearly 57% of the total, were nanophanerophytes; chamaephytes 3%, hemicryptophytes 12%, geophytes 6% and therophytes 10.5% (Aplin and Newbey 1990). The life form spectrum gives a clear indication of the dominance of shrub species, and other woody perennial species, in the vegetation of the Park.

Acknowledgements

We wish to thank I.L. Lethbridge for technical assistance in the field; Vicki Hamley for her patience in typing the several drafts; and Cheryl Lynch and Karen Barker for assistance in the preparation of the paper. Cartography was performed by the Cartographic Section, Lands and Surveys Department. Financial assistance from the Science and Industry Environment Fund (to KRN) to undertake a regional plant ecology study is gratefully acknowledged.

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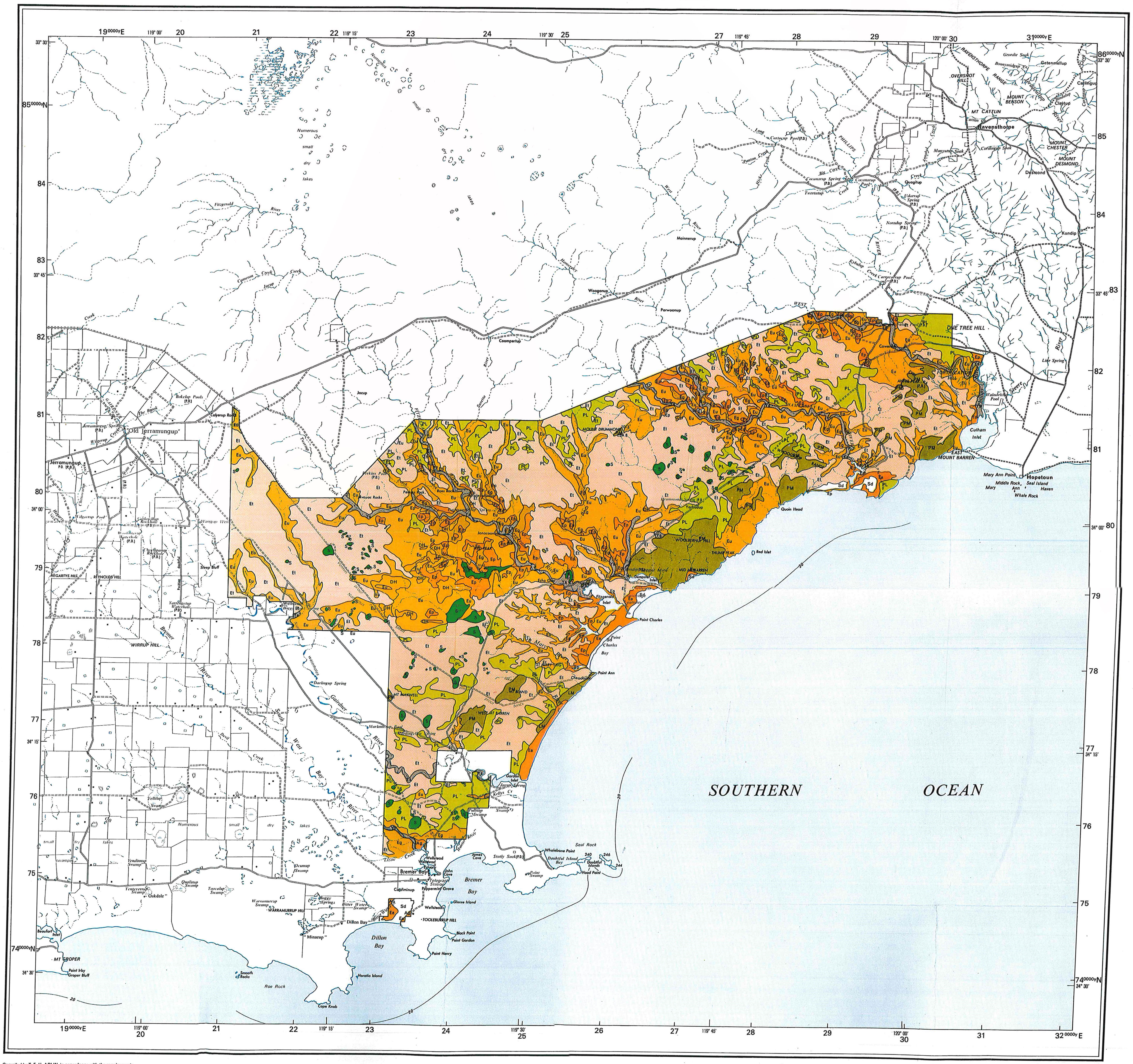
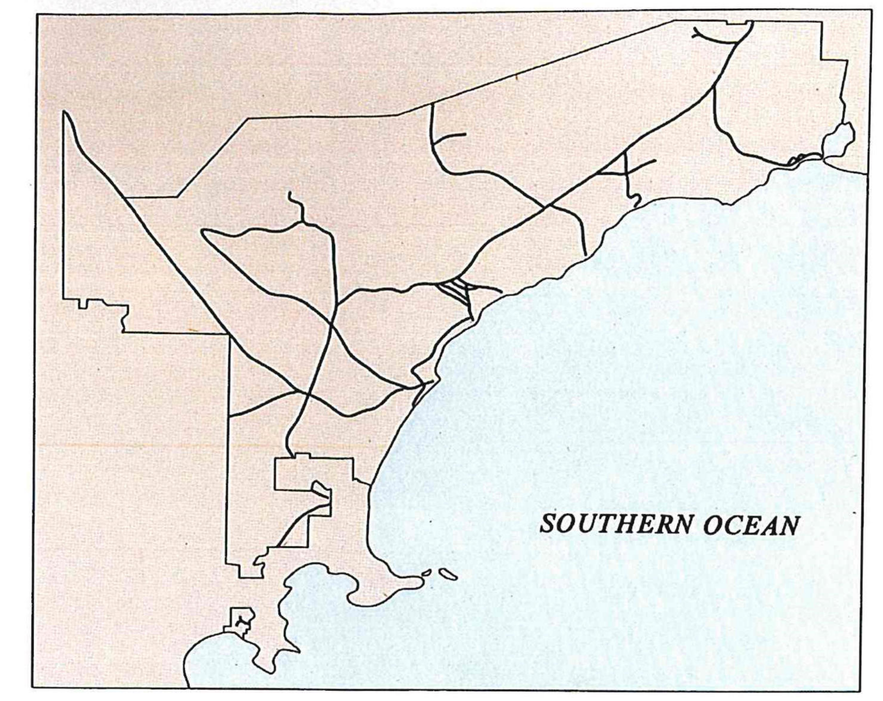
FITZGERALD RIVER NATIONAL PARK



VEGETATION SURVEY TRAVERSES



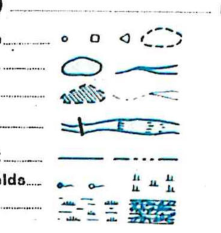
LEGEND

VEGETATION STRUCTURE

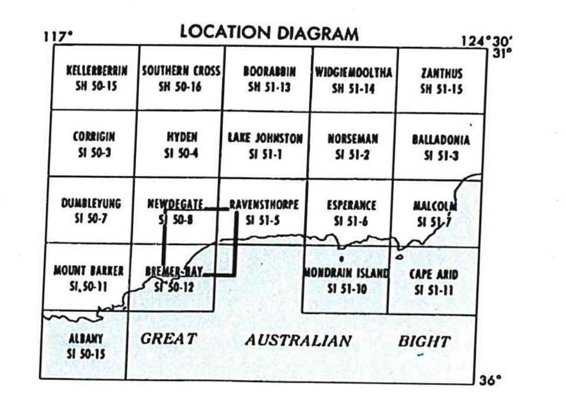
LIFE FORM AND HEIGHT OF TALLEST STRATUM	FORMATION	PROJECTIVE FOLIAGE COVER OF TALLEST STRATUM, PER CENT
TREES (Above 30 metres)	High closed forest	70-100
	High open forest	30-70
	High woodland	10-30
	High open woodland	BELOW 10
TREES (10 to 30 metres)	Closed forest	70-100
	Open forest	30-70
	Woodland	10-30
	Open woodland	BELOW 10
TREES (Below 10 metres)	Low closed forest	70-100
	Low open forest	30-70
	Low woodland	10-30
	Low open woodland	BELOW 10
SHRUBS (Above 2 metres)	Closed scrub	70-100
	Open scrub	30-70
	High Shrubland	10-30
	High open shrubland	BELOW 10
SHRUBS (Below 2 metres)	Closed heath	70-100
	Open heath	30-70
	Low open shrubland	BELOW 10
HERBS	Closed herbland	70-100
	Herbland	30-70
	Open herbland	10-30
HUMMOCK GRASSES	Hummock Grassland	70-100
	Open Hummock Grassland	30-70
BARREN	Sand Dunes	Sd
CLEARED LAND		

PLANT ASSOCIATIONS

Agonis flexuosa .... Ag
Dryandra spp.—Hakea spp.—Casuarina spp. .... DH
Eucalyptus gardneri—E. conglobata—E. nutans .... Eg
E. platypus—E. gardneri .... Ep
E. angulosa—E. platypus var. heterophylla—Melaleuca nesophila .... Ea
E. tetragona—E. bupestrium—Banksia baxteri—B. attenuata .... Et
E. uncinata—E. redunca—E. incrassata—E. tetragona .... Eu
Leguminosae—Myrtaceae (Mixed Coastal Heath) .... LM
Proteaceae—Leguminosae—Myrtaceae (Mixed Sand Heath) .... PL
Sedgelands and Swamp Complexes .... S
Eucalyptus occidentalis—E. spp. .... Ys
Proteaceae—Myrtaceae (Mixed Rock Heath) .... PM



LOCATION DIAGRAM



VEGETATION
FITZGERALD RIVER NATIONAL PARK
WESTERN AUSTRALIA

Compiled by T. E. H. APLIN, in accordance with the requirements of the Western Australian Vegetation Survey Committee from aerial photography flown 1968 and 1969, and field surveys carried out by the author from July, 1970 to January, 1971.
Drawings prepared under the direction of the Surveyor General, Department of Lands and Surveys, Western Australia, on base maps made available by courtesy of the Director of National Mapping, Department of National Development, Canberra, and printed by the Government Printer of Western Australia.

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Scale 1:250,000

5 0 5 10 15 20 25 Statute Miles
5 0 5 10 15 20 Nautical Miles
10,000 0 10,000 20,000 30,000 Yards
5 0 5 10 15 20 25 Kilometres

ELEVATIONS SHOWN IN FEET
VERTICAL DATUM IS BASED ON MEAN SEA LEVEL, FREMANTLE

TRANSVERSE MERCATOR PROJECTION
HORIZONTAL DATUM IS BASED ON PERTH OBSERVATORY, LATITUDE 31°57'09.63"S LONGITUDE 115°50'26.10"E

GRID NUMBERS INDICATE THE 10,000 YARD TRANSVERSE MERCATOR GRID, ZONE 2 (AUSTRALIA SERIES) CLARKE 1858 SPHEROID
THE LAST FOUR DIGITS OF THE GRID NUMBERS ARE OMITTED

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