VEGETATION SURVEY OF SMITHS BROOK NATURE RESERVE

(Shire of Manjimup)

Prepared for
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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

SUMMARY

The vegetation of Smiths Brook Nature Reserve is described. Five vegetation units are defined and mapped although one of these may be artificially created by disturbance. This reserve is dominated by Karri forest which has subordinate trees and understorey species which are well related to landscape and soil types. The area was found to be relatively undisturbed by European man despite the number of tracks and alien species present. It is considered that this small reserve provides both a good example of Karri near the limit of its northeast distribution and an area which is relatively long unburnt. Recommendations are made to maintain the long unburnt nature of the majority of the reserve.

INTRODUCTION

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

DESCRIPTION OF PROJECT

To ensure that nature reserves are effectively managed it is essential that comprehensive biological information is collected on all reserves. Vegetation surveys form an important component of this data base which is utilised in both operational work - for example firebreak construction - and species management.

One nature reserves for which vegetation surveys are urgently required is Smiths Brook (Reserve No "A" 14063) (Figure 1).

Smiths Brook Nature Reserve (Shire of Manjimup): although small, this nature reserve is the site of important, long-term, bird studies. To complement these studies and to assess the present burning programme for the reserve a vegetation survey is required.

PROJECT REQUIREMENTS

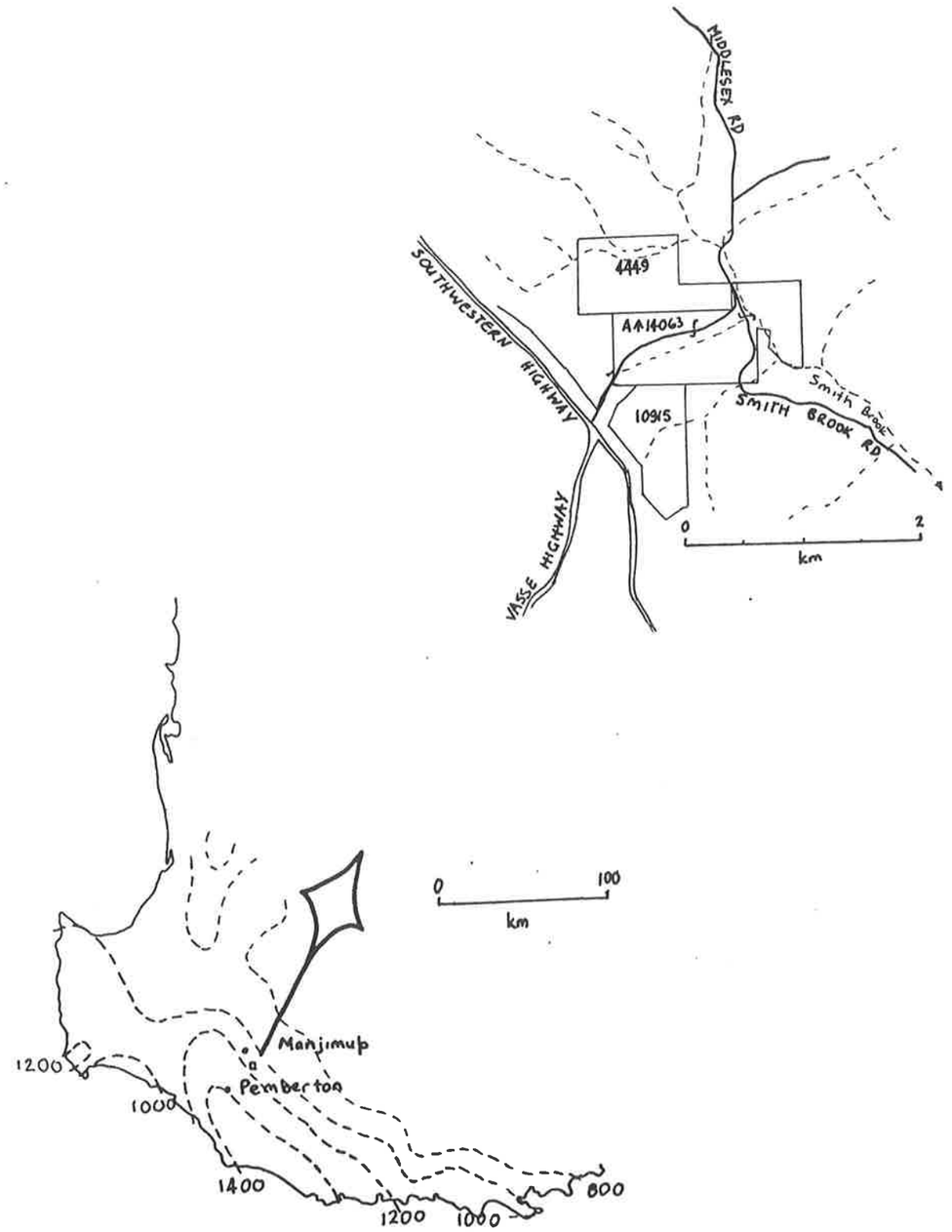
The consultant will survey the reserve described above, and

1. Produce a vegetation map for the reserve 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 described 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.

FIGURE 1 Location Map Smiths Brook



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4. Collect and identify a representative sample of the flora of the reserves and lodge specimens with the field herbarium at the Department's Katanning Office. Samples of less common, flowering specimens should also be lodged with the Western Australian Herbarium.

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

STUDY AREA AND LANDUSE HISTORY

Smiths Brook Nature Reserve was set aside on 12.4.1912 for the purpose of Parkland. This was part of the original suddivision of the area. The earliest adjacent location 4449 was taken up in 1909, while 10915 was taken up in 1928/1929 in a soldier settlement scheme. The change in purposes to the Conservation of Flora and Fauna and vesting to the W.A. Wildlife Authority appeared in the Government Gazette of 2.7.1982. The change in purpose was because of the regionally significant Karri on the reserve and because it is an important site for bird studies (Wallace 1984). The area appears to have remained approximately unchanged at 95.8 ha except for the road reserves which pass through it.

It is not clear whether the reserve was used in anyway but there has been minor sand extraction on the northern boundary near Smiths Brook. The area was managed for fire protection purposes until recently by the Forests Department.

GEOLOGY

Smiths Brook is in a region of Archaean rocks on the Yilgarn Block just north of its boundary with the Albany Fraser Province. There are no surface expressions in Smiths Brook of the mainly "Ang" unit ("Granitic gneiss, coarse-grained orthogneiss, commonly braided with biotite foliation, includes local augen gneiss and migmatite") mapped by Wilde and Walker (1984). In the vicinity of Smiths Brook there is mapped a band of "Aqd" ("Quartzite - deformed metamorphosed orthoquartzite, with Kyanite, sillimanite and muscovite. Flaser to mylonitic texture"). Within the reserve, the valleys are mapped as "Qrc" ("Colluvium, including valley-fill deposits, variably lateritized and podsolized"). There are two upland units "Cs" ("Ferruginous soil with pisolites and local areas of massive laterite (includes 'Karri loam') may contain small outcrops of rock") and "Czl" ("Laterite - chiefly massive, but includes overlying pisolitic gravel and minor lateritized sand"). However, there did not seem to be very much difference in the areas mapped as these units. No geological map of the area is reproduced in this report.

SOIL

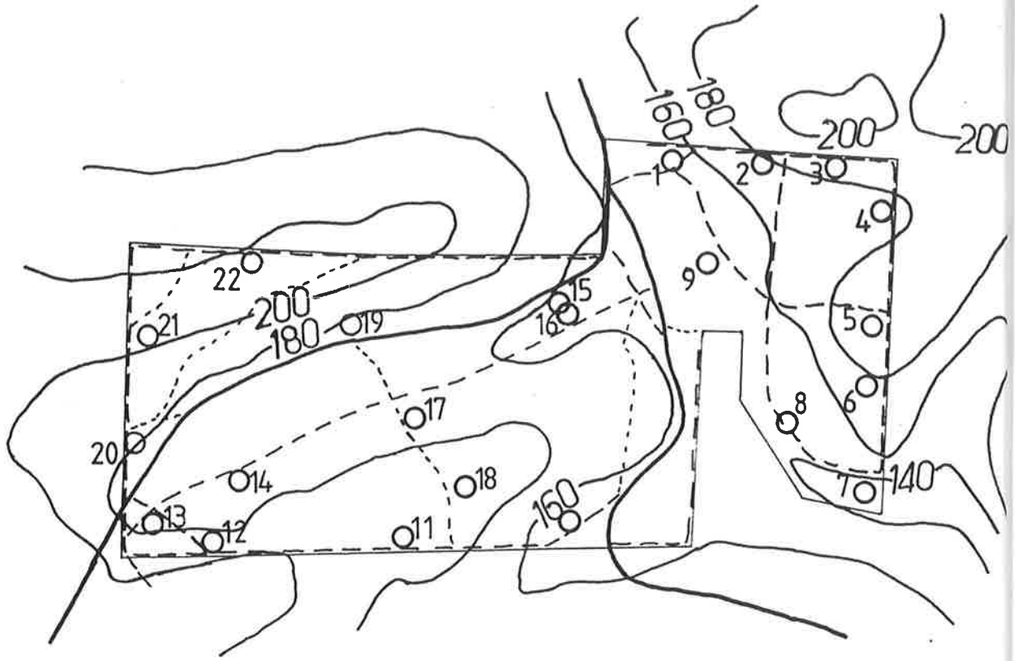
The soils of the Pemberton area have been mapped at an "association" level by McArthur and Clifton (1975). Smiths Brook is mapped as mainly "Pemberton" (Dissected lateritic country with steep slopes; podzolic soils (Dy 3.6) on upper slopes and red earths (Gn 2.15) below. Associated soils are sandy colluvium in gullies and alluvium along major streams"). A small area of "Balbarrup" is mapped at the western end of the reserve ("Block laterite on tops of rises, colluvial pisolitic grav.." (KS-Uc 4.2) on slopes merging with brown sands (Uc 5.2). Associated soils are the swampy heads of drainage lines (Dy 3.4, Dy 3.8) and sometimes minor areas of grey sands of the Quaggering Association"). Near the north boundary of the eastern portion of the reserve there is some "Quaggering" mapped ("Gently undulating drainage divides developed on quartzite; soils are podzolitic (Dy 5.81) and podzols (Uc 2.3) often associated with deep deposits of water-worn quartz sand and grit. Laterites (KS.Uc 4.2) are sometimes associated"). This units seems associated with the geological unit "Aqd").

In synthesis, the reserve is mainly a deeply dissected lateritic upland (see Contour Map Figure 2). The major areas of lateritic soils are on the west and eastern boundaries on the highest points. The upland spurs are mainly a loamy gravel. There are several short V-shaped gullies with very little alluvium deposited. Smiths Brook itself is a narrow belt of alluvium.

VEGETATION AND FLORA

Smith (1972) in his 1:250,000 maps showed the entire area of the Smiths Brook Reserves as Karri High Open Forest. This is close to the north-eastern limit of Karri. McArthur and Clifton (1974) give a more useful description of the vegetation in relation to the soil types. The "Balbarrup" uplands have mainly jarrah forest and in this lower rainfall zone the undergrowth is relatively xeromorphic. The "Pemberton" association is dominated by Karri with a definite correspondence between soil and understorey. The hills are dominated by Jarrah which changes to Karri-Marri and Marri on the middle and upper slopes. While the lower soils have pure Karri. The Smiths Brook has little of the flood plain type which in other areas is dominated by Agonis juniperina or Casuarina decussata. There is much sedges beneath the Karri in the drainage lines.

FIGURE 2 Contour Map and Sample Sites



300 CONTOUR (m. amsl)

FORMED ROAD

TRACKS - MAJOR

" - INTER

130 SAMPLE SITES

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FIRE HISTORY

Wallace (1984) gives an account of the fire history of the reserve for the last 25 years. In that time the reserve has been burnt twice (most in 1959/60 and all in 1968/69). These fires were probably only mild as there was no evidence of them on the aerial photographs nor were there any dead mature trees seen during the survey.

CLIMATE

Beard (1981) indicates the climate of Smiths Brook to be a Moderate Miditerranean one (high rainfall with 3-4 dry months). Table 1 gives mean monthly minimum and maximum temperatures and mean rainfall for the nearest comprehensive recording stations (Pemberton and Manjimup). As the rainfall gradient declines in a north easterly direction, Smiths Brook probably has about 1100mm per annum. Both Pemberton and Manjimup have had a significant deline in rainfall over the last 40 years. (Figure 2). This is similar to that reported for other areas on the south coast (Griffin 1984, 1985a, 1985b). Only in two out of the last ten years did Manjimup receive more than its average rainfall.

METHODS

Smiths Brook Nature Reserve was visited for about three days on two occasions in January and February 1985. While the timing of the survey was inappropriate for the recognition of many of the herbs and geophytes, most perennial shrubs were readily recognised. All tracks were traversed and detailed observations were made at 22 sites (see Figure 2). The study relied on field recognition of vegetation units and qualitative correlation with aerial photo signals and landscape interpretation. Stereo examination of black and white aerial photographs taken on 25.3.81. Mapping was done at a scale of about 1:16,666 on the 1981 photographs of Pemberton run number 5695.

TABLE 1. MONTLY CLIMATIC DATA FOR PEMBERTON AND MANJIMUP.

Station Name PEMBERTON FORESTRY WESTERN AUSTRALIA

Number 009592 Latitude 34 Deg 27 Min S Longitude 116 Deg 3 Min E Evaluation 174.0 M

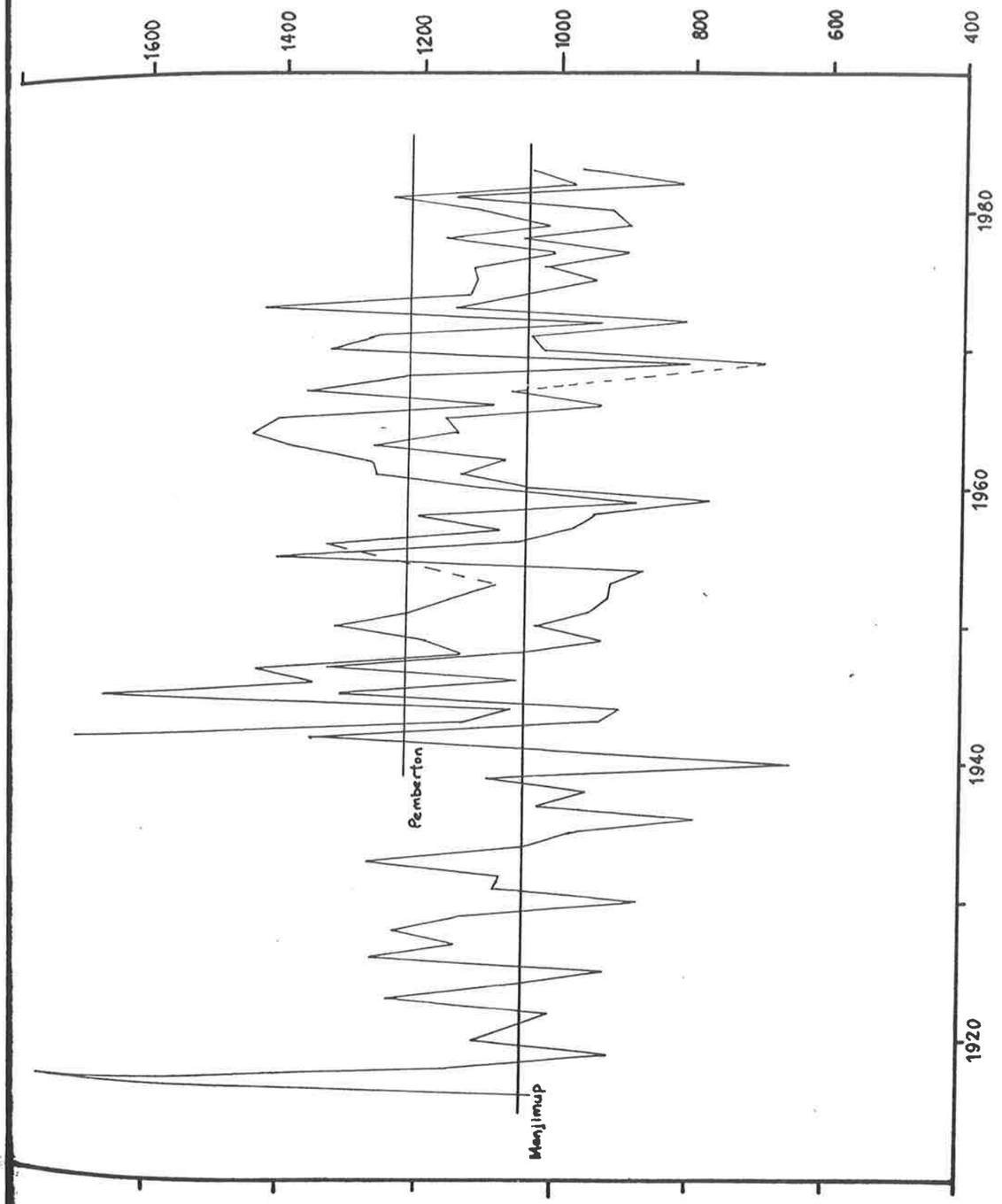
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Maximum Temperature (C)													
Mean	26.3	26.5	24.2	20.5	17.9	15.7	14.8	15.1	16.2	18.6	21.0	24.3	20.1
86 Percentile	32.2	33.0	30.0	24.5	20.8	17.9	17.1	17.8	19.0	23.0	25.6	30.0	
14 Percentile	21.1	21.0	19.1	16.5	15.0	13.3	12.5	12.5	13.3	14.4	16.7	19.0	
Daily Minimum Temperature (C)													
Mean	13.4	13.9	12.7	10.9	9.6	8.3	7.4	7.1	7.6	8.8	10.4	12.3	10.2
86 Percentile	16.7	17.0	16.1	13.9	12.5	11.1	10.0	10.0	10.5	11.7	13.3	15.0	
14 Percentile	10.5	10.6	9.0	7.5	6.5	5.5	5.0	4.4	4.5	5.6	7.5	9.4	
Rainfall (mm)													
Mean	21	18	40	86	159	204	226	183	120	96	59	36	1228
Medium	17	11	27	79	164	186	213	155	112	92	54	27	1200
Raindays (No)													
Mean	6	5	8	13	18	20	22	21	18	16	12	9	169

Station Name MANJIMUP POST OFFICE WESTERN AUSTRALIA

Number 009573 Latitude 34 Deg 14 Min S Longitude 116 Deg 9 Min E Elevation 280.1 M

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Year
Daily Maximum Temperature (C)													
Mean	27.9	27.6	25.0	20.6	17.6	15.3	14.4	14.8	16.3	18.6	21.8	25.8	20.5
86 Percentile	33.6	34.2	31.1	24.9	20.8	17.7	16.7	17.5	19.2	23.2	27.2	31.8	
14 Percentile	22.1	21.8	19.7	16.2	14.6	12.8	12.1	12.1	13.3	14.6	17.3	20.6	
Daily Minimum Temperature (C)													
Mean	13.5	13.9	12.6	10.8	9.1	7.6	6.7	6.4	7.2	8.3	10.3	12.3	9.9
86 Percentile	16.7	17.1	15.8	14.0	11.7	10.4	9.4	9.0	10.0	11.2	13.2	15.2	
14 Percentile	10.6	10.8	9.0	7.8	6.4	5.0	4.3	3.9	4.5	5.5	7.2	9.4	
Rainfall (mm)													
Mean	20	19	31	65	139	179	182	148	109	83	47	25	1047
Median	13	12	23	61	134	162	180	142	96	80	42	18	1041
Raindays (No)													
Mean	5	5	7	11	17	20	21	20	17	14	10	7	154

FIGURE 3 Long Term Rainfall Data



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RESULTS AND DISCUSSION

VEGETATION

The vegetation of Smiths Brook is dominated by Karri as indicated by previous workers. Five different units were recognised and mapped (Figure 4). Most of these are Karri with variations in cohort rees or understorey. Detailed descriptions are provided in Appendix 1. The mapping of the units is principally based on landscape relationships. Most of the boundaries are indicative rather than absolute. The numbering of the vegetation units is an attempt to represent a landscape gradient from lateritic upland to valley floors:

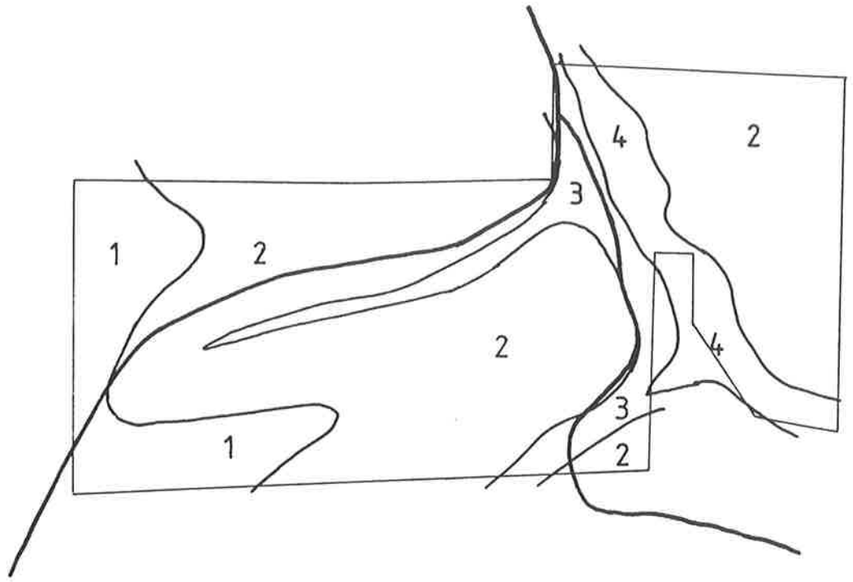
1. Eucalyptus marginata - E. diversicolor Tall Forest.
2. Eucalyptus diversicolor - E. calophylla Tall Forest.
3. Eucalyptus diversicolor - E. patens Tall Forest.
4. Eucalyptus diversicolor Tall Forest.
5. Oxylobium lineare - Agonis flexuosa thicket.

GENERALISED VEGETATION SEQUENCE DESCRIPTION

The whole of the landscape variation in Smiths Brook reserve is dominated by Karri. Only in Unit 1 where Jarrah is co-dominant and Unit 5 which is possibly a unit created by disturbance is the importance of Karri diminished. Therefore the vegetation units defined here are best considered as variants of Karri forest.

The upland areas where the laterite (gravels and duricrust) is still intact have a mixed stand of Jarrah and Karri Tall Forest with Karri replacing Jarrah as the laterite is eroded away. There is also significant amounts of Marri present. A small tree (or large shrub) stratum is generally present in this (and all other units). Banksia grandis and Trymalium floribundum are the main species present here. Bossiaea linophylla usually forms a Scrub strata or even a Thicket, sometimes with Podocarpus drouynianus and Acacia saligna. The low shrubs are common in Unit 1 which is the most species rich of the units found in Smiths Brook. There are two layers of low shrubs. Hovea elliptica, Acacia urophylla, Leucopogon verticellatus, L. capitellatus, Hibbertia cuneiformis and Agonis parviceps tend to form a Low Heath C with Pteridium esculentum. The lower shrubs and herbs generally ensure that there is little bare ground. Tremandra diffusa and Opercularia hispidula are the most important species while Scaevola striata, S. auriculata, Tremandra stelluligera and Clematis pubescens are also significant. There are also herbs and grasses present.

FIGURE 4 Vegetation Map



VEGETATION UNITS (See Appendix 1)

1 Jarrah - Karri Tall Forest

2 Karri - Marri Tall Forest

3 Karri - Blackbutt Tall Forest

4 Karri Tall Forest

As the laterite is removed the soil is more loamy which seems to lead to the replacement of Jarrah and many of the shrubs. On the slopes the Karri is clearly the dominant tree in the Tall Forest of Unit 2 while Marri is usually also present. The small tree stratum is less important here than in Unit 1 (or 3). The Banksia grandis is often present but less abundant and the Trymalium floribundum is also less abundant. It appears however, that the abundance of Trymalium in this unit is inversely related to the steepness of the slope. Other tall shrubs are not very abundant but are more important in the less steep areas of this unit (Pimelea clavata, Hovea elliptica, Bossiaea linophylla , Acacia urophylla and Phebalium anceps). Pteridium esculentum dominates the main plant layer below the trees. The main shrub species also present includes Hibbertia cuneiformis and Leucopogon verticellatus. There are also significant low shrubs which combine to maintain a relatively complete cover (Tremandra stelluligera and Opercularia hispidula). There is usually abundant Clematis pubescens and occassional Hardenbergia comptoniana draping the taller species.

Unit 3 represents a narrow band of Karri Tall Forest with some Blackbut (E. patens) and Marri. It occupies the bottom of minor V-shaped drainage lines and some steeper lower slopes. The understorey is dominated by Trymalium floribundum which was essentially a Low Forest B or Low Woodland B. This is probably quite variable dependant on the age since last fire. There may be some Banksia grandis also present. The other shrub species are relatively open and generally little more than 0.5 m tall. Leucopogon verticillatus is the more common taller species while Tremandra stelluligera is a common small one. Pteridium esculentum is also very important. The centre of these V-shaped gullies are usually occupied by scattered clumps of the sedge Lepidosperma effusum.

The alluvial sandy loams of Smiths Brook seem to have only Karri in the Tall Forest. Agonis flexuosa dominates a well developed Low Forest A and there are also occassional Banksia littorelis and B. verticellata. Shrubs seem less important in this unit than in any of the others. Trymalium floribundum forms a Scrub which occurs mainly along the creeklines. Other species such as Pteridium esculentum, Hibbertia cuneiformis and Clematis pubescens occur along the terrace. In the creeklines there is significant amounts of the sedge Lepidosperma effusum.

The removal of trees from along the power easements have made it difficult to interprute an area along Smiths Brook. This is beneath the powerline, has no trees and there is significant disturbance of the soil. The difficulty lies in deciding whether this should be part of Unit 4. This areas has Oxylobium lineare and Agonis flexuosa thicket with a dense sedge understorey. These sedges are dominated by Lepidosperma effusum and Juncus holoschoenus and J. microcephalus, the later are growing in the standing water.

FLORA

A total of 73 native and 21 alien species were found on the Smiths Brook Reserve (Appendix 2). There were many families represented by native species with the most important one (in terms of numbers of species) was Leguminosae (10). Eucalyptus was the genus with the greatest number of species (4).

The species composition of the vegetation limits was assessed using a qualitatively constructed phytosociological table (Appendix 3). This was done to establish the floristic integrity of the vegetation limits. For this exercise 28 key species were selected amongst which were ones used to help discriminate between the units. The table is ordered to highlight the gradient from uplands to valleys.

The data show that most of these species have a definite limit to their ecological range although some species like Karri, Pteridium esculentum and Trymalium floribundum were abundant in the all main units. This data support the view of McArthur and Clifford (1975) that the "...vegetation of the Pemberton (soil) association is diverse and is very strongly tied to the soil pattern".

Alien Species

The 21 alien species represent a significant invasion of the reserve. Most of these are annual herbs (e.g. Holcus lanatus, Hypochoeris glabra and Lotus ? uliginosus) but others are perennial (Robinia pseudoacacia and Rubus sp.) and pose a serious threat to parts of the reserve.

Rare and Restricted Species

No gazetted rare or geographically restricted plant species were found on the reserve (Rye 1982, Marchant & Keighery 1979). Most of the species seem typical of the Karri forest.

CONDITION OF VEGETATION

Except for the disturbances, particularly along the power easements, this example of Karri forest shows little evidence of being affected by European man. Stumps are very rare. The Karri trees are healthy, with little fire damage. Significantly, there is a wide range of sizes in the Karri from about 20cm d.b.h. to at least 80cm d.b.h. The Karri is clearly not a typical "even-aged" stand. This makes the area quite significant as it demonstrates that Karri can be recruited in the absence of "hot, regenerative fires". It is possible that major recruitment occurred after the last fires (14 and 25 years previously) which were clearly not "hot" fires. Importantly, it seems that the last fire did not kill all the recruits since the previous fire (nine years earlier in part of the reserve and somewhat longer in other parts). This it seems likely that an interfire period can be developed which will allow for the recruitment of Karri. This must be greater than the current 7-8 year interval currently being used in the Karri forest as Karri are sensitive to fire for at least their first 15-20 years.

MANAGEMENT

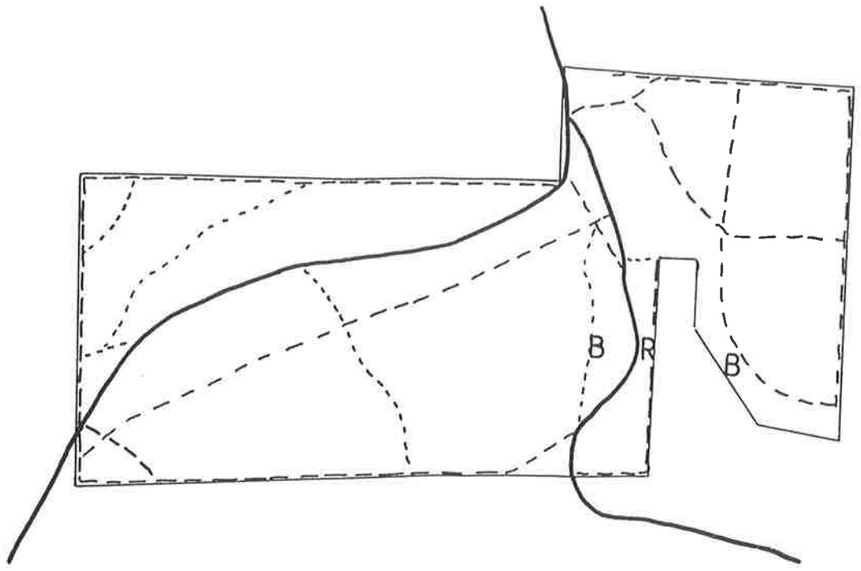
Alien Plants

The two species of greatest concern are Robinia pseudoacacia and Rubus sp. Figure 5 shows the known location of these species. These species are potentially so vigerous that they require urgent attention. It seems unlikely that mechanical removal will be adequate and therefore it is recommended that careful application, preferably of an appropriate herbicide will be necessary.

Firebreaks

The perimeter firebreaks are in good condition and are comfortably trafficable. However, the potential for serious erosion exists if these continue to be ploughed. The internal tracks are mostly adequate but there have been a number of tree falls preventing vehicular traffic. The need for these to be maintained requires consideration. The provision of an additional break inside the perimeter to provide a buffer may be desirable if much of the area is to be left unburnt as is suggested below.

FIGURE 5 Location of Rubus and Robinia



B RUBUS

R ROBINIA

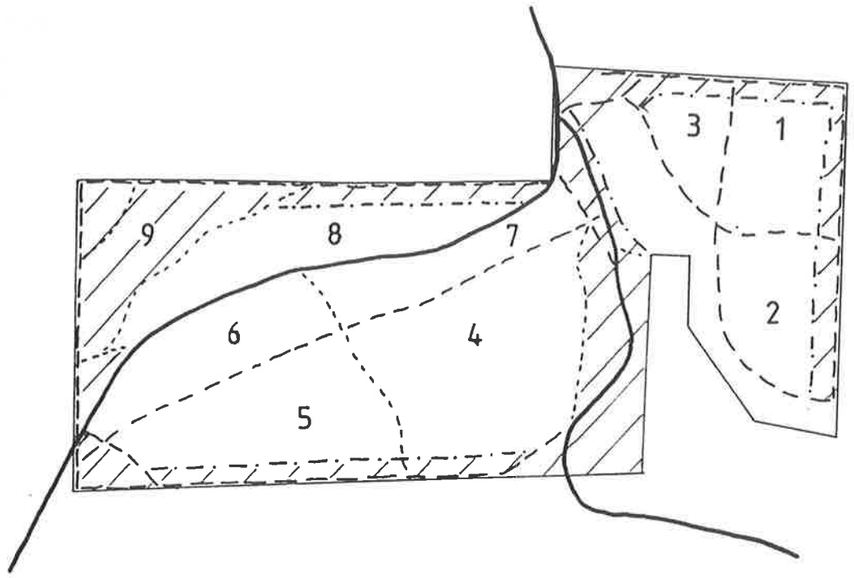
Fuel Reduction Burning

Fuel accumulation in the Karri Forest is very rapid and much of the Karri dominated units in Smiths Brook (3 and 4 and lower slopes of unit 2) have substantial quantities of fallen bark and limbs. The removal of such fuel on a 7-8 year rotation seem unlikely to reduce the chance of ignition as fuel loads quickly reaccumulate. The values of the reserve in being relatively undisturbed by European man will be quickly lost if such a rotation is invoked. Natural recruitment of Karri will be much diminished, weeds invasion which is mainly confined to physically disturbed areas will be exasibated and the structural diversity which is of great importance to the birds will be much compressed.

The Fire Protection Plan prepared for Smiths Brook (Wallace 1984) recognises the need for "a sample of unburnt karri vegetation..." to be protected from fire. That area not to be burnt is essentially the core of the reserve but it fails to include any of Unit 4 and little of Unit 1. No indication is given to suggest on what rotation interval burning will be for other areas.

In view of the value of the reserve as an area of relatively undistrubed Karri, and one that can be managed relatively easily as well as its importance for bird studies, it is recommended that most of the reserve be left unburnt for as long as possible, certainly for at least another 15 years. This will allow an opportunity to study such a long unburnt area of Karri. This recommendation is clearly not readily acceptable to adjacent land owners and therefore additional firebreaks should be created to provide adequate buffers (Figure 6). This will essentially provide two core areas parts of blocks 1, 2, and 3 and the area along Smiths Brook and most of Blocks 4 to 6. The breaks provided by the powerline easements would be maintained. Additionally the old road should be maintained to provide additional protection for parts of the main core area.

FIGURE 6 Fire Management Recomendations



2 COMPARTMENTS

PROPOSED FIREBREAKS

REGULAR BURN AREA

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ACKNOVLEDGEMENTS

Ms. C. Taylor provided valuable support and assistance. Dr. and Mrs Merrilees provided accommodation for the field work. Dr. A.S. Weston's list of plant species of the Karri forest was invaluable. Mr G.J. Keighery and members of the staff of the W.A. Herbarium were of assistance in identifyinig plant speciemens. Mr D. and Mrs M. Brown discussed their bird study and their views on the reserve.

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APPENDIX 1 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 2). The key to the dominant species used in the code is located at the end of this Appendix.

1) Eucalyptus marginata - E. diversicolor Tall Forest

Site Nos: SB12, SB13, SB14, SB20, SB21.

Diagnosis: Tall Forest over Open Low Woodland B over Scrub over Low Heath C over Dwarf Scrub D.

Code: e_3e_2Tc. b_1tLBr. boSi. x SCc x SDi

Description:

Stratum 1. Eucalyptus marginata and E. diversicolor were nearly equally dominant in this Tall Forest Unit, though Jarrah tended to be more abundant in the more lateritic parts. E. calophylla was significant at most sites.

Stratum 2. Trymalium floribundum and Banksia grandis are normally present. At the time of survey these combined to form a Low Woodland B in much of this unit. Because of the sensitivity of the Trymalium to fire this stratum could be more open, with a (?) denser lower layer if fire frequency is increased.

Stratum 3. Bossiaea linophylla is an important component of this unit, probably reflecting the sandy soils. It nominally forms a Scrub but can form a Thicket in some areas with Podocarpus drouynianus and Acacia saligna.

Stratum 4. A Low Heath C covers much of the remaining ground. Pteridium esculentum is dominant in some areas together with a number of moderately tall shrubs (Hovea elliptica, Acacia urophylla, Leucopogon verticellatus, L. capitellatus, Hibbertia cuneiformis and Agonis parviceps).

Stratum 5. There are a lot of small shrubs and herbs which tend to complete the covering of the ground. Individually they only amount to a Dwarf Scrub D. The important shrub species include Tremandra diffusa, and Opercularia hispidula with Scaevola striata, S. auriculata, Tremandra stelluligera and Clematis pubescens. There are also annual and perennial herb species (e.g. Amphipogon debilis and Gonocarpus benthamii).

Soil: This unit is basically an upland unit where there are lateritic gravels and duricrust with mainly grey sandy loam either covering or as a matrix.

2) Eucalyptus diversicolor - E. calophylla Tall Forest

Site Nos: SB1, SB2, SB3, SB4, SB5, SB6, SB11, SB17, SB18, SB19, SB22.

Diagnosis: Tall Forest over (occasional) Open Low Woodland B over Open Scrub over Low Heath C over Dwarf Scrub D.

Code: e_2e_1 Tc. bLBr. ptSr. p_1SCc. trSDi

Description:

Stratum 1. Eucalyptus diversicolor dominates this Tall Forest Stratum but E. calophylla is also significant in almost all parts. Jarrah is only rarely present and then only on the upper slopes.

Stratum 2. There is often a few Banksia grandis present which form an Open Low Woodland B Trymalium floribundum can also reach small tree status however, this species seems to not be as important in this unit as it is in Units 1 and 3, perhaps an artifact.

Stratum 3. The tall shrub stratum, nominally an Open Scrub is variable in height, cover and species composition. It varies from a Dense Low Heath B to an Open Scrub or Thicket. Pimelea clavata and Trymalium floribundum are the most consistent/important but also significant are Hovea elliptica, Bossiaea linophylla, Acacia urophylla and Phebalium anceps.

Stratum 4. The Low Heath C is really a combination of shrubs and the fern Pteridium esculentum. This species is the dominant species of this stratum. The significant shrubs include Hibbertia cuneiformis and Leucopogon verticellatus.

Stratum 5. Low shrubs like Tremandra stelluligera and Opercularia hispidula form a layer which nearly completes the cover of the soil. Included in this Dwarf Scrub D layer are two lianes (Clematis pubescens and Hardenbergia comptoniana) which also drape over the taller shrubs.

Soil: This unit occupies most of the valley slopes except for certain minor gullies. The soil is mostly a grey/orange loamy gravel.

3) Eucalyptus diversicolor - E. patens Tall Forest

Site Nos: SB10, SB15, SB16

Diagnosis: Tall Forest over Low Woodland B over Dwarf Scrub D over (occasionally) Open Tall Sedges.

Code: e_2e_4 Tc. tSBi. 1eSDi. 1VTi

Description:

Stratum 1. Eucalyptus diversicolor dominates this Tall Forest which at times can be a Dense Tall Forest. E. patens is commonly present as is E. calophylla.

Stretum 2. Trymalium floribundum is clearly the dominant shrub in this unit. It was growing as small trees which vary in cover from Low Forest B to Low Woodland B. There may be an occasional Banksia grandis also present.

Stratum 3. The lower shrubs are relatively open and nominally a Dwarf Scrub D. Leucopogon verticellatus is the most consistant moderately tall shrub while Tremandra stelluligera is a common small shrub. Pteridium esculentum is also very important.

Stratum 4. In the centre of small gullies Lepidosperma effusum is an important sedge, usually with few shrubs.

Soil: The unit is based on minor V-shaped valleys and encompasses the lower slopes and centre of these valleys. The soil is a sandy loam.

4) Eucalyptus diversicolor Tall Forest

Site Nos: SB7, SB9.

Diagnosis: Tall Forest over Low Forest A over Scrub over Open Tall Sedges.

Code: e_2Tc.eLAc. tSi. 1VTi

Description:

Stratum 1. Eucalyptus diversicolor is the only tall tree in this Tall Forest unit.

Stratum 2. Agonis flexuosa forms a Low Forest A beneath the Karri along Smiths Brook. There are occasional Banksia littoralis and B. seminuda also present.

Stratum 3. Trymalium floribundum is the major shrub in this unit which is relatively open beneath the trees. This stratum is mainly a Scrub occurring along the creekline.

Stratum 4. Lepidosperma effusum forms an Open Tall Sedge stratum which is concentrated along the creeklines. There are also some shrubs present on the terraces above the creekline.

Soil: This unit occupies the alluvial terraces and creeklines which are incised about a metre below the terraces. The soil is mainly a grey sandy loam.

5) Oxylobium lineare - Agonis flexuosa Thicket

Site Nos: SB8.

Diagnosis: Thicket over Dense Tall Sedges.

Code: oaSc. 1VTd

Description:

Stratum 1. Oxylobium lineare and Agonis flexuosa dominate a rather disturbed area which may have once had a tree stratum, probably of Karri. Paraserianthes lophantha (Albizia) may also be present.

Stratum 2. Lepidosperma effusum dominates a Dense tall sedge layer. Other sedges present along the water include Juncus holoschoenus and J. microcephalus. There are numerous alien weeds and grasses (eg. Paspalum dilatatum, Anagallis arvensis and Rubus sp. (Blackberry)).

Soil: This unit is also an alluvial sandy loam along a creekline. It appears to be wetter than unit 4 however, the difference may be artificial.

SPECIES KEY TO FLORISTIC COMPONENT OF CODE

a	Agonis flexuosa
b	Banksia grandis
bo	Bossiaea linophylla
e_1	Eucalyptus calophylla
e_2	Eucalyptus diversicolor
e_3	Eucalyptus marginata
e_4	Eucalyptus patens
l	Lepidosperma effusum
le	Leucopogon verticellatus
o	Oxylobium lineare
p	Pimelea clavata
p	Pteridium esculentum
t	Trymalium floribundum
tr	Tremandra stelluligera
x	mixed

TABLE 2 VEGETATION CLASSIFICATION USED IN SURVEY

(From Muir 1977, page 11)

LIFE 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 M Trees 15-30m LA Trees 5-15m LB Trees <5m	Dense Tall Forest Dense Forest Dense Low Forest A Dense Low Forest B	Tall Forest Forest Low Forest A Low Forest B	Tall Woodland Woodland Low Woodland A Low Woodland B	Open Tall Woodland Open Woodland Open Low Woodland A Open Low Woodland B
KT Mallee tree form KS Mallee shrub form	Dense Tree Mallee Dense Shrub Mallee	Tree Mallee Shrub Mallee	Open Tree Mallee Open Shrub Mallee	Very Open Tree Mallee Very Open Shrub Mallee
S Shrubs >2m SA Shrubs 1.5-2.0m SB Shrubs 1 0-1.5m SC Shrubs 0.5-1.0m SD Shrubs 0.0-0.5m	Dense Thicket Dense Heath A Dense Heath B Dense Low Heath C Dense Low Heath D	Thicket Heath A Heath B Low Heath C Low Heath D	Scrub Low Scrub A Low Scrub B Dwarf Scrub C Dwarf Scrub D	Open Scrub Open Low Scrub A Open Low Scrub B Open Dwarf Scrub C Open Dwarf Scrub D
P Mat plants H Hummock Grass GT Bunch grass >0.5m GL Bunch grass <0.5m J Herbaceous spp.	Dense Mat Plants Dense Hummock Grass Dense Tall Grass Dense Low Grass Dense Herbs	Mat Plants Mid-Dense Hummock Grass Tall Grass Low Grass Herbs	Open Mat Plants Hummock Grass Open Tall Grass Open Low Grass Open Herbs	Very Open Mat Plants Open Hummock Grass Very Open Tall Grass Very Open Low Grass Very Open Herbs
VT Sedges >0.5m VL Sedges <0.5m	Dense Tall Sedges Dense Low Sedges	Tall Sedges Low Sedges	Open Tall Sedges Open Low Sedges	Very Open Tall Sedges Very Open Low Sedges
X Ferns Mosses, liverwort	Dense Ferns Dense Mosses	Ferns Mosses	Open Ferns Open Mosses	Very Open Ferns Very Open Mosses

APPENDIX 2 SPECIES LIST FOR SMITHS BROOK NATURE RESERVE

Species listed in alphabetical order. Nomenclature after Green (in prep.). Some specimens were unidentifiable to species level because the time of year in which the survey was conducted meant that inadequate material was collected in some cases. Most species are represented by specimens provided.

*indicates Alien species.

Acacia pulchella R.Br.
Acacia saligna (Labill.) H.L. Wendl.
Acacia urophylla Benth. ex Lindley
*Acaena nova-zelandiae Kirk
Adianthum aethiopicum L.
Agonis flexuosa (Sprengel) Schauer
Agonis perviceps Schauer
Amphipogon debilis R.Br.
*Anagallis arvensis L.
Anigozanthos flavidus Redoute & DC.
*Aster subulatus Michaux
Astroloma ? ciliatum (Lindley) Druce
Banksia grandis Willd.
Banksia littoralis R.Br. var. littoralis
Banksia seminuda (A.S. George) B.L. Rye
Billardiera floribunda (Putterl.) F.Muell.
Bossiaea linophylla R.Br.
Cassytha racemosa Nees
*Centaurium erythraea Refn.
Clematis pubescens Huegel ex Endl.
Comesperma virgatum Labill.
*Conyza bonariensis (L.) Cronq.
Cyperus congestus M. Vahl
Dampiera elata Lindley
Danthonia caespitosa Gaudich
Echinopogon ovatus (G. Forster) P. Beauv.
Eucalyptus calophylla Lindley
Eucalyptus diversicolor F. Muell.

Eucalyptus marginata Donn. ex Smith
Eucalyptus patens Benth.
*Geranium molle L.
Gonocarpus benthamii Orch.
*Hainardia cylindrica (Willd.) Greuter
Hakea amplexicaulis R.Br.
Hakea oleifolia (Smith) R.Br.
Hibbertia amplexicaulis Steudel
Hibbertia cuneiformis (Labill.) Smith
*Holcus lanatus L.
Hovea elliptica (Smith) DC.
*Hypochoeris ? glabra L.
*Isolepis prolifera (Rottb.) R.Br.
Juncus holoschoenus R.Br.
*Juncus microcephalus Kunth
Lepidosperma angustatum R.Br.
Lepidosperma effusum Benth.
Lepidosperma ? leptostachyum Benth.
Leucopogon ? capitellatus DC.
Leucopogon propinquus R.Br.
Leucopogon verticillatus R.Br.
Levenhookia pusilla R.Br.
Lindsaea ? linearis Sw.
Lobelia alata Labill.
Logania serpyllifolia R.Br.
Lomandra initegra T.D. McFarlane
Lomandra pauciflora (R.Br.) Ewart
*Lotus ? uliginosus Schkuhr
Macrozamia reidlei (Fisch. ex Gaud.) C.A. Gardner
Monotaxis occidentalis Endl.
Opercularis hispidula Endl.
Orbanche australiana F.Muell.
*Oxelis sp. inder
Oxylobium lineare (Benth.) Benth.
Paraserianthes ? lophantha (Willd.) I. Nielsen
*Paspalum dilatatum Poiret
Petersonia umbrosa Endl.
Persoonia longifolia R.Br.
Phebalium anceps DC.
Pimelea clavata Labill

*Pinus ? radiata D. Don
*Plantago lanceolata L.
Platysace compressa (Labill.) Norman
Platysace tenuissima (Benth.) Norman
Poa ? poiformis (Labill.) Druce
Podocarpus drouynianus F. Muell.
Polygonum salicifolium Brouss. ex Willd.
Pronaya fraseri (Hook.) E.M. Bennett
*Pseudognaphalium leuteo-album (L.) Hilliard & B.L. Burtt
Pteridium esculentum (G. Forster) Cockayne
*Robinia pseudoacacia L.
*Rubus sp. indet
Scaevola auriculata Benth.
Scaevola striata R.Br.
*Senecio vulgaris L.
*Sonchus oleraceus L.
Sphaerolobium ? scabriusculum Meissner.
Stylidium ednatum R.Br.
Stylidium amoenum R.Br.
Stylidium luteum R.Br.
Tetraria octandra (Nees) Kuek.
Tetrarrhena laevis R.Br.
Tremandra diffusa R.Br. ex DC.
Tremandra stelligera R.Br. ex DC.
Trymalium floribundum Steudel
Veronica calycina R.Br.
Xanthorrhoea gracilis Endl.
Xanthosia huegelii (Benth.) Steudel

APPENDIX 3 PHYTOSOCIOLOGICAL TABLE FOR VEGETATION UNITS RECOGNISED AT SMITHS BROOK NATURE RESERVE USING 28 KEY SPECIES.

VEGETATION UNITS

1. Eucalyptus marginata - E. diversicolor Tall Forest.
2. Eucalyptus diversicolor - E. calophylla Tall Forest.
3. Eucalyptus diversicolor - E. patens Tall Forest.
4. Eucalyptus diversicolor Tall Forest.
5. Oxylobium lineare - Agonis flexuosa Thicket.

SPECIES ABUNDANCE CODES

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

	Vegetation Unit Nos.				
	1	2	3	4	5
Leucopogon capitellatus	3	-	-	-	-
Tremandra diffusa	3	-	-	-	-
Acacia saligna	2	-	-	-	-
Eucalyptus marginata	4	1	-	-	-
Bossiaea linophylla	4	2	-	-	-
Podocarpus drouynianus	2	1	-	-	-
Scaevola striata	2	1	-	-	-
Scaevola auriculata	2	1	-	-	-
Hovea elliptica	3	3	-	-	-
Opercularia hispidula	3	3	-	-	-
Acacia urophylla	3	2	1	-	-
Banksia grandis	3	3	1	-	-
Macrozamia riedlei	-	2	-	-	-
Leucopogon verticellatus	4	4	4	-	-
Leucopogon propinquus	1	2	1	-	-
Eucalyptus calophylla	3	4	3	-	-
Pimelea clavata	-	3	-	-	-
Phebalium anceps	-	2	-	-	-
Hibbertia cuneiformis	3	4	2	1	-
Tremandra stelluligera	2	3	4	-	-
Clematis pubescens	2	4	3	1	-
Eucalyptus diversicolor	4	4	4	4	-
Pteridium esculentum	3	4	4	3	-
Trymalium floribundum	3	2	4	4	-
Eucalyptus patens	-	-	3	-	-
Agonis parviceps	2	-	-	-	4
Agonis flexuosa	-	1	-	4	4
Leptospermum effusum	-	-	2	4	4
Oxylobium lineare	-	-	-	-	4