Floristic Survey of Poorly Known Remnant Vegetation Types and Revegetation in the Coorong, Lower Lakes and Murray Mouth Region

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Executive summary

Quadrat and transect based data were gathered from 62 sites in the Coorong, Lower Lakes Murray Mouth Program area using a method analogous to the Biological Survey of South Australia methodology. Thirty one sites were located in sites with remnant vegetation, and 31 sites were located in sites where revegetation has been undertaken. Remnant sites were located in vegetation types for which there is a current paucity of data.

Sites were allocated to an environmental setting *a priori*, based upon soil type and vegetation type from existing Biological Database of SA (BDBSA) data and floristic vegetation mapping. Native species richness overall was lower in revegetation sites than in remnant sites from the same environmental setting. A greater variety of grasses, sedges and herbaceous species were generally found in remnant sites when compared to revegetation sites. Remnant sites also had generally higher densities for all lifeform types, with the most marked differences in sedges in environmental setting 3 (Mallee communities in the Southeast Coorong), shrubs, grasses and sedges in environmental setting 4 (Low woodlands), sedges in setting 5 (Allocasuarina grassy woodlands), and sedges and mat plants in setting 8 (Samphire and saline edge). Ongoing research should focus upon the loss of ecological functionality as a result of a paucity of these lifeform types in revegetation, to help determine whether revegetation efforts need to focus upon improving the species richness and cover of these particular lifeforms and species.

The methodology used for this project was reviewed, and suggestions are made for potential changes or improvements for future work.

This data gathered in this project will prove valuable in ongoing landscape level planning, and will help inform and improve the continued delivery of the vegetation program through better design of habitat restoration strategies.

Contents

1.0 Introduction:

The Coorong, Lower Lakes Murray Mouth Program (CLLMM) began in 2009 as part of the Commonwealth's Bioremediation and Revegetation Project. Works were undertaken as an emergency response to the prolonged drought. Before water returned to the Lower Lakes system, mid-2010, the Bioremediation and Revegetation Project (BRP)was designed to build community resilience and support for the broader program through involvement and capacity building of local community groups to have the skills, experience and equipment necessary to be involved in the ongoing environmental care of the region.

The BRP has now transitioned from emergency works to habitat restoration through revegetation of the Coorong Lower Lakes region, and is now part of the Commonwealth's broader Murray Futures Initiative. To maximise the benefit of habitat restoration, it is necessary to gain an understanding of the existing vegetation composition in the CLLMM region so as to better understand the communities the CLLMM restoration project are trying to restore.

The purpose of this project is to fill in the spatial gaps in plant knowledge across the CLLMM region. This will help inform and improve the continued delivery of the vegetation program through better design of habitat restoration strategies. The vegetation assessment survey aims to characterise the condition, age and composition of the vegetation within different environmental settings, including remnant vegetation and revegetation. This information will also be used to determine if any particular environmental settings are under particular threat and require restoration and how our restored sites are tracking towards a desirable state.

2.0 Methods:

Sixty two sites were chosen across the Coorong Lower Lakes program area (Figure 1). Thirty one sites were located in areas that have been revegetated, and thirty one sites were located in remnant vegetation (Appendix 1). Remnant sites were located in vegetation types that were under-represented in existing biological survey data in the region. A waypoint was generated which was used for vegetation sampling (see below).

Landholders were contacted for permission to access the sites, and to provide any detail required regarding access. All landholder liaison was recorded in a log.

Two key components to describe vegetation were gathered at each site:

1. Vegetation composition and structure:

From the central waypoint, a cell consisting of a circle of radius 17m was established (Figure 2), which corresponds to an overall area of 900m^2. Within each cell, all plant species were identified to species level, or were vouchered for subsequent identification. For each species, the following attributes were estimated, using the codes and descriptions provided in Appendix 2:

- cover abundance;

- life form;
- strata dominance; and
- life stage.

The ground cover of live plants, dead plants, moss/microphytic crust, bare ground and rock was also estimated and categorised as per the codes in Appendix 2. The structural formation of the vegetation was also delineated, based upon the cover and height of the dominant overstorey species. The overstorey height, crown depth, canopy diameter and gap between canopies was measured for 10 individuals or discrete foliage clumps of the species that formed the dominant overstorey.

2. Estimating number of individuals per hectare:

At each site, four 50m transects running north, south, east and west were established from the central waypoint. The number of individuals for all species of tree, shrub, sedge and grass species that occurred within 1 metre on either side of the 50 metre transect was recorded. A photograph was also taken along each transect in all four directions from the central point. If there was insufficient native vegetation of a similar type to that at the GPS waypoint in any direction, the short-fall was added to one of the other transects so the final total of the four transects was 200 metres.

2.1 Data analysis:

All revegetation and remnant sites were allocated to an environmental setting (Appendix 3), based upon soil type and vegetation type from existing Biological Database of SA (BDBSA) data and floristic vegetation mapping. These environmental settings have been used as the basic grouping for analysis.

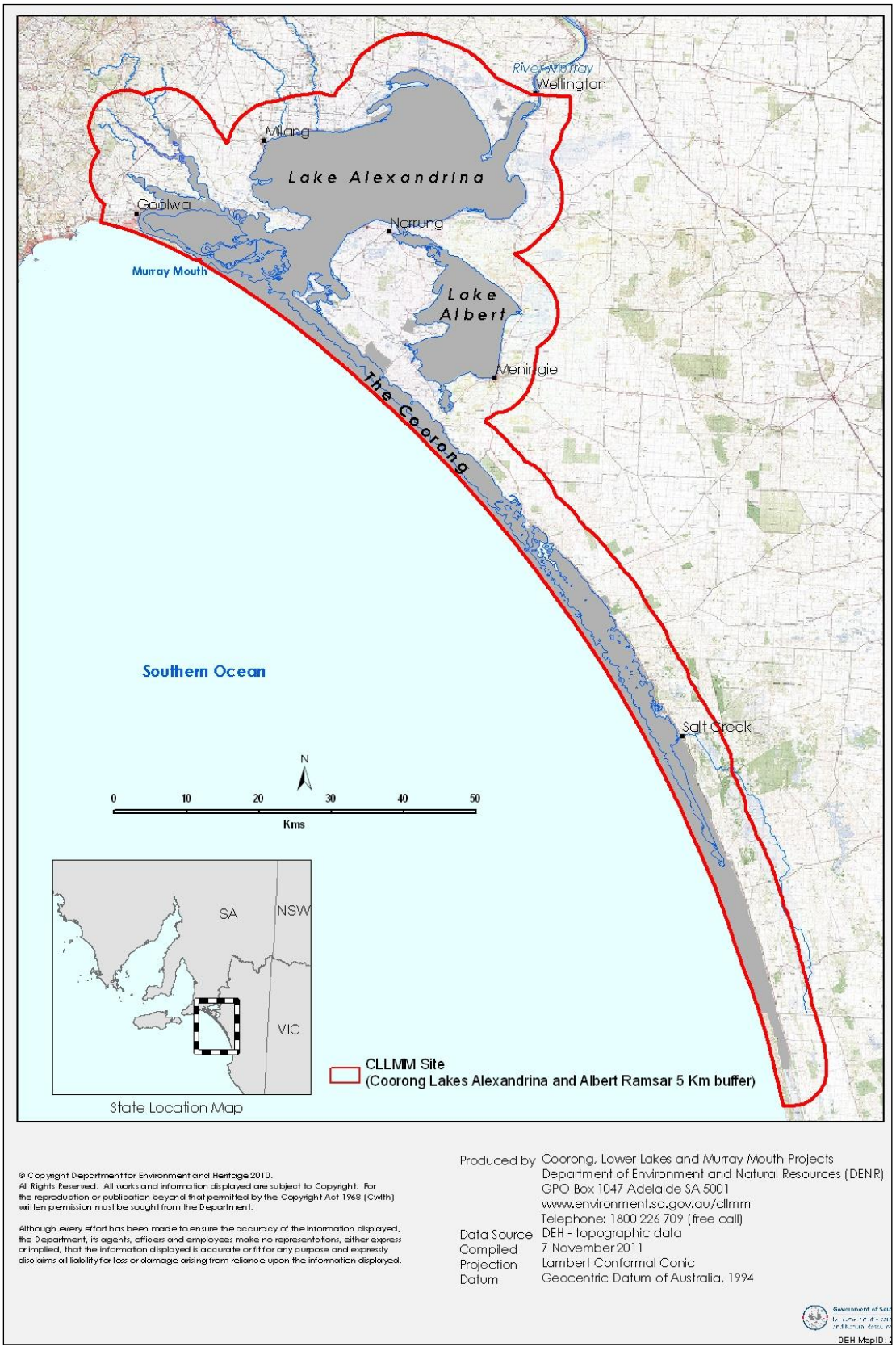


Figure 1: The CLLMM region where the Vegetation survey sites were located.

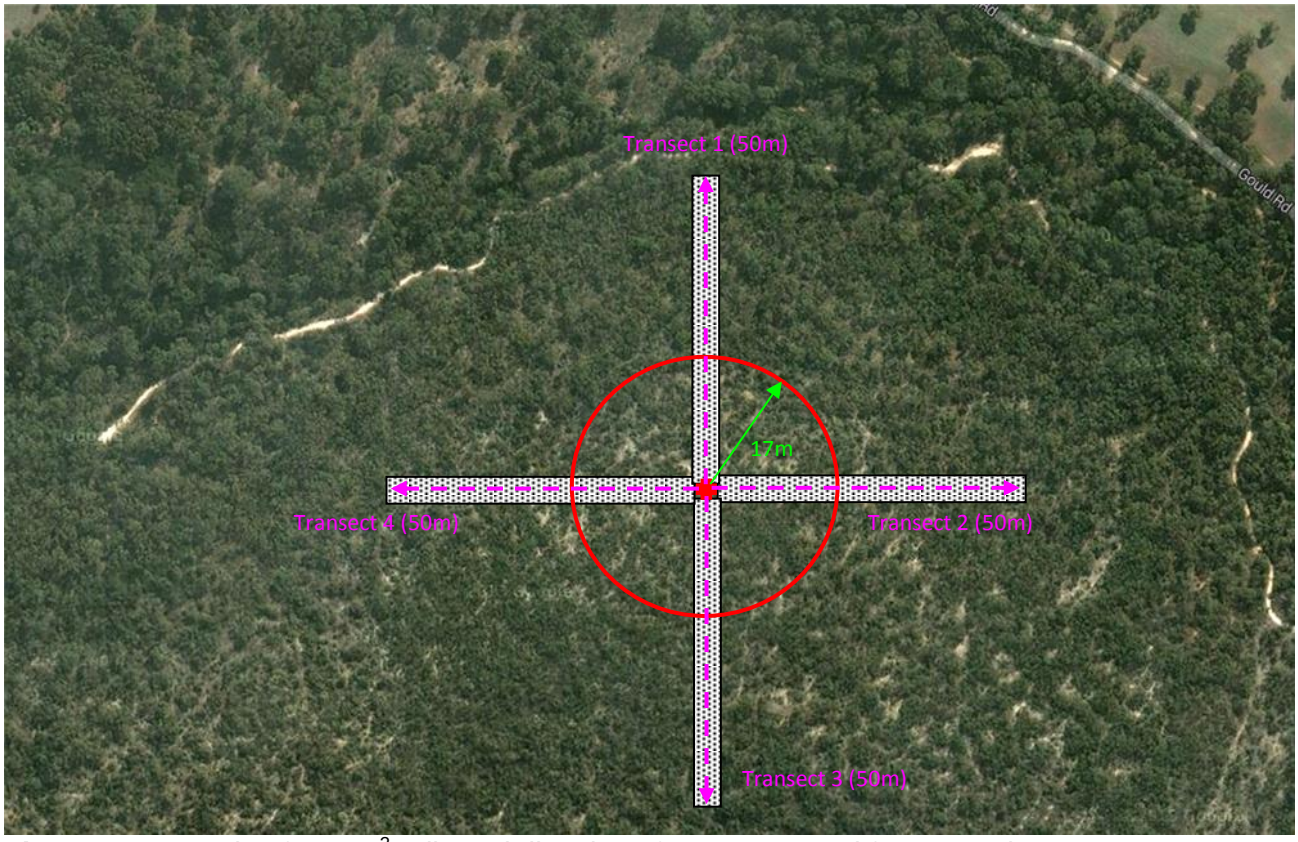


Figure 2. Example of 900 m^2 cells and direction of transects used for vegetation surveys

3.0 Results summary:

Section 3.1 describes the characteristics of each environmental setting. Of the nine environmental settings surveyed, there were only five settings where samples were taken from both remnant and revegetation sites (Table 1).

Table 1: Number of remnant and revegetation sites by environmental setting

Environmental setting	Number of remnant sites	Number of revegetation sites
2 – Mallee communities in the Mt Lofty Ranges and Lower lakes	7	
3 – Mallee communities in the Southeast Coorong	3	1
4 – Low woodlands	5	19
5 – Allocasuarina grassy woodlands	6	5
6 – Eucalyptus grassy woodlands	4	
7 – Grassland	1	
8 – Samphire and saline edge	4	4
9 – Freshwater damp with some saline tolerance		2
10 – Inland freshwater	1	

Species richness

Native species richness within the 900m^2 cells was highest in remnant vegetation in environmental settings 2,3,4,5 and 6, all of which averaged in excess of 30 species total (Figure 3). Contrastingly, revegetation sites all averaged 15 or less native species. Paired t-test comparison of settings 3,4,5 and 8 indicates remnant sites have significantly more native species overall than analogous revegetation sites (t-stat=3.06, df=3, P=0.027).

The highest number of introduced species was also found in environmental settings in remnant sites, with settings 2,5,6 and 7 having an average of 13 or more introduced species. Paired comparison of revegetation and remnant sites showed no significant difference in introduced species richness overall (t-stat=-0.33, df=3, P=0.76).

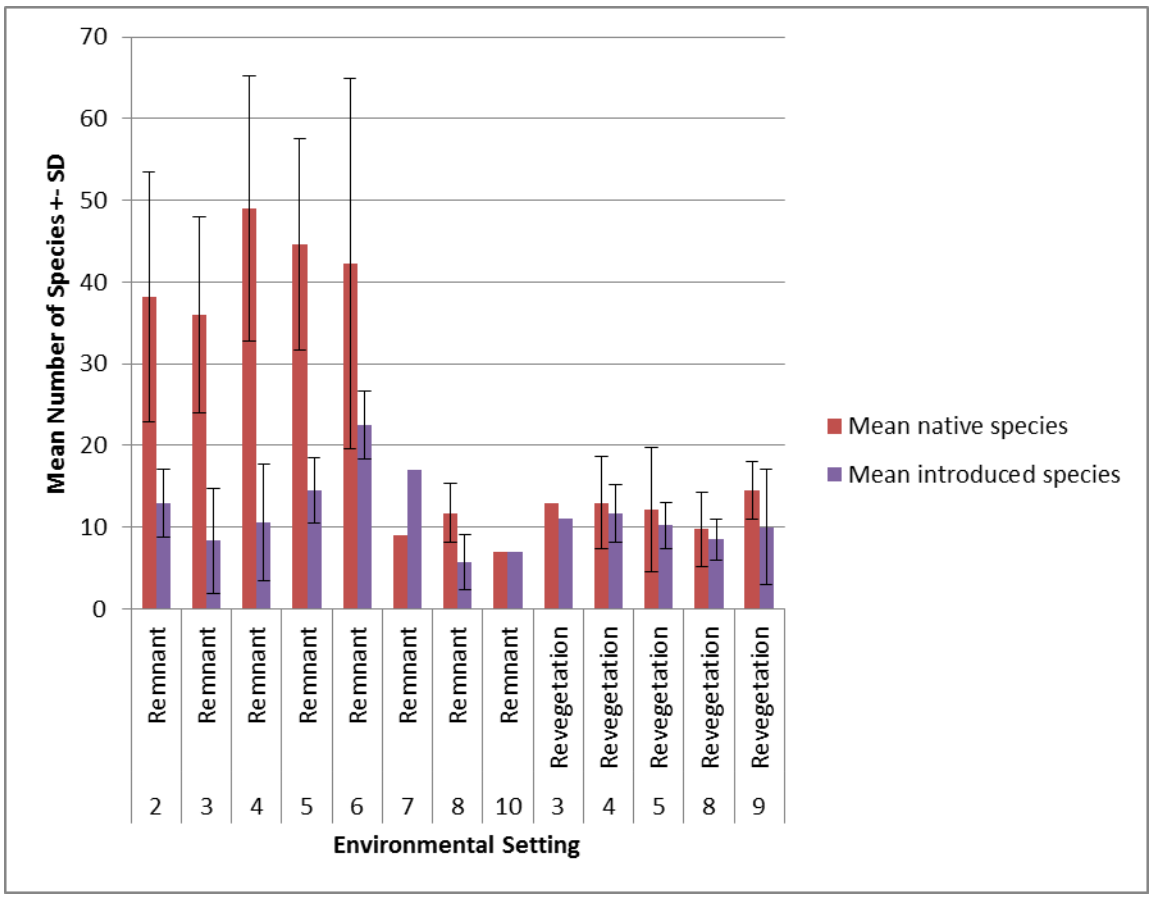


Figure 3: Species richness for native and introduced species for sites in different environmental settings

Species richness by lifeform

A greater variety of grasses, sedges and herbaceous species were generally found in remnant sites when compared to revegetation sites (Figures 4,5). These species are more problematic to propagate and plant in sufficient densities in revegetation programs than many tree and shrub species.

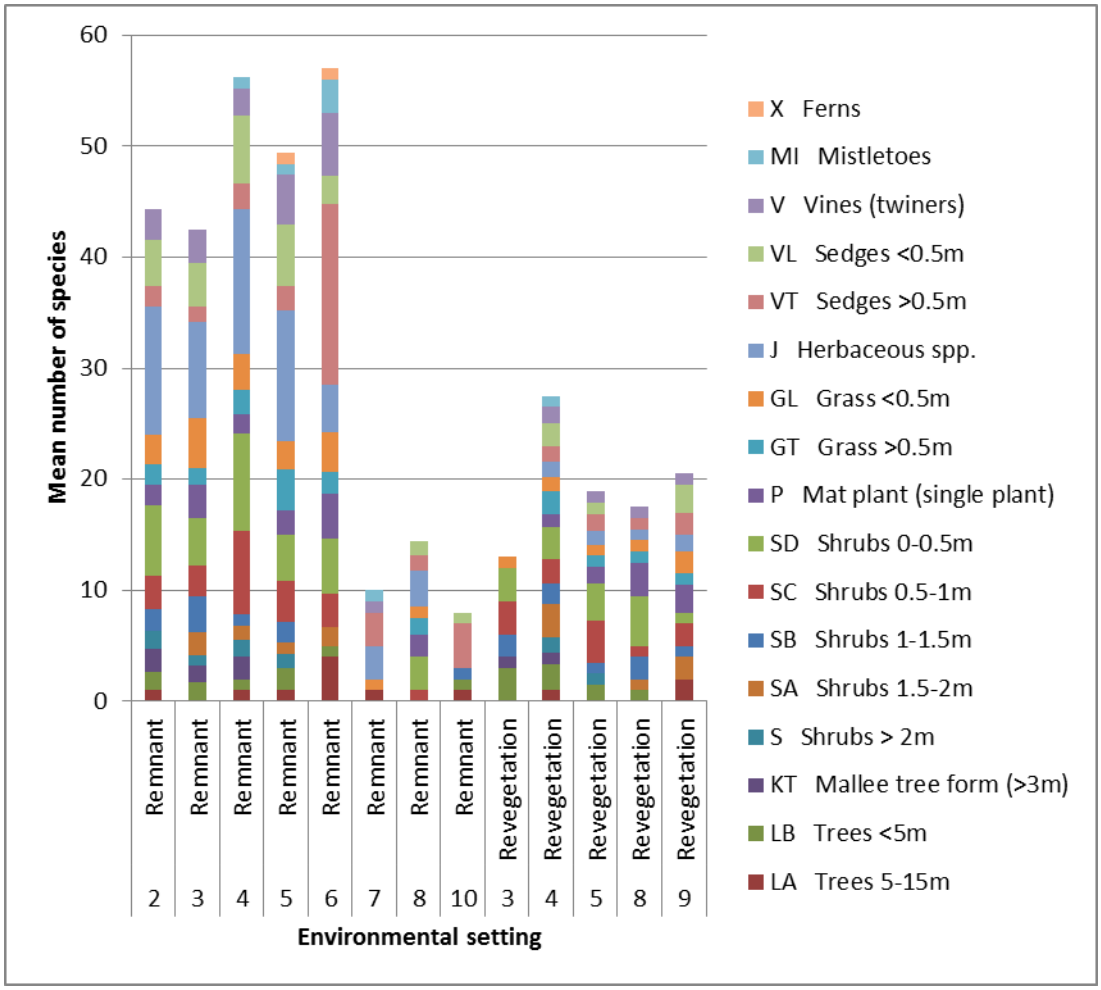


Figure 4: Native species richness by lifeform species for sites in different environmental settings

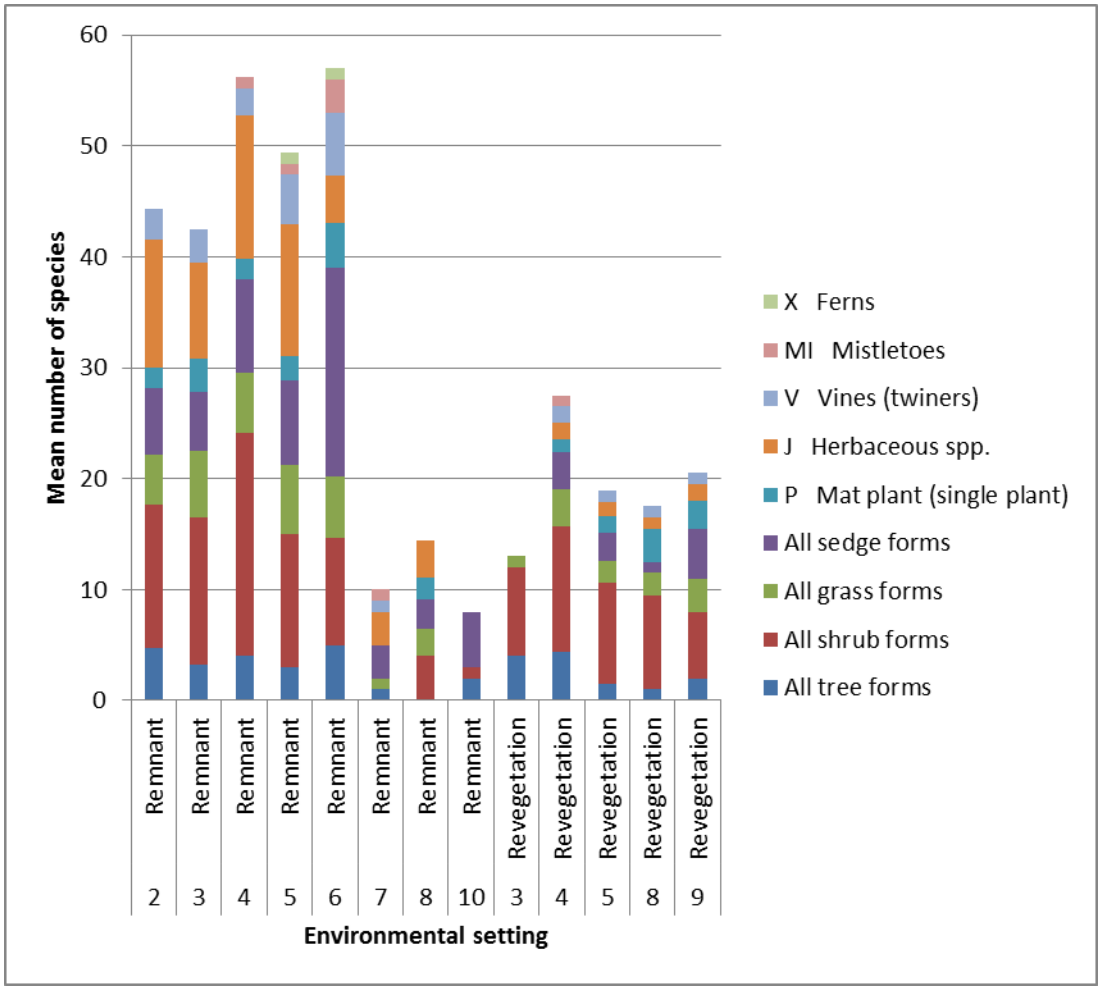


Figure 5: Native species richness by simplified lifeform classification

Density of different lifeforms

Sites in remnant vegetation had average total densities of tree, shrub, grass, mat plant and sedge species ranging from 5250 (environmental setting ten which consisted of only one site in a degraded riparian woodland) up to 47615 (Figure 6). All settings in remnant vegetation exceeded 16000 individuals per hectare other than environmental setting 10. In revegetation sites average total densities for environmental settings ranged from 2461 to 18600 individuals per hectare (Table 3), with all bar one setting (setting 9) having densities of 16000 or less individuals per hectare. This shows a general pattern of a higher density of native species in remnant than revegetation sites.

Table 3 shows data for consolidated lifeform types. Remnant sites have generally higher densities for all lifeform types, with the most marked differences in sedges in environmental setting 3, shrubs, grasses and sedges in environmental setting 4, sedges in setting 5, and sedges and mat plants in setting 8, where densities were an order of magnitude or more higher in remnant vegetation than in revegetation.

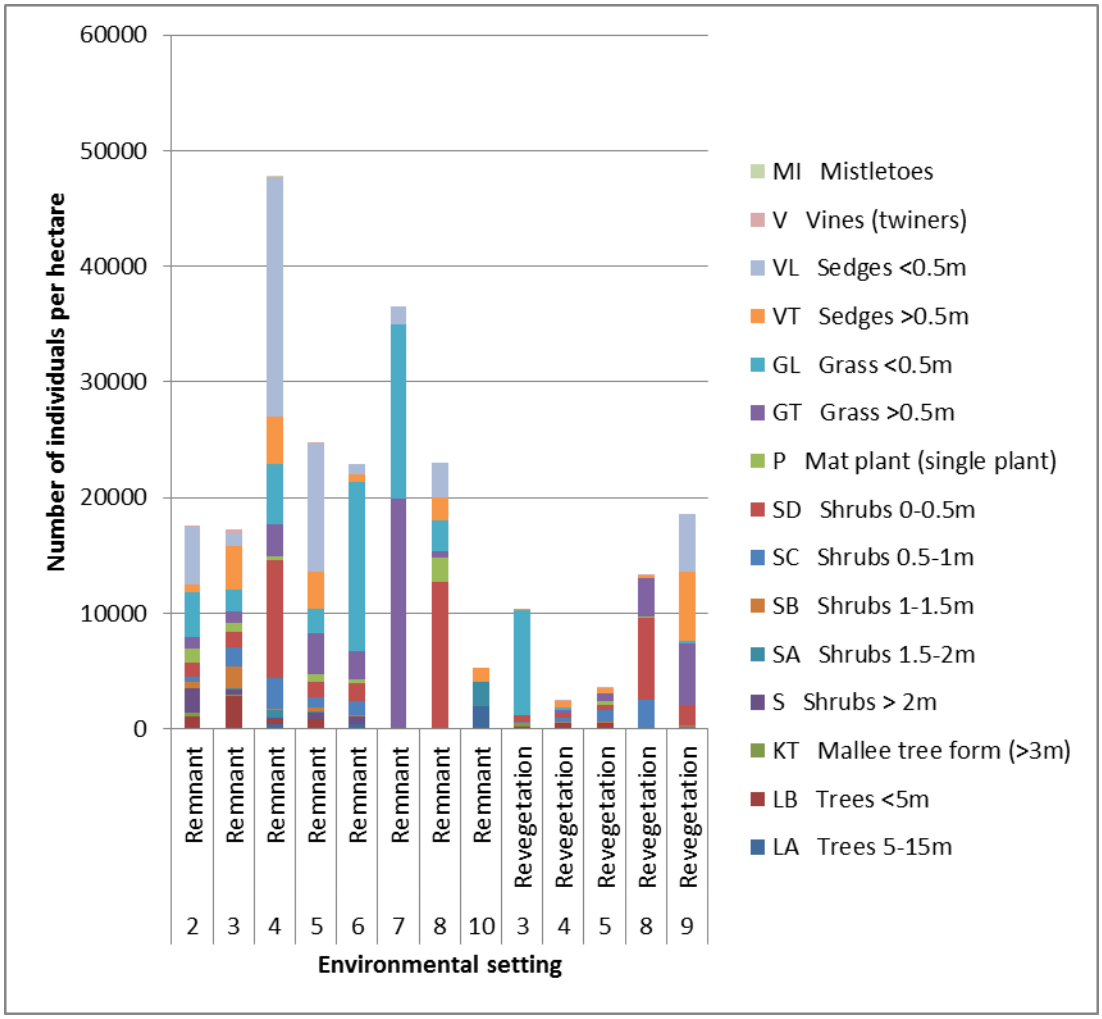


Figure 6: Individual densities by lifeform in different environmental settings

Table 3: Total number of tree, shrub, grass and sedge individuals per hectare by environmental setting

	Remnant Sites						Revegetation sites					
Environmental setting Number	All tree forms	All shrub forms	All grass forms	All sedge forms	Mat plants (single plant)	**Total**	All tree forms	All shrub forms	All grass forms	All sedge forms	Mat plants (single plant)	**Total**
2	1429	4321	4889	5629	1161	**17429**						
3	2983	5450	2908	4933	700	**16975**	375	775	9100	25	0	**10275**
4	830	13790	7930	24710	355	**47615**	426	842	536	618	38	**2461**
5	850	3225	5646	14329	638	**24687**	485	1655	675	465	280	**3560**
6	481	3538	17106	1519	231	**22875**						
7	0	0	34950	1600	0	**36550**						
8	0	12700	3175	5006	2113	**22994**	6	9619	3325	200	75	**13225**
9							0	2088	5525	10988	0	**18600**
10	1950	2175	0	1125	0	**5250**						
Average	**1065**	**5650**	**9576**	**7356**	**650**	**24297**	**259**	**2996**	**3832**	**2459**	**79**	**9624**

3.1 Descriptions of environmental settings

Environmental Setting Number: 2 Remnant

Remnant or revegetation: Remnant

Sites included in this environmental setting: 466, 472, 476, 494, 497, 498, 505

Description of Environmental Setting: Sites allocated to this environmental setting were included shrublands, woodlands and open mallee. Species diversity was generally high. The most commonly occurring native species was *Callitris gracilis*, with *Ehrharta calycina* the most frequently recorded weed species. These sites were also characterised by relatively high diversity of low shrubs (0-0.5m), sedges and herbaceous native species. Mat plants were in relatively high abundance in comparison to other environmental settings. Surface calcrete was evident in two of the sites.

Indicative Photographs:

Site 466: *Callitris gracilis* woodland

Site 494: *Melaleuca uncinata* Closed shrubland

Cell data:

Number of sites in this vegetation type: **7**
Mean native plant species richness per site (±SD): **38.14** (15.31)
Mean introduced plant species richness per site (±SD): **13.0** (4.16)

Ground Cover Components for this Environmental Setting

Ground Cover Component:	N	T	1	2	3	4	5
Mean live plant cover:					3	3	1
Mean dead plant litter & fallen timber:			1	3	3		
Mean moss and microphytic crust:				1	6		
Mean bare ground:		4	1	2			
Other (e.g. rock, calcrete):		1	1				

Key to codes: N = Not many (1-10 plants and <5%), T = sparsely present; cover small (less than 5%) , 1 = plentiful, but of small cover(less than 5%), 2 = any number of individuals covering 5-25% of area, 3= any number of individuals covering 25-50% of area, 4 = any number of individuals covering 50-75% of area, 5 = covering more than 75% of area

Most commonly occurring species (number of sites):

Native:	Number of sites:	Introduced:	Number of sites:
Callitris gracilis	6	*Ehrharta calycina*	7
Podotheca angustifolia	6	*Hypochaeris glabra*	5
Dillwynia hispida	5	*Plantago bellardii*	5
Enchylaena tomentosa var.	5	*Trifolium arvense var. arvense*	5
Hibbertia devitata	5	*Asparagus asparagoides*	4

		f. asparagoides	
Helichrysum leucopsideum	4	*Hypochaeris radicata*	4
Lepidosperma viscidum	4	*Pentaschistis sp.*	4
Melaleuca uncinata	4	*Sonchus oleraceus*	4
Muehlenbeckia gunnii	4	*Aira cupaniana*	3
Rytidosperma caespitosum	4	*Avellinia michelii*	3
Trachymene pilosa	4	*Brassica tournefortii*	3
Acacia leiophylla	3	*Lagurus ovatus*	3
Acrotriche affinis	3	*Silene nocturna*	3
Carpobrotus sp.	3	*Avena barbata*	2
Clematis microphylla	3	*Bromus rubens*	2
Daucus glochidiatus	3	*Petrorhagia dubia*	2
Dianella brevicaulis	3	*Trifolium campestre*	2
Eucalyptus incrassata	3	*Vulpia fasciculata*	2
Hibbertia virgata	3	*Vulpia muralis*	2
Lepidosperma carphoides	3	*Vulpia myuros forma*	2
Leptospermum coriaceum	3	*Vulpia sp.*	2
Lomandra juncea	3		
Neurachne alopecuroidea	3		
Thelymitra sp.	3		
Thysanotus patersonii	3		
Wahlenbergia gracilenta	3		

Transect and Cell Data: Number and density of native species by lifeform type (±SD):

Lifeform type	**Mean number of native species (cell data)**	**Mean number of introduced species (cell data)**	**Mean density of native species (transect data)**
LA Trees 5-15m	1.0 (0.0)	1.0	42.86 (68.79)
LB Trees <5m	1.7 (0.8)		1028.57 (1770.27)
KT/KS Mallees	2.0 (1.7)		357.14 (740.88)
S Shrubs > 2m	1.6 (0.8)		2107.14 (3079.53)
SA Shrubs 1.5-2m			
SB Shrubs 1-1.5m	2.0 (0.8)		575.0 (999.69)
SC Shrubs 0.5-1m	3.0 (1.6)	1.0 (0.0)	464.29 (579.31)
SD Shrubs 0-0.5m	6.4 (4.0)		1175.0 (954.38)
P Mat plant (single plant)	1.8 (1.5)		1160.71 (3005.34)
GT Grass >0.5m	1.9 (1.1)	1.4 (0.5)	1075.0 (1390.52)
GL Grass <0.5m	2.6 (1.3)	4.3 (1.4)	3814.29 (3732.12)
J Herbaceous spp.	11.6 (5.3)	6.1 (2.4)	NA
VT Sedges >0.5m	1.8 (1.0)		692.86 (918.41)
VL Sedges <0.5m	4.2 (2.1)		4935.71 (6407.94)
V Vines (twiners)	2.7 (1.1)	1.0 (0.0)	50.0 (90.14)
MI Mistletoes			NA
X Ferns			NA

Environmental Setting Number: 3 Remnant

Remnant or revegetation: Remnant

Sites included in this environmental setting: 464, 470, 471

Description of Environmental Setting: Sites allocated to this environmental setting were mallee vegetation formations. Native species richness was comparatively high, and weed species richness and cover comparatively low. Grass, shrub and herbaceous species diversity was high in comparison to other sites surveyed. The density of low trees was high in comparison to other environmental settings.

Indicative Photographs:

Site 464: *Eucalyptus diversifolia* Open mallee

Site 470: *Eucalyptus diversifolia* +/- *Eucalyptus leucoxylon* +/- *Callitris gracilis* Mallee

Cell data:

Number of sites in this vegetation type: **3**
Mean native plant species richness per site (±SD): **36.0** (12.0)
Mean introduced plant species richness per site (±SD): **8.33** (6.43)

Ground Cover Components for this Environmental Setting

Ground Cover Component:	N	T	1	2	3	4	5
Mean live plant cover:					2	1	
Mean dead plant litter & fallen timber:				1	1	1	
Mean moss and microphytic crust:				2	1		
Mean bare ground:			2	1			
Other (e.g. rock, calcrete):	1		1				

Key to codes: N = Not many (1-10 plants and <5%), T = sparsely present; cover small (less than 5%) , 1 = plentiful, but of small cover(less than 5%), 2 = any number of individuals covering 5-25% of area, 3= any number of individuals covering 25-50% of area, 4 = any number of individuals covering 50-75% of area, 5 = covering more than 75% of area

Most commonly occurring species (number of sites):

Native:	Number of sites:	Introduced:	Number of sites:
Helichrysum leucopsideum	3	*Asparagus asparagoides f. asparagoides*	3
Acacia leiophylla	3	*Aira cupaniana*	2
Eucalyptus diversifolia ssp. diversifolia	3	*Centaurium tenuiflorum*	2
Hibbertia devitata	2	*Sonchus oleraceus*	2
Muehlenbeckia gunnii	2	*Vulpia sp.*	2
Rytidosperma caespitosum	2	*Anagallis arvensis*	1
Acrotriche affinis	2	*Avena barbata*	1

Dianella brevicaulis	2	*Briza minor*	1
Eucalyptus incrassata	2	*Bromus diandrus*	1
Thysanotus patersonii	2	*Catapodium rigidum*	1
Arthropodium fimbriatum	2	*Ehrharta calycina*	1
Astroloma humifusum	2	*Gomphocarpus cancellatus*	1
Billardiera versicolor	2	*Hypochaeris glabra*	1
Hibbertia sericea	2	*Lolium sp.*	1
Rhagodia candolleana ssp.	2	*Petrorhagia dubia*	1
Thomasia petalocalyx	2	*Pinus halepensis*	1
Kunzea pomifera	2	*Plantago bellardii*	1
Tetragonia implexicoma	2	*Senecio pterophorus*	1
Xanthorrhoea caespitosa	2	*Trifolium arvense var. arvense*	1
Carpobrotus rossii	2		
Olearia axillaris	2		

Transect and Cell Data: Number and density of native species by lifeform type (±SD):

Lifeform type	Mean number of native species (cell data)	Mean number of introduced species (cell data)	Mean density of native species (transect data)
LA Trees 5-15m		1.0	
LB Trees <5m	1.7 (1.2)		2825.0 (1825.51)
KT/KS Mallees	1.5 (0.7)		158.33 (212.62)
S Shrubs > 2m	1.0 (0.0)		383.33 (364.29)
SA Shrubs 1.5-2m	2.0		158.33 (274.24)
SB Shrubs 1-1.5m	3.3 (0.6)		1908.33 (1702.27)
SC Shrubs 0.5-1m	2.7 (2.9)		1608.33 (1215.1)
SD Shrubs 0-0.5m	4.3 (1.5)	1.0	1391.67 (950.11)
P Mat plant (single plant)	3.0 (1.7)		700.0 (1039.53)
GT Grass >0.5m	1.5 (0.7)	1.0 (0.0)	1066.67 (1006.64)
GL Grass <0.5m	4.5 (3.5)	4.0 (0.0)	1841.67 (1641.33)
J Herbaceous spp.	8.7 (4.9)	5.0 (1.4)	NA
VT Sedges >0.5m	1.3 (0.6)		3766.67 (284.31)
VL Sedges <0.5m	4.0		1166.67 (1722.16)
V Vines (twiners)	3.0 (0.0)	1.0 (0.0)	266.67 (461.88)
MI Mistletoes			NA
X Ferns			NA

Environmental Setting Number: 4 Remnant

Remnant or revegetation: Remnant

Sites included in this environmental setting: 479, 480, 488, 489, 490

Description of Environmental Setting: Sites allocated to this environmental setting were generally heathy low woodlands on sandy soils, with Pink Gum (*Eucalyptus fasciculosa*) being the most commonly occurring native tree species. Mean native species richness was higher than all other environmental settings surveyed, and introduced species richness and cover was comparatively low. Low shrub species richness, and overall shrub and sedge densities were high in comparison to other environmental settings.

Indicative Photographs:

Site 479: *Eucalyptus fasciculosa* Low woodland

Site 488: *Eucalyptus fasciculosa* Very Low woodland

Cell data:

Number of sites in this vegetation type: **5**
Mean native plant species richness per site (±SD): **49.0** (16.19)
Mean introduced plant species richness per site (±SD): **10.6** (7.16)

Ground Cover Components for this Environmental Setting

Ground Cover Component:	N	T	1	2	3	4	5
Mean live plant cover:					1	2	2
Mean dead plant litter & fallen timber:			1	4			
Mean moss and microphytic crust:				4	1		
Mean bare ground:		1	2	2			
Other (e.g. rock, calcrete):		1					

Key to codes: N = Not many (1-10 plants and <5%), T = sparsely present; cover small (less than 5%) , 1 = plentiful, but of small cover(less than 5%), 2 = any number of individuals covering 5-25% of area, 3= any number of individuals covering 25-50% of area, 4 = any number of individuals covering 50-75% of area, 5 = covering more than 75% of area

Most commonly occurring species (number of sites):

Native:	Number of sites:	Introduced:	Number of sites:
Lomandra micrantha ssp.	5	*Ehrharta calycina*	4
Acacia pycnantha	4	*Hypochaeris glabra*	4
Austrostipa sp.	4	*Aira cupaniana*	2
Hibbertia devitata	3	*Aira elegantissima*	2
Astroloma humifusum	3	*Avellinia michelii*	2
Lepidosperma congestum	3	*Avena barbata*	2
Acacia spinescens	3	*Centaurium sp.*	2
Lepidosperma viscidum	3	*Disa bracteata*	2
Hibbertia virgata	3	*Plantago bellardii*	2

Lomandra juncea	3	*Vulpia fasciculata*	2
Calytrix tetragona	3		
Eucalyptus fasciculosa	3		
Rytidosperma sp.	3		
Schoenus breviculmis	3		
Burchardia umbellata	3		
Hypolaena fastigiata	3		
Gonocarpus tetragynus	3		
Leptospermum myrsinoides	3		
Platylobium obtusangulum	3		
Xanthorrhoea semiplana ssp. semiplana	3		

Transect and Cell Data: Number and density of native species by lifeform type (±SD):

Lifeform type	**Mean number of native species (cell data)**	**Mean number of introduced species (cell data)**	**Mean density of native species (transect data)**
LA Trees 5-15m	1.0 (0.0)	1.0	440.0 (445.32)
LB Trees <5m	1.0 (0.0)		380.0 (767.59)
KT/KS Mallees	2.0		10.0 (22.36)
S Shrubs > 2m	1.5 (0.7)		190.0 (424.85)
SA Shrubs 1.5-2m	1.3 (0.6)		650.0 (721.76)
SB Shrubs 1-1.5m	1.0 (0.0)		105.0 (195.58)
SC Shrubs 0.5-1m	7.5 (1.7)	2.0	2645.0 (2843.98)
SD Shrubs 0-0.5m	8.8 (4.7)		10200.0 (11192.73)
P Mat plant (single plant)	1.8 (1.0)		355.0 (592.24)
GT Grass >0.5m	2.2 (0.8)	1.4 (0.9)	2685.0 (3355.11)
GL Grass <0.5m	3.2 (1.8)	3.2 (1.6)	5245.0 (6511.23)
J Herbaceous spp.	13.0 (5.9)	4.6 (3.6)	NA
VT Sedges >0.5m	2.3 (1.3)		4085.0 (5431.35)
VL Sedges <0.5m	6.2 (1.9)		20625.0 (29133.44)
V Vines (twiners)	2.4 (1.3)	1.3 (0.6)	125.0 (265.75)
MI Mistletoes	1.0 (0.0)		NA
X Ferns			NA

Environmental Setting Number: 5 Remnant

Remnant or revegetation: Remnant

Sites included in this environmental setting: 465, 468, 473, 495, 500, 501

Description of Environmental Setting: Sites allocated to this environmental setting were low woodlands, open woodlands and mallee, with She-oak (*Allocasuarina verticillata*) an overstorey dominant in five of the six sites. The ground layer was characterised by an abundance of low sedges. Average species diversity was high. Sedges of height <0.5m were at high density in comparison to other environmental settings.

Indicative Photographs:

Site 465: *Allocasuarina verticillata, Callitris gracilis* Low woodland

Site 495: *Eucalyptus fasciculosa* Low open woodland

Cell data:

Number of sites in this vegetation type: **6**
Mean native plant species richness per site (±SD): **44.67** (12.91)
Mean introduced plant species richness per site (±SD): **14.5** (4.04)

Ground Cover Components for this Environmental Setting

Ground Cover Component:	N	T	1	2	3	4	5
Mean live plant cover:					2	4	
Mean dead plant litter & fallen timber:				6			
Mean moss and microphytic crust:		1		5			
Mean bare ground:		2	2	2			
Other (e.g. rock, calcrete):		3	1				

Key to codes: N = Not many (1-10 plants and <5%), T = sparsely present; cover small (less than 5%) , 1 = plentiful, but of small cover(less than 5%), 2 = any number of individuals covering 5-25% of area, 3= any number of individuals covering 25-50% of area, 4 = any number of individuals covering 50-75% of area, 5 = covering more than 75% of area

Most commonly occurring species (number of sites):

Native:	Number of sites:	Introduced:	Number of sites:
Clematis microphylla	6	*Aira cupaniana*	6
Lepidosperma carphoides	6	*Ehrharta calycina*	6
Helichrysum leucopsideum	5	*Asparagus asparagoides f. asparagoides*	5
Muehlenbeckia gunnii	5	*Avena barbata*	4
Rhagodia candolleana ssp.	5	*Hypochaeris glabra*	4
Allocasuarina verticillata	5	*Lycium ferocissimum*	4
Oxalis perennans	5	*Plantago bellardii*	4
Rytidosperma caespitosum	4	*Sonchus oleraceus*	4

Dianella revoluta var. revoluta	4	*Briza maxima*	3
Lomandra collina	4	*Centaurium sp.*	3
Lomandra micrantha ssp.	3	*Lagurus ovatus*	3
Acacia pycnantha	3	*Trifolium arvense var. arvense*	3
Austrostipa sp.	3	*Vulpia sp.*	3
Rytidosperma sp.	3	*Brassica tournefortii*	2
Schoenus breviculmis	3	*Petrorhagia dubia*	2
Burchardia umbellata	3	*Scabiosa atropurpurea*	2
Neurachne alopecuroidea	3	*Trifolium campestre*	2
Tricoryne elatior	3	*Vulpia myuros forma*	2
Wahlenbergia gracilenta	3		
Dianella brevicaulis	3		
Thysanotus patersonii	3		
Kunzea pomifera	3		
Austrostipa elegantissima	3		
Gahnia deusta	3		
Austrostipa flavescens	3		
Bursaria spinosa ssp. spinosa	3		
Austrostipa eremophila	3		
Lepidosperma concavum	3		
Romulea rosea var. australis	3		
Olearia axillaris	3		
Kennedia prostrata	3		
Poranthera microphylla	3		
Themeda triandra	3		

Transect and Cell Data: Number and density of native species by lifeform type (±SD):

Lifeform type	Mean number of native species (cell data)	Mean number of introduced species (cell data)	Mean density of native species (transect data)
LA Trees 5-15m	1.0 (0.0)		33.33 (81.65)
LB Trees <5m	2.0 (0.0)		816.67 (1022.46)
KT/KS Mallees			
S Shrubs > 2m	1.3 (0.6)		525.0 (1026.65)
SA Shrubs 1.5-2m	1.0		200.0 (489.9)
SB Shrubs 1-1.5m	1.8 (1.0)		283.33 (550.38)
SC Shrubs 0.5-1m	3.7 (2.3)	1.0 (0.0)	950.0 (1229.13)
SD Shrubs 0-0.5m	4.2 (2.1)	1.0 (0.0)	1266.67 (1286.14)
P Mat plant (single plant)	2.2 (0.8)		637.5 (925.44)
GT Grass >0.5m	3.7 (2.2)	1.8 (0.8)	3545.83 (3520.99)
GL Grass <0.5m	2.5 (0.5)	4.0 (0.9)	2100.0 (897.36)
J Herbaceous spp.	11.8 (4.7)	6.8 (2.9)	NA
VT Sedges >0.5m	2.2 (1.2)		3220.83 (3835.28)
VL Sedges <0.5m	5.5 (2.2)		11108.33 (16063.58)
V Vines (twiners)	4.5 (1.2)	1.0 (0.0)	45.83 (81.27)
MI Mistletoes	1.0 (0.0)		NA
X Ferns	1.0		NA

Environmental Setting Number: 6 Remnant

Remnant or revegetation: Remnant

Sites included in this environmental setting: 482, 485, 491, 493

Description of Environmental Setting: Sites allocated to this environmental setting were woodlands, with either Peppermint Box (*Eucalyptus odorata*) Pink Gum (*Eucalyptus fasciculosa*) or Blue Gum (*Eucalyptus leucoxylon*) as the dominant overstorey tree. Site 491, pictured below, was quite degraded, with only emergent Blue Gums through a predominantly grassland layer. The other three sites had relatively high species diversity, and a high number of introduced species for remnant sites. The species richness and density of native grass species was also high.

Indicative Photographs:

Site 491: Mixed native and exotic Grassland with emergent *Eucalyptus leucoxylon ssp leucoxylon*

Site 482: *Eucalyptus fasciculosa, Eucalyptus odorata* Low open woodland

Cell data:

Number of sites in this vegetation type: **4**
Mean native plant species richness per site (±SD): **42.25** (22.6)
Mean introduced plant species richness per site (±SD): **22.5** (4.2)

Ground Cover Components for this Environmental Setting

Ground Cover Component:	N	T	1	2	3	4	5
Mean live plant cover:					2		2
Mean dead plant litter & fallen timber:		1		2	1		
Mean moss and microphytic crust:		1		1	2		
Mean bare ground:		4					
Other (e.g. rock, calcrete):		1	1				

Key to codes: N = Not many (1-10 plants and <5%), T = sparsely present; cover small (less than 5%) , 1 = plentiful, but of small cover(less than 5%), 2 = any number of individuals covering 5-25% of area, 3= any number of individuals covering 25-50% of area, 4 = any number of individuals covering 50-75% of area, 5 = covering more than 75% of area

Most commonly occurring species (number of sites):

Native:	Number of sites:	Introduced:	Number of sites:
Arthropodium strictum	3	*Bromus diandrus*	4
Austrostipa sp.	3	*Lolium rigidum*	4
Bursaria spinosa ssp. spinosa	3	*Avena barbata*	3
Caesia calliantha	3	*Briza minor*	3
Clematis microphylla	3	*Ehrharta calycina*	3
Elymus scaber	3	*Trifolium arvense var. arvense*	3
Thysanotus patersonii	3	*Trifolium campestre*	3

Acacia calamifolia	2	*Aira cupaniana*	2
Acacia pycnantha	2	*Aira elegantissima*	2
Acaena echinata	2	*Anagallis arvensis*	2
Astroloma humifusum	2	*Asparagus asparagoides f. asparagoides*	2
Austrostipa exilis	2	*Brachypodium distachyon*	2
Austrostipa flavescens	2	*Briza maxima*	2
Austrostipa scabra ssp. falcata	2	*Ehrharta longiflora*	2
Centrolepis strigosa ssp. strigosa	2	*Eucalyptus odorata*	2
Chrysocephalum apiculatum	2	*Hypochaeris glabra*	2
Convolvulus angustissimus ssp. angustissimus	2	*Hypochaeris radicata*	2
Daucus glochidiatus	2	*Lagurus ovatus*	2
Dianella revoluta var. revoluta	2	*Plantago bellardii*	2
Dichondra repens	2	*Romulea rosea var. australis*	2
Eucalyptus leucoxylon ssp. leucoxylon	2	*Sonchus oleraceus*	2
Eucalyptus odorata	2		
Helichrysum leucopsideum	2		
Lagenophora huegelii	2		
Lepidosperma viscidum	2		
Lomandra multiflora ssp. dura	2		
Microlaena stipoides var. stipoides	2		
Microtis sp.	2		
Oxalis perennans	2		
Pimelea humilis	2		
Rytidosperma geniculatum	2		
Schoenus apogon	2		
Wahlenbergia gracilenta	2		

Transect and Cell Data: Number and density of native species by lifeform type (±SD):

Lifeform type	Mean number of native species (cell data)	Mean number of introduced species (cell data)	Mean density of native species (transect data)
LA Trees 5-15m	1.0 (0.0)	1.0 (0.0)	481.25 (571.32)
LB Trees <5m			
KT/KS Mallees			
S Shrubs > 2m	1.7 (1.2)		650.0 (769.2)
SA Shrubs 1.5-2m			
SB Shrubs 1-1.5m	3.0		25.0 (35.36)
SC Shrubs 0.5-1m	5.0 (2.8)		1287.5 (1388.42)
SD Shrubs 0-0.5m	4.0 (2.0)	1.0 (0.0)	1575.0 (2559.54)
P Mat plant (single plant)	2.0 (1.4)		231.25 (429.81)
GT Grass >0.5m	3.5 (1.3)	2.0 (0.8)	2475.0 (2508.82)
GL Grass <0.5m	4.3 (0.5)	8.3 (2.2)	14631.25 (16423.37)
J Herbaceous spp.	16.3 (16.3)	9.5 (1.7)	NA
VT Sedges >0.5m	2.5 (0.7)		650.0 (907.61)
VL Sedges <0.5m	5.7 (2.3)	3.0	868.75 (1438.37)
V Vines (twiners)	3.0 (0.8)	1.3 (0.6)	
MI Mistletoes	1.0		NA
X Ferns	1.0		NA

Environmental Setting Number: 7 Remnant

Remnant or revegetation: Remnant

Sites included in this environmental setting: 477

Description of Environmental Setting: Only one site was surveyed in this environmental setting. This site was a *Lomandra effusa, Austrostipa eremophila, Avena barbata* Grassland. Native plant species richness was relatively low. There were no tree or shrub species in either the surveyed cell or along the transect. Grass density was higher than in any other environmental setting. There was also 5-25% exposed rock.

Indicative Photographs:

Site 477: *Lomandra effusa, Austrostipa eremophila, Avena barbata* Grassland

Site 477: *Lomandra effusa, Austrostipa eremophila, Avena barbata* Grassland

Cell data:

Number of sites in this vegetation type: **1**
Mean native plant species richness per site (±SD): **9.0**
Mean introduced plant species richness per site (±SD): **17.0**

Ground Cover Components for this Environmental Setting

Ground Cover Component:	N	T	1	2	3	4	5
Mean live plant cover:					1		
Mean dead plant litter & fallen timber:				1			
Mean moss and microphytic crust:				1			
Mean bare ground:		1					
Other (e.g. rock, calcrete):				1			

Key to codes: N = Not many (1-10 plants and <5%), T = sparsely present; cover small (less than 5%) , 1 = plentiful, but of small cover(less than 5%), 2 = any number of individuals covering 5-25% of area, 3= any number of individuals covering 25-50% of area, 4 = any number of individuals covering 50-75% of area, 5 = covering more than 75% of area

Most commonly occurring species (number of sites):

Native:	Number of sites:	Introduced:	Number of sites:
Aristida behriana	1	*Aira cupaniana*	1
Austrostipa eremophila	1	*Asphodelus fistulosus*	1
Convolvulus angustissimus ssp. peninsularum	1	*Avena barbata*	1
Enneapogon nigricans	1	*Carthamus lanatus*	1
Hyalosperma semisterile	1	*Centaurium sp.*	1
Lomandra effusa	1	*Hedypnois rhagadioloides spp.*	1
Podolepis rugata var. rugata	1	*Hypochaeris glabra*	1

Rytidosperma caespitosum	1	*Medicago minima var. minima*	1
Vittadinia cuneata var.	1	*Neatostema apulum*	1
		Petrorhagia dubia	1
		Plantago bellardii	1
		Poa bulbosa	1
		Reichardia tingitana	1
		Rostraria cristata	1
		Salvia verbenaca var.	1
		Trifolium scabrum	1
		Vulpia sp.	1

Transect and Cell Data: Number and density of native species by lifeform type (±SD):

Lifeform type	**Mean number of native species (cell data)**	**Mean number of introduced species (cell data)**	**Mean density of native species (transect data)**
LA Trees 5-15m			
LB Trees <5m			
KT/KS Mallees			
S Shrubs > 2m			
SA Shrubs 1.5-2m			
SB Shrubs 1-1.5m			
SC Shrubs 0.5-1m			
SD Shrubs 0-0.5m			
P Mat plant (single plant)			
GT Grass >0.5m	1.0	1.0	19900.0
GL Grass <0.5m	3.0	4.0	15050.0
J Herbaceous spp.	3.0	12.0	NA
VT Sedges >0.5m			
VL Sedges <0.5m	1.0		1600.0
V Vines (twiners)	1.0		
MI Mistletoes			NA
X Ferns			NA

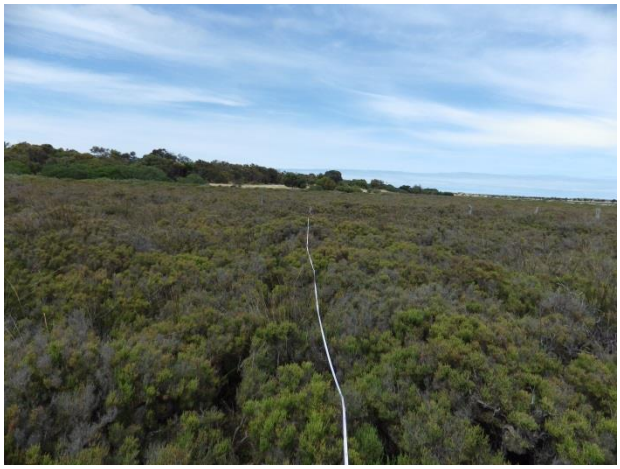
Environmental Setting Number: 8 Remnant

Remnant or revegetation: Remnant

Sites included in this environmental setting: 475, 478, 503, 507

Description of Environmental Setting: Sites allocated to this environmental setting were characterised by the presence of samphire species. These sites all sat in depressions or drainage lines in the landscape, and would at times be inundated with water. Species richness for both native and weed species was low in comparison to other environmental settings in remnant vegetation. The density of low shrubs (principally samphire species) and mat plants (*Wilsonia spp., Mimulus repens, Disphyma crassifolium ssp. clavellatum*) is high in comparison to sites in other environmental settings.

Indicative Photographs:



Site 475: *Tecticornia sp, Gahnia filum* Low closed shrubland

Site 503: *Sarcocornia quinqueflora* Low open shrubland

Cell data:

Number of sites in this vegetation type: **4**
Mean native plant species richness per site (±SD): **11.75** (3.59)
Mean introduced plant species richness per site (±SD): **5.75** (3.4)

Ground Cover Components for this Environmental Setting

Ground Cover Component:	N	T	1	2	3	4	5
Mean live plant cover:						1	3
Mean dead plant litter & fallen timber:		3	1				
Mean moss and microphytic crust:		4					
Mean bare ground:		2	1	1			
Other (e.g. rock, calcrete):							

Key to codes: N = Not many (1-10 plants and <5%), T = sparsely present; cover small (less than 5%) , 1 = plentiful, but of small cover(less than 5%), 2 = any number of individuals covering 5-25% of area, 3= any number of individuals covering 25-50% of area, 4 = any number of individuals covering 50-75% of area, 5 = covering more than 75% of area

Most commonly occurring species (number of sites):

Native:	Number of sites:	Introduced:	Number of sites:
Samolus repens	3	*Parapholis incurva*	3
Sarcocornia quinqueflora	3	*Lagurus ovatus*	2
Distichlis distichophylla	2	*Plantago coronopus ssp.*	2
Frankenia pauciflora var.	2	*Polypogon monspeliensis*	2
Juncus kraussii	2	*Sonchus oleraceus*	2
Puccinellia stricta	2		
Samphire sp.	2		
Spergularia marina	2		
Suaeda australis	2		

Transect and Cell Data: Number and density of native species by lifeform type (±SD):

Lifeform type	Mean number of native species (cell data)	Mean number of introduced species (cell data)	Mean density of native species (transect data)
LA Trees 5-15m			
LB Trees <5m			
KT/KS Mallees			
S Shrubs > 2m			
SA Shrubs 1.5-2m			
SB Shrubs 1-1.5m			
SC Shrubs 0.5-1m	1.0 (0.0)		100.0 (154.11)
SD Shrubs 0-0.5m	3.0 (1.4)		12600.0 (8143.22)
P Mat plant (single plant)	2.0 (1.0)		2112.5 (2269.96)
GT Grass >0.5m	1.5 (0.7)		518.75 (909.07)
GL Grass <0.5m	1.0 (0.0)	3.3 (2.1)	2656.25 (5312.5)
J Herbaceous spp.	3.3 (1.0)	2.5 (1.7)	NA
VT Sedges >0.5m	1.3 (0.6)		2081.25 (1921.95)
VL Sedges <0.5m	1.3 (0.6)		2925.0 (5766.97)
V Vines (twiners)			
MI Mistletoes			NA
X Ferns			NA

Environmental Setting Number: 10 Remnant

Remnant or revegetation: Remnant

Sites included in this environmental setting: 492

Description of Environmental Setting: Only one site was surveyed in this environmental setting. This site was a Red Gum (*Eucalyptus camaldulensis*) woodland with a lignum (*Duma sp.*) understorey. Species richness for both native and introduced species was low. Tree density was relatively high.

Indicative Photographs:

Site 492: *Eucalyptus camaldulensis var camaldulensis* Woodland

Site 492: *Eucalyptus camaldulensis var camaldulensis* Woodland

Cell data:

Number of sites in this vegetation type: **1**
Mean native plant species richness per site (±SD): **7.0**
Mean introduced plant species richness per site (±SD): **7.0**

Ground Cover Components for this Environmental Setting

Ground Cover Component:	N	T	1	2	3	4	5
Mean live plant cover:						1	
Mean dead plant litter & fallen timber:		1					
Mean moss and microphytic crust:		1					
Mean bare ground:			1				
Other (e.g. rock, calcrete):		1					

Key to codes: N = Not many (1-10 plants and <5%), T = sparsely present; cover small (less than 5%) , 1 = plentiful, but of small cover(less than 5%), 2 = any number of individuals covering 5-25% of area, 3= any number of individuals covering 25-50% of area, 4 = any number of individuals covering 50-75% of area, 5 = covering more than 75% of area

Most commonly occurring species (number of sites):

Native:	Number of sites:	Introduced:	Number of sites:
Alternanthera denticulata	1	*Anthoxanthum odoratum*	1
Chenopodium sp.	1	*Atriplex prostrata*	1
Eleocharis acuta	1	*Crassula natans var. minus*	1
Eucalyptus camaldulensis ssp. camaldulensis	1	*Hordeum marinum*	1
Lythrum hyssopifolia	1	*Lolium rigidum*	1
Duma sp.	1	*Ranunculus trilobus*	1
		Rumex conglomeratus	1

Transect and Cell Data: Number and density of native species by lifeform type (±SD):

Lifeform type	Mean number of native species (cell data)	Mean number of introduced species (cell data)	Mean density of native species (transect data)
LA Trees 5-15m	1.0		1950.0
LB Trees <5m			
KT/KS Mallees			
S Shrubs > 2m			
SA Shrubs 1.5-2m	1.0		2175.0
SB Shrubs 1-1.5m			
SC Shrubs 0.5-1m			
SD Shrubs 0-0.5m			
P Mat plant (single plant)			
GT Grass >0.5m		1.0	
GL Grass <0.5m		2.0	
J Herbaceous spp.	4.0	4.0	NA
VT Sedges >0.5m	1.0		1125.0
VL Sedges <0.5m			
V Vines (twiners)			
MI Mistletoes			NA
X Ferns			NA

Environmental Setting Number: 3 Revegetation

Remnant or revegetation: Revegetation

Sites included in this environmental setting: 363

Description of Environmental Setting: Only one revegetation site was surveyed in this environmental setting. Native plant species diversity was low when compared to remnant sites, especially for grasses, herbs and sedges. Plant densities were lower for all life forms than in remnant sites, aside from grasses (all of which was Emu Grass, *Distichlis distichophylla*), which was found at higher densities than in the remnant site.

Indicative Photographs:

Site 363: *Callitris gracilis, Allocasuarina verticillata, Eucalyptus spp* Very low open woodland

Site 363: *Callitris gracilis, Allocasuarina verticillata, Eucalyptus spp* Very low open woodland

Cell data:

Number of sites in this vegetation type: **1**
Mean native plant species richness per site (±SD): **13.0**
Mean introduced plant species richness per site (±SD): **11.0**

Ground Cover Components for this Environmental Setting

Ground Cover Component:	N	T	1	2	3	4	5
Mean live plant cover:							1
Mean dead plant litter & fallen timber:			1				
Mean moss and microphytic crust:		1					
Mean bare ground:		1					
Other (e.g. rock, calcrete):							

Key to codes: N = Not many (1-10 plants and <5%), T = sparsely present; cover small (less than 5%) , 1 = plentiful, but of small cover(less than 5%), 2 = any number of individuals covering 5-25% of area, 3= any number of individuals covering 25-50% of area, 4 = any number of individuals covering 50-75% of area, 5 = covering more than 75% of area

Most commonly occurring species (number of sites):

Native:	Number of sites:	Introduced:	Number of sites:
Acacia pycnantha	1	*Avena barbata*	1
Allocasuarina verticillata	1	*Bromus diandrus*	1
Bursaria spinosa ssp. spinosa	1	*Chondrilla juncea*	1
Callitris gracilis	1	*Cynodon dactylon var. dactylon*	1
Distichlis distichophylla	1	*Euphorbia paralias*	1
Dodonaea viscosa ssp. spatulata	1	*Hypochaeris radicata*	1
Eucalyptus diversifolia ssp.	1	*Lactuca serriola f.*	1

diversifolia		*serriola*	
Eucalyptus incrassata	1	*Lagurus ovatus*	1
Hakea mitchellii	1	*Scabiosa atropurpurea*	1
Melaleuca halmaturorum	1	*Sonchus oleraceus*	1
Melaleuca lanceolata	1	*Vulpia sp.*	1
Myoporum insulare	1		
Rhagodia candolleana ssp.	1		

Transect and Cell Data: Number and density of native species by lifeform type (±SD):

Lifeform type	**Mean number of native species (cell data)**	**Mean number of introduced species (cell data)**	**Mean density of native species (transect data)**
LA Trees 5-15m			
LB Trees <5m	3.0		250.0
KT/KS Mallees	1.0		125.0
S Shrubs > 2m			
SA Shrubs 1.5-2m			
SB Shrubs 1-1.5m	2.0		175.0
SC Shrubs 0.5-1m	3.0		75.0
SD Shrubs 0-0.5m	3.0		525.0
P Mat plant (single plant)			
GT Grass >0.5m		1.0	
GL Grass <0.5m	1.0	4.0	9100.0
J Herbaceous spp.		6.0	NA
VT Sedges >0.5m			25.0
VL Sedges <0.5m			
V Vines (twiners)			
MI Mistletoes			NA
X Ferns			NA

Environmental Setting Number: 4 Revegetation

Remnant or revegetation: Revegetation

Sites included in this environmental setting: 5, 77, 78, 322, 323, 328, 345, 348, 351, 360, 364, 406, 408, 417, 510, 513, 514, 515, 516

Description of Environmental Setting: Sites allocated to this environmental setting were highly varied, ranging from grassland dominated by exotic species (eg Site 322 shown below), to infill plantings in remnant woodland (eg Site 417 shown below). The prevalence of Perennial Veldt Grass (*Ehrharta calycina*) was notable, and it was the overstorey dominant in 5 sites. Native plant species richness was low in comparison to remnant sites in this environmental setting, particularly for herbs, sedges and low shrubs. Densities of lower shrub forms, grasses and sedges were also very low in comparison to remnant sites.

Indicative Photographs:

Site 322: *Ehrharta calycina* Exotic grassland

Site 417: *Eucalyptus fasciculosa* Open woodland

Cell data:

Number of sites in this vegetation type: **19**
Mean native plant species richness per site (±SD): **13.0** (5.63)
Mean introduced plant species richness per site (±SD): **11.74** (3.51)

Ground Cover Components for this Environmental Setting

Ground Cover Component:	N	T	1	2	3	4	5
Mean live plant cover:				1	1	8	9
Mean dead plant litter & fallen timber:		1	7	8		2	
Mean moss and microphytic crust:		11	1	5	1		
Mean bare ground:	1	10	1	6			
Other (e.g. rock, calcrete):		2		1		1	

Key to codes: N = Not many (1-10 plants and <5%), T = sparsely present; cover small (less than 5%) , 1 = plentiful, but of small cover(less than 5%), 2 = any number of individuals covering 5-25% of area, 3= any number of individuals covering 25-50% of area, 4 = any number of individuals covering 50-75% of area, 5 = covering more than 75% of area

Most commonly occurring species (number of sites):

Native:	Number of sites:	Introduced:	Number of sites:
Allocasuarina verticillata	14	*Ehrharta calycina*	14
Acacia cupularis	8	*Bromus diandrus*	13
Acacia paradoxa	8	*Lagurus ovatus*	12
Acacia pycnantha	8	*Vulpia sp.*	11
Ficinia nodosa	8	*Trifolium arvense var. arvense*	10

Eucalyptus diversifolia ssp. diversifolia	7	*Sonchus oleraceus*	9
Austrostipa sp.	6	*Avena barbata*	7
Dodonaea viscosa ssp. spatulata	6	*Trifolium campestre*	7
Eucalyptus sp.	6	*Arctotheca calendula*	6
Olearia axillaris	6	*Hypochaeris radicata*	6
Bursaria spinosa ssp. spinosa	5	*Hypochaeris glabra*	5
Callitris gracilis	5	*Lolium rigidum*	5
Eucalyptus fasciculosa	5	*Oenothera stricta ssp. stricta*	5
Eucalyptus porosa	5	*Plantago coronopus ssp.*	5
Hakea mitchellii	5	*Trifolium angustifolium*	5
Melaleuca lanceolata	5	*Acetosella vulgaris*	4
Melaleuca uncinata	5	*Asphodelus fistulosus*	4
Myoporum insulare	5	*Chondrilla juncea*	4
Acacia dodonaeifolia	4	*Euphorbia terracina*	4
Clematis microphylla	4	*Reichardia tingitana*	4
Dianella brevicaulis	4	*Scabiosa atropurpurea*	4
Dodonaea viscosa ssp. cuneata	4	*Taraxacum officinale(NC)*	4
Eucalyptus incrassata	4	*Vulpia fasciculata*	4
Kennedia prostrata	4		
Rytidosperma sp.	4		

Transect and Cell Data: Number and density of native species by lifeform type (±SD):

Lifeform type	**Mean number of native species (cell data)**	**Mean number of introduced species (cell data)**	**Mean density of native species (transect data)**
LA Trees 5-15m	1.0 (0.0)	1.0	55.26 (194.47)
LB Trees <5m	2.4 (1.3)	1.0 (0.0)	356.58 (297.07)
KT/KS Mallees	1.0 (0.0)		14.47 (42.75)
S Shrubs > 2m	1.4 (0.7)		92.11 (173.22)
SA Shrubs 1.5-2m	3.0		22.37 (85.75)
SB Shrubs 1-1.5m	1.8 (1.1)		163.16 (225.21)
SC Shrubs 0.5-1m	2.2 (1.1)		278.95 (282.88)
SD Shrubs 0-0.5m	2.9 (2.0)		285.53 (367.08)
P Mat plant (single plant)	1.2 (0.4)		38.16 (83.9)
GT Grass >0.5m	2.0 (1.1)	1.4 (0.6)	318.42 (724.42)
GL Grass <0.5m	1.3 (0.5)	3.5 (1.4)	217.11 (513.23)
J Herbaceous spp.	1.4 (0.5)	6.7 (2.4)	NA
VT Sedges >0.5m	1.4 (0.5)		540.79 (1167.62)
VL Sedges <0.5m	2.0 (1.7)		77.63 (140.41)
V Vines (twiners)	1.5 (0.5)	1.0	42.11 (82.52)
MI Mistletoes	1.0		NA
X Ferns			NA

Environmental Setting Number: 5 Revegetation

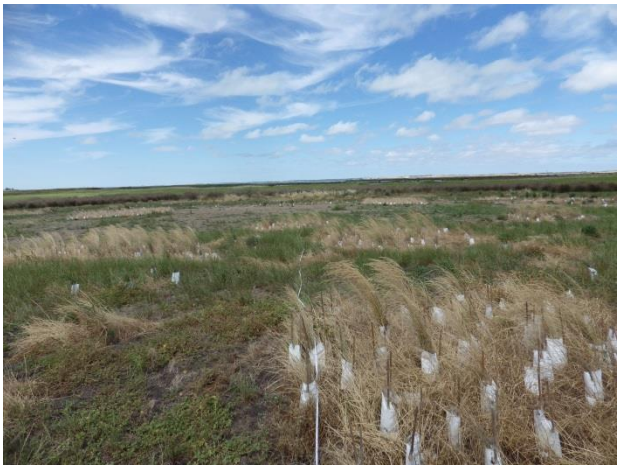
Remnant or revegetation: Revegetation

Sites included in this environmental setting: 444, 454, 509, 511, 512

Description of Environmental Setting: There were five revegetation sites in this environmental setting. Most were in early stages, so were low woodland, shrubland or grassland vegetation formations. Bare ground was also high compared to other revegetation sites, principally due to ongoing spraying and maintenance of introduced species. Native plant species richness was low in comparison to remnant sites in this environmental setting, particularly for herbs, grasses, sedges and vines/twiners. Densities of grasses and sedges were also very low in comparison to remnant sites.

Indicative Photographs:

Site 444: *Enchylaena tomentosa, Melaleuca lanceolata* Low very open shrubland with emergent *Allocasuarina verticillata*



Site 454: *Poa labillardieri var labillardieri* Very open tussock grassland

Cell data:

Number of sites in this vegetation type: **5**
Mean native plant species richness per site (±SD): **12.2** (7.6)
Mean introduced plant species richness per site (±SD): **10.2** (2.77)

Ground Cover Components for this Environmental Setting

Ground Cover Component:	N	T	1	2	3	4	5
Mean live plant cover:					3	1	1
Mean dead plant litter & fallen timber:		1	1	2	1		
Mean moss and microphytic crust:		5					
Mean bare ground:		1	2	1	1		
Other (e.g. rock, calcrete):				1			

Key to codes: N = Not many (1-10 plants and <5%), T = sparsely present; cover small (less than 5%) , 1 = plentiful, but of small cover(less than 5%), 2 = any number of individuals covering 5-25% of area, 3= any number of individuals covering 25-50% of area, 4 = any number of individuals covering 50-75% of area, 5 = covering more than 75% of area

Most commonly occurring species (number of sites):

Native:	Number of sites:	Introduced:	Number of sites:
Allocasuarina verticillata	4	*Bromus diandrus*	4
Enchylaena tomentosa var.	4	*Ehrharta calycina*	3
Kunzea pomifera	4	*Euphorbia terracina*	3
Melaleuca lanceolata	4	*Lactuca serriola f. serriola*	3
Acacia cupularis	3	*Trifolium arvense var. arvense*	3

Acacia longifolia ssp. sophorae	2	*Vulpia fasciculata*	3
Acacia pycnantha	2	*Arctotheca calendula*	2
Adriana quadripartita	2	*Lagurus ovatus*	2
Atriplex semibaccata	2	*Malva parviflora*	2
Bursaria spinosa ssp. spinosa	2	*Oenothera stricta ssp. stricta*	2
Cucurbitaceae sp.	2	*Polygonum aviculare*	2
Ficinia nodosa	2		
Hakea mitchellii	2		
Olearia axillaris	2		
Rytidosperma caespitosum	2		
Senecio pinnatifolius var.	2		

Transect and Cell Data: Number and density of native species by lifeform type (±SD):

Lifeform type	Mean number of native species (cell data)	Mean number of introduced species (cell data)	Mean density of native species (transect data)
LA Trees 5-15m			
LB Trees <5m	1.5 (0.6)		485.0 (580.57)
KT/KS Mallees			
S Shrubs > 2m	1.0 (0.0)		95.0 (185.74)
SA Shrubs 1.5-2m			
SB Shrubs 1-1.5m	1.0 (0.0)		55.0 (75.83)
SC Shrubs 0.5-1m	3.8 (1.9)		975.0 (1051.34)
SD Shrubs 0-0.5m	3.3 (2.1)		530.0 (387.86)
P Mat plant (single plant)	1.5 (0.6)	1.5 (0.7)	280.0 (227.35)
GT Grass >0.5m	1.0	1.0 (0.0)	625.0 (1075.87)
GL Grass <0.5m	1.0 (0.0)	3.2 (0.8)	50.0 (111.8)
J Herbaceous spp.	1.3 (0.6)	5.6 (2.5)	NA
VT Sedges >0.5m	1.5 (0.6)		450.0 (431.93)
VL Sedges <0.5m	1.0		15.0 (33.54)
V Vines (twiners)	1.0		40.0 (89.44)
MI Mistletoes			NA
X Ferns			NA

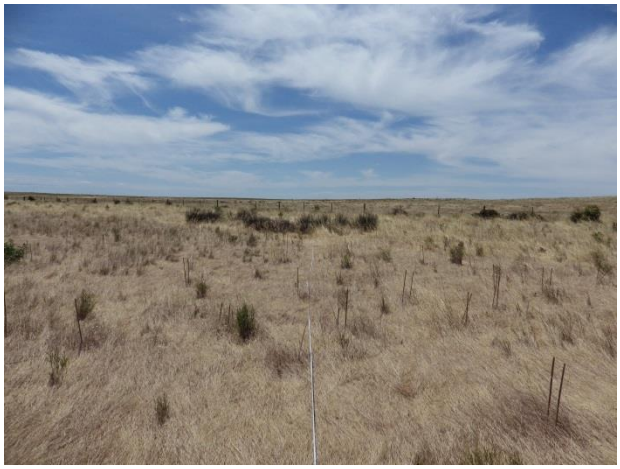
Environmental Setting Number: 8 Revegetation

Remnant or revegetation: Revegetation

Sites included in this environmental setting: 204, 255, 270, 325

Description of Environmental Setting: Sites allocated to this environmental setting generally still had significant remnancy, with all four sites having remnant samphire species present (as can be seen from site 255 and 270 photographs below). Site 325 had no revegetation evident in the cell assessed. The cover of introduced grass species was generally higher than in remnant sites. Average species richness was 9.75 compared to 11.75 in the remnant sites. Herbaceous species richness was lower than the remnant sites, as well as sedge density. *Meleleuca halmaturorum* was planted in 3 of the four sites, but was not observed in the remnant sites in this environmental setting.

Indicative Photographs:



Site 255

Site 270

Cell data:

Number of sites in this vegetation type: **4**
Mean native plant species richness per site (±SD): **9.75** (4.5)
Mean introduced plant species richness per site (±SD): **8.5** (2.52)

Ground Cover Components for this Environmental Setting

Ground Cover Component:	N	T	1	2	3	4	5
Mean live plant cover:							4
Mean dead plant litter & fallen timber:		1	3				
Mean moss and microphytic crust:		1	1	1			
Mean bare ground:		2		1			
Other (e.g. rock, calcrete):							

Key to codes: N = Not many (1-10 plants and <5%), T = sparsely present; cover small (less than 5%) , 1 = plentiful, but of small cover(less than 5%), 2 = any number of individuals covering 5-25% of area, 3= any number of individuals covering 25-50% of area, 4 = any number of individuals covering 50-75% of area, 5 = covering more than 75% of area

Most commonly occurring species (number of sites):

Native:	Number of sites:	Introduced:	Number of sites:
Atriplex paludosa ssp.	3	*Avena barbata*	4
Frankenia pauciflora var.	3	*Lolium rigidum*	4
Melaleuca halmaturorum	3	*Sonchus oleraceus*	4
Distichlis distichophylla	2	*Hordeum sp.*	3
Enchylaena tomentosa var.	2	*Medicago polymorpha var. polymorpha*	3
Tecticornia halocnemoides ssp. halocnemoides	2	*Bromus hordeaceus ssp. hordeaceus*	2

Transect and Cell Data: Number and density of native species by lifeform type (±SD):

Lifeform type	Mean number of native species (cell data)	Mean number of introduced species (cell data)	Mean density of native species (transect data)
LA Trees 5-15m			
LB Trees <5m	1.0		6.25 (12.5)
KT/KS Mallees			
S Shrubs > 2m			
SA Shrubs 1.5-2m	1.0		
SB Shrubs 1-1.5m	2.0		68.75 (121.41)
SC Shrubs 0.5-1m	1.0 (0.0)	1.0	2462.5 (4759.4)
SD Shrubs 0-0.5m	4.5 (1.7)		7087.5 (9991.97)
P Mat plant (single plant)	3.0 (0.0)		75.0 (106.07)
GT Grass >0.5m	1.0 (0.0)	1.0 (0.0)	3325.0 (6633.34)
GL Grass <0.5m	1.0 (0.0)	4.0 (2.0)	
J Herbaceous spp.	1.0	3.3 (1.0)	NA
VT Sedges >0.5m	1.0		200.0 (231.84)
VL Sedges <0.5m			
V Vines (twiners)	1.0		25.0 (50.0)
MI Mistletoes			NA
X Ferns			NA

Environmental Setting Number: 9 Revegetation

Remnant or revegetation: Revegetation

Sites included in this environmental setting: 208, 232

Description of Environmental Setting: Only 2 sites were surveyed in this environmental setting. Sites allocated to this environmental setting were low lying in the landscape. Native richness was generally low. No native species were shared between sites, indicating these sites may not belong in the same environmental setting. Grass, sedge and low shrub densities were relatively high. It was unclear whether site 208 had any revegetation within it.

Indicative Photographs:

Site 232: *Myoporum insulare*, *Olearia axillaris*, *Dodonaea viscosa ssp spatulata* Tall very open shrubland

Site 208: *Gahnia filum* Open Sedgeland over *Tecticornia sp* Low closed shrubland

Cell data:

Number of sites in this vegetation type: **2**
Mean native plant species richness per site (±SD): **14.5** (3.54)
Mean introduced plant species richness per site (±SD): **10.0** (7.07)

Ground Cover Components for this Environmental Setting

Ground Cover Component:	N	T	1	2	3	4	5
Mean live plant cover:							2
Mean dead plant litter & fallen timber:		1	1				
Mean moss and microphytic crust:		1					
Mean bare ground:		2					
Other (e.g. rock, calcrete):							

Key to codes: N = Not many (1-10 plants and <5%), T = sparsely present; cover small (less than 5%) , 1 = plentiful, but of small cover(less than 5%), 2 = any number of individuals covering 5-25% of area, 3= any number of individuals covering 25-50% of area, 4 = any number of individuals covering 50-75% of area, 5 = covering more than 75% of area

Most commonly occurring species (number of sites):

Native:	Number of sites:	Introduced:	Number of sites:
Senecio sp.	2	*Bromus diandrus*	2
Atriplex paludosa ssp.	1	*Asphodelus fistulosus*	1
Austrostipa eremophila	1	*Avena barbata*	1
Austrostipa nodosa	1	*Brachypodium distachyon*	1
Baumea juncea	1	*Carduus tenuiflorus*	1
Cyperus gymnocaulos	1	*Catapodium rigidum*	1
Dianella brevicaulis	1	*Euphorbia terracina*	1
Distichlis distichophylla	1	*Hypochaeris radicata*	1

Dodonaea viscosa ssp.	1	*Lagurus ovatus*	1
Enchylaena tomentosa var.	1	*Lolium rigidum*	1
Exocarpos syrticola	1	*Medicago polymorpha var. polymorpha*	1
Ficinia nodosa	1	*Myosotis sylvatica*	1
Gahnia filum	1	*Plantago coronopus ssp.*	1
Juncus kraussii	1	*Polypogon sp.*	1
Lachnagrostis billardierei ssp. billardierei	1	*Sanguisorba minor ssp. muricata*	1
Melaleuca halmaturorum	1	*Scabiosa atropurpurea*	1
Muehlenbeckia sp.	1	*Sonchus oleraceus*	1
Myoporum insulare	1	*Taraxacum officinale(NC)*	1
Myoporum parvifolium	1	*Vulpia sp.*	1
Olearia axillaris	1		
Phragmites australis	1		
Rhagodia candolleana ssp.	1		
Rytidosperma caespitosum	1		
Samolus repens	1		
Samphire sp.	1		
Sporobolus virginicus	1		
Suaeda australis	1		
Vittadinia australasica var.	1		

Transect and Cell Data: Number and density of native species by lifeform type (±SD):

Lifeform type	**Mean number of native species (cell data)**	**Mean number of introduced species (cell data)**	**Mean density of native species (transect data)**
LA Trees 5-15m			
LB Trees <5m			
KT/KS Mallees			
S Shrubs > 2m	2.0		100.0 (141.42)
SA Shrubs 1.5-2m	1.0		137.5 (194.45)
SB Shrubs 1-1.5m	2.0		125.0 (176.78)
SC Shrubs 0.5-1m	1.0	1.0	
SD Shrubs 0-0.5m	2.5 (0.7)		1725.0 (2050.61)
P Mat plant (single plant)	1.0		
GT Grass >0.5m	2.0 (0.0)	1.0	5337.5 (4684.58)
GL Grass <0.5m	1.5 (0.7)	4.0 (1.4)	187.5 (265.17)
J Herbaceous spp.	2.0 (1.4)	10.0	NA
VT Sedges >0.5m	2.5 (0.7)		5975.0 (2156.68)
VL Sedges <0.5m	1.0		5012.5 (7088.75)
V Vines (twiners)			
MI Mistletoes			NA
X Ferns			NA

4.0 Discussion:

Quadrat and transect based data were gathered from 62 sites in the Coorong, Lower Lakes Murray Mouth Program area using a methodology analogous to the Biological Survey of South Australia methodology. These sites were located in vegetation types for which there is a current paucity of data. This will prove valuable in ongoing landscape level planning, and will help inform and improve the continued delivery of the vegetation program through better design of habitat restoration strategies.

Native species richness overall was lower in revegetation sites than in analogous remnant sites. A greater variety of grasses, sedges and herbaceous species were generally found in remnant sites when compared to revegetation sites. These species are more problematic to propagate and plant in sufficient densities in revegetation programs than many tree and shrub species. Remnant sites also had generally higher densities for all lifeform types, with the most marked differences in sedges in environmental setting 3 (Mallee communities in the Southeast Coorong), shrubs, grasses and sedges in environmental setting 4 (Low woodlands), sedges in setting 5 (Allocasuarina grassy woodlands), and sedges and mat plants in setting 8 (Samphire and saline edge), where densities were an order of magnitude or more higher in remnant vegetation than in revegetation. Some of the generally lower densities observed for trees and shrubs in revegetation could be attributed to mortality rates of revegetation, although this observation is anecdotal only as no specific data was gathered on these rates. However, it was also apparent that for the grasses, shrubs, mat plants and sedges noted in the environmental settings above that, irrespective of mortality rates, the original plantings were at densities much lower than observed in remnant sites . Ongoing research should focus upon the loss of ecological functionality as a result of a paucity of these lifeform types in revegetation, to help determine whether revegetation efforts need to focus upon improving the species richness and cover of these particular lifeforms and species.

Many revegetation sites were highly degraded, with the Perennial Veldt Grass (*Ehrharta calycina*) a particular problem. There were 5 sites (e.g. site 322 photograph shown in environmental setting 4) where this species was the dominant overstorey, with revegetation currently smaller, or at insufficient density to be classified as dominant. These sites may require ongoing follow-up to ensure the revegetation species remain viable.

4.1 Comments on methodology

Data gathered from the 900m^2 cells in this project were gathered using the standard Biological Survey of South Australia methodology. This enables comparison and analysis with data already collected using this method in this region. It is suggested that it may be worthwhile, if a key part of the project is to describe sites (as done in this report), to gather overall native and introduced species abundance data by lifeform. In the standard methodology, data is categorised for each individual species cover and abundance, but these cannot be accumulated for an overall cover score (eg if a site has two grassy weeds that are categorised as 5-25% cover then this data only tells us that they could cumulatively cover somewhere between 10% to 50%). Most revegetation sites

anecdotally had high introduced grass cover, but this was difficult to demonstrate from the data collected. If cover data was gathered by lifeform for both native and introduced species, then general patterns in cover could be easily identified.

Only data on species was gathered along transects – no life form was noted. It is suggested that in future there may be value in also gathering life form data, as this would help to better quantify the structure of the vegetation (as some species may occur as more than one life form in the site). It may also be of value to gather information on mortality rates in revegetation by including a count of dead plants or empty tree-guards in the transect count, although in many cases the species would not be able to be identified (and thus mortality rates by species or lifeform could not be calculated).

The transect sampling method seemed appropriate overall as a method to calculate plant densities, however there may be some imprecision for species at lower densities. The probability (P) of encountering at least one individual of a species of density (d) using the transect methodology (ie a sample of $400m^2$) from the project can be calculated as below:

P (encountering at least one individual) = 1 – P(encountering no individuals)

where in this case $P = 1- 0.96^d$

Table 4 shows that at low densities there is a low probability that a species will be detected using the sampling method from this project. This may not be a concern for detecting general patterns, but it may be worth considering supplementing the transect method (which was considered effective for species with moderate to high density) with a plotless sampling methodology, such as the point centred quarter technique[1] (described in Appendix 2), if there are key species (e.g. trees) which may be at low densities. Clumping species, or species that are difficult to discern as individual plants were also problematic.

Table 4: Probability of detecting species of different densities along transects as used in this project

Number of individuals per hectare	1	5	10	20	30	40	50	60	70	80	90	100
Probability of encountering at least one individual along a transect	4	18	34	56	71	80	87	91	94	96	97	98

[1] Cottam, G. and Curtis, J.T. (1956). The use of distance measures in phytosociological sampling. Ecology, 37(3):451-460.

Appendix 1: Location details of Vegetation Survey Sites

Site No.	Property	Environmental Setting	State	Easting	Northing
204		8	Revegetation	319827	6070607
479		4	Remnant	311113	6074555
494		2	Remnant	310891	6074335
495		5	Remnant	311090	6073871
5		4	Revegetation	306486	6076734
208		9	Revegetation	306253	6076704
471		3	Remnant	348746	6037390
490		4	Remnant	299164	6090439
491		6	Remnant	300145	6090399
512		5	Revegetation	349296	6038755
482		6	Remnant	312260	6081345
505		2	Remnant	312435	6084415
472		2	Remnant	351446	6066299
475		8	Remnant	354448	6031167
501		5	Remnant	297860	6068189
476		2	Remnant	356433	6091696
360		4	Revegetation	309353	6069549
513		4	Revegetation	304801	6077884
497		2	Remnant	330105	6099487
498		2	Remnant	329829	6100135
364		4	Revegetation	299875	6068167
493		6	Remnant	301986	6082810
480		4	Remnant	315130	6082572
516		4	Revegetation	303168	6072363
511		5	Revegetation	357942	6025710
465		5	Remnant	359212	6086374
466		2	Remnant	359210	6086158
477		7	Remnant	361677	6093301
444		5	Revegetation	337798	6066619
509		5	Revegetation	337218	6065647
464		3	Remnant	360076	6088124
500		5	Remnant	297211	6068440
232		9	Revegetation	328625	6053782
255		8	Revegetation	327632	6054611
351		4	Revegetation	305945	6065744
507		8	Remnant	312166	6066048
363		3	Revegetation	305422	6065655
325		8	Revegetation	348869	6070844

470		3	Remnant	351095	6049724
345		4	Revegetation	303814	6068006
348		4	Revegetation	304171	6068070
515		4	Revegetation	307512	6064558
489		4	Remnant	300167	6078302
322		4	Revegetation	340325	6068473
323		4	Revegetation	341031	6067891
468		5	Remnant	331600	6052123
473		5	Remnant	351274	6067607
492		10	Remnant	318218	6084667
478		8	Remnant	304780	6065875
488		4	Remnant	299251	6086444
485		6	Remnant	294412	6079490
514		4	Revegetation	298144	6074315
503		8	Remnant	296571	6067370
454		5	Revegetation	337336	6052840
510		4	Revegetation	344478	6048544
77		4	Revegetation	302539	6077645
78		4	Revegetation	302865	6077272
417		4	Revegetation	302331	6077620
270		8	Revegetation	350773	6078304
406		4	Revegetation	313309	6070449
408		4	Revegetation	313044	6070514
328		4	Revegetation	306998	6064823

Appendix 2: Datasheets and Categorisations used for this Project

900m² Cell Datasheets

BIOLOGICAL SURVEY of SA - BS 886

SA Department of Environment, Water & Natural Resources

VEGETATION PATCH / QUADRAT DATA

		Waypoin	Quadrat		DD	MM	YY
Site ID	CLL		01	Date			

Observers | Climatic Condition | 1= Wet -rainfall prior to survey, annuals; 2 = Dry - vegetation dry, few annuals present

Vegetation Condition | 1 = virtually no cover, 2 = undisturbed natural, 3 = disturbed natural; 4 = degraded natural, 5 = highly degraded

LF = Life form;				
	T Trees >30m	S Shrubs >2m	H Hummock Grass	V Vines (twiners)
	M Trees 15-30m	SA Shrubs 1.5-2m	GT Grass >0.5m	MI Mistletoes
	LA Trees 5-15m	SB Shrubs 1-1.5m	GL Grass <0.5m	X Ferns
	LB Trees <5m	SC Shrubs 0.5-1m	J Herbaceous spp.	MO Mosses
	KT Mallee tree form (>3m)	SD Shrubs 0-0.5m	VT Sedges >0.5m	LI Lichens
	KS Mallee shrub form (<3m	P Mat plant (single plant)	VL Sedges <0.5m	

AD = Flag the dominant/codominant species for Overstorey (up to 3 spp), Emergents (up to 3 spp) and Understorey (up to 5 spp) (O/E/U).

*Note: an emergent species is defined as a species that emerges above the dominant overstorey and has a cover abundance of less than 2.

AD: Cover Abundance scale adapted from Braun-Blanquet system	LS = Life stages; enter code where relevant to >10% of that speci
N = Not many (1-10 plants and <5%)	at site and if ?10% of reproductive organs are at that stage. Enter
T = sparsely present; cover small (less than 5%)	seedlings always.
1 = plentiful, but of small cover(less than 5%)	V = vegetative
2 = any number of individuals covering 5-25% of area	R = regenerating
3= any number of individuals covering 25-50% of area	D = dead/domnant
4 = any number of individuals covering 50-75% of area	B = budding
5 = covering more than 75% of area	F = flowering
	I = immature fruits
S where large shrubs or trees are involved upgrade the category	M = mature fruits
to reflect the cover rather than the number of individuals	X = recently shed
	S = seedling

Ground Layer Cover for the site	Braun-Blanquet Percentage Cover	Comments
Live plant cover		
Dead plant litter & fallen timber		
Moss and microphytic crust		
Bare ground		
Others (e.g. rock, calcrete)		

	Species	Previous Voucher No	Voucher No	AD O/E/U	LF	CA	LS	Comments
1								
2								
3								
4								
5								
6								
7								
8								
9								
10								

VEGETATION ASSOCIATION DESCRIPTION (PLA)

ASSEMBLAGE INFORMATION (VEGETATION STRUCTURAL SUMMARY): (From highest to lowest stratum):

Life form height class LF / Canopy cover (d=70-100% / c=30-70% / i = 10-30% / r=1-10%) (Muir 1977)

From observations of site, not plant list. Strike out life forms not present as a +/- consistent/identifiable 'layer' in vegetation.

T	/ _____	KS	/ _____	SD	/ _____	VL	/ _____	X	/ _____
M	/ _____	S	/ _____	GT	/ _____	P	/ _____	MO	/ _____
LA	/ _____	SA	/ _____	GL	/ _____	J	/ _____	LI	/ _____
LB	/ _____	SB	/ _____	H	/ _____	VL	/ _____		
KT	/ _____	SC	/ _____	VT	/ _____	MI	/ _____		

SA STRUCTURAL FORMATION: (Overstorey structural category)

Check that all dominants (O, E, U) are entered in AD column on plant list.

Record the vegetation structure, using the adapted Forward & Robinson table (below), based on the cover and average height of the overstorey at the site.

Overstorey is the tallest stratum with a canopy cover of 5% or more (taller 'layers' of less than 5% are emergents), or the tallest layer where no layers attain 5% cover. If two different lifeforms are more or less codominant eg. a Mallee/Callitris mix, then use both combined average height and cover, butconspicuous to select a name

select most prevalent or conspicuous to select a name. Canopy cover is based on projected foliage cover - refer to manual.

Life Form/Height Class	Projective Foliage Cover of Tallest Stratum			
	Dense (70-100%)	**Mid-dense (30-70%**	**Sparse (10-30%**	**Very sparse (<10%)**
Trees > 30m	Tall closed forest	Tall open forest	Tall woodland	Tall open woodland
Trees 10-30m	Closed forest	Open forest	Woodland	Open woodland
Trees 5-10m	Low closed forest	Low open forest	Low woodland	Low open woodland
Trees <5m	Very low closed forest	Very low open forest	Very low woodland	Very low open woodland
Mallee (>3m)	Closed mallee	Mallee	Open mallee	Very open mallee
Low Mallee (<3m)	Closed low mallee	Low mallee	Open low mallee	Very open low mallee
Shrubs >3m	Tall closed shrubland	Tall shrubland	Tall open shrubland	Tall very open shrubland
Shrubs 1-2m	Closed shrubland	Shrubland	Open shrubland	Very open shrubland
Shrubs <1m	Low closed shrubland	Low shrubland	Low open shrubland	Low very open shrubland
Mat plants	Closed mat plants	Mat plants	Open mat plants	Very open mat plants
Hummock grasses	Closed Hummock grassland	Hummock grassland	Open hummock grassland	Very open hummock grassland
Tussock grasses	Closed (tussock) grassland	(Tussock) grassland	Open (tussock) grassland	Very open (tussock) grassland
Sedges	Closed sedgeland	Sedgeland	Open sedgeland	Very open sedgeland
Herbs	Closed herbland	Herbland	Open herbland	Very open herbland
Ferns	Closed fernland	Fernland	Open fernland	Very open fernland

Upper Stratum Age Class (for dominant / codominat species) Circle if present; Slash if absent (Tree layer only)

		Comments
Seedling (<1m)	SE	
Sapling (juvenile)	SA	
Mature	MA	
Senescent	SN	
Hollows	HO	

OVERSTOREY MEASUREMENTS (OVE) (Dominant / co-dominant overstorey, including if shrubland; 10 estimates)

Eyeball the site in cross-section to distinguish the stratum and to determine the overstorey height range. For overstorey, measure 10 individuals or discrete foliage clumps of any speciesthat occur in the broad lifeform category that corresponds to the structural description completed above. Broad lifeform categories include trees, mallees and shrubs. Include all individuals regardless of height, except where there is a recognisable height gap corresponding to a separate lower stratum. In circumstances where two lifeforms are codominant include measurements for both.

Canopy Type		% Estimate average canopy type For overstorey species measured	Overstorey Height (m)	
			Crown Depth (m)	
VEGETATION COMMENTS (*VEG)			Canopy Diameter (m)	
			Gap (m)	

Vegetation Assessment Survey Transect Datasheet

Property: _____

Main Observers: _____ Field Assistants:

_____

Date: _____ Time:

_____

Site Number:

	Direction (bearing in degrees)	Length
1	N	
2	E	
3	S	
4	W	

Survey:

DataEntry RecordID	Species	Transect Direction1	Transect Direction 2	Transect Direction 3	Transect Direction 4

Appendix 3: Environmental Setting Descriptions

1. Coorong Heathland

- Shrubland and grassland communities dominated by *Olearia axillaris* and *Leucopogon parviflorus* (AP0024PE), *Spinifex hirsutus* (*S. sericeus*) and *Ficinia nodosa* (SE0043PE) communities.
    - Coorong and to a lesser degree Southeast Coorong
        - Coastal dunes and flats with sandy soils that are either deep (H1, H2) or shallow on calcrete (B3, B6, B8).
        - *Spinifex hirsutus* on coastal foredunes (SE0043PE)

2. Mallee Communities in the Mt Lofty Ranges and Lower Lakes Terrestrial

- Mallee communities including *Eucalyptus calycogona var. trachybasis*, *E. phenax*, *E. dumosa* and *E. socialis ssp. socialis* with a sparse shrubby understorey (MM1101PE, MM1701PE, SL3008PE, WM0301PE), as well as *E. gracilis, E. oleosa* and *E. brachycalyx* mallee (MN0019PE)
    - Mt Lofty Ranges
        - Flats and lower slopes with loam over red clay soil (D2, D3).
        - *Eucalyptus calycogona var. trachybasis* (MM1701PE) restricted to Mt Lofty Ranges and have been selectively logged. They are usually on flats in good quality clay soils (D2, D3).
        - *E. phenax* & *E. dumosa* (MM1101PE) on flats with loam and clay loam soils while *E. socialis ssp. socialis* on sandy loam soils (D2, D3).
        - *E. gracilis, E. oleosa* and *E. brachycalyx* (MN0019PE) in flats on calcareous loam soils (B3)
- *Callitris gracilis* low open forest with a grassy understorey (MN0010PE). Also associated with *E. porosa* grassy woodland (MN0011PE)
    - Mt Lofty Ranges and Lower Lakes Terrestrial (Narrung and around Meningie)
        - Dunes with shallow sandy loam on calcrete (B3)

3. Mallee Communities in the Southeast Coorong

- Mallee communities dominated by *Eucalyptus diversifolia ssp. diversifolia* and *E. incrassata, E. leptophylla* & *E. socialis ssp. socialis* (MM1301PE, SE0024PE, SE0025PE, MM4501PE). Also including *E. rugosa* mallee (SE0027PE) and *Banksia ornata* shrubland (SE0031PE). Some *E. diversifolia* communities with *Olearia axillaris* over *Dianella revoluta* and *Leucopogon sp.* (MM1301PE). Woodland/open forest communities dominated by *E. arenacea* (SE0001PE, MM0301PE).
    - Southeast Coorong
        - Consolidated dunes, flats or lower and mid slopes. Shallow loam and shallow sandy loam soils (B3, B6, B8)
        - *E. diversifolia ssp. diversifolia* (MM1301PE) can be found in Lower Lakes Terrestrial around Narrung and Meningie
        - *E. incrassata* mallee (SE0025PE) in Mt Lofty Ranges on dunes with sandy soils (H1)
        - *E. rugosa* (SE0027PE) around Messent NP on red loam soils over calcrete (B6)
- *E. odorata, E. phenax* & *E. dumosa* mallee (MN0021PE)
    - Mt Lofty Ranges
        - Flats or lower and mid slopes. Shallow loam and shallow sandy loam soils (B3, B6, B8)

4. Low Woodlands

- *Eucalyptus fasciculosa* and *E. baxteri, E. fasciculosa* & *E. cosmophylla* low woodland over sclerophyll shrub understorey (ML2403PE, ML0404PE, WM1801PE, ML2602PE), which can include *Eucalyptus leucoxylon ssp.leucoxylon* (ML2001PE).
    - Mt Lofty Ranges
        - On flats and lower to mid slopes with a mixture of loamy soils (J2, B3, D2)
        - *E. cosmophylla* (ML2602PE) - Ironstone soils (J2)
        - *E. fasciculosa* (ML2403PE) – Sandy loam (B3)
        - *Eucalyptus leucoxylon ssp.leucoxylon* (ML2001PE) - Loam over red clay (D2)
- *Allocasuarina verticillata* low woodland over *Xanthorrhoea semiplana ssp. semiplana* (WM8701PE).
    - Mt Lofty Ranges and in Lower Lakes Terrestrial around Narrung and Meningie
        - Lower to mid slopes on sandy loam soils (B3)

5. Allocasuarina Grassy Woodlands

- *Allocasuarina verticillata* low woodland over an open grassy and herbaceous understorey (MN0017PE) and can include *Melaleuca lanceolata* (SE0022PE)
    - Lower Lakes Terrestrial and Southeast Coorong
        - Ridges and hillocks on shallow sandy loam soils on calcrete (B3)

6. Eucalypt Grassy Woodland

- A mixture of *Eucalyptus odorata* woodland (MN0003PE), *E. leucoxylon ssp. leucoxylon* woodland (AP0003PE), *E. viminalis ssp. cygnetensis* woodland (SE0013PE, WM7401PE) and *E. fasciculosa* woodland occurring over a grassy and herbaceous understorey (AP0017PE). Can also include *E. porosa* and *Callitris gracilis* grassy woodland (MN0011PE) and *C. gracilis* low open forest (MN0010PE) on sandy sites
    - Mt Lofty Ranges, Southeast Coorong and Lower Lakes Terrestrial
        - Shallow sandy loam on calcrete soils (B3) and shallow loam over red clay on calcrete soils (D2, D3, B6) on simple slopes or flat areas
        - *Eucalyptus odorata* (MN0003PE) and *E. viminalis ssp. cygnetensis* (SE0013PE) found in the Mt Lofty Ranges along flats (drainage lines) with loam soils (D2, D3)
        - *E. leucoxylon ssp. leucoxylon* (AP0003PE) (can also include *Callistemon* sp. in depressions) in the Mt Lofty ranges and Southeast Coorong on flats
        - *E. fasciculosa* (AP0017PE) in the Lower Lakes Terrestrial and Southeast Coorong on simple slopes and flats (gullies)

7. Grasslands

- Tussock grassland species including *Lomandra effusa*, *Austrostipa spp., Austrodanthonia spp.* (MN0039PE, WM1301PE) and *Poa spp* (SE0042PE). *Dodonaea viscosa ssp. angustissima* low shrubland (WM9001PE) also share similar habitats.
    - Lower Lakes Terrestrial
        - Flats on shallow sandy loam soils over calcrete (B3)
        - *Lomandra effusa* (WM1301PE) reliant on dry freshwater environments while other communities need a fresh flush

8. Samphire and Saline Edge

- *Melaleuca halmaturorum* tall shrubland (SE0030PE) with a samphire understorey (AP0023PE) dominated by *Sarcocornia quinqueflora* (MM3201PE) and *Tecticornia spp*. (SE0036PE).
    - Found in all low-lying areas in the CLLMM region.

        - Black clacking clays (E1, E3) or saline soils (N2) in open depressions with a saline inundation regime.
        - *Melaleuca halmaturorum* (SE0030PE) can tolerate saline areas but requires a fresh flush.

9. Freshwater damp with some saline tolerance

- *Gahnia filum* sedgeland (AP0032PE, ML5001PE) and *Melaleuca brevifolia* (SE0033PE) communities as well as *Phragmites australis* & *Typha spp.* grassland (AP0033PE) in waterlogged areas. *Duma florulenta* shrubland also occurs in these areas (MN0029PE). *Eucalyptus largiflorens* (SE0006PE, SL2901PE, MM0601PE), *Enchylaena tomentosa* & *Einadia nitans* woodlands occur in the Mt Lofty Ranges.
    - In the Mt Lofty Ranges, Lower Lakes Terrestrial and Lower Lakes aquatic.
        - Flat areas or open depressions on black clacking clays (E1). Require an inundation regime and in some cases a freshwater flush.
        - *Gahnia filum* sedgeland*, Phragmites australis* & *Typha spp.* grassland have a tolerance to brackish/saline water. *Gahnia* mainly in Mt Lofty Ranges but can be found in Coorong and Southeast Coorong.
        - *Melaleuca brevifolia* (SE0033PE) can only withstand short periods of waterlogging
        - *E. largiflorens* in the Mt Lofty Ranges. Generally found at the bottom of creeks on cracking clays (E1).

10. Inland Freshwater

- Can be dominated by *Eucalyptus* species such as *E. ovata ssp* (SE0011PE, SL0301PE) and *Eucalyptus camaldulensis var. camaldulensis* (AP0005PE, MN0007PE, SE0004PE) woodland with a sedge/herb understorey in the Mt Lofty Ranges. Sedgeland and shrubland species include *Gahnia trifida* (SE0040PE) and *Leptospermum lanigerum* (AP0031PE).
    - Almost exclusively in the Mt Lofty Ranges and the Lower Lakes Terrestrial
        - *C*losed depressions or flat areas on peat soils (N1) that are usually regularly inundated.
        - *Eucalyptus ovata ssp* (SE0011PE, SL0301PE) rare and on fresh watercourses
        - *Eucalyptus camaldulensis var. camaldulensis* (AP0005PE, MN0007PE, SE0004PE) in Mt Lofty ranges and Southeast Coorong such as Martins Washpool.

11. Lower Lakes Aquatic

- Species include mixed sedges, *Alternanthera denticulata*, *Aster subulatus*, *Cyperus gymnocaulos*, *Eleocharis acuta*, *Hydrocotyle verticillata*, *Juncus usitatus*, *Rumex bidens* & *Triglochin procerum* herbland. Other species include *Myriophyllum verrucosum, Ruppia sp., Chaophytes sp.* and *Vallisneria spiralis* herbland.
    - Lower Lakes aquatic.
        - Inundated freshwater (N1).

Appendix 4: Point Centred Quarter method

Description of method

The Point Centred Quarter (PCQ) method is a type of plotless density estimator. These estimators are also commonly called distance methods because they make use of the distances between plants or between plants and sampling points to estimate the average area occupied by a plant in the population. Density, plants per unit area, is then simply the inverse of the average area occupied per plant. Representative sampling by plotless methods is much less dependent upon consideration of scale than quadrat based methods because the density of plants defines the scale, rather than the size of the sampling unit as in quadrat based techniques. So, for example, one sampling point could be used to measure density of native grasses, that may occur within centimetres of the reference point, as well as trees, that may be tens of metres away. These would require different size quadrats for a quadrat based assessment. Therefore, greater replication and dispersion throughout a vegetation stand can be achieved per unit of sampling effort. This also means that the methods are equally applicable to plants of any life form and size, from grasses and herbs to large trees, at any scale within reason. Consequently, there is no requirement for time consuming pilot measurements and calculations to determine appropriate quadrat sizes for each particular community and life form within it.

Using the PCQ method, the area around a sample point is divided into four equal quadrants and the distance is measured to the individual of interest within each quadrant nearest to the point (**Error! Reference source not found.**).

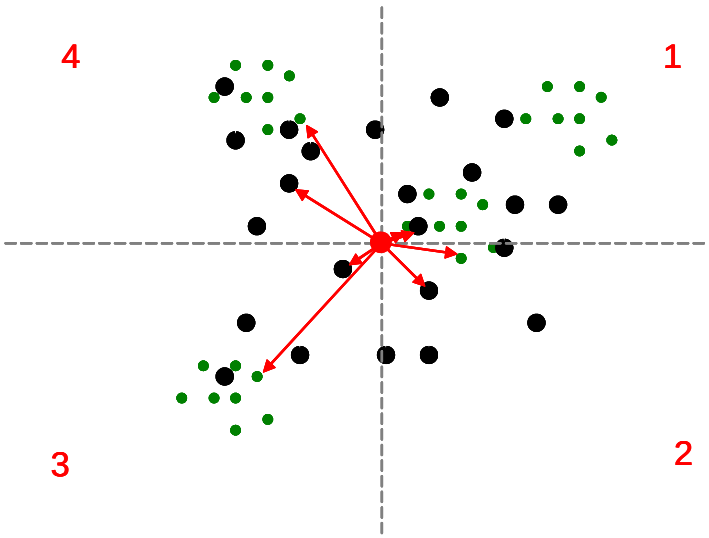


Figure 1. Schematic showing the point centered quarter method with the area around the sampling point divided into four 90° quadrants. The red arrows represent the distances measured from the point to the nearest plant in each quadrant. Two plant populations are being sampled in this example, each with a different kind of spatial distribution.

Data treatment follows Cottam *et al.* (1953):

$$\bar{\lambda} = \frac{n}{\sum_{i=1}^{n} d_i^2}$$

Where $\bar{\lambda}$ is the density estimate, *d* is an individual point to plant distance measurement (4 per sample point) and *n* is the number of such measurements. Dahdouh-Guebas and Koedam (2006)[2] suggest a correction factor to allow for quadrants where no plant can be found as follows:

$$\bar{\lambda} = \frac{n}{\sum_{i=1}^{n} d_i^2} \times \frac{q_n}{q_t}$$

Where q_n is the number of quadrants containing a tree and q_t is the total number of quadrants.

Other plotless density estimators exist, most notably the closest individual, the nearest neighbour and the random pairs method. The PCQ method is considered the most appropriate for use as it provides the most accurate estimate of density[3], is least susceptible to subjective bias[4] and provides more data per sampling effort[4,5] than these other estimators.

[2] Dahdouh-Guebas, F. and Koedam, N. (2006). Empirical estimate of the reliability of the use of the Point-Centred Quarter Method: Solutions to ambiguous field situations and description of the PCQM+ protocol. Forest Ecology and Management 228: 1-18.

[3] Beasom, S.L. and Haucke, H.H (1975). A comparison of four distance sampling techniques in south Texas live oak mottes. Journal of Range Management, 28(2):142-144.

[4] Cottam, G. and Curtis, J.T. (1956). The use of distance measures in phytosociological sampling. Ecology, 37(3):451-460.

[5] Gillespie, C. (2008). Evaluating Plotless Density Estimators as a Method for Rapidly Assessing Native Vegetation. Unpublished report for the Native Vegetation Council, Adelaide.