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**A botanical survey of vegetation remnants on heavy  
soils between Harvey and Dardanup**



*Eucalyptus rudis* – *Melaleuca raphiophylla* Community along the Wellesley River

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## Contents

	Page
Introduction	1
Methods	1
Geology and soils	1
Table 1 – Description of soils	2
Vegetation associations and mapping	2
Table 2 – Vegetation structural types	2
Early descriptions of the vegetation	3
Disturbance and weeds	4
Results	5
Discussion	6
Conclusions	7
Bibliography	8
Map 1 – Survey sites	
Map 2 – Distribution of heavy soils communities	
Appendix 1– TWINSpan output	
Appendix 2 – List of species	

## **Introduction**

This survey was carried out to document what is left of the native plant species occurring in remnant vegetation on alluvial soils adjacent to streams and rivers on the southern Swan Coastal Plain between Harvey and Boyanup (the study area). Over the past 160 years since the first European settlement at Australind most of these relatively fertile soils have been cleared of natural vegetation for agriculture. The soils immediately surrounding the infant settlement of Australind were generally infertile sands and within a few years settlers had established small farms on alluvial soils along the Wellesley, Brunswick, Collie, Preston and Ferguson rivers. However because of the lack of markets and the difficulty of farming the alluvial soils, which were prone to waterlogging, most of them were not cleared until the 1890's. Stock were grazed on the native pastures along the rivers in the early years of settlement but tended to lose 'condition' after some time and a system of transhumance evolved whereby cattle were moved from native pastures on the limestone soils along the coast to the foothills of the Darling range and back again. Fire was used to stimulate fresh native pasture growth.

## **Methods**

The survey was carried out on an opportunistic basis during spring and early summer 2001. Sites were selected which had at least five native species. All native species within an area approximately 100m by 50m were recorded. The list of native species at any site was not exhaustive. Because only a single visit was made to each of the sites some annual species may have been missed. Major weed species were also recorded though no attempt was made to make a complete list of these.

A general description of the surface soil type and landscape position was also recorded.

## **Geology and Soils**

All of the sites occur in the Perth Basin, a 1.5 km thick deposit of sediments since continental breakup in the Neocomian. The majority of the surveyed sites, those close to rivers and streams, were on recent alluviums primarily of Holocene age (< 25,000 years old) which correspond to the Swan landform association (Churchward & McArthur, 1978). Several others (B1, B4, B9, B10) were on the older alluvial sands and clays of the Guildford Formation (corresponding to the Guildford landform association), which was formed in the Middle to Late Pleistocene (Geological Survey of Western Australia, 1975).

Soils at all of the sites fall within the Guildford Association of Pym & Poutsma (1957). They range from the Guildford Formation brown or meadow podzolics of the Dardanup Series of McArthur & Bettenay (1956) and the Harvey Series of Pym & Poutsma (1957) to alluvial complexes associated with present stream courses, eg. the River Series of McArthur & Bettenay (1956). Descriptions of a representative soil from the Guildford Formation and recent alluvium are given in Table 1 below (modified from McArthur & Bettenay, 1956).

**Table 1.** Description of soils typical of the sites surveyed for this study.

Geology	Guildford Formation	Recent Alluvium
Landform name	Guildford	Swan
Landscape position	Alluvial plain	Floodplain adjacent to rivers
Soil Series	Dardanup Loam	River Series I
0-3 cm	Very dark grey-brown loam	Dark greyish brown loam
3-20 cm	Very dark brown loam	Dark brown loam
20-43 cm	Dark grey clay	Dark brown loam
43-110 cm	Dark grey-brown clay	Dark brown loam

### Vegetation associations and mapping

Vegetation complexes on the Swan Coastal Plain taking the same name as the landform type were associated with typical vegetation structural types in Churchward & McArthur (?1978). The vegetation structural types for the Guildford and Swan landform associations are given in Table 2 below.

**Table 2.** Vegetation structural types found in the Guildford and Swan landform associations. (from Churchward & McArthur, ?1978).

	Guildford association	Swan association
Should be present	<ul style="list-style-type: none"> <li>◆ <i>Corymbia calophylla</i> - <i>Eucalyptus marginata</i>-<i>E. wandoo</i> open forest</li> <li>◆ <i>Corymbia calophylla</i>-<i>E. marginata</i>-<i>Banksia</i> sp. open forest</li> <li>◆ <i>Eucalyptus wandoo</i> woodland</li> </ul>	<ul style="list-style-type: none"> <li>◆ <i>Eucalyptus rudis</i>-<i>Melaleuca raphiophylla</i> woodland</li> </ul>
Often present	<ul style="list-style-type: none"> <li>◆ <i>Corymbia calophylla</i> - <i>Eucalyptus marginata</i>-<i>E. wandoo</i> tall open forest</li> <li>◆ <i>Eucalyptus rudis</i>-<i>Melaleuca raphiophylla</i> woodland</li> </ul>	<ul style="list-style-type: none"> <li>◆ <i>Casuarina obesa</i>-<i>M. cuticularis</i> low open forest</li> </ul>

Smith (1974) mapped the vegetation structural formations of the Swan Coastal Plain between Dardanup and Harvey. Mapping on the mostly cleared more fertile soils was based primarily on the evidence of paddock trees and narrow remnants along roads and railways. Most of the Guildford landform association was mapped as Jarrah-Marri (*E. marginata*-*C. calophylla*) Open Forest with Flooded Gum (*E. rudis*) Woodland occurring on the younger alluvials of the Swan landform.

### Early descriptions of the vegetation

Early accounts of the vegetation on loamy soils adjacent to the Collie and Preston rivers describe it with language such as 'beautiful open forest' with here and there 'open plains, covered with grass, and thinly scattered with trees' (J. Cross, 1833, pp. 82-84). Shenton and Wells (quoted in Staples, 1979, p. 38) described the lushness of vegetation on the alluvial flats along the Collie River near present day Burekup;

[they came to] "a flat so dense with vegetation, consisting of grass, sow thistles, groundsel and fern, that after forcing our way with great labour, we were compelled again to make the high land, which here is of much the same character as the Swan but more pleasing from the variety of the surface."

From the description given of the "sow thistles" and "groundsel" elsewhere in this account we can recognise the Native Sowthistle *Sonchus hydrophilus* which may grow to 1.8 metres tall and the groundsel, or "giant Jacobea" as probably *Senecio ramosissimus*, or perhaps *S. hispidulus* or *S. quadridentatus*. These native species are allied to plants the explorers knew from their mother country. The species of "grass" growing on the treeless flats of the Collie River can only be guessed at, native grasses have virtually disappeared from the fertile soils along streams on the coastal plain being unable to withstand the twin pressures of vigorous introduced pasture and weed species and grazing by settlers' stock.

Amongst native grasses known to grow in streamside habitats on the Swan Coastal Plain are *Microlaena stipoides*, *Deyeuxia quadriseta* and *Themeda triandra* (Kangaroo grass). The latter species, a bunch grass, that may become the dominant groundcover under the right conditions, is the most likely species to have formed the extensive "plains" and grassy open woodlands described for such areas as the Henty Plains between the Preston and Capel rivers or the 20 to 30 acre grassland at the junction of the Brunswick and Collie rivers. This was described as "particularly thick and free from bushes or scrub" and pronounced fit for mowing (Shenton and Wells, quoted in Staples, 1979, p. 38). Contrary to what Beard (1981, pp. 69-70) wrote there *is* an indigenous Western Australian grass which fits the description of a grass like "the Brome or Kangaroo-grass of New South Wales [which grew] in great luxuriance" (Fraser, 1830) on the alluvial soils of the Swan River – it is the same species, *Themeda triandra* (Lamp *et al.*, 1990). However, because of its intolerance for heavy grazing *T. triandra* is now usually only found on road and reserves in the south of the State, where it gets the high light conditions it appears to thrive on. It must be pointed out however, that although they usually meant members of the family Poaceae when they wrote "grass" or "grassy" the early explorers sometimes used these terms for herbaceous vegetation generally.

The early explorers also described the Flooded Gum (*Eucalyptus rudis*) and Marri (*Corymbia calophylla*) woodlands along the rivers that are still evident, although usually much degraded. Mr Collie and Lieut. Preston, whose surnames were given to two of the major rivers of the Swan Coastal Plain, described the banks of the Preston River about 2 km from its mouth thus;

"The banks are from three to six feet deep. The surface was thickly covered with grass and other herbs, with stringy bark and other trees, liguminous shrubs, ferns and sow thistles, and exposed soil of blackish brown earth, being a good mixture of loam and mould, about two feet deep. We walked thirty or forty yards from the bank, and as far as we could see the same soil and productions continued. A short way further up, however, on a subsequent day we found the channel much obstructed with trees, and near its banks low knolls and intervening vales, almost wholly sand, yet supporting a little herbaceous, but mostly shrubby vegetation, and the tallest and finest eucalypti (red and blue gum) trees, we have any where discovered." (J. Cross, 1833, p. 44).

The "liguminous shrubs" may well have included *Acacia pulchella* (Prickly Moses) which is still quite common in this vegetation and the "ferns" were most likely Bracken (*Pteridium esculentum*) which is also still common. "Stringy bark" was probably *Eucalyptus marginata*, "red gum" was *C. calophylla* and "blue gum" was most likely *E. rudis*.

Shenton and Wells, who travelled through the area in 1837, described the vegetation between the Collie and Brunswick rivers north west of present-day Roelands as "immense plain of tolerable soil, with vetch grass and blackboys" and "excellent clay plains thickly covered with blackboy and grass" (quoted in Staples, 1979, p. 39). It is not clear what they meant by "vetch grass" but it was possibly a species of *Kennedia* and of course the "blackboy" was most probably *Xanthorrhoea preissii*. Governor James Stirling who in 1837 journeyed between Benger Swamp and the Harvey River near the base of the hills wrote of approaching the river through "beautiful land encumbered with blackboys and large handsome redgums, much grass and prickly acacia" (quoted in Staples, 1979, p. 41). A map of the Korijekup Estate just east of the present Harvey townsite, dated 1895, when most of the land was still uncleared notes most of the vegetation as being "Blackboy and Redgum" growing on the "fine loamy soil" (Staples, 1979, p. 354). This "Redgum forest" below the range, the trees varying from 3 to 10 to the acre (10-25 per ha) had "nothing else in the way of the plough" apart from a "considerable subgrowth of blackboys" (Staples, 1979, p. 48).

While these descriptions by the early explorers of the vegetation they encountered are invaluable it appears that no trained botanist has left a detailed description of the vegetation of the fertile soils of the southern Swan Coastal Plain in the early years after settlement. James Drummond travelled from Pinjarra to Bunbury and on to the Vasse River in 1842 his route bypassed most of the more fertile soils in the area of this study.

### **Disturbance and weeds**

Virtually all of the sites visited during this survey had been heavily invaded by weeds. This has come about through physical disturbance, grazing by livestock, changes of local hydrology, influxes of nutrients and seeds from pasture species (Hobbs, 1987). Although many of the sites had apparently not been burned for many years, previous too-frequent fire in the presence of weed species would have accelerated weed invasion (Milberg and Lamont, 1995). Previous to European settlement and in some areas up till the 1950's burning at intervals of three or four years was used first by the Aborigines and then by graziers to maintain the quality of herbage for grazing (Ward, 2000). Aborginal burning practises, by limiting the establishment of shrubs were responsible for the open grassy woodlands on the more fertile soils. However the post fire environment was ideal for invasion by introduced species that outcompeted the native grasses, herbs and shrubs, especially those that were seed regenerators (Trémont and McIntyre, 1994). Native grasses and herbs also did not withstand the plough. As early as 1839, a bare ten years after settlement at the Swan River, James Drummond noted that various European and South African weeds were taking hold, especially on previously cultivated ground (Drummond, 1839).

## Results

Analysis of species presence at the survey sites using TWINSPLAN (a FORTRAN program for two-way indicator species analysis; Hill, 1979) produced four main groups of species, hereafter referred to as communities (Table I). The communities, named according to their dominant native species, are described below.

### Community I

#### *Corymbia calophylla* – *Agonis flexuosa* Community

Five of the seven sites where the vegetation was classified as belonging to this community were situated on the Guildford Formation (see Table 1) while two were in the transition zone between that formation and Recent Alluvium along streams.

Other common species were the shrubs *Acacia pulchella*, *Hibbertia hypericoides*, *Phyllanthus calycinus* and *Xanthorrhoea gracilis*, the sedge *Lepidosperma squamatum* and the grass *Austrostipa campylachne*.

Plant species also often present are *Eucalyptus marginata*, the shrubs *Acacia extensa*, *Hypocalymma robustum*, *Persoonia longifolia*, *Xanthorrhoea preissii*, the herb *Patersonia umbrosa* and the sedge *Mesomelaena tetragona*. Bracken fern (*Pteridium esculentum*) may also be locally abundant.

### Community II

#### *Corymbia calophylla* – *Xanthorrhoea preissii* Community

This community (14 sites) only occurs on the older alluvial soils of the Guildford Formation.

In dryer areas the characteristic species also include *Eucalyptus wandoo* and *E. marginata*, the shrubs *Dryandra nivea* and *Hypocalymma angustifolium* and the grass *Austrostipa campylachne*. In wetter areas *Eucalyptus rudis* and *Meleleuca rhapsiophylla* are common along with the shrubs *Acacia extensa*, *A. pulchella*, *A. saligna*, *Hakea varia* and *Meleleuca lateritia*.

The shrubs *Hakea lissocarpa* and *Kennedia prostratum*, the sedge *Lepidosperma squamatum*, and the grasses *Austrodanthonia caespitosa* and *Themeda triandra* are often found in this community where conditions are favourable. For instance, *T. triandra* appears only on roadsides or railway reserves where the lack of grazing and high light conditions favour it.

### Community III

#### *Eucalyptus rudis* – *Corymbia calophylla* – *Agonis flexuosa* Community

The six sites having this community occurred exclusively in the riparian zone on Recent Alluvial soils. Most of the sites had been disturbed by grazing and had low numbers of native species.

The shrub *Astartea fascicularis* is common at the edge of streams in this community. Species often encountered include *Acacia alata*, *A. pulchella*, *Agonis linearifolius*, *Grevillea diversifolia*, *Meleleuca raphiophylla*, *Mirbelia dilatata* and the rush *Juncus pallidus*.

#### Community IV

##### *Eucalyptus rudis* – *Melaleuca raphiophylla* Community

This community (5 sites) is also restricted only to the riparian zone on Recent Alluvials. However, whereas Community III is found throughout the study area along the middle to upper reaches of streams Community IV is mainly found along the lower Collie River and its major tributaries. It also has been heavily grazed in the past and most of the sites have less than 10 native species.

The rush *Juncus pallidus* is frequently found as are *Agonis flexuosa* (on sandier soils), *Melaleuca preissii* and *M. incana* (on clayey soils) and bracken fern, *Pteridium esculentum*. *Casuarina obesa* overhangs the Collie River in its lower reaches and *Astartea fascicularis*, *Baumea juncea* (a rush) and the sedge *Gahnia trifida* are commonly also found near the water's edge.

#### **Discussion**

The communities defined by this study generally fall within the structural types identified by Churchward & McArthur (?1978) (Table 2). Their *Corymbia calophylla*-*Eucalyptus marginata*-*E. wandoo* open forest and tall open forest of the Guildford Association would encompass communities I and II of this study. Likewise Community III and Community IV of this study could fit within the *Eucalyptus rudis*-*Melaleuca raphiophylla* woodland of their Swan Association. *Eucalyptus rudis* is usually found in a narrow band along the edges of streams with *C. calophylla* occurring just upslope of it; on some broader floodplains they are interspersed.

Similar communities to those found in this study have been identified by Keighery & Trudgeon (1992) in their study of remnant vegetation on the eastern side of the northern Swan Coastal Plain. These remnants were also often heavily weed invaded. The *Corymbia calophylla*– *Xanthorrhoea preissii* Community found during this survey is similar to *Eucalyptus* (*Corymbia*) *calophylla*-*Xanthorrhoea preissii* woodlands and shrublands community identified by Gibson *et al.* (1994).

The number of native species at each site ranged from 20-25 for several sites with Community I and II vegetation down to 5 for several sites with grazed Community IV vegetation.

Widespread weeds included *Avena fatua* (wild oats), *Cirsium vulgare* (thistle), *Sonchus oleraceus* (sowthistle), *Lolium multiflorum* (rye grass), *Bromus hordeaceus* (brome grass), *B. diandrus*, *Briza maxima* (blowfly grass), *Hypochaeris glabra* (capeweed), *Medicago* spp. (medic), *Pennisetum clandestinum* (kikuyu grass), *Plantago lanceolata*, *Watsonia* spp., *Trifolium* spp. (clover) *Rumex* spp. (dock). *Eragrostis curvula* (African love grass) and *Asparagus asparagoides* (bridal creeper) were particularly invasive at some sites.

## Conclusions

There is very little of the coastal plain heavy soil communities described in this report in nature reserves. A small area of Community II (*Calophylla calophylla-Xanthorrhoea preissii*) occurs on a nature reserve near Waterloo and along the edge of State Forest south of Boyanup there are areas of communities I and III adjacent to the Preston River. Almost all remnants of these communities on private land have been so heavily grazed that there is little understorey apart from introduced species and little prospect of seedlings of the overstorey tree species establishing or surviving while grazing continues.

It would be possible, however, to at least partially recreate these communities if grazing were prevented by fencing, weed control was undertaken and native seedlings of local provenance were planted. Such restoration efforts would be particularly valuable in reducing erosion of riverbanks and consequent silting of the streams and estauries.

The vegetation and species described in this report would be useful in determining what taxa to use in such rehabilitation efforts.

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Appendix 2. Species found at the heavy soil sites.

Species code	Authority	Species
<b>Acacia alata var alata</b>	R.Br.	ACA ALA
<i>Acacia erinacea</i>	Benth.	ACA ERI
<i>Acacia extensa</i>	Lindl.	ACA EXT
<i>Acacia incurva</i>	Benth.	ACA INC
<i>Acacia pulchella</i>	R.Br. in W.T.Aiton	ACA PUL
<i>Acacia saligna</i>	(Labill.)H.L.Wendl.	ACA SAL
<i>Acacia urophylla</i>	Lindl.	ACA URO
<i>Acacia willdenowiana</i>	H.L.Wendl.	ACA WIL
<i>Adiantum aethiopicum</i>	L.	ADI AET
<i>Agonis flexuosa</i>	(Willd.)Sweet	AGO FLE
<i>Agonis linearifolia</i>	(DC.)Sweet	AGO LIN
<i>Agrostocrinum scabrum</i>	(R.Br.)Baill.	AGR SCA
<i>Anigozanthus flavidus</i>	Redoute & DC.	ANI FLA
<i>Apium prostratum</i>	Vent	API PRO
<i>Astartea fascicularis</i>	(Labill.)DC.	AST FAS
<i>Astroloma pallidum</i>	R.Br.	AST PAL
<i>Austrodanthonia caespitosa</i>	Gaud.	AUS CAE
<i>Austrostipa campylachne</i>	(Nees)S.W.L.Jacobs & J.Everett	AUS CAM
<i>Austrostipa semibarbata</i>	(R.Br.)S.W.L.Jacobs & J.Everett	AUS SEM
<i>Banksia grandis</i>	Willd.	BAN GRA
<i>Banksia littoralis</i>	R.Br.	BAN LIT
<i>Baumea juncea</i>	(R.Br.) Palla	BAU JUN
<i>Beaufortia sparsa</i>	R.Br. in W.T.Aiton	BEA SPA
<i>Billardiera floribunda</i>	(Putt.)F.Muell.	BIL FLO
<i>Bossiaea linophylla</i>	R.Br. in W.T.Aiton	BOS LIN
<i>Bossiaea ornata</i>	(Lindl.)Benth.	BOS ORN
<i>Brachysema praemorsum</i>	Meisn. in Lehm.	BRA PRA
<i>Carex tereticaulis</i>	F.Muell.	CAR TER
<i>Cassutha racemosa</i>	Nees in Lehm.	CAS RAC
<i>Casuarina obesa</i>	Miq. in Lehm.	CAS OBE
<i>Corymbia calophylla</i>	(Lindl.)K.D.Hill & L.A.S.Johnson	COR CAL
<i>Cyathochaeta avenacea</i>	(R.Br.)Benth.	CYA AVE
<i>Dampiera linearis</i>	R.Br.	DAM LIN
<i>Dasyogon bromeliaefolius</i>	R.Br.	DAS BRO
<i>Daviesia preissii</i>	Meisn. in Lehm.	DAV PRE
<i>Desmocladus fasciculatus</i>	(R.Br.)B.G.Briggs & L.A.S.Johnson	DES FAS
<i>Deyeuxia quadriseta</i>	(Labill.) Benth.	DEY QUA
<i>Dodonaea viscosa</i>	Jacq.	DOD VIS
<i>Dryandra nivea</i>	(Labill.)R.Br.	DRY NIV
<i>Eucalyptus marginata</i>	Sm.	EUC MAR
<i>Eucalyptus patens</i>	Benth.	EUC PAT
<i>Eucalyptus rudis</i>	Endl. in Endl.,Fenzl,Benth.& Schott	EUC RUD
<i>Eucalyptus wandoo</i>	Blakely	EUC WAN
<i>Gahnia trifida</i>	Labill.	GAH TRI
<i>Gastrolobium bilobum</i>	R.Br.	GAS BIL
<i>Gastrolobium spinosum</i>	Benth. in Lindl.	GAS SPI
<i>Goodenia caerulea</i>	R.Br.	GOO CAE
<i>Grevillea bipinnatifida</i>	R.Br.	GRE BIP
<i>Grevillea diversifolia</i>	Meisn. in Lehm.	GRE DIV
<i>Hakea amplexicaulis</i>	R.Br.	HAK AMP
<i>Hakea lissocarpha</i>	R.Br.	HAK LIS
<i>Hakea varia</i>	R.Br.	HAK VAR

	Authority	Species Code
<i>Hardenbergia comptoniana</i>	(Andrews)Benth. in Endl.,Fenzl,Benth.& Schott	HAR COM
<b>Species</b>		
<i>Hibbertia hypericoides</i>	(DC.)Benth.	HIB HYP
<i>Hovea chorizemifolia</i>	(Sweet)DC.	HOV CHO
<i>Hovea trisperma</i>	Benth. in Endl.,Fenzl,Benth.& Schott	HOV TRI
<i>Hypocalymma angustifolium</i>	(Endl.)Schauer	HYP ANG
<i>Hypolaena exsulca</i>	R.Br.	HYP EXS
<i>Hypocalymma robustum</i>	(Endl.)Lindl.	HYP ROB
<i>Juncus pallidus</i>	R.Br.	JUN PAL
<i>Juncus subsecundus</i>	N.A. Wakef.	JUN SUB
<i>Kennedia prostrata</i>	R.Br. in W.T.Aiton	KEN PRO
<i>Lepidosperma gladiatum</i>	Labill.	LEP GLA
<i>Lepidosperma squamatum</i>	Labill.	LEP SQU
<i>Leptocarpus laxus</i>	(R.Br.)B.G.Briggs	LEP LAX
<i>Leptocarpus tenax</i>	(Labill.)R.Br.	LEP TEN
<i>Leucopogon capitellatus</i>	DC.	LEU CAP
<i>Isolepis nodosa</i>	(Rottb.)R.Br.	ISO NOD
<i>Isotoma hypocrateriformis</i>	(R.Br.)Druce	ISO HYP
<i>Macrozamia riedlii</i>	(Gaudich.)C.A.Gardner	MAC RIE
<i>Melaleuca incana</i>	R.Br.	MEL INC
<i>Melaleuca lateritia</i>	A.Dietr.	MEL LAT
<i>Melaleuca preissiana</i>	Schauer in Lehm.	MEL PRE
<i>Melaleuca raphiophylla</i>	Schauer in Lehm.	MEL RHA
<i>Melaleuca uncinata</i>	R.Br. in W.T.Aiton	MEL UNC
<i>Melaleuca viminea</i>	Lindl.	MEL VIM
<i>Mesomelaena tetragona</i>	(R.Br.)Benth.	MES TET
<i>Mirbelia dilatata</i>	R.Br. in W.T.Aiton	MIR DIL
<i>Nuytsia floribunda</i>	(Labill.)Fenzl in Endl.Fenzl,Benth.& Schott	NUY FLO
<i>Opercularia vaginata</i>	Juss.	OPE VAG
<i>Patersonia umbrosa</i>	Endl. in Lehm.	PAT UMB
<i>Pentapeltis peltigera</i>	(Hook.)Bunge in Lehm.	PEN PEL
<i>Persoonia longifolia</i>	R.Br.	PER LON
<i>Phylanthus calycinus</i>	Labill.	PHY CAL
<i>Pteridium esculentum</i>	(G.Forst.)Cockayne	PTE ESC
<i>Scaevola striata</i>	R.Br.	SCA STRI
<i>Stypandra glauca</i>	R.Br.	STY GLA
<i>Synaphea gracillima</i>	Lindl.	SYN GRA
<i>Tetrarrhena laevis</i>	R.Br.	TET LAE
<i>Themeda triandra</i>	Forssk.	THE TRI
<i>Tripterococcus brunonis</i>	Endl. in Endl.,Fenzl,Benth.& Schott	TRI BRU
<i>Trymalium floribundum ssp. floribundum</i>	Steud. in Lehm.	TRY FLO
<i>Viminaria juncea</i>	(Schrad.& J.C.Wendl.)Hoffmanns.	VIM JUN
<i>Xanthorrhoea gracilis</i>	Endl. in Lehm.	XAN GRA
<i>Xanthorrhoea preisii</i>	Endl. in Lehm.	XAN PRE
<i>Xylomelum occidentale</i>	R. Br.	XYL OCC

## Twinspan analysis of Mattiske Community Groups for the Waterloo-Busselton Survey

### GROUP A

#### 1j, 1h, 2c, 1k

1j – Disturbed woodland of *Banksia grandis* over *Xanthorrhoea preissii*, *Kingia australis*, *Xylomelum occidentale*, *Melaleuca viminea* ssp. *viminea*, *Viminaria juncea* and a range of introduced species on seasonally inundated flats

1h – Woodland of *Corymbia calophylla*-*Eucalyptus rudis*-*Melaleuca raphiophylla*-*Agonis flexuosa* on valley floor of streams crossing the coastal plain

2c – Disturbed woodland of *Melaleuca raphiophylla* over *Astartea fascicularis* over sedges along seasonal creeklines

1k – Open woodland of *Eucalyptus gomphocephala*-*Melaleuca raphiophylla* on creekline

### GROUP B

#### 1l, 2a, 4a, 1g

1l – Woodland of *Eucalyptus rudis*-*Melaleuca preissiana*-*Banksia littoralis* over sedges and shrubs on seasonally wet flats over ironstone on low undulating plain

2a – Open low woodland of *Melaleuca preissiana*-*Melaleuca raphiophylla* over shrubs on seasonally wet flats (Gibson 4)

4a – Closed heath of *Melaleuca incana* ssp. *incana*-*Viminaria juncea*-*Pericalymma ellipticum* var. *ellipticum*-*Grevillea manglesioides* ssp. *manglesioides*-*Kunzea recurva* on shallow ironstone outcropping on seasonally wet flats (Gibson 10b)

1g – Disturbed woodland of *Corymbia calophylla*-*Melaleuca raphiophylla* over shrubs on flat low undulating plains

### GROUP C

#### 2b, 1e, 3a

2b- Open low woodland of *Melaleuca preissiana*-*Melaleuca raphiophylla*-*Banksia littoralis* and *Banksia illicifolia* over shrubs on seasonally wet flats

1e – Woodland of *Eucalyptus marginata*-*Corymbia calophylla*-*Melaleuca preissiana*-*Banksia littoralis* over shrubs on seasonally wet flats on low undulating plains

3a – Low woodland of *Banksia littoralis*-*Banksia illicifolia*-*Nuytsia floribunda* over shrubs on localized outcropping on low undulating plains. Occasional *Corymbia calophylla* and *Eucalyptus marginata*.

### GROUP D

#### 1a, 1m, 1b, 1d

1a - Open forest of *Eucalyptus marginata*-*Corymbia calophylla*-*Allocasuarina fraseriana*-*Banksia grandis*-*Persoonia longifolia* over shrubs on lower slopes of Whicher Scarp

1m – Disturbed woodland to open forest of *Eucalyptus marginata*-*Allocasuarina fraseriana*-*Banksia grandis* over shrubs on slopes of Whicher Scarp

1b – Woodland to open forest of *Eucalyptus marginata*-*Allocasuarina fraseriana*-*Corymbia calophylla*-*Corymbia haemotoxylon* over banksias and shrubs on slopes of Whicher Scarp (Gibson 1a)

1d – Woodland of *Eucalyptus marginata*-*Corymbia calophylla* over *Banksia grandis*-*Banksia littoralis* and shrubs on low low undulating plains

**GROUP E**

**1i, 1f, 1c**

1i - Woodland of *Eucalyptus marginata*-*Corymbia calophylla*-*Eucalyptus patens*-*Agonis flexuosa* over shrubs on river banks

1f – Disturbed woodland of *Corymbia calophylla*-*Eucalyptus marginata*-*Agonis flexuosa* with *Nuytsia floribunda* over shrubs on flat low undulating plains

1c – Woodland of *Eucalyptus marginata*-*Corymbia calophylla* over shrubs in Whicher Scarp valleys

**Preliminary analysis of woodlands on heavy soils of the Swan Coastal Plain between Waterloo and Dunsborough based on WPGMA Clustering.**

Russell Smith, May 2005

**Community A**

**Sub-community A1: Sabina 1, Sabina 2, Sabina 3**

Site	Soil	Soil-landscape
Sabina River 1	yellow brown clay loam	Goodwood valleys
Sabina River 2	yellow brown clay loam	Goodwood valleys
Sabina River 3	grey-brown loam	Goodwood valleys

Note: In major river valley on alluvial soils.

Characteristic species (all quadrats)	Other species (> 50% of quadrats)
<i>Adenanthos barbiger</i>	<i>Corymbia calophylla</i>
<i>Chamelaucium erythrochlorum</i>	<i>Crowea angustifolia</i>
<i>Dryandra lindleyana</i>	<i>Hakea amplexicaulis</i>
<i>Eucalyptus marginata</i>	<i>Hibbertia amplexicaulis</i>
<i>Grevillea bronwenae</i>	<i>Kennedia carinata</i>
<i>Hibbertia hypericoides</i>	<i>Leucopogon verticillatus</i>
<i>Hypocalymma angustifolium</i>	<i>Persoonia longifolia</i>
<i>Isopogon sphaerocephalus</i>	<i>Pultenaea brachytropis</i>
<i>Xanthorrhoea gracilis</i>	<i>Tetratea viminea</i>
	<i>Xanthorrhoea preisii</i>

**Sub-community A2: Smith 1, Taylor 2, Taylor 3**

Site	Soil	Soil-landscape
Smith 1	yellow-brown loam	Whicher Scarp
Taylor 2	grey-brown sandy loam	Abba Plain (near Whicher Scarp)
Taylor 3	yellow-brown loam	Abba Plain (near Whicher Scarp)

Characteristic species (all quadrats)	Other species (> 50% of quadrats)
<i>Dampiera linearis</i>	<i>Acacia mooreana</i>
<i>Dasyopogon hookeri</i>	<i>Acacia pulchella</i>
<i>Eucalyptus marginata</i>	<i>Adenanthos barbiger</i>
<i>Patersonia umbrosa</i> var. <i>xanthina</i>	<i>Agrostocrinum scabrum</i>
<i>Scaevola caliptera</i>	<i>Billardiera variifolia</i>
<i>Taxandria parviceps</i>	<i>Boronia crenulata</i>
<i>Xanthorrhoea gracilis</i>	<i>Comesperma confertum</i>
	<i>Haemodorum laxum</i>
	<i>Johnsonia lupulina</i>
	<i>Lindsaea linearis</i>
	<i>Mesomelaena tetragona</i>
	<i>Pentapeltis peltigera</i>
	<i>Xanthorrhoea preisii</i>
	<i>Xylomelum occidentale</i>

**Sub-community A3:** Hurst Road 1, Hurst Road 2, [Hurst Road 3, Donnybrook 1, Yoongarillup]

Site	Soil	Soil-landscape
Hurst Road 1	red-brown loam	Goodwood valleys
Hurst Road 2	red-brown loam	Goodwood valleys
Hurst Road 3	red-brown loam	Goodwood valleys
Donnybrook 1	grey-brown loam	Pinjarra Plain (near Goodwood valleys)
Yoongarillup	red-brown loam	Abba Plain

Note: On alluvial soils in valleys or near rivers crossing the plain, or lower slopes of minor valleys.

Characteristic species (all quadrats)	Other species (> 50% of quadrats)
<i>Agonis flexuosa</i> <i>Corymbia calophylla</i>	<i>Acacia pulchella</i> <i>Bossiaea linophylla</i> <i>Eucalyptus marginata</i> <i>Hakea amplexicaulis</i> <i>Hakea lissocarpha</i> <i>Hibbertia hypericoides</i> <i>Hypocalymma robustum</i> <i>Kennedia prostrata</i> <i>Patersonia umbrosa</i> var. <i>xanthina</i> <i>Xanthorrhoea gracilis</i> <i>Xanthorrhoea preisii</i>

**Community B**

Waterloo 1, Waterloo 2, Waterloo 3, Waterloo 4, Railway 1, Railway 2, Speedway, Roselands 1, Roselands 2, Taylor 1, Taylor 4

Characteristic species (all quadrats)	Other species ( $\geq$ 50% of quadrats)
<i>Corymbia calophylla</i>	<i>Agrostocrinum scabrum</i> <i>Austrostipa semibarbata</i> <i>Dampiera linearis</i> <i>Hakea varia</i> <i>Mesomelaena tetragona</i> <i>Schoenus bifidus</i> <i>Viminaria juncea</i> <i>Xanthorrhoea gracilis</i> <i>Xanthorrhoea preisii</i>

**Sub-community B1**

Waterloo 1, Waterloo 2, Waterloo 3, Waterloo 4

Site	Soil	Soil-landscape
Waterloo 1	red-brown clay loam	red-brown clay loam
Waterloo 2	red-brown clay loam	red-brown clay loam
Waterloo 3	red-brown clay loam	red-brown clay loam
Waterloo 4	red-brown clay loam	red-brown clay loam

Characteristic species (all quadrats)	Other species ( $\geq 50\%$ of quadrats)
<i>Corymbia calophylla</i> <i>Mesomelaena tetragona</i> <i>Xanthorrhoea preisii</i>	<i>Acacia pulchella</i> <i>Dampiera linearis</i> <i>Eucalyptus rudis</i> <i>Kennedia prostrata</i> <i>Schoenus bifidus</i> <i>Viminaria juncea</i>

**Sub-community B2:** Railway 1, Railway 2, Speedway, Roselands 1, Roselands 2, Taylor 1, Taylor 4

Site	Soil	Soil-landscape
Railway 1	red-brown clay loam	Pinjarra Plain
Railway 2	red-brown clay loam	Pinjarra Plain
Railway 3	red-brown loam	Pinjarra Plain
Roselands 1	brown loam	Pinjarra Plain
Roselands 2	brown loam	Pinjarra Plain
Taylor 1	red-brown loam	Abba Plain
Taylor 4	red-brown loam	Abba Plain

Characteristic species (all quadrats)	Other species ( $\geq 50\%$ of quadrats)
<i>Corymbia calophylla</i>	<i>Agrostocrinum scabrum</i> <i>Austrostipa semibarbata</i> <i>Hakea varia</i> <i>Microtis media</i> <i>Mesomelaena tetragona</i> <i>Schoenus bifidus</i> <i>Viminaria juncea</i> <i>Xanthorrhoea gracilis</i>

## Community C

Smith 2, Dardanup 1, Dardanup 2, Ruabon 1, Ruabon 2, Ruabon 3, Crooked Brook Road, Ambergate, Railway 3

Characteristic species (all/most quadrats)	Other species ( $\geq 50\%$ of quadrats)
<i>Corymbia calophylla</i> <i>Xanthorrhoea gracilis</i> <i>Xanthorrhoea preisii</i>	<i>Acacia extensa</i> <i>Acacia pulchella</i> <i>Adenanthos meisneri</i> <i>Austrostipa semibarbata</i> <i>Caladenia flava</i> <i>Cyathochaeta avenacea</i> <i>Dampiera linearis</i> <i>Dasyogon bromeliifolius</i> <i>Desmocladius fasciculatus</i> <i>Dryandra lindleyana</i> <i>Eucalyptus marginata</i> <i>Hibbertia hypericoides</i> <i>Mesomelaena tetragona</i>

### Sub-community C1: Crooked Brook Road, Ambergate

Site	Soil	Soil-landscape
Crooked Brook Road	grey-brown loam	Pinjarra Plain
Ambergate	grey-brown loam	Abba Plain

Characteristic species (all quadrats)	Other species ( $\geq 50\%$ of quadrats)
<i>Adenanthos meisneri</i> <i>Agrostocrinum scabrum</i> <i>Austrostipa semibarbata</i> <i>Conostylis setigera</i> <i>Corymbia calophylla</i> <i>Dasyogon bromeliifolius</i> <i>Desmocladius fasciculatus</i> <i>Dryandra lindleyana</i> <i>Eucalyptus marginata</i> <i>Lagenophora heugelii</i> <i>Lyginia barbata</i> <i>Mesomelaena tetragona</i> <i>Patersonia umbrosa var. xanthina</i> <i>Synaphea petiolaris</i> <i>Tripterococcus brunonis</i> <i>Xanthorrhoea gracilis</i> <i>Xanthorrhoea preisii</i>	

**Sub-community C2: Smith 2, Dardanup 1, Dardanup 2, Ruabon 1, Ruabon 2, Ruabon 3, Railway 3**

Site	Soil	Soil-landscape
Smith Road 2	yellow-brown sandy loam	Whicher Scarp
Dardanup 1	grey sandy loam	Pinjarra Plain
Dardanup 2	grey sandy loam	Pinjarra Plain
Ruabon 1	yellow brown sandy loam	Abba Plain
Ruabon 2	grey-brown sandy loam	Abba Plain
Ruabon 3	red-brown gravelly loam	Abba Plain
Railway 3	red-brown loam	Pinjarra Plain

Characteristic species (all or most quadrats)	Other species ( $\geq 50\%$ of quadrats)
<i>Corymbia calophylla</i> <i>Eucalyptus marginata</i> <i>Xanthorrhoea gracilis</i>	<i>Acacia extensa</i> <i>Acacia pulchella</i> <i>Adenanthos meisneri</i> <i>Burchardia umbellata</i> <i>Caladenia flava</i> <i>Cyathochaeta avenacea</i> <i>Dampiera linearis</i> <i>Desmocladius fasciculatus</i> <i>Eucalyptus marginata</i> <i>Hibbertia hypericoides</i> <i>Philotheca spicata</i> <i>Xanthorrhoea preisii</i>

## Community D

Donnybrook 1, Hurst Road 3

Site	Soil	Soil-landscape
Donnybrook 1	grey-brown loam	Pinjarra Plain (near Goodwood valleys)
Hurst Road 3	red-brown loam	Goodwood valleys (near Pinjarra Plain)

Characteristic species (all quadrats)	Other species ( $\geq 50\%$ of quadrats)
<i>Acacia pulchella</i> <i>Agonis flexuosa</i> <i>Agrostocrinum scabrum</i> <i>Boronia spathulata</i> <i>Bossiaea linophylla</i> <i>Corymbia calophylla</i> <i>Desmocladus fasciculatus</i> <i>Deyeuxia quadriseta</i> <i>Eucalyptus marginata</i> <i>Hakea amplexicaulis</i> <i>Hibbertia hypericoides</i> <i>Hypocalymma robustum</i> <i>Leucopogon capitellatus</i> <i>Patersonia umbrosa</i> var. <i>xanthina</i> <i>Xanthorrhoea gracilis</i> <i>Xanthorrhoea preisii</i>	

Site data for Woodlands of southern Swan Coastal Plain survey – Russell Smith, 2005

Site Number	Site Code	Site Name	Latitude	Longitude	Soil	Soil_landscape	Community	Sub-community
1	SAB1	Sabina River 1	-33.7708	115.4548	yellow brown clay loam	214Gv	A	A1
2	SAB2	Sabina River 2	-33.7706	115.4549	yellow brown clay loam	214Gv	A	A1
3	SAB3	Sabina River 3	-33.7700	115.4555	grey-brown loam	214Gv	A	A1
4	YON1	Yoongarillup	-33.7207	115.4388	red-brown loam	213Ab	A	A3
5	SMI1	Smith Road 1	-33.8001	115.2976	yellow-brown loam	214Ws	A	A2
6	SMI 2	Smith Road 2	-33.8014	115.2975	yellow-brown sandy loam	214Ws	C	C2
7	WAT1	Waterloo 1	-33.3277	115.7632	red-brown clay loam	213Pj	B	B1
8	WAT2	Waterloo 2	-33.3271	115.7692	red-brown clay loam	213Pj	B	B1
9	WAT3	Waterloo 3	-33.3289	115.7640	red-brown clay loam	213Pj	B	B1
10	WAT4	Waterloo 4	-33.3278	115.7625	red-brown clay loam	213Pj	B	B1
11	HUR1	Hurst Road 1	-33.5170	115.7541	red-brown loam	214GV	A	A3
12	HUR2	Hurst Road 2	-33.5264	115.7612	red-brown loam	214GV	A	A3
13	HUR3	Hurst Road 3	-33.5076	115.7470	red-brown loam	214GV	A	A3
14	CRO1	Crooked Brook Road	-33.4118	115.7547	grey-brown loam	213Pj	C	C1
15	DON1	Donnybrook Block 1	-33.4929	115.7487	grey-brown loam	213Pj	A	A3
16	DAR1	Dardanup 1	-33.4405	115.7793	grey sandy loam	213Pj	C	C2
17	DAR2	Dardanup 2	-33.4409	115.7798	grey sandy loam	213Pj	C	C2
18	RAL1	Railway Line 1	-33.5023	115.6640	red-brown clay loam	213Pj	B	B2
19	RAL2	Railway Line 2	-33.5023	115.6646	red-brown clay loam	213Pj	B	B2
20	RAL3	Railway Line 3	-33.5210	115.6032	red-brown loam	213Pj	C	C2
21	RUA1	Ruabon 1	-33.6417	115.5053	yellow brown sandy loam	213Ab	C	C2
22	RUA2	Ruabon 2	-33.6415	115.5002	grey-brown sandy loam	213Ab	C	C2
23	RUA3	Ruabon 3	-33.6443	115.5038	red-brown gravelly loam	213Ab	C	C2
24	SPE1	Bunbury Speedway	-33.3768	115.6850	grey-brown sandy loam	213Bs	B	B2
25	ROS1	Roselands 1	-33.4743	115.6020	brown loam	213Pj	B	B2
26	ROS2	Roselands 2	-33.4744	115.6028	brown loam	213Pj	B	B2
27	AMB1	Ambergate Reserve	-33.7365	115.3273	grey-brown loam	213Ab	C	C1
28	TAY1	Taylor's Ironstone Reserve	-33.7513	115.2021	red-brown loam	213Ab	B	B2
29	TAY2	Taylor's Ironstone Reserve	-33.7534	115.2018	grey-brown sandy loam	213Ab	A	A2
30	TAY3	Taylor's Ironstone Reserve	-33.7581	115.2034	yellow-brown loam	213Ab	A	A2
31	TAY4	Taylor's Ironstone Reserve	-33.7515	115.2033	red-brown loam	213Ab	B	B2