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Att: Mr Frank Batini

Your Ref Min 22666
Our Ref
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BIOLOGICAL SURVEY OF SOUTH GUILDERTON DEVELOPMENT AREA

In response to your request for information on any DEP survey of the proposed development on the south side of the Moore River Estuary. This proposal was not formally assessed because the bushland was not recognised as regionlly significant at the time.

The owner of the land in question (through his planning consultant) refused the DEP botanist access to the property to undertake a flora and vegetation assessment, on the basis that DEP had determined that the land was not regionally significant.

DEP argued the need for a flora, vegetation and landform assessment to define an effective foreshore reserve along the Moore River, to take into account the environmental values of the foreshore (reference System 6 general recommendation recognising the potential for a regional park along the Moore River) and the management difficulties associated with the steep land along the river.

As the DEP botanist had been refused access DEP contracted a suitably experienced alternative botanist/soil scientist from AGWEST Land Management to do this work, though in the end the DEP botanist was allowed to accompany and work with the consultant botanist on the survey. This vegetation survey was confined to an assessment of the areas that might reasonably be considered for inclusion in a foreshore reserve along the estuary of the Moore River including their regional context, and considering development constraints such as land stability, management and landscape issues.

A copy of this report is attached for your information. The report identified significant values and was used to help define a proposed foreshore reserve.

Yours sincerely

R A D Sippe
DIRECTOR
POLICY COORDINATION DIVISION

9 March 2000

ENTERED ON GIS

Name: An Assessment of Foreshore Vegetation of the South Guilderton Project
Date: 15/05/2006
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An Assessment of Foreshore Vegetation of the South Guilderton Project

prepared for

Department of Environmental Protection

by

AGWEST Land Management

E. A. Griffin

February 25, 1998

to be quoted as

E.A. Griffin (1998) An assessment of foreshore vegetation of the south Guilderton Project. Unpublished report for Department of Environment Protection. AGWEST Land Management Job 9837.

Summary

This report is prepared to assist the Department of Environmental Protection in providing advice to the Shire of Gingin as to the adequacy of the foreshore reserve proposed for the South Guilderton development. In so doing it describes the vegetation adjacent to the foreshore south of the Moore River and places the plant communities into a regional context. It considers what land would be necessary to protect the river environment and the adequacy of the reserve proposed by the proponent.

The floristic composition of vegetation of the Quindalup dunes has been recognized to vary in composition in response to geomorphology and also follows a regional pattern (Griffin, 1993 and Griffin and Trudgen, 1994). The Moore River was nominated as a boundary between sectors of the coast which have suites of vegetation with different floristic composition. The vegetation of the South Guilderton area fits well into these geomorphological and regional patterns. There is some evidence of a zone of overlap between the regional sectors.

While the vegetation fits into this regional pattern, some elements are localized in character. In particular the floristic composition of the vegetation west of the mobile sand sheet (deflated areas) is different from other vegetation in the data sets south of Lancelin. These areas relate to vegetation of similar age north of Lancelin. It is different from and older than that of the deflated areas of the mobile sand sheet between Burns Beach and Mindarie.

Like the Hill and Swan Rivers, the Moore River truncates the Tamala Limestone. Quindalup dunes are perched on the limestone but not covering all of it. The vegetation adjacent to the southern boundary of the Moore River is diverse both in floristic composition and structure and reflects the diversity of landforms. *Melaleuca rhaphiophylla* dominates a narrow strip immediately adjacent to the river. *Melaleuca cardiophylla* and *M. huegelii* dominate areas of limestone outcrop. The vegetation of the calcareous Quindalup dunes reflects different geomorphological sere. There are areas of partially vegetated sand, older areas with *Spyridium globulosum* and *Allocasuarina lehmanniana*, areas of Tuart woodland and a number of different types dominated by *Melaleuca acerosa* and allies.

The steep areas of the Moore River adjacent the estuary is highly vulnerable to degradation. Some areas are above the angle of repose, being held together by the sparse vegetation. Other areas, some bare sand and some well vegetated, are moderately to steeply inclined. Even the well-vegetated areas are highly vulnerable and it takes as little as a heavy rain storm to initiate erosion. Development as low key as tracks and firebreaks could initiate degradation affecting the character of the river and its environment. Careful planning will be needed to minimise the export of nutrients which leach in ground water from parks and gardens and could end up in the river.

Careful consideration should be given to the portions of the mobile sandsheet which are to be included in the foreshore reserve. These should be protected by fencing where erosion risk is high. Stabolising with vegetation including pip grass should be avoided since it will inevitably invade adjacent natural areas.

Introduction

The privately owned land south of the Moore River at Guilderton has been proposed for urban development. Most aspects of the rezoning the area from rural to urban have been through a review process. The requirements for an area to protect the Moore River is currently being considered.

The Department of Environmental Protection requested advice on the character of the natural areas adjacent to the river and to place the vegetation composition into a the regional context.

Griffin and Trudgen (1994) recognized several broad floristic clusters and sub clusters (Table 1). Griffin (1993) and Griffin and Trudgen (1994) demonstrated regional floristic patterns in detailed site studies of Quindalup dune vegetation. A number of coast sectors which had particular suites of floristic types were identified (Table 2). Gibson et al (1994) demonstrated distinct differences between Quindalup and other dune systems. The also recognized some variation within broad geomorhpological types.

Table 1 Broad floristic clusters Griffin and Trudgen (1994)

A	older dunes
Aa	included most of the older dune sites from Alkimos, Wilbinga, Manakoora and the two reserves from Ledge Point
Ab	mostly from the Burns Beach and Mindarie areas with a few sites from Alkimos and Trigg
Ac	mostly from Swanbourne with one site from Trigg
B	a grouping of dunes and shallow plains mostly sampled in 1991, somewhat artificial group, mostly from Breton Bay, Mindarie and Burns Beach
Ba	principally plains (Qs, Qp and Kls) and a few dunes, more calcareous sand than other plains with limestone close to the surface
Bb	mostly dunes between Ledge Point and Breton Bay
Bc	lacked the annual species typical of the rest of group B
C	exposures of Tamala limestone and yellow siliceous sand, Ledge Point and Wilbinga
D	incipient foredunes and very young dunes
E	young dunes and very young plains
Ea	young dunes and foredunes
Eb	almost entirely recently deflated plains (Qs, Qp and Qb). They occurred close to the coast throughout the study area

Table 2 Floristic sectors of Quindalup dune vegetation (Metropolitan area).

1	Lancelin to Moore River,
2	Moore River to Quinns Rock,
3	Quinns Rock to Sorrento, and
4	South of Sorrento

Methods

The areas bordering the south of the river were visited on two occasions; one in October 1997 and one in January 1998. The vegetation was described and species lists were made at 17 releves of about $100m^2$ (Figure 1). Neither visit was at a time that was ideal for collecting floristic data. However, from experience in this vegetation, at least 80% of species are likely to have been recorded. This is generally adequate for this type of analysis.

There was no attempt to sample all vegetation types. The strategy was to collect information to assist in describing the areas along the banks of the river and to be able to make comparisons with vegetation of other coastal areas.

This data was combined with comparable data from four other sets, Griffin (1993), Griffin and Trudgen (1994), Gibson et al. (1994) and DEP (1996). The 344 sites with 483 plant taxa were from south of Lancelin to south of Busselton. These data were subjected to a number of numerical analysis techniques from the package PATN (Belbin et al 1984). This involved classification, ordination and a number of summary programs. A number of clustering levels were assessed, but no attempt was made to define floristic units such as associations.

Aerial photo interpretations were made of the vegetation of the southern fringe of the river. The units, mainly soil-landscape phases, were described.

Risks of land degradation were assessed.

Plate 1 Westward view from eastern boundary of south Guilderton Project

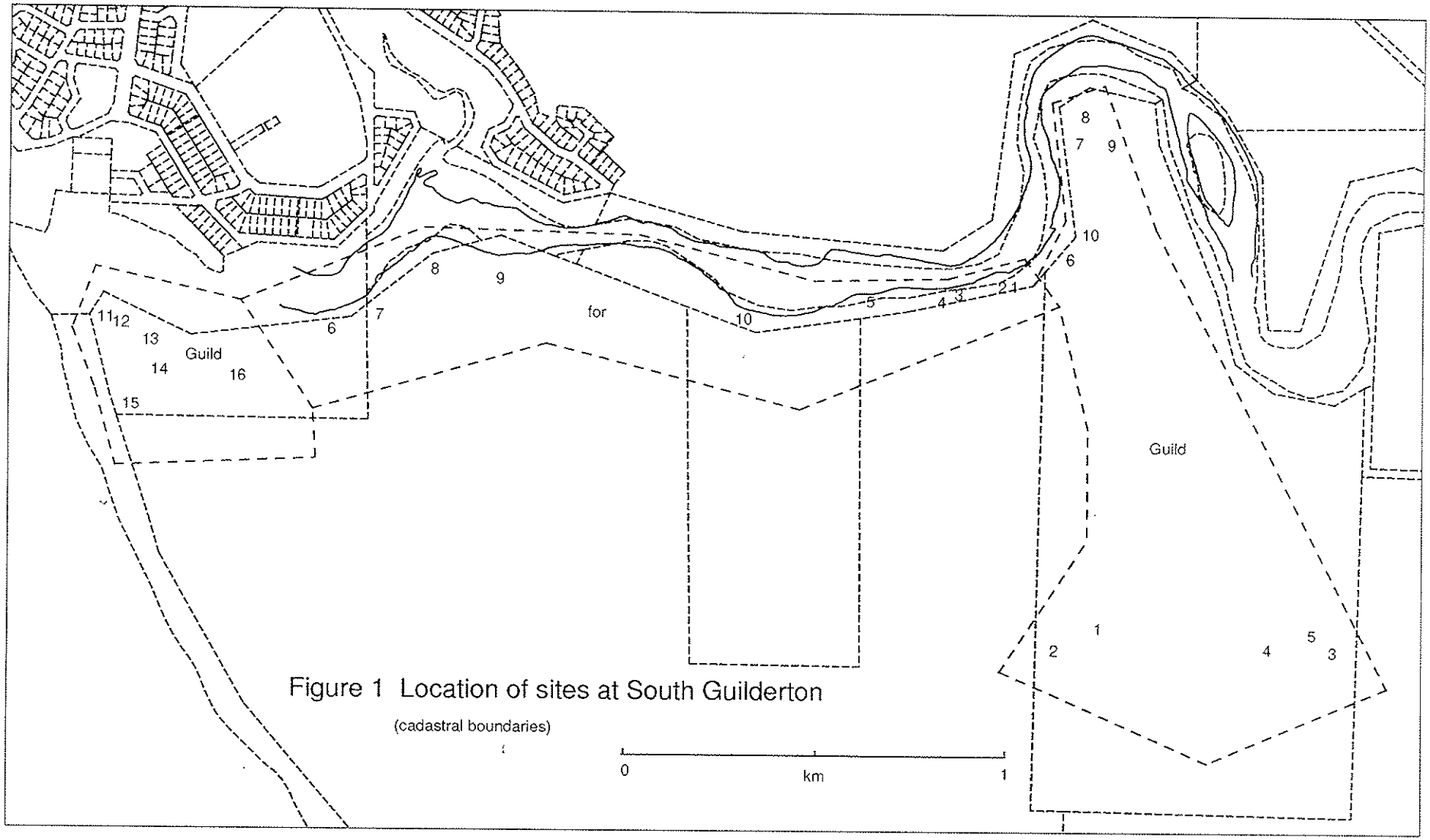


Figure 1 Location of sites at South Guilderton

(cadastral boundaries)

Results

Floristic data

Despite being mostly from Quindalup dunes, the data set was diverse. Over 40 % of the species occurred in just one or two sites (<1% sites), e.g. *Centella asiatica, Pimelea calcicola, Thomasia triphylla, Schoenus pleiostemoneus, Eucalyptus argutifolia* and *Patersonia occidentalis*. In part this was because some sites were from damplands or Spearwood dunes. This has meant that some sites were very different from the rest. Falling into this class were 18 sites that had similarity coefficients of greater than 0.55 to any other site. Many of these tended to form clusters of 3 or fewer sites.

On the other hand Melaleuca acerosa, the most common species was in 234 sites (68%). Other more commonly occurring species included *Conostylis candicans* subsp. *calcicola, Lomandra maritima, Loxocarya aspera, Stipa flavescens* and *Acanthocarpus preissii*. Some sites were very similar having similarity coefficients of less than 0.2 to at least one other site. These tended to fall in cluster 1 (of 20 level clustering).

There was a wide range of species richness. Twelve sites had less than 10 species. These were mostly areas of strand and very young regeneration on the deflation basins. The maximum richness was 63 with 3 others having greater than 50 species. These data also confirm the diversity of the data set. Potentially the analysis will be affected by the diversity, not so much because of the wide range of variation but more because of the disproportionate representation (odd sites). At the 20, 50, and 100 cluster levels there were 2, 8 and 37 singleton clusters respectively. The effects of these singletons are minor at the lower levels of clustering (100 or 50 cluster levels). At the higher (20 or 7 cluster levels) it is common for many of the disparate clusters to be joined together and the product clusters have little meaning.

The minimum spanning diagram joins all sites to their nearest possible neighbor to form a tree (Figure 2). The minimum number of inter-cluster linkages is one less than the number of clusters. The number of inter-cluster linkages in relation to this minimum is an indication of how tight the clusters are. It can also be used to give an indication of how many 'real' clusters there are in the data set. This method of analysis demonstrates that the 7 cluster level is not particularly meaningful since there is over five times the minimum number of inter-cluster linkages (Table 3). This percentage drops significantly as the number of clusters increase. The number of 'real' clusters in this data set is probably greater than 50. At this level of clustering there is good correspondence between the clustering and the minimum spanning analysis.

Table 3 Minimum Spanning Diagram linkages

	Cluster level			
	7	20	50	100
min # inter-cluster linkages	6	19	49	99
# inter-cluster linkages	41	72	100	142
% of min #	583	279	204	143

Homotoneity can be used as a measure of how homogeneous clusters are. Values of at least 1 are considered homotonous. The whole data set has a homotoneity value of 0.00, extremely heterotonous. Table 4 demonstrates clusters become more homotonous as the data set in divided into more clusters. It also demonstrates that the clusters at the 7 and 20 cluster levels and probably also the 50 cluster levels are not homotonous. This suggests also that there should be more than 50 "natural" clusters in this data set.

Figure 3
Minimum Spanning Tree

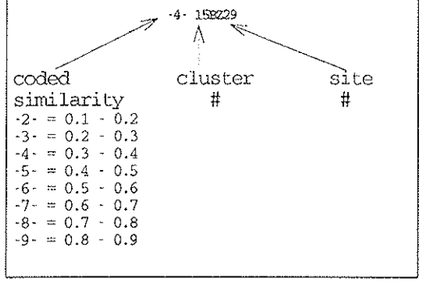


Table 4 Homotoneity values for 7, 20 and 50 cluster levels

Homotoneity = CIV+CV/CII+CIII, where

CII number of species occurring in 20 to 40% of sites in cluster
CIII number of species occurring in 40 to 60% of sites in cluster
CIV number of species occurring in 60 to 80% of sites in cluster
CV number of species occurring in 80 to 100% of sites in cluster

7	H	20	H	50	H
1	0.27	1	0.63	1	0.63
		2	0.58	2	0.57
				3	0.29
				4	1.00
		3	0.50	5	0.58
				6	0.42
				7	0.41
2	0.20	4	0.23	8	0.48
				9	0.26
				10	0.26
				11	0.34
				12	0.31
		5	0.29	13	0.45
				14	0.84
				15	0.45
				16	0.67
				17	0.31
		6	0.58	18	0.58
		7	0.38	19	0.50
				20	0.39
				21	0.55
3	0.85	8	0.85	22	0.85
4	0.15	9	0.27	23	0.40
				24	0.46
				25	0.50
		10	0.44	26	0.44
5	0.35	11	0.43	27	0.68
				28	0.79
				29	0.46
		12	0.18	30	0.93
				31	na
6	0.06	13	0.24	32	0.93
				33	0.79
				34	0.41
		14	0.09	35	0.35
				36	0.18
				37	0.50
				38	na
				39	0.61
		15	0.17	40	0.41
				41	0.64
		16	0.22	42	na
				43	na
				44	na
		17	0.15	45	0.50
				46	0.38
		18	0.37	47	na
				48	0.23
		19	na	49	na
7	na	20	na	50	na

na not applicable, only one site in cluster group

There were some patterns of clusters on the ordination diagram (not presented) which tends to support the clustering. However, the diversity of the data set was too great to be portrayed reasonably on 2 or 3 ordination axes. More involved analysis of subsets would be necessary to achieve more from ordination techniques. This was not possible in the current time frame or considered necessary in light of the data from the classification.

Appendix 1 provides a dendrogram illustrating the fusion of sites into clusters. Cluster numbers from four different levels of clustering are indicated for each site. An obvious feature is wide range of size of clusters. This supports the earlier comments about how these data included a number of "odd" sites and how these were treated in the analysis.

Appendix 2 is a tabulation of species by the 20 clusters. The species are ordered and grouped by a dendrogram derived from the classification of species. Only species which were present in more than 30% of sites in at least one cluster have been included. This table is presented as a way of illustrating the degree of overlap of species in cluster groups. There are some small groups of species which are only present in one or two clusters, frequently singleton clusters. Most other species are present in several to many clusters. Tables 5 and 6 are derivations of this appendix. They show respectively the species which are faithful to the 7 and 20 clusters. Most of these are faithful to the small and relatively small site clusters.

Table 5 Faithful species to 7 clusters in data set

(Species present in less than 30% of any cluster have been omitted.)
(Species ordered to emphasize the association of species with site clusters.)
(Number prefix to name is 50 cluster number from classification of species.)

	clusters -->	1	2	3	4	5	6	7
	name # sites -->	154	87	6	18	39	39	1
20	Mesomelaena pseudostygia			67			7	
20	Hibbertia hypericoides			50			10	
30	Daviesia divaricata		3	50				
34	Anigozanthos humilis subsp. humilis		2	33				
36	Allocasuarina humilis		2	67			2	
36	Bossiaea eriocarpa			67				
36	Hakea trifurcata			83		2		
36	Petrophile serruriae		2	83				
36	Hakea lissocarpha		6	83				
36	Hakea prostrata	1	4	67			2	
36	Jacksonia stricta			50				
6	Olearia rudis		2	50				
36	Grevillea thelemanniana subsp. preissii		12	67			2	
36	Dryandra lindleyana	1	12	83			2	
36	Dryandra sessilis var. cygnorum	1	12	83		5	12	
10	Spinifex hirsutus				27			
10	Cakile maritima				38			
11	Calocephalus brownii				55	9		
11	Myoporum insulare	4	7		5	45	7	
25	Caladenia latifolia		7				33	
25	Carex preissii		5				34	
25	Oxalis perennans						27	
25	Agonis flexuosa		2				30	
42	Melaleuca rhaphiophylla						2	100
43	Triglochin procerum							100
43	Baumea arthrophylla							100
43	Baumea articulata							100
43	Baumea juncea							100
43	Lepidosperma longitudinale							100
46	Samolus repens						3	100
13	Gahnia trifida						3	100

Table 6 Faithful species to 20 clusters in data set
(Species present in less than 30% of any cluster have been omitted.)
(Species ordered to emphasize the association of species with site clusters.)
(Number prefix to name is 50 cluster number from classification of species.)

	7 clusters -->	1			3	2				4		5		6							7
	20 clusters -->	3	1	2	8	5	6	4	7	9	10	11	12	13	14	15	16	17	18	19	20
	name # sites -->	59	79	16	6	43	8	21	15	14	4	35	4	12	12	4	3	4	3	1	1
30	Daviesia divaricata				50	7															
36	Bossiaea eriocarpa			6	67	2															
36	Petrophile serruriae	2			83	5															
36	Hakea prostrata	2		6	67	9								8							
36	Jacksonia stricta			6	50	2															
36	Olearia rudis				50	5															
10	Spinifex hirsutus									7	100										
10	Actites megalocarpa										50										
1	Banksia prionotes												50								
25	Geranium retrorsum								7					58							
25	Hibbertia cuneiformis													83							
19	Drosera erythrorhiza															50					
19	Conyza albida															50					
20	Sowerbaea laxiflora													8		50					
20	Urospermum picroides															50					
20	Podotheca gnaphalioides							5								50					
26	Thysanotus manglesianus													8			33				
29	Pelargonium littorale					5								8			67				
42	Alyogyne huegelii var. glossulariaefolius					2											67				
47	Lolium sp.																		67		–
47	Hydrocotyle diantha																		100		
47	Triglochin mucronatum																		67		
47	Plantago exilis																		67		
41	Spergula sp. scps																			100	
41	Crassula sp.																			100	
41	Siloxerus sp.																			100	
41	Hydrocotyle medicaginoides																			100	
41	Ranunculus pumilio													8						100	
41	Lolium perenne	3										3								100	
43	Triglochin procerum																				100
43	Baumea arthrophylla																				100
43	Baumea articulata																				100
43	Baumea juncea																				100
43	Lepidosperma longitudinale																				100

The constant (most frequently occurring) species in each of the 7 and 20 level clusters are provided in Appendix 3. This Appendix is nested to show what species are constant in the 7 level clusters and the corresponding 20 level clusters.

The sector of the coast in which the site falls, the floristic clusters of Griffin and Trudgen 1994 and of Gibson et al (1994) are provided in the dendrogram in Appendix 1. The clusters in this analysis show significant correspondence with these other data.

Table 7 indicates the association of the present clustering with that of Griffin and Trudgen (1994). This association is good. However, it illustrates that additional sites can influence the clustering, particularly at the higher levels (larger clusters). Griffin and Trudgen (1994) noted that their cluster B was diverse and this is borne out in this table. The other clusters show a stronger association. Although all subdivisions of their cluster Aa was within cluster 1 (at 50 cluster level), there was good association with the subdivisions with each associated with one or two distinct clusters at the 100 cluster level.

Table 7 Comparison of clustering with that of Griffin and Trudgen (1994).

Sites not in both data sets have been omitted from this table,
so too are clusters to which some of the omitted sites belong.
gp cluster from Griffin and Trudgen (1994)# 40 cluster number from Griffin and Trudgen (1994)

7 clusters ->		1						2										3	4				5		
20 clusters ->		1	2		3			4				5			6	7		8	9			10	11		
50 clusters ->		1	2	3	5	6	7	8	9	10	11	13	14	17	18	19	20	22	23	24	25	26	27	28	29
gp*	#																								
Aa	1	22			1																				
Aa	2	18				1																			
Aa	3	4																							1
Aa	4	34																							
Ab	5				26	1							1												
Ab	6					19																			
Ab	7						2																		
Ab	8						3																		
Ab	9						1																		
Ac	10															7									
Ac	11																1								
Ba	12							2																	
Ba	13								1																
Ba	14								2																
Ba	15														1										
Ba	16									2															
Ba	17														5										
Ba	18					4																			
Ba	19														2										
Bb	20											11													
Bb	21											4													
Bc	22		4																						
Bc	23		4																						
Bc	24			4																					
C	25																	1							
C	26																	5							
D	27																		5						
D	28																			2					
D	29																			1					
D	30																					4			
Ea	31																						8		
Ea	32																						8		
Ea	33																							8	
Ea	34																						1		5
Eb	35										2														
Eb	36																								
Eb	37																				1				
Eb	38																		2						
Eb	39																								2
Eb	40																				3				

There is some correlation of the clusters between the current study and that of Gibson et al (1994) (Table 8). This shows that the association is moderate at the 7 cluster level but declines at more detailed levels. The low correspondence may be associated with the analysis of Gibson et al (1994) being of a much wider range of vegetation types and the relatively small number of sites in their data from the Quindalup dunes.

Table 8 Comparison of clustering with that of DEP (1996).

f_type floristic type from DEP (1996).

7 clusters ->	1			2				3	4		5		6							7
20 clusters ->	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
f_type																				
29a	1			10	1				1				3	1			1		1	
29b	5		7	3	18	1	7													
s11							1													
30a2																	2			
30c2														6	2	2				
30b													9			1				
other sites	73	16	52	8	24	7	7	6	13	4	35	4		5	2		1	3		1

Tables 9, 10 and 11 show that there is broad and significant correspondence between the site clustering and the sector of the coast in which the sites fall. Most site clusters from the 7 and 20 cluster levels fall into sites in more than one sector. However, when the 50 cluster levels are considered the correspondence with sectors is much stronger. Sectors are characterised by one or several clusters which are confined to one (or two adjacent) sectors. This analysis supports the division of the coast into sectors suggested by Griffin and Trudgen (1994). The clusters which are more wide spread tend to be those from the strand and young foredunes. The more confined clusters are older dunes and restricted habitat types such as damp lands etc.

Plate 2 Eastward view towards eastern boundary of south Guilderton project.

Two additional sectors are tentatively proposed, these for south of the Swan River. The existence of these additional sectors is clear but the data is too few to define them in any detail. These will need to be reconciled with those sectors suggested by Searle and Semeniuk (1985) and Semeniuk et al (1989) from geomorphological characteristics.

The existence of sectors can be explained in overlapping distribution patterns of species. Griffin (1994) documented the range of a wide range of species which contribute to this phenomenon. This aspect has not been investigated in this study but would be worth further study.

Guilderton sites

The 26 sites sampled in this study are highlighted in the dendrogram (Appendix 1). While these were from 5 of the 7 level clusters, they were concentrated in relatively few of the higher (e.g. 50) level clusters. Plant communities which belong to other clusters were noted but not sampled. These include the strand vegetation, the foredunes and the early stages of regeneration after the passing of the sand sheet. The nearest neighbours to these 26 sites were mostly sites from close by such as at Wilbinga. These data indicated local consistency in floristic composition. This can also be seen in the minimum spanning tree.

Further investigation showed that the sites from the Guilderton South area fitted well into the regional patterns. From Table 10 it can be seen that most of the sites belonged to 20 level site clusters which were from combinations of sectors 1, 2 or 3; not strongly confined at this level. However, from Table 11 it can be seen that 11 of the sites belonged to 50 level site clusters which were confined to sector 2. All but one of the other sites belonged to 50 level site clusters which were confined to sectors 1 and 2.

The level 50 clusters which were confined to the south Guilderton area were mostly associated with the regeneration of deflated areas after the passing of the mobile sand sheet. These areas were typically dominated by a suite of species including *Spyridium globulosum* and *Allocasuarina lehmanniana*, with a range of faithful species. These clusters are contributing to a localized characteristic suite of floristic communities. This is in part because there are virtually no other deflated areas within the study area with vegetation at this stage of re-establishment. There are very young areas in the deflated areas at Mindarie and Manakoora. The nearest that vegetation of similar development occurs is in the Nilgen Nature Reserve (north of Lancelin). However, there are species in these areas at south Guilderton not in corresponding parts of Nilgen, e.g. *Billardiera* sp. Seabird (G.J. Keighery 12977), *Dryandra sessilis* and *Banksia prionotes*. These differences are probably due to the differences in the nature of the deflated areas. At Nilgen the deflated area is mainly weakly cemented Holocene limestone with calcareous sand. At south Guilderton the deflated area is Tamala limestone with its yellow sand and added calcareous sand.

The areas of Tuart in the South Guilderton area are associated with the species favouring post sand sheet regeneration - *Spyridium globulosum* and *Acanthocarpus preissii.*

The occasional presence of *Allocasuarina lehmanniana* in a number of sites along the foreshore tended to contribute to these being different from other sites in the data set with *Melaleuca acerosa* and *Acacia lasiocarpa.*

Table 9 Clusters by area and sector

(areas sorted roughly from N to S)

1 Lancelin to Moore River,
2 Moore River to Quinns Rock,
3 Quinns Rock to Sorrento,
4 Sorrento to Swan River,
5 Swan River to Mandurah,
6 Mandurah to Busselton

7 cluster -->		1			2				3	4				5						6
20 cluster -->		1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
S	area																				
1	LS	6	1							3		5									
1	PS	13	2						2												
1	MAN	21	6						2												
1	LP					4															
1	BB	6	1		3	11	6		1	3		8									
1	SEAB				3	3											1				
2	for	1	4		1								3		1						
2	Guild				1	10							1		1	2					1
2	NWIL					2															
2	WIB	21	1	2	1				1			1									
2	wilb				2	3						2									
2	tokyu				1	2															
2	xyan																1				
2	pip																1				
2	ALK	7		8	1																
3	MI			17			2			6	2	8									
3	BZ	4	1	29		1				1		7									
3	BU				4																
3	BURN				2																
3	Pinn					1															
4	TR			2				1		1	1	1			2						
4	TRIG							1							1						
4	SW							7			1	3									
4	bold							4							1						
4	m46							2													
4	PEPGRV														2						
5	MHENRY															2					
5	NAVB				1																
5	WOODP														2						
5	rich				1																
5	GARDEN														2			2			
5	rotto																	2	3		
5	PB					4															
6	NPRES					1															
6	PRES																			1	
6	WHILL			1		1															
6	LESCH													5							
6	BMaid													1							
6	NMaid													3							
6	PEPB													1							
6	Possum													2							

Table 10 Clusters by area and sector
(areas sorted roughly from N to S)
Clusters ordered to emphasize relationships with areas

1 Lancelin to Moore River,
2 Moore River to Quinns Rock,
3 Quinns Rock to Sorrento,
4 Sorrento to Swan River,
5 Swan River to Mandurah,
6 Mandurah to Busselton

	7 cluster -->	3	1	1	5	2	4	4	2	2	6	4	1	4	5	2	5	5	5	5	5
	20 cluster -->	8	2	1	16	6	9	11	4	5	20	12	3	10	14	7	15	17	18	19	13
S	area																				
1	LS		1	6			3	5													
1	PS	2	2	13																	
1	MAN	2	6	21																	
1	LP									4											
1	BB	1	1	6		6	3	8	3	11											
1	SEAB				1				3	3											
2	for		4	1					1			3			1						
2	Guild								1	10	1	1			1		2				
2	NWIL									2											
2	WIB3	1	1	21				1	1				2								
2	wilb							2	2	3											
2	tokyu								1	2											
2	xyan				1																
2	pip				1																
2	ALK			7					1				8								
3	MI					2	6	8					17	2							
3	BZ		1	4			1	7		1			29								
3	BU								4												
3	BURN								2												
3	Pinn									1											
4	TR						1	1					2	1	2	1					
4	TRIG														1	1					
4	SW							3						1		7					
4	bold														1	4					
4	m46															2					
4	PEPGRV														2						
5	MHENRY																2				
5	NAVB								1												
5	WOODP														2						
5	rich								1												
5	GARDEN														2			2			
5	rotto																	2	3		
5	PB									4											
6	NPRES									1											
6	PRES																			1	
6	WHILL									1			1								
6	LESCH																				5
6	BMaid																				1
6	NMaid																				3
6	PEPB																				1
6	Possum																				2

Table 11 Clusters by area and sector

(areas sorted roughly from North to South) Clusters ordered to emphasize relationships with areas. **Sectors (S)-->** 1 Lancelin to Moore River, 2 Moore River to Quinns Rock, 3 Quinns Rock to Sorrento, 4 Sorrento to Swan River, 5 Swan River to Mandurah, 6 Mandurah to Busselton

S	area	7 cluster -->	1	2	6	1	5	6	7	2	5	3	2	2	2	1	1	4	5	2	2	4	1	1	2
		20 cluster -->	2	5	16	2	12	15	20	5	12	8	5	4	5	1	2	9	11	4	6	9	3	3	4
		50 cluster -->	3	13	43	4	30	40	50	17	31	22	16	10	15	1	2	25	29	9	18	23	5	6	8
1	LS		1									2				6		3	5						
1	PS		1									2				13	1								
1	MAN		2													21	4								
1	LP			4								1													
1	BB			11										2		6	1			1	6	3			
1	SEAB				1								1	3	2										
2	for					3	3									1	1			1					
2	Guild							2	1	4	1		2	1	4										
2	NWIL											1			2										
2	WIB															21	1						1	1	1
2	wilb													2	3										
2	tokyu													1	2										
2	xyan																								
2	pip																								
2	ALK															7							7	1	1
3	MI																	1			2	4	4	13	
3	BZ															4	1	1	2				14	10	
3	BU																			2					
3	BURN																								
3	Pinn																								
4	TR																						1		
4	TRIG																								
4	bold																								
4	SW																								
4	m46																								
4	PEPGRV																								
5	MHENRY																								
5	NAVB																								
5	WOODP																								
5	rich																								
5	GARDEN																								
5	rotto																								
5	PB																								
6	NPRES														1										
6	PRES																								
6	WHILL														1								1		
6	LESCH																								
6	BMaid																								
6	NMaid																								
6	PEPB																								
6	Possum																								

S	area	7 cluster -->	5	5	6	6	6	4	4	1	2	2	6	2	6	2	2	6	6	2	6	6	6	6	6	6	6	6	6
		20 cluster -->	11	11	14	16	16	9	10	3	5	4	14	7	14	7	7	14	15	4	14	17	17	18	18	19	13	13	13
		50 cluster -->	28	27	36	44	42	24	26	7	14	11	39	20	35	19	21	37	41	12	38	45	46	47	48	49	33	32	34
1	LS																												
1	PS																												
1	MAN																												
1	LP																												
1	BB			8																									
1	SEAB																												
2	for				1																								
2	Guild				1																								
2	NWIL																												
2	WIB		1																										
2	wilb		1	1																									
2	tokyu																												
2	xyan					1																							
2	pip						1																						
2	ALK																												
3	MI		3	4				2	2																				
3	BZ		4	1						5	1																		
3	BU											2																	
3	BURN											2																	
3	Pinn										1																		
4	TR			1				1	1	1			2	1	1														
4	TRIG												1	1															
4	bold														1	4													
4	SW			3					1							7													
4	m46																2												
4	PEPGRV																	2											
5	MHENRY																		2										
5	NAVB																			1									
5	WOODP			1											1														
5	rich																			1									
5	GARDEN			1													1	2											
5	rotto																		2	1	2								
5	PB									4																			
6	NPRES																												
6	PRES																												
6	WHILL																												
6	LESCH																												
6	BMaid																												
6	NMaid																												
6	PEPB																												
6	Possum																												

Aerial Photo Interpretation

The area adjacent to the southern bank of the Moore River east of the recreation reserve was interpreted using stereo aerial photos. Several distinct soil-landscape units were recognised and mapped. This was done to give an areal extent to the vegetation recognized during the inspection and as a basis for assessment of degradation risk.

The Moore River truncates the Pleistocene Tamala Limestone which, along much of its banks, is exposed as gently to steeply inclined slopes. This truncation probably occurred in the Pleistocene.

Typical of this portion of the west coast, the areas south Guilderton area is dominated by Holocene dunes perched on an undulating surface of Tamala Limestone. These are parabolic dunes which originated on the coast and travelled in a north-easterly direction. Their age varies greatly with most being deposited in early to mid-Holocene and others still mobile. Some older Holocene dunes have crossed the river but all since mid-Holocene appear to have terminated at its southern margin.

Characteristic of these landforms is the leading and trailing dunes which contain a deflated surface. In this sector of the coast the deflated surfaces are usually small and have small dune remnants (chaots). These chaots appear to have developed either in association with re-establishing vegetation or by a small parabolic dune following on the same path.

It is common for a mobile sand sheet to be the product of the coalescence of several sand sheets. This appears to be the case for the one at south Guilderton. From the form of the stabilized dunes and the vegetation types there appears to have been a sand sheet which terminated approximately at the NW corner of the sand sheet. The vegetation south west of that point is the re-establishment since that earlier sand sheet stopped. The present sand sheet followed a parallel route slightly to the east. It has modified the eastern trailing arm of the earlier parabolic dune. This is important to the understanding of the vegetation patterns which exist west and south-west of the sand sheet. Griffin (1994) demonstrated seral development of vegetation re-establishing after the passing of the sand sheets. Vegetation in the south Guilderton area follows this model.

Twelve soil-landscape units were recognized in the mapping (Table 12, Figure 3). The major vegetation types associated with these are listed. The surrounding area is mostly older dunes (Q1 and Q2 of McArthur and Bartle, 1980). The leeward slopes of these dunes are typically moderate to steeply inclined. On the older dunes these slopes are less well vegetated than the rest of the dune. The mobile sand sheet is level to gently undulating with a moderate to steeply inclined leeward face. This face has in part been truncated by the river. The sandsheet is slowly moving and discharging only relatively small quantities into the river.

A number of units characterize the area lying in the wake of the mobile sand sheets. The most recently vegetated areas are a mixture of plains and small chaots. There is an older deflated area which is gently undulating following the shape of the underlying Tamala limestone surface. Small dune remnants are common. The other main unit is an area of short axis dunes with moderate to steeply inclined slopes. Typically these are vegetated by Tuart woodlands.

Areas of exposed limestone and limestone with shallow calcareous sand occur along the bank of the river.

Mobile sand sheet

While the sandsheet is slowly filling parts of the river, it is unlikely to extend much further and certainly will not block the river. This conclusion is drawn from several features of the sand sheet. Firstly, the amount of available sand has nearly been exhausted. The majority of the area is a deflated surface with very little in the way of a frontal dune. Secondly, the progress of the frontal dune has declined because it has moved down the slope of the Moore River and is less exposed to the prevailing south-westerly winds. Finally, the Moore River has shown the ability to remove and truncate these sandsheets. This will inevitably occur in the next flood.

Land degradation risks.

The major land degradation risk is wind erosion. All areas with calcareous sand are vulnerable because of the loose surface. The risk for dune crests is extreme because of their exposure to the wind. The sand sheet and the upper portions of the old dunes are the areas where the risk is greatest.

Water erosion is normally not associated with rapidly draining calcareous sands. However, there is a combination of factors in some of the units mapped with brings this to importance. The factors of significance are slope and water repellent soil surface. Even in natural vegetated areas a storm event will cause erosion on moderate to steep slopes of calcareous sand dunes. Recently burnt areas suffer much more. Animals and people moving on these slopes are a major cause of erosion.

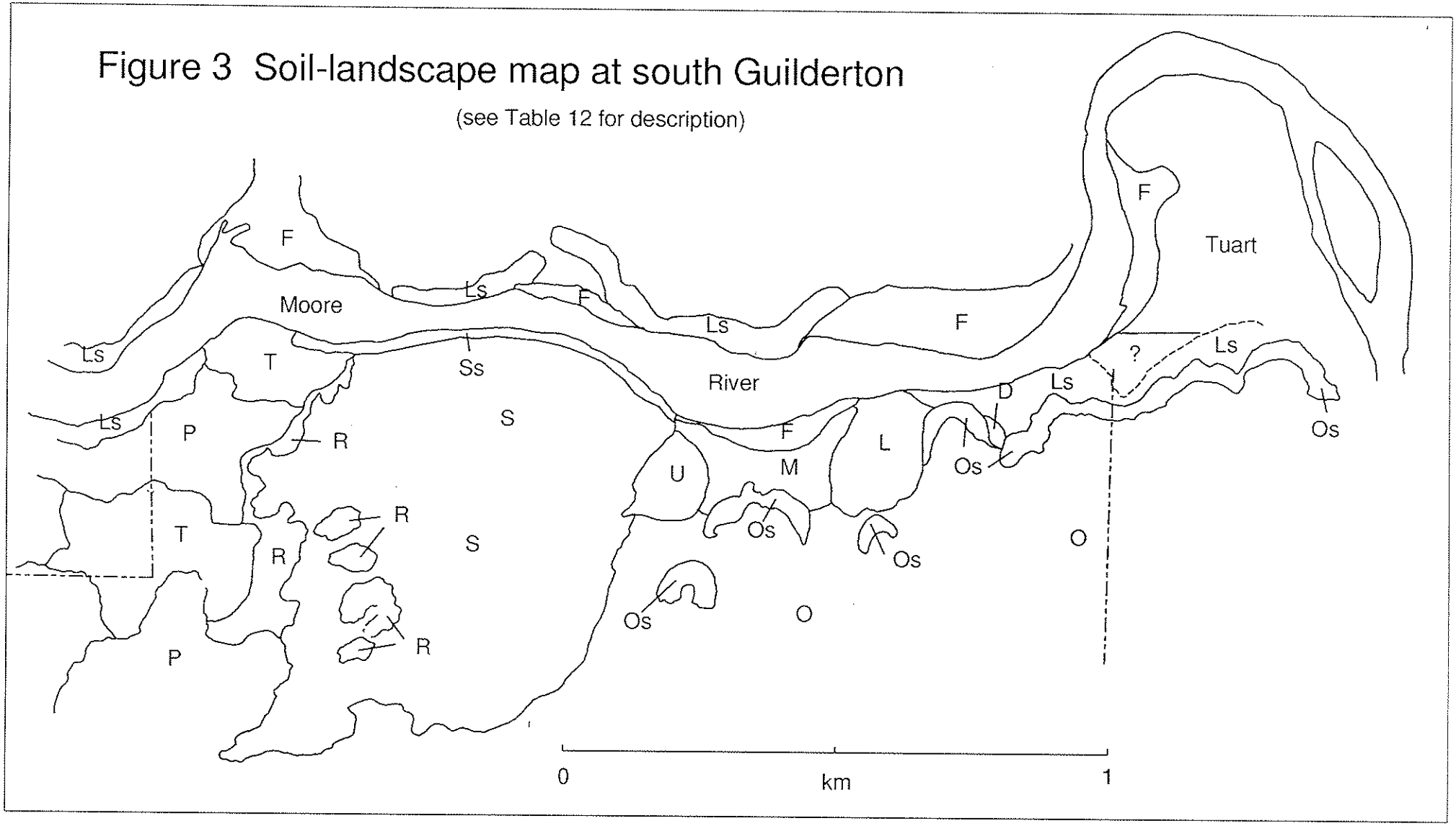
Nutrient export risk is also a significant issue for urban development, even those with deep sewerage. Parks, gardens and storm water drains are the major sources of nutrients and pollutants. The risk of export of phosphorus is low since calcareous deep sand and limestone bind phosphorus reasonably well. However, the risk of nitrogen export is likely to be high since the calcareous sand is rapidly drained and the nitrogen will be flushed with the ground water. Of particular relevance to the impact of the nutrient export is the movement of ground water in the unsaturated layers. The underlying Tamala Limestone and associated yellow clayey sand is capable of shedding water in preference to transmitting it. In this case nutrient rich water may be shed on the boundary between the calcareous sand and the Tamala Limestone. If the limestone slopes towards the Moore River, the contained nutrients will end up in the river.

Table 12 Soil-landscape units in south Guilderton (see Figure 3)

	Map Unit	Soil and lithology	Landform element	Slope	Vegetation
O	Old dunes	Oldest calcareous deep sand dunes	crests, hillslopes and swales with occasional outcropping limestone	gently to moderately inclined	*Melaleuca acerosa* low heath
Os	Old dunes, steep	Oldest calcareous deep sand dunes	hillslopes		*Melaleuca acerosa* open low heath
F	River flats	River margin with calcareous and peaty sand	plain	level to very gently inclined	*Melaleuca rhaphiophylla* scrub and areas of sedges
D	Foecunda	Slope with calcareous shallow and deep sand over Tamala limestone	hillslope	gently inclined	*Eucalyptus foecunda* with mixture of associated spp.
L	Limestone	Tamala limestone with calcareous shallow and deep sand	hillslopes	gently inclined	*Melaleuca cardiophylla* and *M. huegelii* heath
Ls	Limestone slopes	Tamala limestone with calcareous shallow sand	hillslopes	gently to moderately inclined, in places steeply inclined	*Melaleuca cardiophylla* and *M. huegelii* low heath, Tuart on steeper slopes
M	Misc slope	Calcareous deep sand	hillslopes	gently inclined	*Melaleuca cardiophylla* heath
S	Sandsheet	Calcareous deep sand	hillslopes, plains and crests	level to gently inclined	mainly bare
Ss	Sandsheet steep	Calcareous deep sand	hillslopes	moderately to steeply inclined	mainly bare
R	Sparse regeneration	Calcareous shallow and deep sand, over Tamala limestone	plains, hillslopes and crests	level to moderately inclined in places	*Spyridium globulosum, Calocephalus brownii* and *Isolepis nodosus* open low shrubland
	Deflation plain	Calcareous shallow sand, over yellow sand and Tamala limestone	plains, hillslopes and crests	level to gently inclined	*Spyridium globulosum, Allocasuarina lehmanniana* heath with small areas of *Banksia* open low woodland.
T	Small dunes	Dunes left in wake of sand sheet, calcareous deep sand	hillslopes, crests and swales	moderately to steeply inclined	Tuart woodland
U	Undefined rise	An older dune or rise with calcareous deep sand with yellow sand	crest and hillslopes	gently inclined	heath and low heath

Figure 3 Soil-landscape map at south Guilderton

(see Table 12 for description)



Discussion

Regional Variation

The species composition of most of the vegetation is related to that of vegetation in the Wilbinga and Seabird areas. The cluster analysis of the floristic data has demonstrated that the south Guilderton area fits into a pattern of regional variation in floristic composition. South Guilderton is transitional between the Lancelin to Moore River and the Moore River to Quinns Rock Sectors.

South Guilderton, however, contains some vegetation which appears to be different from that of most other areas south of Lancelin. These are mainly in the deflation basin with Spyridium globulosum and Allocasuarina lehmanniana common or characteristic species. The main reason for this appears to be that this is the largest mature sand sheet on the west coast south of Lancelin. Other sand sheets are less well developed and have only the very early stages of regeneration on them.

The banks of the Moore River have an association of vegetation and landform types only present in a few places along the west coast. Its fringing riverine vegetation is associated with vegetation of limestone slopes and cliffs and calcareous sand dunes. It also has the only active mobile sand sheet discharging into a river along the lower and central west coast of WA. Neither the Swan nor Hill Rivers which also truncate the Tamala limestone have the perched calcareous sand dunes adjacent to the river. The vegetation of most of the Swan River has been removed or degraded.

Sites from south of the Swan River, including the off-shore islands, are consistently different from those north of the Swan River. Two sectors in addition to those recognised by Griffin and Trudgen (1994) are tentatively proposed; Swan River to Mandurah and Mandurah to Busselton. Unfortunately, the number of sites south of the Swan River is too few to define these sectors and/or to document their characteristic vegetation. A priority should be placed on collecting data to clarity these patterns as they could have significance to planning issues in those areas.

Foreshore protection

The issues related to foreshore protection relate to two aspects; protection of the river and river related and dependent communities, and protection of the visual and aesthetic quality of the river. The latter aspect though significant is beyond the scope of this study.

Several areas adjacent to the river are vulnerable to risks of degradation which could have adverse impacts on the river and vegetation adjacent to it. The area to be included in the foreshore reserve should take this potential into account. Any access along the steeper parts of the river will have potential of adverse impacts. The most vulnerable is the steeper leeward slopes of the calcareous dunes, even the vegetated ones. Any subdivision of this land which resulted in clearing or just the creation of tracks and firebreaks will result in erosion. Any erosion will also degrade the vegetation down slope and adjacent to the river. Erosion will promote the dispersal of weed seeds.

The nutrient status of Spearwood and Quindalup sands can support prolific growth of invading exotic weed species. It is important, therefore, that in these areas management includes minimising disturbances or the opportunity for propagule ingress. It is doubly important that the steep calcareous dune slopes be not developed and managed to protect the river and associated vegetation.

The nutrient export risk is obvious for areas immediately adjacent to the river. However, it is much more difficult to determine the movement of ground water across the undulating surface of the buried Tamala Limestone. A conservative approach should be taken to the location of parks, gardens and houses upslope of the river.

The fate of the mobile sand sheet also needs some consideration. At least part of it will be included in a foreshore reserve no matter how wide it is. There are proposals to vegetate the areas not developed for housing. If species such as pip grass are used they will invade and adversely affect the remaining native vegetation in the foreshore reserve. Anything other than leaving the sandsheet to re-establish naturally should be given careful consideration. A conservative approach should be taken in the initial management plan. The initial focus should be on the protection of the most vulnerable areas, especially the steep slopes.

Acknowledgments

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Dr Paul van der Moezel accompanied the visit to the proponent's property.

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Appendix 1 Dendrogram of sites

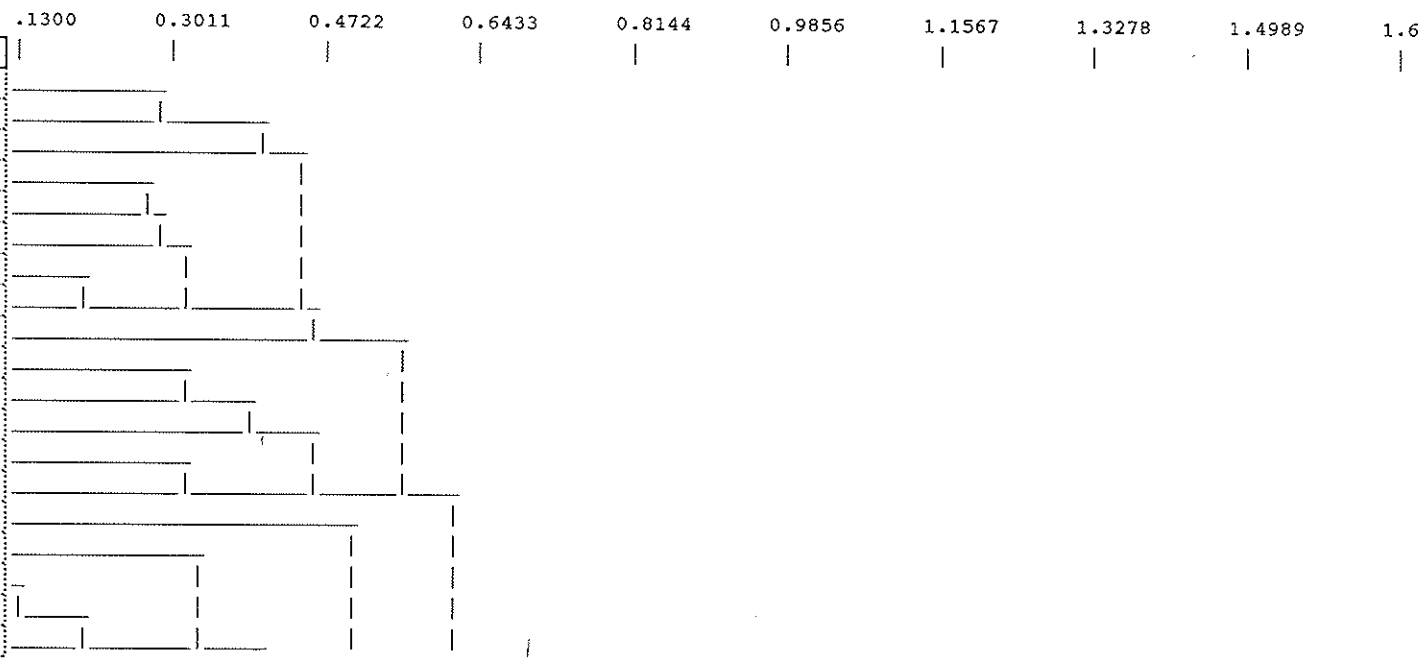
First five columns are the cluster numbers for 4 cluster levels
S- Sector (1 - 4 from Griffin and Trudgen 1994, 5 & 6 tentative sectors).

1 Lancelin to Moore River,
2 Moore River to Quinns Rock,
3 Quinns Rock to Sorrento,
4 Sorrento to Swan River
5 Swan River to Mandurah
6 Mandurah to Dunsborough

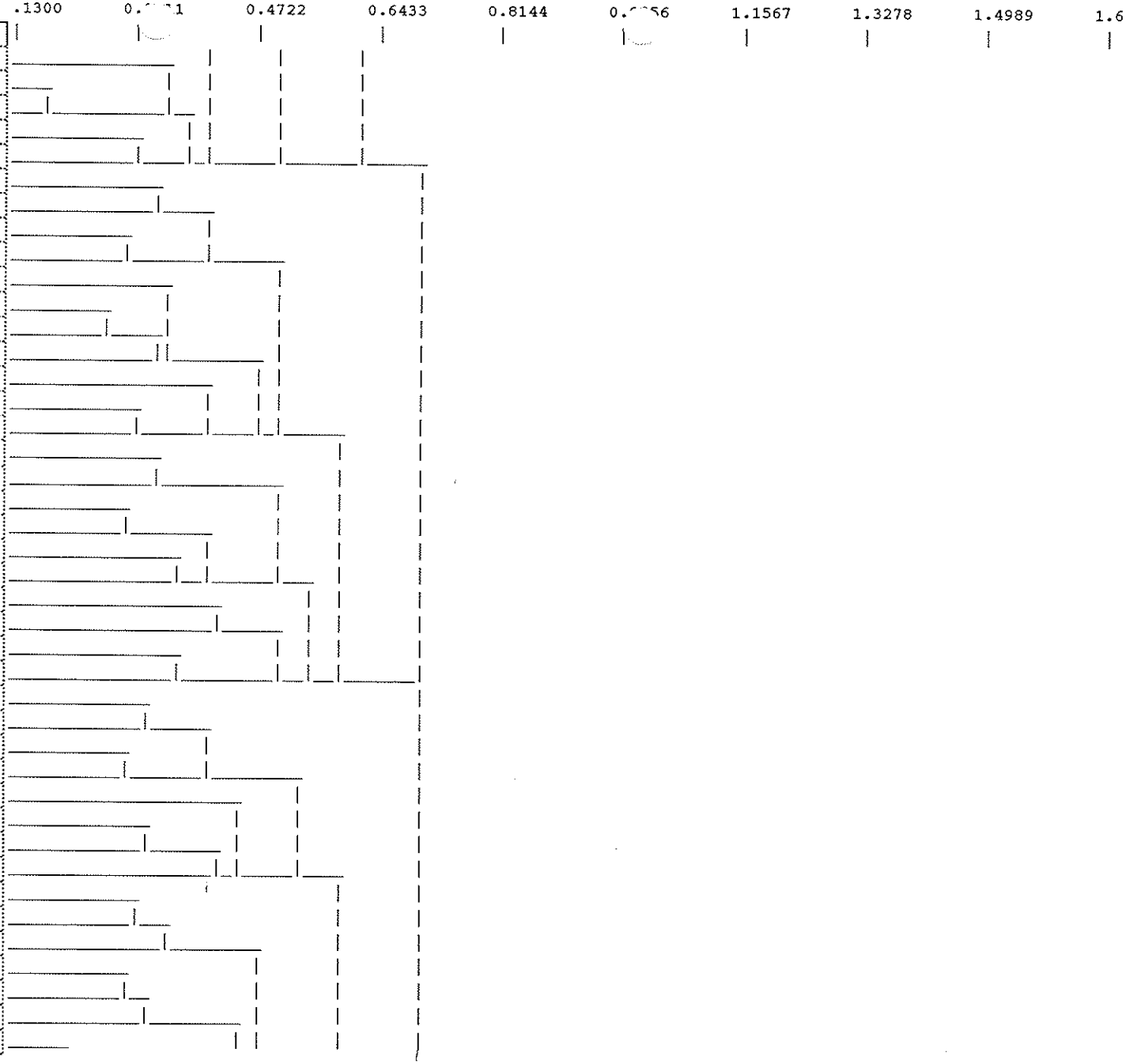
gp- group from Griffin & Trudgen (1994)
ft- floristic type of DEP (1996)

Sites on the south side of the Moore River are highlighted.
for01 to **10** are the foreshore area, **guild11** to **16** were on the recreational reserve, Guild01 to 10 were on the property of Frank Roberts to the east.

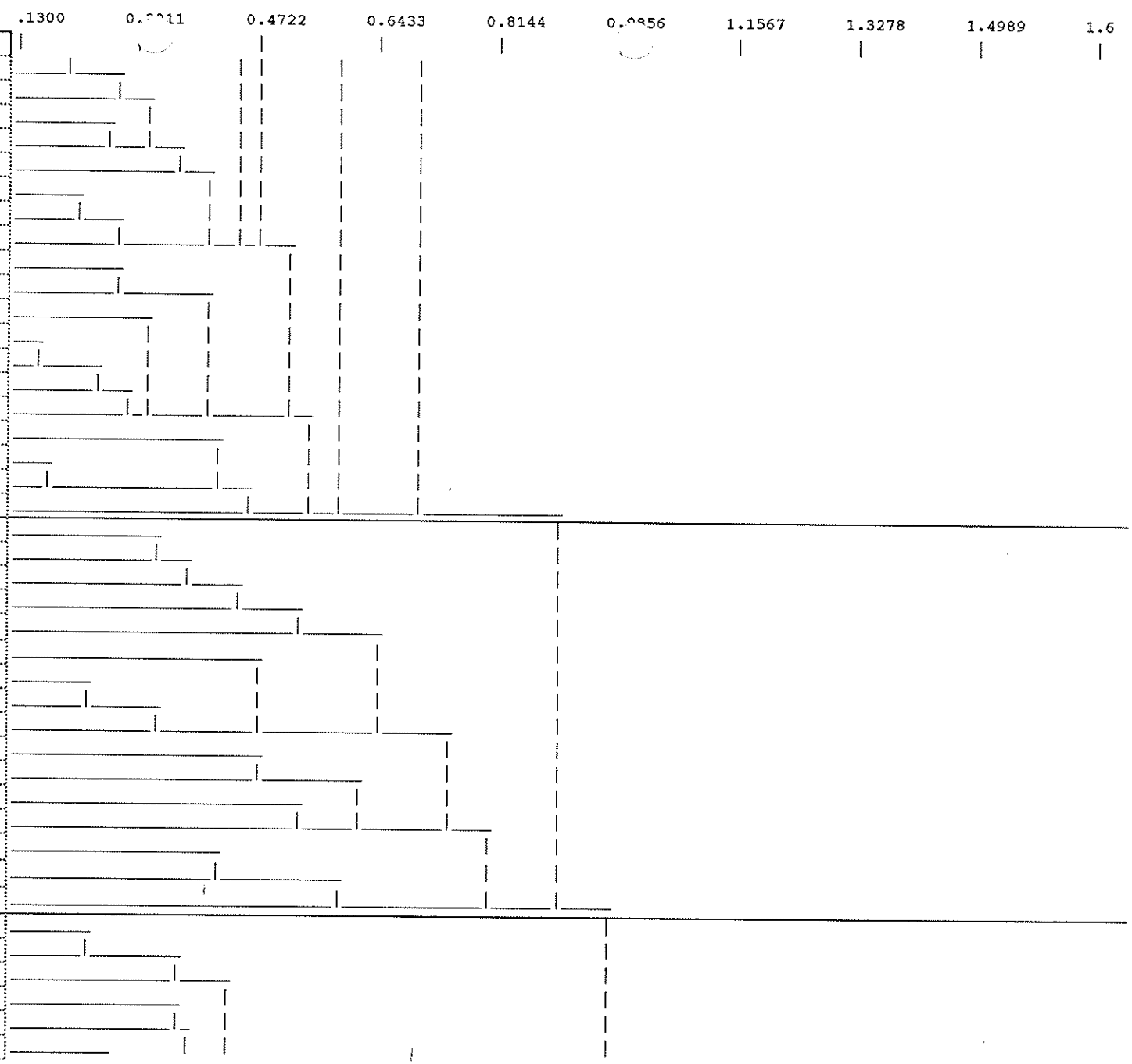
Cluster Level							
7	20	50	100	S	gp	vt	site
1	1	1	1	2	Aa		ALK01
1	1	1	1	3	Aa		BZ40
1	1	1	1	2	Aa		ALK15
1	1	1	1	2	Aa		ALK02
1	1	1	1	2	Aa		ALK06
1	1	1	1	2	Aa		ALK14
1	1	1	1	2	Aa		ALK12
1	1	1	1	2	Aa		ALK13
1	1	1	1	2	Aa		WIB27
1	1	1	1	3	Aa		BZ36
1	1	1	1	2	Aa	29a	WIB11
1	1	1	1	2	Aa		WIB02
1	1	1	1	3	Aa		BZ39
1	1	1	1	1	Aa		LS15
1	1	1	2	2	Aa	29b	WIB01
1	1	1	2	2	Aa	29b	WIB03
1	1	1	2	2	Aa		WIB04
1	1	1	2	2	Aa		WIB07
1	1	1	2	2	Aa		WIB05



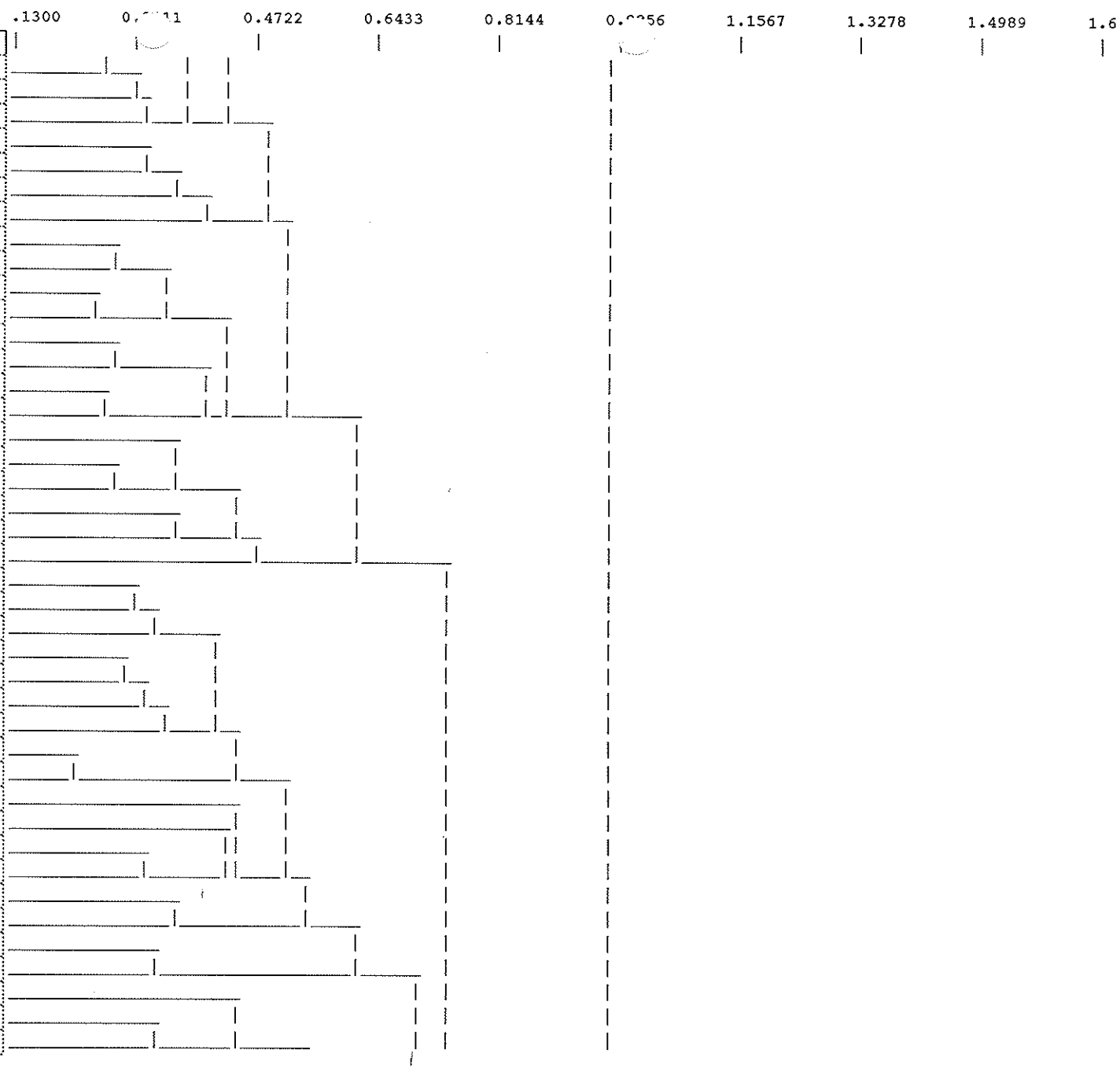
Cluster Level							
7	20	50	100	S	gp	vt	site
1	1	1	2	2	Aa	29b	WIB09
1	1	1	2	2	Aa	29b	WIB12
1	1	1	2	2	Aa		WIB13
1	1	1	2	2	Aa		WIB23
1	1	1	2	2	Aa		WIB26
1	1	1	3	3	Aa		BZ08
1	1	1	3	2	Aa		WIB18
1	1	1	3	1	Aa		LS09
1	1	1	3	1	Aa		PS10
1	1	1	3	1	Aa		LS05
1	1	1	3	1	Aa		LS06
1	1	1	3	2	Aa		WIB16
1	1	1	3	1	Aa		PS16
1	1	1	3	1	Aa		MAN07
1	1	1	3	1	Aa		PS15
1	1	1	3	2	Aa		WIB20
1	1	1	4	2			**for01**
1	1	1	4	1	Aa		PS13
1	1	1	4	2	Aa	29b	WIB10
1	1	1	4	2	Aa		WIB15
1	1	1	4	2	Aa		WIB14
1	1	1	4	2	Aa		WIB17
1	1	1	4	1	Aa		MAN08
1	1	1	4	1	Aa		MAN10
1	1	1	4	1	Aa		PS14
1	1	1	4	2	Aa		WIB21
1	1	1	5	1	Aa		BB33
1	1	1	5	1	Aa		BB34
1	1	1	5	1	Aa		BB35
1	1	1	5	1	Aa		BB36
1	1	1	5	1	Aa		BB39
1	1	1	5	1	Aa		LS01
1	1	1	5	1	Aa		MAN28
1	1	1	5	1	Aa		MAN05
1	1	1	6	1	Aa		BB37
1	1	1	6	1	Aa		MAN18
1	1	1	6	1	Aa		MAN15
1	1	1	6	1	Aa		MAN01
1	1	1	6	1	Aa		MAN14
1	1	1	6	1	Aa		MAN22
1	1	1	6	1	Aa		MAN04



Cluster Level							
7	20	50	100	S	gp	vt	site
1	1	1	6	1	Aa		MAN25
1	1	1	6	1	Aa		PS17
1	1	1	6	1	Aa		MAN17
1	1	1	6	1	Aa		PS07
1	1	1	6	1	Aa		MAN20
1	1	1	6	1	Aa		MAN16
1	1	1	6	1	Aa		MAN29
1	1	1	6	1	Aa		MAN21
1	1	1	6	1	Aa		LS02
1	1	1	6	1	Aa		PS12
1	1	1	6	1	Aa		MAN12
1	1	1	6	1	Aa		PS01
1	1	1	6	1	Aa		PS04
1	1	1	6	1	Aa		PS03
1	1	1	6	1	Aa		PS02
1	1	1	6	1	Aa		MAN03
1	1	1	6	1	Aa		MAN23
1	1	1	6	1	Aa		MAN24
1	1	1	6	1	Aa		PS08
1	2	2	7	1	Bc		BB38
1	2	2	7	1	Bc		PS11
1	2	2	7	3	Bc		BZ33
1	2	2	7	2	Bc		WIB22
1	2	2	7	2			**for10**
1	2	2	8	1	Bc		MAN09
1	2	2	8	1	Bc		MAN11
1	2	2	8	1	Bc		MAN26
1	2	2	8	1	Bc		MAN13
1	2	3	9	1	Bc		LS10
1	2	3	9	1	Bc		MAN19
1	2	3	10	1	Bc		MAN27
1	2	3	10	1	Bc		PS06
1	2	4	11	2			**for02**
1	2	4	11	2			**for04**
1	2	4	12	2			**for03**
1	3	5	13	2	Ab		ALK03
1	3	5	13	3	Ab		BZ21
1	3	5	13	2	Ab		ALK10
1	3	5	13	2	Aa		ALK04
1	3	5	13	4	Ab		TR08
1	3	5	13	3	Ab		BZ03

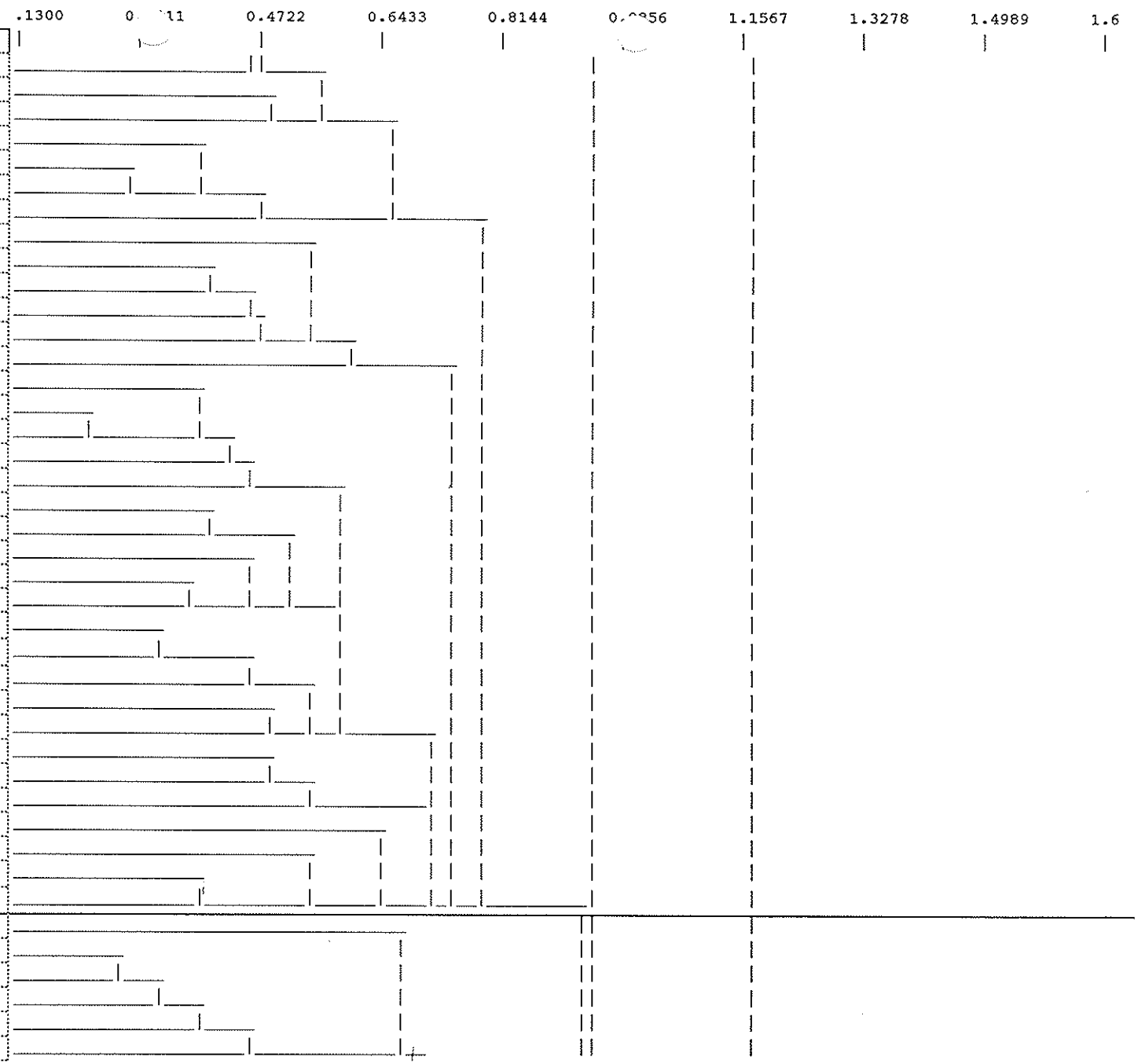


Cluster Level							
7	20	50	100	S	gp	vt	site
1	3	5	13	3	Ab		BZ06
1	3	5	13	3	Ab		BZ04
1	3	5	13	3	Ab		BZ20
1	3	5	13	3	Ab		BZ02
1	3	5	13	2	Ab		WIB25
1	3	5	13	3	Ab		BZ05
1	3	5	13	3	Ab		BZ31
1	3	5	13	2	Ab		ALK05
1	3	5	13	2	Ab		ALK16
1	3	5	13	2	Ab		ALK07
1	3	5	13	2	Ab		ALK09
1	3	5	13	3	Ab		BZ01
1	3	5	13	3	Ab		BZ07
1	3	5	13	3	Ab		BZ32
1	3	5	13	3	Ab		MI26
1	3	5	14	3	Ab		BZ09
1	3	5	14	3	Ab		MI24
1	3	5	14	3	Ab		MI28
1	3	5	14	3	Ab		BZ34
1	3	5	14	3	Ab		MI33
1	3	5	14	3	Ab		BZ35
1	3	6	15	2	Ab		ALK08
1	3	6	15	3	Ab		BZ37
1	3	6	15	3	Ab		BZ27
1	3	6	15	3	Ab		BZ28
1	3	6	15	3	Ab		MI29
1	3	6	15	3	Ab		BZ41
1	3	6	15	3	Ab		MI31
1	3	6	15	3	Ab		MI04
1	3	6	15	3	Ab		MI05
1	3	6	15	3	Aa		BZ10
1	3	6	15	3	Ab		BZ11
1	3	6	15	3	Ab		BZ29
1	3	6	15	3	Ab		BZ30
1	3	6	15	3	Ab		BZ43
1	3	6	15	3	Ab		MI30
1	3	6	16	3	Ab		BZ26
1	3	6	16	2	Ab		WIB24
1	3	6	17	3	Ba	29b	MI01
1	3	6	17	3	Ba	29b	MI02
1	3	6	17	3	Ba	29b	MI06

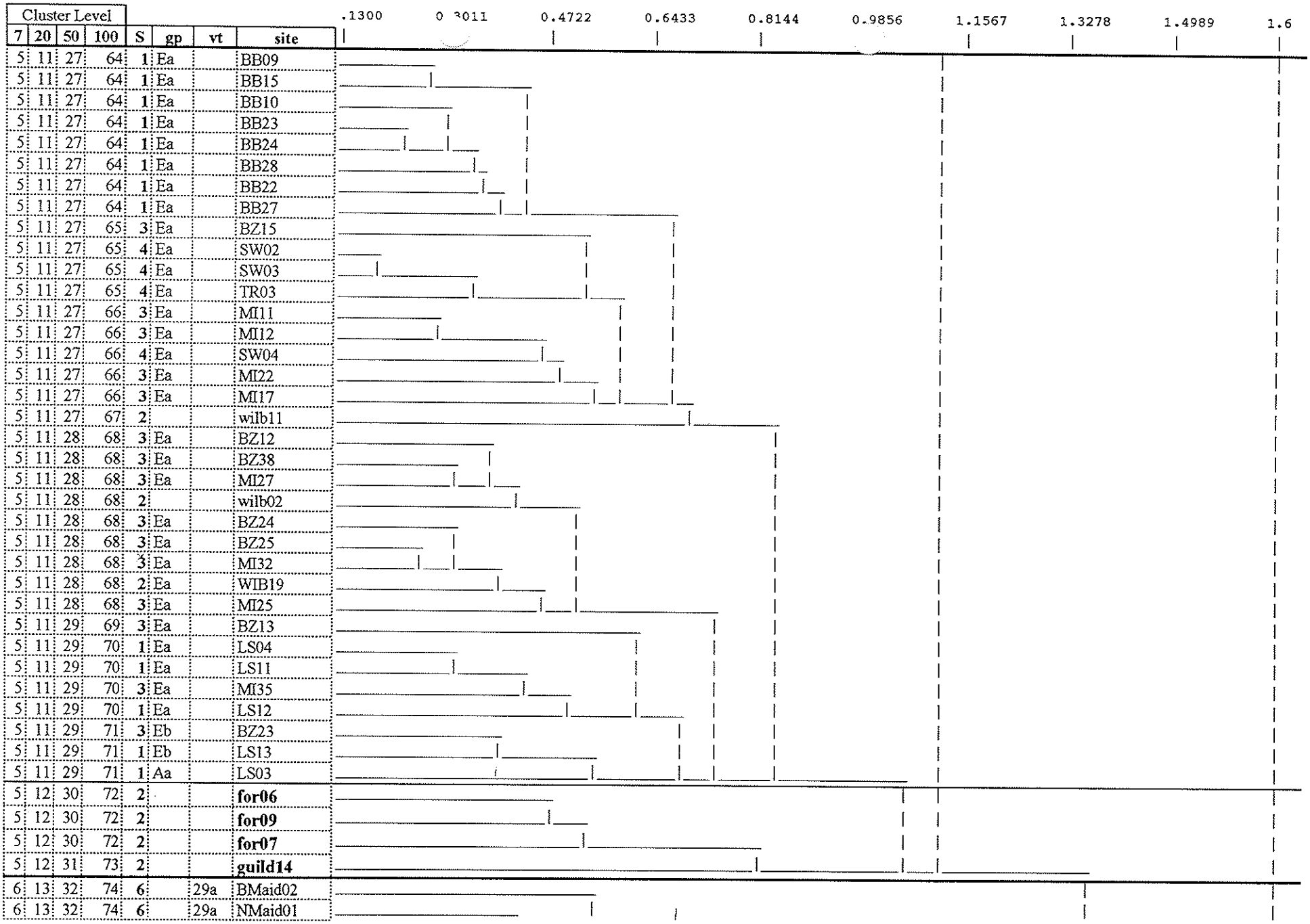


Cluster Level								.1300	0.3011	0.4722	0.6433	0.8144	0.9856	1.1567	1.3278	1.4989	1.6
7	20	50	100	S	gp	vt	site										
1	3	6	17	3	Ab		MI34										
1	3	6	17	6		29b	WHILL-2										
1	3	6	17	3	Ba		MI23										
1	3	6	18	3	Ab	29b	MI07										
1	3	6	18	3	Ab	29b	MI09										
1	3	6	18	3	Ab	29b	MI18										
1	3	7	19	3	Ab		BZ14										
1	3	7	20	4	Ab		TR06										
1	3	7	21	3	Ab		BZ16										
1	3	7	21	3	Ab		BZ18										
1	3	7	21	3	Ab		BZ42										
1	3	7	22	3	Ab		BZ17										
2	4	8	23	2	Ba		ALK11										
2	4	8	23	2	Ba	29b	WIB08										
2	4	9	24	1	Ba		BB18										
2	4	9	25	2			**for05**										
2	4	9	26	3	Ba		BU03										
2	4	9	26	3	Ba	29a	BU04										
2	4	10	27	1	Ba		BB16										
2	4	10	27	1	Ba		BB17										
2	4	10	28	2		29b	Guild06										
2	4	10	28	2			wilb09										
2	4	10	28	2			wilb12										
2	4	10	29	1		29a	SEAB-4										
2	4	10	29	1		29a	SEAB-5										
2	4	10	30	1		29a	SEAB-8										
2	4	10	30	2		29b	tokyu07										
2	4	11	31	3	Eb	29a	BU01										
2	4	11	31	3		29a	BURN-1										
2	4	11	31	3	Eb	29a	BU02										
2	4	11	32	3		29a	BURN-2										
2	4	12	33	5		29a	NAVB-2										
2	4	12	34	5		29a	rich02										
2	5	13	35	1	Bb		BB01										
2	5	13	35	1	Bb		BB06										
2	5	13	35	1	Bb		BB02										
2	5	13	35	1	Bb		BB05										
2	5	13	35	1	Bb		BB07										
2	5	13	35	1	Bb		BB20										
2	5	13	35	1	Bb		BB21										
2	5	13	35	1	Bb		BB11										

Cluster Level							
7	20	50	100	S	gp	vt	site
2	5	13	35	1	Bb		BB14
2	5	13	35	1	Bb		BB03
2	5	13	35	1	Bb		BB13
2	5	13	36	1	Bb		LP01
2	5	13	36	1	Bb		LP02
2	5	13	36	1	Bb		LP03
2	5	13	36	1	Bb		LP04
2	5	14	37	3	Ab		BZ19
2	5	14	37	5		29b	PB-2
2	5	14	37	5		29b	PB-4
2	5	14	37	5		29b	PB-5
2	5	14	37	5		29b	PB-3
2	5	14	38	3		29a	Pinn02
2	5	15	39	2		29b	Guild01
2	5	15	39	2		29b	NWIL-1
2	5	15	39	2		29b	NWIL-3
2	5	15	39	2			wilb08
2	5	15	39	2		29b	Guild03
2	5	15	40	6		29b	NPRES-1
2	5	15	40	6		29b	WHILL-1
2	5	15	40	2		29b	tokyu04
2	5	15	40	2			wilb01
2	5	15	40	2			wilb03
2	5	15	41	2			**guild11**
2	5	15	41	2			**guild12**
2	5	15	41	2		29b	tokyu06
2	5	15	41	1		29b	SEAB-2
2	5	15	41	1		29b	SEAB-3
2	5	16	42	2		29b	Guild04
2	5	16	42	2			Guild05
2	5	16	42	1		29b	SEAB-7
2	5	17	43	2		29b	Guild02
2	5	17	44	2		29b	Guild10
2	5	17	44	2			**guild13**
2	5	17	44	2			**guild15**
2	6	18	45	1	Ba		BB12
2	6	18	46	1	Ba		BB19
2	6	18	46	1	Ba		BB30
2	6	18	46	1	Ba		BB32
2	6	18	46	1	Ba		BB31
2	6	18	46	1	Ba		BB29

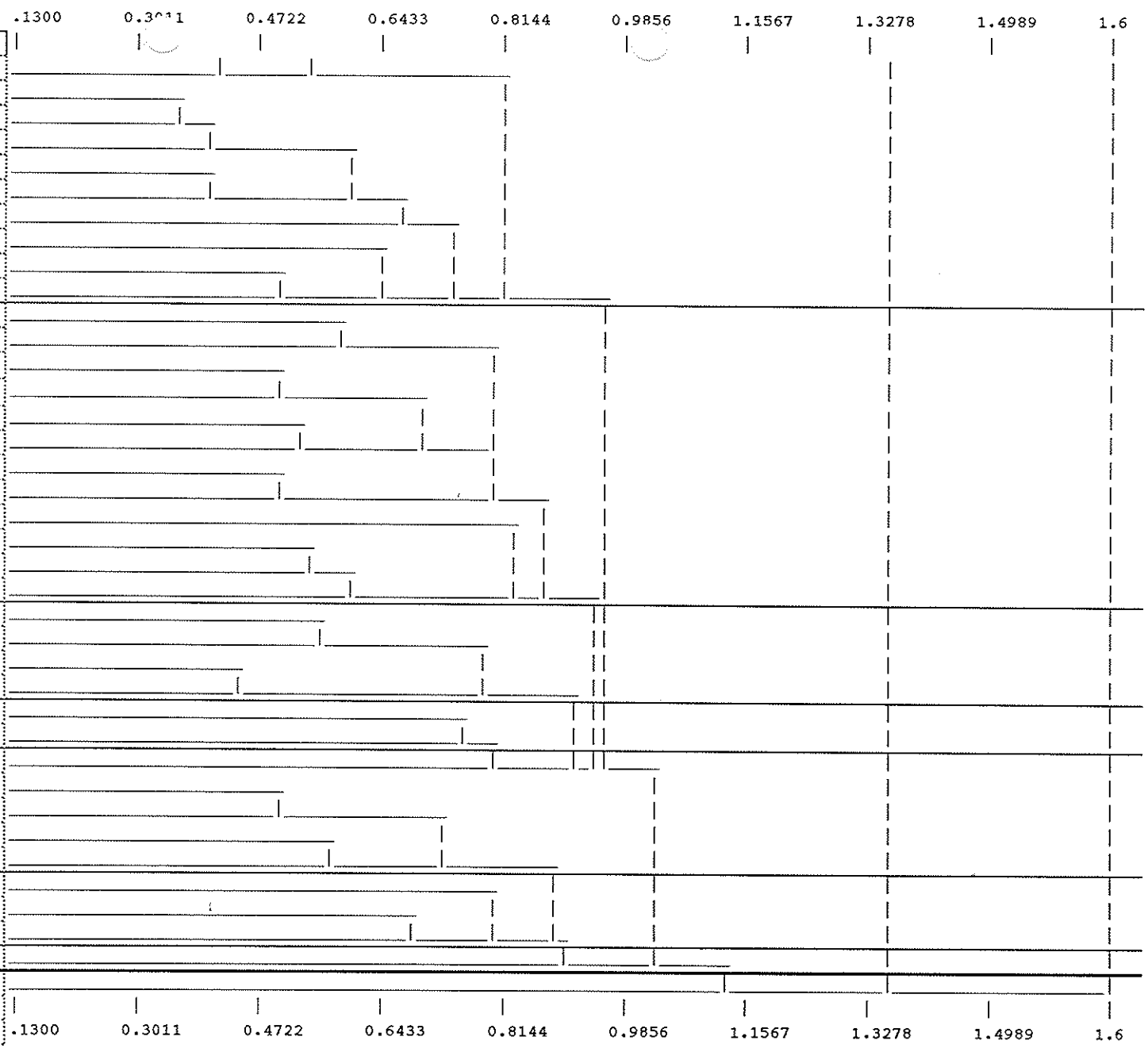


Cluster Level								.1300	0.3011	0.4722	0.6433	0.8144	0.9856	1.1567	1.3278	1.4989	1.6
7	20	50	100	S	gp	vt	site										
2	6	18	47	3	Ba	29b*	MI03										
2	6	18	47	3	Ba		MI08										
2	7	19	48	4		s11	bold05										
2	7	19	48	4		29b	bold11										
2	7	19	48	4		29b	bold08										
2	7	19	48	4		29b	bold10										
2	7	19	49	4	Ac		SW05										
2	7	19	49	4	Ac	29b	SW06										
2	7	19	49	4	Ac	29b	SW07										
2	7	19	49	4	Ac		SW08										
2	7	19	49	4	Ac	29b	SW11										
2	7	19	49	4	Ac		SW09										
2	7	19	50	4	Ac		SW10										
2	7	20	51	4	Ac		TR07										
2	7	20	51	4		29b	TRIG-1										
2	7	21	52	4			m4601										
2	7	21	52	4			m4602										
3	8	22	53	1	C		BB04										
3	8	22	54	1	C		MAN02										
3	8	22	54	2	C		WIB06										
3	8	22	54	1	C		MAN06										
3	8	22	54	1	C		PS05										
3	8	22	55	1	C		PS09										
4	9	23	56	1	D		BB08										
4	9	23	56	3	D		MI15										
4	9	23	56	3	D		MI16										
4	9	23	56	1	D		BB25										
4	9	23	56	1	D		BB26										
4	9	23	57	3	Eb		MI20										
4	9	23	57	3	Eb	29a	MI21										
4	9	24	58	3	D		MI10										
4	9	24	59	3	D		MI19										
4	9	24	60	4	D		TR02										
4	9	25	61	3	Eb		BZ22										
4	9	25	62	1	Eb		LS07										
4	9	25	62	1	Eb		LS14										
4	9	25	62	1	Eb		LS08										
4	10	26	63	3	D		MI13										
4	10	26	63	3	D		MI14										
4	10	26	63	4	D		SW01										
4	10	26	63	4	D		TR01										



Cluster Level							
7	20	50	100	S	gp	vt	site
5	11	27	64	1	Ea		BB09
5	11	27	64	1	Ea		BB15
5	11	27	64	1	Ea		BB10
5	11	27	64	1	Ea		BB23
5	11	27	64	1	Ea		BB24
5	11	27	64	1	Ea		BB28
5	11	27	64	1	Ea		BB22
5	11	27	64	1	Ea		BB27
5	11	27	65	3	Ea		BZ15
5	11	27	65	4	Ea		SW02
5	11	27	65	4	Ea		SW03
5	11	27	65	4	Ea		TR03
5	11	27	66	3	Ea		MI11
5	11	27	66	3	Ea		MI12
5	11	27	66	4	Ea		SW04
5	11	27	66	3	Ea		MI22
5	11	27	66	3	Ea		MI17
5	11	27	67	2			wilb11
5	11	28	68	3	Ea		BZ12
5	11	28	68	3	Ea		BZ38
5	11	28	68	3	Ea		MI27
5	11	28	68	2			wilb02
5	11	28	68	3	Ea		BZ24
5	11	28	68	3	Ea		BZ25
5	11	28	68	3	Ea		MI32
5	11	28	68	2	Ea		WIB19
5	11	28	68	3	Ea		MI25
5	11	29	69	3	Ea		BZ13
5	11	29	70	1	Ea		LS04
5	11	29	70	1	Ea		LS11
5	11	29	70	3	Ea		MI35
5	11	29	70	1	Ea		LS12
5	11	29	71	3	Eb		BZ23
5	11	29	71	1	Eb		LS13
5	11	29	71	1	Aa		LS03
5	12	30	72	2			**for06**
5	12	30	72	2			**for09**
5	12	30	72	2			**for07**
5	12	31	73	2			**guild14**
6	13	32	74	6		29a	BMaid02
6	13	32	74	6		29a	NMaid01

Cluster Level							
7	20	50	100	S	gp	vt	site
6	13	32	74	6		29a	NMaid03
6	13	33	75	6		30b	LESCH-1
6	13	33	75	6		30b	LESCH-2
6	13	33	75	6		30b	LESCH-5
6	13	33	76	6		30b	LESCH-3
6	13	33	76	6		30b	LESCH-4
6	13	33	77	6		30b*	NMaid04
6	13	34	78	6		30b	PEPB-1
6	13	34	79	6		30b	Possum3
6	13	34	79	6		30b	Possum4
6	14	35	80	4		30a2	bold06
6	14	35	81	5		30a2	WOODP-1
6	14	36	82	2			**for08**
6	14	36	82	2			**guild16**
6	14	36	83	5		30a2	GARDEN-4
6	14	36	83	5		30a2	WOODP-2
6	14	37	84	4		30a2	PEPGRV-1
6	14	37	84	4		30a2	PEPGRV-2
6	14	38	85	5		29a	GARDEN-2
6	14	39	86	4	Eb		TR04
6	14	39	86	4	Eb		TR05
6	14	39	87	4			TRIG-2
6	15	40	88	2			Guild08
6	15	40	88	2			Guild09
6	15	41	89	5		30a2	MHENRY-1
6	15	41	89	5		30a2	MHENRY-2
6	16	42	90	2		30b*	pip01
6	16	43	91	1		30a2	SEAB-1
6	16	44	92	2		30a2	xyan08
6	17	45	93	5		30a1	GARDEN-1
6	17	45	93	5		30a1	GARDEN-3
6	17	46	94	5			rott01
6	17	46	95	5		29a	rott02
6	18	47	96	5			rott03
6	18	48	97	5			rott04
6	18	48	98	5			rott06
6	19	49	99	6		29a	PRES-1
7	20	50	100	2			Guild07



Appendix 2 Species by clusters at 20 cluster level

(Species present in less than 30% of any cluster have been omitted).
(Number prefix to name is 50 cluster number from classification of species.)
(Species are ordered by the dendrogram from classification of species)

	7 cluster →	1			3	2				4		5		6						7
	20 cluster →	3	1	2	8	5	6	4	7	9	10	11	12	13	14	15	16	17	18	19	20
	# sites →	59	79	16	6	43	8	21	15	14	4	35	4	12	12	4	3	4	3	1	1
	name																				
1	Diplolaena angustifolia			6		7							50		17		33				
1	Banksia prionotes												50								
1	Cassytha aurea var. hirta					5		5		21		17					33				
1	Allocasuarina lehmanniana subsp. lehmanniana		1	19		7			27	7		6	75		8						
2	Catapodium rigida							10							33						
2	Apium annuum					2		10						17	17			50	67		
2	Threlkeldia diffusa					2		14				6							67	100	
2	Sagina maritima							10										25	67		
2	Melilotus indicus							29						8		25				100	
2	Ehrharta longiflora							24	13			3		17	42	25	33			100	
2	Sonchus oleraceus	2				9		38	60			9		42	42	75			33	100	
2	Cerastium glomeratum	2		6		5		33	7					33	42	75		50			
2	Galium murale	2						19						50	42	25		75	33	100	
2	Dianella revoluta	5	3					24	40				50	25	42	50	33				
2	Eucalyptus gomphocephala	3		6					20					33	42	50	67				100
2	Eremophila glabra subsp. West Coast(T.E.H.Aplin 3401)	3	9			5		33	13					8	17			25			
2	Parietaria debilis	3				21	88	33	20			11		75	8		67	100	67	100	
2	Poranthera microphylla	2				16	13	10						25	8		33	50			
2	Clematis linearifolia	3	1	31			88	5	27			6		17	17		33				
2	Thysanotus patersonii	3				7	13	10	7			3		8	17	50		50			
2	Templetonia retusa	5	19	38	17	9		57	33			6		42	33	50					
2	Melaleuca huegelii subsp. huegelii		3	19		2	25	76					25		8						
2	Melaleuca cardiophylla	2	1	19		2	13	48				6					33				
3	Isolepis marginata	5				23	13	24	13			14		25			33		33		
3	Rhagodia baccata subsp. dioica					14		33	13			6			8		100	50	33		
3	Hydrocotyle hispidula					7		19						17			33				
3	Lobelia tenuior					14		10						50		25					
3	Triglochin trichophorum					12		5						17		25		25	33		
3	Danthonia occidentalis					35		24	7												
3	Leptorhynchos scabrus	5				33		10													
3	Leucopogon racemulosus			6		16		14					75		17						
3	Podotheca angustifolia	15	6		17	35	25	14					25		8			25			
4	Vulpia myuros var. hirsuta	34	11		50	12		33	7	14		20	25	8		25				100	
4	Lagurus ovatus	29	4			7		24	80	7		14		33	25			25	33		
4	Anagallis arvensis	42	4		17	2	13	76	60			3	25	42	25	25	33	25			
4	Romulea rosea var. australis	42	9			5		19				3		17	17						
4	Avena barbata	22						10	13			3								100	
4	Acacia saligna	19	5			14									8	25	33				
4	Diplopeltis huegelii var. huegelii		8		33	2			27												
4	Conostylis candicans subsp. candicans	2							47			9									
4	Lolium rigidum					7		10	33			3			8					100	
4	Petrorhagia velutina	3				9		14	60					8		50					

	7 cluster -->	1			3	2				4		5		6							7
	20 cluster -->	3	1	2	8	5	6	4	7	9	10	11	12	13	14	15	16	17	18	19	20
	# sites -->	59	79	16	6	43	8	21	15	14	4	35	4	12	12	4	3	4	3	1	1
	name																				
4	Briza minor	3																	33		
4	Trifolium campestre	8			17	2										50					
4	Hypochaeris glabra	8			17	12		24	7					8		100			67		
5	Triglochin calcitrapum					21	25	10	27			3			8		33		33		
5	Schoenus grandiflorus	15	5	19	50	42	13	5	47					8	17						
5	Calandrinia corrigioloides	2				35	38	19	27			20		8			33				
5	Thysanotus arenarius	12	3			26		10	33					8	8						
5	Lechenaultia linarioides		4	13		12			33												
5	Danthonia caespitosa	27	53	13	33	7				7		3			8						
5	Poa drummondiana		19	19	33	35	13	19													
5	Scaevola thesioides subsp. thesioides	10	35	19	17	26		19					25								
5	Acacia xanthina	2	23	44		14		5				3			8						
5	Acacia pulchella var. glaberrima		16	6	83	16		10	7			6		8			33				
5	Chamelaucium uncinatum		13	6		42	38	5	13												
5	Brachyscome iberidifolia		9	25	33	44	13	5								50					
	Schoenus brevisetis	5	16		33	2						3									
7	Leptomeria preissiana	2	1			2				21		17	50		8						
7	Acacia truncata		16		33	12		14				14									
10	Spinifex hirsutus									7	100										
10	Cakile maritima									21	100										
10	Actites megalocarpa										50										
11	Spinifex longifolius						13			36	75	23									
11	Calocephalus brownii									64	25	11									
11	Isolepis nodosa	5				2	13	14		79	25	60							33		
11	Scaevola crassifolia	2	1			7	13	24		64		77	25	8	8			25		100	
11	Tetragonia decumbens							5		36	75	37									
11	Trachyandra divaricata	2		6				14		29	50	20		50	33			75	67		
11	Lepidosperma gladiatum	24	9			9	25	5	20	29		74		42		25	67				
11	Ozothamnus cordatus	27	9			7	25		33			66		8							
11	Pelargonium capitatum	53	3			7		19	87	50	25	51			8		33				
11	Myoporum insulare	8	1	6		5	13	14		7		51			25						
11	Carpobrotus virescens	19	9			26	13	14			50	26		25							
11	Acacia cyclops	5	5			5		14		21		37	50		33	25					
	Comesperma integerrimum	12		13		7		14				29			50						
13	Fumaria sp. scsp																		33		
13	Cardamine sp. scsp																		33		
13	Gahnia trifida																		33		100
13	Melaleuca lanceolata														8			75	67	100	
13	Callitris preissii subsp. preissii														50			50	33		
13	Solanum nigrum							5							8		33	25	33		
14	Pittosporum phylliraeoides														8		33				
14	Fumaria capreolata								13						33						
14	Asparagus asparagoides								7					8	50						
14	Euphorbia peplus							5	7						33			50	33		
14	Oxalis pes-caprae														17	50					
15	Poa porphyroclados					23		10						17		50				100	
15	Exocarpos sparteus	2			17	2			7			11	25	42							
16	Isolepis cernua					5		5											33		
16	Leucopogon australis					2			7					8	8		33				
19	Drosera erythrorhiza															50					
19	Conyza albida															50					
19	Briza maxima	5						5	27					17	8	50					

	7 cluster -->	1			3	2				4		5		6							7
	20 cluster -->	3	1	2	8	5	6	4	7	9	10	11	12	13	14	15	16	17	18	19	20
	# sites -->	59	79	16	6	43	8	21	15	14	4	35	4	12	12	4	3	4	3	1	1
	name																				
20	Macrozamia riedlei													8		75	33				
20	Aira caryophyllea					5		10						8	8	75		25			
20	Mesomelaena pseudostygia			6	67											75					
20	Hibbertia hypericoides	2			50											75	33				
20	Ursinia anthemoides				33				13							75					
20	Sowerbaea laxiflora													8		50					
20	Urospermum picroides															50					
20	Podotheca gnaphalioides							5								50					
20	Silene gallica	2						14								50					
20	Xanthorrhoea preissii	2				5										25	33				
22	Thysanotus thyrsoideus				17												33				
22	Crassula exserta																33				
22	Eucalyptus decipiens																33				
22	Eucalyptus argutifolia																33				
23	Caladenia longicauda subsp. calcigena					2		5									33				
25	Acacia sp.													8	8				33		
25	Stellaria media					2		10						42	8					100	
25	Trachymene coerulea					2		5						33				100			
25	Microlaena stipoides	2												42	8	50	33				
25	Caladenia latifolia					7		10	7					58	25	25	67				
25	Calandrinia brevipedata	2				2			27					42	8		33	25		100	
25	Carex preissii					2	13	14						83		25			33	100	
25	Geranium retrorsum								7					58							
25	Oxalis perennans													75			33	25			
25	Dichondra repens													42					33		
25	Hibbertia cuneiformis													83							
25	Agonis flexuosa	2							13					92	8						
25	Zantedeschia aethiopica													42	8			25			
25	Eriochilus dilatatus													33		25					
26	Pterostylis aff. nana	2												33		50					
26	Diplolaena dampieri													42	8			50			
26	Guichenotia ledifolia													17				50			
26	Thysanotus manglesianus													8			33				
29	Pelargonium littorale					5								8			67				
29	Bellardia trixago					2		10						8		25				100	
29	Hydrocotyle callicarpa						50							8						100	
30	Tetragonia tetragonoides					5		5									33				
30	Daviesia divaricata				50	7															
31	Grevillea vestita					2											33				
33	Hakea ruscifolia				17																100
34	Anigozanthos humilis subsp. humilis				33	5															
36	Allocasuarina humilis				67	5										25					
36	Bossiaea eriocarpa			6	67	2															
36	Hakea trifurcata				83	2							25								
36	Petrophile serruriae	2			83	5															
36	Hakea lissocarpha			6	83	7		14													
36	Hakea prostrata	2		6	67	9								8							
36	Jacksonia stricta			6	50	2															
36	Olearia rudis				50	5															
36	Grevillea thelemanniana subsp. preissii			6	67	5		43							8						
36	Dryandra lindleyana	2		6	83	12		29									33				

	7 cluster →	1			3	2				4		5		6							7
	20 cluster →	3	1	2	8	5	6	4	7	9	10	11	12	13	14	15	16	17	18	19	20
	# sites →	59	79	16	6	43	8	21	15	14	4	35	4	12	12	4	3	4	3	1	1
	name																				
36	Dryandra sessilis var. cygnorum	3		6	83	5		33	13				50		8	75	33				
37	Bromus diandrus	29	5			51	38	67	20	7		43		25	8	25				100	
37	Crassula glomerata	56	15	6		42	13	67		36		37	25		33			25			
37	Acanthocarpus preissii	78	44	25		53	88	67	100			80	50	75	67	25	33	100	33		
37	Hardenbergia comptoniana	56	53	31	17	47	63	76	40	14		83		83	67	25	100				
37	Spyridium globulosum	64	25	63		53	63	43		36		66	100	92	100	100	100	25			
37	Olearia axillaris	69	30			37		43	73	79	25	89	50	33	17	50		25			
37	Rhagodia baccata subsp. baccata	32	22	56	17	63	88	52	13	14		66	25	92	58	25		25		100	
37	Senecio lautus	8	49	13	17	72	50	48	7	50	25	46		42	17			25			
37	Acacia rostellifera	54	11	44		28	88	19	53			31		33	33			25			
37	Calandrinia liniflora					44	50	24	7			11		25							
37	Crassula colorata	3	1	6		40	25	71	7	21		20		17	25			25		100	
37	Daucus glochidiatus	14		31	17	79	88	62	27			31		42	33	100	67	25		100	
37	Trachymene pilosa	12	3		17	70	88	57	20					67	33	100	67	50			
37	Dischisma arenarium	34	4			77	75	48	27	21		43	25	33	25	50					
[illegible]	assytha racemosa	3	5	19	33	35		52	33	7	25	49	50	33			33				
37	Poa poiformis	78	73	63	50	28		38		7		40	50	25	17			25			
37	Leucopogon parviflorus	42	62	13	17	44		52	20			23	50	58	33			25			
37	Stipa flavescens	69	59	88	33	98	50	86	87	7		17		58	33			100			
37	Lepidosperma angustatum	68	76	44	67	84	13	33	47			3		58	25						
37	Lomandra maritima	92	95	81	67	100	50	43	40			6			17		33				
37	Melaleuca acerosa	98	99	100	100	95	75	57	80			6			25						
37	Loxocarya aspera	90	85	75	100	95	25	71	80						8	50					
37	Conostylis candicans subsp. calcicola	73	89	81	83	84	50	33	60	29		66	75	8	33	25		25			
37	Acacia lasiocarpa var. lasiocarpa	31	82	56	17	74		19	73			6	100		17	50					
37	Phyllanthus calycinus	61	61	19	17	44	38	29	7					67	8		33	50			
37	Heliophila pusilla	29	25	19	17	58		29	40	7		6		8		75					
37	Gompholobium tomentosum	37	39	13	33	47		24	47					8							
37	Cassytha glabella	10	72	13	33	23		5				3									
37	Calothamnus quadrifidus	7	62	19	83	53	13	29	47			3									
37	Cryptandra mutila	5	37	25	17	37		10													
[illegible]	Opercularia vaginata	10	49	19	17	42		29	33			6	75	8		50					
37	Hibbertia racemosa	19	39	6	17	40			73			17									
37	Hemiandra pungens	29	63	19		47		10	60	7		49	75	33							
37	Nemcia reticulata	22	53	13	33	35		29	7	7		17	25								
37	Pimelea ferruginea	8	34			19		5				3	25								
41	Spergula sp. scps																			100	
41	Crassula sp.																			100	
41	Siloxerus sp.																			100	
41	Hydrocotyle medicaginoides																			100	
41	Ranunculus pumilio													8						100	
41	Lolium perenne	3										3								100	
42	Alyogyne huegelii var. glossulariaefolius					2											67				
42	Carex appressa																33				
42	Amyema miquelii																33				
42	Geranium solanderi																33				
42	Adriana quadripartita																33				
42	Melaleuca rhaphiophylla			6													33				100
43	Triglochin procerum																				100

	7 cluster -->	1			3	2				4		5		6							7
	20 cluster -->	3	1	2	8	5	6	4	7	9	10	11	12	13	14	15	16	17	18	19	20
	# sites -->	59	79	16	6	43	8	21	15	14	4	35	4	12	12	4	3	4	3	1	1
	name																				
43	Baumea arthrophylla																				100
43	Baumea articulata																				100
43	Baumea juncea																				100
43	Lepidosperma longitudinale																				100
44	Leucopogon sp.																33				
44	Homeria flaccida																33				
44	Banksia grandis																33				
44	Persoonia saccata																33				
44	Hibbertia subvaginata																33				
44	Stypandra glauca													8			33				
44	Carpobrotus edulis							5	7								33				
45	Jacksonia sternbergiana							5									33				
46	Angianthus sp. scps																		33		
46	Halosarcia halocnemoides																		33		
46	Halosarcia indica																		33		
46	Sarcocornia quinqueflora																		33		
46	Samolus repens																		33		100
	olium sp.																		67		
47	Hydrocotyle diantha																		100		
47	Triglochin mucronatum																		67		
47	Plantago exilis																		67		
47	Triglochin minutissimum																		33		
47	Wurmbea dioica																		33		
47	Hypoxis glabella																		33		
47	Drosera stolonifera subsp. stolonifera																		33		
47	Centrolepis polygyna															25			33		

7 Cluster Level

#2

Stipa flavescens	88
Melaleuca acerosa	81
Loxocarya aspera	80
Lomandra maritima	71
Acanthocarpus preissii	67
Daucus glochidiatus	66
Conostylis candicans subsp. calcicola	64
Dischisma arenarium	61
Trachymene pilosa	59
Lepidosperma angustatum	58
Rhagodia baccata subsp. baccata	54
Hardenbergia comptoniana	54
Acacia lasiocarpa var. lasiocarpa	53
Senecio lautus	52

20 Cluster Level

#4

Stipa flavescens	86
Hardenbergia comptoniana	76
Melaleuca huegelii subsp. huegelii	76
Anagallis arvensis	76
Crassula colorata	71
Loxocarya aspera	71
Acanthocarpus preissii	67
Bromus diandrus	67
Crassula glomerata	67
Daucus glochidiatus	62
Melaleuca acerosa	57
Trachymene pilosa	57
Templetonia retusa	57
Cassytha racemosa	52
Leucopogon parviflorus	52
Rhagodia baccata subsp. baccata	52

#5

Lomandra maritima	100
Stipa flavescens	98
Melaleuca acerosa	95
Loxocarya aspera	95
Conostylis candicans subsp. calcicola	84
Lepidosperma angustatum	84
Daucus glochidiatus	79
Dischisma arenarium	77
Acacia lasiocarpa var. lasiocarpa	74
Senecio lautus	72
Trachymene pilosa	70
Rhagodia baccata subsp. baccata	63
Heliophila pusilla	58
Acanthocarpus preissii	53
Calothamnus quadrifidus	53
Spyridium globulosum	53
Bromus diandrus	51

#6

Rhagodia baccata subsp. baccata	88
Clematis linearifolia	88
Acanthocarpus preissii	88
Trachymene pilosa	88
Parietaria debilis	88
Daucus glochidiatus	88
Acacia rostellifera	88
Melaleuca acerosa	75
Dischisma arenarium	75
Spyridium globulosum	63
Hardenbergia comptoniana	63
Stipa flavescens	50
Conostylis candicans subsp. calcicola	50
Calandrinia liniflora	50
Hydrocotyle callicarpa	50
Lomandra maritima	50
Senecio lautus	50

#7	
Acanthocarpus preissii	100
Pelargonium capitatum	87
Stipa flavescens	87
Loxocarya aspera	80
Melaleuca acerosa	80
Lagurus ovatus	80
Acacia lasiocarpa var. lasiocarpa	73
Olearia axillaris	73
Hibbertia racemosa	73
Conostylis candicans subsp. calcicola	60
Sonchus oleraceus	60
Hemiandra pungens	60
Anagallis arvensis	60
Petrorhagia velutina	60
Acacia rostellifera	53

7 Cluster Level

#3	
Loxocarya aspera	100
M leuca acerosa	100
Petrophile serruriae	83
Hakea lissocarpha	83
Hakea trifurcata	83
Dryandra lindleyana	83
Calothamnus quadrifidus	83
Dryandra sessilis var. cygnorum	83
Conostylis candicans subsp. calcicola	83
Acacia pulchella var. glaberrima	83
Lepidosperma angustatum	67
Mesomelaena pseudostygia	67
Lomandra maritima	67
Bossiaea eriocarpa	67
Hakea prostrata	67
Grevillea thelemanniana subsp. preissii	67
Allocasuarina humilis	67
Olearia rudis	50
Vulpia myuros var. hirsuta	50
Daviesia divaricata	50
penus grandiflorus	50
Jacksonia stricta	50
Hibbertia hypericoides	50
Poa poiformis	50

20 Cluster Level

#8

(same as opposite)

7 Cluster Level

#4	
Olearia axillaris	67
Isolepis nodosa	67
Calocephalus brownii	55

20 Cluster Level

#9	
Olearia axillaris	79
Isolepis nodosa	79
Calocephalus brownii	64
Scaevola crassifolia	64
Senecio lautus	50
Pelargonium capitatum	50

#10	
Cakile maritima	100
Spinifex hirsutus	100
Tetragonia decumbens	75
Spinifex longifolius	75
Actites megalocarpa	50
Carpobrotus virescens	50
Trachyandra divaricata	50

7 Cluster Level

#5

Olearia axillaris	85
Acanthocarpus preissii	76
Hardenbergia comptoniana	74
Scaevola crassifolia	71
Spyridium globulosum	69
Conostylis candicans subsp. calcicola	66
Lepidosperma gladiatum	66
Rhagodia baccata subsp. baccata	61
Ozothamnus cordatus	59
Isolepis nodosa	53
Hemiandra pungens	51

20 Cluster Level

#11

Olearia axillaris	89
Hardenbergia comptoniana	83
Acanthocarpus preissii	80
Scaevola crassifolia	77
Lepidosperma gladiatum	74
Ozothamnus cordatus	66
Conostylis candicans subsp. calcicola	66
Rhagodia baccata subsp. baccata	66
Spyridium globulosum	66
Isolepis nodosa	60
Myoporum insulare	51
Pelargonium capitatum	51

#12

Spyridium globulosum	100
Acacia lasiocarpa var. lasiocarpa	100
Allocasuarina lehmanniana subsp. lehmanniana	75
Conostylis candicans subsp. calcicola	75
Opercularia vaginata	75
Hemiandra pungens	75
Leucopogon racemulosus	75
Acanthocarpus preissii	50
Dianella revoluta	50
Banksia prionotes	50
Leptomeria preissiana	50
Cassytha racemosa	50
Poa poiformis	50
Diplolaena angustifolia	50
Dryandra sessilis var. cygnorum	50
Leucopogon parviflorus	50
Olearia axillaris	50
Acacia cyclops	50

7 Cluster Level

#6

Spyridium globulosum	78
Acanthocarpus preissii	59
Hardenbergia comptoniana	56
Rhagodia baccata subsp. baccata	53
Trachymene pilosa	50

20 Cluster Level

#13

Agonis flexuosa	92
Spyridium globulosum	92
Rhagodia baccata subsp. baccata	92
Hardenbergia comptoniana	83
Carex preissii	83
Hibbertia cuneiformis	83
Acanthocarpus preissii	75
Parietaria debilis	75
Oxalis perennans	75
Phyllanthus calycinus	67
Trachymene pilosa	67
Stipa flavescens	58
Leucopogon parviflorus	58
Caladenia latifolia	58
Lepidosperma angustatum	58
Geranium retrorsum	58
Trachyandra divaricata	50
Galium murale	50
Lobelia tenuior	50

#14	
Spyridium globulosum	100
Hardenbergia comptoniana	67
Acanthocarpus preissii	67
Rhagodia baccata subsp. baccata	58
Callitris preissii subsp. preissii	50
Asparagus asparagoides	50
Comesperma integerrimum	50

#15	
Trachymene pilosa	100
Hypochaeris glabra	100
Spyridium globulosum	100
Daucus glochidiatus	100
Macrozamia riedlei	75
Aira caryophyllea	75
Ursinia anthemoides	75
Sonchus oleraceus	75
Dryandra sessilis var. cygnorum	75
Mesomelaena pseudostygia	75
Hibbertia hypericoides	75
Cerastium glomeratum	75
Heliophila pusilla	75
Silene gallica	50
Petrorhagia velutina	50
Sowerbaea laxiflora	50
Oxalis pes-caprae	50
Dianella revoluta	50
Poa porphyroclados	50
Microlaena stipoides	50
Briza maxima	50
Thysanotus patersonii	50
Drosera erythrorhiza	50
Pterostylis aff. nana	50
Trifolium campestre	50
Eucalyptus gomphocephala	50
Dischisma arenarium	50
Opercularia vaginata	50
Brachyscome iberidifolia	50
Conyza albida	50
Olearia axillaris	50
Podotheca gnaphalioides	50
Urospermum picroides	50
Acacia lasiocarpa var. lasiocarpa	50
Loxocarya aspera	50
Templetonia retusa	50

#16	
Rhagodia baccata subsp. dioica	100
Spyridium globulosum	100
Hardenbergia comptoniana	100
Trachymene pilosa	67
Daucus glochidiatus	67
Eucalyptus gomphocephala	67
Pelargonium littorale	67
Parietaria debilis	67
Caladenia latifolia	67
Lepidosperma gladiatum	67
Alyogyne huegelii var. glossulariaefolius	67

#17	
Acanthocarpus preissii	100
Trachymene coerulea	100
Parietaria debilis	100
Stipa flavescens	100
Galium murale	75
Trachyandra divaricata	75
Melaleuca lanceolata	75
Phyllanthus calycinus	50
Thysanotus patersonii	50
Cerastium glomeratum	50
Euphorbia peplus	50
Callitris preissii subsp. preissii	50
Poranthera microphylla	50
Guichenotia ledifolia	50
Apium annuum	50
Trachymene pilosa	50
Rhagodia baccata subsp. dioica	50
Diplolaena dampieri	50

#18	
Hydrocotyle diantha	100
Hypochaeris glabra	67
Plantago exilis	67
Apium annuum	67
Melaleuca lanceolata	67
Sagina maritima	67
Threlkeldia diffusa	67
Parietaria debilis	67
Trachyandra divaricata	67
Triglochin mucronatum	67
Lolium sp.	67

#19	
Calandrinia brevipedata	100
Crassula sp.	100
Siloxerus sp.	100
Vulpia myuros var. hirsuta	100
Avena barbata	100
Bromus diandrus	100
Ehrharta longiflora	100
Lolium perenne	100
Lolium rigidum	100
Poa porphyroclados	100
Carex preissii	100
Spergula sp. scps	100
Threlkeldia diffusa	100
Rhagodia baccata subsp. baccata	100
Stellaria media	100
Ranunculus pumilio	100
Crassula colorata	100
Melilotus indicus	100
Melaleuca lanceolata	100
Daucus glochidiatus	100
Hydrocotyle callicarpa	100
Hydrocotyle medicaginoides	100
Bellardia trixago	100
Galium murale	100
Scaevola crassifolia	100
Sonchus oleraceus	100
Parietaria debilis	100

7 Cluster Level

#7

Samolus repens	100
Melaleuca rhaphiophylla	100
Eucalyptus gomphocephala	100
Hakea ruscifolia	100
Lepidosperma longitudinale	100
Gahnia trifida	100
Baumea juncea	100
Baumea articulata	100
Baumea arthrophylla	100
Triglochin procerum	100

20 Cluster Level

#20

(same as opposite)

Appendix 3 Main species in Site Clusters

Constant (Most frequently occurring) species in each of the 7 and 20 Cluster Levels (values - % of sites in cluster)

7 Cluster Level

#1

Melaleuca acerosa	98
Lomandra maritima	92
Loxocarya aspera	85
Conostylis candicans subsp. calcicola	82
Poa poiformis	73
Lepidosperma angustatum	69
Stipa flavescens	65
Acacia lasiocarpa var. lasiocarpa	59
Phyllanthus calycinus	56
Acanthocarpus preissii	55
Hardenbergia comptoniana	51

20 Cluster Level

#1

Melaleuca acerosa	99
Lomandra maritima	95
Conostylis candicans subsp. calcicola	89
Loxocarya aspera	85
Acacia lasiocarpa var. lasiocarpa	82
Lepidosperma angustatum	76
Poa poiformis	73
Cassytha glabella	72
Hemiandra pungens	63
Leucopogon parviflorus	62
Calothamnus quadrifidus	62
Phyllanthus calycinus	61
Stipa flavescens	59
Danthonia caespitosa	53
Nemcia reticulata	53
Hardenbergia comptoniana	53

#2

Melaleuca acerosa	100
Stipa flavescens	88
Conostylis candicans subsp. calcicola	81
Lomandra maritima	81
Loxocarya aspera	75
Spyridium globulosum	63
Poa poiformis	63
Acacia lasiocarpa var. lasiocarpa	56
Rhagodia baccata subsp. baccata	56

#3

Melaleuca acerosa	98
Lomandra maritima	92
Loxocarya aspera	90
Acanthocarpus preissii	78
Poa poiformis	78
Conostylis candicans subsp. calcicola	73
Olearia axillaris	69
Stipa flavescens	69
Lepidosperma angustatum	68
Spyridium globulosum	64
Phyllanthus calycinus	61
Hardenbergia comptoniana	56
Crassula glomerata	56
Acacia rostellifera	54
Pelargonium capitatum	53