Ecology of Pinnaroo Valley Memorial Park, Western Australia: floristics and nutrient status

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Abstract

Foulds, W. Ecology of Pinnaroo Valley Memorial Park, Western Australia: floristics and nutrient status. Kingia 1(1): 27-48 (1987). The floristics and nutrient status of Pinnaroo Valley Memorial Park, Perth, are described. The vegetation was represented by a low, open *Banksia* woodland with emergent *Eucalyptus marginata*, on neutral yellow sands belonging to the Spearwood Dune System. One hundred and eighty three plant species were recorded, of which 41 were introduced. The tree canopy comprised five species with *Banksia attenuata* dominant. *Xanthorrhoea preissii* was the most abundant understorey species. Macro- and micronutrient analyses were conducted on soil, plant and litter samples. The soil was found to be deficient in carbon, phosphorus and nitrate nitrogen, but relatively high in potassium. Species belonging to the Leguminosae family contained nearly twice the nitrate nitrogen content in above-ground tissue compared to species in other families.

Introduction

Pinnaroo Valley Memorial Park, occupying an area of 11 hectares in the Perth suburb of Padbury, Western Australia (31° 45'S; 115° 52'E), is a reserve set aside as a cemetery and recreation area. The Park is situated approximately 2 km from the Indian Ocean on the Spearwood Dune System (Bettenay *et al.* 1960). The vegetation consists of low open *Banksia* woodland.

The Spearwood dunes have had a complex history, being subjected to both deposition and later erosion (Seddon 1972). In its natural state the Spearwood System supports a high open forest of *Eucalyptus gomphocephala*, *E. marginata* and *E. calophylla*. In the western portion the dunes are generally younger and the shallower soils are referred to as the Cottesloe Soil Association (Seddon 1972). These soils support a similar species composition as the deeper Karrakatta soils to the east. *E. gomphocephala*, however, is much more common than *E. marginata* and *E. calophylla*, and limestone usually occurs within 2 metres of the surface in the Cottesloe soils. A nearby *Banksia* woodland at Star Swamp, which lies within the Cottesloe Association, is dominated by *Banksia attenuata*, *B. menziesii* and *B. prionotes*, with minor contributions of *E. gomphocephala*, and *Allocasuarina fraseriana* (Bell *et al.* 1979). The top soil is generally dark grey-brown becoming yellowish-brown deeper, with a neutral pH value. In general, the soils of the Spearwood System are moderately to weakly leached with low calcium levels, high iron content and weakly acidic pH values (Havel 1976). The Star Swamp understorey includes *Xanthorrhoea preissii*, *Jacksonia sternbergiana* and *Dryanda nivea*, while the more common introduced species are *Ehrharta longiflora*, *Avena barbata*, *Hypochaeris glabra* and *Romulea rosea* (Bell *et al.* 1979). The percentage of plant cover from introduced species is 36%.

The study area has a dry Mediterranean climate with average annual rainfalls of ca 740 mm per year. About 80% of the yearly total falls in winter between the months of May and August. The winters are mild with mean temperatures of: maximum 18.7°C and minimum 9.9°C, while summers are warm to hot with mean temperatues of: maximum 29.9°C and minimum 18.6°C.

Methods

Three areas of native woodland within Pinnaroo Valley Memorial Park were selected for this study: 4, 6 and 11 (Figure 1). They were similar with respect to topography and vegetation. Area 11 was burned in 1979, but the fire histories of the other areas were unknown. The study was conducted mainly in September of 1981 and 1982, although visits were made each month to record flowering data.

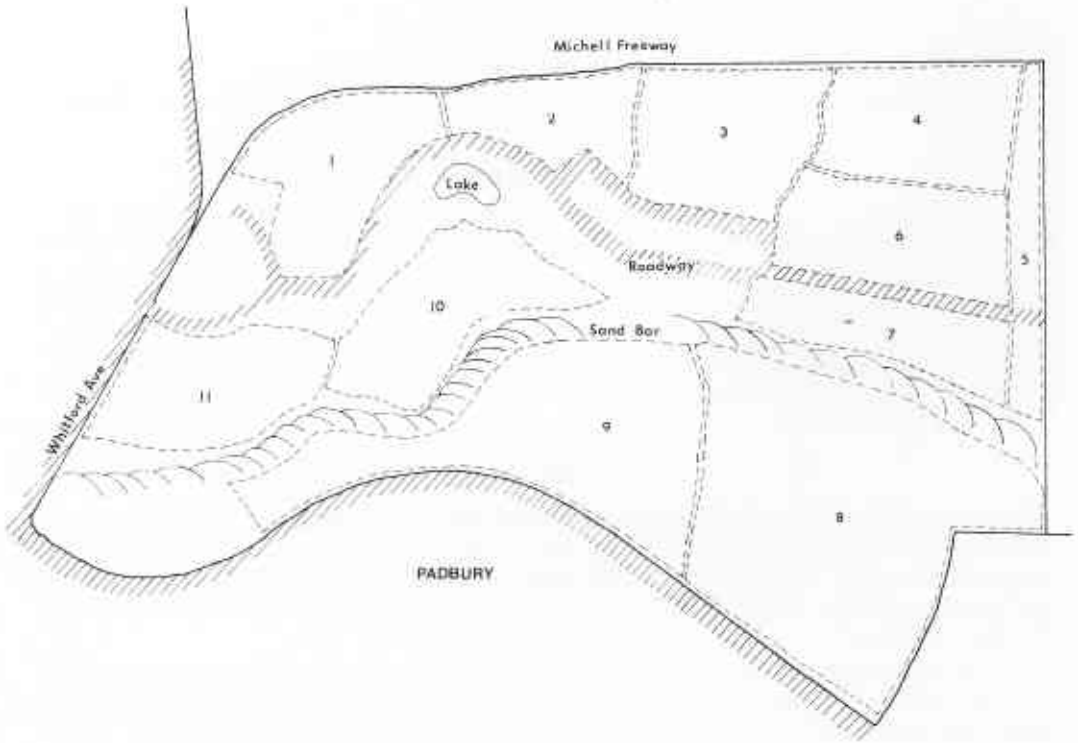

Figure 1. Map of Pinnaroo Valley Memorial Park.

Vegetation

A number of plots, each 10 m^2 in area, were established at each of the three areas and a list of vascular plants was constructed. The nomenclature followed Green (1985). A voucher specimen for each plant species was deposited in the Western Australian Herbarium (PERTH). All perennial species were given a cover/abundance value on the Braun-Blanquet scale (Mueller-Dombois & Ellenberg 1974). To determine the frequency and percentage cover of herbaceous species a 1 m^2 quadrat was divided into 100 equal subsections. Each occurrence of a plant in a subsection was recorded. This was repeated ten times for each area.

Measurements of the tree canopy were made by recording tree height, diameter at breast height (dbh) and number of stems ($\geqq$ 4 cm) within 30 m x 30 m quadrats. Two such quadrats were sampled in each of the three areas. The biomass of the shrub and herb layers was determined by collecting above ground living plant material in four random 1 m^2 quadrats at each site. The litter retained by a 1 mm sieve was also gathered from the same 1 m^2 quadrats. The litter and plant material were oven dried at 95°C to constant weight.

The frequency (%) and the relative cover abundance (%) for herbaceous species and the relative dry weight contribution (%) for the perennial shrub species were calculated as follows:

F(%) = number of quadrats including a species x 100/total number of quadrats
RCA(%) = total % cover for a species x 100/total % cover for all species
RDW(%) = dry weight of a single species x 100/total dry weight for all species.

Nutrients

Five soil samples from the surface 10 cm were collected at each site and analysed by C.S.B.P. and Farmers. Spectrophotometric determinations were undertaken on sodium bicarbonate extractable phosphorus and potassium. The water soluble nitrate-nitrogen (NO_3-N) was calculated with a nitrate specific ion electrode at 30°C. D.T.P.A. extractable copper, zinc and manganese concentrations were determined by atomic absorption.

Samples of above ground living plant material were harvested for nutrient analyses in October. At least ten herbaceous plants and ca 10 cm of new growth (both stem and leaf) from a minimum of ten shrubs, were collected per sample.

Analyses of the shoot and litter material after acid digestion gave the total P, K and N as mg g^{-1} and the Cu, Zn and Mn as $\mu g\ g^{-1}$.

The carbon content was determined by oven drying at 100°C overnight and then heating to 500°C for eight hours.

Results

Vegetation

The vegetation was a low open *Banksia* woodland with emergent *Eucalyptus marginata* trees. The flora was relatively rich and varied, with 183 species recorded within 50 families (Appendix 1). There were 69 woody perennial and 114 herbaceous species. The flora excluded the numerous planted trees and shrubs in the gardens and 10 species associated with a nearby lake (Appendix 2). The herbs included 39 introduced annual species, but only 2 introduced perennials, *Solanum sodomeum* and *Pelargonium capitatum*.

Table 1. Tree canopy parameters.

Species	No. stems ha^{-1}	Basal area ($m^2\ ha^{-1}$)	Average height (m)
Eucalyptus gomphocephala	5.5	9.6	14.2 (30)*
E. marginata	93.6	24.1	9.3 (18)
Banksia attenuata	338.7	22.9	3.0 (8)
B. menziesii	51.4	4.8	4.5 (9)
Allocasuarina fraseriana	14.8	2.4	4.0 (9)
Total	504.0	63.8	

* Height of tallest tree in woodland shown in parenthesis.

The tree canopy was made up of five species of which *Banksia attenuata* was dominant (Table 1 and Appendix 1) with a density of 338.7 stems ha^{-1}, a basal area of 22.9 $m^2\ ha^{-1}$, an average height of 3 m, and a frequency of 82%. *E. marginata* was the next most common species, while all other species had little influence on the density of the upper stratum. *Banksia menziesii* was interesting in that all three flower colour variants (red, yellow and rusty brown) were present in the park.

Xanthorrhoea preissii was the most abundant understorey species with a frequency of 100% and a biomass contribution of over 25% for the whole of the lower stratum (Appendix 1). Other common shrubs included four *Daviesia* species, mostly with frequencies greater than 50%, while *Daviesia nudiflora* contributed 6% of the total biomass. Members of this genus flowered in winter and a yellow-flowered variant of *D. nudiflora* was observed. Three *Hibbertia* species were recorded, with the ubiquitous *Hibbertia hypericoides* contributing 3% of the total dry weight. Another common south-western Australian species, *Bossiaea eriocarpa*, was also frequently found.

The predominant herbaceous species in the southern site was *Mesomelaena stygia* which contributed 27% of the total biomass, 14% cover and had a frequency of 80% occurrence. *Loxocarya flexuosa* and *Restio* aff. *sphacelatus* were dominant in the northern site, each contributing over 10% of the cover and biomass. The most common introduced species were the two geophytes, *Romulea rosea* and *Homeria flaccida*, which were 4.7% and 1% of the total biomass and had frequencies of 50% and 27%, respectively. They were followed by three annuals, in order of decreasing cover abundance, *Hypochaeris glabra*, *Briza maxima*, and *Trifolium campestre*. Introduced species provided 52% of ground floor cover (Table 2). Although there was a similar number of introduced species at both sites, the northern sites had 30% more cover. The northern sites had double the dry weight of litter compared to the southern sites (Table 3). This was probably due to the greater density of *Banksia attenuata* trees and their consequent leaf fall, rather than to any small differences in understorey densities.

Table 2. Total number and cover abundance (m^2) of native and introduced herbaceous species in the northern (roadside) and southern sites.

Species types	Northern site		Southern site		Total Park	
	No. spp.	Cover	No. spp.	Cover	No. spp	Cover
Native	20	51.5	23	33.6	31	85.1
Introduced	13	45.0	12	24.7	18	69.7

Only those species recorded in quadrat data are included.

Table 3. Average dry weight (g m^{-2}) of living vegetation and litter of the Northern and Southern sites.

Species Types	Sites		
	Northern	Southern	Park Average
Woody perennials	120.6 (4)	159.6 (8)	146.6
Native herbs	96.8 (4)	117.6 (8)	110.6
Introduced herbs	21.8 (4)	0.0 (8)	7.3
Litter	127.3 (7)	63.0 (10)	89.5

Number of samples shown in parenthesis

The main flowering period for most species was early spring (Figure 2). The response to the winter rains was reflected in the spring flowering winter annuals. Although the dry summer usually inhibits growth and reproduction, *Banksia attenuata*, *Leucopogon propinquus*, *Melaleuca acerosa* and *Calytrix fraseri* of the shrub component and *Restio* aff. *sphacelatus*, *Ptilotus caespitulosus*, *Thysanotus patersonii* and *Tricoryne elatior* of the herb layer flowered mostly at this time of year. The natives *Jacksonia sternbergiana* and *Scaevola paludosa* and the well adapted exotics *Pelargonium capitatum* and *Solanum nigrum* flowered all year round, while *Corynotheca micrantha* possessed flowers for only a few days. *Drosera erythrorhiza* and *Conostylis teretifolia* were never observed to bloom between 1979 and 1983.

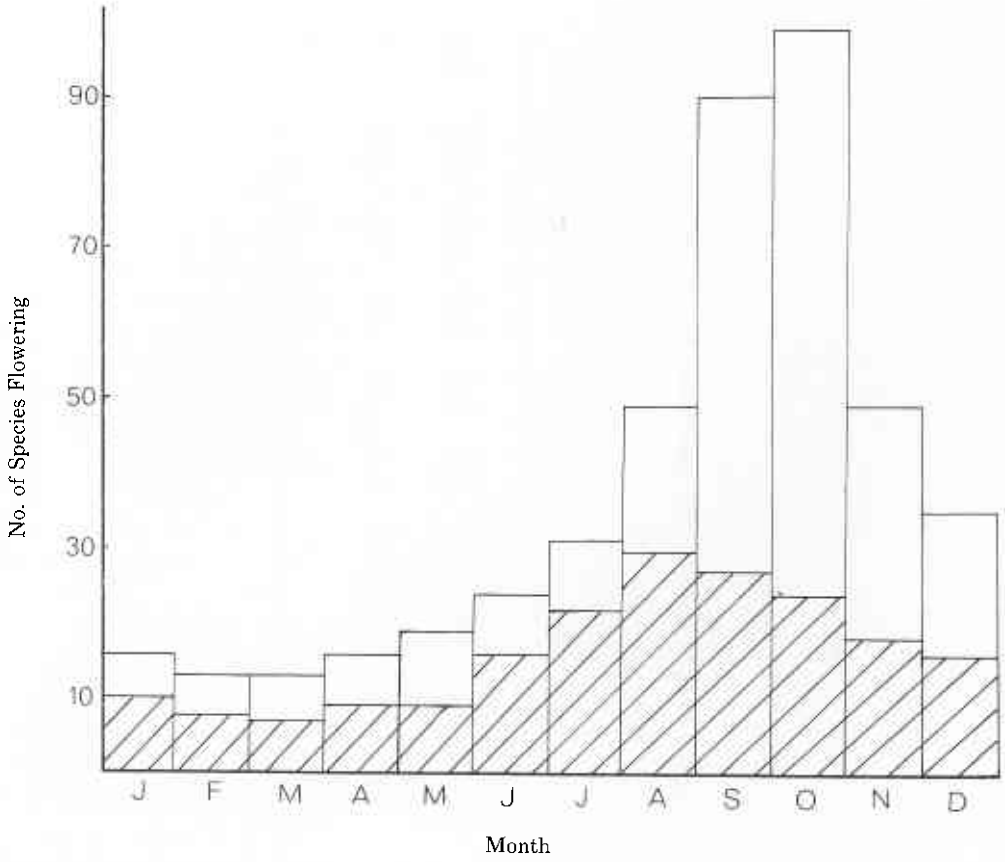

Figure 2. Number of species flowering during each month of the year. The data summarize observations from 1981 and 1982 (shrubs, hatched; herbs, open).

Mineral Nutrient Status

The soils were neutral yellow sands varying in depth from zero to 11 metres over pinnacles of limestone. The carbon content was low compared to darker soils such as sand heaths (Table 4).

As in the case with most Australian soils there was a paucity of nutrients (Table 4), particularly phosphorus and nitrate nitrogen, but compared to Quindalup and Bassendean soils the potassium level was relatively high ($24.8 \mu g\ g^{-1}$). The low chloride content of $20 \mu g\ g^{-1}$, compared with $261.5 \mu g\ g^{-1}$ for foredunes, could be attributed to the distance of the study area from the sea and a decrease in deposition of aerosol salt.

Table 5 shows that the average phosphorus content of the litter, $0.2\ mg\ g^{-1}$, and plant tissues, $0.08\ mg\ g^{-1}$, were like the soil, very low compared with other macronutrients tested such as K, $9.8\ mg\ g^{-1}$ and NO_3-N, $10.3\ mg\ g^{-1}$. Members of the family Papilionaceae possessed twice the NO_3-N content compared with other species analysed (Table 5). The species dominating the ecosystem, *Banksia attenuata*, was relatively low in N, P and K. Along with *Banksia menziesii* and *Dryandra nivea* it contained massive quantities of manganese. This rich source of Mn probably accounts for the high levels recorded in the litter.

Table 4. Nutrient Status of Quindalup, Spearwood and Bassendean Soil Association.

Soil Association / Habitat	W.A. District	Distance from sea	Annual rainfall (mm)	pH	C (%)	μg g^{-1} Fe	P	K	NO_3-N	Cu	Zn	Mn	Cl
QUINDALUP													
Fore-Dune	Greenough	20 m	505	9.2	0.9	2.6	20.0	23.8	26.5	0.27	0.33	0.90	261.5
Shrubland	Green Head	500 m	541	8.2	7.0	4.2	11.5	31.0	20.3	0.11	0.40	0.90	107.6
SPEARWOOD													
Banksia Woodland	Pinnaroo	2 km	740	7.0	2.2	16.0	3.0	24.8	8.2	0.38	0.46	2.10	< 20
BASSENDEAN													
Banksia Woodland	Gnangara	14 km	896	5.8	2.4	-	1.7	7.3	2.0	-	-	-	< 20

Table 5. Nutrient Status of the more common plant species and the litter layer.

	mg g^{-1}			$\mu g\ g^{-1}$		
	P	K	NO_3 -N	Cu	Zn	Mn
Litter	0.2	2.0		1.4	8.1	39.5
POACEAE						
**Briza maxima*	1.2	13.5	7.1	2.6	9.9	49
**Lagurus ovatus*	1.0	14.6	5.2	1.8	19.5	23
Stipa compressa	1.1	12.1	5.8	2.2	10.9	21
CYPERACEAE						
Lepidosperma gracile	0.4	9.6	5.5	3.3	11.8	41
Mesomelaena stygia	0.5	6.3	5.4	2.4	8.3	25
RESTIONACEAE						
Loxocarya flexuosa	0.6	10.7	6.3	2.4	14.2	63
Restio aff. *sphacelatus*	0.4	7.8	8.0	1.0	8.0	71
XANTHORRHOEACEAE						
Xanthorrhoea preissii	0.5	9.5	4.5	1.8	5.1	10
CASUARINACEAE						
Allocasuarina fraseriana	0.5	6.8	5.6	2.2	28.6	20
PROTEACEAE						
Banksia attenuata	0.5	4.5	7.6	10.4	11.4	241
Banksia menziesii	0.6	3.2	5.5	4.0	10.2	220
Dryanda nivea	0.6	5.0	4.4	2.7	7.4	135
Petrophile linearis	0.6	5.8	4.7	1.3	10.0	21
PAPILIONACEAE						
Daviesia decurrens	0.8	8.5	12.7	5.3	12.5	33
Daviesia divaricata	0.8	4.8	8.4	7.9	6.3	7
Daviesia gracilis	0.5	6.0	10.5	3.1	5.6	28
Daviesia nudiflora	0.8	8.8	14.5	6.2	7.3	15
Hardenbergia comptoniana	1.2	17.4	15.2	2.4	10.3	20
Jacksonia sternbergiana	1.0	9.2	13.1	2.4	12.8	11
Kennedia prostrata	1.1	13.4	17.9	4.2	21.2	69
Oxylobium capitatum	0.6	8.2	13.9	2.9	13.1	29
**Trifolium campestre*	1.7	14.8	26.8	5.2	27.8	39
DILLENIACEAE						
Hibbertia hypericoides	0.6	7.1	9.9	3.1	10.8	38
Hibbertia racemosa	0.6	7.9	7.9	11.2	23.4	38
MYRTACEAE						
Eucalyptus gomphocephala	0.9	6.2	7.1	2.4	11.8	33
Eucalyptus marginata	1.1	5.9	7.5	10.5	15.2	31
GOODENIACEAE						
Scaevola canescens	0.7	13.4	8.9	1.6	11.1	15
Scaevola paludosa	0.7	16.9	7.0	2.5	13.0	18
ASTERACEAE						
**Hypochaeris glabra*	1.6	23.5	7.8	2.5	32.7	19
Waitzia suaveolens	1.0	13.6	9.2	7.4	29.7	30
MEAN	0.8	9.8	10.3	4.0	14.0	47.1

* Naturalized alien species.

Discussion

The *Banksia* community at Pinnaroo Valley Memorial Park was similar to the nearby woodland at Star Swamp (Bell *et al.* 1979) which was dominated by *Banksia* species and with minor contributions by *Eucalyptus gomphocephala* and *Allocasuarina fraseriana*. However, the frequency of *Eucalyptus marginata* in Pinnaroo Park was much greater and the understorey layer also showed local variations. *Xanthorrhoea preissii* was predominant and although the ubiquitous *Hibbertia hypericoides* was commonly seen, the shrub canopy was dominated by the four *Daviesia* species.

Pinnaroo Park was floristically similar to other *Banksia* communities found in Spearwood sand north of Perth, e.g. Type D of Havel (1976), but lacked certain shrub species such as *Synaphea polymorpha*. The *Banksia* woodland described by Milewski and Daridge (1981) at Jandakot Airport occupies deep, highly leached white over yellow sand between the Bassendean and Spearwood Dune Systems, and differs mainly in the composition of the shrub stratum. At that site *Beaufortia elegans* and *Leucopogon kingianus* are common, but both are absent at Pinnaroo. In areas where yellow sand reached the surface mutually common components were *Mesomelaena stygia*, *Hibbertia racemosa* and *Daviesia nudiflora*.

The Pinnaroo woodland had a typical Western Australian ground floor vegetation, with few grasses and the ground cover predominantly *Mesomelaena stygia* and two species of Restionaceae.

Degradation of vegetation, similar to that seen at Star Swamp, is evident from the high frequency of introduced 'weedy' species and the presence of pyrogenic grasses, typical of often-burnt vegetation. This was particularly true in the case of the northern section of the Park where secondary succession was occurring faster than in the southern areas. Here a new floristic composition is evolving, caused by the introduction of alien species. In this altered community there was no regeneration of *Eucalyptus gomphocephala*, although young *Banksia* and *E. marginata* saplings were common.

The woodland community, which developed in mildy leached soils, contained a large number of species. Areas where severe conditions prevail are reported to support fewer species (Bell 1980). The presence of *Xanthorrhoea preissii* suggested a relatively moist habitat whereas the presence of *Hibbertia hypericoides*, *Mesomelaena stygia* and *Petrophile macrostachya* indicated a substratum of a weakly leached sandy soil, typical of the Spearwood Series (Havel 1976). This was confirmed by the level of soil nutrients which although well below that of coastal sand dune areas had more than double the amount of macronutrients (PKN) of the leached Bassendean sands (Table 4).

The plant tissues that had been shown to act as a means of storage of nutrients in woodland communities, (Ovington 1962) were relatively low in P but did possess larger quantities of other minerals. Legume species were a common component of the understorey and with their high nitrogen content, the soil N should be maintained.

Excessive leaching of the nutrients through the permeable sandy, humus-depleted soil by the winter rains may be prevented by the *Banksia* trees acting as reservoirs. Slow growing species, gradual leaf fall and low litter component caused a slow recycling of nutrients, although fire probably speeds up the turnover to some degree.

Nutrient input by clearfall rain was low compared to that in a nearby coastal heathland area located at Ocean Reef (Foulds unpublished data). Although the July K recording was the same, 1.2 kg ha^{-1}, no phosphorus, nitrate nitrogen or trace elements were found.

Estimates of canopy nutrient leaching from tree leaves and stems by throughfall rain in Eucalypt forests (Smith 1974) suggests that some mineral replacement in the *Banksia* woodland would occurr in this manner. This is probably true for manganese which was

present in extremely large quantities in the shoots of *Banksia menziesii* and *B. attenuata*. The accumulation of ions, such as Mn, by indigenous plants from nutrient deficient soil suggests a specialised adaptation. In the case of the Banksias and *Dryanda nivea*, which contained a high amount of Mn, their success may have been due to the presence of proteiod roots (Lamont 1974).

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Appendix 1. Name, family, type, origin, frequency, cover and biomass of species in the woodland area of Pinnaroo Valley Memorial Park

W = Woody perennial; H = herb; n = native; i = introduced; F = frequency; RCA = Relative cover abundance (herbs); RDW = dry weight contribution; ECA = estimated cover abundance (shrubs) [o = occasional plant; r = rare (0.1%); f = few (0.1-1%); c = common (1-5%); ab = abundant (5-25%)] nf = no flowers.

Species (nomenclature after Green 1985)	Family	Type	F%	RCA%	RDW%	ECA	Flowering Period
Acacia cochlearis (Labill.) H.L. Wendl. Rigid Wattle	Mimosaceae	W(n)	-	-	-	o	Aug
Acacia cyclops Cunn. ex Don	Mimosaceae	W(n)	-	-	-	o	Sept
Acacia lasiocarpa Benth.	Mimosaceae	W(n)	-	-	-	o	Sept
Acacia pulchella R.Br. Prickly Moses	Mimosaceae	W(n)	5.9	-	-	r	Sept
Acacia rostellifera Benth.	Mimosaceae	W(n)	-	-	-	o	Aug-Oct
Acacia saligna (Labill.) H.L. Wendl. Orange Wattle	Mimosaceae	W(n)	17.6	-	-	r	Sept
Acacia willdenowiana H.L. Wendl. Wattle Grass	Mimosaceae	W(n)	5.9	-	-	r	Jul-Aug
Acanthocarpus preissii Lehm. Prickly Lily	Dasypogonaceae	W(n)	3.3	0.8	-	o	Apr-Aug
Agropyron scabrum (Labill.) P. Beauv. Common Wheatgrass	Poaceae	H(n)	13.3	4.7	-	-	Oct
Agrostocrinum scabrum (R.Br.) Baillon False Blind Grass	Anthericaceae	H(n)	6.7	0.1	-	-	Sept-Oct
Allocasuarina fraseriana (Miq.) L. Johnson	Casuarinaceae	W(n)	17.6	-	-	f	Aug-Oct
Allocasuarina humilis (Otto & Dietr.) L. Johnson Dwarf Casuarina	Casuarinaceae	W(n)	-	-	-	o	Aug-Oct
Anagallis arvensis var. *caerulea* (L.) Gouan Blue Pimpernel	Primulaceae	H(i)	-	-	-	-	Sept-Oct

Anigozanthos humilis Lindley Cat's Paw	Haemodoraceae	H(n)	-	-	-	-	Sept-Nov
Anthocercis littorea Labill. Yellow Tailflower	Solanaceae	W(n)	5.9	-	-	r	June-Sept
Arctotheca calendula (L.) Levyns Capeweed	Asteraceae	H(i)	-	-	-	-	Sept-Oct
Asteridea pulverulenta Lindley	Asteraceae	H(n)	-	-	-	-	Oct-Dec
Avena barbata Link Bearded Oat	Poaceae	H(i)	3.3	0.1	-	-	Oct-Nov
Banksia attenuata R.Br. Sandplain Banksia	Proteaceae	W(n)	82.4	-	-	ab	Nov-Feb
Banksia grandis Willd. Bull Banksia	Proteaceae	W(n)	-	-	-	o	Aug
Banksia menziesii R.Br. Menzies' Banksia	Proteaceae	W(n)	35.3	-	-	c	Apr-Sept
Banksia prionotes Lindley Orange Banksia	Proteaceae	W(n)	-	-	-	r	May-Jul
Bossiaea eriocarpa Benth. Granny's Bonnets	Papilionaceae	W(n)	53.0	-	4.4	c	Oct-Nov
Brassica tournefortii Gouan Wild Turnip	Brassicaceae	H(i)	-	-	-	-	Jul-Aug
Brassicaceae sp. indet. (WFP1)	Brassicaceae	H(i)	-	-	-	-	Sept
Briza maxima L. Quaking Grass	Poaceae	H(i)	46.7	8.2	-	-	Sept-Nov
Briza minor L. Lesser Quaking Grass	Poaceae	H(i)	16.7	1.1	-	-	Sept-Oct
Bromus diandrus Roth Great Brome	Poaceae	H(i)	-	-	-	-	Sept
Burchardia umbellata R.Br. Milkmaids	Colchicaceae	H(n)	-	-	-	-	Sept-Oct

Species	Family	Type	F%	RCA%	RDW%	ECA	Flowering Period
Caladenia deformis R.Br. Blue Fairy Orchid	Orchidaceae	H(n)	-	-	-	-	Jul-Sept
Caladenia ferruginea Nicholls Rusty Spider Orchid	Orchidaceae	H(n)	-	-	-	-	Oct
Caladenia filamentosa R.Br. Spider Orchid	Orchidaceae	H(n)	-	-	-	-	Sept-Oct
Caladenia flava R.Br. Primrose Orchid	Orchidaceae	H(n)	-	-	-	-	Sept-Oct
Caladenia longicauda Lindley White Spider Orchid	Orchidaceae	H(n)	-	-	-	-	Sept-Oct
Calandrinia liniflora Fenzl	Portulacaceae	H(n)	-	-	-	-	Oct-Nov
Calocephalus brownii (Cass.) F. Muell.	Asteraceae	W(n)	-	-	-	o	Jan
Calothamnus sanguineus Labill. Silky Leaved Blood Flower	Myrtaceae	W(n)	-	-	-	o	Jul-Aug
Calytrix fraseri Cunn.	Myrtaceae	W(n)	-	-	-	o	Jan-Feb
Carpobrotus edulis (L.) L. Bolus Hottentot Fig	Aizoaceae	H(i)	6.7	1.6	0.6	-	May-Nov
Cerastium glomeratum Thuill. Mouse Ear Chickweed	Caryophyllaceae	H(i)	-	-	-	-	Aug-Sept
Clematis microphylla DC. Small Leaf Clematis	Ranunculaceae	W(n)	-	-	-	o	Aug-Sept
Comesperma confertum Labill.	Polygalaceae	W(n)	-	-	-	o	Sept-Oct
Conospermum distichum R.Br.	Proteaceae	W(n)	-	-	-	o	Oct
Conospermum triplinervium R.Br. Tree Smoke Bush	Proteaceae	W(n)	-	-	-	o	Oct-Nov
Conostephium pendulum Benth. Pearl Flower	Epacridaceae	W(n)	29.4	-	2.1	f	Apr-Aug

Conostephium preissii Sonder Lesser Pearl Flower	Epacridaceae	W(n)	17.6	-	-	f	Dec
Conostylis aculeata subsp. *bracteata* R.Br. Spiny Cotton Head	Haemodoraceae	H(n)	16.7	0.7	-	-	Jul-Nov
Conostylis teretifolia J.W. Green Spiny Conostylis	Haemodoraceae	H(n)	-	-	-	-	July
Conyza bonariensis (L.) Cronq. Flaxleaf Fleabane	Asteraceae	H(i)	-	-	-	-	Dec
Corynotheca micrantha (Lindley) J.F. MacBr.	Anthericaceae	H(n)	3.3	0.1	-	-	Dec
Crassula colorata (Nees) Ostenf. Dense Stonecrop	Crassulaceae	H(n)	3.3	0.1	-	-	Sept-Oct
Cynodon dactylon (L.) Pers. Couch	Poaceae	H(n)	-	-	-	-	nf
Cyperaceae sp. indet. (WFP2)	Cyperaceae	H(n)	6.7	0.7	-	-	nf
Daucus glochidiatus (Labill.) Fischer, C. Meyer & Ave-Lall. Australian Carrot	Apiaceae	H(n)	13.3	1.3	-	-	Sept
Daviesia decurrens Meissner Thorny Bitter Pea	Papilionaceae	W(n)	41.2	-	-	f	June-Aug
Daviesia divaricata Benth.	Papilionaceae	W(n)	76.5	-	2.0	c	Aug-Oct
Daviesia gracilis M.D. Crisp	Papilionaceae	W(n)	52.9	-	-	c	June-Jul
Daviesia nudiflora Meissner	Papilionaceae	W(n)	76.5	-	6.0	c	Jul-Oct
Dianella revoluta R.Br. Spreading Flax Lily	Phormiaceae	H(n)	-	-	-	-	Nov-Sept
Diplotaxis muralis (L.) DC. Wall Rocket	Brassicaceae	H(i)	-	-	-	-	Nov-Dec
Diuris longifolia R.Br. Donkey Orchid	Orchidaceae	H(n)	-	-	-	-	Sept-Oct

Species	Family	Type	F%	RCA%	RDW%	ECA	Flowering Period
Drosera erythrorhiza Lindley Red-ink Sundew	Droseraceae	H(n)	10.0	0.7	-	-	nf
Drosera macrantha Endl.	Droseraceae	H(n)	16.7	0.2	-	-	Jul-Oct
Dryandra nivea (Labill.) R.Br. Dwarf Dryandra	Proteaceae	W(n)	29.4	-	-	f	Aug-Sept
Dryandra sessilis (Knight) Domin Parrot Bush	Proteaceae	W(n)	-	-	-	o	Jul-Oct
Ehrharta calycina Smith Perennial Veldtgrass	Poaceae	H(i)	10.0	0.9	-	-	Sept-Oct
Emex australis Steinh. Doublegee	Polygonaceae	H(n)	-	-	-	-	Aug-Sept
Eremaea pauciflora (Endl.) Druce	Myrtaceae	W(n)	-	-	-	o	Nov
Eriostemon spicatus A. Rich. Pepper and Salt	Rutaceae	W(n)	11.7	-	-	f	Oct
Erodium cicutarium (L.) L'Her. Common Crowfoot	Geraniaceae	H(i)	3.3	-	-	-	Aug-Oct
Erodium cygnorum Nees Blue Storksbill	Geraniaceae	H(i)	-	-	-	-	Sept
Eryngium rostratum Cav. Blue Devil	Apiaceae	H(n)	-	-	-	-	Oct
Eucalyptus gomphocephala DC. Tuart	Myrtaceae	W(n)	11.7	-	-	f	Jan
Eucalyptus marginata Donn ex Smith Jarrah	Myrtaceae	W(n)	47.7	-	-	e	Dec
Freesia leichtlinii Klatt Freesia	Iridaceae	H(i)	-	-	-	-	Oct
Geranium molle L. Dove's foot Cranesbill	Geraniaceae	H(i)	3.3	0.05	-	-	Sept

Hibbertia hypericoides (DC.) Benth. Guinea Flower	Dilleniaceae	W(n)	58.8	-	3.0	c	Aug-Dec
Hibbertia polystachya Benth.	Dilleniaceae	W(n)	5.9	-	-	o	Sept-Oct
Hibbertia racemosa (Endl.) Gilg Stalked Guinea Flower	Dilleniaceae	W(n)	58.8	-	-	c	June-Oct
Homeria flaccida Sweet Oneleaf Cape Tulip	Iridaceae	H(i)	26.7	2.2	1.1	-	Sept-Oct
Hovea trisperma Benth. Hovea	Papilionaceae	W(n)	29.4	-	-	f	June-Aug
Hybanthus calycinus (DC. ex Ging.) F. Muell. Wild Violet	Violaceae	H(n)	-	-	-	-	Sept-Nov
Hypocalymma robustum Endl. Swan River Myrtle	Myrtaceae	W(n)	35.3	-	-	f	Aug-Oct
Hypochaeris glabra L. Smooth Catsear	Asteraceae	H(i)	40.0	10.8	0.01	-	May-Nov
Isolepis marginata (Thunb.) A. Dietr.	Cyperaceae	H(n)	26.7	3.1	1.5	-	Sept-Oct
Isolepis sp. (WFP3)	Cyperaceae	H(n)	-	-	-	-	Sept
Isotoma hypocrateriformis (R.Br.) Druce Woodbridge Poison	Lobeliaceae	H(n)	3.3	0.1	-	-	Oct-Nov
Isotropis cunefolia (Smith) Benth. ex B.D. Jackson Lamb Poison	Papilionaceae	H(n)	10.0	0.7	-	-	Sept-Oct
Jacksonia furcellata (Bonpl.) DC.	Papilionaceae	W(n)	-	-	-	o	June-Oct
Jacksonia sericea Benth.	Papilionaceae	W(n)	5.9	-	-	r	June-Oct
Jacksonia sternbergiana Huegel Stink Bush	Papilionaceae	W(n)	11.7	-	-	f	Jan-Dec
Kennedia prostrata R.Br. Scarlet Runner	Papilionaceae	W(n)	41.2	-	-	f	Jul-Oct

Species	Family	Type	F%	RCA%	RDW%	ECA	Flowering Period
Lachenalia reflexa Thunb.	Hyacinthaceae	H(i)	-	-	-	-	Aug
Lagenifera huegelii Benth. Common Lagenifera	Asteraceae	H(n)	23.3	0.8	-	-	Jul-Sept
Lagurus ovatus L. Hare's tail Grass	Poaceae	H(i)	3.3	0.1	0.01	-	Nov
Lechenaultia linarioides DC. Yellow Lechenaultia	Goodeniaceae	W(n)	-	-	-	o	Oct-Jan
Lepidosperma gracile R.Br. Slender Sword Sedge	Cyperaceae	H(n)	6.7	0.05	-	-	Nov
Leucopogon nutans E. Pritzel	Epacridaceae	W(n)	-	-	-	o	Aug
Leucopogon propinquus R.Br.	Epacridaceae	W(n)	5.9	-	-	r	Feb-Apr
Lobelia rarifolia F. Wimmer	Lobeliaceae	H(n)	-	-	-	-	Dec
Lomandra preissii (Endl.) Ewart	Dasypogonaceae	H(n)	20.0	0.8	0.1	-	May-June
Loxocarya flexuosa (R.Br.) Benth. Cord Rush	Restionaceae	H(n)	50.0	11.7	10.1	-	Sept
Lupinus cosentinii Guss. Sandplain Lupin	Papilionaceae	H(i)	-	-	-	-	Oct-Dec
Luzula meridionalis Nordensk.	Juncaceae	H(n)	-	-	-	-	Oct
Macrozamia riedlei (Fischer ex Gaudich.) C. Gardner Western Zamia	Zamiaceae	W(n)	-	-	-	o	Aug
Medicago polymorpha L. Burr Medic	Papilionaceae	H(i)	-	-	-	-	Sept-Oct
Melaleuca acerosa Schauer	Myrtaceae	W(n)	17.6	-	-	f	Dec-Apr
Melaleuca huegelii Endl. Chenille Honey Myrtle	Myrtaceae	W(n)	-	-	-	o	Dec
Melilotus indica (L.) All. Hexham Scent	Papilionaceae	H(i)	-	-	-	-	Nov

Mesomelaena stygia (R.Br.) Nees	Cyperaceae	H(n)	80.0	17.8	27.1	-	Apr-June
Mesomelaena tetragona (R.Br.) Benth. Semaphore Sedge	Cyperaceae	H(n)	6.7	2.1	-	-	Aug
Millotia myosotidifolia (Benth.) Steetz	Asteraceae	H(n)	6.7	0.05	-	-	Sept-Oct
Olearia axillaris (DC.) F. Muell. ex Benth. Native Rosemary	Asteraceae	W(n)	-	-	-	o	May
Opercularia spermacocea Labill.	Rubiaceae	H(n)	3.3	0.5	0.02	-	Sept-Nov
Orobanche minor Smith	Orobanchaceae	H(i)	-	-	-	-	Oct
Orthrosanthus laxus (Endl.) Benth. Morning Iris	Iridaceae	H(n)	-	-	-	-	Sept-Nov
Oxylobium capitatum Benth. Bacon and Eggs	Papilionaceae	W(n)	35.3	-	-	c	Aug-Oct
Parentucellia latifolia (L.) Caruel Common Bartsia	Scrophulariaceae	H(i)	3.3	-	-	-	Sept
Pelargonium capitatum (L.) L'Her.	Geraniaceae	W(i)	-	-	-	o	Jan-Dec
Pentaschistis airoides (Nees) Stapf	Poaceae	H(i)	16.7	3.9	-	-	Sept-Oct
Persoonia saccata R.Br.	Proteaceae	W(n)	-	-	0.2	o	Nov-Dec
Petrophile linearis R.Br. Pixie Mops	Proteaceae	W(n)	23.5	-	3.0	c	Sept-Nov
Petrophile macrostachya R.Br.	Proteaceae	W(n)	-	-	-	o	June
Petrorhagia velutina (Guss.) P. Ball & Heyw. Proliferous Pink	Caryophyllaceae	W(i)	30.0	1.5	-	-	Sept-Oct
Pimelea floribunda Meissner	Thymelaeaceae	W(n)	-	-	-	o	Oct
Pimelea rosea R.Br. Native Rose	Thymelaeaceae	W(n)	17.6	-	-	r	Oct
Pimelea suaveolens Meissner	Thymelaeaceae	W(n)	-	-	-	o	Oct

Species	Family	Type	F%	RCA%	RDW%	ECA	Flowering Period
Poa drummondiana Nees Knotted Poa	Poaceae	H(n)	3.3	0.2	-	-	Oct
Poa poiformis (Labill.) Druce Blue Tussock Grass	Poaceae	H(n)	-	-	-	-	Sept
Podolepis gracilis (Lehm.) R.A. Graham Slender Podolepis	Asteraceae	H(n)	-	-	-		Sept
Podotheca chrysantha (Steetz) Benth. Yellow Podotheca	Asteraceae	H(n)	-	-	-	-	Sept
Podotheca gnaphalioides R.A. Graham Golden Long-heads	Asteraceae	H(n)	-	-	-	-	Sept
Polypogon tenellus R.Br. Lesser Beardgrass	Poaceae	H(n)	-	-	-	-	Oct
Pterostylis recurva Benth. Jug Greenhood	Orchidaceae	H(n)	-	-	-	-	Aug
Ptilotus caespitulosus F. Muell.	Amaranthaceae	H(n)	3.3	0.1	-	-	Oct-June
Ptilotus exaltatus Nees Tall Mulla Mulla	Amaranthaceae	H(n)	-	-	-	-	Oct-June
Ptilotus manglesii (Lindley) F. Muell. Rose Tipped Mulla Mulla	Amaranthaceae	H(n)	-	-	-	-	Oct-Jan
Regelia ciliata Schauer	Myrtaceae	W(n)	5.9	-	-	r	Nov-Dec
Restio aff. *sphacelatus* R.Br. (WFP4) Cord Rush	Restionaceae	H(n)	40.0	13.1	7.0	-	Mar-Apr
Rhagodia baccata (Labill.) Moq. Camel Berry	Chenopodiaceae	W(n)	11.7	-	-	r	Dec
Ricinocarpos glaucus Endl. Wedding Bush	Euphorbiaceae	W(n)	35.3	-	-	f	Sept-Nov
Romulea rosea (L.) Ecklon Guildford Grass	Iridaceae	H(i)	50.0	14.3	4.7	-	Aug-Sept

Scaevola canescens Benth. Grey Scaevola	Goodeniaceae	W(n)	70.6	-	0.2	c	Mar-Dec
Scaevola paludosa R.Br. Marsh Scaevola	Goodeniaceae	W(n)	23.5	-	-	f	Jan-Dec
Schoenus grandiflorus (Nees) F. Muell. Large-flowered Bog Rush	Cyperaceae	H(n)	-	-	-	-	Apr-Nov
Senecio hispidulus A. Rich Hispid Fireweed	Asteraceae	H(n)	-	-	-	-	Sept
Senecio lautus G. Forster ex Willd. Fireweed	Asteraceae	H(n)	3.3	1.3	-	-	Aug-Nov
Silene gallica L. French Catchfly	Caryophyllaceae	H(i)	13.3	0.6	-	-	Aug-Oct
Solanum nigrum L. Black Berry Nightshade	Solanaceae	H(i)	-	-	-	-	Jan-Dec
Solanum sodomeum L. Apple of Sodom	Solanaceae	W(i)	-	-	-	o	Nov-Feb
Sonchus oleraceus L. Common Sowthistle	Asteraceae	H(i)	16.7	0.8	-	-	Aug-Dec
Sowerbaea laxiflora Lindley Vanilla Lily	Anthericaceae	H(n)	13.3	0.3	-	-	Aug-Oct
Stenopetalum robustum Endl.	Brassicaceae	H(n)	-	-	-	-	Sept
Stipa compressa R.Br. Compressed Speargrass	Poaceae	H(n)	-	-	-	-	Oct-Nov
Stipa aff. *eremophila* Reader (WPF5)	Poaceae	H(n)	-	-	-	-	Oct
Stirlingia latifolia (R.Br.) Steudel Blueboy	Proteaceae	W(n)	17.6	-	-	f	June
Stylidium brunonianum Benth. subsp. *brunonianum* Pink Fountain Trigger Plant	Stylidiaceae	H(n)	3.3	0.05	-	-	Oct
Stylidium calcaratum R.Br. Book Trigger Plant	Stylidiaceae	H(n)	-	-	-	-	Sept-Oct

Species	Family	Type	F%	RCA%	RDW%	ECA	Flowering Period
Stylidium guttatum R.Br. Dotted Trigger Plant	Stylidiaceae	H(n)	3.3	0.05	-	-	Oct-Nov
Stylidium repens R.Br. Matted Trigger Plant	Stylidiaceae	H(n)	-	-	-	-	May
Stylidium schoenoides DC. Cow-kicks	Stylidiaceae	H(n)	-	-	-	-	Oct
Styphelia tenuiflora Lindley Slender-flowered Heath	Epacridaceae	W(n)	5.9	-	-	r	May-June
Tersonia cyathiflora (Fenzl) A.S. George	Gyrostemonaceae	H(n)	-	-	-	-	Sept
Thelymitra fuscolutea R.Br. Leopard Sun Orchid	Orchidaceae	H(n)	-	-	-	-	Oct
Thysanotus banksii R.Br. Common Fringe Lily	Anthericaceae	H(n)	-	-	-	-	Dec
Thysanotus dichotomus (Labill.) R.Br. Branching Fringe Lily	Anthericaceae	H(n)	-	-	-	-	Dec-Feb
Thysanotus multiflorus R.Br. Many Flowered Fringe Lily	Anthericaceae	H(n)	-	-	-	-	Oct
Thysanotus patersonii R.Br. Twining Fringe Lily	Anthericaceae	H(n)	3.3	0.1	-	-	Oct
Thysanotus tenellus Endl.	Anthericaceae	H(n)	-	-	-	-	Oct
Trachyandra divaricata (Jacq.) Kunth	Asphodelaceae	H(i)	-	-	-	-	Oct
Trachymene pilosa Smith Dwarf Parsnip	Apiaceae	H(n)	6.7	0.4	0.2	-	Sept-Oct
Tricoryne elatior R.Br. Yellow Autumn Lily	Anthericaceae	H(n)	6.7	0.4	-	-	Nov-Dec, Mar-Apr
Trifolium campestre Schreber Hop Clover	Papilionaceae	H(i)	46.7	6.3	1.0	-	Sept-Nov

Trifolium glomeratum L. Cluster Clover	Papilionaceae	H(i)	-	-	-	-	Oct
Tripterococcus brunonis Endl.	Stackhousiaceae	H(n)	-	-	-	-	Oct
Ursinia anthemoides (L.) Poiret Ursinia	Asteraceae	H(i)	33.3	1.7	0.03	-	Sept-Oct
Vicia sativa L. Common Vetch	Papilionaceae	H(i)	-	-	-	-	Sept-Oct
Vulpia bromoides (L.) Gray Squirrel tail Fescue	Poaceae	H(i)	-	-	-	-	Oct
Vulpia myuros (L.) C. Gmelin Rat's tail Fescue	Poaceae	H(i)	-	-	-	-	Oct
Wahlenbergia gracilenta Loth. Annual Bluebell	Campanulaceae	H(n)	-	-	-	-	Oct
Waitzia acuminata Steetz	Asteraceae	H(n)	10.0	0.6	-	-	Sept-Oct
Waitzia suaveolens (Benth.) Druce Fragrant Waitzia	Asteraceae	H(n)	23.3	1.8	-	-	Sept-Nov
Xanthorrhoea preissii Endl. Blackboy	Xanthorrhoeaceae	W(n)	100.0	-	27.5	ab	Oct-Nov

Appendix 2. Name, family, type of species associated with Lake near Pinnaroo Valley Memorial Park

W = woody perennial; H = herb; n = native; i = introduced.

Lakeside Species	Family	Type
Anagallis arvensis L. var. *arvensis* Scarlet Pimpernel	Primulaceae	H(i)
Centaurium spicatum (L.) Fritsch ex Janchen Spike Centaury	Gentianaceae	H(n)
Cyperus vaginatus R.Br. Stiffleaf Sedge	Cyperaceae	H(n)
Juncus holoschoenus R.Br. Jointed Rush	Juncaceae	H(n)
Juncus aff. *holoschoenus* R.Br.	Juncaceae	H(n)
Juncus planifolius R.Br. Broadleaf Rush	Juncaceae	H(n)
Lotus angustissimus L. Narrowleaf Trefoil	Papilionaceae	H(i)
Melaleuca rhaphiophylla Schauer Swamp Paperbark	Myrtaceae	W(n)
Rumex crispus L. Curled Dock	Polygonaceae	H(i)
Schoenoplectus validus (M. Vahl) A. Love & D. Love River Clubrush	Cyperaceae	H(n)