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VEGETATION SURVEY OF THREE NATURE RESERVES IN THE LAKE UNICUP COMPLEX

(LAKE UNICUP, KULUNILUP LAKE AND YARNUP SWAMP)

Prepared for

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TABLE OF CONTENTS 2

SUMMARY 4

INTRODUCTION 5

DISCRIPTION OF PROJECT 5

PROJECT REQUIREMENTS 5

STUDY AREA AND LANDUSE HISTORY 6

GEOLOGY 8

SOILS 8

VEGETATION AND FLORA 9

FIRE HISTORY 10

CLIMATE 11

METHODS 12

RESULTS 13

VEGETATION 13

Unicup Reserve 13
Kulunilup Reserve 17
Yarnup Swamp 19

FLORA 20

Rare Species 22

COMPARISON BETWEEN VEGETATION UNITS AND GEOLOGICAL UNITS 23

CONDITION OF VEGETATION 23

MANAGEMENT 25

Firebreaks 25
Controlled Burning 27

ACKNOWLEDGEMENTS 28

REFERENCES 28

APPENDICES 30

LIST OF TABLES

1. Reserve Numbers and Dates of Creation 6a

2. Brief explanation of Geological Units 8b

3. Monthly Climatic Data for Boyup Brook and Mount Barker 11a

4. List of Vegetation Units defined and mapped in survey 13a

5. Comparison between Vegetation Units and Geological Units 23a

6. Vegetation Classification used in Survey 57a

LIST OF FIGURES

1. Location Map 6b

2. Geological Map Unicup Area 8a

3. Contour Map and Sample Sites

4. Long Term Rainfall Data 11b

5. Vegetation Map

LIST OF APPENDICES

1. Description of Soil Fasc probably occurring in the Unicup Area (From Smith, 1951 pp 29-30

2. Summary of Christensen's (1980) Principal Component Analysis (pp 11-13)

3. Detailed Description of Vegetation Units

4. Combined Species List for Survey

5. Phytosociological Table for Major Vegetation Units in Unicup Reserve using 72 key species

SUMMARY

The vegetation of Nature Reserves at Lake Unicup, Lake Kulunilup and Yarnup Swamp is described. Twenty-four vegetation units are defined and mapped. Jarrah Forest and Woodland predominates at Unicup and Yarnup but shrub and sedge communities dominate at Kulunilup. A general relationship between vegetation units and geological units is presented. No rare or geographically restricted species were found although a number of species and vegetation units which occur in the Unicup area are at their westen limit of their distributions. Comments are made on management options. One site was found to be affected by Phytophthora cinnamomi.

INTRODUCTION

The following extract from Consultancy Offer and Agreement outlines the scope of the current survey.

DESCRIPTION OF PROJECT

The Lake Unicup-Lake Muir complex of nature reserves is an important conservation area at both the State and regional level. Their importance in the context or our knowledge is twofold. Firstly, the reserves contain a wide variety of wetlands which represent a successional sequence from lagoons with open water through to swamps closed by rushes. This range of wetlands is of geomorphological as well as biological interest. Secondly, the wetlands on the nature reserves provide important habitat for a variety of waterbirds including less well known species such as the Little Bittern. Presently the RAOU Wetlands Survey Group is working on several of the reserves, and early data suggests that at least some of the swamps may be of national importance.

Despite the importance of the nature reserves, little is known of their flora or terrestrial fauna. Also there has been, and continues to be, a great deal of local pressure for prescribed burning on the reserves. Consequently research on the biota of these reserves is of high priority. The first stage of research will involve a vegetation survey of the following nature reserves: Lake Unicup (Reserve No. 'A' 25798); Kulunilup Lake (Reserve No. 26677); and Yarnup Swamp (Reserve No. 29601).

PROJECT REQUIREMENTS

The vegetation survey should treat the group of reserves individually to:

1. Produce a vegetation map for the reserves at the formation level with each

formation to be further sub-divided into associations described by dominant species in the highest strata.

2. Provide a series of association descriptions, based on the classification system devised by B. Muir, which describe the range of associations found on each reserve. The site of each description should be recorded on the appropriate vegetation map.

3. Identify vegetation associations and habitat types which, as a matter of priority, should remain undisturbed. Particular attention should be given to identifying those areas from which fire should be excluded.

4. Collect and identify a representative sample of the flora of the reserves, and lodge specimens of each species in the WA Herbarium and the field herbarium at the Department's Katanning Office.

5. Record the identity, location and estimated population size of any gazetted rare plants which may occur on the reserves.

6. Include a short conclusion which indicates similarities and differences in the vegetation of the three reserves.

7. Provide data from a small number of samples from each reserve which indicate the presence or absence of Phytophthora cinnamomi on each reserve.

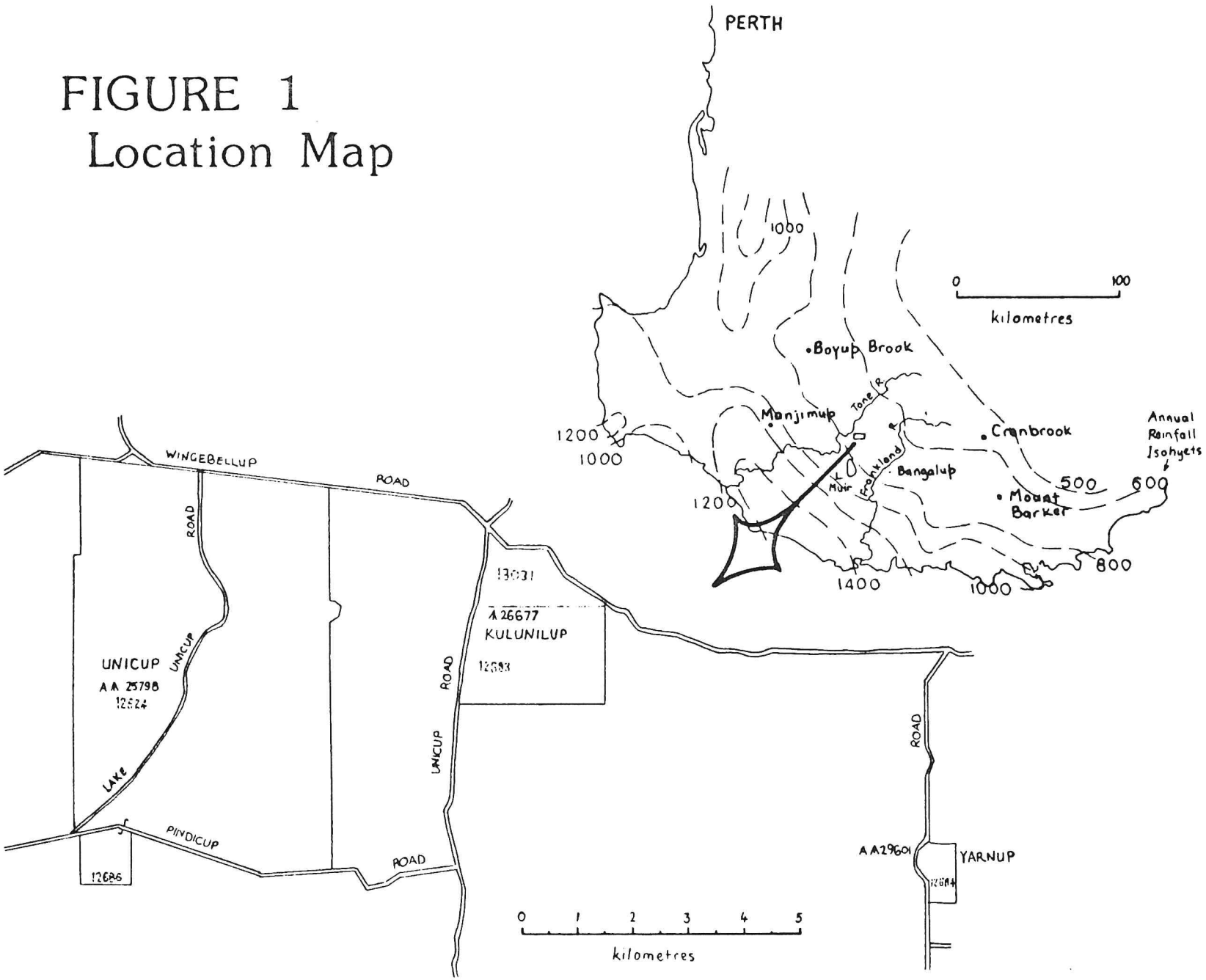
STUDY AREA AND LANDUSE HISTORY

The three reserves were composed of five location numbers and were set aside for conservation of Flora and Fauna at various times (Table 1). Location 13031 was originally part of Location 12646 but was surrendered in September 1970 as it was considered unsuitable for Agriculture. It has not been cleared. All other locations were created in the early 1960's when the West Frankland Land

TABLE 1 RESERVE NUMBERS AND DATES OF CREATION

NAME	NUMBER	NELSON LOC. NO.	DATE RESERVE CREATED
Unicup	25798	12624	2.12.1960
		12686	17. 1.1969
Kulunilup	26677	12683	5. 4.1963
		13031	8. 4.1971
Yarnup	29601	12684	17. 1.1969

FIGURE 1
Location Map



Settlement area was being opened up. This area had not been previously settled because of soil nutrient deficiencies. Surounding Yarnup Swamp were two conditional purchase blocks (1928) with a total of about 8,000 acres but these were cancelled in 1935 and converted into pastoral leases. These together with other leases one of which covered Lake Kulunilup, were resumed in 1961 for the West Frankland Land Settlement area. There is no record of this type of legal use of land around Unicup lake. The pastoral activity was probably responsible for some old fences and small clearings in Kulunilup and Yarnup. Some tracks in these reserves probably also date from this activity.

Most land clearing on private property adjacent to the reserves only commenced in the mid 1960's. Although clearing control legislation was introduced in 1978 some clearing still occurs. Under this legislation some partially cleared farms have been purchased by the Public Works Department (e.g. location numbers 12650, 12646). A scheme to divert saline water from the Tone river into the Frankland involved one option which would have transgressed the Unicup reserve (Anon 1980). This diversion scheme which would have allowed more farm land to be cleared was not proceeded with because of the high cost.

Although the Unicup area was never part of State Forest, timber was cut after 1946 and perhaps up to 1960 on the Unicup reserve, and later (up to 1970) on some private lands (J. Williamson pers. comm.). The timber was cut by Bunnings and Hawker Siddeley (G. Hornham pers. comm.) and processed at the old Unicup Mill (just South of Kodjinup Swamp). No details of cutting dates or areas cut are extant either from Bunnings of the Forests Department. A "Timber Classification" (No. 629) is reputed to exist at the Department of Lands and Surveys but Lands and Surverys Department officers could not find it. It is, however, clear from the aerial photos and from this survey that considerable timber cutting occurred in the Unicup reserve. Many jarrah stumps about one metre in diameter were seen. Kulunilup seems to have had little or no timber cut from it while some cutting and ringbarking of Jarrah occurred at Yarnup.

Unicup Lake has been used for recreation for some time. A water ski club was once established at the Lake but because of persistant low water levels, use by

this group has been discontinued. A proposal to increase the water level of Unicup lake by this group was not approved and has been abandoned.

GEOLOGY

The Unicup area is in the northern portion of the Albany-Fraser Province. This is an area where there is considerable intrusion of the Archaen granitic rocks by Proterozoic granitic rocks with considerable metamorphism. The Geological Map (Figure 2) shows this. Small areas of Tertiary deposits occur in the Tone River Area but none are shown in Figure 2. These may have been overlooked, as one outcrop of a ferruginous sandstone was found on the eastern boundary of Kulunilup (K21), an area mapped as Czl (laterite).

The Tertiary deposits are either marine (Eocene transgression) or alluvial (Tertiary drainage lines). The sandy alluvium (Cza, Czat) represent later drainage lines (either late Tertiary or early Quaternary). These areas are a major feature of the Unicup area. They are flanked by lateritized interfluvial residuals (CZl) and minor colluvial deposits (Qrc, Qrcs). Many swamp and lacustrine deposits (Qrw) occur as rounded clay pans and lakes associated with the drainage lines (Cza, Czat). There was little erosion or deposition in the Recent period and the rounded lakes attest to the truncated drainage pattern. A number of the Lakes are surrounded by small lunette dunes which have effectively prevented filling of some lakes (e.g. Little Unicup) in all but exceptional circumstances. There are few drainage channels and it is probable that surface sheet drainage and subsurface drainage predominates in normal circumstances. It is possible that some water movement occurs through the Tertiary deposits which are considered a reasonable local water supply.

SOILS

The soils of the area were mapped prior to the release for Agriculture. The maps available were general and involved only 7 units (Soil associations of

FIGURE 2 Geology

SYMBOLS:

Mafic dyke ——

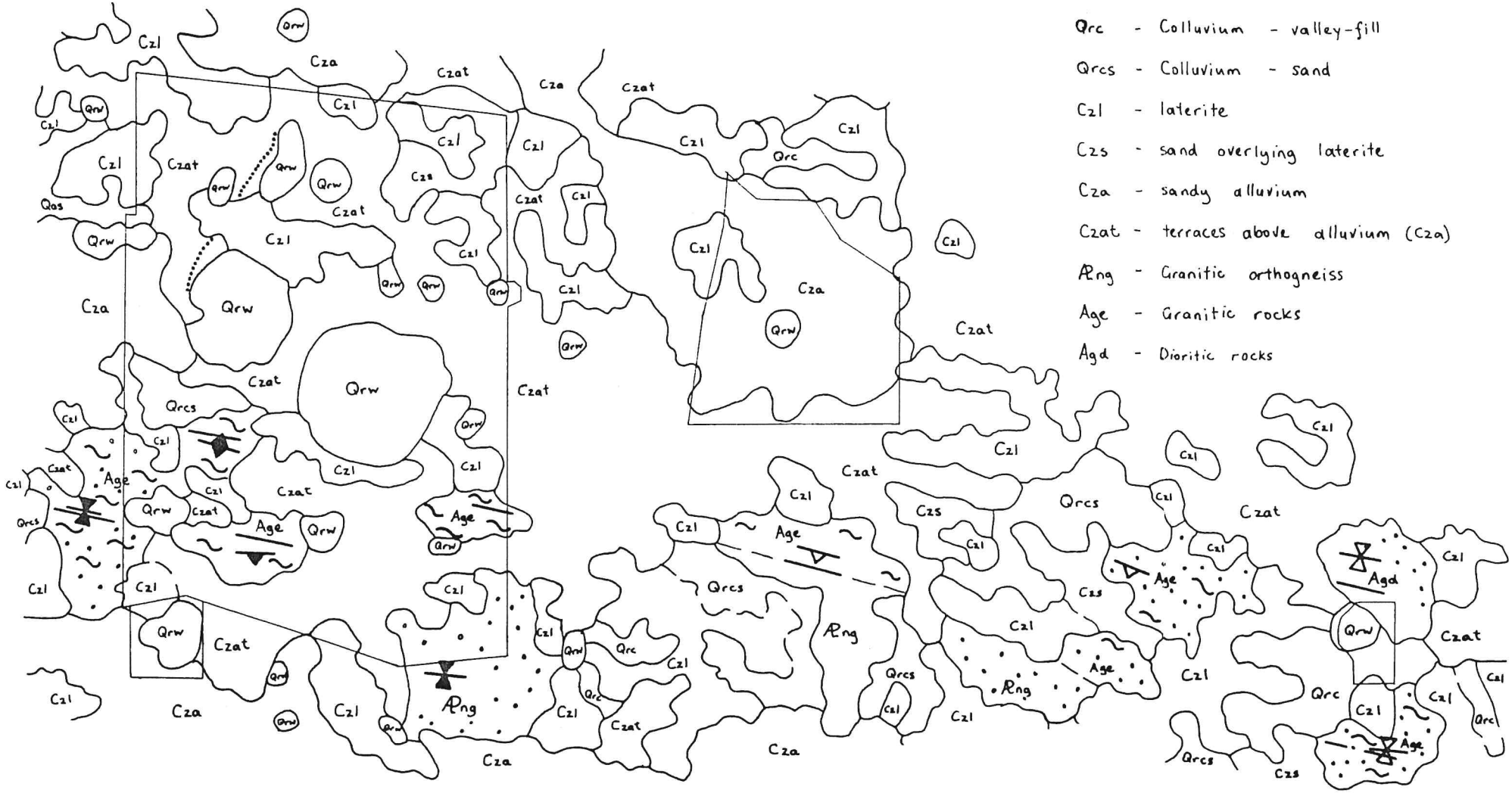
Bedrock obscured

Gneissic foliation :- (inclined), (indeterminate).

Sheared plutonic rocks ~

Mineral foliation in plutonic rocks :- (inclined), (vertical), (indeterminate).

Sand dunes



GEOLOGIC UNITS: (see Table 2 for more detailed explaination)

- Qrw - Swamp and lacustrine deposits
- Qas - Sand in older stream channels
- Qrc - Colluvium - valley-fill
- Qrcs - Colluvium - sand
- Czl - laterite
- Czs - sand overlying laterite
- Cza - sandy alluvium
- Czat - terraces above alluvium (Cza)
- Æng - Granitic orthogneiss
- Age - Granitic rocks
- Agd - Dioritic rocks

TABLE 2 BRIEF EXPLANATION OF GEOLOGICAL UNITS (FIGURE 2)
(From Pemberton-Irwin Inlet Sheet preliminary printing 1981)

Recent

Qrw Swamp and lacustrine deposits - peaty sand and clay

Pleistocene - Recent

Qas Sand - variously reworked, associated with older stream channels

Qrc Colluvium, including valley-fill deposits, variably lateritized and podsolized

Qrcs Colluvium - sand, often associated with older drainage courses

? Late Tertiary

Czl Laterite - chiefly massive, but includes overlying pisolitic gravel and minor lateritized sand

Czs Sand overlying laterite - yellow, white, grey or orange

Cza Broad tracts of sandy alluvium often traversed by dunes, variously reworked by present drainage

Czat Terraces above alluvium, often lateritized

Precambrian

Æng Granitic orthogneiss - strongly deformed Archaeangranite, locally interdeveloped with less deformed material

Age Even-grained granite rocks - fine to medium-grained granodiorite, adamellite and granite

Agd Dioritic rocks, range from monzonite to diorite. Small intrusions only

Smith, 1951). Only three of these were mapped in the Unicup area. A more detailed soil survey was done on an area between Pindicup Lake and the north-eastern corner of Lake Muir. Each of the three units mapped in the Unicup area were complexes and had many soil types in common. Therefore, the map available only provides an indication of the dominant soils and was of no value for this survey. By comparison, the geological map was much more useful even at its small scale (1:250,000).

The soil types closely relate to landscape and dissection and Smith (1951) has provided general descriptions of groups (fasc) of similar soil types. These are the most useful descriptions presently available as it is not immediately obvious what specific soil types would be present in the Unicup area. The general descriptions of the five main groups of soils which occur in the Unicup area are given in Appendix 1. A broad relationship to landscap is as follows:

Upland, little truncation, sandy	-	Kordabup fasc
Upland, A horizon removed, gravelly	-	Wakundup fasc
Upland, Stripped, loamy/clayey	-	Scotsdale fasc
Valley, wide flat valley floors	-	Camballup fasc
Valley, permanent water table	-	Plantagenet fasc

VEGETATION AND FLORA

Smith (1972) mapped the vegetation of the Pemberton-Irwin Inlet area at a scale of 1:250,000. In the Unicup area he indicated there to be Jarrah forest, Jarrah and Wandoo woodland and paperbark low woodland with a few lakes and swamps. Beard (1981) coined the name Kwornicup System within the Menzies subdistrict of the Darling Botanical Province to describe a swampy plain including Lakes Muir, Kwornicup and Pooranecup. He describes this area as a mosaic of Jarrah and Marri

forest, paperbark low forest and reed swamps.

Some indication of the likely flora of the Unicup area is provided by Christensen's (1980) study in the adjoining Perup area. While the Perup area is principally a higher rainfall Jarrah forest type; the analysis provides an indication of the relationship between flora and soil/landscape. A summary of the major species associated with the extremes of the four principal axes of Christensen's Principal Component Analysis are provided in Appendix 2.

The site vegetation units of Havel (1975) were not applicable in this area although some of the units recognised here were similar to those described by that author.

FIRE HISTORY

The history of fires in the area is rather unclear. It is obvious, however, that there have been no recent major fires. The last one was thought to have been a crown fire in about 1950/51 (P. Christensen pers. comm.). Inspection of aerial photos (1946, 1963, 1970, 1979 and 1981) have added little to interpretation of fire history. It is likely that some fire scars have been lost through subsequent regeneration. A few small scars are noticeable in the north-east corner of Kulunilup reserve (amongst Melaleuca heath/thicket), but they are of very limited extent and are not able to be aged. A small hemispherically shaped area on the southern portion of the western bourndary was burnt between 1970 and 1979.

According to the Department of Fisheries and Wildlife's records on Unicup, burning of firebreaks on the western and northern boundaries (10.2.1975) led to areas between the inner firebreak and Little Unicup lake being also burnt. These were not very obvious, either in th 1979 or 1981 photos but two tongues were recognisable (see Vegetation map, Figure 5). These extended about 500m in towards Little Unicup lake. Other tongues of burning occurred but are not noticeable on the aerial photos. One boundary was distinct on the ground at site

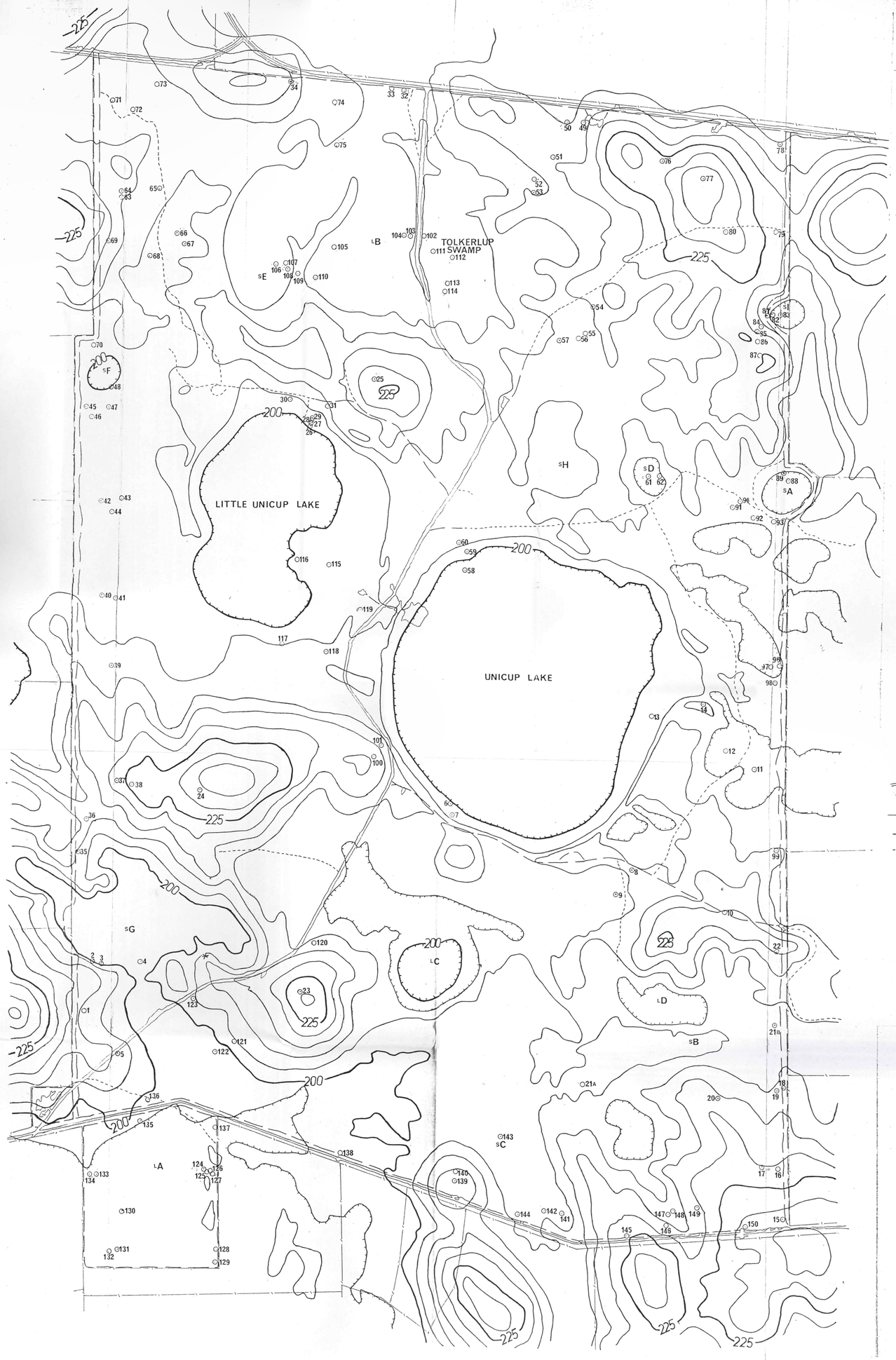


FIGURE 3

[illegible]

- Formed roads
- Disturbed areas
- Fencelines
- Tracks - major
- Tracks - minor, not traffic
- 99 Survey site
- LA Unnamed lakes
- SC Unnamed swamps

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U66 but the limits were not recognisable on the photos. The results of a reported fire on the SE margin of Little Unicup lake was not located on the ground or on photos. It is expected that this fire only occurred in parts of the Melaleuca cuticularis and Gahnia trifida fringing vegetation. A small (a few hectares) fire intruded from a clearing burn on the western boundary of the reserve at a point about 2.9km south of the northwest corner of Lake Unicup reserve. This seems to have happened about 12 months ago. No evidence of fires having occurred at Yarnup is available.

CLIMATE

Table 3 shows the mean monthly minimum and maximum temperatures and rainfall for the nearest comprehensive recording stations with comparable climates (Mt Barker and Boyup Brook). Extrapolation from these and other Bureau of Meterology data suggest that the Unicup area receives about 750mm of rain per annum. The rainfall declines to the NE at about 3mm/km in this area. Temperature values are probably between those of Mt. Barker and Boyup Brook. Beard (1981) places the Unicup area into a Moderate Mediterranean Climatic Zone according to the Bagnouls and Gaussen (1957) classification which uses average number of dry months per annum.

Long term rainfall values from Cranbrook and Bangalup suggest that the annual rainfall has declined over the last 20 years (Figure 3). These data appear to support observations that Lake Unicup has less water in it than when the area was first settled in the 1960's. (G. Hornham pers comm.)

TABLE 3 MONTHLY CLIMATIC DATA FOR BOYUP BROOK AND MOUNT BARKER

Station Name BOYUP BROOK POST OFFICE WESTERN AUSTRALIA

Number 009504 Latitude 33 Deg 50 Min S Longitude 116 Deg 22 Min E Elevation 189.0 M

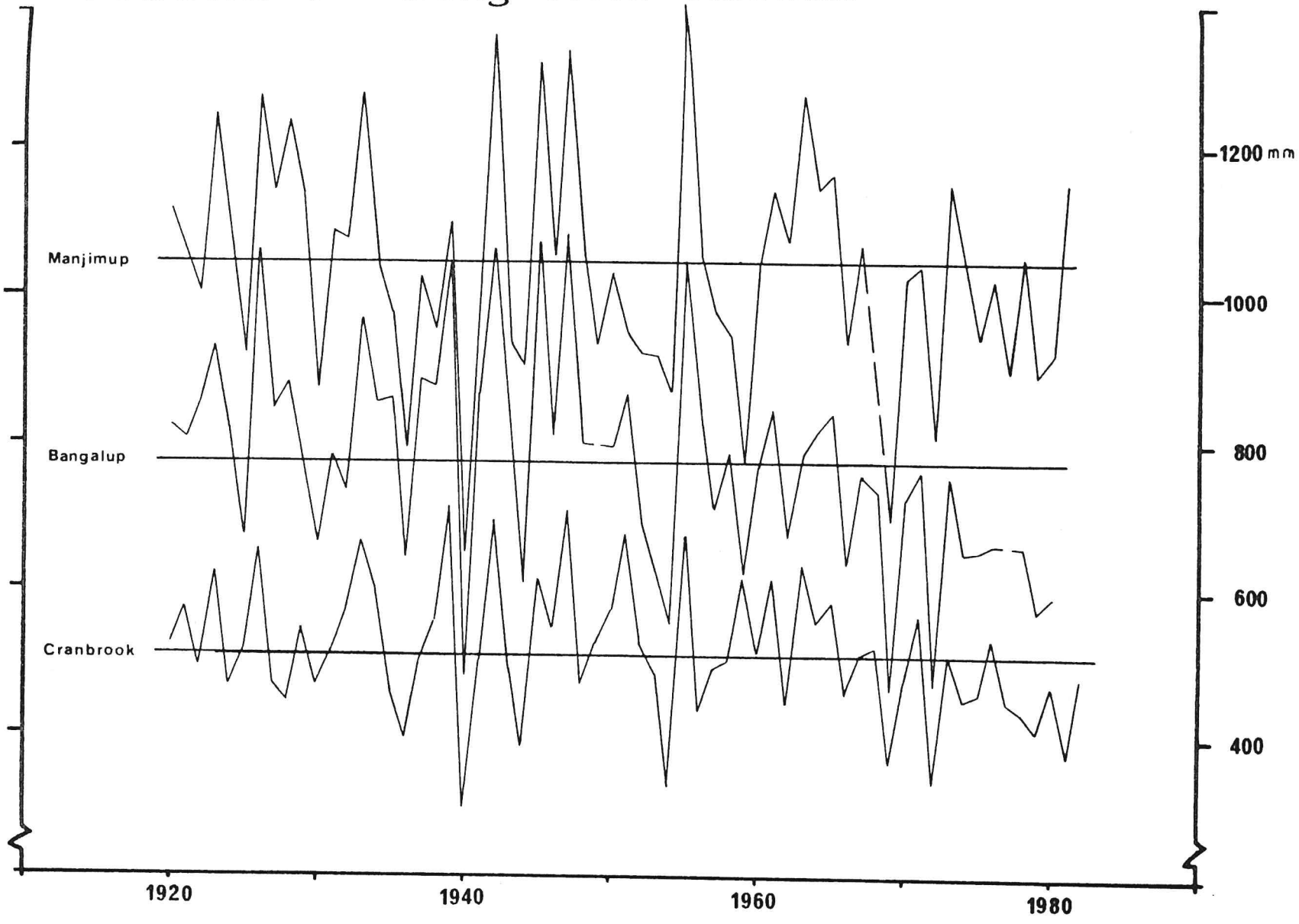
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Maximum Temperature (C)													
Mean	30.9	30.7	27.4	22.3	19.1	16.5	15.8	16.0	17.7	21.0	24.2	28.7	22.5
86 Percentile	36.0	37.0	33.4	27.2	22.1	18.8	17.9	18.7	20.6	25.7	29.9	33.9	
14 Percentile	25.9	25.2	22.3	17.8	15.9	14.1	13.4	13.3	14.9	16.7	18.8	23.6	
Daily Minimum Temperature (c)													
Mean	12.9	13.6	11.2	8.5	6.3	5.0	5.0	4.2	4.8	6.8	8.7	11.4	8.2
86 Percentile	16.3	17.4	15.6	13.2	10.3	8.6	8.3	7.8	8.9	10.7	12.5	15.3	
14 Percentile	9.1	8.8	6.3	3.4	2.4	1.3	1.8	0.5	0.6	3.0	4.4	7.3	
Rainfall (mm)													
Mean	12	15	21	39	91	126	122	97	64	50	25	14	676
Median	7	6	12	33	90	117	116	94	59	44	22	8	671
Raindays (No)													
Mean	3	3	4	8	14	18	19	17	14	12	6	4	122

Station Name MOUNT BARKER POST OFFICE WESTERN AUSTRALIA

Number 009581 Latitude 34 Deg 38 Min S Longitude 117 Deg 40 Min E Elevation 253.0 M

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Maximum Temperature (C)													
Mean	27.4	26.6	24.7	20.7	18.2	15.6	14.8	15.1	16.9	19.2	21.9	24.9	20.5
86 Percentile	33.4	33.3	31.0	25.6	21.7	18.0	17.0	17.8	20.4	24.2	27.2	31.7	
14 Percentile	21.7	20.8	19.2	16.1	14.9	13.1	12.2	12.2	13.3	14.7	16.7	19.1	
Daily Minimum Temperature (C)													
Mean	13.5	13.9	12.8	10.8	8.9	7.4	6.5	6.0	6.9	8.3	10.0	12.0	9.8
86 Percentile	16.1	16.8	15.6	14.0	11.7	10.2	9.0	8.3	9.3	11.1	13.0	14.5	
14 Percentile	10.6	11.0	9.5	7.8	5.8	4.4	4.3	3.5	4.0	5.3	6.9	9.4	
Rainfall (mm)													
Mean	22	25	36	57	86	100	108	93	82	73	42	30	754
Median	15	16	27	47	80	93	106	87	77	69	34	26	745
Raindays (No)													
Mean	8	7	10	13	17	19	21	20	18	16	11	9	169

FIGURE 4 Long Term Rainfall

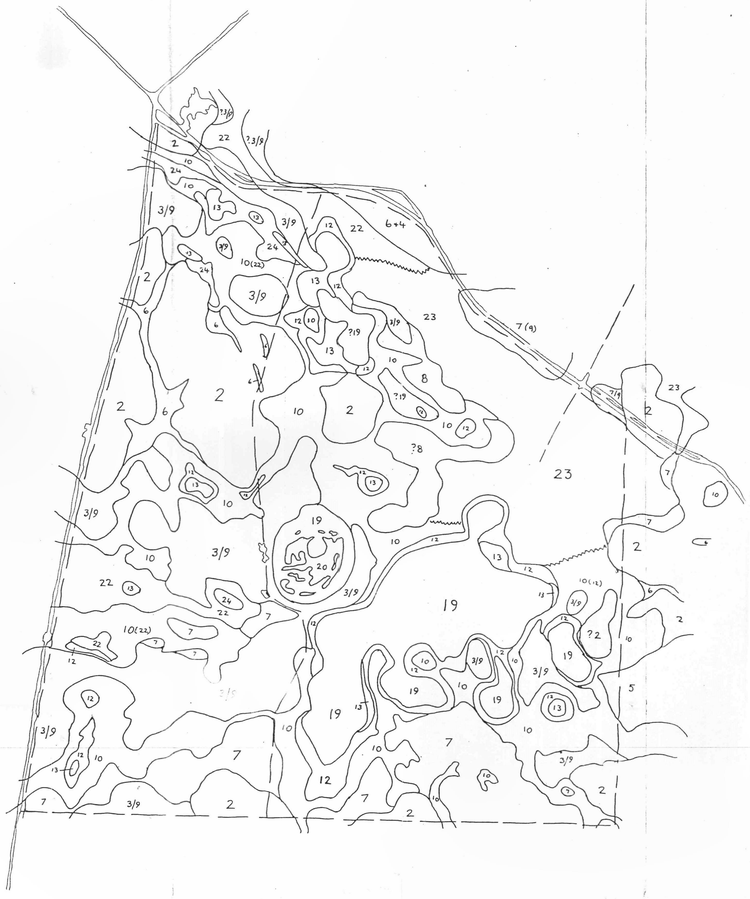


METHODS

The Unicup area was visited for 15 days during April 1984. Eleven days were spent on Unicup reserve, 3 days on Kulunilup and 1 day on Yarnup. The study was spread over three trips which provided a good opportunity to maximise accuracy of field identifications of species. The 219 sites examined are shown on the contour map which was taken from maps provided by the Public Works Department (Figure 4). The study relied on field recognition of vegetation units and qualitative correlation with aerial photo signals. Stereo examination of aerial photographs taken in 1946, 1963, 1970, 1979 (colour) and 1981 was used to delimit the vegetation units. Mapping was done at a scale of about 1:12,500 on photographs Pemberton 1:250,000 Run 5 photo 5706 and Run 6 photo 5723 flown on 25.3.1981.

Interpretation of photo signals relied on tone, texture, changes in these over time, landscape and soil colour. Some areas were only recognisable as complexes, partly because of units being small or narrow and partly in areas where the vegetation appeared in a state of flux, in response to drying out or increasing salt levels.

Generally, boundaries drawn would be accurate to about 50m though there was difficulty in defining the boundaries of Type 2 Jarrah Forest (Unit 3). This unit ocurs on lower slopes where it was mapped as a mixture of this unit and Agonis parviceps Thicket (Unit 9).



1 km

FIGURE 5

VEGETATION MAP

- Vegetation Unit boundary
- Major tracks
- Fire boundary
- Proposed firebreak locations
- 7 — Vegetation Unit number
- 3/9 — Inseparable combination of units
- 19 (14) — Major unit (19) with minor (14)

TABLE 4 LIST OF VEGETATION UNITS DEFINED AND MAPPED IN SURVEY

1. Dryandra armata - Hakea undulata Heath
2. Jarrah Forest (Type 1) (lateritic upland)
3. Jarrah Forest (Type 2) (lower slopes)
4. Jarrah-Wandoo Forest
5. Wandoo Forest
6. Hakea prostrata Low Scrub A
7. Eucalyptus decipiens Open Low Woodland B (Type 1)
8. Eucalyptus decipiens Open Low Woodland B (Type 2)
9. Agonis parviceps Thicket (under Jarrah Woodland)
10. Melaleuca preissiana - Banksia littoralis Open Low Woodland A
11. Eucalyptus rudis Woodland
12. Melaleuca lateritia Dense Low Heath
13. Melaleuca raphiophylla Dense Low Forest B
14. Melaleuca cuticularis Dense Low Forest B
15. Melaleuca cuticularis complex
16. Gahnia trifida Hummock Grass
17. Halosarcia - Wilsonia Mat Plants
18. Saline lake bed
19. Baumea Sedges
20. Open Water
21. Melaleuca densa - M. viminea Thicket
22. Melaleuca viminea Heath
23. Melaleuca spathulata complex
24. Leptocarpus Sedges

RESULTS AND DISCUSSION

VEGETATION

The Unicup area is as previouly reported a Jarrah Forest with Open Low Woodlands of paperbarks and swamps and lakes. Twenty-four vegetation units were mapped and several of these were clearly complexes and gradients. (Figure 5, Table 4). The numbering of these units was an attempt to show a relationship with landscape. Detailed descriptions of the units is provided in Appendix 3 while the descriptions of specific sites are provided separately from this report.

Unicup Reserve

Jarrah Forest (Units 2 and 3) is the most extensive formation in the Lake Unicup Reserve. The Jarrah Forest was divided into two landscape/soil type related units (Type 1 - gravel uplands, and Type 2 - sandy lower slopes). The differences between these types were not easily distinguishable on the photos. On the ground the soil type and a few key species (Hakea lissocarpha and Bossiaea ornata) to Type 1 are useful distinguishable characters. Marri is usually present in most parts of the Jarrah Forest. A few areas along the northern boundary also have Wandoo present. There were two small units recognised with Wandoo present - Unit 4 Wandoo-Jarrah Forest and Unit 5 Wandoo Woodland. Wandoo seems to be present where the soil has more clay than under most of the Jarrah forest.

On sandy valleys and lower slopes, the Jarrah Forest opens out into Jarrah Woodland/Open Woodland with the shrub layer dominated by Agonis parviceps typically as a Thicket (unit 9 - Agonis parviceps Thicket). This unit appeared to be on well drained but generally moist sand. It appears that it has been from this unit that most of the timber cutting occurred. Not surprisingly, as Christensen (1980) described "High Quality Jarrah Forest" as having an

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8. Eucalyptus decipiens Open Low Woodland B (Type 2)
9. Agonis parviceps Thicket (under Jarrah Woodland)
10. Melaleuca preissiana - Banksia littoralis Open Low Woodland A
11. Eucalyptus rudis Woodland
12. Melaleuca lateritia Dense Low Heath
13. Melaleuca raphiophylla Dense Low Forest B
14. Melaleuca cuticularis Dense Low Forest B
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23. Melaleuca spathulata complex
24. Leptocarpus Sedges

understorey of Agonis parviceps. Melaleuca thymoides is a very important cohort of Agonis parviceps but tends to predominate in the drier portions of this unit e.g. on dunes and terraces. In wetter broad sandy flats Banksia ilicifolia is often present (e.g. sites U32 and U129) as an Open Low Woodland stratum beneath the Jarrah.

Depressions, swamps and lakes were the most prominant group of units. These areas showed a very complex suite of vegetation units and species complexes which appear clearly related to soil type, moisture status and salinity. It is not possible to precisely define the relationship, because limited time prevented detailed assessment of soil types. Generally, however, the following represents a gradual gradient from the Agonis parviceps Thickets to the centre of fresh swamps and lakes.

Jarrah and Banksia ilicifolia are usually replaced by Melaleuca preissiana and Banksia littoralis Open Low Woodland (Unit 10), often just a narrow fringe but sometimes completely covering small depressions. Pericalymma ellipticum (formerly known Leptospermum ellipticum) usually dominates a Heath B or Low Heath C beneath. Astartea fasciculata, Calothamnus lateralis and Melaleuca densa are common cohorts while Viminaria juncea and Hakea varia are often emergent species which in places form a Low Scrub A. Kunzea recurva may form a Heath B or Low Scrub A or B on sandy fringes or small sandy depressions which have dried out (U39). Areas of Dense Low Heath C or Dense Heath B of almost pure Melaleuca lateritia (Unit 12) often occur as eyes in depressions where it is clayier or wetter. Alternatively it may surround a Dense Low Forest B or just scattered trees of Melaleuca raphiophylla with or without a few Eucalyptus rudis (Unit 13). These species usually define areas with permanent fresh water close to the surface. One small depression (U143) had a dense Thicket of Melaleuca densa and M. viminea (Unit 21) apparently in this niche. The centre of the wettest fresh areas usually have Dense Tall Sedges of Baumea articulata (Unit 18). Often between these sedges and the Melaleuca raphiophylla are bare patches which are probably the result of Baumea dying as these patches dry out. There are no permanent fresh lakes in the Unicup reserve but in Lake Kulunilup and Yarnup Swamp there are openings in the Baumea articulata with aquatic plants

floating in the water.

The comparable gradient to saline areas usually still has a fringe of Melaleuca preissiana and Banksia littoralis with Pericalymma ellipticum and Kunzea recurva (Unit 10). This unit gives way to patches of Hakea trifurcata and Melaleuca densa Heath A beneath a Melaleuca cuticularis Open Low Woodland (Unit 15). Some of the species from unit 10 are also present e.g. Pericalymma ellipticum, Hypocalymma angustifolia. The Melaleuca cuticularis becomes increasingly important while Gahnia trifida and Brachysema sericeum are almost the only large understorey species present. In some places the Gahnia can form a Mid Dense Hummock Grass (Unit 16) with only a few M. cuticularis as tall shrubs. Close to the edge of the saline lakes (and salt pans) M. cuticularis can form a Dense Low Forest B (Unit 14) with little understorey at all. Usually between the M. cuticularis and the lake bed Halosarcia and Wilsonia form what is best called Mat Plants or Dense Mat Plants (Unit 17). These two species usually form monospecific swards (ignoring annual herbs). The bed of these saline areas show evidence of aquatic plants which could not be identified.

There appears to be a general trend for the lakes and swamps to be drying out and becoming more saline. Some areas therefore show intermediate combinations of the above gradients. Noticeable during salination is the death of Banksia littoralis, Melaleuca preissiana and Eucalyptus rudis. Baumea articulata appears to prefer permanently wet and non-saline areas. Baumea juncea is often the dominant sedge in the swamps turning saline. (e.g. Unicup Lake, Tolkerlup Swamp, Swamps A,D,E,F,G and other smaller ones). Melaleuca densa and M. Leptoclada appear to be more important surrounding the saline areas than fresh areas.

The Unicup reserve really has only one permanent lake (Lake A). Unicup Lake which has some water is much shallower than it once was and may be on the verge of dying out completely in some summers to come. Lake A has the same geomorphology as Kulunilup Lake and Yarnup Swamp; round and relatively deep with some lunette dunes. It is possible these lakes are connected to the ground water-table and not just perched. The vegetation of Lake A differs markedly

from that of the other two because it is slightly saline. There are only a few patches of Baumea articulata - Baumea juncea being the main sedge fringing Lake A which is principally open water. Small but separate areas of Melaleuca cuticularis (Unit 15) and Melaleuca raphiophylla (Unit 13) occur with the Baumea understorey. A narrow band of Melaleuca preissiana and Banksia littoralis grows upslope between the melaleucas and the Jarrah Forest or Agonis parviceps Thicket.

There are several other vegetation types present in the Unicup reserve. On the top of many of the laterite covered hills are "bald" patches covered in a shrub dominated community (Dryandra armata - Hakea undulata, Unit 1). These areas usually have no Jarrah but a few Mallee tree form Marri and Eucalyptus decipiens. The soil here is generally an orange loam and appears to be shallow with some country rock outcropping. These areas probably correspond to the Scotsdale fasc of soil. (Appendix 1). Christensen (1980) suggested that this type of area has soil which is too shallow for Jarrah. In some surrounding areas (U145, U150) the Jarrah vegetation is very stunted. The species composition of these bare areas is variable and probably reflects the variation in the country rocks and their metamorphic origin.

The other main type of vegetation is small shrub dominated areas usually occurring as narrow openings in the Jarrah Forest and Woodland. These areas appear to be old drainage lines which have been left high in the landscape by subsequent erosion elsewhere. The soil is grey sand probably shallow over clay. Two variants of this vegetation have been recognised: Hakea prostrata Low Scrub A (Unit 6) and Eucalyptus decipiens Open Low Woodland B (Unit 7). The Hakea prostrata unit is usually present in narrow patches in the Jarrah Forest (Type 1). Other tall species here include Acacia saligna, Hakea varia and Xanthorrhoea ? pressii. Hypocalymma angustifolia is often a dominant low shrub and the sedges Mesomelaena stygia and M. tetragona are important. Often present are a few plants of Pericalymma ellipticum, Kunzea recurva or Melaleuca preissiana which are species typical of moist depressions and drainage lines. E. decipiens (Unit 7) is similar to this in many ways. It appears to occupy a shallow sand over clay soil (probably an alluvial terrace) close to some present

drainage lines. Species typical of these drainage lines (E. rudis, M. preissiana and Pericalymma ellipticum are more important in Unit 7 than in Unit 6. Also more important are species such as Hakea trifurcata which tend to prefer more clayey soils. Conversely there appears to be less Calytrix flavescens and Bossiaea eriocarpa which prefer sandier areas.

The vegetation alongside the Unicup road West of Tolkerlup swamp was difficult to typify. This area had an Open Low Woodland of Eucalyptus decipiens (some plants Mallee trees) with a dense shrub understorey dominated by Melaleuca thymoides and Casuarina humilis. There were no other tree species. This combination of species represents something intermediate between the E. decipiens Open Low Woodland (Unit 7) and the dry phase of the Agonis parviceps Thicket (Unit 9). The soil here appeared to be a deep sandy one being a dune blown up from Tolkerlup Swamp and Lake B.

In the area between Unicup Lake and Little Unicup Lake there was once at least two drainage lines with interfluvial laterite rises between. These drainage lines are now filled with colluvial and aeolian sand. The vegetation, however, shows the drainage line history. The southern area which was probably the most active into recent times has and Open Woodland of E. rudis with some E. calophylla (Unit 11). Beneath these species, Kunzea vestita is prominant forming in places a Thicket or Dense Thicket.

Lake Kulunilup

In the Kulunilup reserve the vegetation is dominated by shrub and sedge communities associated with broad alluvial plains. Forest and Woodland areas are limited to the rather few lateritic or aeolian dune rises. Many of the vegetation units in the Unicup reserve are also in Kulunilup but there are substantial differences in their relative importance. This is mainly a reflection of topographic and soil differences. Kulunilup has only about 10m of relief while Unicup has 40m and Yarnup almost 20m.

The Forest areas in Kulunilup are mainly of Unit 2 (Jarrah Forest type 1 on lateritic upland). The sandy dune rises support a Jarrah Forest/Woodland which has been mapped as a complex of Units 3 and 9 (Jarrah Forst type 2 on lower slopes and Agonis parviceps Thicket under Jarrah Woodland). Melaleuca thymoides is very important in these areas.

The broad alluvial flats support the drainage line gradient unit 10 to unit 19 (Melaleuca preissiana - Banksia littoralis Open Low Woodland to Baumea articulata Dense Sedges). These units were described under the Unicup reserve. Also present on these broad clayey flats are extensive areas of Melaleuca Heath and Thickets. These areas appear to have a ferrugineous hard pan a few centimetres beneath the surface. Three units were mapped covering these areas: Melaleuca spathulata complex (Unit 23), Melaleuca viminea Heath A (Unit 22) and Leptocarpus ? scariosus Low Sedges (Unit 24). The Melaleuca viminea Heath A is structurally variable (Thicket, Heath A, Scrub and Low Scrub A and B). These variations appear to be related to fire age and to the drying out of the area. The Leptocarpus is closely associated with the Melaleuca viminea and forms in the centre of some drainage flats (K30). It may also be surrounded by Unit 10 as at K22.

The Melaleuca spathulata complex was very difficult to separate into its components on the photos because the area was drying out and the signals were misleading. There are clearly several vegetation units present. Some of these have already been described for the Unicup reserve (Melaleuca lateritia Heath B - Unit 12 and Melaleuca cuticularis Low Forest B Unit 14). Melaleuca cuticularis occurs in several patches usually surrounded by pale areas on aerial photos. These pale areas are apparently affected by increasing salt and the sedge Leptocarpus is the predominant species now present here. Melaleuca cuticularis also occurs as scattered trees along the fringe of the complex. Beneath the M. cuticularis there is a Low Heath C which is similar in composition to the shrub component of Unit 10. The dominant species include Astartea fascicularis, Calothamnus lateralis, Melaleuca densa and M. leptoclada. In places there are skeletons of Eucalyptus rudis, Banksia littoralis and Melaleuca preissiana e.g. north of K20. This supports the hypothesis that these

areas are dying out and becoming more saline than they once were. In the centre of these drainage areas are expanses of Melaleuca spathulata forming a dense Heath of a variable height (Dense Heath A to Low Heath C). These appear to be related mainly to fire age and soil conditions. In these areas the soil is a heavy red/brown clay loam over a shallow ferricrete hard pan. Only a few other species are present - M. viminea and M. cuticularis the most important. In some places M. densa and M. raphiophylla may form a Dense Heath A fringing the M. spathulata (e.g. K21,K15). The remaining vegetation has been mapped as units 6,7 or 8. Unit 6 (Hakea prostrata) is in old dry drainage lines between areas of Jarrah Forest. This type of vegetation has been described under the Unicup reserve. Unit 7 (Eucalyptus decipiens Open Low Woodland) occurs on broad flats mainly on the southern part of the reserve surrounding the main swamp area. The soil is a grey sand of variable depth over clay. As well as the E. decipiens, other trees here include E. rudis, E. calophylla and M. preissiana. The shrub vegetation is variable in composition depending on the amount of sand present. On shallow sand over clay Hakea varia emerges from a Heath B dominated by Hypocalymma angustifolia, Kunzea recurva and Astartea fascicularis. Sandier areas have Casuarina humilis dominated Heath B, often with Hakea prostrata and Xanthorrhoea ? preissii.

There are also two small areas of Wandoo on the reserve (K12,K13,K44). At K44 there is a Wandoo Forest with a Low Heath D understorey (Unit 4). K12 and K13 are in an area where this unit is mixed with Unit 6 (Hakea prostrata Low Scrub A).

Yarnup Swamp

The vegetation and topography of Yarnup Swamp reserve is very similar to parts of the Unicup reserve. The swamp is very similar to Kulunilup Lake. This reserve is dominated by Jarrah Forest. lateritic upland supports Type 1 Jarrah Forest (Unit 2) though on the southern boundary it is mixed with some shrub dominated areas (Hakea prostrata Low Scrub A - Unit 6). The bulk of the vegetation on the south-east side of the swamp is a Type 2 Jarrah Forest (Unit

3) with some areas of Melaleuca thymoides (Unit 9). Parts of this area are badly affected by disturbance - many Jarrah are ringbarked and there is much Pteridium esculentum.

The remainder of the area is a complex drainage line dominated by Melaleuca preissiana - Banksia littoralis (Unit 10) and Jarrah Woodland (Unit 9 but with no Agonis parviceps Thickets). The other tree species present are Eucalyptus rudis, E. decipiens, E. cornuta and Melaleuca raphiophylla.

Fringing the swamp is a narrow band of Melaleuca preissiana with a few E. cornuta and E. rudis on the west and south-west side. Beneath are a few lower trees of Banksia littoralis. Tall shrubs include Oxylobiun linearifolium and Acacia saligna which are above a Dense Low Sedges of Baumea juncea. Except for the presence of E. cornuta, this swamp is very similar to Kulunilup Lake. The centre of the swamp is dominated by Dense Baumea articulata with a few patches of open water.

FLORA

Almost 250 native plant species were found during the survey of the three reserves (Appendix 4). All but a few of these (e.g. Melaleuca spathulata and Oxylobium linearifolium) were present on the Unicup reserve. This probably represents a total flora for Unicup reserve of around 300 species as many of the annual herbs and geophytes were not found. Time limitations prevented collection of a comprehensive flora of the Kulunilup and Yarnup reserves. They would, however, be substantially poorer in species at least by virtue of the size differences.

Comparing the vegetation of these three reserves suggests that some significant differences exist between the flora of the reserves. Unicup has the only areas of Dryandra armata - Hakea undulata Heath. D. armata is at its western limit of its distribution in this area and it is probable that so too are other species of this unit. Of the three reserves Unicup has the main areas of Agonis

parviceps Thicket. In Kulunilup there are the only sizeable areas of Melaleuca spathulata which is a species more typical of the wheatbelt to the northeast. Yarnup is not known to have any vegetation units or flora that the others don't have but it has in its swamp a good duplication of the Kulunilup lake habitat. Yarnup also has a modest number of Eucalyptus cornuta (Yate) which is also in the Unicup reserve north of Lake A.

It is not reasonable to thoroughly compare the reserves to the adjacent State Forest but a few comments are possible. The Unicup area has many species in common with the State Forest but the vegetation is more dominated by wet communities. The Jarrah Forest (Units 2 and 3) is probably very similar in composition to Jarrah Forest in the adjacent State Forest but it is clearly burnt less often. The State Forest also has areas of Hakea prostrata and Eucalyptus decipiens (Units 6 and 7). Small areas of Dryandra armata - Hakea undulata Heath (Unit 1) may occur in State Forest but each of these areas are likely to be floristically different. Very few wet areas with vegetation similar to the sedge communities of the Unicup reserves would occur in State Forest. The variants of the Melaleuca preissiana - Banksia littoralis (Unit 10) are present in State Forest. Melaleuca spathulata complex (Unit 23) is very unlikely to occur in State Forest although some patches of Melaleuca viminea do occur.

The species composition of the main vegetation units was assessed using a qualitatively constructed phytosociological table (Appendix 5). This was done to establish the floristic integrity of the vegetation units. For this exercise 72 species were selected amongst which were ones used to help discriminate between vegetation units. Many of the species used were adopted for Christensen's (1980) Principal Component Analysis set. The phytosociological table was prepared to highlight the gradient from upland ridges to fresh swamps and valley floors: Dryandra armata - Hakea undulata Heath (Unit 1), Jarrah Forest Type 1 (Unit 2), Jarrah Forest Type 2 (Unit 3), Agonis parviceps Thicket (Unit 9), Melaleuca preissiana - Banksia littoralis Open Low Woodland A (Unit 10) and Baumea Sedges (Unit 19). Unit 6 (Hakea prostrata Low Scrub A) and Unit 7 (Eucalyptus decipiens Open Low Woodland A) were placed next to Unit 1 to which

they seemed to have most similarities. Unit 15 (Melaleuca cuticularis complex) was placed at the end of the gradient. Units 6, 7 and 15 were not considered in the main ordering of species. Only sites from the Unicup reserve were used but sites those where the vegetation unit was ambiguous were excluded.

The data suggest that most of the species in Appendix 5 have a definite ecological range. Some species, particularly those of wet areas, have a narrow range. It is suggested that this phytosociological table attests to the appropriateness of the approach used in defining the vegetation units. There is, however, considerable overlap in species distribution between units 1 and 2 and between units 2, 3 and 9. The latter three were not easily separated from each other during mapping. Units 6 and 7 are floristically very similar to each other using Jaccard coefficient of similarity (+/-). They are both more similar to unit 1 than to any other unit, even to unit 10 to which they must have one time been similar.

Rare Species

No gazetted rare or geographically restricted species were thought to occur in the Unicup area (Rye 1982, S.D. Hopper pers. comm.). None of this type of species was found during this survey. However, several species were only found in very restricted localities on the reserves or in small numbers of individuals.

Rarest of these is Eucalyptus uncinata which was found in two localities - U50 as a few trees and east of U4 (marked * on contour map) as a mallee. This area is the western limit of this species. Banksia meisneri var. meisneri was found at only one locality, U102, but it may occur in Kulunilup reserve in the same vegetation type. This record is considerably south-west of the distribution reported for it by George (1981). A few plants of Eucalyptus occidentalis were found on the south side of Unicup Lake (U7) and north-east and west of Kulinilup Lake - K 15 and near K58 respectively. This is a species more common in the

wheat belt. Additionally, some of the species which occurred in the Dryandra armata - Hakea undulata Heath are probably not common in this area but their distributions have not been ascertained.

COMPARISON BETWEEN VEGETATION UNITS AND GEOLOGICAL UNITS

Table 5 shows a comparison between the vegetation units and geological units. The asterisks indicate the relative proportions of vegetation units occurring in each geological unit. A general correlation is apparent which is not particularly suprising as both the vegetation and geology are closely related to topography. This correlation suggests that, with care, the vegetation of this area could be predicted in general terms from the geology map. The only apparent difference between the comparisons for Unicup and Kulunilup was that Czat in Kulunilup had a higher proportion of Jarrah Forest Type 1 (Unit 2) but little of this vegetation unit was on Czat in Unicup. This is not a problem but draws attention to the heterogeneous nature of Czat i.e. it is often lateritized (see Table 2). The difference in the Czat between Kulunilup and Unicup is probably relief related - in areas with low relief Czat is lateritized to a greater degree than areas with more relief.

CONDITIONS OF VEGETATION

Attention was given to observing the condition of the vegetation in the reserves. This was principally to detect the possible ocurrences of Phytophthra cinnamomi. In all reserves much of the Jarrah is staggy. Although this raised suspicion of Phytophthora, its widespread presence is considered unlikely. Examination of the staggy Jarrah showed that most have significant fire scars - both in upper branches and on the trunk. It seems probable that these scars were caused by the crown-fire of about 1950/51 (or some undetected crown-fire perhaps after the major logging activities). Other tree species (e.g. Melaleuca preissiana and Eucalyptus wandoo) show similar fire damage. Jarrah leaf miner is reported to have had a significant affect on some of the Jarrah Forest in the

TABLE 5 COMPARISON BETWEEN VEGETATION UNITS AND GEOLOGICAL UNITS
(Asterisks represent low, medium and high proportion of vegetation unit in geologicl unit)

UNICUP

Vegetation Units	Png	Age	Czl	Czs	Czat	Cza	Qas	Qrcs	Qrw
1		**	*						
4		*	*						
5			*						
6	**		*		*				
7		**	*	**	**	*			
2	***	***	***	**	*			**	
3/9		**	**	***	***	***	*	**	
9	*	*		**	***	***	***	**	
10		*			**	***		*	**
8					*				
11					*				
21						*			
13					*	*			*
15					*	*			***
12									*
14									**
16									**
17									**
19					*				**
20									**
18									***

KULUNILUP

Vegetation Units	Png	Age	Czl	Czs	Czat	Cza	Qas	Qrcs	Qrw
6			**		*	*			
4			**		*	*			
2			***		***	*			
7					***	*			
3/9					**	***			**
8						**			
10					**	**			*
12						**			
13						**			*
22						*			
23					*	**			
24						*			
25						*			
20						***			***
19									***

Perup area. This insect may be contributing to the staggyness in the Unicup area but the fire damage is considered to be the main cause.

There was only one site on the reserves (U70) which was considered to show signs of plant death suspicious of Phytophthora cinnamomi. This was a flat sandy depression adjacent to a small swamp. The vegetation was a Jarrah Open Woodland with Banksia littoralis and B. ilicifolia Open Low Woodland over Low Heath C in which Pericalymma ellipticum was dominant. There were about 40 dead Banksia plants (B. ilicifolia, B. littoralis and B. grandis) and they appeared to have died over a period of several years. Dying pants were rare. A root specimen was taken from the plant of each Banksia secies which appeared to have died most recently. The B. grandis had P. cinnamomi, the B. ilicifolia had Phytophthora which may or may not be P. cinnamomi, and B. littoralis no Phytophthora was detected. Other species with dead plants in the area included Adenanthos obovata, Pultenaea ochreata and Dasypogon bromeliifolius.

There were other areas with dead plants but these were mainly on the edge of swamps etc. These deaths were mainly attributed to changes in water level or salinity. Banksia littoralis was the most commonly affected species but others included Melaleuca preissiana and Eucalyptus rudis. Usually only a few of the plants in an area were dead.

There were a number of instances where branches of Banksia grandis plants had died. These were most common close to fire breaks and it is considered that the plowing of firebreaks might be responsible. A specimen from one such plant was taken for Phytophthora testing but was negative. (Eastern boundary of Unicup, south of U22.)

There are small areas of disturbances (other than tracks and fire breaks) on each of the reserves. These have been invaded by weed species and are a source for further spreading. Probably of greatest concern is the Bracken (Pteridium esculentum) which only occurs in some of these areas and its extent may expand under a regular burning regime.

It is concluded that the vegetation of the reserves in the Unicup area is probably relatively free of serious pathogens. It is, however, still recovering from severe fire damage and, in the Unicup reserve, the affects of severe logging. (There appears to be no millable Jarrah left in an area where there were once substantial trees.) Recovery from this may take hundreds of years. Complete recovery to pre-cutting conditions is debatable, especially if the suggestion that the area is becoming drier is real and long term. This apparent drying and increasingly saline trend seems to be changing the conditions of the wet depressions. The fringing Melaleuca preissiana - Banksia littoralis Open Low Woodland appears to be changing to the Melaleuca cuticularis complex. The Baumea articulata areas appear to be contracting, particularly on small clayey flats and B. juncea or bare areas replacing it. Melaleuca viminea thickets appear to be opening up and allowing an increased cover of the sedge Leptocarpus. If these observations accurately portray the long term situation there are implications for fire management.

MANAGEMENT

The need for some active management of these areas is recognised in light of the pressure from adjacent land owners and the apparent length of time since these reserves have been burnt (probably > 20 years). It should first be pointed out that the reserves do not appear to "require" any regenerative burning. There are a few places with substantial litter buildup but this is probably not a problem. Of more concern is where there are piles of felled timber (particularly on eastern boundary of Yarnup Swamp).

Firebreaks

At present the Unicup reserve has parallel firebreaks about 30-40m apart where there is no road between it an alienated land (except for small block South of Pindecup Rd). These buffer areas occupy about 50ha (1.5% of the reserve). If these were increased to 100m wide, these would occupy about 140ha (4%) of the

reserve. This may not have a significant affect on the reserve but needs to be considered cautiously. If the new firebreak were put in precisely at 100m from the boundaries, Swamps A, F and G would be directly affected by changes. Each of these have substantial reed beds and most of the Baumea articulata in the reserve (other than in Unicup Lake) are on swamps F and G. These could not be allowed to burn on a regular, frequent basis. Of immediate oncern is where the proposed western firebreak would pass through the area infected by P. cinnamomi (U70). Care should be taken to not spread the infection and perhaps the area (and Swamp F). This would mean that the infected area would be totally within the buffer but the swamp would be subject to frequent burning. Minor deviations necessay from a 100m firebreak are indicated on the vegetation map (Figure 5). The small block south of Pindecup Rd. does not warrant such a wide buffer and if one were put in it would impinge substantially into the fringing vegetation of the lake. A 20 to 30m wide buffer should be considered. There are a substantial number of tracks in the reserve which were created by timber harvesting. Most of these would be trafficable if fallen timber is removed. Some of these should be opened up for fire control purposes but it is acknowledged that this will increase the accessibility of the reserve to the general public.

Neither Kulunilup nor Yarnup have buffers surrounding them. A 100m wide buffer on the south and east boundaries of Kulunilup (adjoined by farms) would consume 10% of the reserve. At Yarnup a similar buffer (on south, east and north sides) would involve 30% of the reserve. These proportions could not be considered acceptable. However, some improvement in the firebreaks on these reserves is necessary, particularly on the western side of Yarnup.

Some firebreaks are difficult to drive along and may impede fire suppression activities. The main cause is large lateritic and ferricrete rocks unearthed by ploughing breaks. Consideration should be given to using a grader instead of plough for firebreak maintenance. Alternatively, the depth of ploughing should be reduced.

Controlled Burning

As mentioned above, there appears to be no vegetation types in the reserve which require "regenerative burning". Most of the species occurring in the area regenerate after fire from root stock but this is not a justification for concluding that the area needs a fire on a frequent cycle nor can survive such treatment. It is not known which species are fire sensitive but at least some of the major species of wet depressions are (e.g. Pericalymma ellipticum and Kunzea recurva). Melaleuca viminea, M. spathulata and M. lateritia have growth forms which suggest that they also are fire sensitive. Regular burning with frequency say < 15 years will probably permanently change the structure and composition of these areas. Also to be considered is the possible deleterious interactions between burning and increasing aridity. It is probable that regeneration after any fire in these circumstances would result in an altered vegetation type or at least altered structure. The one known population of Banksia meisneri var. meisneri in the Unicup area (U102) is also vulnerable to depletion as it is a fire sensitive species (George 1981)and it is adjacent to Unicup road.

For the purpose of considering fire management, no other vegetation units are considered to require special attention. Most units are represented in a number of locations and unless the whole area is burnt on a regular frequent basis, few should be under threat. However, it is considered that if any regular controlled burning is required, it should be confined to areas of Jarrah Forest and Woodland (Units 2, 3 and 9). Other areas should "rely" on accidental infrequent burning.

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APPENDIX 1

Description of Soil Fasc probably occurring in the Unicup area (From Smith, 1951 pp 29-30.

(1) The Kordabup fasc of lateritic podsols includes Carrolup sand, Frankland sand, Kent sand, Kordabup sand, and Kwilalup sand. All series conform to the following generalized descriptions: shallow A_1 horizon; deep, bleached, sandy A_2; stony lateritic hardpan (B_1) overlying mottled clay (B_2) at depths between extremes of 15 and 60 in.

These are typical lateritic formations existing as remnants of the late Tertiary land surface formed under conditions of high and fluctuating water tables on the old peneplain. They are fossil soils, sometimes with slight truncation of, or with slight additions to the A horizon. The main profile, however, remains undisturbed with kaolinitic clays beneath the laterite horizon. They correspond to the normal lateritic profile of Stephens (1946).

(2) The Plantagenet fasc of humus podsols includes Quindabellup sand, Poorrarecup sand, and Plantagenet peaty sand. Series conform to the following generalized description: black, deep A_1 horizon with much organic matter; bleached, sandy A_2; black organic pan and permanent water-table in the B horizons.

These soils form on deep sandy beds in topographic situations favourable to permanent water-tables. These sandy beds are probably the result of truncation of the A horizons of soils of the Kordabup fasc. The soils of the Plantagenet fasc are the most acid in their respective landscape groups.

(3) The Wakundup fasc of south-western laterites includes Eulanda series, Bangalup series, Yeriminup series, Wakundup series, Koorrabup series, and

Koorundurup series. All series conform to the following description.

A horizon from 12 to 30 in. deep and carrying much lateritic gravel and sometimes boulders; B horizon of mottled clay overlying C horizon at varying depths. These are fossil soils in that they represent a Tertiary lateritic soil the A horizon of which has been removed by the forces of natural erosion. Although truncation has stopped at the top of the old B horizon it seems probable that changes have been brought about by the deep-rooted trees and shrubs growing on these soils. For example, these soils are weakly acid to neutral, in sharp contrast with the strong acidity of morphologically similar soils in Ceylon as reported by Joachim (personal communication). It seems probable that the roots of the indigenous forest have reached downwards to the zone of rock weathering and have absorbed and transported to the above-ground tissues the plant nutrients liberated from the parent rock. The liberation of these elements at the soil surface on the decay or combustion of the forest litter has enabled the soil, not only to counter the current leaching effects of climate, but also to raise the pH to the weakly acid range.

(4) The Scotsdale fasc of south-western brown soils includes Ucarro series, Muradup series, Bolbelup series, Rocky Gully series, and Scotsdale series. All series conform to the following generalized description: brown, loamy, sometimes stony or gravelly A horizon; brown to red-brown, clayey and often stony or gravelly B horizon; decomposing rock (C horizon) at shallow depths, generally 12 to 30 in.

The soils are found in rejuvenated river valleys or in comparatively steep upland areas wherever the forces of natural erosion have stripped off the Tertiary lateritic horizons and exposed the Pre-Cambrian country rock. Their genesis is uncomplicated - they are the product of rock weathering and soil building under the current climatic regime. These soils have been regarded by Teakle (1940) and by Prescott (1913) as representative of the zonal soils of this part of the continent. This investigation indicates that the boundary between pedalfers and pedocals is more to the east than is indicated on the maps of the above workers.

(5) The Camballup fasc of solonetizic soils includes Camballup series and some valley complex types. Soil types conform to the following generalized description: shallow, bleached, sandy, and slightly acid A horizons; grey, heavy-textured B horizon with marked columnar structure and alkaline reaction; deeper layers (C horizons) of alkaline clays.

These soils are found on the floors of the wide, flat valleys of the recently uplifted peneplain. Their genesis is the result of leaching, under a subhumid climate, of saline clay beds, following changes in the drainage pattern of the uplifted peneplain. These solonetzic soils, which are a minor constituent of the continental soil pattern, are found in local depressed areas of 10 to 1,000 acres, where they are associated with characteristic plant communities. They belong to the group of solodized-solonetz soils of North America (Smith 1950).

APPENDIX 2

Summary of Christensen's (1980) Principal Component Analysis (pp 11-13).

Species occurring at the extremities of each axis are listed below.

-C1 Leucopogon capitellatus, Eucalyptus marginata, Hakea lissocarpha, Leucopogon verticillatus, Macrozamia riedlei - species occurring on well drained upper slopes with deep sandy gravelly loams.

+C1 Drosera bulbosa, Acacia saligna, Hakea prostrata, Hypocalymma angustifolium, Melaleuca preissiana - species typically associated with broad, flat, seasonally swampy drainage lines.

-C2 Pteridium esculentum, Clematis pubescens, Hovea elliptica, Ranunculus colonorum, Bossiaea linophylla, Persoonia longifolia - species associated with well drained, fertile upper slopes in the high rainfall western sector.

+C2 Xanthorrhoea ? preissii, Acacia pulchella, Pimelea suaveolens, Dryandra nivea, Trymalium ledifolium, Leucopogon pulchellus, Thomasia grandiflora - species more common in the eastern sector, often on poor, infertile sites supporting low-quality forest.

-C3 Eucalyptus marginata, Macrozamia riedlei, Leucopogon propinquus, Hakea lissocarpha, Leucopogon verticillatus - species commonly occurring on deep soils, very similar to -C1.

+C3 Gastrolobium spinosum, Hakea incrassata, Hakea undulata, Dryandra armata, Baeckea camphorosmae - species common on soils too shallow for tree growth and often overlying massive granite.

-C4 Melaleuca preissiana, M. viminea, Astartea fascicularis, Banksia

littoralis, Eucalyptus rudis - species occurring on moist to wet sites in depressions.

+C4 Hibbertia quadricolor, Petrophile serruriae, Pultenaea ericifolia, Leucopogon pulchellus, Conostylis setigera, Banksia sphaerocarpa - species occurring on dry upland sites in the eastern sector, which is subject to drought.

APPENDIX 3

Description of Vegetation Units

These units are based on a synthesis of the field observations of sites. Definition is necessarily subjective and influenced by ability to recognise and map units consistently. The Diagnosis and Code is based on the scheme of Muir (1977) (Table 6). The key to the dominant species used in the Code is located at the end of this Appendix.

1) Dryandra armata - Hakea undulata Heath

Site Nos: U23, U24, U25, U37, U87, U145

Diagnosis: Low Scrub B over Low Heath D with patches of Tree Mallee and Open Low Sedges

Code: h_4SBi. dSDc

Description:

Stratum 1. Patches of Eucalyptus calophylla and Eucalyptus decipiens Tree Mallee occur within this unit and usually fringing.

Stratum 2. Hakea undulata (mostly with H. trifurcata and Xanthorrhoea ? preissii) Low Scrub B, often exceeding 2m forming small areas of Heath A. This stratum is usually discontinuous.

Stratum 3. Dryandra armata Low Heath D (sometimes more than 0.5m tall). This stratum is generally continuous and commonly includes Baeckea camphorosmae, Bossiaea ornata, Daviesia incrassata, Hakea lissocarpha, Leucopogon elatior, Petrophile serruriae and Verticordia sp.indet.

Stratum 4. Mesomelaena styqia Open Low Sedges often occur in patches with other sedges.

Soil: This unit usually occurs on the top or the upper slopes of some hills. These soils are generally shallow orange to light brown loams often with gravel present. Small patches of country rock may be exposed. These are predominantly metamorphic and include both acidic and basic types. This combination suggests that this soil type has developed on a stripped lateritic profile with the present soil being derived from the clayey portion of the profile or from the exposed country rock. The vegetation appears to reflect a linear trend in the soil and rock outcrops. This soil-type, the shallow slope on which it occurs and species present suggest winter waterlogging and summer water deficite conditions often occur.

Comments: This unit is principally defined by soil-type. It is replaced by Jarrah Forest (Type 1) (Unit 2) as the lateritic gravels and duricrust increased in importance. The transition seems fairly abrupt but many species of this Heath continue as understorey of the Jarrah Forest (Type 1).

2) Eucalyptus marginata (Jarrah) Forest (Type 1)

Site Nos. U1, U2, U5, U15, U22, U34, U35, U69, U77, U80, U86, U123, U135, U140, K1, K7, K20, K26, K43, K48, Y11

Diagnosis: Forest over Low Scrub A over Low Scrub D

Code: e_3Mc. bo_1SAi. h_1SDi

Description:

Stratum 1. Eucalyptus marginata Forest, usually with an occasional E.calophylla

but on some "poorer" sites it may only form a Low Forest A (e.g. surrounding site U15). Considerable coppice growth may occur in some sites, particularly where the area has been logged, been burnt severely or on the poorer sites.

Stratum 2. Bossiaea linophylla and Leucopogon capitellatus form a patchy tall shrub stratum (Low Scrub A). In places it may be a Heath A or Heath B. These are usually slightly sandy areas. Where there is more gravel or duricrust Stratum 3 is more important. Other tall shrub species usually include Acacia extensa, Macrozamia riedlei and Persoonia longifolia.

Stratum 3. Hakea lissocarpha and Bossiaea ornata are the principal Low Shrub species of the gravelly sites. They usually form a Open Dwarf Scrub D but sometimes a Low Heath D. Important in sandier areas is Hypocalymma angustifolia. Other small shrub species usually present include Astroloma ciliatum, A. pallidum, Hibbertia cunninghamii, H. racemosa, Leucopogon propinquus, L. verticellata, Loxocarya fasciculata, Tymalium ledifolium and Xanthorrhoea ? preissii.

Soil: Lateritic gravel and duricrust are usually on or close to the surface in these upland areas. Grey sand is the usual matrix or sometimes is a shallow covering.

Comments: The definition of this unit in mapping was essentially topographically determined.

3) Eucalyptus marginata (Jarrah) Forest (Type 2)

Site Nos: U8, U51, U53, U100, U120, U126, U127, U146, Y5, Y10.

Diagnosis: Forest over Low Scrub A over Low Heath D

Code: e_3Mc. bo_1,1SAi. xSDc

Description: (This vegetation unit can be considered as a transition between Unit 2 and Unit 9. Typification of this unit is unclear but general absence of some species more typical of Unit 2 e.g. Hakea lissocarpha and Bossiaea ornata and Unit 9 Agonis parviceps, Dasypogon bromeliifolius and Melaleuca thymoides).

Stratum 1. As with Unit 2, Jarrah occurs as a Forest with a few Marri. In places there is much regrowth.

Stratum 2. Bossiaea linophylla and Leucopogon capitellatus forms a Low Scrub A which at times is more dense (Heath A). (This is very similar to the sandier areas of Unit 2). There appears to be more Banksia grandis than in Unit 2. Other tall species continue to be Acacia extensa, Macrozamia reidlei, Persoonia longifolia and Xanthorrhoea ? preissii.

Stratum 3. Bossiaea eriocephala, Hibbertia racemosa, Hypocalymma angustifolia and Melaleuca thymoides are amongst the most common species which make up a Low Heath D. These are species more typical of sandy dry sites than those in Unit 2. There is usually more sedges in this unit (e.g. Lepidosperma angustifolia) than is Unit 2.

Soil: This area is typically grey surface sand, but it is expected that it would be yellow in lower parts of its probable depth up to 1m.

4) Eucalyptus marginata (Jarrah) - E. wandoo Forest

Site Nos: U74

Diagnosis: Forest over Dwarf Scrub D

Code: e_1e_5Mc. xSDi

Description:

Stratum 1. Jarrah and Wandoo Forest with some E. calophylla (Marri) have an open understorey.

Stratum 2. Jarrah and Marri regrowth and a few E. decipiens.

Stratum 3. The lower stratum is open and a mixture of shrubs and sedges. It has been defined here as a Dwarf Scrub. Important species include Hypocalymma angustifolia, Bossiaea eriocarpa, Phyllanthus calycinus, Acacia pulchella and Lomandra.

5. Eucalyptus wandoo Forest

Site Nos: U10, K44

Diagnosis: Forest over Low Heath D

Code: e_5Mc. h_1dSDc

Description:

Stratum 1. Wandoo Forest or Low Forest A occurs as small patches in Jarrah Forest.

Stratum 2. The Low Heath D (occasionally >0.5m) is mainly dominated by Hakea lissocarpha and Dryandra armata. Other important species include Xanthorrhoea ? preissii, Mesomelaena tetragona, Hypocalymma angustifolia, Dryandra nivea and Bossiaea eriocarpa.

Soil: Orange to brown loamy gravel. (Loamy or clayey soils in upland areas

often have E. wandoo Forest or Woodland).

6) Hakea prostrata Low Scrub A

Site Nos: U16, U50, U78, U93, U101, U101, U149, K2, K13, K17, K24, K45

Diagnosis: Open Low Scrub A over Low Heath D and Open Low Sedges

Code: h_2SAr. hySDc. meVLi

Description:

Stratum 1. Hakea prostrata, usually as a Low Open Scrub A but sometimes greater than 2m. Other important tall species are Acacia saligna, Hakea varia and Xanthorrhoea ? preissii. This unit is usually in narrow patches in Jarrah Forest.

Stratum 2. Hypocalymma angustifolia Low Heath D includes Pericalymma ellipticum, Dryandra nivea.

Stratum 3. Mesomelaena tetragona and M. stygia are usually present and usually the main sedge species.

Soil: Grey sand (?) over clay together with a few species typical of wet depressions (e.g. Melaleuca preissiana, Pericalymma ellipticum and Kunzea recurva) indicate that these areas are old drainage lines which have been left stranded in upland areas and dried out.

Comments: This and the following unit (No 7) Eucalyptus decipiens Open Low Woodland B are very similar and are probably variants of sandy drainage lines which have dried out.

7) Eucalyptus decipiens Open Low Woodland B (Type 1)

Site Nos: U3, U7, U92, U121, U148, K31, K33, K40, K47, K49, K54

Diagnosis: Open Low Woodland B over Open Low Scrub A over Low Heath C

Code: e_2LBr. h_2SAr. hySCc

Description:

Stratum 1. With the Eucalyptus decipiens there is often some Melaleuca preissiana to form an Open Low Woodland B. Jarrah and Marri are often present as occasional taller trees. Rarely present are E. rudis and E. uncinata.

Stratum 2. Hakea prostrata with Hakea trifurcata and Xanthorrhoea ? preissii form an Open Low Scrub A.

Stratum 3. Hypocalymma angustifolia is a consistantly important species in these areas and together with other low shrubs (e.g. Pericalymma ellipticum, Dryandra nivea, Baekea camphorosmae) forms a Low Heath C.

Stratum 4. In some areas there is a sedgy layer which includes ?Anarthria scabra and Loxocarya fasciculata.

Soil: Grey Loamy sand, sometimes gravelly. This vegetation unit is usually on terraces above drainage lines.

Comments: See comment for Unit 6.

8) Eucalyptus decipiens Open Low Woodland B (Type 2)

Site No: U102

Diagnosis: Open Low Woodland B over Heath B over Low Heath D

Code: e_2LBr. m_7SDc. hySDc

Description:

Stratum 1. Eucalyptus decipiens occurred as small trees (some Mallee trees) forming an Open Low Woodland B. There were a few Banksia ilicifolia and B. littoralis (on fringe).

Stratum 2. Taller shrubs (Heath B) were mainly Melaleuca thymoides with a few Kunzea recurva and Casuarina humilis.

Stratum 3. The lower shrubs which form Low Heath D combine with the taller shrubs to form quite a dense shrub layer. Important species in the lower stratum include Hypocalymma angustifolia, Pultenaea ochreata and Hibbertia stellaris. In this lower stratum, sedges are very important - Anarthria prolifera, Lepidosperma angustifolia and Lyginia barbata.

Soil: Grey sand ? deep, well drained. The area appears to be a dune blown up from the bed of Lakes (Tolkerup Swamp and Lake B).

Comments: This unit is intermediate between Unit 7 and Unit 9.

9) Agonis parviceps Thicket

Site Nos: U18, U19, U30, U32, U46, U55, U60, U63, U68, U81, U90, U98, U99, U109, U117, U129, U134, U147, K9, K29, K34, K55, Y1.

Diagnosis: Woodland over Thicket over Low Heath C

Code: e_3Mi. agSc. m_7SCc

Description:

Stratum 1. Jarrah Woodland (occasionally Open Woodland) rarely with some Marri. The Jarrah is often staggy.

Stratum 2. Banksia ilicifolia Open Low Woodland A is a stratum in some areas, particularly where the Jarrah is an Open Woodland. It is usually in broad sandy flats.

Stratum 3. Occasionally plants of Banksia grandis, Melaleuca preissiana, Persoonia longifolia and Nuytsia floribunda may be present.

Stratum 4. Agonis parviceps forms Thickets in the areas where Jarrah is more open. Quite often it is less than 2m tall, and particularly on some sandy terraces it become sparse (e.g. a Low Scrub)

Stratum 5. Melaleuca thymoides is the dominant lower shrub species and may form a Low Heath C (sometimes a Dense Low Heath C). The abundance of this species is inversely related to that of Agonis parviceps i.e. Melaleuca thymoides is typical of the "dry phase" of this unit but is present through out. Other important tall species in the wet phase includes Adenanthos obovata, Pultenaea ochreata and Daviesia incrassata.

Stratum 6. This lowest stratum includes a Dwarf Scrub D and Open Low Sedges. Important species in drier areas are Calytrix flavescens, Bossiaea eriocarpa and Dasypogon bromeliifolius. Other important small species (in both wet and dry areas) include Anarthria prolifera, Casuarina humilis, Lepidosperma angustifolia, and Hibbertia ? racemosa.

Soil: Grey sand, apparently moist but well drained. In places there may be considerable litter.

10) Melaleuca preissiana - Banksia littoralis Open Low Woodland A

Site Nos: U11, U13, U39, U40, U42, U44, U45, U47, U62, U66, U71, U82, U91, U94, U97, U110, U122, U125, U128, U132, U142, K3, K8, K11, K19, K23, K28, K32, K38, K41, K42, K46, K50, K51, K56, Y2, Y4, Y7, Y8

Diagnosis: Open Low Woodland A over Heath B

Code: $m_5$baLAr. pSBc

Description: (The above Diagnosis and Code represents what was considered to be the "typical" vegetation formula for this unit. There is considerable variation in this unit and the principal ones will be described at the end of the "typical" one.)

Stratum 1. Melaleuca preissiana and Banksia littoralis usually fringe wet depressions and often form areas of Open Low Woodland A. In some areas, Melaleuca raphiophylla, Eucalyptus rudis and E. decipiens, are also present.

Stratum 2. Pericalymma ellipticum is the major species of this vegetation unit. It usually forms a Heath B or Low Heath C. Mostly it has a few Melaleuca preissiana and Banksia littoralis but there but there are areas where there are no trees present. Other important tall species include Kunzea recurva and Melaleuca densa. Commonly present tall species include Hakea varia, Jacksonia furcellata and Viminaria juncea. Important species which are less than 1m tall include Astartea fascicularis, Hypocalymma angustifolia, Calothamnus lateralis, Hibbertia stellaris and Daviesia incrassata.

Stratum 3. There are usually some sedges like species present. These include Anarthria prolifera, A. scabra, Baumea juncea and Dasypogon bromeliifolius.

Other Units present:

Two tall units, often small or narrow have been included as variants.

a. Kunzea recurva may form an almost pure upper stratum (e.g. Heath B). This appears to be sandy areas or areas which have dried out for some reason (U39).

b. Melaleuca densa may form a Heath A usually as small fringes to some wet depressions (e.g. parts of Unicup Lake). It appears that this species may be indicative of some soil types. These appear to be clayey and maybe slightly saline.

c. Some areas with Melaleuca preissiana and Banksia littoralis have a sedgy understorey with only a few shrubs. Anarthria scabra and Baumea juncea are usually the important species here.

Soil: The soil in this vegetation type is undoubtedly complex. It appears to usually be a loamy grey sand, often moist. It is probable that these areas have an impeded drainage layer (probably ferricrete) close to the surface.

Comments: This unit often has small patches of Melaleuca viminea, M. lateritia and M. raphiophylla Thicket and Heath.

11) Eucalyptus rudis Woodland

Site No: U118

Diagnosis: Woodland over A Shrub over Low Heath D.

Code: e_4Mi. K_2Si. xSDc

Description:

Stratum 1. Eucalyptus rudis and E. calophylla Woodland occur in a limited area along some (perhaps inactive) drainage lines. The main area is between Unicup Lake and Little Unicup Lake but may be also along drainage line feeding into Unicup from the east.

Stratum 2. Kunzea vestita forms a Scrub and sometimes a thicket or dense thicket.

Stratum 3. The lowest stratum is generally sparse. Leucopogon capitellatus, Macrozamia riedlei, Bossiaea eriocarpa and Phyllanthus calycinus were commonest.

Soil: The soil seems to be a grey sand but is probably yellow at depth.

12) Melaleuca lateritia Dense Low Heath

Site Nos: U21A, U67, K5, K6, K18, K52

Diagnosis: Dense Low Heath C

Code: m_3SCd

Description:

Stratum 1. These Low Heath areas are usually dominated by Melaleuca lateritia. Other tall species present (usually as only a few individuals)

include M. viminea, M. raphiophylla, Astartea fascicularis, Hakea varia and Brachysema sericeum.

Stratum 2. Sedges are often important in this unit. These include Baumea ? laxum, B. juncea, and B. articulata.

Stratum 3. There are usually some small shrub perennial herb species e.g. Hibbertia stellaris and Stylidium repens.

Soil: The soil appears to be a grey loam, probably over a clay.

13) Melaleuca raphiophylla Dense Low Forest B

Site Nos: U43, U131, K4, K53, K58, Y6

Diagnosis: Dense Low Forest B

Code: m_6LBd

Description:

Stratum 1. Melaleuca raphiophylla often occurs as circular or ring shaped areas in the centre of some depressions. No other tree species was found with it when it formed a Low Forest. In other areas M. raphiophylla may occur as a Thicket or just singularly surrounding Baumea swamps.

Stratum 2. Where there was a Low Forest, few other species were present. Here, a few Baumea articulata are usually present. Where there was a Thicket of M. raphiophylla, there were usually many more shrub species e.g. Kunzea recurva, Melaleuca viminea, Pericalymma ellipticum, Pultenaea ochreata, Brachysema sericeum and Leucopogon australis.

Soil: The soil of these areas have a large amount of organic matter and clay. The areas of Thickets appear to be drier than the Forest.

14) Melaleuca cuticularis Dense Low Forest B

Site Nos: U113, U116

Diagnosis: Dense Low Forest B

Code: m_1LBd

Description:

Stratum 1. Some areas around Little Unicup Lake and Tolkerlup Swamp had substantial areas of M. cuticularis Dense Low Forest B. Often this species occurred as scattered trees (Unit 15).

Stratum 2. Usually there are no major species in the areas of Forest. Areas of Wilsonia Mat Plants occur between groves of M. cuticularis forest on the east side of Little Unicup Lake.

Soil: Friable grey loam, quite saline with some organic matter.

15) Melaleuca cuticularis Complex

Site Nos: U27, U28, U104, U105, U107, U111, U124

Diagnosis: a. Open Low Woodland B over Open Scrub over Dwarf Scrub C
b. Low Woodland B over Mid-Dense Hummock Grass
c. Low Forest B

Code: a. m_1LBr. h_3Sr. pSCi
b. m_1LBi. gHc
c. m_1LBc

Description: (The above Diagnoses and Cdes represent a gradient (a to c) which this complex includes.

Segment a.:

Stratum 1. A few Melaleuca cuticularis trees blend into the narrow Melaleuca preissiana - Banksia littoralis Open Low Woodland A (Unit 10) which usually surrounds these saline areas. Some M. raphiophylla and E. rudis may be present.

Stratum 2. Small areas of Hakea trifurcata Thicket which includes Melaleuca densa, Acacia saligna and Kunzea recurvea are the main shrub stratum. It usually occurs in small patches.

Stratum 3. Between the Thicket patches are areas of Pericalymma ellipticum Dwarf Scrub C. Also present are some Gahnia trifida, Brachysema sericeum and Hypocalymma angustifolia.

Segment b.:

Stratum 1. M. cuticularis forms a Low Woodland B in this Segment of this unit. The trees are generally smaller than the few in Segment a.

Stratum 2. Beneath the M. cuticularis is a Mid-Dense Hummock Grass area of Gahnia trifida. Few shrub species are present but the most common ones include Brachysema sericum, Hypocalymma angustifolia, Hakea trifurcata and Melaleuca densa. A herb layer is probably significant in the winter and spring.

Segment c.:

Stratum 1. M. cuticularis Low Forest B is often present only as a narrow band of trees but usually with only a few Gahnia trifida and herbs and mat plants. At its densest it can form a Dense Low Forest B (Unit 14). Usually there are many smaller plants on the lake-side forming a Thicket or Scrub.

Soil: The soil in this complex varies from a sandy loam to a friable alkaline loam.

16) Gahnia trifida Hummock Grass

Site Nos: U114, U115

Diagnosis: Mid-Dense Hummock Grass

Code: gHc

Description: (This unit is really segment b of Unit 15 where it is not mappable as a separate unit).

Stratum 1. Occasional M. cuticularis occurring as an Open Low Woodland A.

Stratum 2. Gahnia trifida Mid-Dense Hummock Grass unit.

17) Halosarcia - Wilsonia Mat Plants

Site No: 26

Diagnosis: Mat Plants

Code: ha,wPc

Description:

Stratum 1. Occasional low M. cuticularis trees and shrubs are present at the edge of lakes.

Stratum 2. Halosarcia indica, Wilsonia humilis and W. backhousei form broad areas of Mat Plants sometimes Dense Mat Plants. Usually these species occur in essentially monospecific swards.

18. Saline Lake bed

This map unit shows evidence of some aquatic plants but none were identifiable.

19) Baumea Sedges

Site Nos: U6, U12, U13, U58, U106, U112, K27, K39.

Diagnosis: (variable from Dense Tall Sedges to Open Low Sedges)

Code: b_1VTd to b_2VLi

Description:

Stratum 1. Generally there is a single stratum of Sedges with some herbs between in drier sites. In the wettest sites Baumea articulata forms Dense Tall Sedge community. Usually there are no other sedge or shrub in the densest areas. In apparently fresh swamps, B. articulata is surrounded by Melaleuca lateritia (Unit 12) or M.

raphiophylla (Unit 13). In areas apparently slightly saline B. juncea forms a Dense Low Sedge opening out to Open Low Sedges as one moves from the centre outwards. Leptocarpus ? aristatus becomes important towards the dry edge. A few shrubs e.g. M. cuticularis, M. densa, Viminaria juncea and Brachysema sericeum may be present in this outer zone.

Soil: Dark humic clay.

20) Open Water

There are several lakes with open water but they are not equivalent. Kulunilup Lake and Yarnup Swamp have fresh water with abundant aquatic plants (not identified). Unicup Lake has slightly saline but shallow water also with some aquatics. Lake A (south of Pindecup Rd) has deeper slightly saline water with few aquatic plants obvious from the shore.

21) Melaleuca densa - M. viminea Thicket

Site No: U143

Diagnosis: Thicket

Code: m_2m_8Sc

Description:

Stratum 1. In one small area in the Unicup reserve M. densa and M. viminea formed a Thicket (in parts a Dense Thicket). A few M. preissiana and Banksia littoralis emerged from this area. Other shrub species included M. raphiophylla, Hakea varia and Brachysema sericeum.

Stratum 2. Low Sedges of Baumea ? laxum and B. juncea.

Soil: Red/brown sandy loam ? over clay.

Comments: This area is surrounded by M. preissiana and B. littoralis Open Low Woodland (Unit 10).

22) Melaleuca viminea Heath

Site Nos: K57

Diagnosis: Heath A

Code: m_7SAc

Description:

Stratum 1. Melaleuca viminea forms a unit which is structurally variable (Thicket to Low Scrub B). There are usually no ther shrub species but in some areas there is M. raphiophylla.

Stratum 2. Leptocarpus aristatus and Baumea ? laxum Open Low Sedges is a veriable understorey to the M. viminea.

Soil: Grey clayey soil.

23) Melaleuca spathulata Complex

Site No: K15

Diagnosis: a. Low Heath C
b. Dense Low Heath C

c. Heath A

Code: a. xSCc
b. m_3SCd
c. m_8SAc

Description: (This complex appears to have two distinct zones and 3 or 4 vegetation units.) Segment c. is generally in the centre of this drainage flat, surrounded by Segment a. In some areas between the two is Segment b.)

Segment a.

Stratum 1. Occasional Melaleuca cuticularis and Eucalyptus occidentalis trees emerge from the Low Heath C.

Stratum 2. This Low Heath C has many species in common with the shrub component of Unit 10. There is less Pericalymma ellipticum and Kunzea recurva. In places there are skeletons of Eucalyptus rudis, Banksia littoralis and Melaleuca preissiana. The important shrub species here are Astartea fascicularis, Calothamnus lateralis, Melaleuca densa and M. leptoclada.

Segment b. This vegetation unit is essentially Melaleuca lateritia Dense Low Heath C (Unit 12).

Segment c.

Stratum 1. Melaleuca spathulata forms a dense Heath of variable height (Dense Heath A to Low Heath C). Few other species are present and the most important are Melaleuca viminea and M. cuticularis.

Soil: The area appears to be a sandy clay flat with a ferricrete hard pan close to the surface. The centre of the area with Segment c. has a dark red/brown clay loam. Away from this the soil becomes lighter and sandier.

24) Leptocarpus Sedges

Site No: K22

Diagnosis: Low Sedges

Code: leVLc

Description:

Stratum 1. In some areas there are a few Melaleuca viminea which form an Open Low Scrub A or B.

Stratum 2. Leptocarpus aristatus is the main species here and forms Sedge communities with a wide cover range (Dense Low Sedges to Open Low Sedges). In some areas there is Baumea preissii.

Stratum 3. There are usually a few herbs.

Soil: These areas have a grey clay covered by a thin layer of fine sand or loam.

Comments: This unit occupies the centre of some drainage lines. It may be surrounded by Units 10 or 22.

SPECIES KEY TO FLORISTIC COMPONENT OF CODE

a	Acacia saligna
ag	Agonis parviceps
as	Astartea fascicularis
ba	Banksia littoralis
b_1	Baumea articulata
b_2	Baumea juncea
bo_1	Bossiaea linophylla
bo_2	Bossiaea ornata
c	Calytrix flavescens
d	Dryandra armata
e_1	Eucalyptus calophylla
e_2	Eucalyptus decipiens
e_3	Eucalyptus marginata
e_4	Eucalyptus rudis
e_5	Eucalyptus wandoo
g	Gahnia trifida
ha	Halosarcia indica
h_1	Hakea lissocarpha
h_2	Hakea prostrata
h_3	Hakea trifurcata
h_4	Hakea undulata
h_5	Hakea varia
hy	Hypocalymma angustifolia
j	Jacksonia furcellata
k_1	Kunzea recurva
k_2	Kunzea vestita
le	Leptocarpus scariosus
l	Leucopogon capitellatus
m_1	Melaleuca cuticularis
m_2	Melaleuca densa
m_3	Melaleuca laterita

m_4 Melaleuca leptoclada
m_5 Melaleuca preissiana
m_6 Melaleuca raphiophylla
m_7 Melaleuca thymoides
m_8 Melaleuca viminea
me Mesomelaena tetragona
p Pericalymma ellipticum
w Wilsonia
x No Dominant Species

TABLE 6

VEGETATION CLASSIFICATION USED IN SURVEY
(From Muir 1977, page 11)

TABLE 1: VEGETATION CLASSIFICATION TO BE USED IN WHEATBELT SURVEY

FE	FORM/HEIGHT CLASS	CANOPY COVER			
		DENSE 70-100% d	MID-DENSE 30-70% c	SPARSE 10-30% i	VERY SPARSE 2-10% r
T	Trees >30m	Dense Tall Forest	Tall Forest	Tall Woodland	Open Tall Woodland
M	Trees 15-30m	Dense Forest	Forest	Woodland	Open Woodland
LA	Trees 5-15m	Dense Low Forest A	Low Forest A	Low Woodland A	Open Low Woodland A
LB	Trees <5m	Dense Low Forest B	Low Forest B	Low Woodland B	Open Low Woodland B
KT	Mallee tree form	Dense Tree Mallee	Tree Mallee	Open Tree Mallee	Very Open Tree Mallee
KS	Mallee shrub form	Dense Shrub Mallee	Shrub Mallee	Open Shrub Mallee	Very Open Shrub Mallee
S	Shrubs >2m	Dense Thicket	Thicket	Scrub	Open Scrub
SA	Shrubs 1.5-2.0m	Dense Heath A	Heath A	Low Scrub A	Open Low Scrub A
SB	Shrubs 1.0-1.5m	Dense Heath B	Heath B	Low Scrub B	Open Low Scrub B
SC	Shrubs 0.5-1.0m	Dense Low Heath C	Low Heath C	Dwarf Scrub C	Open Dwarf Scrub C
SD	Shrubs 0.0-0.5m	Dense Low Heath D	Low Heath D	Dwarf Scrub D	Open Dwarf Scrub D
P	Mat plants	Dense Mat Plants	Mat Plants	Open Mat Plants	Very Open Mat Plants
H	Hummock Grass	Dense Hummock Grass	Mid-Dense Hummock Grass	Hummock Grass	Open Hummock Grass
GT	Bunch grass >0.5m	Dense Tall Grass	Tall Grass	Open Tall Grass	Very Open Tall Grass
GL	Bunch grass <0.5m	Dense Low Grass	Low Grass	Open Low Grass	Very Open Low Grass
J	Herbaceous spp.	Dense Herbs	Herbs	Open Herbs	Very Open Herbs
VT	Sedges >0.5m	Dense Tall Sedges	Tall Sedges	Open Tall Sedges	Very Open Tall Sedges
VL	Sedges <0.5m	Dense Low Sedges	Low Sedges	Open Low Sedges	Very Open Low Sedges
X	Ferns	Dense Ferns	Ferns	Open Ferns	Very Open Ferns
	Mosses, liverwort	Dense Mosses	Mosses	Open Mosses	Very Open Mosses

APPENDIX 4 Combined species list for Unicup, Kulunilup and Yarnup Reserves.

(Species listed in alphabetical order. Some specimens were unidentifiable to species level because the time of year in which the survey had to be conducted meant that adequate material was collected in some cases. Most species are represented by specimens provided to Katanning Reserve Management Officer)

* in front of name signifies introduced species.

Acacia biflora R.Br.
Acacia cyclops A.Cunn.ex.G.Don
Acacia extensa Lindl.
Acacia laricina Meisn.
Acacia latipes Benth.
Acacia nervosa DC.
Acacia pulchella R.Br. var bracteolata
Acacia pulchella R.Br. var pulchella
Acacia rostellifera Benth.
Acacia saligna (Labill.) H. Wendl.
Acacia stenoptera Benth.
Acacia tetragonocarpa Meisn.
Acacia varia Maslin var varia
Actinodium sp. (EAG 3684)
Actinostrobus pyramidalis Miq.
Adenanthos obovatus Labill.
Agonis parviceps Schauer
Agrostocrinum ? scabrum (R.Br.) Baill.
* Aira caryophyllea L.
Amphipogon strictus R.Br.
Anarthria ? gracilis R.Br.
Anarthria prolifera R.Br.
Anarthria scabra R.Br.
Andersonia ? caerulea R.Br.
?Angianthus
Angiozanthos ? humilis Lindl.
Asplenium flabellifolium Cav.
Astartea fascicularis (Lindl.) DC.
Asterixia pulverulenta Lindl.
Astroloma ciliatum Lindl.
Astroloma pallidum R.Br.
Astroloma ? prostratum R.Br.
Baeckea camphorosmae Endl.
Banksia grandis Willd.
Banksia ilicifolia R.Br.
Banksia littoralis R.Br.
Banksia meisneri Lehm. var meisneri
Baumea articulata (R.Br.) S.T.Blake
Baumea juncea (R.Br.) Palla
Baumea preissii Nees

Baumea rubiginosa (Sprengel) Boeck.
Baumea aff laxa (Nees) Boeck. (EAG 3620)
Billardiera drummondiana (Putterl.) E.M.Bennett var drummondiana
Billardiera parviflora DC. var parviflora
Boronia megastigma Nees
Boronia ramosa (Lindl.) Benth.
Boronia spathulata Lindl.
Boronia crenulata Smith
Borya nutida Labill.
Bossiaea eriocarpa Benth.
Bossiaea linophylla R.Br.
Bossiaea ornata (Lindl.) Benth.
Bossiaea rufa R.Br.
Brachysema praemorsum Meisn.
Brachysema sericeum (Sm.) Domin
Burchardia umbellata R.Br.
Burtonia conferta DC.
Caladenia aphylla Benth.
Calothamnus lateralis Lindl.
Calothamnus lehmannii Schauer
Calothamnus ? preissii Schauer
Calytrix flavescens A.Cunn.
Calytrix ? tenuiramea (Turcz.) Benth.
Calytrix ? leschenaultii (Schauer) Benth.
* Carpobrotus sp. indet
Cassytha glabella R.Br.
Cassytha racemosa Nees
Casuarina humilis Otto & Dietr.
Casuarina microstachya Miq.
Casuarina thuyoides Miq.
Caustis sp.
Centrolepis aristata (R.Br.) Roemer & Schultes
Centrolepis drummondii
Chamaexeros serra (Endl.) Benth.
Chorizandra enodis Nees
Chorizema ilicifolium Labill.
Clematis ? pubescens Huegel ex. Endl.
Comesperma ? calymega Labill.
Comesperma ? drummondii Steetz
Comesperma flavum DC.
Comesperma ? volubile Labill.
Conospermum flexuosum R.Br.
Conostylis aculeata R.Br. ssp. aculeata
Conostylis setigera R.Br.
Cryptandra sp. indet. (EAG 3766)
Cyperaceae indet (EAG 3736)
Dampiera ? alata Lindl.
Dampiera linearis R.Br.
Darwinia sp. aff. vestita (Endl.) Benth. (EAG 3777)
Dasypogon bromeliifolius R.Br.
Daucus glochidiatus (Labill.) Fisch. C.Meyer & Ave-Lall.

Daviesia cordata Sm.
Daviesia ? incrassata Sm.
Daviesia ? preissii Meisn
Dianella revoluta R.Br.
Drosera gigantea Lindl.
Drosera ? macrantha Endl.
Drosera paleacea DC.
Dryandra armata R.Br.
Dryandra bipinnatifida R.Br.
Dryandra nivea (Labill.) R.Br.
Eremaea pauciflora (Endl.) Druce
Eucalyptus calophylla Lindl.
Eucalyptus cornuta Labill.
Eucalyptus decipiens Endl.
Eucalyptus marginata Donn ex Sm.
Eucalyptus occidentalis Endl.
Eucalyptus rudis Endl.
Eucalyptus uncinata Turcz.
Eucalyptus wandoo Blakely
? Exocarpus aphyllus R.Br.
Franklandia fucifolia R.Br.
Gahnia trifida Labill.
Glischrocaryon sp. indet.
Gompholobium aristatum Benth.
Gompholobium burtonioides Meisn.
Gompholobium capitatum A.Cunn.
Gompholobium Knightianum Lindl.
Gompholobium ? preissii Meisn.
Goodenia filiformis R.Br.
Grammatotheca bergiana (Cham.) C.Presl.
Gratiola peruviana L.
Grevillea brownii Meisn.
Grevillea ? pilulifera (Lindl.) Druce
Grevillea pulchella (R.Br.) Meisn.
Haemodorum ? spicatum R.Br.
Haemodorum simplex Lindl.
Hakea ceratophylla (Sm.) R.Br.
Hakea corymbosa R.Br.
Hakea gilbertii Kipp.ex.Meisn.
Hakea lissocarpha R.Br.
Hakea prostrata R.Br.
Hakea ruscifolia Labill.
Hakea trifurcata (Sm.) R.Br.
Hakea undulata R.Br.
Hakea varia R.Br.
Halosarcia indica (Willd.) P.G.Wilson
Hemiandra pungens R.Br.
Hibbertia ? acerosa (R.Br. ex DC.) Benth.
Hibbertia cunninghamii W.T.Aiton
Hibbertia ? polystachya Benth.
Hibbertia racemosa (Endl.)Gilg

Hibbertia silvertris Diels
Hibbertia stellaris Endl.
Hibbertia subvaginata (Steud.)F.Muell.
Hovea trisperma Benth.
Hypocalymma angustifolia Endl.
Hypocalymma strictum Schauer
? Hypocalymma sp. indet (EAG 3742)
* Hypochoeris glabra L.
Isopogon ? attenuatus R.Br.
Isopogon teretifolius R.Br.
Jacksonia furcellata (Bonpl.) DC.
Johnsonia lupulina R.Br.
Juncus bufonis L.
Juncus pallidus R.Br.
Juncus sp. indet (EAG 357a)
Kennedia ? prostrata R.Br.
Kunzea recurva Schauer
Kunzea vestita Schauer
Laxmannia sp. indet
Lepidosperma angustatum R.Br.
Lepidosperma ? leptophyllum Benth.
Lepidosperma ? tenue Benth.
Leptocarpus aristatus R.Br.
Leptocarpus coangustatus Nees
Leptocarpus scariosus R.Br.
Leptocarpus ? tenellus (Nees) F.Muell.
Leptomeria cunninghamii Miq.
Leptospermum ? erubescens Schauer
Leucopogon australis R.Br.
Leucopogon capitellatus DC.
Leucopogon ? conostephioides DC.
Leucopogon ? elatior Sonder
Leucopogon gibbosus Stschegl
Leucopogon pendulus R.Br.
Leucopogon propinquus R.Br.
Leucopogon verticellatus R.Br.
Leucopogon sp. 1 indet (EAG 3677)
Leucopogon sp. 2 indet (EAG 3698)
Leucopogon sp. 3 indet
Levenhokia sp. indet
Lobelia ? heterophylla Labill.
Logania serpyllifolia R.Br.
Lomandra collina
Lomandra hermaphrodita (C.Andrews) C.A.Gardner
Lomandra micrantha (Endl.) Ewart.
Lomandra sericea (Endl.) Ewart
Loxocarya fasciculata (R.Br.) Benth.
Loxocarya flexuosa (R.Br.) Benth.
Lyginia barbata R.Br.
Lysinema ciliatum R.Br.
Macrozamia riedlei (Fisch. ex Gand.) C.A.Gardner

Melaleuca cuticularis Labill.
Melaleuca densa R.Br.
Melaleuca lateritia A.Dietr.
Melaleuca leptoclada Benth.
Melaleuca preissiana Schauer
Melaleuca raphiophylla Schauer
Melaleuca spathulata Schauer
Melaleuca thymoides Labill.
Melaleuca viminea Lindl.
Melaleuca sp. indet. (EAG 3753)
Mesomelaena stygia (R.Br.) Nees
Mesomelaena tetragona (R.Br.) Benth.
Neurachne alopecuroidea R.Br.
Nuytsia floribunda (Labill.) R.Br.
Olax phyllanthi (Labill.) R.Br.
Olearia paucidentata (Steetz) F.Muell.
Opercularia ? rubioides Juss.
Oxylobium linearifolium (G. Don) Domin
Patersonia juncea Lindl.
Patersonia ? occidentalis R.Br.
Pericalymma ellipticum (Endl.) Schauer
Persoonia longifolia R.Br.
Petrophile brevifolia Lindl.
Petrophile ? divaricata R.Br.
Petrophile longifolia R.Br.
Petrophile ? media R.Br.
Petrophile serruriae R.Br.
Petrophile squamata R.Br.
Petrophile ? rigida R.Br.
Petrophile sp. indet (EAG 3671)
Phyllanthus calycinus (DC. ex Ging.) F.Muell.
Pimelea ? lehmanniana Meisn.
Pimelea suaveolens (Endl.) Meisn.
Pimelea sp.
Pithocarpa ? pulchella Lindley
Platysace ? juncea (Bunge) Norman
Podotheca angustifolia Less.
Podolepis gracilis (Lehm.) R.A. Graham
Pseudanthus virgatus (Klotzsch) Muell. Arg.
Pterostylis sp. indet
Ptilotus ? manglesii (Lindl.) F.Muell.
Pultenaea ericifolia Benth.
Pultenaea ochreata Meisn.
Pultenaea ? reticulata (Smith) Benth.
Restio tremulus R.Br.
Restio sp. 1 indet. (EAG 3609)
Restio sp. 2 indet. (EAG 3681)
Schoenolaena tenuior Bunge
Schoenus curvifolius (R.Br.) Benth.
Schoenus grandiflorus (Nees) Benth.
Schoenus subflavus Kuekenthal

Schoenus sp. indet (EAG 3701)
Sollya heterophylla Lindl.
Stackhousia brunonis Benth.
Stirlingia simplex Lindl.
Styphellia tenuiflora Lindl.
Stylidium brunonianum Benth.
Stylidium junceum R.Br.
Stylidium repens R.Br.
Stylidium scandans R.Br.
Stylidium spathulatum R.Br.
Stylidium ? squamellosum DC.
Synaphea ? petiolaris R.Br.
Synaphea reticulata (Sm.) C.A. Gardner
Tetraria octandra (Nees) Kuekenthal
Tetratheca virgata Steetz
Thomasia ? grandiflora Lindl.
Thomasia sp. indet (EAG 3751)
Tricoryne elatior R.Br.
Tricostularia neesii Lehm.
Triglochia muricata
Trymalium ? ledifolium Fenzl
Verticordia densiflora Lindl.
Verticordia sp. indet (EAG 3699)
Villarsia parnassifolia (Labill.) R.Br.
Viminaria juncea (Schrad. & Wendl.) Hoffmanns.
Waitzia paniculata F.Muell. ex Benth.
Wilsonia backhousei J.D. Hooker
Wilsonia humilis R.Br.
Xanthorrhoea gracilis Endl.
Xanthorrhoea ? preissii Endl.
Xanthosia huegelii (Benth.) Steud.

APPENDIX 5 Phytosociological Table for Major Vegetation Units in Unicup Reserve Using 72 key species.

NO. VEGETATION UNITS

1. Dryandra armata - Hakea undulata Heath

6. Hakea prostrata Low Scrub A

7. Eucalyptus decipiens Open Low Woodland B

2. Jarrah Forest (Type 1) (upland)

3. Jarrah Forest (Type 2) (slope)

9. Agonis parviceps Thicket

10. Melaleuca preissiana - Banksia littoralis Open Low Woodland B

19. Baumea articulata Tall Sedges

15. Melaleuca cuticularis - Gahnia trifida complex

Species Abundance Codes

- not found in unit
1 rarely present
2 often present
3 usually present
4 usually abundant

	Vegetation Unit Numbers								
	1	6	7	2	3	9	10	19	15
Dryandra armata	4	-	-	1	-	-	-	-	-
Hakea undulata	4	1	1	1	-	-	-	-	-
Bossiaea ornata	3	-	-	2	1	1	-	-	-
Daviesia ? incrassata	3	1	2	-	-	1	1	-	-
Mesomelaena stygia	3	1	2	1	-	-	-	-	-
Petrophile serruriae	3	1	2	1	2	1	-	-	-
Leucopogon	3	1	2	-	2	2	-	-	-
Baeckea comphorosmae	3	1	3	1	-	1	-	-	-
Hakea trifurcata	3	-	3	-	-	-	-	-	1
Casuarina humilis	1	2	-	-	-	1	-	-	-
Acacia saligna	-	3	1	-	1	-	-	-	-
Mesomelaena tetragona	1	3	-	2	1	-	-	-	-
Synaphea ? petiolaris	2	2	2	1	1	-	-	1	-
Hypocalymma angustifolia	2	4	3	3	3	2	3	-	2
Dryandra nivea	1	3	3	2	2	-	-	-	-
Hakea prostrata	1	4	3	1	1	-	1	-	1
Eucalyptus decipiens	3	3	4	1	-	2	1	-	1
Acacia pulchella	1	-	2	1	-	-	1	-	-
Loxocarya fasciculata	3	3	3	3	2	1	1	-	-
Xanthorrhoea ? preissii	4	3	4	4	4	2	1	-	-

	Vegetation Unit Numbers								
	1	6	7	2	3	9	10	19	15
Hakea lissocarpha	3	-	2	4	1	-	-	-	-
Leucopogon verticellatus	1	-	-	3	-	-	-	-	-
Astroloma ciliatum	1	1	1	3	-	-	-	-	-
Trymalium ledifolium	1	1	1	3	-	-	1	-	-
Astroloma pallidum	2	1	2	3	1	1	-	-	-
Hibbertia cunninghamii	1	2	1	3	1	1	1	-	-
Eucalyptus calophylla	3	3	2	3	3	2	-	-	-
Leucopogon capitellatus	1	-	-	3	2	1	-	-	-
Leucopogon propinquus	-	1	-	3	2	1	1	-	-
Phyllanthus calycinus	1	-	-	1	2	-	-	-	-
Macrozamia riedlii	1	2	1	4	3	2	-	1	-
Bossiaea linophylla	-	-	2	4	3	1	1	-	-
Hibbertia ? racemosa	-	2	1	3	3	3	-	-	-
Acacia extensa	1	1	1	3	3	3	1	-	-
Acacia biflora	-	-	-	1	1	1	-	-	-
Hakea ruscifolia	-	-	-	1	2	1	-	-	-
Lepidosperma angustatum	-	-	1	2	3	2	1	-	-
Eucalyptus marginata	1	2	3	4	4	3	1	-	-
Conostylis aculeata	-	1	2	2	4	2	1	1	-
Persoonia longifolia	-	-	1	3	3	3	2	-	-
Bossiaea eriocarpa	-	3	1	2	3	3	1	-	-
Banksia grandis	-	-	1	1	2	3	1	-	1
Calytrix flavescens	-	2	1	-	1	3	-	-	-
Melaleuca thymoides	-	-	-	-	3	4	1	-	-
Agonis parviceps	-	-	-	1	1	4	1	-	-
Anarthria prolifera	-	-	-	-	1	3	2	-	-
Adenanthos obovatus	-	-	-	-	-	3	3	-	-
Lyginia barbata	-	1	1	-	-	2	2	-	-
Jacksonia furcellata	-	2	1	-	2	2	3	-	-
Hibbertia stellaris	-	1	-	-	1	1	3	-	-
Pultenaea ochreata	-	-	-	-	-	2	3	-	-
Kunzea recurva	2	3	1	1	1	1	3	1	3
Pericalymma ellipticum	-	2	3	1	1	1	4	1	1
Dasypogon bromeliifolius	-	-	-	-	1	2	3	2	-
Hakea varia	-	3	1	-	-	-	2	-	2
Eucalyptus rudis	-	1	1	-	-	-	1	-	-
Anarthria scabra	-	1	-	-	-	-	2	-	-
Melaleuca raphiophylla	-	-	-	-	-	-	2	-	-
Astartea fascicularis	-	-	-	-	-	-	3	-	-
Melaleuca viminea	-	-	-	-	-	-	1	-	-
Melaleuca lateritia	-	-	-	-	-	-	1	-	-
Calothamnus lateralis	-	-	-	-	-	-	1	-	-
Banksia littoralis	-	-	-	-	-	1	3	1	1
Melaleuca preissiana	-	1	3	-	-	-	3	3	-
Leptocarpus scariosus	-	-	-	-	-	1	1	2	-
Melaleuca densa	-	1	1	-	-	-	1	1	1
Melaleuca leptoclada	-	1	-	-	-	-	1	-	1
Baumea juncea	-	-	1	-	-	-	3	4	2
Baumea articulata	-	-	-	-	-	-	1	4	2
Brachysema sericeum	-	-	-	-	-	-	1	1	2

Melaleuca cuticularis	-	-	-	-	-	-	1	2	4
Gahnia trifida	-	-	2	-	-	-	-	-	4