VEGETATION SURVEY OF WESTERN AUSTRALIA

THE VEGETATION OF THE

ALBANY & MT. BARKER AREAS

WESTERN AUSTRALIA

MAP AND EXPLANATORY MEMOIR

1:250,000 SERIES

by J S Beard

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VEGETATION SURVEY OF WESTERN AUSTRALIA

Index to 1:250,000 Series

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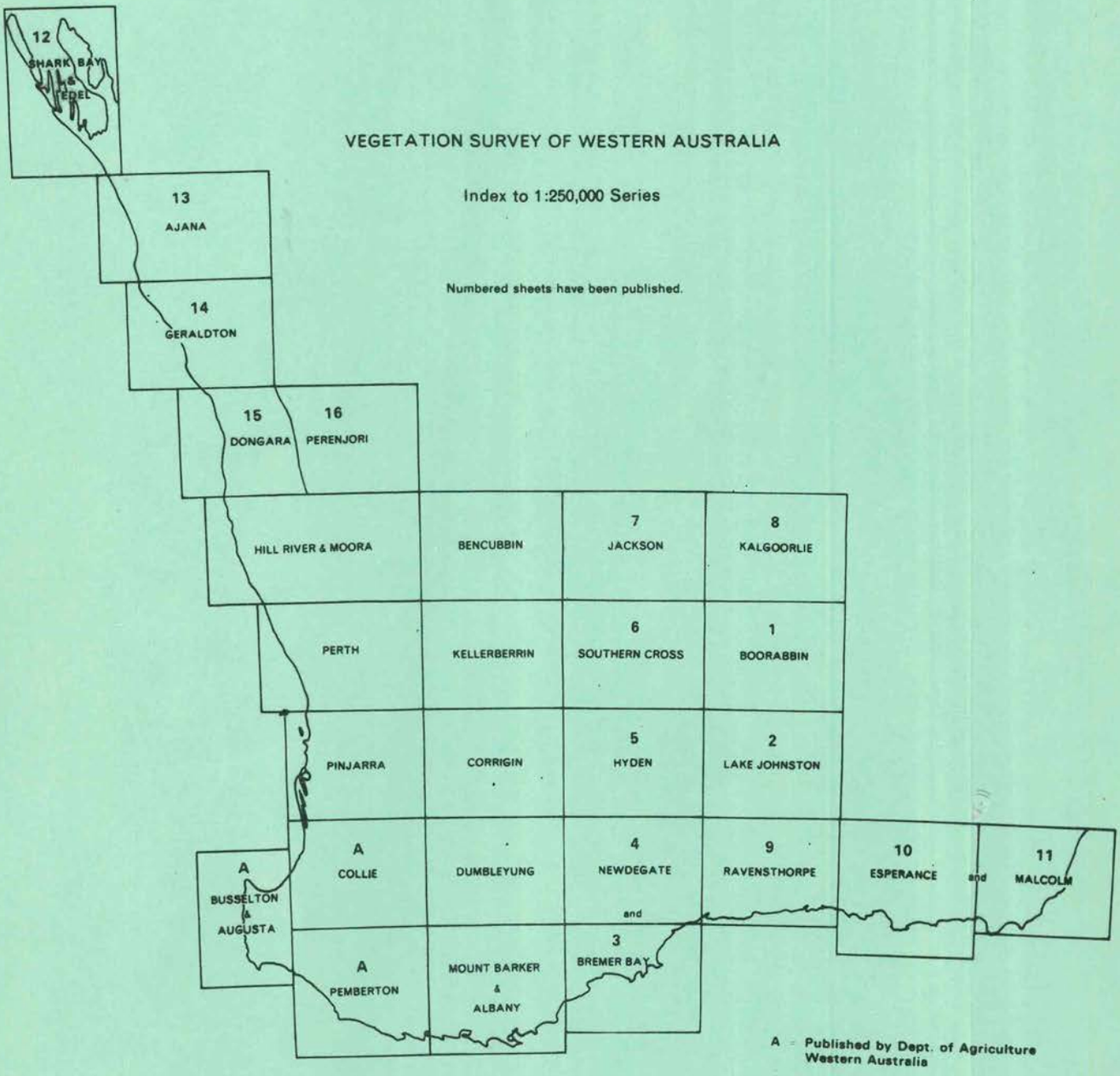

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VEGETATION SURVEY OF WESTERN AUSTRALIA

EXPLANATORY MEMOIR TO 1:250,000 MAP SHEET

THE VEGETATION OF THE ALBANY & MT. BARKER AREAS

BY J.S. BEARD

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I. INTRODUCTION

The vegetation map "Albany and Mt. Barker" has been produced by combining the Albany and Mt. Barker sheets of the standard topographic series which are used as a base. The combined sheet extends from $34^{\circ}0'$ to $35^{\circ}8'$ south latitude and from $117^{\circ}00'$ to $118^{\circ}30'$ east longitude.

The first sighting of the south coast of Australia by Europeans was made by the Dutch captain Thyssen in the *Gulde Zeepaerd* in 1627, exploring it east as far as the Bight and naming it Nuytsland after the Dutch East India Company's official aboard the vessel. There were no other visitors for 150 years until French and British vessels began a more systematic survey of the coast. Expeditions arrived by coincidence in pairs. In September 1791 Vancouver on his way to the western coast of America explored the area he named King George Sound, landing in several places. Vancouver actually took possession of the land for the crown of Britain, at Point Possession, but this was never officially acknowledged by the British Government. Vancouver named many others of the coastal features (Data from Garden 1977).

Archibald Menzies, the naturalist aboard this expedition, wrote enthusiastically :

"If we may judge of the fertility of the country in general from the luxuriancy of vegetation in many places, we may pronounce the tract within our view capable with a little labour of sustaining thousands of inhabitants with the necessaries as well as the comforts of life".

Menzies made the first botanical collection in south-Western Australia, here at this time, though the results were not published until much later, by Robert Brown (1810).

In December of the same year the French under Bruny d'Entrecasteaux sighted but were blown past King George Sound, landing later at Esperance. The next Franco-British pair arrived in 1801-3, first Matthew Flinders in the *Investigator* who was accompanied by the botanist Robert Brown, the scientific illustrator Ferdinand Bauer and the horticulturist P. Good. The French ships *Geographe* and *Casuarina* entered King George Sound in February 1803, accompanied by the botanist Leschenault de la Tour. Further round the coast they encountered an American sealing vessel and named the spot Two Peoples Bay in consequence. This shows that there were already vessels visiting the coast at that time other than official explorers. Convict ships making for Sydney passed that way and may often have called for water and repairs.

W. Baxter collected specimens and live plants for Henchman's nursery in England on the south coast in 1823-25, travelling by sealing vessels, but it is not certain that he visited King George Sound. It is documented that he did do so in 1828-29 (Diels 1906 : N. Marchant *pers. comm.*).

Lt. King called at King George Sound in January 1818 and December 1821 in the course of his surveys of the Australian coast enabling the botanist,

Allan Cunningham, to collect there and Captain J.S. Dumont d'Urville passed through with another French party in 1826. It was widely rumoured (incorrectly) that he intended to take possession of the land for France; in any case the British had already decided to claim it and a party of soldiers and convicts under Major Lockyer in the brig *Amity* was landed on December 25th, 1826. Their settlement was at first called Frederickstown after Frederick Augustus, Duke of York and Albany, second son of George III, but the name was later changed to the shorter Albany using one of the Duke's titles. The intention was to establish a penal settlement as an outpost of Sydney but it proved very difficult to maintain communications owing to the prevailing westerly winds along the south coast and the settlement was withdrawn in 1831 after Captain Stirling's colony on the Swan River had been established. The first party overlanded from Fremantle in summer 1830-31, Captain Thomas Bannister, George Smythe (a Government surveyor) and two others. A small garrison was brought round by sea from the Swan, and Albany was proclaimed part of the new Colony in March 1831. Thereafter free settlers gradually - very gradually - occupied Albany and its hinterland (Garden 1977).

For a very long time settlement was frustrated by the extreme infertility of the surrounding country. Charles Darwin, who landed there on the home voyage of the *Beagle* in March 1836, proved a more penetrating observer than the rosy-tinted Menzies:

"The general bright green colour of the brushwood and other plants viewed from a distance, seemed to bespeak fertility. A single walk, however, will quite dispel such an illusion; and he who thinks with me will never wish to walk again in so uninviting a country." (Darwin 1839).

For many years the port of Albany survived as an isolated settlement living from the sea as a centre for sealing and whaling and as a port of call. A coaling station was established in 1852 when steamships were introduced, and the Colony's mails were shipped in and out through Albany. Parties pushing inland from Albany reported better land in the interior but the first settlements failed when sheep were killed by poisonous plants. For the same reason attempts to overland sheep between Albany and the Swan failed. Once this menace was recognised however pastoral leases were gradually taken up beginning on the Hay River west of Mt. Barker and at Kendenup, and were followed by agricultural settlement. By 1870 some small areas around Albany itself and at Kendenup had been alienated and by 1900 there had been a little further expansion, at Cranbrook, Mt. Barker, Albany and Denmark. The opening of the Great Southern Railway connecting Perth and Albany in 1889 failed substantially to stimulate settlement, though timber cutting first for railway sleepers and then for the general market began at Torbay and later Denmark, to which the railway was extended. The prosperity of Albany was improved by activities following the discovery of gold at Coolgardie in 1893. Between 1900 and 1930 settlement of the country between Mt. Barker and Kojonup was completed, and the coastal strip

from Albany to Denmark. Advances in farming techniques permitted the huge areas of infertile soils on the Kalgan Plains and between Albany and Narrikup to be taken up only as recently as since the second World War while the hinterland west of Narrikup has remained substantially under its native forest until now, much of it proclaimed as State Forest. A considerable area of natural vegetation is preserved in the Stirling Range National Park and in the various smaller National Parks and reserves (Bolton, Cooper and Murray 1979).

The first land-based botanical exploration was carried out by the resident botanist James Drummond and the German visitor Ludwig Preiss in 1839 who often collected together and collaborated in an attempt to identify the cause of the serious stock losses that were occurring. Drummond at first suspected *Isotoma hypocrateri formis* as a poison plant but Preiss identified *Gastrolobium calycinum* (York Road Poison) as the cause of deaths though at first he discounted poisonous properties and said it was only an irritant. Drummond later confirmed the poisonous nature of *Gastrolobium* by experiment (Erickson 1969).

In 1846 Drummond again came south, examining the Stirling Range botanically for the first time, and crossing the Kalgan Plains to Cape Riche, thence to Albany. He passed through Albany again in 1848 on his way to explore further east in the Barren Ranges.

Dr. W.H. Harvey collected between Perth and Albany in 1854. The great botanist Ferdinand von Mueller landed at Albany on a visit from Melbourne in 1967 and botanised rather thoroughly over the south coast, Porongurups and Stirlings, and the sand plains. He came again ten years later on an invitation from the Government of Western Australia to report on the forest resources of the Colony, travelling through Fremantle, and the contacts made on these visits secured numerous correspondents who collected for him and sent him specimens. Maxwell and Oldfield are prominent as general collectors. Webb sent a collection from Mt. Lindesay, Hassell from the Pallinup River. All these collections were documented in von Mueller's *Fragmenta* and contributed to Bentham's *Flora Australiensis* (1863-78).

The German botanists Diels and Pritzel visited Western Australia from October 1900 to December 1901, travelling as widely as possible and including the Stirlings and Albany in their orbit. Their observations were incorporated in Diels' book of 1906, the first and still the only detailed account of the flora and vegetation of the southern half of the State.

All the names of the early botanical pioneers have been perpetuated in plant names from *Banksia menziesii* to *Eucalyptus dielsiana*.

In the present century knowledge of the flora continued to be expanded by Government Botanist C.A. Gardner and his staff and collaborators including Dr. W.E. Blackall who originated the "Blackall Key" (Blackall

and Grieve, 1954 - 1975). Many flowers and plants of the Albany - Mt. Barker district were illustrated by Erickson *et al.* 1973. An account of the flora of the Stirling Range was published by George (1969) and a checklist of the flora later compiled by Hussey (1977).

Vegetation studies in the district have been few. A detailed study of the vegetation of Bald Island was made by Storr (1965) and of some communities in the Torndirrup National Park by Enright (1978). Vegetation maps of adjoining areas have been published, the Bremer Bay sheet by Beard (1972) and the Pemberton sheet by Smith (1972). Portion of the area falls within the account of the Darling Botanical District by Speck (1958). There is a paper on the distribution and prehistory of *Eucalyptus diversicolor, E.marginata* and *E.calophylla* by Churchill (1968) which applies in part to this district, and data on the Karri and Jarrah forests of the adjoining Pemberton area in relation to climate and soils by McArthur and Clifton (1975) are applicable.

II. METHODS OF SURVEY

The author visited the Albany-Mt. Barker district cursorily on a number of occasions from 1962 and carried our field work expressly for the vegetation mapping in September and October 1975 and April 1978. Road traverses taking detailed notes of the plant cover, soils, topography and so on were made systematically. Some mountain areas were covered on foot. The vegetation map was compiled in 1978 and shows original natural vegetation. In agricultural areas this is the vegetation inferred to have existed before settlement on the evidence of relics on roadsides and in paddocks and with reference to the topography and soil as seen in photo patterns. Since most of such country has only been recently cleared there is still much of the original vegetation to be seen. On Crown Land the present vegetation is normally assumed to represent the original.

Mapping was done on semi-controlled photo-mosaics compiled in the format of the 1:50,000 National Series (A.M.G.) by the Dept. of Lands and Surveys of W.A. from aerial photgraphy dated February 1973, and was reduced for compilation at 1:250,000. The vegetation map was drawn onto a topographic base provided by the Division of National Mapping, Canberra. Much assistance in mapping was afforded by Forests Dept. Stock maps scale 1:63,360 covering the State Forests, vacant Crown Land and timbered private land, also Forests Dept. district maps scale 1:50,000. It should be noted that the Denmark sheet in the latter series shows Karri stands remaining on private land and not the original extent of Karri which was much greater.

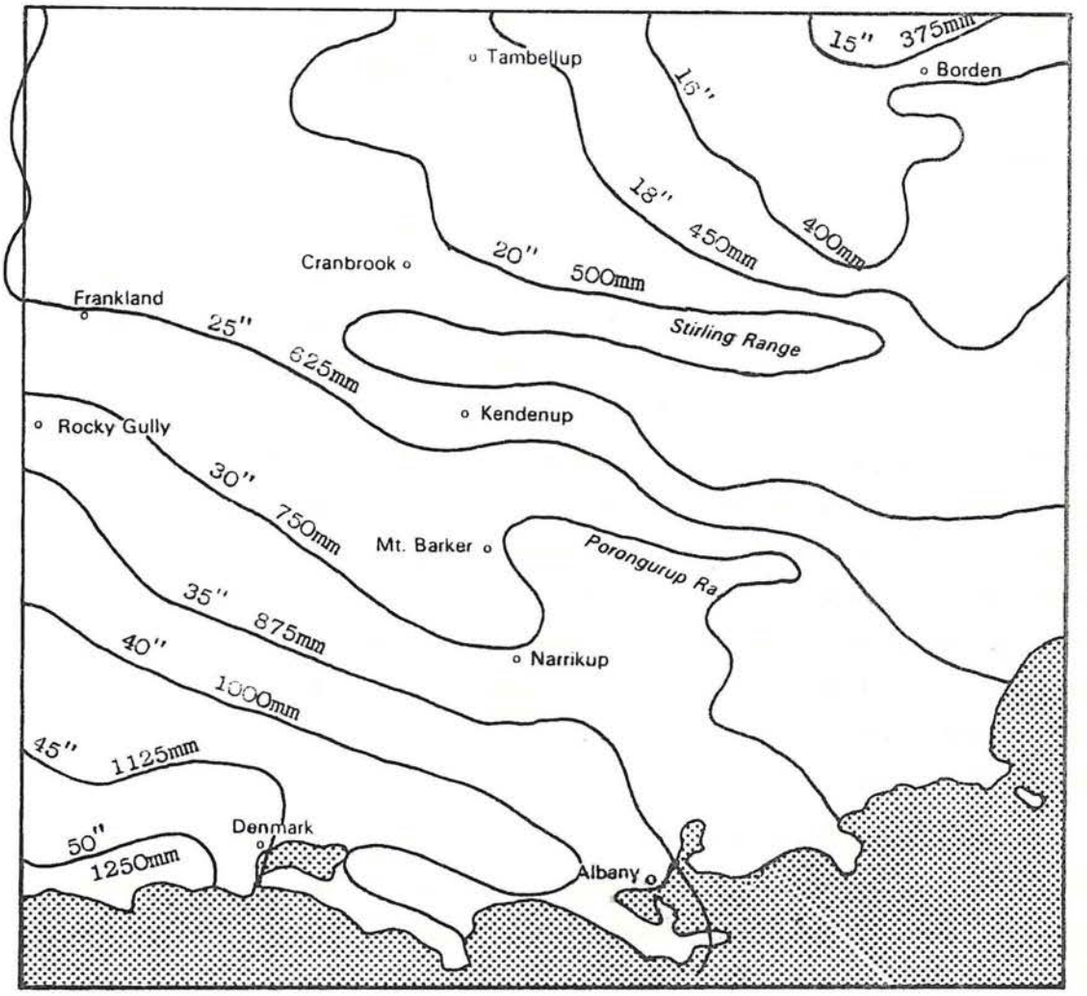

FIG. 1 - Rainfall map taken from the State map by the Commonwealth Bureau of Meteorology 1962.

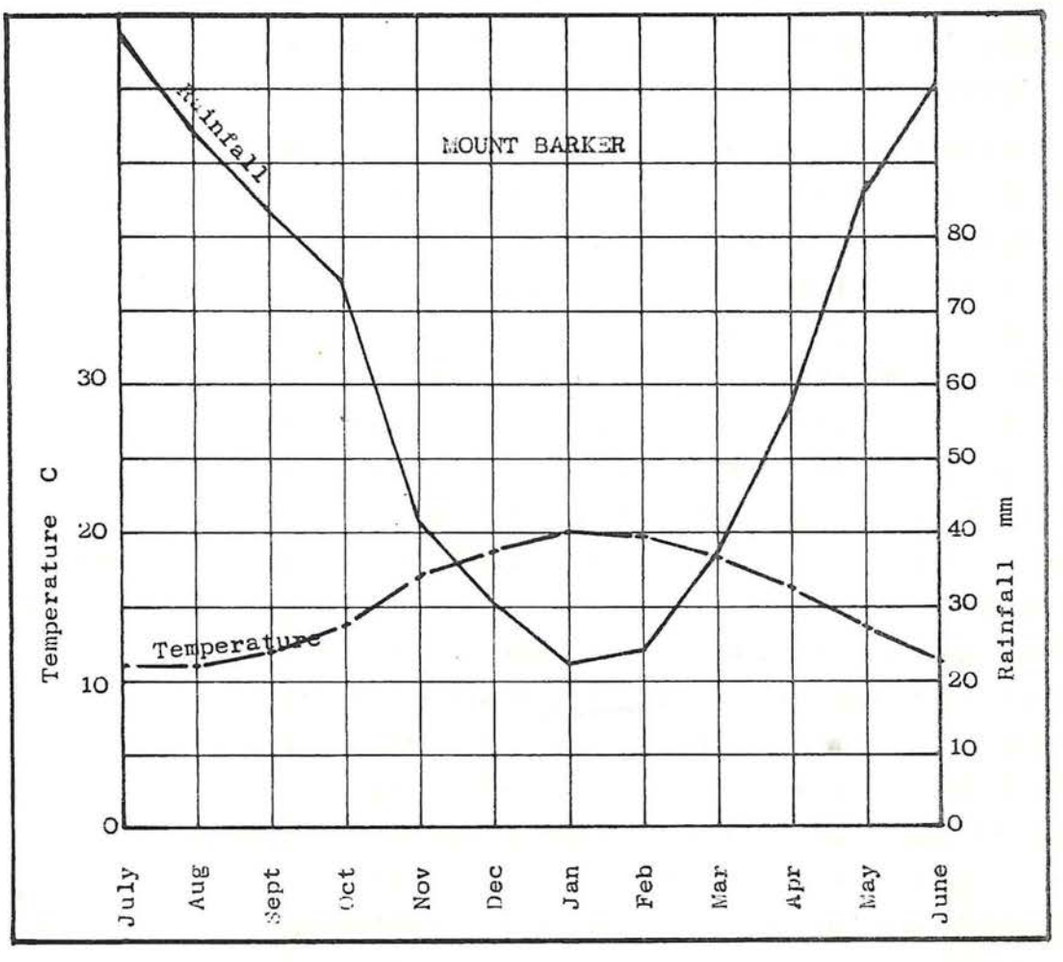

FIG. 2 - Ombrothermic Diagram showing average monthly rainfall and temperature recorded at Mt. Barker.

III. DESCRIPTION OF THE AREA

A. CLIMATE

There is a steep rainfall gradient from south-west to north-east across the Albany-Mt. Barker area as shown in the rainfall map (Fig. 1) which is taken from the rainfall map of the State published by the Bureau of Meteorology in 1962 with isohyets in inches. Average annual rainfall exceeds 50 inches (1250mm) west of Denmark, falling to 15 inches (375mm) at Borden. Meteorological stations recording daily rainfall, temperature and relative humidity are or have been maintained at Albany Airport, Denmark Research Station, Eclipse Island Lighthouse and Mount Barker Post Office while Kojonup and Ongerup are situated just north of the map boundary giving data for further inland. Figures are available in the Bureau's "Climate Averages" 1975 from which data are given in Table I for selected stations chosen to represent coastal, central and inland situations.

Albany has the reputation relative to the more northerly parts of the State of being cool and rainy throughout the year. While there is a winter rainfall maximum, summer rainfall is substantial and the number of wet days averages almost 1 in 2 for the year. Both winters and summers are mild, August the coldest month, January the warmest. Frost is unknown and extreme heat linked to rare heatwaves. Humidity is high. Towards the interior rainfall declines and becomes less reliable. The number of rainy days becomes halved and humidity declines, the winter becomes colder and the summer hotter.

Availability of moisture is the most important characteristic of climate for plant growth, and this is a function of the amount of precipitation, its distribution throughout the year, and temperature. These characteristics are usefully embodied in so-called "ombrothermic diagrams" (Bagnouls and Gaussen 1957); a representative one, for Mt. Barker, is given in Fig. 2. Graphs for monthly mean temperature in ^{o}C and monthly mean rainfall in mm are plotted, the former on double the scale of the latter. Temperature rises in summer, rainfall decreases. The period during which the rainfall line falls below the temperature line is presumed to be "dry"; precipitation is less than that required to maintain growth, and moisture stress may occur. The average dry period at Mount Barker is given in the diagram as 3.6 months and the whole district from there to the coast enjoys a similar short dry season, falling into a climatic classification of Moderate Mediterranean (UNESCO-FAO 1963), defined as having a winter rainfall maximum and a dry season of less than 4 months. Inland of the 25-inch isohyet the dry season lengthens to 4-6 months. Confirmation of this assessment based on Bagnouls and Gaussen is obtained from the determination of the length of the growing season for agricultural purposes - that is, the wet season

TABLE 1

METEOROLOGICAL DATA FOR SELECTED STATIONS

Monthly precipitation in millimetres - temperatures in °C.

	JAN	FEB	MAR	APR	MAY	JUN	JUL	AUG	SEP	OCT	NOV	DEC	YEAR
ALBANY AIRPORT													
Rainfall - Mean	19	21	33	72	89	102	122	113	86	82	43	33	815
- Median	13	16	24	70	69	102	103	101	83	64	33	29	837
Raindays - No.	9	8	11	16	17	20	23	22	19	14	10	10	179
Mean Temp. - Max.	25.8	25.4	24.2	21.0	18.5	16.3	15.7	15.5	16.7	18.8	21.1	23.9	20.2
- Min.	13.3	13.9	12.9	11.6	9.5	8.1	7.4	6.8	7.4	9.0	10.4	12.4	10.2
Rel. Hum. % 3 p.m.	51	54	57	63	65	70	70	68	67	68	65	58	63
MOUNT BARKER													
Rainfall - Mean	22	24	37	57	86	101	107	94	83	74	41	30	756
- Median	15	14	27	47	78	95	105	88	79	68	33	27	745
Raindays - No.	8	7	10	13	17	20	21	20	18	16	11	10	171
Mean Temp. - Max	27.4	26.3	24.7	21.0	18.1	15.5	14.8	15.0	16.5	19.2	21.8	24.9	20.4
- Min.	13.3	13.6	12.7	10.8	8.7	7.5	6.5	6.0	6.7	8.3	10.0	12.0	9.7
Rel. Hum. % 3 p.m.	47	46	49	59	64	73	71	67	64	59	55	50	59
ONGERUP													
Rainfall - Mean	17	17	25	26	46	55	50	42	38	35	23	14	388
- Median	9	8	16	20	46	47	49	41	34	30	17	9	395
Raindays - No.	3	3	4	5	9	12	13	12	10	8	5	3	87
Mean Temp. - Max.	29.2	28.0	25.3	21.9	18.4	15.6	14.8	15.0	17.0	21.0	24.4	27.4	21.5
- Min.	13.6	13.8	12.4	10.5	8.1	6.7	5.5	5.0	5.7	8.0	10.2	12.3	9.3
Rel. Hum. % 3 p.m.	32	34	40	46	53	63	62	57	53	43	36	31	46

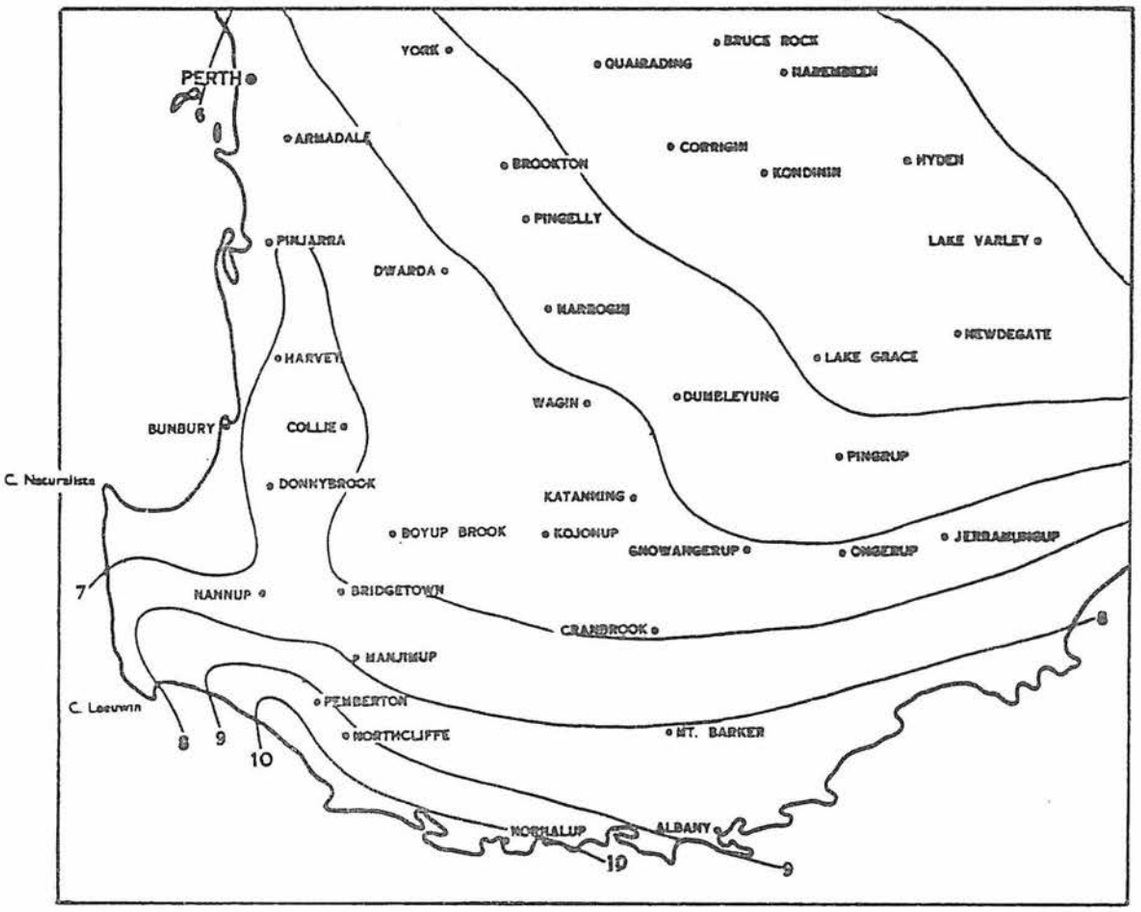

FIG. 3 - Map of the South-west showing period during which average rainfall exceeds effective rainfall (from official Yearbook of W.A.).

instead of the dry season - made from the Prescott formula (Prescott 1952) where $r = 0.54 \times e^{0.7}$, r being effective rainfall for the month and e mean monthly evaporation. If effective rainfall so calculated for any month is exceeded by the average rainfall that is a "wet" month. Fig. 3 is an extract from the map published in the Yearbook of Western Australia 1965 and shows the line for 8 wet months, the equivalent of 4 dry months. This line, which runs just north of Mt. Barker, will be found to be significant in discussing the distribution of Karri. Major occurrences of Karri lie south of the line for 9 wet months but outlines of Karri occur up to the 8-month line.

The eastward extension of an area with a long growing season reaching, as it does, as far as Bremer Bay is at variance with the pattern of annual rainfall totals which decline steadily in an easterly direction. At Manjimup on the 8 wet month line the rainfall total is 1055mm, at Mt. Barker 756mm and at Bremer Bay 625mm. The relationship between total annual rainfall and the length of the dry/wet season in fact changes from west to east and if a line is drawn from Mt. Barker to Narembeen on Fig. 2, it will be found to define two distinct climatic sectors. West of the line a higher total rainfall is associated with a given length of season than east of it. In the southern, coastal, <4 dry month climatic belt the effect is to prolong eastward the occurrence of Karri and Jarrah forests. Inland in the drier climatic belts the effect is to

separate eucalypt woodlands mainly of York gum, salmon gum and wandoo west of the line from the mallee region east of it.

B. GEOLOGY

No detailed geological map of Albany/Mt. Barker in the 1:250,000 Series has as yet been published but the general geology is quite well known and has been described by various authors in *The Geology of Western Australia,* (Geol. Surv. West. Aust. 1975). Inland of the Stirling Range the country belongs to the South-western Province of the Yilgarn Block, part of the Precambrian Western Shield. The rocks are poorly exposed due to deep weathering and thick soil cover but are believed to be predominantly granitic including granite, migmatite and gneiss. Ages between 2200 and 3100 million years have been established.

South of the Yilgarn Block - the boundary has not been exactly determined - the basement consists of similar but much younger metamorphic rocks and granites of Proterozoic age dated between 1300 and 1700 m.y. Porphyritic granite batholiths were emplaced at about 1100 m.y. ago and appear today in the massive granite outcrops which dominate the landscape e.g. in Mt. Lindesay, Mt. Clarence, Mt. Manypeaks and the Porongurup Range.

The Stirling Range is composed of sedimentary rocks of Proterozoic age dated as probably older than 1340 m.y. which rest unconformably on the Archaean of the Yilgarn Block and are believed to be part of the same succession as the rocks forming the Barren Ranges further east. The Stirling Range sediments were originally laid down in shallow water and consist of quartz sandstone at the base overlain by phyllite and muddy sandstone. The succession is from 760 to 910m thick and in general dips at low angles to the south. Only remnants have been preserved and it seems at least probable that the formation was once more extensive over a considerable area representing sediments derived from the erosion of the Yilgarn Block and deposited around its margin.

During the Mesozoic Era the Australian and Antarctic continents were joined together but towards its close a rift developed between them off what is now the edge of the continental shelf of the south coast of Australia, and the two continents became progressively more separated by the formation of new oceanic crust between them from about middle Eocene time 45 m.y. ago. In association with this movement the south coast of Australia slumped towards the rift and became submerged so that relatively thin sequences of sedimentary rocks were laid down upon it. These are known as the Plantagenet Group, consist mainly of siltstone and spongolite (but with a limestone member known as Nanarup) of late Eocene age, are less than 200m thick and cover the greater part of the district to an ill-defined extent. They have been identified north of the Stirling Range and underlie most of the plains country with the granite batholiths protruding through the mantle. At the time of deposition these granites must have been islands like those of the

Recherche Archipelago at the present day.

During the Quaternary there were climatic fluctuations from warm to cold or "ice age" conditions. During the latter global sea level fell, and rose again when warmer conditions supervened. These fluctuations were associated with periodic deposition of beach sands which formed dunes in low sections of the coastline or could be blown up over cliffs and headlands. Most of the south coast is mantled with this sand in a belt which may be as much as 6 km wide. On the west coast of the State dune systems of several different ages have been recognised. On the south coast no similar studies have been made but there can be no doubt that equivalent successive periods of sand accumulation have occurred. The most recent sands are calcareous with up to 67% $CaCO_3$ (Enright 1978) and little consolidated. There is progressive decalcification and consolidation with age.

Another result of the climatic fluctuations of the Quaternary was the deposition of sheets of wind-blown sand in the interior, presumably during some acutely arid and windy phase. These sheets may be recognised today by their aerial photo-patterns and the heath vegetation on them. The biggest of them in this area surrounds the village of Tambellup where sand was blown out of the bed of the Gordon River over a length of 10 Km and land down in sheets extending to a maximum of 13 Km from the river on a bearing of E 25°S. A similar sandblow occurred along the Pallinup River above its confluence with the Warperup Creek but as the river's course is heading in the same direction in that area there was little lateral spread. Southeast of the Stirling Range there is also evidence of such sand movement.

All salt lakes in the north-east sector of this map sheet are bordered by lunettes on the ESE side and the lakes tend to be elongated on an axis at 90°, i.e. NNE - SSW. It is conceivable that lunettes are still being built up today but the sand sheets are no longer mobile.

C. PHYSIOGRAPHY

The Albany-Mt. Barker district consists essentially of a plain ascending gradually from the coast and levelling off further inland. Albany Airport is 69m above sea level, Narrikup 134m, Mt. Barker 254m. Beyond this point the plain undulates gently with little significant change in level. Above the plain rise numerous isolated granite bosses and the commanding peaks of the Stirling Range. Below the plain are the entrenched valleys of the numerous short rivers draining to the south coast. Sand dunes have been built up on the coastal margin of the plain and have impounded numerous swamps and sea inlets on their landward side.

Taking these features in order, along the coast, the granite bosses are relatively small but very numerous. They have been exposed by dissection of the country and rarely exceed 200m in height. Two of them, Mt. Melville and Mt. Clarence, dominate the town of Albany, rising to

bare, smooth rounded domes of rock. Most of the coastline is dominated by granite bosses forming headlands with embayments in the lower country between them. Further inland the outcrops become higher and more massive. Mt. Lindesay attains 456m, Mt. Barrow 486m, the Porongurup Range 670m and Mt. Manypeaks 562m. The Porongurup is one of the largest granite massifs in the State where granite domes crowd upon one another over a length of 12 Km and a breadth of 3 Km. Such granite outcrops are limited to a belt 40 Km wide from the coast, beyond which the plains stretch to the foot of the Stirling Range. This extends east to west for 60 Km and contains Bluff Knoll (1074m), the highest eminence in the southern half of the State. In keeping with its image as a relict geological outcrop of immense age the Range consists of a series of isolated high and precipitous peaks or groups of peaks rather than a continuous chain. The formation begins in the isolated Warriup Hill (400m) 15 Km west of Cranbrook, continues through Sukey Hill and Hamilla Hill to Donnelly Peak (650m) where the Range proper begins, thence through Mondurup (817m) to Talyuberlup (784m) with its adjacent Gog (625m) and Magog (857m). Next come Toolbrunup (1052m) and Mt. Hassell (848m), and then Mt. Trio (857m) and Toll Peak (735m). Finally the eastern part of the Range is more continuous and stretches from Yungermere (753m) through Mt. Success (750m), Bluff Knoll (1074m) and Isongerup (994m) to terminate abruptly at Ellen Peak (1012m). The peaks become steadily higher towards the east and at the same time more jagged and angular, with exposed cliffs and rock faces replacing rounded outlines.

Deep gaps between the peaks have been used as passes such as Chester Pass between Toolbrunup and Yungermere which carries the main road from Albany to Borden and Red Gum Pass between Donnelly Peak and Mondurup. North of the Stirling Range the plain is resumed. It is dissected by numerous short rivers draining to the south coast. In the high rainfall area of the southwest the Kent, Denmark and Hay Rivers are close together and have an intensive tributary drainage pattern. Next to the east the Kalgan River and its tributaries have entrenched the country without completely dissecting it so that much of the original surface of the plain is preserved in broad interfluves. The Kalgan receives virtually no tributary drainage from the east so that the extensive Kalgan Plains to the eastward lack organised drainage and have a flat surface dotted with small lakes. Only within 15 Km of the coast there are numerous short streams, the Bluff River, Wongerup and Mollocullup Creeks, draining to Hassell Beach. Numerous short streams rise in the Stirling Range; some reach the Young River, a tributary of the Kalgan, in the southwest and some the Pallinup River in the northeast, others terminate in salt lakes on reaching the plain. The Pallinup River taking a south-easterly course drains the north-eastern sector between the Stirling Range and Borden in broad, flat valleys. The Gordon River flowing south and then west and eventually becoming a tributary of the Frankland takes a sluggish course winding across the plain in the north-

western sector. Between the Gordon and the Pallinup there is again a plain without organised drainage full of small lakes, most of them salt. North of the Gordon towards Jingalup the country becomes more broken and dissected, south of it into the headwaters of the Kent, Denmark and Hay Rivers it is somewhat flat, and imperfectly drained with numerous lakes and swamps. Under the higher rainfall of this area most of the lakes are fresh.

Sand dune systems have built up all along the coast but principally along the stretch west of Albany where the coastline is more exposed to the prevailing westerly winds. Nearly all dunes are stabilised and there is very little mobile sand at the present day. Most dunes do not form coherent patterns but there is a disposition to occur in chains aligned with the prevailing wind. The sand belt is usually 2-3 Km wide, reaching a maximum of 6 Km, west of Princess Royal Harbour. The sand has been swept up over the granite hills and headlands of the coast and may attain 200m above sea level as in the great ridge which shelters Albany, between Torbay and Princess Royal Harbour. The dunes have frequently obstructed drainage of the hinterland so that there tends to be a belt of lakes and swamps behind them. Drowned estuaries of rivers have been turned into inlets intermittently cut off from the sea by sand bars, e.g. Parry Inlet, Wilson Inlet, Torbay Inlet. Owing to their sheltered position the entrances to Princess Royal Harbour and Oyster Harbour remain open but the Owingup Swamp, Lake Powell, Gardner and Angove Lakes are permanently cut off.

D. SOILS

A general account only of the soil will be given in this section as it will be more informative to give detailed descriptions with the vegetation later under each Botanical District. A soil survey of the Frankland River Valley (including therefore the Gordon) was published by R. Smith in 1951. A general soil map of the Albany-Mt. Barker district can be obtained from portion of Sheet 5 of the Atlas of Australian Soils (Northcote and others, 1967) but as the scale of 1:2,000,000 is rather small it does not go into great detail. In any case only "Dominant Soils" can be mapped. Soil types occur associated with one another in mosaics or catenas where any given unit normally has a fixed position in relation to the others determined by slope or drainage or similar factors, and this forms a recurring pattern. The dominant soil is the one occupying the greatest area in the mosaic or catena.

In the Stirling Range soils are young, shallow and of little development, and thus mapped as unbleached sand over rock. In the granite ranges the rock decays to loam instead of sand. On the plains the gentle slopes and slow rate of erosion and long time lapse have enable more soil development to take place. This varies according to parent material and rainfall. Sandy materials under a wet climate become first leached in

the upper horizon and then bleached; the sand becomes paler in colour until a pure white is obtained. Such white sands are often seen in the southern part of the area and are of extreme infertility. At the same time finer material leached out of the upper layers tends to be concentrated lower down so that soils with contrasting (duplex) texture profiles develop. The upper sand is underlain by a clayey subsoil, generally mottled and indicating poor drainage, and a ferruginous hardpan may form between the two.

Over less sandy parent material and under lower rainfall eluviation is less extreme and the soil tends to become a loam, usually described as "hard-setting" from its behaviour as it dries out, overlying mottled yellow clayey subsoil. Such soils are more favourable than those described above. Forest soils tend to be acid hard-setting loams, unbleached under Karri bleached under Jarrah which will also grow on leached sands with or without iron pan. Woodland soils (jarrah, marri, wandoo) are neutral hard-setting loams with yellow mottled clayey subsoils, or of alkaline reaction where yate appears and with a red clayey subsoil under York gum. Mallee soils are similar. The Kalgan Plains with their heath vegetation are on leached (and usually bleached) sands overlying clay and are acid to neutral. Owing to the age of the landscape it is not always necessary to suppose that soils have formed under the present climate, and it seems probable that the soil development under these sand plains took place under a higher rainfall than that now prevailing.

E. HUMAN INFLUENCES

A careful study of the burning of the landscape by aborigines prior to the coming of Europeans has been made by Mrs. S.J. Hallam (1975) who quotes the observation of early residents of Albany, particularly of Scott Nind who was medical officer to the initial settlement established in 1827. Nind (1831) showed that burning was not an accidental or incidental activity of the Aborigines but was closely meshed into their pattern of life, as the following quotations demonstrate.

> "At King George's Sound they live upon the productions of nature, varying at different seasons and in different districts ... The population is ... far from numerous."
>
> "As the country does not abound in food, they are seldom stationary, removing according to the time of year to those parts which produce the articles of provision that may be in season ... During the winter and early spring they are very much scattered; but as summer advances they assemble in greater numbers."
>
> "About Christmas they commence firing the country for game ... At this season they procure the greatest abundance of game ... by setting fire to the underwood and grass which, being dry, is rapidly burnt ... With a kind of torch made of the dry leaves of the grass tree they set fire to the sides of the cover by which the game is enclosed ... The hunters concealed stand in the paths most frequented by the animals and with facility spear them as they pass by. On these

occasions vast numbers of animals are destroyed. The violence of the fire is frequently very great and extends over many miles of country; but this is generally guarded against by their burning it in consecutive portions" (Nind 1831).

This account of "controlled burning off" was confirmed by Lieut. J.L. Stokes in describing a sortie northwards from Albany in November 1840 during the voyage of H.M.S. *Beagle* (Stokes 1846). Stokes described how the natives set fire to the bush in sections and controlled it by beating the fire out with branches if it threatened to get away. It is thought that the more lightly wooded country was burnt in this way more or less annually in early summer, but that the heavier jarrah and karri forest country was not much populated by the aborigines and thus burnt only at infrequent intervals (Hallam 1975).

Virtually all the vegetation of south-western Australia becomes very inflammable during summer. As fires may be set by lightning it has undoubtedly been subject to fire hazard of some sort for an extremely long period and has evolved various adaptations assisting it to withstand and recover from fire (Gardner, 1957). Burning probably became more frequent and more systematic after the arrival of the aborigines in the past 30,000 years. Study of the vegetation of naturally fire-protected habitats such as off-shore islands which were not reached by aborigines can be very informative as to likely changes effected by fire but such sources are limited. In this district the study of Bald Island by Storr (1965) is of special interest as its vegetaion was found to be radically different from the adjacent mainland.

Since the arrival of Europeans their activities have mainly been directed to wholesale clearing of native vegetation and its replacement by introduced crop plants, weeds and ornamentals. Lip service is paid to preservation of native flora on roadsides but relentless destruction in fact continues. A considerable area of State Forest and vacant Crown Land remains in the south-western sector of this area whose plant cover is still substantially unmodified, as well as the large Stirling Range National Park and numerous small National Parks and Reserves. A list of these is given in an Appendix and they are marked on the vegetation map. State Forests and National Parks are now under management and appropriate policies as regards burning are in force.

IV. DESCRIPTION OF THE VEGETATION

A. PLANT FORMATIONS

The plant communities mapped are classified primarily by physiognomy (that is, by their structure and life form) into formations which may be subdivided into associations according to floristic composition. 12 formations can be distinguished in this area but 22 separate units have been mapped and may be regarded as plant associations. There are also

four types of bare areas without or substantially without vegetation - rock outcrops, drift sand, salt lakes and freshwater lakes. A full list of the vegetation units is as follows :

A. TALL FOREST

1. *Karri tall-forest.* Forest more than 30m or 100 ft tall, mainly Karri (*Eucalyptus diversicolor*).

B. FOREST

2. *Jarrah forest.* Forest between 10 and 30m (35-100 ft) tall, normally jarrah (*E.marginata*) and marri (*E.calophylla*).

C. LOW FOREST

3. *Low Forest* of two different associations :
   (a) *Jarrah low forest* - Jarrah forest under 10m (35 ft) tall.
   (b) *Paperbark low forest* - Dense paperbark stands, (*Melaleuca cuticularis*).

D. WOODLAND

4. *Sclerophyll woodlands.* More open stands of trees 10 to 30m tall. Six eucalypts in addition to jarrah and marri above, and one sheoak, occur either singly or in various mixtures. They are :

Wandoo	*E.wandoo*
York gum	*E.loxophleba*
Yate	*E.occidentalis*
Salmon gum	*E.salmonophloia*
Morrell	*E.longicornis*
River gum	*E.rudis*
Sheoak	*Casuarina huegeliana*

Other species such as *E.cornuta* and *E.megacarpa* are not extensive enough to be mapped but are mentioned in the text.

E. LOW WOODLAND

5. *Low Woodland.* Open stands less than 10m tall. Principal dominants in the five different associations are :
   (a) Jarrah - *E.marginata*
   (b) Peppermint - *Agonis flexuosa*
   (c) Redheart - *E.decipiens*
   (d) Paperbark - *Melaleuca cuticularis*
   (e) Jarrah-Sheoak - *E.marginata, E.staeri* and *Casuarina fraserana* in various mixtures.

F. SHRUBLAND

6. *Thicket.* Closed tall shrub community. One association of mixed species covers the higher levels of peaks in the Stirling Range.
7. *Mallee.* Open tall shrub community with mallee eucalypts dominant in the upper layer and an understory of Melaleuca and other ericoid shrubs. Three different associations are distinguished :
   (a) *E.redunca - E.uncinata* association
   (b) *E.angulosa - E.decipiens* association
   (c) *E.cornuta - E.lehmannii* association

8. *Scrub-heath.* A mixed two-layered assemblage with an open upper layer of tall shrubs and a closed lower layer of small ericoid shrubs. In this case the lower layer is the dominant one. Two associations are recognised :
   (a) Mixed, with mainly Proteaceae in the upper layer and Myrtaceae in the lower.
   (b) *Agonis flexuosa* as principal species.
9. *Mallee-heath.* As above but with mallee-form eucalypts in the upper layer. Mallee-heath differs from true mallee in the openness of the mallee layer. There are three associations :
   (a) Jarrah - *E.marginata* - as principal species
   (b) Tallerack - *E.tetragona* - ditto
   (c) Mixed community
10. *Heath.* Closed community of dwarf shrubs, representing the lower layer only of the preceding formation. One association, very heterogeneous.

G. REED SWAMP

Dense single-layered community principally of sedges and Restionaceae with scattered heath shrubs. Associations have not been differentiated.

H. HALOPHYTES

Communities of samphire - low, stem-succulent shrubs - with or without paperbarks and teatree present.

EFFECT OF LAND CLEARING

A large proportion of the Albany-Mt. Barker area has been cleared for farming. The map shows Original Natural Vegetation as existing before clearing took place. In farming areas the map is not evidence that the vegetation is there now except as roadside relics and uncleared patches. Reserves, where the natural vegetation remains, have as far as possible been marked on the map.

B. CLASSIFICATION; MAPPING NOTATION AND FORMULAE

The communities mapped are classified in three categories each expressed by a code-letter, the resulting three letters, two small letters and a capital, being combined into a triplet formula which is used as a mapping notation and is known as the Beard-Webb formula, from Beard and Webb 1974. The classification is as follows :

1. *Physiognomy of dominant stratum (capital letters)*

T	Tall trees $>$ 30m tall	G	Bunch grasses
M	Medium trees 10-30m tall	H	Hummock grass (spinifex)
L	Low trees $<$ 10m tall	F	Forbs
S	Shrubs $>$ 1m tall	X	Lichens and mossess
Z	Dwarf shrubs $<$ 1m tall	C	Succulents

2. *Floristic* (small letters) Dominant genus.
   a Agonis
   c Casuarina
   e Eucalyptus

m *Melaleuca*

k *Halophytes (Atriplex, Maireana, etc.)*

t *Triodia*

x *Heterogeneous* (mixed or other)

3. *Density* (small letters) of canopy cover. Projective foliage cover as defined by Specht (1970).

d Dense canopy. Projective foliage cover > 70%

c Mid-dense canopy. P.f.c. 30-70%

i Incomplete canopy - open, not touching. P.f.c. 10-30%

r Rare but conspicuous. P.f.c. < 10%

b Barren, vegetation largely absent. P.f.c. negligible

p Scattered groups. No definite foliage cover.

The actual formulae are written with the floristic category first, then the capital for physiognomy, finally density, resulting in such combinations as eMc, aLi, meaning respectively a Eucalypt-dominated medium height mid-dense tree community or forest, and an Agonis-dominated low open tree community or woodland. The floristic letter stands for a genus. It may be extended to nominate species of the genus by the addition of subscript numbers, e.g. e_6, a_9. (See list below of species designated in mapping.)

The relevent classification formulae for the Albany-Mt. Barker map are as follows. Those in the Beard-Webb column appear on the vegetation map. They are contrasted in the adjacent columns with the parallel world systems of Küchler (1949) and Dansereau (1951).

Vegetation Unit	Beard-Webb Formula	Kuchler Formula	Dansereau Formula
Tall forest	eTc	Btc	Tteaxc
Forest	eMc	Bmc	Tmeaxc
Low forest	eLc	Blc or Elc	Tleaxc
Woodland	eMi	Bmli.szt	Tmeaki.Fmleaxb
Low woodland	eLi	Bli or Eli	Tleaxi
Thicket	xSc	Bsc	Fmeaxc
Mallee	eSi	Bszi	Fleaxi.Fmeaxc
Scrub-heath	xSZc	Bszc	Fleaxi.Fmeaxc
Mallee-heath	eSZc	Bszc	Fleaci.Frieaxc
Heath	jZc	Bzc	Fmeanxc
Reed Swamp	xGc	Gmc	Hmegxc
Halophytes	kCi	Bzik.Oik	Fljaki

List of species designated in mapping :

a	*Agonis flexuosa* (Spreng.) Schau.	Peppermint
C_5	*Casuarina huegeliana* Miq.	Sheoak
C_7	*Casuarina fraserana* Miq.	Sheoak
e_n	*Eucalyptus*, various	
e_1	*E.diversicolor* F.Muell.	Karri
e_2	*E.marginata* Sm.	Jarrah

e_3	*E.calophylla* R.Br.	Marri
e_5	*E.wandoo* Blakely	Wandoo
e_6	*E.loxophleba* Benth.	York gum
e_7	*E.occidentalis* Endl.	Swamp yate
e_8	*E.salmonophloia*	Salmon gum
e_9	*E.longicornis* F.Muell.	Morrell
e_{18}	*E.rudis* Endl.	River gum
e_{26}	*E.tetragona* (R.Br.) F.Muell	Tallerack
e_{27}	*E.redunca* Schau.	Black marlock
e_{29}	*E.angulosa* Schau.	
e_{37}	*E.cornuta* Labill.	Yate
e_{38}	*E.lehmannii* (Schau.) Benth.	Bald Island marlock
e_{67}	*E.decipiens* Endl.	Redheart
j	*Jacksonia spinosa* (Labill.) R.Br.	
k_3	*Arthrocnemum, Sarcocornia* and other samphires	
m	*Melaleuca cuticularis* Labill.	Paperbark
x	*Heterogeneous*	

C. PLANT GEOGRAPHY : DISTRIBUTION OF THE PLANT FORMATIONS.

The vegetation of the Albany-Mt. Barker area is unusually varied. This is expressed first in the large number of formations and associations mapped, secondly in their distribution in regular patterns and groupings. The latter are the result of the steep rainfall gradient from 1250mm (50 in) at Irwin Inlet in the southwest to 375mm (15 in) at Borden in the northeast, and also to marked topographic features such as the Stirling and Porongurup Ranges and Mount Manypeaks. For purposes of plant geography the Albany-Mt. Barker area is divided into four Botanical Districts, first along a north-south line which divides the forest and woodland zone of the west from the mallee zone of the east, secondly along east-west lines which separate the wetter coastal sector from the drier interior. The north-south line runs from Toolbrunup Siding (20 km east of Tambellup) southward to pass round the eastern end of the Stirling Range, thence along the Young River to the Kalgan, cutting south-easterly across country from Noorabup Pool to the Bluff River, then bending south to exclude Mount Manypeaks. West of this line forest and woodland predominate and fall into the Darling and Avon Botanical Districts. East of it mallee and heath predominate and form the Roe and Eyre Botanical Districts (Fig. 4.).

The Avon Botanical District stretches from Cranbrook northwards and is the driest part of the western sector (rainfall under 500mm or 20 in). It contains mainly woodland of wandoo and yate. The Darling Botanical District is divided into two sub-districts : The Warren Sub-district which is a coastal strip narrowing eastward as far as Albany and has a rainfall of over 1000mm (40 in.), and the remainder the Menzies sub-district. The Warren Sub-district is the Karri Forest zone and the Menzies Sub-district the southern Jarrah Forest zone. In the eastern half

Fig. 4 : Botanical Districts and Sub-districts (Capitals) and Vegetation Systems (small letters) in the Albany-Mt. Barker area.

the Roe Botanical District extends northwards from a boundary just north of the Stirling Range. Its vegetation is predominantly mallee with some woodland in valleys. The remainder constitutes the Eyre District and the mallee element still predominates but is lower and more open, in the form of mallee-heath. All the Botanical Districts belong to the South-west Botanical Province in the sense of Diels (1906) and Gardner (1942, 1956). New light thrown on the subject by vegetaion mapping in recent years has resulted in the revision (Beard 1979) of the earlier treatment of Botanical Districts by these previous authors, Diels' Stirling District has been eliminated as it could not be substantiated as a natural region, while a new Roe District has been proposed.

D. VEGETATION SYSTEMS :

Each Botanical District is divisible into a number of units called Vegetation Systems within each of which a typical pattern of vegetation occurs. The technical definition is that a Vegetation System consists of a particular series of plant communities recurring in a catenary sequence or mosaic pattern linked to topographic, pedological and/or geological features (Beard 1969). The concept was originated by Speck (1958) when studying the Irwin and Darling Botanical Districts further north and his

Bannister system extends into this area. No other definition of vegetation systems has previously been made in the Albany-Mt. Barker area except in so far as a number recognised in the adjoining Bremer Bay area by Beard (1972) and the Pemberton area by Smith (1972) extend over the border.

The Districts and Systems of the Albany-Mt. Barker area are shown in Fig. 4. The vegetation will be described district by district and system by system.

1. DARLING BOTANICAL DISTRICT : WARREN SUB-DISTRICT

The Warren Sub-district, formerly the Warren Botanical District of Diels (1906) extends along the coast tapering eastwards to pinch out at Bald Head, Albany. It is essentially the home of the Karri forests and reaches its most luxuriant development further west in the Pemberton area. The inland boundary is drawn where Karri ceases to be a significant component, and is 25 Km inland at the western edge of the map.

KARRI FOREST

The structure and composition of Karri forest and its relation to climate and soils have been described in detail by McArthur and Clifton (1975) for the principal Karri area around Pemberton to the west and these observations can for the most part be applied here. Karri requires a certain climatic zone, cool, humid, with effective rainfall in at least 8 months of the year. It occurs most widely where annual rainfall exceeds 1000mm but can be found with as little as 700mm if the rainfall meets the requirement of distribution over 8 months. Within its climatic zone Karri occupies soils suited to it but will not colonise unfavourable soils no matter how high the rainfall. McArthur and Clifton found that 'the single most significant factor controlling vegetation is soil' and that both physical properties and plant nutrient status are involved. They distinguished six principal soil types in the area : red earths, laterites, red podzolic soils, yellow podzolic soils, podzols and sand, alluvial soils. Karri is so closely associated with the red earths that they are generally known as "Karri loams", but it will also grow on red podzolics, on deeper and more loamy phases of yellow podzolics, and alluvial soils. Karri avoids laterites, sands, and the poorer yellow podzolics.

The red earths have a reddish brown loam or sandy loam surface changing gradually to red clay at about 50 cm. Podzolic soils are more leached, often expressed by paler colour, and may contain ironstone gravel. McArthur and Clifton claimed a close relationship between soil and geology. In the Pemberton area; red earths develop on basic gneiss, podzolic soils on acid and intermediate gneiss. Karri soils are therefore of higher fertility and have been shown to have significantly higher levels of both phosphorus and nitrogen than jarrah soils (Loneragan & Loneragan, 1964). One of the principal reasons for the concentration of

Karri in the Pemberton area may therefore be the predominance there of Archaean gneissic rocks (see Geological Map of W.A. 1:2,500,000, 1973) : Further east Karri soils are found more sparingly.

Karri forms Tall Forest with a general canopy level of about 70m. Below this at about 10m is a scattered layer of *Agonis flexuosa, Casuarina decussata* and *Banksia* and at about 3m a continuous stratum of soft-leaved plants such as *Trymalium spathulatum, Chorilaena quercifolia, Hovea elliptica* and *Acacia* spp. The lack of sclerophylly in the understory of Karri forest is one of its most striking features. The ground cover consists of many shrubs and creepers and a very light cover of the grass *Tetrarrhena laevis* together with some mosses, liverworts and occasional epiphytic ferns.

A list of the Karri forest flora below is taken mainly from McArthur 2 Clifton, Table 4.

Canopy trees : *Eucalyptus diversicolor, E.calophylla, E.marginata.*

Trees 10-30m : *Casuarina decussata, Eucalyptus megacarpa.*

Sm. trees<10m : *Agonis flexuosa, Banksia grandis, B. verticillata, Persoonia longifolia.*

Tall shrubs 2-3m: *Acacia pentadenia, Albizia lophantha, Bossiace aquifolium, Chorilaena quercifolia, Pimelea clavata, Trymalium spathulatum.*

Sm.shrubs 1-2m : *Acacia divergens, A.myrtifolia, A.obscura, A.pulchella, A.urophylla, Bossiaea linophylla, B.ornata, Chorizema ilicifolium, Crowea angustifolia, Hakea amplexicaulis, Hibbertia amplexicaulis, H.crenata, H.serrata, H.tetrandra, Hovea elliptica, Hypocalymma cordifolium, Leucopogon capitellatus, L.propinquus, L.verticillatus, Phyllanthus calycinus, Podocarpus drouynianus, Sphaerolobium medium, Thomasia quercifolia, T.triloba, Tremandra stelligera, Xanthosia spp.*

Cycad, to 2m : *Macrozamia riedlei.*

Grass tree, to 3m: *Xanthorrhoea preissii*

Helbaceous : *Anigozanthos flavidus, Dampiera hederacea, D.linearis, Lepidosperma longitudinale, Lomandra spp., Opercularia hispidula, Orthrosanthus laxus, Patersonia xanthina, Pteridium esculenthum, Scaevola auriculata, S.striata.*

Creepers : *Cassytha glabella, Clematis pubescens, Chorizema diversifolium, Hardenbergia comptoniana, Kennedya coccinea.*

The principal Karri area of Pemberton-Northcliffe is treated as the Nornalup Vegetation System by Smith (1972) but this terminates eastward at the Bow River. The Warren Sub-district as it appears on the Albany-Mt. Barker map comprises the Torndirrup System on the coastal dunes

and the Denmark System inland.

1.1 DENMARK VEGETATION SYSTEM

The principal difference from the Nornalup System where Karri typically appears on mid-slope is that now it appears on the highest ground. Karri soils are associated with the outcrop of porphyritic granite batholiths which may or may not be exposed as bare rock at the summit. Karri is found growing on typical red earth around such exposures or on the hills and ridges which they underlie. Karri appears again on the alluvial soils along the streams but mid and lower slopes are usually occupied by jarrah or jarrah-casuarina on sand and/or laterite. It appears that the latter soil material has been deposited in this position in the catena in the course of formation of the landscape, having originated as laterite on the peneplain before dissection of the country. In and to the west of Denmark there is a belt of high ground culminating in Mount Shadforth where this catena is present, but most of the Karri has been cleared for agriculture. Between the Wilson Inlet and Princess Royal Harbour the country is much lower and while the same catena still exists on rising ground, with Karri on the hilltops, wide belts of swampland occupy flat valley bottoms. The massif of Torbay Hill replicates the Denmark country. Further west of Denmark from William Bay to the Bow River the country is again lower with swampy flats and gently undulating hilly country with Karri only on isolated hilltops and along streams (as at the Kent River) most of the country being sandy and originally under jarrah and casuarina.

The other components of the vegetation system therefore are jarrah-marri forest on laterite and yellow podzolic soils, jarrah or jarrah-casuarina low forest on bleached sands, and reed swamp. The forest and low forest are both described later under the Menzies Sub-district where they occur more widely. The swamps consist principally of dense Cyperaceae and Restionaceae with woody plants present in various communities. One phase, probably perennially wet, has scattered paperbark trees (*Melaleuca cuticularis*) and small teatree (*M.densa*), another has clumps of jarrah mallee (*Eucalyptus marginata*) or of scattered shrubs (*Beaufortia sparsa, Callistemon speciosus*) or blackboys (*Xanthorrhoea preissii*). There is also a "heath swamp" association on sandy, probably seasonally wet ground, in which the reeds are mixed with *Adenanthos obovatus, Acacia myrtifolia, Agonis flexuosa, A.juniperina, A.marginata, Andersonia caerulea, Beaufortia sparsa, Boronia ?spathulata, Callistemon speciosus, Cosmelia rubra, Grevillea brevicuspis, Kunzea ericifolia, Leucopogon ? revolutus, Oxylobium lanceolatum, Pultenaea reticulata*. Many of these shrubs are very showy in flower, especially *Beaufortia sparsa* which is summer-flowering. Among interesting smaller plants in these swamps is the pitcher-plant *Cephalotus follicularis*. Among the reeds *Leptocarpus tenax* seems to be generally dominant : others identified are *Evandra aristata, Mesomelaena tetragona* and *Restio tremulus*.

1.2 TORNDIRRUP VEGETATION SYSTEM

This system is named from the Torndirrup National Park south of Albany and comprises the coastal dune country.

The geography of the south coast is controlled by granite outcrops which rise as low domes and form capes and headlands. From one headland to the next the coast extends in shallow curving bays backed by sand dunes. During the last glacial period which ended about 12,000 years ago, sea level was much lower than now, the coastline lay further off shore and the rivers cut down valleys accordingly. With the onset of the current warmer interglacial period sea level gradually rose drowning the river valleys. On reaching a position of approximate still-stand some 4,000 years ago large quantities of sand were deposited on the strand line and blown into sand ridges which now occupy belts 2-3 Km wide. In addition to forming dunes on low country this sand also mantles the granite headlands whose summits only may peep through it. With the passage of time most of the sand has become stabilised and vegetated but some is still mobile either due to continued accretion as along the shore of William Bay or due to disturbance or to long-term failure to stabilise on high ground, e.g. on Tower Hill and the Flinders Peninsula. In the former case the bare area contains the so-called "Petrified Forest" where solidified root-channels are exposed by deflation and give the impression of being fossilised roots. Ponding of the rivers by the sand dunes has created lakes and swamps behind them.

Most of the vegetation is developed on a mantle of recently consolidated sand which is little weathered, poor in nutrients, and does not constitute a true soil. When this vegetation is burnt it does not regenerate rapidly and most commonly exists as heath and scrub-heath, depauperate shrubland communities which do not fully express the potential of the good rainfall. The climax on this calcareous sand appears to be *Agonis flexuosa* low woodland but this is only seen in low-lying or protected places. Inland of the sand mantle on soils of greater age there is an immediate change to forests, tall, medium and low, of Karri and jarrah. Such forests may occur on older coastal sands where these have become well weathered.

KARRI FOREST (EUCALYPTUS DIVERSICOLOR)

It is possible for Karri to occur on red earth developed over calcarenite after long weathering, and some Karri stands on the inland side of the dune systems may be of this nature. Others are associated with granite outcrops, in which they associate with *E.cornuta*.

BANKSIA LOW FOREST

There is a dense stand of *Banksia verticillata* in the Torndirrup Park north of the Frenchman's Bay road just beyond the turn-off to the Gap. This grove contains some trees of *Agonis flexuosa* and *E.cornuta*.

Patches of the same occur in swampy swales between sand dunes in the William Bay Park. Understory plants include *Anigosanthos flavida, Leptocarpus tenax* and *Xanthorrhoea preissii.*

PEPPERMINT LOW WOODLAND AND SCRUB-HEATH

Agonis flexuosa is dominant in a range of structural types from scrub to low woodland, the latter apparently the climax of sandhill country. The best stands today are to be seen along the south shore of Princess Royal Harbour, where *A.flexuosa* is the principal tree with some *E.cornuta* and *Banksia ilicifolia*. More generally burning has reduced this to an early successional stage of shrubs only. Such scrub-heath contains scattered large shrubs of *A.flexuosa* and *Banksia grandis* with clumps of *E.angulosa* mallee. Smaller shrubs include *Acacia decipiens, A.?divergens, Adenanthos cuneatus, A.sericeus, Andersonia simplex, Anigozanthos flavidus, Anthocercis viscosa, Casuarina humilis, Dryandra sessilis, Hakea elliptica, H.oleifolia, H.prostrata, Hibbertia cuneiformis, Jacksonia horrida, Leucopogon parviflorus, Lysinema ciliatum, Melaleuca acerosa, Olax phyllanthi, Pimelea clavata, Senecio lautus, Spyridium globulosum* and there is a large reed *Loxocaria flexuosa*. Close to the sea *Scaevola crassifolia, S.nitida, Olearia axillaris* and *Senecio elegans* become conspicuous. In the Torndirrup National Park the association described above is given a distinctive aspect by the presence of scattered large shrubs or small trees of *Banksia ilicifolia*. These only occur on the sheltered north side of the main ridge.

MIXED HEATH

On high ground exposed to wind the vegetation is only heath, where the plants grow in a dense mass but do not exceed 60 cm in height.

This community has been studied in a recent paper by Enright (1978) who enumerated 24 quadrats situated along the Frenchman's Bay Road and the roads to the Gap and The Blowholes. 28 component species were recorded, of which 14 occurred sufficiently consistently to permit of numerical analysis which showed that although the heath vegetation was "superficially homogeneous" two distinct plant associations were actually present associated respectively with calcareous and podzolised soil profiles. Leached, acid, podzol sites were characterised by a high frequency of *Andersonia simplex, Lysinema ciliatum, Leucopogon reflexus* and *Dasypogon bromeliaefolius*. Calcareous sites supported larger populations of *Pimelea rosea, Leucopogon revolutus, Bossiaea rufa* and *Olearia axillaris*. The distinction between podzol and calcareous sites was never very clear-cut, most species occurring on both though in varying numbers. Only *Andersonia* and *Dasypogon* were never found on a calcareous site and conversely only *Bossiaea* and *Olearia* showed a strong avoidance of podzol sites. Other species recorded by Enright without obvious soil preferences were *Acacia cuneata, A.pulchella, Albizia lophantha, Agonis flexuosa, Casuarina humilis, Hakea costata, H.prostata,*

Hibbertia racemosa, H.cunninghamii, Kennedia coccinea, Loxocaria flexuosa, Melaleuca acerosa, Scaevola nitida and *S.thesioides* (N.J. Enright, pers. comm.).

ROCK OUTCROPS

Granite outcrops occur in numerous places peeping through the sand mantle. In the eastern part of Torndirrup, these consist of rock slabs patchilly covered with moss and clumps of pin grass (*Borya nitida*) with scattered shrubs of *Anthocercis viscosa, Agonis marginata* and *Platysace* sp. rooting in crevices. On accumulations of rubble on the rock there is a denser shrubby growth of *Andersonia sprengelioides, Hakea elliptica, Dryandra formosa, Xanthorrhoea* and numerous sedges. Peripheral to the outcrop there is mallee-form *Eucalyptus calophylla* and *Banksia* after which the surrounding heath is entered.

2. DARLING BOTANICAL DISTRICT : MENZIES SUBDISTRICT

The Menzies Sub-district, named after Archibald Menzies, botanist with the Vancouver expedition of 1791, corresponds with the southern jarrah forest region extending north from the Karri forest region to the latitude of Collie where the northern jarrah forests are entered. Within the Albany-Mt. Barker area the sub-district extends northward from the boundary of the Warren sub-district to include Frankland and Tenterden, swings south along the western end of the Stirling Range down the Young River to the Kalgan, along the Kalgan to Noorubup Pool, thence across country to the Bluff River and finally south to the coast at Two Peoples Bay excluding Mount Manypeaks and Mt. Gardner. Jarrah forest, low forest and woodland are dominant throughout the sub-district. Outliers of Karri are found, especially in the Porongurup Range. Towards the drier inland boundary forest opens out to woodland with increasing admixture of marri and wandoo or restriction of jarrah to a component of the catena in marri-wandoo woodlands.

Rainfall varies from 1000 to 600 mm per annum mostly with under 4 dry months in the year but dropping to 5 months in the northwest.

Jarrah *(Eucalyptus marginata)* is essentially a tree of poor sandy and lateritic soils and occupies this medium over a great range of profile types and rainfall, modifying its stature accordingly from heights of 40m in tall forest to 20-30m in forest, 10-20m in woodland and $<$ 10m in low forest finally to mallee form at the northern and southern extremities of its range at Mt. Le Sueur and on the Kalgan Plains.

Nine vegetation systems are distinguished within the sub-district in the Albany-Mt. Barker area and as all systems incorporate jarrah forest and/or low forest in some form these will be discussed first.

JARRAH FOREST

More correctly jarrah-marri forest as *E.marginata* and *E.calophylla* associate together, the trees vary in height from 20 to 30m. There is a lower layer of small trees at about 7m and a sclerophyll shrub understory of larger and smaller shrubs reaching 1-2 and 0.5m respectively Leguminous creepers develop in open spaces, for example, where large trees have fallen, and are very prolific after fire. A species list is as follows.

Canopy trees :	*Eucalyptus marginata, E. calophylla.*
Sm. trees < 10m :	*Banksia grandis, Nuytsia floribunda, Persoonia longifolia.*
Shrubs 1-2m :	*Acacia browniana, A.extensa, Agonis marginata, A.theiformis, Bossiaea linophylla, B.ornata, Dryandra formosa, Hakea amplexicaulis, H.oleifolia, H.varia* (in wet places), *Hemigenia divaricata, Hibbertia amplexicaulis, Hovea elliptica, Hypocalymma angustifolium, Isopogon dubius, Leucopogon propinquus, L.verticillatus, Oxylobium sp., Petrophile diversifolia, P.serruriae, Podocarpus drouynianus.*
Cycad, Grass Trees:	*Macrozamia riedlei, Kingia australis, Xanthorrhoea preissii.*
Sml. shrubs < 1m :	*Acacia alata, Pimelea lehmanniana, Verticordia habrantha, Xanthosia rotundifolia.*
Herbaceous :	*Anarthria prolifera, Conostylis* sp., *Johnsonia lupulina, Lepidosperma angustatum, Pteridium esculentum.*
Creepers :	*Clematis pubescens, Hardenbergia comptoniana, Kennedia coccinea, K.prostrata.*

JARRAH LOW FOREST AND WOODLAND

The poorer jarrah areas are commonly a mosaic of jarrah forest with poor, crooked trees up to 15m and lower stands with thinner more crowded stems and increasing mixture of *Casuarina fraserana*. The latter comes in more and more on bleached sands and may become a virtually pure stand on deep sand. *E.marginata* drops out in favour of the related species *E.staeri* on bleached sands over laterite on high rainfall sites near the coast. The understory communities of these associations have not been separately studied but are believed to be similar. A general list for the mosaic was made in Reserve 18739 known as the Millbrook Road Reserve, near Albany.

Trees & small trees :	*Eucalyptus marginata, E.decipiens, E.staeri, Banksia attenuata, B.grandis, B.ilicifolia, B.verticillata* (in valley), *Casuarina fraserana, Nuytsia floribunda, Persoonia longifolia, Xylomelum occidentale.*
Grass trees :	*Kingia australis, Xanthorrhoea preissii.*
Shrubs>1m :	*Adenanthos cuneatus, A.obovatus, Agonis marginata, A.theiformis, Banksia brownii, B.coccinea, B.quercifolia, B.sphaerocarpa, Dryandra carlinoides, D.squarrosa, Hakea amplexicaulis, H.ferruginea, H.oleifolia, Isopogon cuneatus, I.formosus, I.sphaerocephalus, Kunzea ? recurva, Lambertia inermis, Melaleuca striata, M.thyoides, Persoonia teretifolia, Persoonia sp., Petrophile rigida,*
Small shrubs<1m :	*Actinodium cunninghammii, Andersonia sp., Banksia goodii, B.repens, Beaufortia anisandra, Bossiaea linophylla, Burtonia scabra, Conospermum caeruleum, C.flexuosum, C.petiolare, Darwinia vestita, Franklandia fucifolia, Grevillea synapheae, Leucopogon verticillatus, Pimelea spectabilis, P.suaveolens, Sphaerolobium macranthum, Stirlingia tenuifolia, Synaphaea sp.*
Herbaceans :	*Anarthria scabra, Cyathochaete avenacea, Dasypogon bromeliifolius, Drosera spp., Velleia macrophylla.*

Details of the vegetation systems follow.

2.1 KENT SYSTEM

This comprises an area of extremely poor country along the upper Kent and Denmark Rivers, between Mount Lindesay and the Muir Highway. It is characterised by shallow leached sands over rock or laterite, both of which frequently crop out. The country is gently undulating and poorly drained with numerous large swamps. Jarrah low-forest is the predominant formation, normally pure; there is little marri and Casuarina only appears sparingly towards the south. On patches of better soil the cover improves to jarrah-marri forest (medium height) and there are some small patches of Karri on alluvial soil along the Denmark River. Swamps occur as narrow strips along drainage lines or as larger expanses occupying broad flat valley bottoms. In the former case they carry a mixed community of reeds and heath shrubs such as *Beaufortia sparsa* and *Kunzea ericifolia,* in the second of reeds with scattered paperbark trees *(Melaleuca cuticularis).* Composition in detail appears to be similar to the swamps described in the Warren Sub-district.

The granite mass of Mt. Lindesay is included in this system. Unlike the Porongurup Range there are no stands of Karri. It more resembles the Manypeaks massif with bare rock slabs rising out of a heath with *Kingia,*

and this surrounded by jarrah-marri forest. Owing to the poverty of the Kent System it is considered to have no agricultural potential and it has virtually no forestry potential either owing to the scarcity of commercial stands. Most of it remains therefore as vacant Crown land. There are no roads and access is possible only along bush tracks.

2.2 HAY SYSTEM

The Hay System lies east of the Kent, mainly in the basin of the Hay River from Wilson Inlet almost to the Muir Highway. It just reaches the Albany Highway on the east in the vicinity of Chorkerup but excludes Narrikup and Redmond. The country is more dissected than in the Kent System and there is a recognisable catena of jarrah-marri forest on the upper slopes and ridges, jarrah-Casuarina low-forest on lower slopes and swamps in the valley bottoms. There are a few patches of Karri in the south on riverain alluvial soils, otherwise all the forest is rather poor. Jarrah-marri forest is however treated as commercial and is subject to logging. Part of the system is included in State Forest or is reserved from alienation if it lies in the catchment of the Denmark River but the settlement of Denbarker lies in this System and land occupation is creeping in from the east and south. The forest and low-forest are as previously described. Valley-floor swamps crossed on the Denmark-Mt. Barker main road consist predominantly of reeds with scattered shrubs. *Anarthria scabra* and *Evandra aristata* appear to be the principal reed species with *Leptocarpus tenax, Mesomelaena tetragona* and *Restio tremulus* also *Dasypogon bromeliifolius* and *Johnsonia lupulina* as other herbaceous plants. Shrubs include *Agonis marginata, Andersonia caerulea, Beaufortia sparsa, Darwinia vestita, Hypocalymma angustifolium, Kunzea ericifolia, Leptospermum crassipes, Leucopogon alternifolius, Lysinema ciliatum, Melaleuca densa, Pimelea longiflora.* There are occasional small trees of *Nuytsia floribunda. Kunzea ericifolia* may form dense communities at the swamp margins or there may be scattered trees of *Eucalyptus staeri* and *Melaleuca cuticularis* around the fringes. *Boronia megastigma* may form colonies in the forest understory close to such swamps if there is a clay soil.

2.3 ALBANY SYSTEM

The town of Albany lies in this system which stretches from Wilson Inlet to Oyster Harbour and from the Warren Sub-district boundary (roughly along the line of the South Coast Highway) inland to Millbrook Road. The country is a plain entrenched by streams draining south and east in flat-bottomed valleys, but the monotony is relieved by granite domes north of Princess Royal Harbour and a single one further north near the King River. The upland soils are excessively poor, leached and badly drained so that more depauperate members of the low-forest mosaic are dominant, i.e. *Casuarina fraseriana* on deep white sand, becoming mixed with *E.staeri* where this overlies laterite. At Albany Airport there is only

20 cm of topsoil over laterite, waterlogged in winter, and the cover seems to have been jarrah mallee only 2-3m in height. However this may have been the result of disturbance. Jarrah-marri forest may formerly have been present on the steeper slopes of the valleys.

The Millbrook Road Reserve No. 18739 is in this System and a collection list for the forest mosaic has already been given. The valley swamps consist of dense reeds 1m tall, *Leptocarpus tenax* is dominant with *Schoenus multiglumis* and *Baumea preisii*. Associated woody plants are also very common. Not rising above the reeds are *Cosmelia rubra, Leptospermum firmum, Sphaerolobium grandiflorum, S.medium, S.?racemulosum, Sphenotoma gracile*. Larger shrubs mainly peripheral include *Agonis marginata, Beaufortia sparsa, Callistemon speciosus, Kunzea ericifolia* and *Phebalium anceps*. *Boronia megastigma* may occur locally. *Cephalotus follicularis* is a component of the swamp, and *Utricularia* in open places.

The vegetation of granite domes must have been disturbed by cutting for timber and firewood in the early days of settlement. On Mount Clarence at the present time one finds the remains of jarrah-marri forest, becoming mallee among granite rocks at the top. The following components were observed in the mallee :

Acacia decipiens, A.pulchella, A. sp., Agonis marginata, A.parviceps, Banksia grandis, Eucalyptus marginata, Gastrolobium bilobum, Hakea elliptica, H.trifurcata, Hovea elliptica, Kingia australis, Leucopogon asimilis, Olearia sp., Pimelea rosea, Sollya heterophylla, Xanthorrhoea preissii. *Andersonia sprengelioides* forms cushions on the rocks.

2.4 KWORNICUP SYSTEM

The Kwornicup System is situated on a swampy plain extending roughly from the Muir Highway for 30 Km northward and from west of Rocky Gully and Frankland to Kendenup. The plain forms the interfluve between the headwaters of the Kent and Hay Rivers and the Gordon, and is very poorly drained so that it is covered with small lakes and swamps. Lake Muir, to the west of this map sheet, is in this System. Here there is nothing so large. Lakes Kwornicup and Poorarecup are the biggest and serve for recreation. The vegetation system is a mosaic with jarrah-marri forest as the dominant member, enclosing numerous patches of jarrah low-forest, paperbark low-forest and reed swamps. Owing to the flat swampy terrain the jarrah-marri forest is often mixed with yate *(E.cornuta)* swamp yate *(E.occidentalis)* and wandoo *(E.wandoo)*. *E.decipiens*, a small species between a tree and a mallee, comes in as an understory or becomes dominant in sandy-swampy places, with *Xanthorrhoea* and *Hakea varia*. It forms mallee communities on the lunettes bordering lakes as at L. Poorarecup. *Banksia verticillata* becomes common in swampy depressions, and *E.occidentalis* at the borders of swamps. Clay swamps usually contain stands of *E.occidentalis* with an understory of *Melaleuca cuticularis* and *M.violacea*. Sandy swamps may have dense *M.cuticularis* low-forest grading

into reeds with scattered paperbarks. The composition of reed swamps in this System has not been studied.

There are small patches of Karri in two valleys leading to the Kent River, on alluvial soil (R. Smith 1951).

2.5 NARRIKUP SYSTEM

The Narrikup System extends inland of the Hay and Albany Systems to between Mt. Barker and Woogenillup and from Kendenup more or less to the Kalgan River. The Porongurup System occurs as a small enclave. The Narrikup System lies upon a plain, little dissected except in the south-east along the Kalgan River and its tributaries but not as swampy as in the Kwornicup System. Lakes and swamps are few. Jarrah-marri forest was therefore almost continuous before clearing for settlement. *E.occidentalis* is present along minor creeks, *E.rudis* and *E.patens* along the Hay River. *E.decipiens* comes in on wet places. Small patches of Banksia woodland occur on sand, *Banksia attenuata, B.ilicifolia* and *Nuytsia floribunda*. Towards the Kalgan Plains patches of *E.tetragona* mallee-heath begin to be seen, and towards the east and south increasing patches of jarrah and jarrah-Casuarina low-forest. On the dissected country of the Kalgan River however there is a return to good jarrah-marri forest as the soils are younger, less leached and better drained. There are swamps here in valley bottoms containing paperbarks and teatree *(Melaleuca cuticularis, M.densa)*, *E.staeri* and *E.decipiens, Agonis juniperina* and *Oxylobium lanceolatum* line the riverbanks.

The granite hills, Mt. Barrow and Mt. Barker, have some special features On Mt. Barrow jarrah forest extends to the summit but is mixed with *E.cornuta* and *E.megacarpa*. On Mt. Barker jarrah forest on massive laterite covers the slopes, petering out as low woodland and mallee against the rocks as granite is exposed on the summit. Mallee species are *E.cornuta* and *E.decipiens*. Rock slabs carry *Acacia? heteroclita, Stypandra imbricata, Verticordia preissii* and in crevices *Calothamnus quadrifidus, Hakea undulata, Melaleuca polygaloides* and *Xanthorrhoea preisii*.

2.6 PORONGURUP SYSTEM

This system is centred upon the Porongurup Range, one of the largest granite massifs in the State where granite domes crowd upon one another over a length of 12 km and a breadth of 3 km, reaching a general height of 2000 feet above sea level (600m) with a maximum of 670m at the Devil's Slide. Most of the domes have bare summits where the rock is smooth and thinly covered with lichens or mats of moss, or is irregularly covered with boulders and pockets of soil in which scattered plants can take root. These summits are mapped as rock outcrops. The higher summits at the western end such as Marmabup, Devil's Slide, Wall's Summit and Rock of Gibraltar tend to be the smoothest, those in the centre of the Park - Morgan's View, Nancy Peak, Twin Peaks - are more bouldery while the lower Castle Rock in the east (570m) carries gigantic perched boulders which are a scenic feature.

The bare domes rise from an encircling mass of Karri *(Eucalyptus diversicolor)* tall forest whose enormous trees reaching 60m in height form a striking contrast with the scrubby rocks above. In this locality Karri only occurs on the slopes of this Range and is an outlier from the main area of Karri forests 100 km to the west. Karri loam has formed from the decomposition of the granite and a further factor in the favour of Karri is the additional moisture shed into the forest by run-off from the domes, which must be equivalent to an effective increase in available rainfall.

On the pediments of the range the soil becomes more highly leached and lateritised, and the forest cover changes to medium-height trees of jarrah *(E.marginata)* and marri *(E.calophylla)*. On the north-western flank of the range the laterite crust is very massive and the jarrah are reduced to low trees $<$ 10m in height, forming Low Forest. Along the southern flank of the Range there is a lateritic soil with a surface layer of bleached sand which carries only mallee-heath with *E.tetragona* as a character species.

KARRI FOREST

The Karri forest in the Porongurups appears to be in all respects comparable with the forests in the Pemberton area. *E.diversicolor* is almost the sole tree and reaches heights of 60m (confirmed by measurement at Bolganup). There is some mixture of *E.calophylla* particularly on the lower slopes, and of *E.cornuta* and *E.megacarpa* adjacent to rock outcrops.

The understory is also typical, however Karri wattle *(Acacia pentadenia)* has not been recorded. *Clematis, Hovea* and *Kennedia* put on a great show of spring colour at a particular stage after the understory has been burnt. A list of component species based on collections on the Wansborough Walk and below Castle Rock is as follows :

Acacia nigricans, A.pulchella, A.urophylla
Albizia lophantha
Banksia grandis
Clematis pubescens
Chorizema diversifolium
Gastrolobium sp.
Hardenbergia comptoniana
Hibbertia serrata
Hovea pungens
Kennedia coccinea
Leucopogon propinquus, L.verticillatus
Marianthus granulatus
Mirbelia dilatata
Myoporum insulare
Pimelea sylvestris
Pteridium esculentum
Ranunculus lappaceus
Scaevola auriculata
Senecio ramosissimus
Stackhousia sp.
Stypandra grandiflora
Thomasia purpurea
Trymalium spathulatum
Xanthosia ? rotundifolia

At the time of writing much of the Karri in the Range appears to be overmature, the trees tending to die back in the crowns giving the condition known as "stag-headed".

ROCK OUTCROPS

Rock outcrops are seldom completely bare. Going up the Devil's Slide from Wansborough Walk, most of the rock is covered with moss mats in which small pink *Levenhookia* and a tiny white everlasting *Helipterum cotula* appear in spring. Rosettes of perennial *Pelargonium australe* are also seen. The next stage of accumulation of soil sees the appearance of reeds *(Lepidosperma longitudinale)* and blind grass *(Stypandra grandiflora)* and with still more rooting space available, of shrubs and small trees. Shrubs noted include *Acacia drummondii, A.heteroclita, Agonis linearifolia, Andersonia sprengelioides, Brachysema subcordatum, Daviesia sp., Hibbertia bracteosa, Melaleuca depauperata, Platysace compressa, Thryptomene dielsiana* and *Rulingia corylifolia* with the herbaceous plants *Helipterum bracteatum* var. *albidum* and *Scaevola auriculata*. Small trees of *Eucalyptus cornuta* occur in groves; understory plants noted were *Acacia drummondii, Pteridium esculentum, Brachysema subcordatum* and a creeper (unidentified). A few *Xanthorrhoea preissii* and *Boronia crenulata* appear on the summits. Small trees of *E.megacarpa* surround the perched boulders on the summit of Castle Rock.

2.7 EAST KALGAN SYSTEM

Lying mostly east of the Kalgan River this System is the eastern extremity of the Darling Botanical District and is already transitional to the adjoining Eyre District. The western boundary follows the edge of good jarrah-marri forest southwards from Stony Creek 2-3 Km east of Albany-Borden road to the Takenup Creek where it crosses the Kalgan River and follows the edge of the plateau 2-3 Km east of the River south to Oyster Harbour. The northern and eastern boundary of the System is also the District boundary, a line along which mallee-heath becomes dominant. South of the Bremer Bay road there is a sharp transition from woodland to open sandplain, but further north there is a gradual transition with patches of mallee-heath increasing in size and frequency and the mapped boundary is therefore an arbitrary line.

The landscape is a plain, mostly poorly drained, dotted with small freshwater lakes and swamps. The vegetation is a mosaic of jarrah-marri forest, jarrah low forest, jarrah-Casuarina and jarrah mallee-heath. The structural adaptability of *E.marginata* is here seen at its full range within a single system. Jarrah low forest seems to predominate in the north, jarrah-casuarina in the south, jarrah-marri forest in the west and mallee-heath in the east. Floristic composition of the forests has been listed previously : mallee-heath will be found under the Eyre District. Swamp vegetation is as noted under the Albany System.

There are two small patches of Karri, the most easterly known, on farms just south of Circuit Road in the Manypeaks area. One of these was examined. Passing through jarrah-marri forest 15m tall one enters Karri 25-30m, situated on a very gentle southwest slope leading down to a paperbark swamp. There is no granite outcrop and no extra moisture from run-on. The soil is an orange-brown light loam becoming clay at 40 cm with occasional laterite blocks on the surface. There are a few *Eucalyptus calophylla* and *Agonis flexuosa*, an understory of *Trymalium spathulatum* and an *Acacia*, nothing else, perhaps due to being eaten out by sheep. There is dense young Karri regeneration. As noted elsewhere Karri will occur within its climatic zone where it finds suitable soil, and the soil here is classic. The problem remains - why this soil patch? Only deep augering would determine its parent material, perhaps basic granite or a limestone reef in the Plantagenet Beds.

2.8 KENDENUP SYSTEM

The Kendenup System is also a transitional one, stretching in a narrow band between the Kwornicup and Narrikup Systems and the boundary of the Botanical District. Broadly it is wedged between Kendenup and the Stirling Range and extends from north of the Porongurups almost to Frankland. The country is a plain drained by the Young and Kalgan Rivers in the south and by the Gordon in the north.

With the decline in the rainfall to the northeast, the System is below the 25 inch or 635 mm isohyet, and the forests therefore open out to woodland. Jarrah is still present but mixed with both marri and wandoo on upper slopes whereas lower slopes have yate and wandoo. *E.decipiens* appears as usual in depressions. There is some teatree along creeks, and as lower rainfall means salinity, samphire appears to a limited extent.

Geekabee Hill 15 Km west of Cranbrook is in this area and is of special interest as with the adjoining small hills it is an outlier of the Stirling Range, of the same quartzite formation. Geekabee Hill was visited on 16.10.75 by permission of the owners Mr. & Mrs. Preston of Geekabee Downs. Sheep had eaten out the undergrowth of much of the area but a botanical reserve* had been fenced off on the summit and north slope, containing rather open jarrah low woodland *(E.marginata* but no *E.calophylla)* with a good heath layer 1.2m tall. *Kunzea recurva* var. *montana, Melaleuca polygaloides* and *Leptospermum erubescens* are dominant plus *Adenanthos filifolius, Banksia grandis, Boronia albiflora, Burtonia scabra, Dryandra sessilis, Eucalyptus decipiens, E.pachyloma, Hakea cucullata, H.nitida, Hemiandra rupestris, Jacksonia compressa, Lachnostachys* sp., *Leucopogon parviflorus, Sphenotoma dracophylloides, Xanthorrhoea preisii.*

Eucalyptus decurva and *E.macrocera* are present in paddocks at the bottom of the hill.

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* *Reserve No. 30916 rested in the National Parks Authority.*

2.9 JINGALUP SYSTEM (F.G. Smith 1972)

In the Jingalup System which covers the north-western corner of the map sheet we have some country which is entirely different from the rest of the Albany-Mt. Barker area but is typical of the western side of the Darling Range along its whole length northwards. It is undulating and dissected. The whole country was at one time capped with ironstone gravel but this has been eroded away, remaining only on the hilltops and ridges. On the slopes younger soils have developed on granite, acid and neutral hard-setting loams, becoming alkaline in the valleys. Climate is also different, rainfall is below the 25 inch or 625 mm line and the dry season longer extending over more than 4 months. Because of the dissection of the country there is a clearly marked catena with jarrah-marri forest on the summit ironstone gravels and woodland of marri and wandoo without jarrah on the slopes. Jarrah recurs with river gum *(E.rudis)* on sandy alluvia along the Gordon River but is otherwise restricted to ironstone gravels. *E.astringens* may associate with jarrah on breakaways. *E.rudis* occurs along minor drainage, giving way to *E.occidentalis* in the east and south. Major creeks are lined by *E.rudis, Melaleuca cuticularis* and *M.viminea*.

There is an apparent paradox that forest should typically occur on ridges and the less dense woodland on the slopes since the ridges would be expected to be drier, especially as they are capped with inhospitable ironstone gravels. The explanation appears to be that there is a deeply weathered zone some 15m deep beneath the ironstone crust which provides deep water storage whereas the soils of the slopes are relatively shallow.

The woodland trees, *E.calophylla* and *E.wandoo*, reach heights of 15 to 20m. Beneath them are scattered or locally plentiful small trees of jam *(Acacia acuminata)* and sheoak *(Casuarina huegeliana)* with some *Banksia grandis* and *Nuytsia floribunda*. There is a scattered understory - not continuous as in jarrah forest - of sclerophyll shrubs of which the following were recorded :

Acacia lasiocarpa var. *bracteolata, A.saligna, Brachysema praemorsum, Casuarina baxterana, Dampiera lavandulacea, Dryandra formosa, D.sessils, Hakea prostrata, Hypocalymma angustifolium, Jacksonia sternbergiana, Leptospermum erubescens, Leschenaultia formosa, Stypandra imbricata.*

Few undisturbed examples of this community now remain.

3. AVON BOTANICAL DISTRICT

The Avon Botanical District is traditionally equated with the "wheat belt" of Western Australia lying inland of the Darling Range throughout its length. The southernmost tip of the District is seen here extending through Tambellup as far south as Cranbrook, all of it in the drainage of the Gordon River. Rainfall is 18-22 in. (450-550mm) with summer drought of 5 months. Soils are mostly hard-setting loams with mottled yellow

clayey subsoils, neutral on slopes, alkaline in valleys but there is a sand belt along the Gordon River from which sheets of aeolian sand extend ESE. The area is of low relief. Drainage to the Gordon River from the east has become disorganised resulting in a belt of salt lakes around Pootenup.

This portion of the District is denoted the Tambellup System. A few small outliers of ironstone-capped hills are seen with jarrah on them. Predominantly the cover consists of woodland of wandoo *(E.wandoo)* and yate *(E.occidentalis)* without marri. Blue mallet *(E.gardneri)* may appear on rises, and York gum *(E.loxophleba)* comes in around Pootenup in the lakes country. River gum *(E.rudis)* is present near the Gordon River in the western part forming woodland with wandoo and yate but along the upper Gordon drier and saltier conditions force a change to teatree *(Melaleuca viminea)* and samphire *(Arthrocnemum, Sarcocornia)*.

The woodlands have been almost entirely cleared for farming but an example was examined in Reserve 16297 6 Km west of Tambellup. Trees consist of mixed *E.wandoo* and *E.occidentalis* 12m tall and there was only a sparse woody understory. In spring the ground is covered by a sedge or Restio forming a sward. Occasional large shrubs of *Acacia acuminata, Casuarina huegeliana,* and *Jacksonia sternbergiana* become dense in open patches of the woodland. Other small shrubs include *Acacia lasiocarpa* var. *bracteolata, Bossiaea eriocarpa, Calytrix tenuifolia, Chorizema aciculare, Dampiera teres, Gastrolobium calycinum, Hibbertia montana, Pimelea angustifolia.* Ground plants include pin grass *Borya nitida,* orchids *Caladenia flava, Thelymitra antennifera* and a daisy *Ursinia chrysanthemoides.*

The sandplain at Tambellup consists of wandoo with scattered patches of heath. Species have not been listed.

4. ROE BOTANICAL DISTRICT

The southwestern extremity of the Roe Botanical District occupies the north-east corner of this map, its boundary coming south from Toolbrunup Siding to Lake Balicup, then turning east to the Pallinup River and following up the Peenebup Creek to the map boundary. The Roe District stretches north to Narembeen, northeast to the Bremer Range and east to the Nullarbor Plain. It is essentially the mallee region of Western Australia. Sandplains occupy the highest ground and some woodland may occur on bottomland soils but mallee covers the great expanses of the middle slopes. It is characterised by a climatic regime in which annual rainfall is lower in relation to the length of the dry season than it is in the Darling and Avon Districts where the dominant vegetation is forest and woodland. Most of the area represented here belongs to the Chidnup Vegetation System but there are also small sections of the Hyden and System.

4.1 CHIDNUP SYSTEM (Beard, 1972)

This system occurs widely on the adjoining Newdegate and Bremer Bay map sheets. It was characterised by Beard as follows : "Topographic relief is very subdued and the landscape is flat to gently undulating. By far the greater proportion of the area is occupied by mallee but there are patched of mallee-heath on rises while major valleys and the numerous small lakes and pans bear patches of eucalypt woodland."

The mallee-heath is of the *Eucalyptus tetragona* type which is fully described in the Qualup System of the Eyre District.

Mallee belongs mainly to the *E.redunca-E.uncinata* association of previous work (Beard 1972). These two species are the most commonly encountered but *E.flocktoniae, E.gardneri* and *E.occidentalis* are also found. The last three species may occur elsewhere as trees but here they are mallee. *E.platypus* and *E.annulata* occur on heavy winter-wet soil. These are small trees which regenerate from seed after fire, and do not possess the coppicing habit of mallee. Mallee most commonly possesses a dense teatree understory which was examined in Flora and Fauna Reserve No. 25194. Site 1 had a teatree understory 1.5m tall under mallee of 4.5m, consisting of *Melaleuca cuticularis, M.deltoidea, M.polygaloides, M.sp., Acacia* sp. and *Kunzea* sp. Site 2 had teatree 90cm under mallee 2.5-3m, *Melaleuca* sp. aff. *acerosa, M.* sp. aff. *exarata, Astartea ambigua, Pultenaea empetrifolia.* Site 3 had a heath understory of *Casuarina humilis, Calytrix tenuifolia, Hakea prostrata, Anigozanthos humilis.*

Depressions in the plain carry patches of yate woodland *(E.occidentalis)* with wandoo in the west, and with paperbarks if swampy. Lakes are mostly saline and intermittent. Continuous woodland occurs in the larger valleys particularly along the Pallinup and its tributaries. Yate and York gum are the usual species with some wandoo, some marri near the Stirling Range and some morrell *(E.longicornis)* in the Borden area. Yate tends to be dominant on the lower ground and York gum on upper slopes. Along the course of the Pallinup *Casuarina obesa* grows in the river bed river gum and yate on banks and levees. Most of the woodland has been reduced by farming operations to scattered trees in paddocks so that the understory is now hard to assess. *Acacia acuminata* and *Casuarina huegeliana* were evidently present. A few smaller plants listed were *Acacia* sp. inedit. (JSB7480), *Dampiera lavandulacea, Daviesia ? incrassata, Isotropis cuneifolia, Leschenaultia formosa, Orthrosanthus laxus, Thomasia angustifolia.*

4.2 HYDEN SYSTEM (Beard 1972)

A small piece of country above Borden north of the Warperup Creek is placed in the Hyden System to accord with mapping of adjacent sheets, but for present purposes does not differ significantly from the Chidnup System.

5. EYRE BOTANICAL DISTRICT

Named originally by Diels after John Eyre who came through from Adelaide on the first land-based exploration in 1841, the Eyre District stretches from the Stirling Range and Mount Manypeaks as far as the Bight. It is the coastal sector of the mallee region where due to prolonged leaching of the soil over millions of years the plains consist only of poor sands unable to support more vegetation than heath with an open upper layer of stunted mallee - characterised as mallee-heath. True mallee is restricted to hills and valleys, while woodland is almost non-existent. This is a seeming anomaly as the coastal sector of course receives more rain than the better wooded country further inland, but it is explained by the poverty of the soil.

Six vegetation systems are represented.

5.1 QUALUP SYSTEM (Beard 1972)

The Qualup System is the most widespread and characteristic, covering the sandy gravelly plains north and south of the Stirling Range and extending east to the Phillips River beyond which it is continued by the very similar Esperance System to Cape Arid and Israelite Bay. South of the Stirlings the Qualup gives way to the Cape Riche System with a change in vegetation which cannot now after land clearing be exactly traced by means of aerial photo patterns and an arbitrary line has been drawn.

The principal formation is mallee-heath in which the conspicuous tallerack (*Eucalyptus tetragona*) is taken as the character species, growing on plains of sand overlying clay often with ironstone gravel. On deep sand the formation changes to scrub-heath in which mainly Protaeceous shrubs, e.g. *Lambertia inermis*, largely replace mallee. Mallee itself occurs on the lunettes of lakes. There is limited woodland along creeks coming down from the Stirling Range and along the Kalgan River. The plains are dotted with numerous salt lakes and pans or simply swampy depressions which contain *E.decipiens* mallee if sandy, *E.occidentalis* woodland if loamy.

In mallee-heath there is an open upper layer of tall shrubs capable of reaching perhaps 3.5m in height. These consist mainly of *Eucalyptus* but other shrubs, usually Proteaceae, may be present. There is a lower layer, closed and about 50 cm tall when mature, of small shrubs which have typically small "ericoid" leaves. Profile diagrams illustrating the structure of *E.tetragona* mallee-heath were given by Beard (1972).

The character-species *E.tetragona* is conspicuous for its straggly growth and large very glaucous leaves. The stems are twisted and rambling, and form very open clumps.

A species list was made from various localities.

Small trees (rare):

Nuytsia floribunda

Grass trees :

Xanthorrhoea gracilis

Mallee :

Eucalyptus angulosa, E.buprestium, E.decipiens, E.decurva, E.flocktoniae, E.marginata, E.pachyloma, E.preissiana, E.redunca, E.tetragona, E.uncinata.

Other tall shrubs :

Acacia saligna, Agonis spathulata, Banksia sphaerocarpa, Beaufortia schaueri, Calothamnus sp., *Casuarina humilis, Dryandra falcata, D.proteoides, D.sessilis, Gastrolobium spinosum, Grevillea brownii, G.fasciculata, Hakea corymbosa H.pandanicarpa, H.prostrata, H.trifurcata, H.undulata, Isopogon buxifolius, I.formosus, I.longifolius, I.teretifolius, Kunzea preissiana, Lambertia ericifolia, L.inermis, L.uniflora, Melaleuca pungens, M.scabra, Petrophile ericifolia, P.serruriae, P.squamata, Regelia inops.*

Smaller shrubs :

Astroloma serratifolium, Banksia petiolaris, B.repens, Calectasia cyanea, Calytrix brachyphylla, Chorizema aciculare, Conospermum floribundum, Darwinia diosmoides, Daviesia incrassata, D.obtusifolia, Dryandra nivea, D.pteridifolia, Gompholobium burtonioides, Hibbertia cf. *recurvifolia, Kunzea* sp.aff. *recurva, Leschenaultia formosa, Leucopogon bracteolaris, Lysinema ciliatum, Stirlingia latifolia, Synaphaea spinulosa, Verticordia chrysantha, V.habrantha.*

Herbaceous :

Anigosanthos humilis, Conostylis villosa, Lomandra hastilis, Patersonia occidentalis, Stackhousia pubescens, Restionaceae spp.

Hamilla Hill, an outlying portion of the Stirling Range National Park at the western end and formed of the same quarzite as the Range, is covered by this mallee-heath with scattered wandoo trees. On Sukey Hill closer to Cranbrook the mallee-heath covers the north slope again with scattered wandoo and *E.decipiens*. Wandoo woodland covers the south slope.

On deep sand there is a radical change as follows, to the scrub-heath formation which may be seen on the plains south of Bluff Knoll, and in the Camel lake area north of the Range.

Tall shrubs :

E.decipiens replaces the other mallees and is subordinate to other large shrubs, notably *Adenanthos cuneatus, Banksia attenuata, B.baxteri, B.coccinea, Isopogon attenuatus, Lambertia inermis, Leptospermum erubescens, Melaleuca polygaloides. Nuytsia floribunda, Petrophile rigida.*

Smaller shrubs :

Actinodium cunninghamii, Burtonia scabra, Bossiaea linophylla, Conospermum amoenum, Daviesia incrassata, Hibbertia cf. *lineata, Leucopogon polymorphum, Pimelea modesta, Platytheca* sp., *Stirlingia latifolia, Verticordia habrantha.*

Herbaceous :

Anigozanthos humilis, Anarthria scabra.

Lambertia inermis becomes very abundant and is the commonest and most conspicuous shrub. *Hakea corymbosa* is common. Large open patches tend to occur with the dwarf Banksias and Dryandras *(B.petiolaris, B.prostrata, B.repens, D.nivea, D.pterifidolia)* and small ericoid shrubs *(Lysinema, Verticordia)*.

In damp sandy areas the mallee returns in the shape of *E.angulosa, E.falcata, E.tetragona* and *E.uncinata*. *Melaleuca exarata* is conspicuous among the ground plants.

There is little mallee in the strict sense in the Qualup System, i.e. a shrubland in which mallee-form eucalypts are dominant.

E.decipiens may occur as an understory species to *E.occidentalis* woodland in hollows or be peripheral to it. Other mallees notably *E.lehmannii, E.falcata, E.preissiana* and *E.buprestium* may similarly occur fringing patches of woodland.

The principal occurrence of mallee in the system is on the curving, parallel sand ridges known as lunettes on the south-east side of Lake Quarderwardup and its adjacent salt lakes. Principal species are *Eucalyptus angulosa, E.decipiens* and *E.tetragona* associated with *Banksia media, Beaufortia squarrosa, Callitris roei, Hakea corymbosa, H.laurina, Lambertia inermis* and *Nuytsia floribunda*.

Strips of jarrah-marri woodland are found along streams descending from the Stirling Range and pure stands of marri occur round the southeastern salt lakes in the National Park, e.g. at Kojaneerup Spring. In the valleys of the Pallinup and Kalgan Rivers there are woodlands of York gum and yate as in the Chidnup System, and more or less circular patches of yate growing in hollows dot the plains.

Samphire communities composed of small stem-succulent shrubs play a minor role fringing some of the salt lakes and in some cases covering the lake bed. The samphires themselves are species of *Arthrocnemum* and *Sarcocornia* associated with the succulent *Disphyma australe* and sedges one of which is a large tussock-forming species *(?Gahnia trifida)*. Scattered paperbark trees, *Melaleuca cuticularis*, may be present.

5.2 JERRAMUNGUP SYSTEM (Beard 1972)

A small portion of the Jerramungup System lies between the Peenebup and Dedalup Creeks, tributaries of the Pallinup. The country is intermediate between the Chidnup and Qualup systems with mallee-heath a more significant member of the catena than in the Chidnup.

5.3 STIRLING RANGE SYSTEM

This system is associated with the Range of that name and covers the slopes, peaks and valleys. Surrounding plains and pediments are included in the Qualup System where their vegetation is *E.tetragona* mallee-heath or mixed scrub-heath.

Principal control of vegetation is by topography and soil. Owing to the mountainous nature of the Range, topography exerts a very strong influence, and the relationships of the various units can be explained in terms of a catena. Both geology and soils are also related to positions in this catena. The rocks forming the Stirling Range are of sedimentary origin, consisting of quartz sandstone at the base, overlain by phyllite and muddy sandstone. As the beds are mostly fairly flat-lying this sequence exists throughout and there is an absence of the lithological diversity which is marked in the Barren Ranges further east and has created ecological niches favourable to local endemic species there. Broadly, the thicket of the mountain tops is associated with phyllite and the mallee-heath of the lower slopes with quartz sandstone. Woodland in the valleys is associated with colluvium brought down from the mountains, forming relatively young, undeveloped soils. Although these may contain quantities of laterite, it is in the form of transported nodules. On the other hand the *Eucalyptus tetragona* mallee-heath of the surrounding plains and pediments, (Qualup System), while it is also developed partly on colluvium, has a highly weathered soil profile dating probably from the Early and Middle Tertiary.

WOODLAND

Woodland and Open Woodland are found in many of the valleys. They have not been separated in mapping owing to the restricted areas occupied and the prevalence of intergrading situations. Density varies from near-forest along the creeks north of Isongerup and Ellen Peak to very open woodland along the Young River. Tree heights of *E.marginata* and *E.calophylla* were estimated at 10-15m in Chester Pass. Some *E.wandoo* were measured at 17-18m in the Magog picnic area, and 20-26m at White Gum Flat, but most woodlands grade upslope into Low Woodland of 5-10m.

Species forming woodland in the Park are (in order of abundance): *E.marginata, E.calophylla, E.wandoo, E.occidentalis, E.rudis, E.cornuta* and *Acacia* sp. inedit. *E.marginata* is normally associated with lesser numbers of *E.calophylla* and sometimes also with *E.wandoo* which may occur pure or with *E.calophylla* or with *E.occidentalis*. *E.marginata* is found on sandy and laterite soils, *E.wandoo* on heavier red and yellow soils while *E.calophylla* is intermediate. *E.occidentalis* favours swampy heavy grey soils, sometimes with *E.rudis*. *E.cornuta* may occur as a tree on creek banks, e.g. along the Mabinup Creek north of Toolbrunup. It occurs also as a mallee e.g. at the north foot of Bluff Knoll, on the col between Magog and Talyuberlup, and on the northeast face of Magog. An unknown Acacia tree froms woodland in gullies on Toolbrunup and Mt. Hassell. Patches of *E.marginata-E.calophylla*

woodland may occur high in the mountains as on the slopes of Magog and in gullies on the south slopes from Bluff Knoll to Ellen Peak.

Understories are variable, according to soil. In stands of *E.marginata* and *E.calophylla* wattles are normally conspicuous, e.g. *Acacia drummondii, A.pulchella, A.myrtifolia*. Other species noted include *Banksia grandis, Conospermum amoenum, Dryandra formosa, D.cirsioides, Hakea ambigua, H.cucullata, Leucopogon unilateralis, Mirbelia dilatata, Xanthorrhoea gracilis*. Banksias may often be conspicuous in sandy places, e.g. *B.attenuata, B.baxteri, B.coccinea* and also *Hakea varia*. Woodland patches at high altitude have mountain thicket species as understory plants, e.g. *Dryandra formosa, Isopogon latifolius, Oxylobium atropurpureum*.

A stand of *E.wandoo* was examined at the Magog Picnic area. The trees are solely of *E.wandoo* except for *E.cornuta* on creek banks. Mallees *E.angulosa, E.decurva* and *E.tetragona* occur as understory on upper slopes. Other understory plants noted included :

Shrubs :

Bossiaea linophylla (abundant and conspicuous), *Calytrix brachyphylla, Casuarina humilis, Chamaelaucium ciliatum, Gastrolobium* sp., *Hakea corymbosa, H.varia, Leptospermum erubescens, Leucopogon polymorphus, Oxylobium velutinum, Phyllanthus calycinus, Pseudanthus virgatus*.

Climbers :

Clematis pubescens, Sollya heterophylla.

Herbaceous :

Caladenia flava, Drosera sp., *Dianella revoluta, Waitzia citrina*.

Reeds :

Lepidosperma leptostachyum

At a higher level, on the eastern slopes of Talyuberlup, *E.wandoo* is mixed with mallee of *E.cornuta, E.lehmannii* and *E.occidentalis* together with *Acacia* sp. inedit., *A.ferocior, Calothamnus* sp. aff. *gracilis, Dryandra cirsioides, Hakea* sp., *Leucopogon unilateralis, L.parviflorus, Melaleuca acerosa, M.depauperata, Oxylobium bilobum* var. *angustifolium, Sollya heterophylla*.

Woodlands formed of or containing *E.occidentalis* commonly have somewhat sparse understories. Mixed *E.occidentalis* and *E.wandoo* at the Chester Pass caravan park have scattered *Billardiera, Calytrix tenuifolia, Chorizema aciculare* and clumps of the sedge *Gahnia ancistrophylla*. Elsewhere in Chester Pass, mixed *E.occidentalis* and *E.rudis* have little but *Acacia saligna* beneath. In Pillenorup Swamp the understory species are *Beaufortia sparsa* and *Leptomeria* sp.

LOW WOODLAND

Low woodland occurs on lower slopes above the Woodland if present or may occupy the whole valley. As with Woodland, Low Woodland mapped includes Open Low Woodland. There seems to be no floristic difference, the two

intergrade with one another and with woodland downslope, mallee-heath up slope. Almost all low woodland in the Park is of *E.marginata-E.calophylla* but three other associations have been observed in a minor role. *E.megacarpa* and *Casuarina huegeliana* occur together on parts of Ellen Peak and perhaps represent the true climax in fire-protected places. *E.macrocera* and *C.huegeliana* were observed in a similar situation on The Abbey. *E.decipiens* is dominant with *E. marginata* in some valleys south of Gog, and forms stands in very sandy soil along the Young River associated with *Banksia attenuata* and *Lambertia inermis*.

Trees in Low Woodland are from 5 to 10m in height. In *E.marginata* stands they are commonly much distorted by frequent burning.

A species list was made along the track to Magog :

Low trees :

E.calophylla, E.marginata, Banksia attenuata, B.grandis, Nuytsia floribunda.

Tall shrubs :

Agonis parviceps, Banksia coccinea, B.sphaerocarpa, Beaufortia heterophylla, Calothamnus sp., *Casuarina humilis, C.trichodon, Dryandra concinna, Hakea baxteri, H.corymbosa, H.cucullata, H.trifurcata, H.varia, Isopogon baxteri, I.cuneatus, I.dubius, Kingia australis, Kunzea recurva* var.*recurva, Lambertia ericifolia, Leucopogon parviflorus, Melaleuca acerosa, M.polygaliodes, Petrophile divaricata, P.serruriae, Sphenotoma* sp.aff. *dracophylloides Xanthorrhoea gracilis.*

Small shrubs :

Adenanthos apiculatus, Andersonia simplex, Astroloma serratifolium, Baeckea sp., *Banksia petiolaris, Burtonia scabra, Daviesia incrassata, Dillwynia cinerascens, Dryandra nivea, D.pteridifolia, Eucalyptus doratoxylon, Grevillea pulchella, Latrobea hirtella, Leucopogon carinatus, Lysinema ciliatum, Petrophile longifolia, Platytheca juniperina, Pultenaea verruculosa, Stirlingia latifolia, Synaphaea spinulosa, Restionaceae* spp. (see list under Mallee-heath).

MALLEE-HEATH

Mallee-heath is the most widespread formation in the Range, covering all the mountain slopes except for the upper parts of the principal peaks where there is a thicket formation described later. *Eucalyptus marginata* now in mallee form is the principal species. This *E.marginata* association is characteristic of the mountain slopes but does also descend to the pediments on the south side of the Range east of Chester Pass where it forms a patchy mixture with the type of scrub heath described in the Qualup System, the two alternating according to the depth of the sandy topsoil.

A species list for the *E.marginata* mallee-heath was made along the Stirling Range Drive east of Mt. Hassell, as follows :

Small trees (rare) :

Nuytsia floribunda

Grass trees to 3m :

Kingia australis, Xanthorrhoea gracilis

Mallee :

Eucalyptus calophylla, E.doratoxylon, E.marginata

Other tall shrubs :

Banksia grandis, Hakea baxteri, H.cucullata, H.pandanicarpa, Lambertia ericifolia, L.uniflora.

Smaller shrubs :

Banksia petiolaris, B.sphaerocarpa, Beaufortia heterophylla, Boronia crenulata, Burtonia villosa, Casuarina humilis, Conospermum dorrienii, Darwinia diosmifolia, Dryandra nivea, D.proteoides, Isopogon cuneatus, I.dubius, Lysinema ciliatum, Melaleuca polygaloides, Petrophile divaricata, Platytheca galioides, Sphaerolobium macranthum, Sphenotoma dracophylloides, Synaphaea? favosa, Xanthosia rotundifolia.

Herbaceous plants :

Conostylis villosa, Dampiera sp., *Diuris longifolia, Drosera* spp., *Johnsonia lupulina*

Restionaceae :

Anarthria gracilis, Caustis dioica, Lepidosperma viscidum, Mesomelaena stygia, M.tetragona, Restio sp. inedit.

The list of Restionaceae is derived from another area at the foot of The Abbey, south side.

THICKET

A formation of closed tall shrubs or thicket, occurs at the upper levels on all the principal peaks in the Range. As with other shrubland formations, structure varies with the time elapsed since the last burn since all top growth is normally killed by fire. As the thicket regenerates it grows taller until a maximum is reached which might be of the order of 3m but would vary according to soil depth, exposure and other factors. Adjacent shrubs grow to approximately the same height so that an even canopy is produced. The stand is dense and difficult to penetrate. Composition was examined on seven of the peaks with consistent results shown in the Table. The north slope of Bluff Knoll and the summit are separated, making eight sites listed since the composition on the plateau shows some special features.

The Table shows first a group of 15 species which occur consistently on at least four of the seven peaks. It is probable that they do occur throughout but were overlooked in some cases. Several of these flower very conspicuously in spring, notably *Dryandra formosa, Isopogon latifolius* and *Oxylobium atropurpureum* which normally put on a most magnificent show in October. In this respect together with the prominence of Proteaceae and the general physiognomy, the thicket more closely resembles the *fynbos* formation of the South African mountains than any other in Western Australia.

There is a second group of 13 species which were recorded less consistently and apparently are not of general occurrence. This group includes the mallee eucalypts which are generally speaking not an important element in the thicket formation, except on Mondurup where it seems drier and more open than elsewhere. Not only are mallees dominant on Mondurup but the principal species, collected as JSB 7624, appears to be an unknown

local endemic. It resembles both *E.marginata* and *E.preissiana* of which the latter is also present on the mountain. Except for this one case, species recorded only once at the seven sites were omitted from the Table.

The Bluff Knoll plateau is in essential respects similar to the thicket elsewhere. *Banksia brownii* replaces *B.solandri*, *Dryandra mucronulata* replaces *D.formosa* while *Xanthorrhoea* is only locally present. *Hypocalymma myrtifolium*, *Leucopogon unilateralis* and *Oxylobium atropurpureum* have not bee been recorded. Other species present on the plateau but not apparently in the thicket on other peaks are *Agonis spathulata*, *Andersonia axilliflora*, *Astartea fascicularis*, *Beaufortia anisandra*, *Darwinia collina*, *Lambertia uniflora*, *Lepidosperma longitudinale* and *Leucopon gnaphalioides*.

Other minor communities of mountain vegetation include mats formed by fleshy rosette-plants on rock slabs, e.g. *Andersonia sprengelioides*, *Monotoca oligarrhenoides* and *Sphenotoma drummondii*. Rock screes on Toolbrunup carry a few scattered plants of *Helichrysum* sp. aff. *bracteatum*, *Hibbertia argentea* and *Sphenotoma drummondii*. The scree is bordered in places by thickets of *Trymalium spathulatum*.

SEDGE SWAMP

The only unwooded freshwater swamp in the Park appears to be in the Pillenorup Swamp. This has an outer zone of woodland of *E.occidentalis*, *E.decipiens* and *Melaleuca cuticularis* merging to scattered *Melaleuca* with a sedge ground layer and finally in the centre to pure sedge. *Gahnia trifida* forms scattered tussocks while another small sedge (unidentified) forms a sward.

NOTES ON THE FLORA

Owing to the diversity of habitats the flora of the Stirling Range has long been recognised for its richness. Erickson, George, Marchant and Morcombe (1973) estimated the flora at over 550 species. A checklist of the flowering plants (Hussey 1977) produced a total of 544. Only the most conspicuous species or those of ecological importance have been mentioned in this account of the vegetation. The collecting done by the writer in the course of field work for the vegetation map added a number of new records to the checklist.

It has also long been recognised that a high proportion of the flora of the Range is endemic to it, that is to say, is found only there and nowhere else, but in the present state of our knowledge it is difficult to be precise about this. The 1977 checklist of the flora does not indicate endemic species and it would require an exhaustive check of the material in the State Herbarium to obtain the information. It is obvious that the Stirlings, being the only substantial mountain range in the South-west of Western Australia, comprise a series of unique habitats in which unique species are likely to be harboured, but the situation differs materially from that in the Barren Ranges further east.

TABLE II

COMPOSITION OF THICKET ON SEVEN PEAKS IN THE STIRLING RANGE.

	Mondurup	Magog	Tabyuberlup	The Abbey	Toolbrunup	North slope BLUFF KNOLL	Summit plateau	Ellen Peak
Acacia drummondii	x	x	x	x	x		x	
Andersonia echinocephala	x	x	x				x	x
Banksia solandri	x	x	x	x	x	x		x
Beaufortia decussata	x	x	x		x	x	x	x
Boronia crenulata	x		x		x	x	x	
Calothamnus sp.aff. *gracilis*	x			x	x		x	x
Dryandra formosa (JSB 7622)	x	x	x	x	x	x		x
Hakea ? florida (JSB 7449)	x	x	x	x	x		x	x
Hypocalymma myrtifolium	x	x	x	x	x	x		
Isopogon latifolius	x	x	x	x	x	x	x	x
Kunzea recurva var. *montana*	x	x	x	x	x		x	x
Leucopogon unilateralis		x	x	x	x			
Oxylobium atropurpureum	x	x	x	x	x	x		x
Sphenotoma sp.aff. *dracophylloides*	x	x	x		x	x	x	x
Xanthorrhoea gracilis (JSB 7436)	x		x	x	x	x	x	
Adenanthos filifolia	x	x					x	
Andersonia axilliflora						x	x	x
Banksia quercifolia		x		x		x	x	
Burtonia villosa						x		x
Casuarina trichodon	x		x			x		
Dryandra concinna			x		x	x		
Eucalyptus calophylla	x		x					
Eucalyptus marginata		x	x		x			
Eucalyptus megacarpa				x		x		x
Eucalyptus sp.inedit. (JSB 7624)	x							
Hakea ambigua	x		x		x			
Leucopogon atherolepis	x		x					
Petrophile heterophylla			x					x
Platytheca juniperina			x		x			

In that area there is considerable lithological diversity with the rocks tilted at high angles, and there are many well-known endemic species associated with particular types of outcrop (Beard, 1972).

In the Stirlings the most specialised habitats are on the mountain peaks and are a product not only of lithological change but of altitude with its lower temperature, higher humidity and exposure to wind. It is possible fairly easily to make a check of the 28 species listed in the Table showing the composition of the Thicket formation, and it is found that 15 of these are endemic to the Range (or probably endemic). Many of the others, e.g. *Dryandra formosa*, also occur nearer to the coast, at lower altitude but under higher rainfall.

The only group which has become well known in this respect is in the genus *Darwinia* where there are eight endemic species having localised distributions within the Park. The outstanding floral beauty of these plants has attracted public and professional interest so that their taxonomy and distribution have been specially studied (Marchant, in press). On the mountains east of Chester Pass from Bluff Knoll to Ellen Peak, *Darwinia collina* occurs on the summits, *D.squarrosa* on middle slopes and *D.leiostyla* on lower slopes. The latter extends also to Mt. Trio. In the central part of the Range, *D.hypericifolia* occurs on and around Toolbrunup, Mt. Hassell, Talyuberlup, The Abbey and other peaks. A new species still unnamed was discovered along the road south of Gog by the late Arthur Fairall about 10 years ago. In the western part of the Range *D.macrostegia* is on Mondurup and the two Mount Mistakes and another not yet precisely named at the foot of Mondurup and on Red Gum Hill. The outlying Hamilla Hill now included as part of the National Park carries *D.meeboldii*. *Darwinia diosmifolia* is a component of the mallee-heaths at the foot of the Range and spreads widely but this species is not floristically striking. It will be seen that the endemic species are divided geographically into four groups no doubt related to variations in climatic conditions.

A popular impression seems to have arisen that the species are isolated on particular mountain peaks but this is seen to be incorrect. They occur rather on groups of peaks and the surrounding pediments. Such distributions may very well be found to occur in species of other genera when these come to be as well studied.

5.4 CAPE RICHE SYSTEM (Beard 1972)

On crossing the bioclimatic boundary line to a shorter dry season of under 4 months, on the Kalgan Plains the mallee-heath becomes dominated by *E.marginata* instead of *E.tetragona*, and other species changes take place. This mallee-heath association, similar to that on the slopes of the Stirling Range, covers the greater part of the area, merging into a scrub-heath as described in the Qualup System on deep sand. Some fairly large patches of jarrah-marri woodland, similar to the jarrah-marri forest described elsewhere but more open, occur along the Bremer Bay Road and again near the sea

on Warriup Road. The plain is dotted as usual with small depressions filled with *E.decipiens* or *E.occidentalis* according to the degree of swampiness, or in some cases with sedges and *Hakea varia*.

A list of the composition of the jarrah mallee-heath has been built up from several localities.

Mallee : *E.marginata, E.decipiens, E.calophylla, E.preissiana, E.tetragona.* Tree : *Nuytsia floribunda.*

Grass trees : *Kingia australis, Xanthorrhoea preissii.*

Tall shrubs>1m : *Adenanthos cuneatus, Agonis spathulata, Banksia attenuata, B.baueri, B.baxteri, B.coccinea, B.grandis Beaufortia heterophylla, Casuarina humilis, Comesperma* sp., *Daviesia alternifolia, D.?incrassata, Dryandra falcata, D.plumosa, Grevillea fasciculata, G.pulchella, Hakea baxteri, H.cucullata, Isopogon cuneatus, I.dubius, I.formosus, I.teretifolius, I.trilobus, Lambertia inermis, L.uniflora, Leucopogon unilateralis, Petrophile heterophylla, Sphenotoma dracophylloides.*

Small shrubs<1m : *Actinodium cunninghamii, Adenanthos apiculatus, Dryandra nivea, Hibbertia gracilipes, Lysinema ciliatum, Sphaerolobium macranthum, Synaphea spinulosa, Verticordia preissii.*

Creeper : *Kennedia coccinea*

In the extreme south below the Bluff River and in the Waychinicup drainage *Eucalyptus staeri* replaces *E.marginata* but no significant change in the associated flora was recorded. As before there is a mallee phase and a scrub-heath phase on deeper sand with Banksias dominant.

On slopes facing the sea there is again a different association with *E.marginata* replaced by *E.lehmanii* and *E.angulosa* with *Casuarina trichodon* conspicuous. Other associated species recorded, at Cheyne Inlet by Beard (1972) and south of Warriup Hill by the present writer, differ, so that this community requires further study. However it is apparent that it is the same community as the "heath" reported by Willis (1953) on Sandy Hook Island in the Recherche Archipelago.

5.5 BREMER SYSTEM (Beard 1972)

This System comprises the coastal complex of granite bosses and sandhills stretching from Nanarup eastward to Bremer Bay. It closely resembles the Torndirrup System. The granite masses of Mt. Gardner, Mt. Manypeaks and Bald Island are included together with the dune complexes between Taylor Inlet and Two Peoples Bay, and along Hassell Beach.

South of Two Peoples Bay the hills are covered with heath dotted with clumps of *Agonis flexuosa* and *Eucalyptus angulosa*, until granite emerges higher up.

Other plants include :

Shrubs : *Adenanthos cuneatus, A.sericeus, Conospermum caeruleum, Darwinia vestita, Dasypogon bromeliaefolius, Jacksonia horrida, J.spinosa, Leschenaultia tubiflora, Lysinema ciliatum, Melaleuca thyoides, Pimelea rosea, Scaevola auriculata, Xanthosia rotundifolia.*

Herbaceous : *Anigozanthos flavidus, Anarthria scabra, Cyathochaete avenacea.*

Patches of woodland of *Casuarina fraserana* and of *Eucalyptus cornuta* are also seen. Swamps and lakes (Gardner Lake, Moates Lake) are impounded by the dunes on the edge of which there are trees of *Melaleuca lanceolata*, shrubs *Myoporum tetrandum, Phebalium anceps* and the sedge *Lepidosperma gladiatum.*

On crossing over to the south coast at Sandy Bay, limestone ridges have thickets of *Dryandra sessilis* with *Acacia decipiens, Agonis flexuosa* and *Eucalyptus angulosa.* The slope facing the sea on calcarenite and sand is covered by a heath so planed by the wind that no plant exceeds 30 cm in height. *Scaevola crassifolia* is dominant together with *Acacia* sp., *Adenanthos sericeus, Agonis flexuosa, Anthocercis littorea, Banksia praemorsa, Carpobrotus aequilaterus, Clematis pubescens, Conostylis* sp., *Hakea* sp., *Hibbertia grossulariifolia, Kennedia coccinea, ?Loxocaria flexuosa, Leucopogon parviflorus, Olearia axillaris, Pimelea ferruginea, Phyllanthus calycinus, Senecio lautus.*

The plant cover of the granite on Mts. Gardner and Manypeaks was not examined in detail. Among the bare rocks some areas appear to be heath since *Kingia* is conspicuous, others are mallee and are expected to consist of *E.cornuta* and *E.lehmannii.*

The sandhills behind Hassell Beach repeat the *Agonis flexuosa - Eucalyptus angulosa* community described above.

Bald Island is an isolated granite dome, cut off from the mainland by a channel less than 2 Km wide and 32m deep. It rises to 310m above sea level but is largely capped with sand and calcarenite. A detailed description of the northern half of the island was given by Storr (1965). Six communities were distinguished which are zoned according to altitude and soil, and exposure to the prevailing south-west winds. In general the vegetation differs rather profoundly from that on the adjacent mainland. The following is Storr's description of his six communities from W.A. Naturalist Vol. 9, pp. 187-196. There is a map in the Journal showing their distribution.

SUCCULENT MAT

Covering the granite rocks of the Peninsula is a dense mat of low spreading succulent herbs and shrubs belonging to the Aizoaceae and Chenopodiaceae. The dominant species are *Carpobrotus aequilaterus* (Haw.) N.E.Br., *Disphyma australe* (Sol.) N.E.Br., *Rhagodia baccata* (prostrate,

succulent form) and *Threlkeldia diffusa*. Minor components include *Enchylaena tomentosa, Atriplex cinerea, Tetragonia implexicoma, Kochia oppositifolia,* and the grasses *Sporobulus virginicus* and *Poa caespitosa*. Elsewhere the community occurs sporadically in a narrow zone between highwater and the tussock-land, into which it merges.

TUSSOCK-LAND

The formation takes its name from the habit of its dominants, *Poa caespitosa* and *Scirpus nodosus*. Associated with them are *Rhagodia baccata* (bushy form). *Lepidosperma gladiatum* and, less frequently, *Hibbertia cuneiformis* and a small Goodeniaceous shrub. Tussock-land occurs almost continuously around the coast but, except for tongues up eroded gullies, it is narrow on the sheltered northern and north-western slopes of the island. It is much more extensive on the exposed south-western slopes and plateaux and ascends in one locality almost to the 400 ft. contour.

HEATH

Occupying a broad zone along the windward slope of the island is a dense shrubbery interspersed with considerable areas of bare rock, which for want of better name is designated "heath", the formation being too low (usually less than four feet) to be aptly described as "scrub". It is emphasized that this formation bears little resemblance to the rich sandplain vegetation of the South Coast mainland. The island heath is composed of but few species, among which myrtaceous shrubs are overwhelmingly dominant, viz., *Melaleuca parviflora, M. microphylla* and *Thryptomene saxicola*. The Proteaceae are represented only by *Hakea suaveolens, H.elliptica* and *Banksia praemorsa,* individuals of which are so few and scattered as to contribute nothing to the physiognomy of the formation. The only other shrubs are *Eutaxia obovata, Gastrolobium bilobum, Leucopogon* spp. (including *capitellatus)* and an *Andersonia,* low-wind-pruned masses of the last being conspicuous around outcrops.

PEPPERMINT SCRUB

Between the 400 and 500 ft. contours the slopes become gentle as the "Backbone" of the island is approached, and a considerable depth of sand lies over the gneiss. A scrub grows here consisting mostly of Peppermint *(Agonis flexuosa). Agonis marginata* is common round rocks that protude through the sand. Everywhere the scrub is broken by small glades carrying a dense tangle of *Thomasia solanacea* and *Acacia alata*.

There are more extensive breaks in the scrub along the main ridge of the island, where the gneiss may be exposed in broad flat sheets or thinly covered with soil. The dominant plants here are sedges, rushes and grasses: *Lepidosperma* spp. (including *angustatum* and *drummondii), Scirpus nodosus, S.antarcticus, Juncus pallidus, Danthonia caespitosa* and *Stipa variabilis*. Other herbaceous species include *Cheilanthes tenuifolia, Stackhousia pubescens. Dichondra repens* (on mats of lichen), *Stylidium glaucum, S.fasciculatum* and

Trachymene compressa.

BUSHY YATE FOREST

On the leeward slope of the island Peppermint scrub gives way not to heath but to a forest of Bushy Yate *(Eucalyptus lehmanni)*. Among boulders it is a small, twisted tree 10-20 ft. high; in damp gullies its bole is straight and twice as tall. Associated with the Bushy Yate is *Callitris preissii*, which here and there forms pure stands of straight trees up to 50 ft. high, under which grow only lichens and moss. At higher levels the forest is mixed with *Agonis flexuosa* and *A.marginata*, at lower levels with *Melaleuca pubescens* and *Templetonia retusa*. The lianas *Sollya fusiformis* and *Clematis microphylla* are uncommon away from gullies.

TEATREE FOREST

The steep calcareous slopes above the northern and north-eastern coasts support a fine forest of *Melaleuca pubescens*. Under-growth is sparse and consists mainly of *Poa caespitosa*, *Rhagodia baccata* (scandent form), *Threlkeldia diffusa* and *Parietaria debilis*. On spurs of residual limestone *Templetonia retusa* appears, associated commonly with *Spyridium globulosum*, more rarely with *Westringia dampieri* and *Boronia alata*. In some of the steeper gullies the limestone capping has been eroded through to the gneiss by small watercourses lined with thickets of *Trymalium spathulatum* and *Thomasia solanacea*. The fern *Asplenium praemorsum* grows profusely on shaded rocks. Other species especially found in gullies include *Myoporum serratum*, *Phebalium rude*, and *Pimelea clavata*.

Some excessively steep slopes have been denuded of vegetation; the burrowing of petrels, if not its cause, is certainly contributory. These denuded areas have been partially recolonised by *Solanum simile*, *Olearia axillaris*, *Scirpus nodosus*, *Lepidosperma gladiatum*, *Vittadinia triloba*, *Carduus tenuiflorus* and *Urtica urens*.

The following calciphilous herbs occur sporadically in tussock-land as well as tea-tree forest : *Senecio lautus*, *Oxalis corniculata*, *Apium australe*, *Pelargonium littorale*, *Geranium molle*, *Erythraea centaurium* and *Anagallis arvensis*.

Making a comparative study of these communities, the succulent mat has not been recorded on the adjacent mainland, though there is something similar in the islands of the Recherche (Willis, 1953). The tussock-land appears to be unique : even in the Recherche Willis reported only small patches of grass. The heath and the peppermint scrub evidently correspond to the mainland communities described by Enright (1978) in the Torndirrup National Park and by the writer in this memoir in the Mt. Gardner area, but on Bald Island the floristic composition is quite different and is much poorer in species. Low forests of *E.lehmanii*, *Callitris preissii* and *Melaleuca pubescens* (now *M.lanceolata*) on the other hand are known elsewhere. Low

forest of *E.cornuta* and *E.lehmanii* with *Callitris preissii* as an associate was considered by Willis to be the climax community in the Recherche Islands where *Melaleuca pubescens* woodland was also found to be common. *Callitris preissii* and *M.pubescens* low forests were the original principal communities of Rottnest Island before European Settlement (Storr 1963). These off-shore islands were all fire-protected habitats because Aborigines had no access to them. Both Storr and Willis commented on the impression of a lush, well-wooded environment in contrast to the adjacent mainland and the communities have evidently had sufficient time for succession to reach something like the potential climax. The floristic poverty is rather harder to explain. Most probably there has been a selective pressure since the attainment of the sea-level maximum several thousand years ago, exerted to eliminate species tender to wind and spray. More importantly perhaps unburnt climax communities, which are closed, naturally tend to harbour fewer species than their more open, frequently burnt homologues on the mainland.

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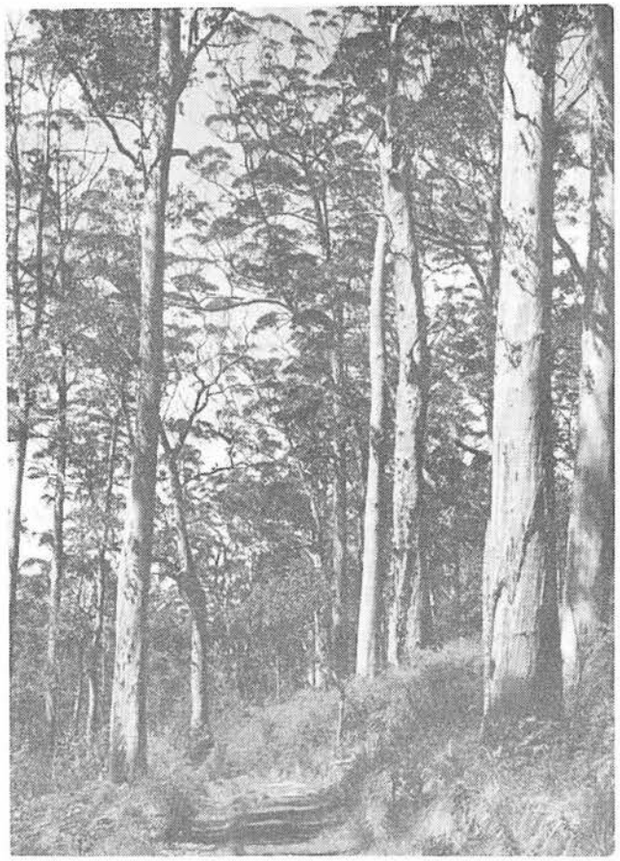
APPENDIX

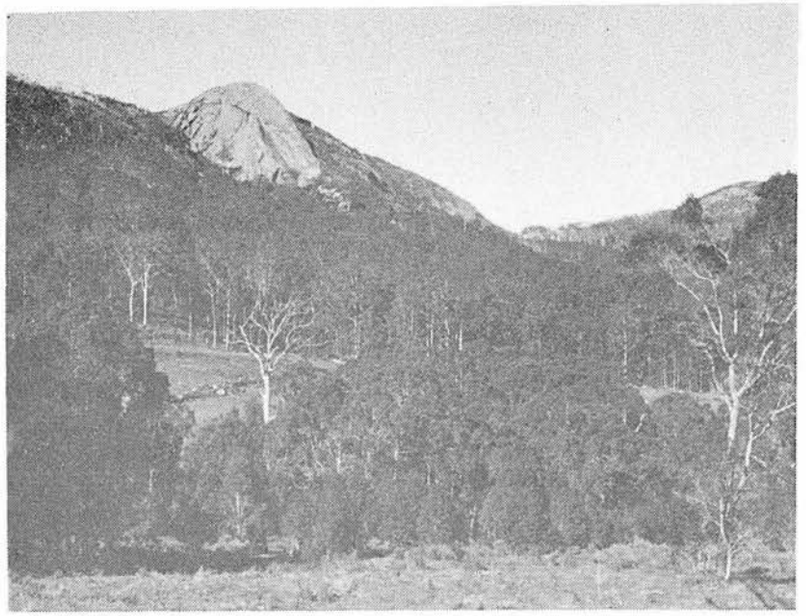
LIST OF RESERVES SHOWN ON THE VEGETATION MAP

Number	Area	Map.Ref	Purpose and Locality
17759	427 ha	502798	Conservation of Flora & Fauna
17760	551	500796	" " " "
A15214	97	509773	Protection of Indigenous Flora
16297	688	557795	Tambellup Water Supply
25194	442	598777	Conservation of Flora & Fauna. Anderson Lake
26162	357	595772	" " " "
21748	150	627787	Borden Water Supply
15756	209	645795	Cons. of Flora, Toompup
A849	255	512735	Public Utility, Quindabellup Well
A22422	944	512739	Conservation of Flora & Fauna
26586	445	520742	Conservation of Flora
A24853	559	522746	Recreation, Poorarecup Lagoon
21543	11	523750	Conservation of Flora
A1931	259	525757	Conservation of Flora & Fauna. Warrenup Swamp
A2079	257	529765	" " " "
2096	80	544760	National Park
30916	4	540762	Protection of Flora. Geekabee Hill
A1759	142	540750	Water and Recreation
A14792	115,685	570760-640740	Stirling Range National Park
18648	687	580765	Conservation of Flora & Fauna Balicup Lake
A26160	1015	585763	Conservation of Flora & Fauna Jebarjup Swan Lake
A25182	151	581761	Conservation of Flora & Fauna
30526	50	585771	Conservation of Flora & Fauna
A26161	3215	600765	Conservation of Flora & Fauna Camel Lake
26264	768	650755	" " " "
25850	74	649743	Recreation Gnowellen Reserve
22841	72	537718	Conservation of Flora
23171	607	542718	Conservation of Flora & Fauna
32284	229	543732	Conservation of Flora & Fauna Lake Kwornicup
11760	112	545736	" " " "
6716	380	547735	" " " "
A19292	53	541700	Protection of Nature Flora (Boronia)
30456	790	545705	" " " " Denmark-Mt.Barker road strip
18536	53	550706	" " " " (Boronia)
A19673	135	555697	Conservation of Flora
18741	337	565698	Conservation of Flora
14493	298	565710	" " " Lake Barnes
25965	26	568702	" " "

Number	Area	Map.Ref.	Purpose and Locality
15775	61	575707	Conservation of Flora
A619	49	576691	" " "
A10003	105	571716	Protection of Boronia
A18987	2359	585716	Porongurup National Park
18739	1497	583693	Conservation of Flora Millbrook Road Reserve
25583	52	594730	" " "
A25386	330	607733	Conservation of Flora
26688	1710	622725	" " "
18772	193	597706	" " "
26564	10	599709	" " "
A25705	61	600713	National Park east of Porongurups
A23850	348	612706	Recreation & Camping Lake Corimup
26385	1008	615702	Conservation of Flora & Fauna North Sister
27139	338	615799	" " " " South Sister
A15107	267	617697	" " " " Lake Pleasant View
27157	367	629699	" " " "
A26650	1282	625700-650725	Hassell National Park
26234	575	640715	Conservation of Flora & Fauna Green Range
16367	?	645709	" " " "
19881	1072	502693	Conservation of Flora
20381	70	501682	Conservation of Flora & Fauna Mehniup Hill
33842	3825	505675	Conservation of Flora & Fauna
A24482	1879	525675	William Bay National Park
31561	52	532685	Conservation of Flora
23325	40	535685	" " "
23068	34	539685	Protection of Flora
12182	123		
14959	243	530677	Timber & National Park Mt. Halowell
1998	38	564680	Conservation of Flora
24891	66	572678	" " " & Fauna Marbellup
A24258	3906	590605	Torndirrup National Park
23923	40	589692	Cons. of Flora (Boronia)
30463	1329	594687	Cons. of Fauna & Flora
30791	3	598686	" " " "
A28690	9	601683	Cons. of Flora
A27107	2132	598675	National Park
A24991	297	608675	National Park and Water
A27956	4637	615680	Cons. of Fauna Two Peoples Bay Wildlife Sanctuary
36028	1330	625689	Cons. of Fauna & Flora Mt. Manypeaks
A25869	809	645685	" " " " Bald Island.



Karri tall forest *(Eucalyptus diversicolor)* in the Porongurup National Park.

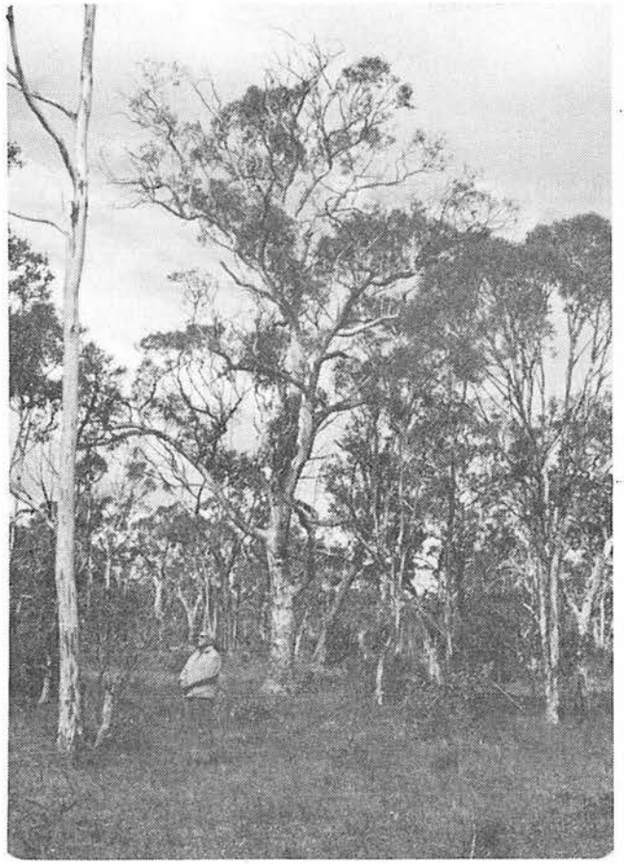


Porongurup. Granite dome of the Devil's Slide emerging from karri forest.

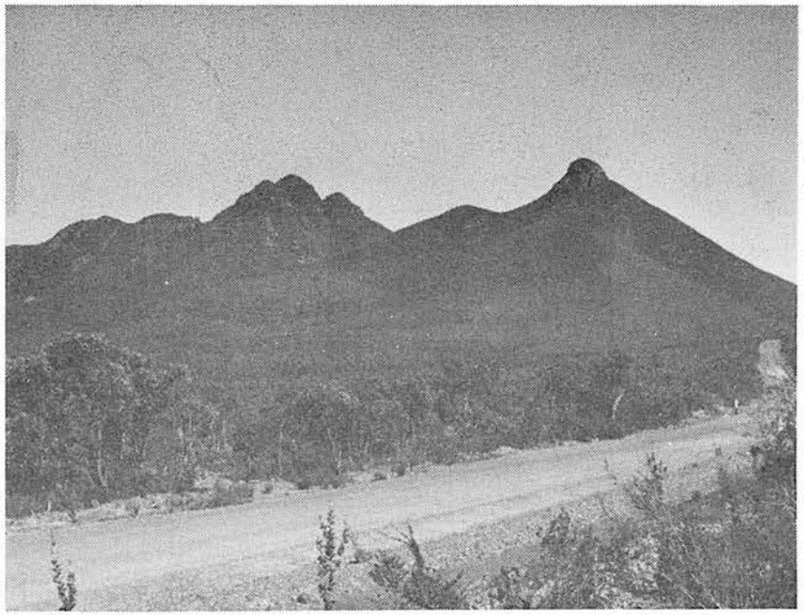
Jarrah forest *(E.marginata)* of poor quality. Denbarker area.

Low woodland of *E.staeri* and Casuarina, heath understory. Near Albany

Reed swamp surrounded by paperbarks and jarrah

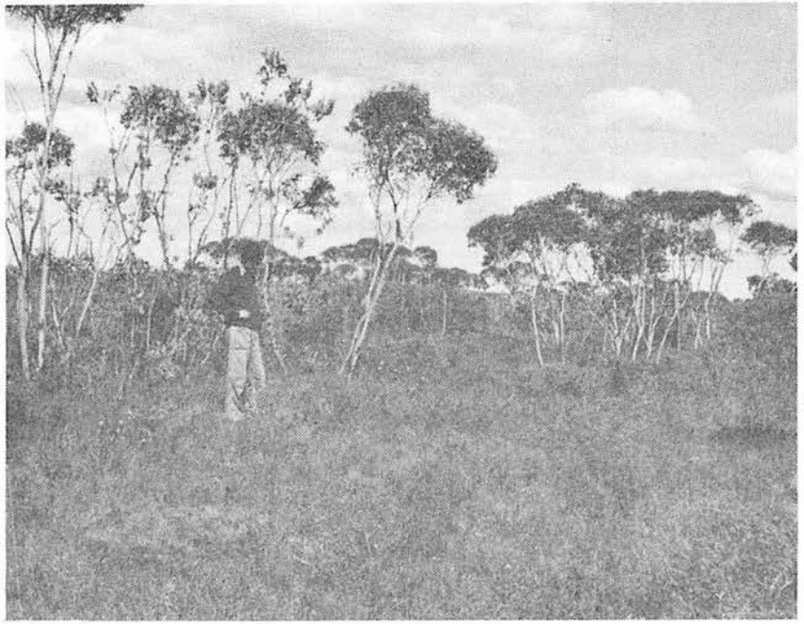


Woodland of wandoo *(E.wandoo).* Cranbrook.



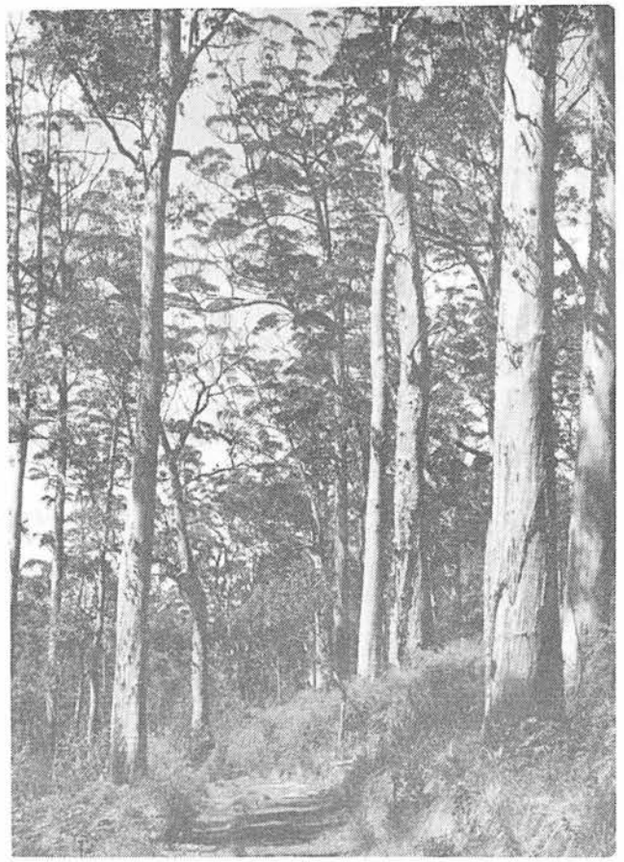
Stirling Range. Toolbrunup and Mt. Hassell.
Jarrah low woodland in foreground.

Thicket on Bluff Knoll in flower, October. *Isopogon, Dryandra, Banksia, Oxylobium, Sphenotoma.*

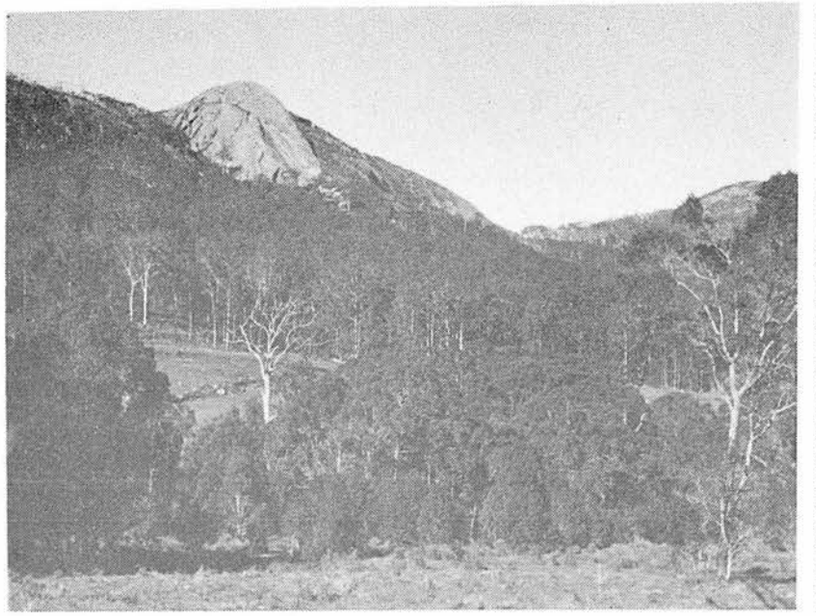


Mallee-heath of *E.doratoxylon* and *E.tetragona* with

Scrub-heath with *Hakea baxteri, Kingia,* some mallee



Karri tall forest *(Eucalyptus diversicolor)* in the Porongurup National Park.



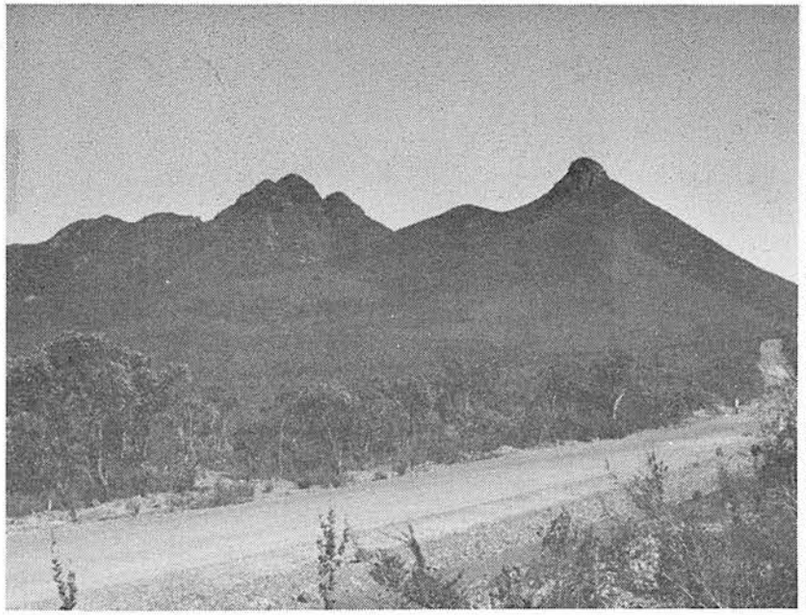
Porongurup. Granite dome of the Devil's Slide emerging from karri forest.

Jarrah forest *(E.marginata)* of poor quality. Denbarker area.

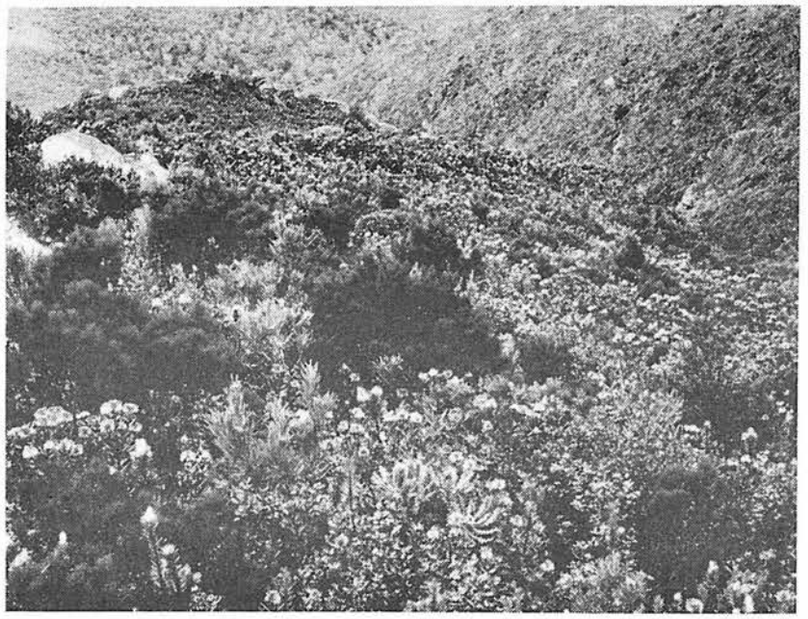
Low woodland of *E.staeri* and Casuarina, heath understory. Near Albany.

Reed swamp surrounded by paperbarks and jarrah low forest. Denmark—Mt. Barker road.

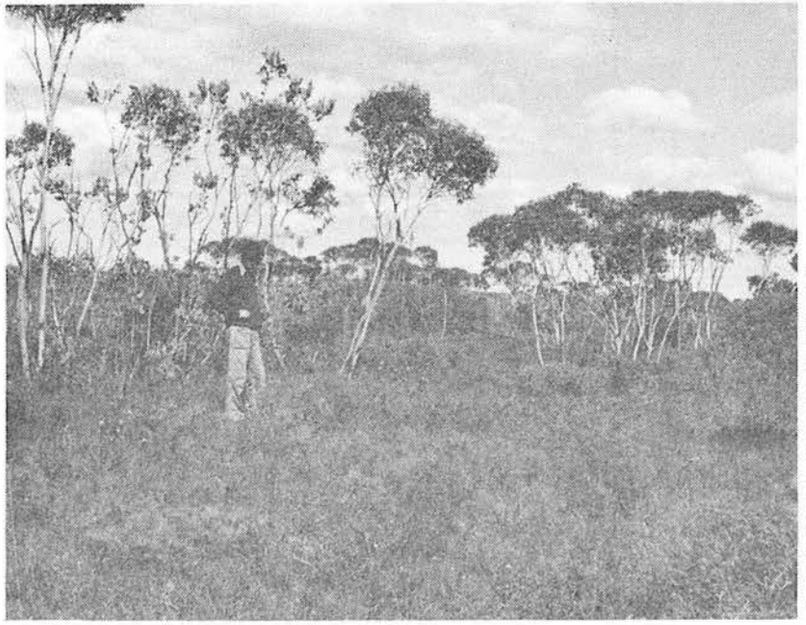
Woodland of wandoo *(E.wandoo).* Cranbrook.



Stirling Range. Toolbrunup and Mt. Hassell.
Jarrah low woodland in foreground.



Thicket on Bluff Knoll in flower, October. *Isopogon, Dryandra, Banksia, Oxylobium, Sphenotoma.*



Mallee-heath of *E.doratoxylon* and *E.tetragona* with
low heath ground layer. Stirling Range

Scrub-heath with *Hakea baxteri, Kingia,* some mallee.

VEGETATION SURVEY OF WESTERN AUSTRALIA

AUSTRALIA 1:250,000

ALBANY & MOUNT BARKER

REFER TO THIS MAP AS: SI 50-11 15
VEGETATION SERIES

KEY

This map shows original natural vegetation

Tall forest

- e_1Tc Karri tall forest

Forest

- e_2^1Mc Jarrah forest

Low Forest

- e_1Lc $e_{2-5}^1C_1Lc$ Jarrah & jarrah-sheoak low forest
- mLc Paperbark low forest

Woodland

- eMi Eucalypt woodlands, various species

Low Woodland

- aLi Peppermint low woodland
- e_2Li Jarrah low woodland
- $e_{6-7}Li$ Redheart low woodland
- mLi Paperbark low woodland

Shrubland

- xSc Mixed thicket, Stirling Range
- eSi Mallee
- aSZc xSZc Scrub-heath
- e_xSZc Mallee-heath
- xZc Heath

Reed swamp

- xGc Sedges, Restionaceae & heath shrubs

Halophytes

- $mLi\ k_1Ci$ Teatree & samphire
- k_1Ci Samphire

Bare Areas

- Rock outcrops
- Drift sand
- Salt lakes
- L Freshwater lakes

- 31908 Conservation Reserves
- State Forest & Crown Lands

Species designated in mapping

a	= *Agonis flexuosa*	Peppermint
c_1	= *Casuarina huegeliana*	Sheoak
c_2	= *Casuarina fraseriana*	Sheoak
e_x	= *Eucalyptus, various*	
e_1	= *E. diversicolor*	Karri
e_2	= *E. marginata*	Jarrah
e_3	= *E. calophylla*	Marri
e_5	= *E. Wandoo*	Wandoo
e_6	= *E. loxophleba*	York gum
e_7	= *E. occidentalis*	Yate, Swamp yate.
e_8	= *E. salmonophloia*	Salmon gum
e_9	= *E. longicornis*	Morrell
e_{10}	= *E. rudis*	River gum
e_{11}	= *E. tetragona*	Tallerack
e_{12}	= *E. lehmannii*	Black marlock
e_{20}	= *E. angulosa*	Ridge-fruited mallee
e_{21}	= *E. cornuta*	Yate
e_{24}	= *E. lehmannii*	Bald Island marlock
e_{25}	= *E. staeri*	Albany blackbutt
e_{26}	= *E. decipiens*	Redheart
k_1	= *Arthrocnemum* etc.	Samphire
m	= *Melaleuca cuticularis*	Paperbark
x	= Heterogeneous	

- Built-up area
- Road sealed surface first class; route marker (79)
- Road sealed surface second class; mileage
- Road loose surface all weather
- Road loose surface dry weather
- Road unimproved earth
- Track, foot or pack; footbridge
- Embankment; cutting
- Gate; cattle grid
- Bridge road; bridge railway
- Railway multiple track
- Railway single track
- Light railway or tramway
- Station; siding; station with siding
- Telephone line; power transmission line
- Fence; stone wall
- Levee or dyke; quarry
- Mine; windpump; yard
- Building (s); church; school
- Post office; wireless transceiver; cemetery (PO W/T)
- Airport or airfield, landing ground
- Control point major, minor; astronomical
- Bench mark; spot elevation in feet (BM 750 750)
- Mud; gravel; sand
- Waterhole; water tank; dam; dry lake
- Lake; river or stream perennial
- Lake; river or stream intermittent
- Dam or weir; falls; rapids
- Drain or ditch perennial, intermittent
- Spring perennial, intermittent; ricefields
- Marsh or swamp; mangroves
- Seaplane anchorage; seaplane base
- Breakwater; pier, dock or wharf
- Fathom line; low water mark; lighthouse (LWM)
- Wreck sunken, exposed; vessel anchorage
- Rocks submerged, bare or awash
- Reef, rocky or coral

Published by Vegmap Publications, Perth

This map has been drawn on a topographic base furnished by the Division of National Mapping, Canberra

LOCATION DIAGRAM

	PINJARRA SI 50-2	CORRIGIN SI 50-3	HYDEN SI 50-4	LAKE JOHNSTON SI 51-1
BUSSELTON SI 50-5	COLLIE SI 50-6	DUMBLEYUNG SI 50-7	NEWDEGATE SI 50-8	RAVENSTHORPE SI 51-5
AUGUSTA SI 50-9	PEMBERTON SI 50-10	MOUNT BARKER SI 50-11	BREMER BAY SI 50-12	GREAT AUSTRALIAN BIGHT
	IRWIN INLET	ALBANY		

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

CONTOUR INTERVAL 250 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..0"E

BLACK NUMBERED LINES INDICATE THE 10,000 YARD TRANSVERSE MERCATOR GRID, ZONE 1 (AUSTRALIA SERIES), CLARKE 1858 SPHEROID
...MBERS ARE OMITTED

15' WESTERLY FOR THE CENTRE OF THE WEST
MEAN ANNUAL CHANGE IS 01' EASTERL...

RELIABILITY DIAGRAM

A

A. Original photo-interpretation by author controlled by ground traverses

Mappec by J. S. Beard 1978

GRID REFERENCE

TO GIVE A GRID REFERENCE ON THIS SHEET
Pay no attention to the smaller co-ordinate figures at the corners and in the margins - they are for finding full co-ordinates.
PAY ATTENTION TO LARGER MARGINAL FIGURES AND TC THOSE PRINTED ON THE FACE OF THE MAP.

PC INT 1843 ○ *MOUNT MANYPEAKS*

East	North
Take west edge of square in which point lies and read the figures printed opposite it is line (on north or south margin) or on the line itself (on the face of the map).	*Take south edge of square in which point lies and read the figures printed opposite this line (on east or west margin) or on the line itself (on the face of the map).*
Estimate tenths Eastward 9	*Estimate tenths Northward* 9
625	689

REFERENCE 626689

Unit	Yard
Square	10,000
Reference to nearest	1,000
Nearest similar reference distant	300 miles

ALBANY & MOUNT BARKER
WESTERN AUSTRALIA
1978