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Vegetation of *Naree* and *Yantabulla* stations on the Cuttaburra Creek, Far North Western Plains, New South Wales

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Abstract: *Naree* and *Yantabulla* stations (31,990 ha) are found 60 km south-east of Hungerford and 112 km north-west of Bourke, New South Wales (lat. 29° 55'S; long. 150°37'N). The properties occur on the Cuttaburra Creek within the Mulga Lands Bioregion. We describe the vegetation assemblages found on these properties within three hierarchical levels (Group, Alliance & Association). Vegetation levels are defined based on flexible UPGMA analysis of cover-abundance scores of all vascular plant taxa. These vegetation units are mapped based on extensive ground truthing, SPOT5 imagery interpretation and substrate. Three 'Group' level vegetation types are described: Mulga Complex, Shrublands Complex and Floodplain Wetlands Complex. Within these Groups nine 'Alliances' are described: Rat's tail Couch – Lovegrass Grasslands, Canegrass Grasslands, Lignum – Glinus Shrublands, Coolibah – Black Box Woodlands, Turpentine – Button Grass – Windmill Grass Shrublands, Turpentine – Hop Bush – Kerosene Grass shrublands and Mulga Shrublands. Sixteen 'Associations' are described 1) Mulga – Poplar Box Shrubland, 2) Mulga – Poplar Box – Bastard Mulga Shrubland, 3) Turpentine – Hop Bush – Senna Shrubland, 4) Turpentine – Elegant Wattle – Boobialla Shrubland, 5) Turpentine – Hop Bush – Daisy Bush Shrubland, 5) Belah – Rosewood – Turpentine Bush Shrubland, 6) Belah – Rosewood – Turpentine Bush Shrubland, 7) Ironwood – Leopardwood – Supplejack Shrubland, 8) Yapunyah – Black Box – River Cooba Woodland, 9) Coolibah – River Cooba – Yapunyah Woodland, 10) Rat's tail Couch – Lovegrass – Fairy Grass Grassland and Herbfield, 11) Rat's tail Couch – Lovegrass – Purslane Grassland and Herbfield, 12) Darling Pratia – Rat's tail Couch – Spike Rush Herbfield, 13) Canegrass Grassland, 14) Glinus – Groundsel – Lignum Herbfield, 15) Poplar Box – Mulga – Coolibah Woodland and 16) Black Box Woodland. In total 355 vascular plant taxa were found of which 6% were considered exotic in origin. A population of *Dentella minutissima*; a species listed as threatened (endangered) under the New South Wales *Threatened Species Conservation Act* 1995 was found. A summary of select structural and habitat attributes within Alliances is also presented.

Key words: mapping, conservation, floristics, floodplain, woodland, mulga lands, wetlands.

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Introduction

Naree and *Yantabulla* are adjoining former sheep and cattle stations (lat. 29° 55'S; long. 150°37'N) located along the Cuttaburra Creek which flows into Yantabulla Swamp and eventually into the Paroo River. The Paroo is a major tributary of the Murray Darling System (Figure 1). The properties lie in the Mulga Lands Bioregion, 150 km north-west of Bourke in north-west New South Wales. A former pastoral property, *Naree* Station (15,000 ha) was purchased by Bush Heritage Australia in 2012 (<http://www.bushheritage.org.au/places-we-protect/new-south-wales/naree>). In 2015 the southern neighbouring pastoral property of *Yantabulla* Station (16,000 ha) was purchased by South Endeavour Trust (<http://www.southendeavour.com.au/>). Both properties are currently managed by Bush Heritage Australia. Both properties have been purchased for conservation purposes but were grazed in the past with sheep and cattle, *Naree* being destocked in 2012 and *Yantabulla* in 2015.

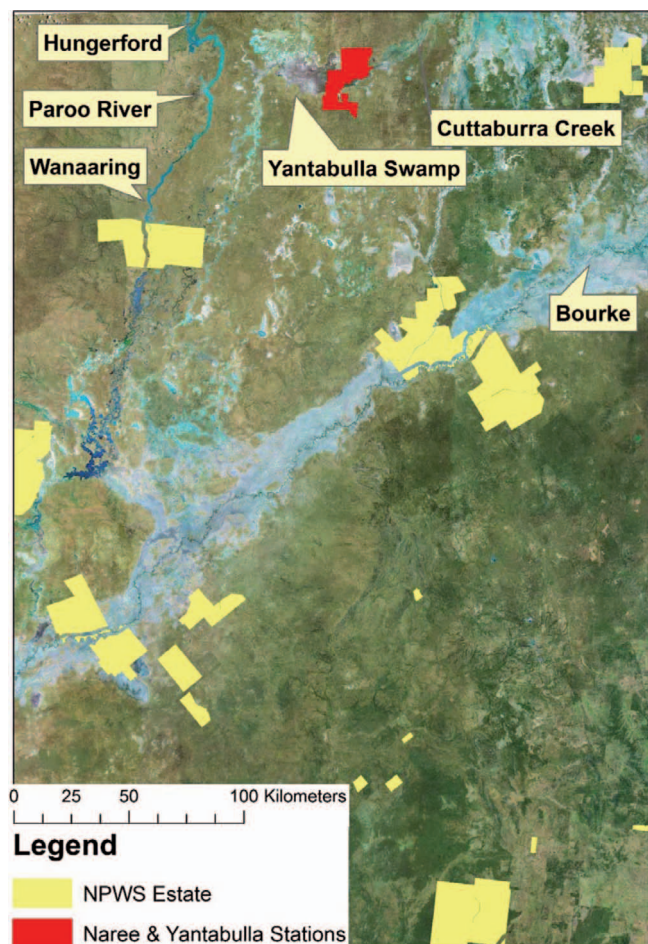


Fig. 1. Location of *Naree* and *Yantabulla* Stations and other nearby National Park Estate reserves.

These properties occur over a variety of landscapes including floodplains of grey to black self-mulching cracking clay soils, wetlands of various sizes, soil types and inundation durations, aeolian dunes and ridge country of red to red brown clays. Altitude ranges from around 120 to 150 m above sea level. Climatic instability is a constant feature of arid and semi-arid areas of western New South Wales and is

generally more unpredictable than in similar climatic zones elsewhere in the world leading to irregular resource and productivity pulsing (Westoby, 1988; Morghan *et al.* 2016).

This paper provides part of the results of a flora survey conducted to acquire baseline data for the future management of *Naree* and *Yantabulla* conservation areas, to construct a map of the floristic vegetation assemblages and the occurrence of rare taxa and communities. The data is to be used in conjunction with ongoing monitoring to assess change and provide feedback on management outcomes.

Methods

Sample site placement

A total of 208 full floristic 20 x 20 m plots were surveyed for vascular plants scored using the Braun-Blanquet six point cover abundance scale (Westhoff & Maarel 1978). In addition, 233 rapid survey plots (RPD) recording only dominant species of each stratum were also placed. Thirty-four of the full floristic plots were originally permanently marked during initial post purchase surveys conducted by Bush Heritage within *Naree* in 2013. These original plots were re-surveyed by the authors in June of 2014; all other plots were surveyed in April 2015. It is acknowledged that due to the ephemerality of much of the herbaceous flora that some variation will have been missed due to the timing of our surveys. Thirty-three plots were randomly placed using ArcGIS (10.1) across the properties with a minimum distance between of 500 m and permanently marked. All other plots were placed using a stratified random methodology based on major landscape types. All permanently marked full floristic survey plots (79 in total) were revisited in April 2016. At each location information was gathered on location and altitude with reference to geographical positioning system (GPS; Garmin Map 62s; Garmin International, Olathe, KS, USA) along with physiography, soil drainage, colour and depth.

Habitat data

Fifty-five permanently marked sites (marked in each of the four corners) were chosen for further investigation of habitat and structural attributes. Within these sites projected foliage cover was recorded every 5 m along a 50 m transect along one side of the plot (extending out a further 30 m) starting at the south-eastern corner. Within the extended 20 x 50 m plot the cumulative length of all logs, small end diameter over 10 cm width, was recorded along with the number of log hollows. The identity and number of all shrubs greater than 1 m in height was recorded within the 20 x 20 m plot and the identity and number of all shrubs below 1 m was recorded within a 5 x 5 m subplot within the south-east corner. At the 2-2.5 m mark from each corner post a 50 x 50 cm subplot was placed and all litter collected (a total of 8 sub-plots per plot). Pieces of wood less than 1 cm diameter were included as litter. All litter sub-plots were combined and weighed using an OHAUS Pioneer balance in grams to two decimal places. Tree density was measured using the method employed by Hunter (2013; 2015ab) whereby a random tree with a minimum diameter at breast height (130 cm) (DBH)

of 5 cm was chosen as a central tree within each randomly placed plot. If no stem >5 cm DBH occurred within the 20 x 50 m plot this process was not followed. From this tree 15 of the closest live trees of over 5 cm DBH (130 cm) were measured (16 live trees inclusive of the central tree) and the DBH of every stem >5 cm DBH was recorded separately for each individual. Diameters were measured using a Haglof diameter clamp to the nearest 0.5 cm. All dead trees within the radius of the furthest live tree were measured but did not count towards the total minimum of 16 live trees. The size of these tree plots was unbounded and dependent on the distance to the furthest tree recorded. For each tree the identity of the species and distance to the first tree (meters) using a Kinchrome 150 mm measuring wheel were recorded. The size of each site was calculated as the area of the circle whose radius was the distance from the central tree to the furthest tree which enclosed all trees previously recorded. The height and number of tree hollows above 1 m from the ground (opening of >5 cm which projected into the stem) was recorded for each tree.

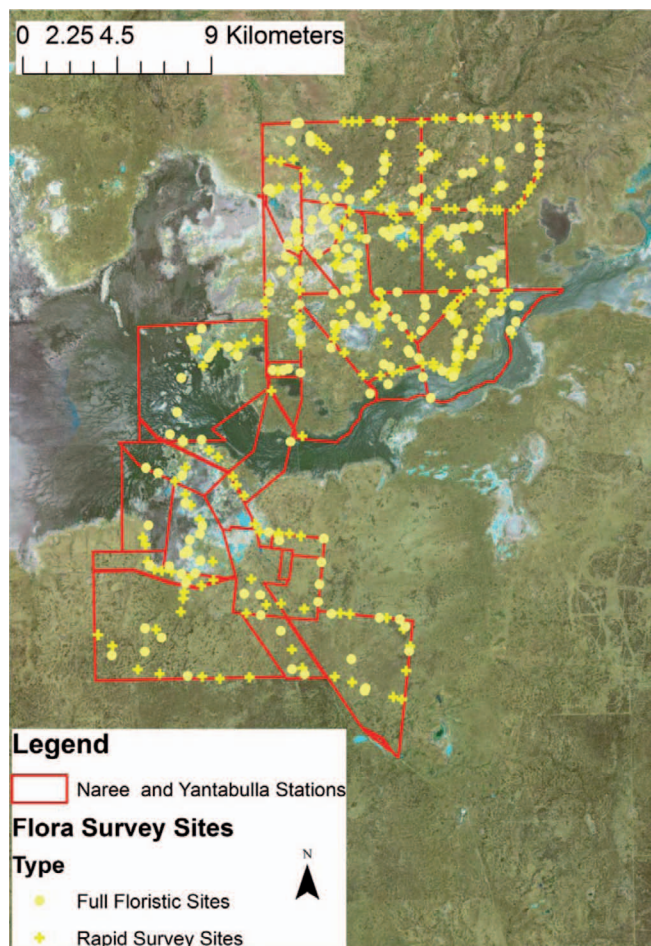


Fig. 2. Placement of full floristic and rapid survey sites across Naree and Yantabulla Stations.

Statistical analysis

Analysis and data exploration were performed using options available in the PATN 3.2 Package (Belbin 1995a, b). For final presentation of results all species and their relative abundance scores were used and the analysis performed using

Kulczynski association measure which is recommended for ecological applications (Belbin 1995a, b) along with flexible Unweighted Pair Group arithmetic Averaging (UPGMA) and the default PATN settings. Each plot (Full floristic and RPD) were assigned to three vegetation classification levels (Group, Alliance, Association) according to the definitions of EcoVeg (Faber-Langedoen *et al.* 2014) based on the results of the statistical analysis of the full floristic survey plot data. Within the EcoVeg criteria a group comprises a set of diagnostic plant species and growth forms that reflect regional mesoclimate, geology, substrates, hydrology and disturbance regimes (Faber-Langedoen *et al.* 2014). The plots and their assigned floristic units were re-projected onto SPOT5 imagery using ArcGIS (10.1) software. The plots, the notes taken on traverses, structural characteristics seen on imagery along with topological information were used to delineate vegetation polygons. This methodology follows the guidelines for vegetation mapping provided within the Native Vegetation Interim Standard (Sivertsen 2009). EstimateS 8.2 (Colwell 2006) was used to produce a rarefaction curve based on 1000 randomisations to calculate the potential number of species within the study area.

Results

In total sixteen Associations are described within nine Alliances and three Groups. Associations have been defined at a dissimilarity level of 0.9; a summary of association relationships is given in the dendrogram (Fig. 3). Mapping of Groups is given in Figure 4 and Associations in Figure 5. Over the survey period and based on opportunistic recordings of other surveyors a total of 355 vascular plant taxa have been found within the two properties. These 355 taxa were from 52 Families and 179 Genera. A total of 22 (6%) of the flora is exotic in origin. The cumulative number of species recorded (355) from all survey periods is higher than the predicted number (350) but within 95% confidence (upper limit of 410) based on the turnover during 2015 survey period (Fig. 7). Species density (species per plot) was highly variable from as few as one to 48 taxa (Table 1). Association 6: *Eragrostis australasica* had the lowest average number of species per site (6) with Association 1: *Acacia aneura* – *Eucalyptus populnea* containing an average of 25 taxa (Table 1). All taxa and their occurrence within associations are given within the Appendix. A total of 485 individuals were measured for their DBH, the majority of these stems were from *Acacia aneura* and secondarily *Eucalyptus coolabah* (Table 2). Litter weights showed a great deal of variability within and across alliances (from 5 to 1488 g/m²). The lowest average weights contained within Alliance 5: Rat's tail Couch – Lovegrass Grasslands and highest within Alliance 8: Poplar Box – Black Box Woodland (Table 3). The highest density of tree hollows per hectare and hollows within logs was found within Alliance 4: Coolibah – Black Box – Yapunyah – Lignum Woodlands (9.5 average with a maximum of 30). The highest average length of logs was within Alliance 1: Mulga Shrublands and the greatest number of overstorey stems within Alliance 8: Poplar Box – Black Box Woodland (Table 3).

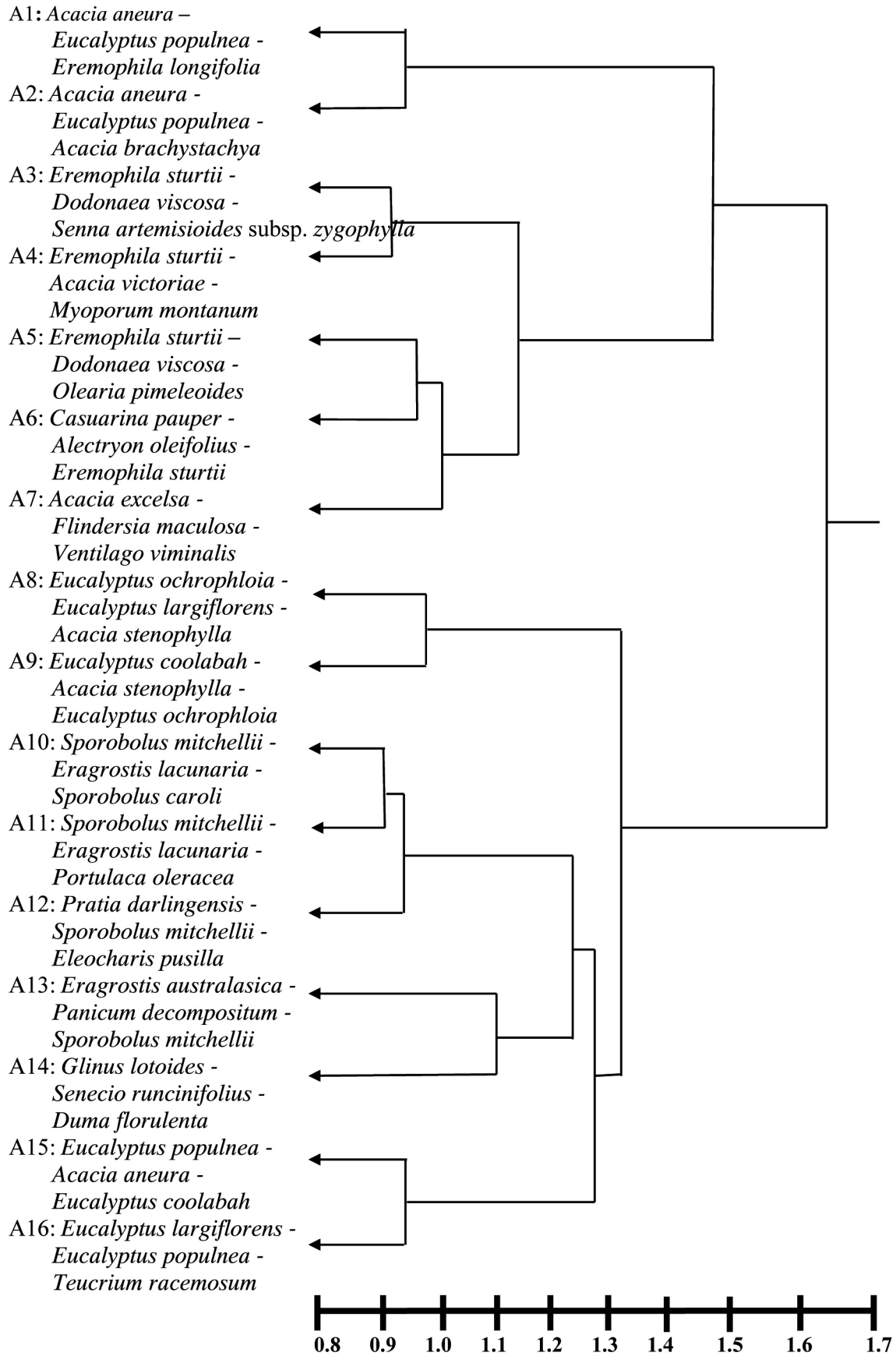


Fig. 3. Summary dendrogram with associations defined at a dissociation of c. 0.9.

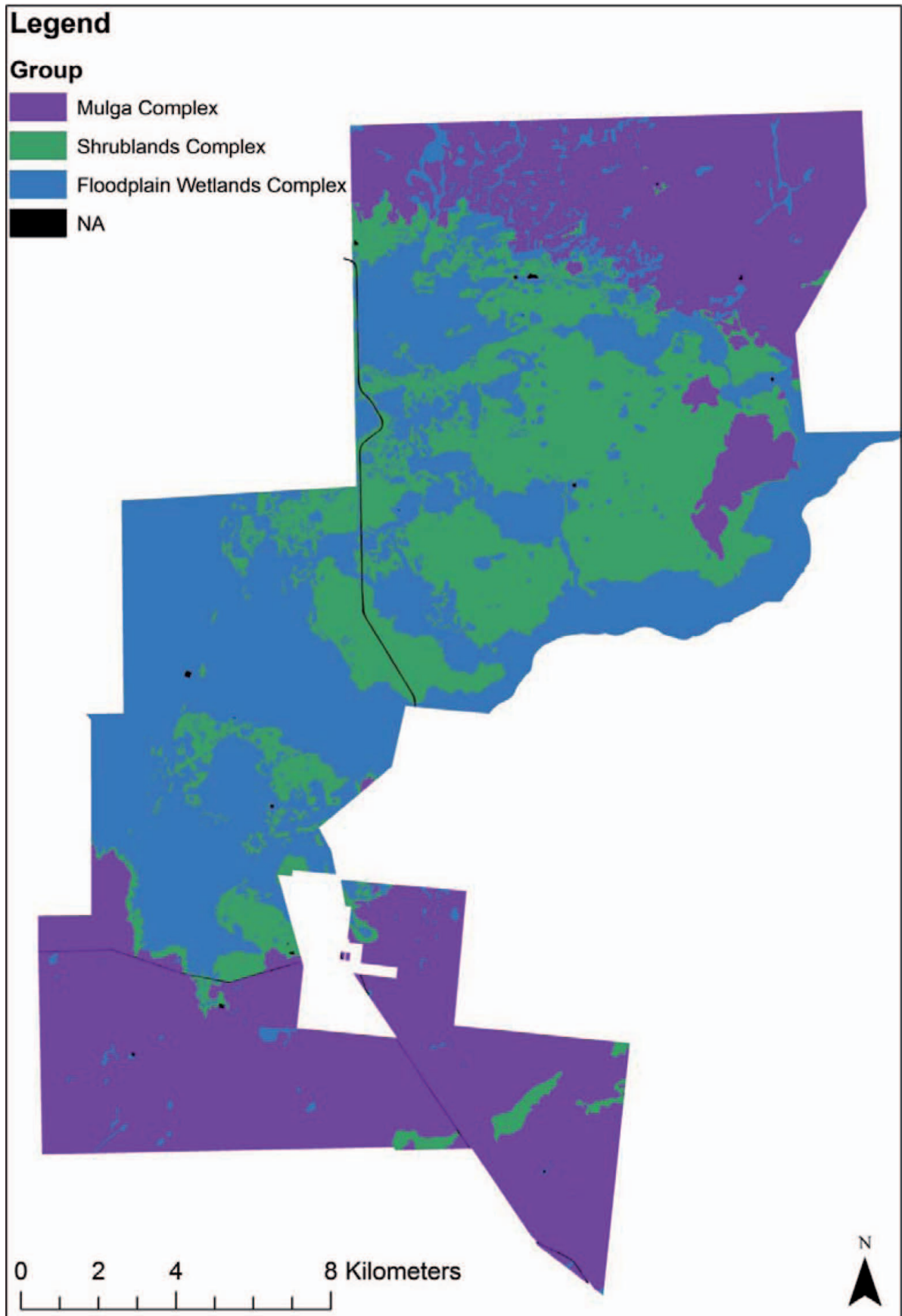


Fig. 4. Mapped distribution of floristic groups within Naree and Yantabulla stations.

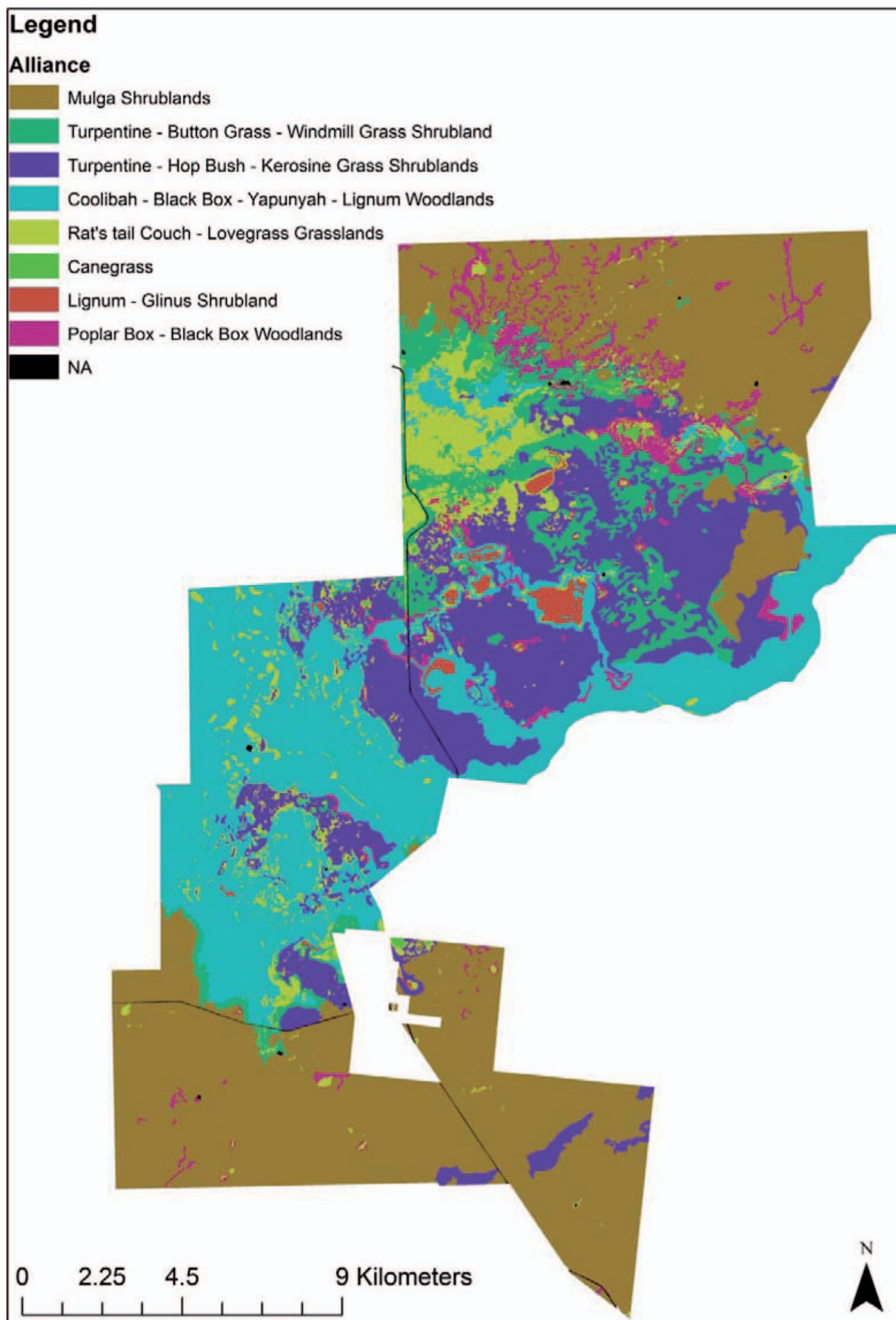


Fig. 5. Mapped floristic alliances within Naree and Yantabulla stations.

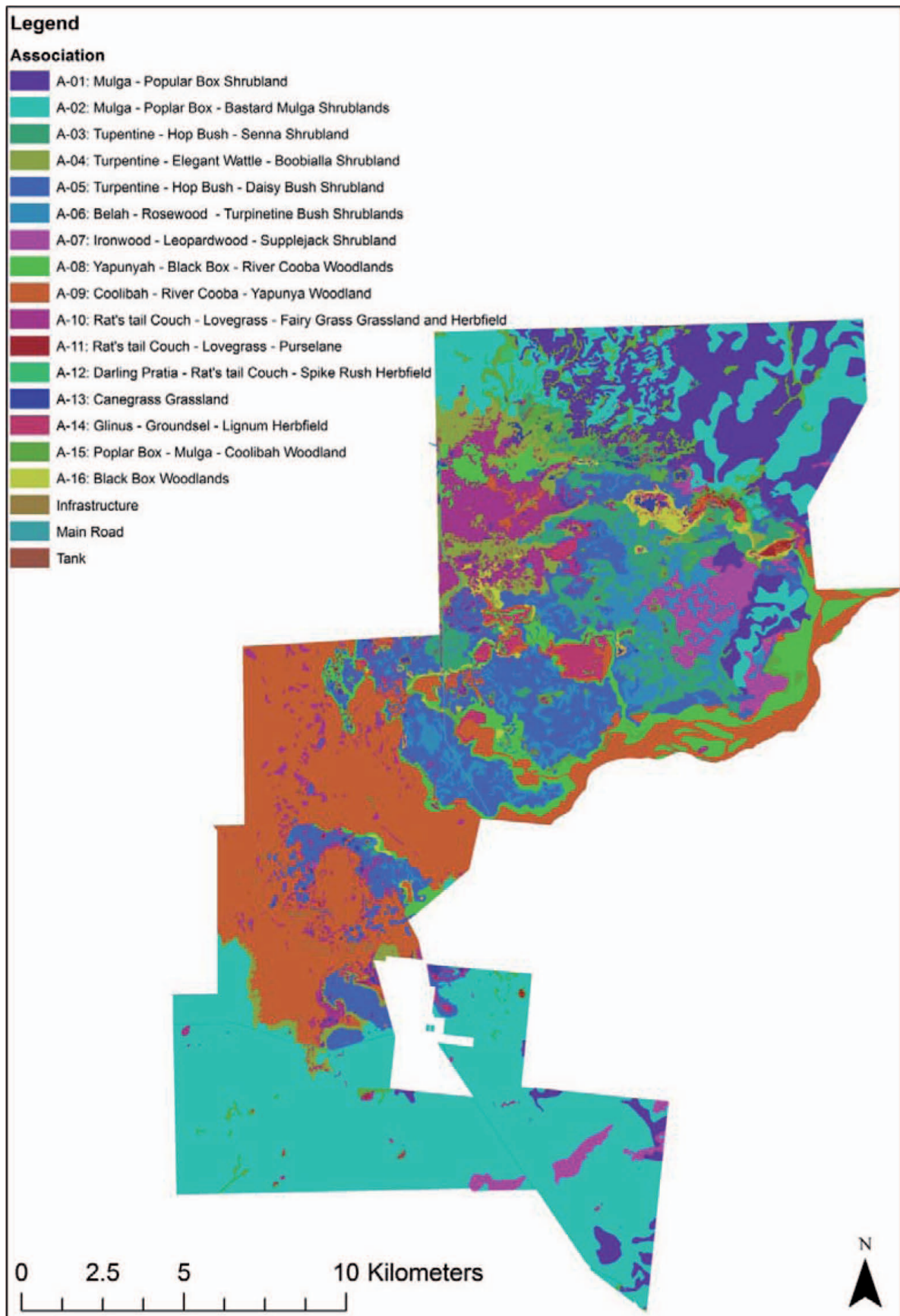


Fig. 6. Mapped floristic associations at Naree and Yantabulla stations.

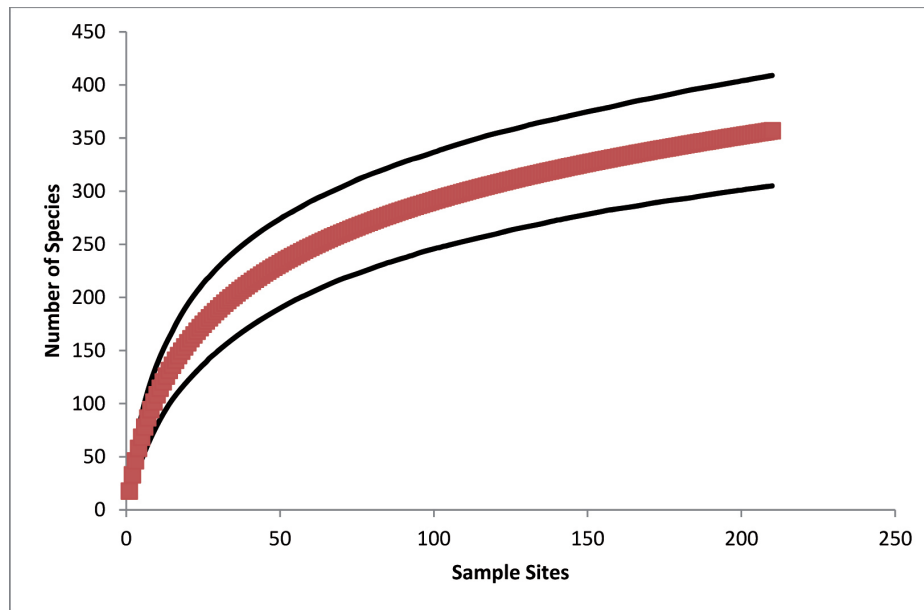


Fig. 7. Coleman rarefaction curves of predicted number of species within *Naree* and *Yantabulla* bounded by 95% confidence limits after 1000 iterations of the dataset. Turnover between sites estimates that the predicted number of species based on differences between full floristic survey sites would be 340 with an upper limit of 410 (95% confidence).

Table 1: Select site attributes of floristic survey plots within hierarchical floristic units.

Type	Full floristic sites	Rapid floristic sites	Total species	Average richness per site (range)	Hectares mapped
Group 1	54	69	180	18 (8-48)	12,450
Alliance 1	54	69	180	18 (8-48)	12,450
Association 1	14	32	132	25 (10-48)	2,908
Association 2	40	37	126	15 (8-28)	9,542
Group 2	46	74	174	16 (7-41)	12,450
Alliance 2	12	33	103	18 (7-41)	2,541
Association 3	6	19	90	30 (24-41)	1,545
Association 4	6	14	27	10 (7-14)	1,071
Alliance 3	34	41	138	15 (8-25)	5,435
Association 5	17	23	93	14 (8-22)	3,143
Association 6	6	8	48	13 (9-20)	1,414
Association 7	11	10	75	17 (11-25)	810
Group 3	103	86	227	15 (1-34)	7,970
Alliance 4	45	37	116	12 (8-21)	7,787
Association 8	22	11	80	13 (8-14)	1,533
Association 9	23	26	92	14 (7-21)	6,248
Alliance 5	33	14	142	17 (7-34)	2,101
Association 10	22	12	113	8 (7-34)	2,005
Association 11	7	1	54	15 (12-25)	57
Association 12	4	1	38	15 (9-21)	39
Alliance 6	2	11	11	6 (1-11)	175
Association 13	2	11	11	6 (1-11)	175
Alliance 7	7	3	32	8 (4-16)	268
Association 14	7	3	32	8 (4-16)	268
Alliance 8	18	21	123	19 (4-19)	1,364
Association 15	13	15	113	22 (6-43)	1,058
Association 16	5	6	113	10 (4-19)	307

Table 2: Diameter measurements in centimetres of the primary stem (>5 cm DBH) of trees within select plots at Naree and Yantabulla Stations.

Species	Average	Minimum	Maximum	Stems
<i>Acacia aneura</i>	15	5	32	212
<i>Acacia brachystachya</i>	15	13	16	3
<i>Acacia excelsa</i>	29	5	52	14
<i>Acacia stenophylla</i>	12	6	23	25
<i>Alectryon oleifolius</i>	34	18	58	9
<i>Atalaya hemiglauca</i>	6	6	6	1
<i>Corymbia tumescens</i>	16	13	21	10
<i>Eremophila bignoniiflora</i>	10	8	16	8
<i>Eremophila longifolia</i>	8	6	9	3
<i>Eucalyptus coolabah</i>	20	5	72	77
<i>Eucalyptus largiflorens</i>	20	5	49	47
<i>Eucalyptus ochrophloia</i>	28	9	56	8
<i>Eucalyptus populnea</i>	17	5	59	44
<i>Grevillea striata</i>	52	8	80	6
<i>Hakea ivoryi</i>	26	8	43	15
<i>Owenia acidula</i>	53	46	60	2
<i>Ventilago viminalis</i>	70	70	70	1

Table 3: Select habitat attributes of permanently marked habitat plots within floristic alliances; average (range).

Alliance	Number of sites	Litter average weight (g/m ²)	% Projected foliage cover	Tree hollows (0.1 ha)	Log length (m/0.1 ha)	Hollows in logs (0.1 ha)	Stems > 5 cm DBH/ha	Shrubs > 1 m height (20 x 20 m)	Shrubs < 1 m height (5 x 5 m)
Alliance 1	16	272 (77-641)	26 (0.2-72)	2.5 (0-9)	75.6 (0-189)	9.0 (0-23)	284 (11-840)	3 (0-8)	20 (8-47)
Alliance 2	5	112 (5-468)	3 (0-18)	0.6 (0-3)	32.0 (0-160)	1.8 (0-9)	4 (0-21)	30 (0-131)	13 (0-65)
Alliance 3	6	162 (41-374)	0	1.7 (0-5)	1.2 (0-4)	0	15 (0-58)	110 (2-377)	7 (0-28)
Alliance 4	8	500 (27-1059)	13 (0-32)	9.5 (0-30)	20.3 (0-88)	10.0 (0-46)	138 (0-320)	44 (2-99)	20 (0-122)
Alliance 5	14	56 (5-142)	6 (0-19)	1.6 (0-14)	11.9 (0-138)	1.8 (0-13)	17 (0-136)	1 (1-8)	2 (0-11)
Alliance 6	2	100 (73-128)	0	0	0	0	0	1	0
Alliance 7	1	239 (239)	0	0	0	0	0	30	0
Alliance 8	3	899 (563-1488)	29 (20-40)	7 (1-18)	23.3 (13-18)	5.3 (3-7)	462 (188-750)	35 (0-102)	5 (0-14)

Vegetation assemblages

Species are listed in decreasing order of fidelity (cover x frequency).

Group 1: Mulga Complex

Alliance 1: Mulga Shrublands

Common Overstorey: *Acacia aneura*, *Eucalyptus populnea*, *Acacia brachystachya*, *Hakea ivoryi*, *Corymbia tumescens*.

Common Mid-storey: *Eremophila longifolia*, *Eremophila gilesii*, *Senna artemisioides* subsp. *zygophylla*, *Senna artemisioides* subsp. *filifolia*, *Eremophila sturtii*, *Dodonaea viscosa*.

Common Understorey: *Eragrostis eriopoda*, *Digitaria brownii*, *Aristida jerichoensis*, *Monachather paradoxus*, *Aristida holathera*, *Fimbristylis dichotoma*, *Solanum cleistogamum*, *Cheilanthes sieberi*, *Panicum effusum*, *Eragrostis laniflora*, *Thyridolepis mitchelliana*.

Association 1: *Acacia aneura* (Mulga) – *Eucalyptus populnea* (Poplar Box) Woodland and Shrubland (Fig. 8).

Environmental relationships: found primarily on red soils on higher topographic positions such as ridges and low plateau areas. Soils can be hard red clay pans and gibber/red clay/red sand landscapes.

Structure: generally a tall shrubland but occasionally a shrubland to low open woodland or layered woodland.

- Tall shrub or low tree layer: (3-) 5-7 (-12) m tall. (5-) 25-35 (-70)% cover.
- Shrub layer: 1-2 (-7) m tall. 10-20 (-60)% cover. Rarely absent.
- Low shrub layer very rarely present.
- Understorey layer: 0.1-0.5 m tall. (10-) 30-35 (-70)% cover.

Trees: *Acacia aneura*, *Eucalyptus populnea*, *Hakea ivoryi*, *Corymbia tumescens*.

Shrubs: *Eremophila longifolia*, *Solanum cleistogamum*, *Senna artemisioides* subsp. *filifolia*, *Solanum parvifolium*, *Thryptomene hexandra*, *Senna artemisioides* subsp. *x coriacea*, *Maireana brevifolia*, *Solanum cinereum*, *Senna artemisioides* subsp. *zygophylla*, *Sclerolaena diacantha*, *Hakea eryeana*, *Eremophila gilesii*.

Climbers & trailers: *Convolvulus clementii*, *Glycine canescens*, *Convolvulus remotus*.

Ground cover: *Fimbristylis dichotoma*, *Cheilanthes sieberi*, *Panicum effusum*, *Digitaria brownii*, *Calotis inermis*, *Calotis hispidula*, *Tripogon loliiformis*, *Aristida jerichoensis*, *Aristida holathera*, *Enneapogon avenaceus*, *Pimelea trichostachya*, *Nicotiana simulans*, *Monachather paradoxus*, *Erodium crinitum*, *Centipeda thespidioides*, *Vittadinia cuneata*, *Goodenia glabra*, *Chenopodium melanocarpum*, *Digitaria divaricatissima*, *Dactyloctenium radulans*, *Eragrostis leptocarpa*, *Digitaria ammophila*, *Chamaesyce drummondii*, *Calandrinia eremaea*, *Wahlenbergia tumidifrutca*, *Thyridolepis mitchelliana*, *Ptilotus gaudichaudii*, *Omphalolappula concava*, *Eragrostis setifolia*, *Enneapogon nigricans*, *Calotis lappulacea*, *Velleia arguta*, *Trachymene ochracea*, *Sida trichopoda*, *Sida fibulifera*, *Ptilotus polystachyus*, *Portulaca oleracea*, *Paspalidium constrictum*, *Oxalis perennans*, *Goodenia cycloptera*, *Dysphania rhadinostachya*, *Digitaria hystrichoides*, *Aristida leptopoda*, *Triraphis mollis*, *Swainsona affinis*, *Solanum esuriale*, *Solanum ellipticum*, *Solanum coactiliferum*, *Sclerolaena convexula*, *Ptilotus leucocoma*, *Plantago turrifera*, *Hibiscus sturtii*, *Eragrostis lacunaria*, *Enneapogon intermedius*, *Chloris truncata*, *Centipeda crateriformis*, *Tragus australianus*, *Trachymene glaucifolia*, *Themeda triandra*, *Stuartina muelleri*, *Streptoglossa liatroides*, *Pycnosorus thompsonianus*, *Perotus rara*, *Panicum simile*, *Marsilea drummondii*, *Evolvulus alsinoides*, *Eragrostis parviflora*, *Eragrostis leptostachya*, *Eragrostis eriopoda*, *Enteropogon acicularis*, *Einadia trigonos*, *Dianella porracea*, *Crassula sieberiana*, *Aristida latifolia*, *Aristida contorta*, *Aristida calycina*, *Abutilon oxycarpum*.

Introduced taxa: *Malvastrum americanum*, *Cenchrus ciliaris*, *Ammi majus*.

Association 2: *Acacia aneura* (Mulga) - *Eucalyptus populnea* (Poplar Box) – *Acacia brachystachya* (Bastard or Umbrella Mulga) Woodland and Shrubland (Fig. 9).

Environmental relationships: found primarily of red soils on higher topographic positions such as ridges and low plateau areas. Soils can be hard red clay pans and gibber/red clay/red sand landscapes.

Structure: usually a tall shrubland but often a shrubland and low open woodland or layered woodland.

- Tall shrub or low tree-layer: 4-7 (-14) m tall. (2-) 20-30 (-80)% cover.
- Shrub layer: 1.5-2.5 (-9.5) m tall. (2-) 15-25 (-50)% cover. Rarely absent.
- Low shrub-layer rarely present.
- Understorey layer: 0.1-1 m tall. (5-) 30-35 (-70)% cover.

Trees: *Acacia aneura*, *Eucalyptus populnea*, *Acacia brachystachya*, *Hakea ivoryi*, *Corymbia tumescens*, *Grevillea striata*, *Callitris glaucophylla*, *Acacia ramulosa*, *Eucalyptus melanophloia*, *Acacia excelsa*.

Shrubs: *Solanum cleistogamum*, *Eremophila longifolia*, *Eremophila gilesii*, *Senna artemisioides* subsp. *zygophylla*, *Maireana villosa*, *Dodonaea viscosa*, *Eremophila sturtii*, *Senna artemisioides* subsp. *filifolia*, *Sclerolaena convexula*, *Thryptomene hexandra*, *Sclerolaena diacantha*, *Sclerolaena birchii*, *Solanum ferocissimum*, *Solanum ellipticum*, *Eremophila bowmanii*, *Solanum parvifolium*, *Eremophila latrobei*.

Climbers & trailers: *Convolvulus remotus*.

Ground cover: *Eragrostis eriopoda*, *Aristida jerichoensis*, *Digitaria brownii*, *Monachather paradoxus*, *Aristida holathera*, *Eragrostis parviflora*, *Panicum effusum*, *Fimbristylis dichotoma*, *Hibiscus sturtii*, *Eriachne helmsii*, *Cheilanthes sieberi*, *Thyridolepis mitchelliana*, *Digitaria divaricatissima*, *Calotis cuneifolia*, *Enneapogon avenaceus*, *Triraphis mollis*, *Dactyloctenium radulans*, *Tripogon loliiformis*, *Ptilotus gaudichaudii*, *Omphalolappula concava*, *Sida trichopoda*, *Perotus rara*, *Panicum simile*, *Tragus australianus*, *Dysphania rhadinostachya*, *Calotis lappulacea*, *Thyridolepis xerophila*, *Pimelea trichostachya*, *Sporobolus actinocladus*, *Sida filiformis*, *Paspalidium constrictum*, *Goodenia cycloptera*, *Chamaesyce drummondii*, *Centipeda thespidioides*, *Amphipogon caricinus*, *Velleia arguta*, *Leptorhynchos baileyi*, *Enneapogon cylindricus*, *Aristida contorta*, *Sida platycalyx*, *Sida cunninghamii*, *Ptilotus polystachyus*, *Ptilotus leucocoma*, *Mollugo cerviana*, *Gypsophyla tubulosa*, *Eriachne mucronata*, *Eragrostis lacunaria*, *Eragrostis kennedyae*, *Enteropogon acicularis*, *Cymbopogon ambiguus*, *Boerhavia coccinea*, *Aristida nitidula*, *Aristida blakei*.

Introduced taxa: *Sisymbrium erysimoides*, *Ammi majus*, *Eragrostis cilianensis*.



Fig. 8. Group 1: Mulga Complex; Alliance 1: Mulga Shrublands; Association 1: *Acacia aneura* – *Eucalyptus populnea* Woodland and Shrubland.



Fig. 9. Group 1: Mulga Complex; Alliance 1: Mulga Shrublands; Association 1: *Acacia aneura* – *Eucalyptus populnea* – *Acacia brachystachya* Woodland and Shrubland.

Group 2: Shrubland Complex

Common Overstorey: *Acacia excelsa*, *Alectryon oleifolius*, *Casuarina pauper*, *Ventilago viminalis*, *Flindersia maculosa*.

Common Mid-storey: *Eremophila sturtii*, *Dodonaea viscosa*, *Senna artemisioides* subsp. *zygophylla*, *Olearia pimeleoides*, *Eremophila deserti*, *Acacia victoriae*.

Common Understorey: *Aristida holathera*, *Enteropogon acicularis*, *Enneapogon avenaceus*, *Eragrostis eriopoda*, *Dissocarpus paradoxus*, *Sclerolaena diacantha*, *Enchylaena tomentosa*, *Dactyloctenium radulans*, *Eragrostis laniflora*.

Within this complex, structure varies considerably from open to dense shrublands or open shrubby woodlands. The assemblages within this Group are generally distinguished by their often dense cover of encroaching native woody species (locally known as ‘Woody Weeds’), particularly of *Eremophila* spp., *Dodonaea* spp. and *Senna* spp.. In some instances, the remnants of original tropical woodlands remain but it is also likely that dense shrublands of these types were also present in some form prior to agricultural intervention.

Alliance 2: Turpentine – Button Grass – Windmill Grass Shrubland

Common Overstorey: *Acacia excelsa*, *Casuarina pauper*, *Alectryon oleifolius*. (Overstorey rarely present).

Common Mid-storey: *Eremophila sturtii*, *Dodonaea viscosa*, *Senna artemisioides* subsp. *zygophylla*, *Olearia pimeleoides*, *Dodonaea viscosa*, *Myoporum montanum*, *Acacia victoriae*.

Common Understorey: *Dactyloctenium radulans*, *Enteropogon acicularis*, *Portulaca oleracea*, *Abutilon otocarpum*, *Chenopodium cristatum*, *Eragrostis setifolia*, *Enneapogon avenaceus*, *Enchylaena tomentosa*, *Tragus australianus*, *Sclerolaena diacantha*, *Aristida jerichoensis*.

Generally, found on lower physiographic positions often associated with wetland, playa-lake and swamp margins. Soils can be sandy to clayey red brown earths but often with higher clay content. This sub-assemblage also occurs in areas of wind and water erosion where alternating patches

of red dune sand occur with flats of calcium carbonate near the surface.

Association 3: *Eremophila sturtii* (Turpentine Bush) – *Dodonaea viscosa* (Hop Bush) Shrubland (Fig. 10).

Environmental relationships: found associated with minor dunes around playa lakes and wetland systems.

Structure: a low shrubby woodland or shrubland to open grassy shrubland.

- Tall shrub-layer: (1-) 3-6 m (-8) tall. (5-) 20-30 (-70) % cover.
- Shrub layer: 1-3 (-5) m tall. (15-) 30-40 (-70)% cover.
- Low shrub layer rarely present.
- Understorey layer: 0.1-0.5 (-0.8) m tall. (10-) 20-30 (-60)% cover.

Trees: *Acacia excelsa*, *Casuarina pauper*, *Alectryon oleifolius*.

Shrubs: *Eremophila sturtii*, *Dodonaea viscosa*, *Senna artemisioides* subsp. *zygophylla*, *Olearia pimeleoides*, *Dissocarpus paradoxus*, *Solanum coactiliferum*, *Sclerolaena lanicuspis*, *Sclerolaena bicornis*, *Senna artemisioides* subsp. *x sturtii*, *Sclerolaena muricata*, *Sclerolaena convexula*, *Myoporum montanum*, *Chenopodium desertorum*, *Atriplex limbata*, *Senna artemisioides* subsp. *filifolia*, *Pimelea microcephala*, *Maireana triptera*, *Maireana brevifolia*.

Climbers & trailers: *Jasminum lineare*.

Ground cover: *Enteropogon acicularis*, *Dactyloctenium radulans*, *Portulaca oleracea*, *Chenopodium cristatum*, *Abutilon otocarpum*, *Eragrostis setifolia*, *Enneapogon avenaceus*, *Enchylaena tomentosa*, *Tragus australianus*, *Aristida jerichoensis*, *Aristida holathera*, *Trianthema triquetra*, *Digitaria brownii*, *Wahlenbergia tumidifruca*, *Triraphis mollis*, *Sida filiformis*, *Sida fibulifera*, *Eragrostis microcarpa*, *Calandrinia eremaea*, *Perotus rara*, *Paspalidium constrictum*, *Monachather paradoxus*, *Eragrostis parviflora*, *Cheilanthes sieberi*, *Chamaesyce drummondii*, *Boerhavia coccinea*, *Zygophyllum iodocarpum*, *Sida trichopoda*, *Ptilotus polystachyus*, *Pimelea trichostachya*, *Omphalolappula concava*, *Hibiscus sturtii*, *Goodenia glabra*, *Brachyscome ciliaris*.

Introduced taxa: *Eragrostis cilianensis*, *Tribulus terrestris*, *Cucumis myriocarpus*, *Cenchrus ciliaris*.

Association 4: *Eremophila sturtii* (Turpentine Bush) – *Acacia victoriae* (Elegant Wattle) Shrubland (Fig. 11).

Environmental relationships: strongly associated with lower dunal positions surrounding playa lakes and wetland areas. Usually with less sandy material and higher clay and calcium carbonate content within the soil profile than Alliance 3.

Structure: shrubland and often a very open shrubland to herbaceous or grassy shrubland, sometimes with very little above ground biomass at all.

- Shrub-layer: (1-) 2-5 m tall. 5-25 (-80)% cover.
- Understorey layer: 0.1-0.5 (-1) m tall. (1-) 20-30 (-70)% cover.

Trees: none apparent.

Shrubs: *Eremophila sturtii*, *Sclerolaena birchii*, *Atriplex pseudocampanulata*, *Atriplex eardleyae*, *Acacia victoriae*, *Myoporum montanum*, *Maireana villosa*, *Eremophila deserti*, *Dodonaea viscosa*, *Atriplex stipitata*.

Climbers & trailers: none apparent.

Ground cover: *Dactyloctenium radulans*, *Eragrostis dielsii*, *Eleocharis pusilla*, *Cyperus difformis*, *Cynodon dactylon*, *Echinochloa turneriana*, *Marsilea costulifera*, *Fimbristylis dichotoma*, *Abutilon otocarpum*, *Sporobolus mitchellii*, *Sida intricate*, *Sida goniocarpa*, *Eragrostis parvifolia*, *Enteropogon acicularis*, *Einadia nutans*.

Introduced taxa: *Eragrostis cilianensis*.

Alliance 3: Turpentine – Hop Bush – Kerosene Grass Shrubland

Common Overstorey: *Acacia excelsa*, *Alectryon oleifolius*, *Casuarina pauper*, *Ventilago viminalis*, *Flindersia maculosa*, *Acacia aneura*.

Common Mid-storey: *Eremophila sturtii*, *Dodonaea viscosa*, *Eremophila deserti*, *Olearia pimeleoides*, *Senna artemisioides* subsp. *zygophylla*, *Acacia victoriae*, *Acacia tetragonophylla*, *Eremophila glabra*.

Common Understorey: *Aristida holathera*, *Enteropogon acicularis*, *Eragrostis eriopoda*, *Enneapogon avenaceus*, *Dissocarpus paradoxus*, *Eragrostis laniflora*, *Sclerolaena convexula*, *Sclerolaena diacantha*, *Monachather paradoxus*.

Layered shrublands found on sandier soils on higher physiographic positions than the Alliance 2. Though often includes areas of internal drainage where clays are deposited above sandier soils.

Association 5: *Eremophila sturtii* (Turpentine Bush) – *Dodonaea viscosa* (Hop Bush) Shrubland (Fig. 12).

Environmental relationships: similar to Community 2 but generally on higher physiographic positions.

Structure: usually a shrubland to open shrubland.

- Tall shrub layer: (2-) 4-6.5 (-12) m tall. (5-) 15-25 (-70)% cover.
- Shrub layer: 1-3 (-5) m tall. (5-) 30-40 (-50)% cover. Rarely absent.
- Low shrub layer rare.
- Ground layer: 0.1-0.4 m (1) tall. (2) 15-20 (50)% cover.

Trees: *Alectryon oleifolius*, *Atalaya hemiglauca*, *Ventilago viminalis*, *Eucalyptus coolabah*, *Casuarina pauper*, *Acacia aneura*.

Shrubs: *Eremophila sturtii*, *Dodonaea viscosa*, *Olearia pimeleoides*, *Dissocarpus paradoxus*, *Eremophila deserti*,

Acacia victoriae, *Acacia tetragonophylla*, *Sclerolaena diacantha*, *Sclerolaena decurrens*, *Sclerolaena convexula*, *Senna artemisioides* subsp. *zygophylla*, *Sclerolaena birchii*, *Chenopodium desertorum*, *Atriplex turbinata*, *Sclerolaena tricuspis*, *Sclerolaena lanicuspis*, *Myoporum montanum*, *Eremophila mitchellii*, *Eremophila longifolia*, *Enchylaena tomentosa*, *Atriplex eardleyae*, *Salsola australis*, *Pimelea microcephala*, *Maireana villosa*, *Hakea tephrosperma*, *Hakea leucoptera*, *Eremophila glabra*, *Atriplex nessorhina*.

Climbers & trailers: none apparent.

Ground cover: *Aristida holathera*, *Enteropogon acicularis*, *Enneapogon avenaceus*, *Eragrostis laniflora*, *Eragrostis parviflora*, *Eragrostis eriopoda*, *Fimbristylis dichotoma*, *Eragrostis lacunaria*, *Tripogon loliiformis*, *Sida trichopoda*, *Sida filiformis*, *Cymbopogon ambiguus*, *Triraphis mollis*, *Panicum simile*, *Evolvulus alsinoides*, *Eragrostis basedowii*, *Enneapogon cylindricus*, *Digitaria brownii*, *Vittadinia dissecta*, *Trianthema triquetra*, *Solanum esuriale*, *Sida ammophila*, *Einadia nutans*, *Digitaria hystrichoides*, *Dactyloctenium radulans*.

Introduced taxa: *Eragrostis cilianensis*, *Cenchrus ciliaris*.

Association 6: *Casuarina pauper* (Black Oak) – *Alectryon oleifolius* (Rosewood) Shrubland (Fig. 13).

Environmental relationships: found within internal drainage locations on red and red brown earths and dunal areas.

Structure: generally an open layered woodland to layered shrubland. The herbaceous understorey is generally very sparse within *Casuarina pauper* dominated areas.

- Tall shrub layer: (3-) 6-10 (-15) m tall. (10-) 20-30 (-50)% cover.
- Shrub layer: 1-3 m tall. (10-) 30-35 (-70)% cover.
- Understorey layer: 0.1-0.4 m tall. (5-) 10-15 (-30)% cover.

Trees: *Casuarina pauper*, *Alectryon oleifolius*, *Eucalyptus populnea*, *Acacia excelsa*, *Flindersia maculosa*, *Acacia aneura*.

Shrubs: *Eremophila sturtii*, *Dodonaea viscosa*, *Dissocarpus paradoxus*, *Sclerolaena diacantha*, *Salsola australis*, *Eremophila deserti*, *Sclerolaena tricuspis*, *Eremophila mitchellii*, *Enchylaena tomentosa*, *Atriplex stipitata*, *Pimelea microcephala*, *Myoporum montanum*, *Eremophila glabra*, *Chenopodium desertorum*, *Atriplex limbata*, *Senna artemisioides* subsp. *zygophylla*, *Sclerolaena birchii*, *Santalum acuminatum*, *Olearia pimeleoides*, *Capparis mitchellii*.

Climbers & trailers: none apparent.

Ground cover: *Enteropogon acicularis*, *Paspalidium constrictum*, *Eragrostis lacunaria*, *Boerhavia coccinea*, *Sida filiformis*, *Chenopodium cristatum*, *Abutilon otocarpum*, *Solanum cleistogamum*, *Sida cunninghamii*, *Eragrostis parviflora*, *Enneapogon avenaceus*, *Einadia nutans*, *Einadia hastata*, *Chenopodium melanocarpum*, *Centipeda*

thespidioides, *Atriplex eardleyae*, *Aristida jerichoensis*, *Aristida holathera*.

Introduced taxa: *Eragrostis cilianensis*, *Lycium ferocissimum*, *Cenchrus ciliaris*.

Association 7: *Acacia excelsa* (Ironwood) – *Flindersia maculosa* (Leopardwood) – *Ventilago viminalis* (Supplejack) Shrubland (Fig. 14).

Environmental relationships: commonly found within internal drainage or sub-soil water accumulation areas on deeper sands and larger dunes.

Structure: generally a layered low open woodland or tall open shrubland.

- Tall shrub layer: (4-) 5-9 (-12) m tall. (5-) 10-15 (-30)% cover.
- Shrub layer: 1-3 (-4) m tall. (5-) 35-40 (-65)% cover. Rarely absent.
- Low shrub layer rarely present.
- Understorey layer: 0.1-0.5 (-1) m tall. (10-) 25-30 (-65)% cover.

Trees: *Acacia excelsa*, *Flindersia maculosa*, *Ventilago viminalis*, *Callitris glaucophylla*, *Acacia aneura*, *Grevillea striata*, *Corymbia tumescens*, *Acacia brachystachya*, *Hakea ivoryi*.

Shrubs: *Eremophila sturtii*, *Senna artemisioides* subsp. *zygophylla*, *Sclerolaena convexula*, *Eremophila deserti*, *Enchylaena tomentosa*, *Dodonaea viscosa*, *Senna artemisioides* subsp. *filifolia*, *Olearia pimeleoides*, *Chenopodium desertorum*, *Sclerolaena muricata*, *Eremophila glabra*, *Dodonaea boroniifolia*, *Eremophila longifolia*, *Dissocarpus paradoxus*, *Alstonia constricta*.

Climbers & trailers: none apparent.

Ground cover: *Aristida holathera*, *Eragrostis eriopoda*, *Monachather paradoxus*, *Aristida jerichoensis*, *Eragrostis laniflora*, *Enteropogon acicularis*, *Enneapogon avenaceus*, *Abutilon otocarpum*, *Solanum cleistogamum*, *Ptilotus leucocoma*, *Evolvulus alsinoides*, *Eriachne aristidea*, *Chamaesyce drummondii*, *Boerhavia coccinea*, *Tragus australianus*, *Sida filiformis*, *Ptilotus polystachyus*, *Hibiscus sturtii*, *Eragrostis parviflora*, *Digitaria brownii*, *Calotis lappulacea*, *Calocephalus sonderi*, *Velleia arguta*, *Thyridolepis mitchelliana*, *Sida platycalyx*, *Panicum simile*, *Eragrostis kennedyae*, *Digitaria divaricatissima*, *Cheilanthes sieberi*, *Calotis cuneifolia*, *Brachyscome ciliaris*, *Aristida contorta*, *Solanum ferocissimum*, *Solanum esuriale*, *Sida trichopoda*, *Ptilotus sessilifolius*, *Pimelea trichostachya*, *Perotus rara*, *Panicum effusum*, *Gnephosis arachnoidea*, *Fimbristylis dichotoma*, *Enneapogon polyphyllus*, *Calotis erinacea*, *Bulbine alata*, *Aristida leptopoda*.

Introduced taxa: *Cenchrus ciliaris*.



Fig. 10. Group 2: Shrubland Complex; Alliance 2: Turpentine – Button Grass – Windmill Grass Shrubland; Association 3: *Eremophila sturtii* – *Dodonaea viscosa* Shrubland.



Fig. 11. Group 2: Shrubland Complex; Alliance 2: Turpentine – Button Grass – Windmill Grass Shrubland; Association 4: *Eremophila sturtii* – *Acacia victoriae* Shrubland.



Fig. 12. Group 2: Shrubland Complex; Alliance 3: Turpentine – Hop Bush – Kerosine Grass Shrubland; Association 5: *Eremophila sturtii* – *Dodonaea viscosa* Shrubland.



Fig. 13. Group 2: Shrubland Complex; Alliance 3: Turpentine – Hop Bush – Kerosine Grass Shrubland; Association 6: *Casuarina pauper* – *Alectryon oleifolius* Shrubland.



Fig. 14. Group 2: Shrubland Complex; Alliance 3: Turpentine – Hop Bush – Kerosine Grass Shrubland; Association 7: *Acacia excelsa* – *Flindersia maculosa* – *Ventilago viminalis* Shrubland.

Group 3: Floodplain Wetlands Complex

Common Overstorey: *Eucalyptus coolabah*, *Acacia stenophylla*, *Eucalyptus largiflorens*, *Eucalyptus ochrophloia*, *Eucalyptus populnea*.

Common Mid-storey: *Duma florulenta*, *Sclerolaena birchii*, *Teucrium racemosum*, *Myoporum montanum*, *Sclerolaena muricata*, *Acacia victoriae*, *Eremophila bignoniiflora*.

Common Understorey: *Sporobolus mitchellii*, *Eragrostis lacunaria*, *Paspalidium jubiflorum*, *Portulaca oleracea*, *Alternanthera nodiflora*, *Sporobolus caroli*, *Centipeda thespidioides*, *Solanum esuriale*, *Marsilea drummondii*, *Eleocharis pusilla*, *Glinus lotoides*, *Trianthema triquetra*, *Eragrostis dielsii*, *Dactyloctenium radulans*, *Chamaesyce drummondii*, *Atriplex eardleyae*, *Pterocaulon sphacelatum*, *Sporobolus actinocladus*, *Chenopodium melanocarpum*, *Cyperus gilesii*, *Atriplex angulata*, *Sida goniocarpa*, *Eragrostis australasica*.

Alliance 4: Coolibah – Black Box – Yapunyah – Lignum Woodlands

Common Overstorey: *Eucalyptus coolabah*, *Acacia stenophylla*, *Eucalyptus ochrophloia*, *Eucalyptus largiflorens*.

Common Mid-storey: *Duma florulenta*, *Sclerolaena birchii*, *Sclerolaena muricata*, *Myoporum montanum*, *Teucrium racemosum*, *Acacia victoriae*, *Eremophila bignoniiflora*, *Atriplex eardleyae*, *Atriplex angulata*, *Atriplex limbata*.

Common Understorey: *Sporobolus mitchellii*, *Eragrostis lacunaria*, *Paspalidium jubiflorum*, *Portulaca oleracea*, *Alternanthera nodiflora*, *Sporobolus caroli*, *Centipeda thespidioides*, *Marsilea drummondii*, *Eleocharis pusilla*, *Trianthema triquetra*, *Eragrostis dielsii*, *Dactyloctenium radulans*, *Chamaesyce drummondii*, *Solanum esuriale*, *Cyperus gilesii*.

Association 8: *Eucalyptus ochrophloia* (Yapunyah) – *Eucalyptus largiflorens* (Black Box) – *Acacia stenophylla* (River Cooba) Woodland and Forest (Fig. 15).

Environmental relationships: restricted primarily to frequently inundated locations, particularly along the margins of open floodplains and along ephemeral watercourses. The density of the overstorey tree layer is highly variable and this may not be distinct.

Structure: open shrubland to low open woodland or open woodland.

- Tree layer: (3-) 5-9 (-16) m tall. (5-) 20-25 (-45)% cover. Not always present.
- Shrub layer: (0.5-) 1-2.5 (-4) m tall. (2-) 10-15 (-30)% cover.
- Understorey layer: 0.1-0.2 (-1.5) m tall. (5-) 30-35 (-80)% cover.

Trees: *Eucalyptus ochrophloia*, *Eucalyptus largiflorens*, *Acacia stenophylla*, *Hakea tephrosperma*, *Eucalyptus coolabah*, *Acacia excelsa*.

Shrubs: *Duma florulenta*, *Sclerolaena birchii*, *Myoporum montanum*, *Eremophila bignoniiflora*, *Teucrium racemosum*, *Sclerolaena muricata*, *Atriplex eardleyae*, *Chenopodium auricomum*, *Acacia victoriae*, *Eremophila deserti*, *Hakea leucoptera*, *Sclerolaena decurrens*, *Eremophila glabra*, *Enchylaena tomentosa*, *Senna artemisioides* subsp. *zygophylla*, *Sclerolaena muricata*, *Eremophila sturtii*, *Atriplex leptocarpa*.

Climbers & trailers: none apparent.

Ground cover: *Sporobolus mitchellii*, *Paspalidium jubiflorum*, *Eragrostis lacunaria*, *Portulaca oleraceus*, *Marsilea drummondii*, *Centipeda thespidioides*, *Eleocharis pusilla*, *Sporobolus caroli*, *Cyperus gilesii*, *Alternanthera nodiflora*, *Solanum esuriale*, *Panicum laevinode*, *Juncus aridicola*, *Trianthema triquetra*, *Pterocaulon sphacelatum*, *Dactyloctenium radulans*, *Chamaesyce drummondii*, *Amaranthus macrocarpus*, *Enteropogon acicularis*, *Boerhavia repleta*, *Vittadinia sulcata*, *Solanum lacunarium*, *Sida goniocarpa*, *Sida filiformis*, *Pluchea tetranthera*, *Cynodon dactylon*, *Vittadinia pterochaeta*, *Streptoglossa adscendens*, *Pluchea dentex*, *Marsilea costulifera*, *Ludwigia peploides*, *Frankenia uncinata*, *Eriochloa australiensis*, *Eleocharis plana*, *Cyperus bifax*, *Centipeda minima*, *Brachyscome ciliaris*, *Alternanthera denticulata*, *Abutilon*

otocarpum, *Tephrosia sphaerospora*, *Sida trichopoda*, *Sauropus trachyspermus*, *Phyllanthus virgatus*, *Leiocarpa semicalva*, *Hibiscus trionum*, *Haloragis glauca*, *Eragrostis australasica*, *Chamaesyce dallachyana*, *Brachyscome melanocarpa*, *Boerhavia coccinea*, *Aristida holathera*.

Introduced taxa: *Eragrostis cilianensis*, *Medicago truncatula*, *Medicago polymorpha*, *Malvastrum americanum*.

Association 9: *Eucalyptus coolabah* (Coolibah) – *Acacia stenophylla* (River Cooba) – *Eucalyptus ochrophloia* (Yapunyah) Woodland and Forest (Fig. 16).

Environmental relationships: commonly found in frequently inundated locations, particularly along the Cuttaburra Creek and within Yantabulla Swamp. Found in locations with more prolonged waterlogging than Association 8.

Structure: generally a woodland, layered shrubby woodland, tall layered shrubland or open to closed shrubland.

- Tree or tall shrub-layer: 4-7 (-12) m tall. (5-) 25-30 (-50)% cover.
- Shrub layer: (0.5-) 1.5-3 (-5) m tall. (5-) 25-30 (-70)% cover.
- Low shrub layer: 1-2.5 (-3) m tall. (25-) 40-45 (-70)% cover. Rarely present.
- Understorey layer: 0.1-0.7 (-2) m tall. (5-) 25-35 (-70)% cover.

Trees: *Eucalyptus coolabah*, *Acacia stenophylla*, *Eucalyptus ochrophloia*, *Atalaya hemiglaucula*, *Eucalyptus largiflorens*.

Shrubs: *Duma florulenta*, *Sclerolaena muricata*, *Eremophila bignoniiflora*, *Sclerolaena birchii*, *Myoporum montanum*, *Atriplex eardleyae*, *Sclerolaena decurrens*, *Atriplex leptocarpa*, *Teucrium racemosum*, *Eremophila gilesii*, *Atriplex elachophylla*, *Hakea tephrosperma*, *Atriplex suberecta*, *Atriplex stipitata*, *Atriplex limbata*, *Atriplex angulata*, *Maireana brevifolia*, *Eremophila deserti*.

Climbers & trailers: none apparent.

Ground cover: *Sporobolus mitchellii*, *Paspalidium jubiflorum*, *Alternanthera nodiflora*, *Cyperus gilesii*, *Ammannia multiflora*, *Eragrostis lacunaria*, *Chamaesyce drummondii*, *Portulaca oleracea*, *Eleocharis pusilla*, *Centipeda thespidioides*, *Sporobolus caroli*, *Marsilea drummondii*, *Glinus lotoides*, *Pluchea dentex*, *Eragrostis australasica*, *Echinochloa inundata*, *Centipeda cunninghamii*, *Trianthema triquetra*, *Juncus aridicola*, *Hibiscus trionum*, *Haloragis glauca*, *Cyperus squarrosus*, *Centipeda crateriformis*, *Streptoglossa adscendens*, *Sporobolus actinocladus*, *Solanum esuriale*, *Pseudognaphalium luteoalbum*, *Eragrostis dielsii*, *Enteropogon acicularis*, *Eleocharis acuta*, *Einadia nutans*, *Cyperus iria*, *Vittadinia pterochaeta*, *Sida goniocarpa*, *Senecio magnificus*, *Pterocaulon sphacelatum*, *Phyllanthus lacunarius*, *Persicaria lapathifolia*, *Panicum laevinode*, *Epaltes australis*, *Dactyloctenium radulans*, *Cyperus difformis*, *Chenopodium melanocarpum*, *Centipeda minima*, *Boerhavia repleta*, *Amaranthus macrocarpus*, *Abutilon*

leucopetalum, *Stemodia glabella*, *Solanum lacunarium*, *Solanum cleistogamum*, *Pluchea tetranthera*, *Ludwigia peploides*, *Goodenia glauca*, *Echinochloa turneriana*, *Cyperus bifax*, *Cynodon dactylon*, *Cullen cinereum*, *Alternanthera denticulata*, *Abutilon otocarpum*.

Introduced taxa: *Sisymbrium erysimoides*, *Malvastrum americanum*, *Heliotropium supinum*, *Cenchrus ciliaris*, *Potentilla supina*, *Medicago polymorpha*, *Eragrostis cilianensis*, *Citrullus lanatus*.

Alliance 5: Rat's-tail Couch – Lovegrass Grasslands

Common Overstorey: *Eucalyptus coolabah*.

Common Mid-storey: *Sclerolaena birchii*, *Teucrium racemosum*, *Acacia victoriae*, *Myoporum montanum*, *Duma florulenta*.

Common Understorey: *Sporobolus mitchellii*, *Eragrostis lacunaria*, *Portulaca oleracea*, *Eragrostis dielsii*, *Trianthema triquetra*, *Centipeda thespidioides*, *Alternanthera nodiflora*, *Dactyloctenium radulans*, *Atriplex angulata*, *Eleocharis pusilla*, *Chenopodium melanocarpum*, *Pratia darlingensis*, *Solanum esuriale*, *Sida goniocarpa*, *Marsilea drummondii*, *Atriplex limbata*, *Sclerolaena decurrens*, *Glinus lotoides*, *Chenopodium cristatum*, *Alternanthera denticulata*, *Paspalidium jubiflorum*.

Association 10: *Sporobolus mitchellii* (Rat's-tail Couch) – *Eragrostis lacunaria* (Purple Lovegrass) – *Sporobolus caroli* (Fairy Grass) Grassland and Herbfeld (Fig. 17).

Environmental Relationships: found in areas where water ponding occurs but on lighter textured soils than Association 8 and 9.

Distribution within Naree and Yantabulla: throughout both properties in areas of water ponding.

Structure: usually an open to closed grassland, low open shrubland or open shrubland.

- Shrub layer: (0.8-) 2.5-4.5 (-9) m tall. (1-) 15-20 (-60)% cover. Often absent.
- Low layer: 1-2.5 (-3) m tall. 10-15 (-20)% cover. Rarely present.
- Understorey layer: 0.1-0.6 (-1) m tall. (5-) 40-45 (-90)% cover.

Trees: *Eucalyptus coolabah*.

Shrubs: *Sclerolaena birchii*, *Teucrium racemosum*, *Acacia victoriae*, *Myoporum montanum*, *Atriplex angulata*, *Duma florulenta*, *Atriplex limbata*, *Sclerolaena decurrens*, *Atriplex holocarpa*, *Atriplex eardleyae*, *Eremophila sturtii*, *Salsola australis*, *Atriplex elachophylla*, *Sclerolaena tricuspis*, *Enchylaena tomentosa*, *Sclerolaena diacantha*, *Sclerolaena bicornis*, *Olearia pimeleoides*, *Maireana brevifolia*, *Atriplex stipitata*.

Climbers & trailers: *Convolvulus remotus*, *Convolvulus clementii*.

Ground cover: *Sporobolus mitchellii*, *Eragrostis lacunaria*, *Portulaca oleracea*, *Sporobolus caroli*, *Eragrostis dielsii*,

Trianthema triquetra, *Dactyloctenium radulans*, *Solanum esuriale*, *Marsilea drummondii*, *Eleocharis pusilla*, *Alternanthera nodiflora*, *Chloris truncata*, *Chamaesyce drummondii*, *Paspalidium jubiflorum*, *Enneapogon avenaceus*, *Chenopodium cristatum*, *Brachyscome ciliaris*, *Tetragonia eremaea*, *Rhynchosia minima*, *Pterocaulon sphacelatum*, *Frankenia uncinata*, *Fimbristylis dichotoma*, *Chenopodium melanocarpum*, *Centipeda thespidioides*, *Centipeda crateriformis*, *Pluchea tetranthera*, *Panicum decompositum*, *Lotus cruentus*, *Linum marginale*, *Glossostigma diandrum*, *Eriochloa australiensis*, *Eragrostis parviflora*, *Calotis hispidula*, *Brachyscome ciliaris*, *Wahlenbergia communis*, *Tragus australianus*, *Pratia darlingensis*, *Eragrostis australasica*, *Einadia nutans*, *Boerhavia repleta*, *Walwhalleya subxerophyllum*, *Stemodia glabella*, *Sporobolus actinocladus*, *Sida platycalyx*, *Sida goniocarpa*, *Sida filiformis*, *Pimelea trichostachya*, *Leiocarpa semicalva*, *Juncus aridicola*, *Glinus lotoides*, *Eragrostis brownii*, *Centipeda minima*, *Boerhavia dominii*.

Introduced taxa: *Eragrostis cilianensis*, *Malvastrum americanum*, *Medicago polymorpha*, *Cucumis myriocarpus*, *Malva parviflora*, *Xanthium occidentale*, *Sonchus oleraceus*, *Silene gallica*, *Lepidium bonariense*, *Cenchrus ciliaris*.

Association 11: *Sporobolus mitchellii* (Rat's-tail Couch) – *Eragrostis lacunaria* (Purple Lovegrass) – *Sporobolus caroli* (Fairy Grass) Grassland and Herbfield (Fig. 18).

Environmental relationships: found in areas of waterlogging but with higher clay content than Association 10.

Structure: usually an open grassland, grassland or open herbfield, more rarely a low open woodland.

- Tree-layer: 5-10 (-15) m tall. 10-15% cover. Usually absent.
- Understorey layer: 0.1-0.3 (-0.6) m tall. 15-30 (-70)% cover.

Trees: *Eucalyptus coolabah*, *Eucalyptus populnea*.

Shrubs: *Teucrium racemosum*, *Sclerolaena diacantha*, *Sclerolaena decurrens*.

Climbers & trailers: *Convolvulus remotus*, *Convolvulus clementii*.

Ground cover: *Sporobolus mitchellii*, *Portulaca oleracea*, *Eragrostis lacunaria*, *Sida goniocarpa*, *Stuartina muelleri*, *Glinus lotoides*, *Alternanthera denticulata*, *Abutilon otocarpum*, *Sida trichopoda*, *Chenopodium melanocarpum*, *Centipeda thespidioides*, *Alternanthera nodiflora*, *Dactyloctenium radulans*, *Abutilon oxycarpum*, *Stemodia glabella*, *Sporobolus caroli*, *Marsilea hirsuta*, *Eragrostis basedowii*, *Epaltes australis*, *Monachather paradoxus*, *Marsilea drummondii*, *Frankenia uncinata*, *Eragrostis dielsii*, *Centipeda minima*, *Bergia trimera*, *Wahlenbergia communis*, *Pluchea dentex*.

Introduced taxa: *Malvastrum americanum*.

Association 12: *Pratia darlingensis* (Darling Pratia) – *Sporobolus mitchellii* (Rat's-tail Couch) Herbfield and Grassland (Fig. 19).

Environmental relationships: found in locations where water ponding occurs, generally in areas with a higher sand context than Association 11.

Trees: *Eucalyptus populnea*.

Shrubs: *Hakea ivoryi*, *Teucrium racemosum*, *Sclerolaena birchii*, *Senna artemisioides* subsp. *zygophylla*, *Sclerolaena muricata*, *Sclerolaena convexula*, *Eremophila longifolia*, *Dodonaea viscosa*, *Acacia victoriae*, *Acacia aneura*.

Climbers & trailers: none apparent.

Ground cover: *Pratia darlingensis*, *Sporobolus mitchellii*, *Eleocharis pusilla*, *Centipeda thespidioides*, *Alternanthera nodiflora*, *Sporobolus caroli*, *Solanum cleistogamum*, *Paspalidium jubiflorum*, *Cyperus squarrosus*, *Chenopodium melanocarpum*, *Sporobolus actinocladus*, *Eragrostis parviflora*, *Eragrostis lacunaria*, *Cyperus iria*, *Alternanthera denticulata*, *Solanum esuriale*, *Sida goniocarpa*, *Panicum laevinode*, *Marsilea costulifera*, *Eragrostis dielsii*, *Eleocharis pallens*, *Cynodon dactylon*, *Chamaesyce drummondii*, *Calotis cuneifolia*, *Boerhavia repleta*.

Introduced taxa: *Eragrostis cilianensis*.

Alliance 6: Canegrass Grassland

Alliance 13: *Eragrostis australasica* (Canegrass) Grassland (Fig. 20).

Environmental relationships: restricted to frequently inundated and water ponding areas, often with a fine silty clay content.

Structure: a grassland to open grassland.

- Upper layer: 0.8-2.5 m tall. 10-80% cover.
- Understorey layer: 0.1-1 m tall. 5-30 (-70)% cover.

Trees: none apparent.

Shrubs: *Atriplex eardleyae*, *Atriplex stipitata*, *Duma florulenta*, *Atriplex angulata*.

Climbers & trailers: none apparent.

Ground cover: *Eragrostis australasica*, *Panicum decompositum*, *Sporobolus mitchellii*, *Eleocharis pusilla*, *Centipeda crateriformis*, *Portulaca oleracea*.

Introduced taxa: none apparent.

Alliance 7: Lignum – *Glinus* Shrubland

Association 14: *Glinus lotoides* (*Glinus*) – *Senecio runcinifolius* (Groundsel) – *Duma florulenta* (Lignum) Herbfield and Shrubland (Fig. 21).

Environmental relationships: restricted to flooded and ponding areas generally on heavier clays.

Structure: an open herbaceous shrubland or open to closed herbfield.

- Upper layer: 1-2.5 m tall. 40-80% cover. Usually absent.
- Understorey layer: 0.1-1.5 m tall. 5-70% cover.

Trees: *Eucalyptus coolabah*, *Acacia stenophylla*.

Shrubs: *Duma florulenta*, *Myoporum montanum*, *Sclerolaena birchii*, *Dodonaea viscosa*.

Climbers & trailers: none apparent.

Ground cover: *Glinus lotoides*, *Senecio runcinifolius*, *Centipeda minima*, *Sporobolus mitchellii*, *Centipeda cunninghamii*, *Centipeda crateriformis*, *Epaltis australis*, *Alternanthera nodiflora*, *Pterocaulon sphacelatum*, *Marsilea costulifera*, *Cyperus squarrosus*, *Centipeda thespidioides*, *Ammannia multiflora*, *Amaranthus grandiflorus*, *Alternanthera angustifolia*, *Stemodia glabella*, *Sporobolus caroli*, *Ludwigia peploides*, *Juncus aridicola*, *Dactyloctenium radulans*, *Cynodon dactylon*, *Chenopodium melanocarpum*.

Introduced taxa: *Heliotropium supinum*, *Citrullus lanatus*, *Cucumis myriocarpus*, *Argemone ochroleuca*.

Alliance 8: Poplar Box – Black Box Woodland

Common Overstorey: *Eucalyptus populnea*, *Eucalyptus largiflorens*.

Common Mid-storey: *Teucrium racemosum*, *Senna artemisioides* subsp. *zygophylla*, *Eremophila sturtii*, *Senna artemisioides* subsp. *filifolia*, *Sclerolaena birchii*, *Eremophila longifolia*, *Eremophila deserti*, *Myoporum montanum*, *Eremophila goodwinii*.

Common Understorey: *Enteropogon acicularis*, *Eragrostis lacunaria*, *Solanum esuriale*, *Sporobolus actinocladus*, *Paspalidium jubiflorum*, *Centipeda thespidioides*, *Sporobolus caroli*, *Marsilea drummondii*, *Cyperus iria*, *Wahlenbergia gracilis*, *Sida trichopoda*, *Eriochloa australiensis*, *Chloris truncata*, *Chenopodium melanocarpum*, *Marsilea costulifera*, *Digitaria brownii*.

Association 15: *Eucalyptus populnea* Woodlands (Fig. 22).

Environmental relationships: often on minor and ephemeral drainage lines associated within Mulga lands (Group 1). Also found on duplex soils between dunal or red clays and grey to black cracking clays of floodplains.

Structure: generally a low woodland or shrubby low woodland.

- Tree-layer: (3-) 5-10 (-16) m tall. (10-) 20-25 (-50)% cover.
- Shrub layer: 1-2.5 (-3) m tall. (5-) 15-25 (-70)% cover.
- Understorey layer: 0.1-0.7 (-1.8) m tall. (10-) 30-35 (-60)% cover.

Trees: *Eucalyptus populnea*, *Acacia aneura*, *Eucalyptus coolabah*.

Shrubs: *Senna artemisioides* subsp. *zygophylla*, *Senna artemisioides* subsp. *filiformis*, *Teucrium racemosum*, *Sclerolaena birchii*, *Eremophila sturtii*, *Eremophila longifolia*, *Eremophila deserti*, *Myoporum montanum*, *Eremophila goodwinii*, *Sclerolaena convexula*, *Eremophila glabra*, *Dodonaea viscosa*, *Eremophila gilesii*, *Dichanthium sericeum*, *Amaranthus macrocarpus*, *Abutilon oxycarpum*, *Tripogon loliiformis*, *Trianthema triquetra*, *Solanum*

ellipticum, *Solanum cinereum*, *Pluchea tetranthera*, *Panicum effusum*, *Panicum decompositum*, *Evolvulus alsinoides*, *Eragrostis setifolia*, *Eragrostis microcarpa*, *Eragrostis brownii*, *Enneapogon avenaceus*, *Elytrophorus spicatus*, *Centipeda minima*, *Centipeda crateriformis*, *Boerhavia repleta*, *Aristida jerichoensis*.

Climbers & trailers: *Convolvulus clementii*.

Ground cover: *Enteropogon acicularis*, *Sporobolus actinocladus*, *Solanum esuriale*, *Centipeda thespidioides*, *Paspalidium jubiflorum*, *Sporobolus caroli*, *Alternanthera nodiflora*, *Eragrostis lacunaria*, *Cyperus iria*, *Calandrinia eremaea*, *Wahlenbergia gracilis*, *Sida trichopoda*, *Pterocaulon sphacelatum*, *Eriochloa australiensis*, *Chenopodium melanocarpum*, *Abutilon otocarpum*, *Sporobolus mitchellii*, *Marsilea drummondii*, *Marsilea costulifera*, *Digitaria brownii*, *Chloris truncata*, *Stemodia glabella*, *Phyllanthus virgatus*, *Eragrostis parviflora*, *Eleocharis pusilla*, *Alternanthera denticulata*, *Aristida holathera*.

Introduced taxa: *Malvastrum americanum*, *Eragrostis cilianensis*, *Verbena gaudichaudii*, *Silene gallica*, *Cucumis myriocarpus*, *Citrullus lanatus*.

Association 16: *Eucalyptus largiflorens* (Black Box) Woodland (Fig. 23).

Environmental relationships: found on low lying areas that are periodically flooded. Usually around the upper margins of lake beds or within islands internal to the lakes. Often forming dense stands due to mass germination after waters recede.

Structure: generally a low open woodland, low woodland or a dense shrubland (due to young cohort regeneration).

- Tree-layer: (3-) 4.5-8 (-10) m tall. (20-) 40-45 (-70)% cover.
- Shrub layer: (0.5-) 0.8-2 (-3) m tall. 5-10% cover. Rarely present.
- Understorey layer: 0.1-0.4 (-1) m tall. (5-) 30-35 (-80)% cover.

Trees: *Eucalyptus largiflorens*, *Eucalyptus populnea*.

Shrubs: *Teucrium racemosum*, *Eremophila sturtii*, *Sclerolaena birchii*, *Hakea leucoptera*, *Dodonaea viscosa*, *Atriplex eardleyae*.

Climbers & trailers: none apparent.

Ground cover: *Eragrostis lacunaria*, *Enteropogon acicularis*, *Stemodia glabella*, *Solanum esuriale*, *Pterocaulon sphacelatum*, *Sporobolus mitchellii*, *Paspalidium jubiflorum*, *Sporobolus caroli*, *Portulaca oleracea*, *Marsilea drummondii*, *Calandrinia eremaea*, *Brachyscome ciliaris*, *Boerhavia coccinea*, *Vittadinia cuneata*, *Sida goniocarpa*, *Sclerolaena birchii*, *Sauropus trachyspermus*, *Linum marginale*, *Leptorhynchos baileyi*, *Eragrostis dielsii*, *Einadia nutans*, *Chloris truncata*, *Chamaesyce drummondii*, *Alternanthera nodiflora*.

Introduced taxa: *Malvastrum americanum*, *Eragrostis cilianensis*.



Fig. 15. Group 3: Floodplain Wetlands Complex; Alliance 4: Coolibah – Black Box – Yapunyah – Lignum Woodlands; Association 8: *Eucalyptus ochrophloia* – *Eucalyptus largiflorens* – *Acacia stenophylla* Woodland and Forest.



Fig. 18. Group 3: Floodplain Wetlands Complex; Alliance 5: Rat’s-tail Couch – Lovegrass Grasslands; Association 11: *Sporobolus mitchellii* – *Eragrostis lacunaria* Grassland and herbfield.



Fig. 16. Group 3: Floodplain Wetlands Complex; Alliance 4: Coolibah – Black Box – Yapunyah – Lignum Woodlands; Association 9: *Eucalyptus coolabah* – *Acacia stenophylla* – *Eucalyptus ochrophloia* Woodland and Forest.



Fig. 19. Group 3: Floodplain Wetlands Complex; Alliance 5: Rat’s-tail Couch – Lovegrass Grasslands; Association 12: *Pratia darlingensis* – *Sporobolus mitchellii* Herbfield and Grassland.



Fig. 17. Group 3: Floodplain Wetlands Complex; Alliance 5: Rat’s-tail Couch – Lovegrass Grasslands; Association 10: *Sporobolus mitchellii* – *Eragrostis lacunaria* – *Sporobolus caroli* Grassland and Herbfield.



Fig. 20. Group 3: Floodplain Wetlands Complex; Alliance 6: Canegrass Grassland; Association 13: *Eragrostis australasica* Grassland.



Fig. 21. Group 3: Floodplain Wetlands Complex; Alliance 7: Lignum – *Glinus* Herbfield and Shrubland; Association 14: *Glinus lotoides* – *Senecio runcinifolius* – *Duma florulenta* Herbfield and Shrubland.



Fig. 22. Group 3: Floodplain Wetlands Complex; Alliance 8: Poplar Box – Black Box Woodland; Association 15: *Eucalyptus populnea* Woodland.



Fig. 23. Group 3: Floodplain Wetlands Complex; Alliance 8: Poplar Box – Black Box Woodland; Association 16: *Eucalyptus largiflorens* Woodland.

Discussion

Significant plant species

Dentella minutissima (family Rubiaceae) is the only flora species currently listed as endangered on the New South Wales *Threatened Species Conservation Act (TSC Act)*. *Dentella minutissima* has been previously recorded within Nocoleche Nature Reserve, Toorale National Park, Toorale State Conservation Area. *Dentella minutissima* is restricted to mudflats around drying waterholes or sandy silts on the edge of drainage lines. Due to the ephemeral flowering and size of the species there may be additional populations across both properties. Other taxa of significance include *Potentella nanopetala* (Rosaceae), which is currently known from two NSW populations and may be a candidate for TSC Act listing. *Eucalyptus melanophloia* (Myrtaceae), *Brachychiton populneus* (Sterculiaceae) and *Dodonaea boroniifolia* (Sapindaceae) are all at their western limit of distribution on the Naree and Yantabulla properties.

Rainfall and periodic recruitment

In arid and semi-arid assemblages the composition and turnover of annual and shortlived perennial species varies from year to year (Porteners *et al.* 1997). The presence and detectability of the many groundlayer taxa is determined by the amount and seasonal distribution of rainfall (Fox 1991) and/or flooding events. Different frequencies of flooding and its duration are known to significantly alter the dominant species of these systems. Grasslands can turn to shrublands and vice versa and trees such as *Eucalyptus largiflorens*, *Eucalyptus coolabah* and *Eucalyptus populnea* can regenerate in large cohorts or suffer extensive dieback. Thus understories may have significant mosaic shifts in their ephemeral floras in the short term with encroachments and retractions of some overstorey species in the long term. While the floristic analysis and mapping in this study is largely based on one season, the resolution of mapping and delineation of units is believed to have occurred at a level that would not be highly influenced by these seasonal changes. Furthermore permanent plots were visited over a three year period to check consistency.

Population sizes of a number of taxa found dominating overstoreys within the study area (*Acacia aneura*, *Acacia oswaldii*, *Alectryon oleifolius*, *Atalaya hemiglauca*, *Casuarina pauper*, *Flindersia maculata*, *Grevillea striata*, *Hakea ivoryi*, *Hakea tephrosperma*, *Hakea leucoptera* & *Ventilago viminalis*) appear to be changing little demographically across the semi-arid regions of Australia (Parsons 1989; Batty & Parsons 1992; Auld & Denham 2001). A number of these taxa are likely to have evolved within the arid and semi-arid regions of Australia when the climate was warmer, more seasonal and more densely vegetated (Cretaceous-Palaeocene) (Specht & Specht 1999). All of these species are generally restricted to associations within Group 1 and in particular Group 2, which occur on the ancient nutrient poor red to brown earths and aeolian deposits. Many of these taxa in western New South Wales regenerate primarily by suckering, this can be seen readily

in stands of *Alectryon* and *Hakea* which show obvious clumping and many exposed root systems. Recruitment via seed is considered a rare event for many overstorey species in arid and semi-arid regions with seedlings often decimated by rabbits and other introduced herbivores (Auld & Denham 2001). Even *Acacia aneura* is thought to only successfully establish once in every six years with germination requiring lower temperatures and good rains in summer and winter (Preece 1971; Burrows 1972; Beadle 1981; Boyland 1984). During the surveys some of these overstorey taxa (e.g. *Atalaya hemiglauca*, *Flindersia maculosa*, *Hakea ivoryi* and *Grevillea striata*) showed visible seedling germination in 2014 and 2015 within Naree, where feral animal control and stock removal had occurred since 2013, but many succumbed to the drier conditions of 2016 (*pers. obs.*). These relictual dominants within the shrublands are common within the sub-humid woodlands of arid and semi-arid Australia in marginal summer rainfall locations. These dominants become less prominent further south within NSW as rainfall becomes more aseasonal or winter dominant. The unpredictable rainfall, lack of seasonality, and increase in aridity that has occurred over millennia in this region of NSW is likely to play a major role in the lack of recruitment in these taxa, which often require a succession of good rainfall seasons, or have survived largely through asexual reproduction. Within the rangelands substantial changes in summer and autumn rainfall are predicted, with an increase in the dominance of warm season rainfall (CSIRO & Bureau of Meteorology 2015). Increasing unpredictability of weather, and increased temperatures and evapotranspiration exacerbating dry times, are likely to further reduce the chances of good recruitment for many of these taxa under anthropogenic climate change.

Importance of shrub vegetation

Floristic Group 2 (Fig. 4) comprises a number of shrub associations that are largely dominated by species thought to have increased in distribution since clearing and grazing was introduced. Such taxa include *Dodonaea viscosa* and *Eremophila sturtii* which are often termed 'woody weeds', with anecdotal evidence suggesting dense stands have higher erosion and reduced species diversity (Porteners *et al.* 1997). Such anecdotal evidence has led to managers believing that areas of 'woody weed' encroachment require intensive management to reduce their density. Initial plans for Naree had included control of 'woody weeds' (David & Sue Akers, Bush Heritage, *pers. comm.*); however others have found little evidence for increased erosion and their presence is not thought to cause any problems with respect to biodiversity (Pickard & Norris 1994; West 2000). While speculation about the effects of this transition have centred on shrub encroachment being a form of desertification or landscape degradation there has been little or no empirical support to suggest this is actually the case. The body of evidence suggests that woody encroachment in western NSW is largely a beneficial process that improves landscape health and soil function on almost all measured variables, and is neutral on others (Elkins *et al.* 1986; Bhark & Small 2003; Eldridge & Fruedenberger 2005; Maestre *et al.* 2009; Eldridge *et al.* 2011; Smith 2013; Daryanto *et al.* 2012;

Daryanto *et al.* 2013; Howard *et al.* 2012; Eldridge *et al.* 2013; Soliveres & Eldridge 2013; Eldridge & Soliveres 2014; Eldridge *et al.* 2014; Soliveres *et al.* 2014; Eldridge *et al.* 2015). In 35 study sites across western NSW no declines in plant, vertebrate or invertebrate richness was found with increasing woody encroachment (Ayres *et al.* 2001). Grazing by stock was found to be the cause of any recorded decline in functionality of soils, productivity or landscape serviceability, while shrubs largely ameliorate the overgrazing damage (Eldridge *et al.* 2013; Eldridge & Soliveres 2015; Eldridge *et al.* 2015). Data from sites where goats and rabbits have been controlled indicate that shrub densities have a much lower impact on grass biomass than grazing (Robson 1995; Daryanto & Eldridge 2010). The state and transition model presented by Eldridge and Soliveres (2015) suggests that intensive grazing and mechanical removal of 'woody weeds' may lead to very dense shrublands with highly modified soil characteristics that could take up to 100 years to naturally recover, even with the removal of grazing and good rainfall. Moderately dense shrubland with a sparse understorey, however, may only require 10 years to return to a diverse state with a rich understorey, without blade ploughing and the exclusion of grazing, depending on seed banks and rainfall (Eldridge & Soliveres 2015). Shrublands with open to moderate shrub density and dominated by more than one species, with a stable soil surface, provide the highest overall ecosystem service values (Eldridge & Soliveres 2015). Eldridge *et al.* (2011) clearly state that shrub encroachment must be decoupled from the concept of degradation. Thus shrub encroachment across large areas of Group 2 within the Naree and Yantabulla study area should not automatically be viewed as an issue causing lowered biodiversity values.

Microhabitats

Litter and logs form important microhabitats for fauna species, germination sites for flora and at times allow protection of flora from grazing and browsing impacts. Thus litter and logs offer shelter, basking and foraging sites for fauna (Croft *et al.* 2011; 2015). Not only are tree hollows important for nesting species, they can also be sites for stored water within an otherwise dry landscape (Vickers *et al.* 2014). These features along with hollows in logs and trees form important components of functional resources that alter faunal abundance and composition (McElhinny *et al.* 2006; Croft *et al.* 2011; 2015; Hunter 2015a). The aim of this research was to provide limited baseline information in regards to the assemblages contained herein, however some generalisations can be made about these important functional attributes. The greatest proportion of logs on the ground is found within Alliance 1, the Mulga Complex. However, this may largely be artificial and related to previous land management practices of mulga pushing during drought times for fodder. The high score for logs within Alliance 2 was due to past clearing activities. Thus, these high scores may be much lower in natural or more mature stands and we might expect the current scores to reduce over time. Overall high abundance of tree hollows, natural logs on ground, litter weight and log hollows were primarily associated with the margins of wetlands and within floodplains such as Alliance

4 and Alliance 8 which is not surprising as these systems occur in the most productive areas of the landscape, being both on higher nutrient soils (clays) that receive and contain higher levels of water. *Acacia anuera* which dominates Alliance 1 contains a large number of natural hollows within the more mature stands along with a moderately high litter weight.

Naree and *Yantabulla* are part of an increasing network of privately purchased properties owned by organisations committed to managing lands for the primary purpose of rehabilitation and conservation. Private conservation lands are important places that augment our state and national reserve systems and may eventually rival government-controlled lands in size and diversity. They are also locations which are decoupled from political whims and public pressure that often infiltrate the management of government controlled reserves. Often this pressure comes from those who may not have a full understanding of the best science, leading to directives for management actions that are contrary to the conservation of biodiversity, or where biodiversity takes an important but none-the-less subsidiary role to other interests or concerns (Croft *et al.* 2016). While the government-controlled reserve network aspires to using the best available information it is often influenced by non-biodiversity priorities, and a lack of appropriate funds and staff. These privately managed lands may offer alternative and more flexible management styles that allow quicker adaptation to new management information and research results.

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Appendix 1: Checklist of species found within Naree and Yantabulla stations within the North Far Western Plains of New South Wales attributed to Association.

	A-01	A-02	A-03	A-04	A-05	A-06	A-07	A-08	A-09	A-10	A-11	A-12	A-13	A-14	A-15	A-16	Total
Fern & Fern Allies																	
Adiantaceae																	
<i>Cheilanthes sieberi</i> subsp. <i>sieberi</i>	1	1	1			1											4
Marsileaceae																	
<i>Marsilea costulifera</i>				1			1			1	1	1	1	1	1		8
<i>Marsilea drummondii</i>	1						1	1	1	1	1				1	1	7
<i>Marsilea hirsuta</i>											1						1
Gymnosperm		1			1		1								1		4
Cupressaceae																	
<i>Callitris glaucophylla</i>		1			1		1								1		4
Monocotyledon																	
Amaryllidaceae		1															1
<i>Calostemma purpureum</i>		1															1
Anthericaceae																	
<i>Tricoryne elatior</i>	1																1
Asphodelaceae																	
<i>Bulbine alata</i>	1						1			1							3
Cyperaceae																	
<i>Cyperus bifax</i>								1	1								2
<i>Cyperus difformis</i>	1			1				1	1								3
<i>Cyperus gilesii</i>		1						1	1								3
<i>Cyperus iria</i>									1	1	1	1			1		4
<i>Cyperus squarrosus</i>								1	1		1	1	1				3
<i>Eleocharis acuta</i>								1	1								1
<i>Eleocharis pallens</i>											1						1
<i>Eleocharis plana</i>							1										1
<i>Eleocharis pusilla</i>				1				1	1	1	1	1	1	1	1		7
<i>Fimbristylis dichotoma</i>	1	1	1	1	1		1			1			1	1	1	1	10
<i>Schoenoplectus laevis</i>															1		1

	A-01	A-02	A-03	A-04	A-05	A-06	A-07	A-08	A-09	A-10	A-11	A-12	A-13	A-14	A-15	A-16	Total
Juncaceae																	
<i>Juncus aridicola</i>								1	1	1				1			4
Phormiaceae																	
<i>Dianella porracea</i>	1														1		2
Poaceae																	
<i>Amphipogon caricinus</i> var. <i>caricinus</i>		1															1
<i>Aristida blakei</i>	1	1															2
<i>Aristida calycina</i> var. <i>praecaltia</i>	1																1
<i>Aristida contorta</i>	1	1	1				1										4
<i>Aristida holathera</i> var. <i>holathera</i>	1	1	1	1	1	1	1	1	1						1	1	11
<i>Aristida jерichoensis</i> var. <i>jerichoensis</i>	1	1	1	1	1	1	1								1		3
<i>Aristida jерichoensis</i> var. <i>subspiculifera</i>	1	1	1	1	1	1	1								1		8
<i>Aristida latifolia</i>	1	1															2
<i>Aristida leptopoda</i>	1	1				1											3
<i>Aristida nitidula</i>	1	1															1
<i>Austrostipa nitida</i>	1	1			1												2
<i>Cenchrus caliculatus</i>	1																1
<i>Cenchrus ciliaris</i>	1	1	1	1	1	1	1	1	1	1					1		10
<i>Chloris truncata</i>	1			1	1					1					1	1	6
<i>Cymbopogon ambiguus</i>	1	1	1		1												3
<i>Cynodon dactylon</i>				1				1	1		1			1			5
<i>Dactyloctenium radulans</i>	1	1	1	1	1	1	1	1	1	1	1	1	1	1	1		13
<i>Dichanthium sericeum</i> subsp. <i>humilis</i>	1	1			1	1									1		5
<i>Digitaria ammophila</i>	1																1
<i>Digitaria brownii</i>	1	1	1	1	1	1	1								1		6
<i>Digitaria coenicola</i>	1		1														1
<i>Digitaria divaricatissima</i>	1	1				1									1		4
<i>Digitaria hystrioides</i>	1				1												2
<i>Echinochloa inundata</i>									1								1
<i>Echinochloa turneriana</i>		1		1				1	1	1							4
<i>Elytrophorus spicatus</i>				1						1						1	3
<i>Enneapogon avenaceus</i>	1	1	1	1	1	1	1	1	1	1	1				1		11

	A-01	A-02	A-03	A-04	A-05	A-06	A-07	A-08	A-09	A-10	A-11	A-12	A-13	A-14	A-15	A-16	Total
<i>Enneapogon cylindricus</i>	1	1			1										1		4
<i>Enneapogon intermedius</i>	1	1															2
<i>Enneapogon nigricans</i>	1				1		1			1					1		5
<i>Enneapogon polyphyllus</i>							1										1
<i>Enteropogon acicularis</i>	1	1	1	1	1	1	1	1	1	1					1	1	12
<i>Eragrostis australasica</i>							1	1	1	1			1	1			5
<i>Eragrostis basedowii</i>					1						1						2
<i>Eragrostis brownii</i>										1					1		2
<i>Eragrostis cilianensis</i>		1	1	1	1	1	1	1	1	1		1	1		1	1	12
<i>Eragrostis dielsii</i>			1	1	1	1	1	1	1	1	1	1	1		1	1	11
<i>Eragrostis elongata</i>		1								1							2
<i>Eragrostis eriopoda</i>	1	1	1	1	1	1	1								1		8
<i>Eragrostis kennedyae</i>	1	1	1				1								1		5
<i>Eragrostis lacunaria</i>	1	1		1	1	1	1	1	1	1	1	1	1		1	1	13
<i>Eragrostis laniflora</i>		1	1		1		1										4
<i>Eragrostis leptocarpa</i>	1		1														2
<i>Eragrostis leptostachya</i>	1																1
<i>Eragrostis microcarpa</i>															1		2
<i>Eragrostis parviflora</i>	1	1	1	1	1	1	1		1	1		1			1	1	12
<i>Eragrostis setifolia</i>	1		1												1		3
<i>Eriachne aristidea</i>							1										1
<i>Eriachne helmsii</i>	1	1			1		1								1		5
<i>Eriachne mucronata</i>		1															1
<i>Eriochloa australiensis</i>								1		1	1				1		4
<i>Eriochloa pseudoacrotricha</i>										1							1
<i>Iseilema membranaceum</i>										1							1
<i>Monachather paradoxus</i>	1	1	1				1				1				1		6
<i>Panicum decompositum</i>										1			1		1		3
<i>Panicum effusum</i>	1	1	1				1								1		5
<i>Panicum laevinode</i>	1							1	1	1		1	1		1	1	8
<i>Panicum simile</i>	1	1					1				1						5
<i>Paspalidium constrictum</i>	1	1	1		1	1									1		6

	A-01	A-02	A-03	A-04	A-05	A-06	A-07	A-08	A-09	A-10	A-11	A-12	A-13	A-14	A-15	A-16	Total
<i>Ptilotus polystachyus</i> var. <i>polystachyus</i>	1	1	1				1								1		5
<i>Ptilotus sessilifolius</i> var. <i>sessilifolius</i>			1				1										2
Apiaceae																	
<i>Ammi majus</i>	1	1															2
<i>Trachymene glaucifolia</i>	1																1
<i>Trachymene ochracea</i>	1																1
<i>Apocynaceae</i>							1										1
<i>Alstonia constricta</i>							1										1
Asclepiadaceae																	
<i>Marsdenia viridiflora</i>			1														1
Asteraceae																	
<i>Angianthus brachypappus</i>					1												1
<i>Brachyscome ciliaris</i> var. <i>lanuginosa</i>			1							1					1		3
<i>Brachyscome melanocarpa</i>		1			1			1		1					1		5
<i>Calocephalus sonderi</i>							1										1
<i>Calotis cuneifolia</i>		1					1				1						3
<i>Calotis erinacea</i>							1										1
<i>Calotis hispidula</i>	1									1							3
<i>Calotis inermis</i>	1																1
<i>Calotis lappulacea</i>	1	1					1										3
<i>Centaurea calcitrapa</i>				1													1
<i>Centipeda crateriformis</i> subsp. <i>compacta</i>	1								1	1			1	1	1		6
<i>Centipeda cunninghamii</i>						1			1					1			3
<i>Centipeda minima</i> var. <i>minima</i>	1							1	1	1	1			1	1		7
<i>Centipeda thespidioides</i>	1	1			1	1		1	1	1	1	1	1	1	1	1	13
<i>Epaltes australis</i>									1		1			1			3
<i>Glossocardia bidens</i>	1														1		2
<i>Gnephosis arachnoidea</i>							1										1
<i>Gnephosis eriocarpa</i>		1															1
<i>Letocarpa semicalva</i> subsp. <i>semicalva</i>	1							1		1							3
<i>Leptorhynchos baileyi</i>		1			1											1	3
<i>Minuria integerrima</i>											1						1

	A-01	A-02	A-03	A-04	A-05	A-06	A-07	A-08	A-09	A-10	A-11	A-12	A-13	A-14	A-15	A-16	Total
<i>Olearia pimeleoides</i>			1		1	1	1			1							5
<i>Pluchea dentex</i>							1	1	1		1						3
<i>Pluchea tetranthera</i>							1	1	1	1				1			4
<i>Pseudognaphalium luteoalbum</i>								1	1								1
<i>Pterocaulon sphacelatum</i>			1		1		1	1	1	1			1	1	1	1	8
<i>Pycnosorus thompsonianus</i>	1																1
<i>Senecio magnificus</i>								1	1								1
<i>Senecio runcinifolius</i>	1				1								1				3
<i>Sigesbeckia australiensis</i>	1	1															2
<i>Sonchus oleraceus</i>										1							1
<i>Streptoglossa adscendens</i>							1	1	1								2
<i>Streptoglossa liatroides</i>	1																1
<i>Stuartina muelleri</i>	1										1						2
<i>Vittadinia cuneata</i> var. <i>cuneata</i>	1	1													1		3
<i>Vittadinia dissecta</i> var. <i>hirta</i>				1													1
<i>Vittadinia pterochaeta</i>	1						1	1	1								3
<i>Vittadinia sulcata</i>			1				1	1									2
<i>Xanthium occidentale</i>										1							1
Boraginaceae																	
<i>Heliotropium supinum</i>									1				1				2
<i>Omphalolappula concava</i>	1	1	1											1			4
Brassicaceae																	
<i>Lepidium bonariense</i>										1							1
<i>Lepidium sagittulatum</i>	1																1
<i>Sisymbrium erysimoides</i>									1								2
Campanulaceae																	
<i>Wahlenbergia communis</i>										1	1						2
<i>Wahlenbergia gracilis</i>	1													1			2
<i>Wahlenbergia tumidifruca</i>	1		1		1												3
Capparaceae																	
<i>Capparis mitchellii</i>									1								2
<i>Caryophyllaceae</i>		1								1			1		1		4

	A-01	A-02	A-03	A-04	A-05	A-06	A-07	A-08	A-09	A-10	A-11	A-12	A-13	A-14	A-15	A-16	Total
<i>Velleia arguta</i>	1																1
<i>Velleia paradoxa</i>		1					1										2
Haloragaceae																	
<i>Haloragis glauca</i> forma <i>glauca</i>								1	1						1		3
<i>Myriophyllum verrucosum</i>							1										1
Lamiaceae																	
<i>Teucrium racemosum</i>				1			1	1	1	1	1	1			1	1	8
Linaceae																	
<i>Linum marginale</i>									1						1		2
Lobeliaceae																	
<i>Pratia darlingensis</i>	1									1		1			1		4
Loranthaceae																	
<i>Amyema cambagei</i>	1																1
<i>Amyema lucasii</i>							1										1
<i>Amyema maidenii</i> subsp. <i>maidenii</i>		1					1										2
<i>Lysiana exocarpi</i>					1		1										2
<i>Lysiana subfalcata</i>									1								1
Lythraceae																	
<i>Ammannia multiflora</i>									1					1			2
Malvaceae																	
<i>Abutilon leucopetalum</i>									1								1
<i>Abutilon malvifolium</i>															1		1
<i>Abutilon otocarpum</i>	1	1	1	1	1	1	1	1	1		1				1		11
<i>Abutilon oxycarpum</i>	1	1	1								1	1			1		6
<i>Hibiscus sturtii</i> var. <i>grandiflorus</i>	1	1					1										3
<i>Hibiscus sturtii</i> var. <i>sturtii</i>		1															1
<i>Hibiscus trionum</i>							1	1	1	1							3
<i>Maha parviflora</i>										1							1
<i>Mabastrum americanum</i>	1			1			1	1	1	1	1				1	1	8
<i>Mabastrum coromandelianum</i>	1																1
<i>Sida ammphila</i>																	1
<i>Sida corrugata</i>										1							1

	A-01	A-02	A-03	A-04	A-05	A-06	A-07	A-08	A-09	A-10	A-11	A-12	A-13	A-14	A-15	A-16	Total
<i>Sida cunninghamii</i>		1			1	1											3
<i>Sida fibulifera</i>	1		1		1										1		4
<i>Sida filiformis</i>	1	1	1		1	1	1			1					1		9
<i>Sida goniocarpa</i>		1		1	1	1	1	1	1	1	1	1				1	9
<i>Sida intricata</i>				1	1												2
<i>Sida platycalyx</i>		1				1				1							3
<i>Sida trichopoda</i>	1	1	1		1	1	1	1			1				1		8
Meliaceae																	
<i>Owenia acidula</i>					1												1
Myrtaceae																	
<i>Corymbia tumescens</i>	1	1			1	1									1		5
<i>Eucalyptus coolabah</i>	1				1			1	1	1	1			1	1		8
<i>Eucalyptus largiflorens</i>					1			1	1	1			1	1	1	1	7
<i>Eucalyptus melanophloia</i>		1															1
<i>Eucalyptus ochrophloia</i>		1			1			1	1								4
<i>Eucalyptus populnea</i> subsp. <i>bimbil</i>	1	1	1		1	1				1	1	1	1	1	1	1	11
<i>Thryptomene hexandra</i>	1	1															2
Nyctaginaceae																	
<i>Boerhavia coccinea</i>		1	1		1	1	1	1								1	7
<i>Boerhavia dominii</i>										1							1
<i>Boerhavia repleta</i>				1				1	1	1	1	1			1		6
Oleaceae																	
<i>Jasminum lineare</i>			1														1
Onagraceae																	
<i>Ludwigia peploides</i> subsp. <i>montevidensis</i>								1	1				1				3
Oxalidaceae																	
<i>Oxalis chnoodes</i>															1		1
<i>Oxalis exilis</i>			1														1
<i>Oxalis perennans</i>	1									1					1		3
Papaveraceae																	
<i>Argemone ochroleuca</i> subsp. <i>ochroleuca</i>										1				1			2

