The vegetation of the Coonavitra area, Paroo Darling National Park, western New South Wales

M. Westbrooke, S. Gowans and M. Gibson

Centre for Environmental Management, University of Ballarat, PO Box 663 Ballarat, Victoria, 3353, AUSTRALIA.

Abstract: The vegetation of Coonavitra area, Paroo Darling National Park (latitude 31°00'–32° 40'S and longitude 142°10'–144°25'E) in north western New South Wales was assessed using intensive quadrat sampling and mapped using extensive ground truthing and interpretation of aerial photograph and Landsat Thematic Mapper satellite images. In the survey 261 vascular plants species including 37 (14%) exotic species, from 50 families were recorded. Eighteen vegetation communities were identified and mapped, the most widespread being *Casuarina pauper/Alectryon oleifolius* low open woodland, *Acacia loderi* tall open shrubland, *Flindersia maculosa* low open woodland and *Acacia aneura* open-shrubland. Of particular significance are the extensive areas of *Acacia loderi* and *Acacia melvillei* tall open shrubland and one of the northernmost occurrences of *Eucalyptus socialis* tall open shrubland. Many of these communities have been impacted by a history of 150 years of pastoral use.

***Cunninghamia* (2011) 12(1) 7–27**

Introduction

Paroo Darling National Park (lat 31° 00'–32 ° 40'S; long 142 ° 10'–144 ° 25'E) in north-western New South Wales, north-east of the town of Wilcannia (Fig. 1), covers an area of approximately 221,000 ha. The park, gazetted in October 2002, incorporates the previously gazetted Peery National Park with the addition of Mount Murchison, Wilga, Coonavitra and Tilpilly pastoral stations. As a result Paroo Darling National Park is made up of six separate non-contiguous areas (Fig. 1). The northernmost area is known as the Peery Lake area (and formerly Peery National Park) and is made up of the former pastoral stations of Peery, Mandalay and Arrow Bar. The Mount Murchison and Wilga areas are separated by the Darling River. The Coonavitra area, south-east of these areas, has a Northern block (north of the Barrier Highway) and a Southern block (south of the Barrier Highway). The southern block of Coonavitra is also referred to as the Emmdale block. The Tilpilly area between the Barrier Highway and the Wilcannia-Bourke Road is the eastern most extent of the park.

Major features of the park are Peery Lake, part of the Paroo Overflow, and the rugged sandstone hills to the west of the lake. Other features are the Darling River that flows between the Mount Murchison and Wilga areas, and the rugged Greenough Hill range of the Northern block of Coonavitra. The study area falls within the Murray Darling Depression Bioregion.

Detailed surveys and vegetation maps have been completed for the Peery Lake area (Westbrooke *et al.* 2002; Westbrooke *et al.* 2003) and the Tilpilly area (Hunter & Fallavollita 2003). In June and November 2005 an intensive vegetation survey of the Mount Murchison, Wilga and Coonavitra blocks, Paroo Darling National Park was conducted. Prior to this study no systematic survey of the vegetation of these

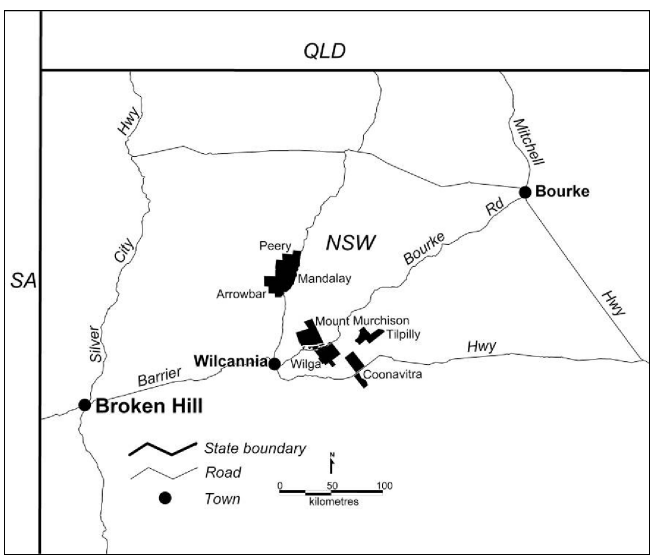

Fig. 1. Location of Paroo Darling National Park

parts of the park had been done. Because of the contrasting landsystems represented, the results of the survey for the Mount Murchison and Wilga areas are presented separately from the Coonavitra area (Westbrooke *et al.* 2006). This paper details the findings of the vegetation survey for the Coonavitra area of Paroo Darling National Park.

History of the area

Prior to European settlement, nomadic Aboriginal tribes, who were able to travel away from permanent soaks, waterholes and native wells, inhabited the area after favourable rains. The Paakantji Aboriginal people travelled the length of the Darling River from Wilcannia through Menindee, towards Wentworth. The Ngiyeempaa people occupied the land south-east of the Darling River. The large number of middens and stone relics encountered today provide evidence of the strong ties of both tribes to the river (H. Johnston, NSW Parks & Wildlife Service, Buronga, pers. comm.). The first Europeans to travel through the area were Charles Sturt and his party who followed the Darling River to Menindee and then travelled west to the Barrier Range and north into Queensland (Stanley 1991). Soon after, others followed the Darling River in search of pasture for sheep. Robert Gow explored the area in 1861 (Jervis 1948) but Vincent Dowling, who had established a cattle station close to the mouth of the Warrego River, had explored the Paroo River to the north-west in 1860 and applied for grazing rights (Heathcote 1965). The township of Wilcannia was surveyed in 1865 and soon thrived (Hardy 1969). Previously there was just a woolshed and a few huts at Mount Murchison Station. Soon after, 38 runs were taken up as Momba (848,000 ha.) which incorporated the existing Mount Murchison lease (Pickard 1990). Smith, Elder and Waite held the Momba pastoral

Table 1. Characteristics and occurrence of Land systems across the Coonavitra area (Walker 1972; Hazelton 1977)

Relief & system	Area	Characteristics
Rolling downs and lowlands		
Lilyvale (Lv)	Emmdale block	Undulating rounded quartzite and sandstone ridges, partly covered by aeolian sand, narrow incised drainage lines. Relief to 15m. Shallow, stony, loamy soils on upper slopes. Shallow to deep sands and red earths on lower slopes.
Plains		
Coonavitra (Cv)	Northern block	Sandy accumulation on range footslopes, level Sandplain with wind-blown sand accumulation. Relief to 5m. Calcareous red earths with sandy surface.
Fulham (Fu)	Emmdale block	Plains with scattered dunes and small drainage sinks. Relief to 5m. Calcareous loamy or sandy slightly ferruginous red earths. Dunes of deep sands. Drainage sinks of calcareous red earths and some cracking clays.
Manara (Ma)	Emmdale block	Extensive plains with few dunes, low sandy accumulations and small drainage sinks. Relief to 5m. Calcareous red earths and solonised brown soils, with sands and sandy earths on dunes, and sandy earths or sandy texture-contrast soils on rises. Drainage sinks.
Nelia (Ne)	Northern block & Emmdale block	Extensive plains with few dunes, and small and large drainage sinks. Relief to 5m. Level solonised brown soils, becoming slightly undulating near larger sinks, and some red-brown texture-contrast soils. Dunes of calcareous sandy earths or sands. Sinks of heavy clay or solonised brown soils.
Dunefields		
Bell Vale (Bv)	Emmdale block	Dunefield with east-west orientated dunes, narrow to broad swales, and drainage sinks. Relief to 5m. Dunes of sands and sandy earths. Swales of calcareous red earths and reddish-brown clay soils. Drainage sinks of calcareous red earths and clay soils.
Blackfella (Bf)	Emmdale block	Sandplain with low east-west oriented dunes and few small drainage sinks. Relief to 3m. Sands and sandy earths. Few small open areas of calcareous red earths and clay soils.
Ranges		
Boorandarra (Bz)	Northern block	Strongly bevelled quartzite and sandstone ridges and footslopes. Relief to 200m. Shallow, stony, sandy soils, becoming deeper and better developed downslope. Narrow valleys of red earths, incised channels.
Hills and footslopes		
Mulga Downs (Mz)	Northern block	Low, partly bevelled quartzite and sandstone ridges and footslopes with narrow alluvial valleys. Relief to 50m. Shallow, stony, sandy soils, grading to deeper and better developed red earths downslope.
Playas and basins		
Karumpito (Ko)	Northern block & Emmdale block	Small lakes in red country with local catchments. Beds of cracking or non-cracking clays and solonised brown soils, with sandy surface deposits around shorelines. Lunettes of sandy solonised brown soils, often shallow overlying calcrete.

lease from early 1870 (Heathcote 1965). In 1889 it was reported that Momba was overrun by kangaroos (Heathcote 1965). About this time a party of shooters found opal in the sandstone hills and by the 1890s White Cliffs township was established (Hardy 1969). With the development of pastoral leases in the 1850s, Aboriginal people were moved from their traditional homes to government missions at Menindee, Ivanhoe and Lake Cargelligo.

The combination of drought and overstocking made the normal recurrence of drought a major disaster. Whereas the land returned rapidly from 'desert' to 'vital glory' after the 1865–70 drought, this was no longer the case by the end of the century and by 1901 there was a catastrophic decline in productivity in the West Darling area. Sheep numbers that had gone from less than two million prior to 1880 to a peak of nearly eight million by 1894, had declined to less than three million again by 1901. After 1902, Momba was successively subdivided until around 1950 when the residue was divided into ten leases which included Peery, Mandalay and Arrow Bar (Pickard 1990).

Peery Station, the first of several pastoral properties to be acquired in the area, was identified as an area of particular conservation value and acquired in 1999 to protect natural and cultural heritage. Peery National Park was proclaimed in March 2000 (NPWS 2000) and the acquisition of Arrow Bar and Mandalay leases in December 2000 gave protection to the entire Peery Lake basin.

Coonavitra Station was part of the resumed area of the original Cultowa run. Colin Wheeler acquired the Coonavitra lease in 1947 and held it till his death in 1989 when his family sold parts of the lease. In June 2000 the National Parks and Wildlife Service acquired the remainder, followed by the Mount Murchison lease on the northern side of the Darling River. The subsequent purchase of Wilga Station, bordering Mount Murchison on the southern bank of the Darling, provided a link between the northern and southern properties and led to the proclamation of Paroo Darling National Park, incorporating what had previously been Peery National Park in October 2002.

Climate

The climate for the area is arid with low and unreliable rainfall (Edwards 1979). Temperatures are high in summer and mild in winter with average daily maximum of 35°C in January and 17°C in July and average daily minimum of 21°C in January and 4°C in July. The mean annual rainfall is approximately 250 mm and annual potential evaporation is 2738 mm. There is a slight summer bias to rainfall and annual variation is high (Clewett *et al.* 1994).

Geology and geomorphology

Three physiographic regions (Abraham 1991) occur within the Park; the Paroo plains of the eastern sector are separated from the Stony Tablelands and Plains by the Mount Pleasant sandstone hills (Morton 1991). The 12 land systems present (Milthorpe 1991) are summarised in Table 1.

The Northern block of Coonavitra supports a large expanse of sand plains in the south and the quartzite and sandstone Greenough Hill range in the north-west. The Emmdale block (Southern block) of Coonavitra supports extensive plains along with dunefields around the boundary with quartzite ridges near the southern boundary. Five land systems for the Northern block and seven land systems for the Emmdale block by are described Walker (1972) and Hazelton (1977) (Table 1). The distribution of the land systems across the Coonavitra area is shown in Fig. 2.

Previous studies

The most complete study of the vegetation of far western New South Wales is that by Beadle (1945; 1948) who included the study area as *Casuarina pauper / Alectryon oleifolius* subsp. *canescens* association along with claypans and swamps associated with the Darling River. Milthorpe (1991) and Pickard and Norris (1994) broadly describe the vegetation of the north-west corner of New South Wales, including the Peery Lake area of Paroo Darling National Park. Parts of the area now included in the Park were included in

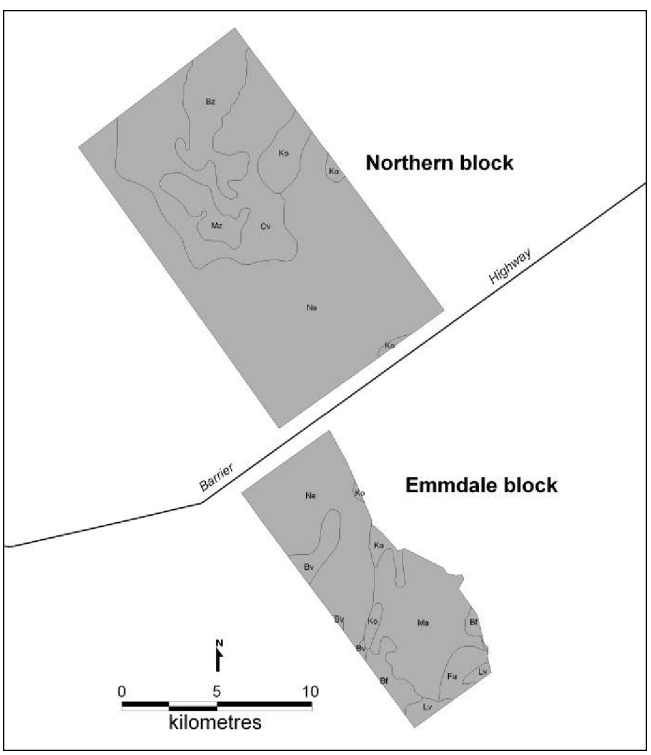

Fig. 2. Distribution of land systems within Coonavitra section, Paroo Darling National Park
(Key to codes used can be found in Table 1)

studies undertaken for the Wilderness Society (Lembit 1993; Knight 1994). A detailed survey and vegetation map have been completed for the Peery Lake area (Westbrooke et al. 2002; Westbrooke et al. 2003) and the Tilpilly area (Hunter & Fallavollita 2003). No systematic survey of the vegetation of Coonavitra had been undertaken prior to this study.

Methods

Study area

The Northern block of Coonavitra is approximately 95 km east of Wilcannia, north of the Barrier Highway and incorporates approximately 19,320 ha of the former Coonavitra Pastoral Station (the Coonavitra Homestead is 2 km north of the Barrier Highway; there are old yards and woolsheds just north of the Homestead). The study area takes in the Greenough Hill range. Following significant rain, a number of swamps and waterholes (Gulguy and Markaira Waterholes) hold water. Four named tanks (Bokara, Thoongama, Woolshed and Old Coonavitra), and two named bores (Bokara and Coolabah) (Fig. 3) were constructed for pastoral use prior to the park gazettal.

The Southern (Emmdale) block of Coonavitra is south of the Barrier Highway and incorporates 8,437 ha of the former Coonavitra Station (a number of old yards are scattered across the park). Several swamps hold water following significant rain and there are four named tanks (Hamton, Kurumpto and Eram), and one named bore (Bruton) constructed prior to park gazettal (Fig. 3).

Transect survey

A preliminary survey of vegetation communities within Coonavitra was undertaken in June 2005, following three years of drought. A transect-based sampling strategy was employed. Driven transects followed existing vehicle access tracks and fence lines, walked transects were across country. All transects were tracked using a Global Positioning System (GPS) receiver in the Australian Map Grid projection (Zone 54 and 55) and the 1984 World Geodetic System datum. The survey included approximately 205 km of walked and driven transects (Fig. 3). Vegetation communities along these transects were recorded and dominant perennial species listed for each community. A preliminary vegetation map at a scale of 1: 50,000 was prepared. Details of how information was collected along these transect and used to define vegetation communities are outlined below.

Table 2. Modified Braun-Blanquet scale (Kershaw & Looney 1985

Scale	Definition
+	Few individuals, less than 1% cover
1	Any number of individuals, less than 5% cover
2	Any number of individuals, 6–25% cover
3	Any number of individuals, 26–50% cover
4	Any number of individuals, 51–75% cover
5	Any number of individuals, 76–100% cover

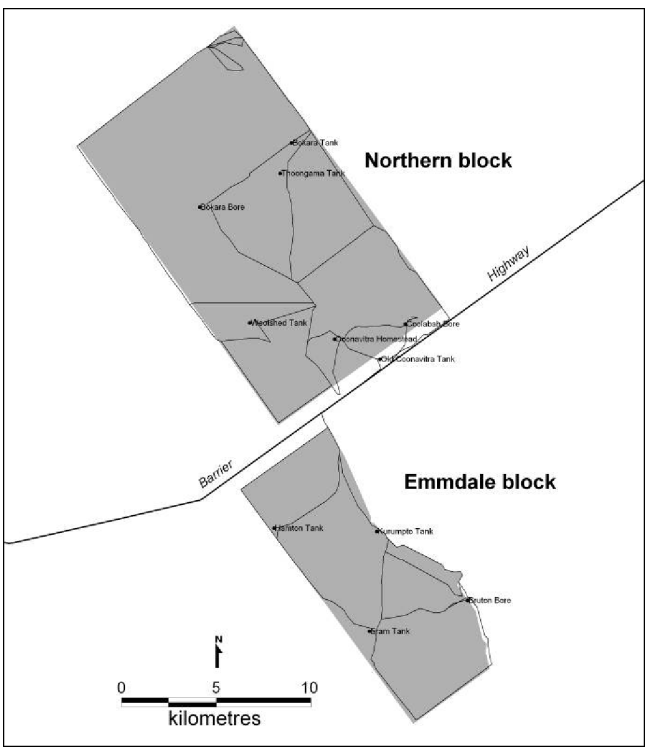

Fig. 3. Survey transects for the Coonavitra area

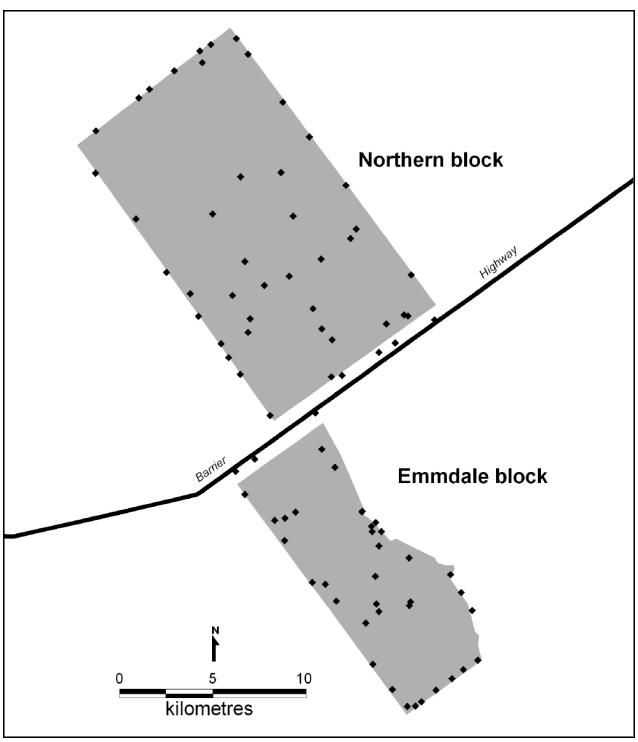

Fig. 4. Quadrat locations for the Coonavitra area

Quadrat survey

In November 2005 following good winter rainfall, a detailed floristic survey was undertaken. A quadrat-based sampling strategy was employed to survey the floristic composition of the vegetation communities. All quadrats were 900 m^2 (30 m x 30 m) in size. The sampling strategy was based on the preliminary vegetation map prepared following the June survey. Communities were generally sampled in proportion to the area they covered but to enable characterisation of communities, those of limited distribution may have been relatively over-sampled. All quadrat locations were recorded using a Global Positioning System (GPS) receiver in the Australian Map Grid projection (Zone 54 and 55) and the 1984 World Geodetic System datum. All vascular plant species occurring in each quadrat were recorded, identified to species level where possible and their conservation status determined. All flora were given a cover / abundance value, modified from Braun-Blanquet scale (as in Kershaw & Looney 1985) (Table 2).

The field survey was undertaken during early spring following good winter rains to take advantage of the opportunities for plant identification, particularly grasses, herbs and forbs. Some later spring-flowering grasses, herbs and forbs may have been dormant at this time and not observed. Similarly,

Table 3 Vegetation communities of Coonavitra with their area and relationship to soil and landform

Note: The total mapped area is 20,174 ha for the Northern block and 8,970 ha for the Emmdale block including the park and the road reserve between the blocks. Point locations of communities (i.e. Anthropogenic herbland) have been treated as occupying approximately 1 ha. Equivalent Benson (2006) vegetation community I.D numbers are shown in bracket

Vegetation community	Area (ha) approx		Soil and landform
	North	Emmdale	
Woodlands			
Callitris glaucophylla open woodland (246)	-	12	Sandy rises within the Bell Vale, Manara, Blackfella and Nelia landsystems of the Emmdale block.
Casuarina pauper / Alectryon oleifolius low open woodland (58)	9,124	4,943	Calcareous sandplains of the Nelia landsystem of both blocks and sandplains of the Bell Vale, Manara and Fulham landsystems of the Emmdale block.
Eucalyptus coolabah / Eucalyptus largiflorens open woodland (38)	56	-	Fringing lakebeds of the Nelia landsystem of the Northern block.
Eucalyptus intertexta open woodland (108)	4	136	Undulating sandstone ridges of the Nelia landsystem of the Northern block and the Manara and Lilyvale landsystems of the Emmdale block.
Eucalyptus populnea open woodland (207)	546	648	Sinks within alluvial plains of the Karumpito and Nelia landsystems of both blocks and the Manara landsystem of the Emmdale block.
Flindersia maculosa low open woodland (144)	4,175	55	Aeolian sands and calcareous plains of the Coonavitra and Nelia landsystems of the Northern block and the Manara landsystem of the Emmdale block.
Tall shrublands			
Acacia aneura tall open shrubland (hills) (120)	2,348	380	Quartzite and sandstone hills of the Mulga Downs and Boorandarra landsystems of the Northern block and the Lilyvale, Manara and Nelia landsystems of the Emmdale block.
Acacia loderi tall open shrubland (128)	3,691	1,080	Calcareous plains of the Nelia landsystem.
Acacia melvillei tall open shrubland (23)	12	553	Calcareous plains of the Nelia landsystem.
Eucalyptus socialis tall open shrubland (173/193)	118	780	Aeolian dunes of the Nelia landsystem of both blocks and the Blackfella and Manara landsystems of the Emmdale block.
Hakea leucoptera tall open shrubland (199)	-	1	Plains of the Nelia landsystem.
Hakea tephrosperma tall open shrubland (199)	-	1	Plains of the Nelia landsystem.
Low shrublands			
Acacia victoriae open shrubland (139)	37	-	Undulating plains and dunes of the Nelia landsystem.
Eremophila / Dodonaea open shrubland (143)	-	340	Plains of the Nelia landsystem.
Grasslands			
Eragrostis australasica hummock grassland (24)	1	60	Lakes and depressions of the Karumpito landsystem.
Herblands			
Anthropogenic herbland	7	5	Areas subject to significant disturbance, including earth tanks and yards.
Lakebed herbland (166)	66	1	Lakes of the Karumpito landsystem of both blocks and the Blackfella landsystem of the Emmdale block.

earlier spring-flowering plants may have completed their growth cycles and may not have been observed. Where dead material (e.g. leaves, stems, seeds) was available such species were recorded to family, genus or species level where possible.

An estimate of the typical height and a visual estimate of the projected foliage cover of both native and introduced species in the tree layer, tall shrub layer (approximately > 1 m high), small shrub layer (approximately < 1 m high) and ground layer were recorded for each quadrat. Visual estimates of the total percentage cover of bare ground, cryptogams, litter, logs and rocks were recorded for each quadrat. All quadrats were photographed to provide a record of the appearance of the site but were not intended to provide permanent monitoring points. For the Coonavitra area 85 quadrats were sampled, 46 for the Northern block and 39 for the Emmdale block (Fig. 4).

The 1: 50,000 vegetation map produced following the June field survey was verified by ground checking the mapped boundaries of the vegetation communities via driven transects.

The map (Appendix 2) is also available on the Cunninghamia website.

Data analysis

Information from the transects was used in conjunction with colour aerial photographs (NSW Dept of Lands) and Landsat Thematic Mapper satellite imagery (Scene 95–83) to produce a vegetation map at 1: 50,000 scale. Vegetation mapping was undertaken using a combination of ArcGIS 9.0 and MapInfo Professional Version 7.5 Geographic Information Systems. The mapped vegetation communities were defined by floristic and structural characteristics (Specht 1970) coupled with expert judgment and analysis. The communities were then compared to those communities outlined in Benson (2006) to determine the equivalent vegetation community name and their conservation status.

Data from quadrats were entered into a Microsoft® Access 2002 database and analysed using PATN (Belbin 1993) to determine the communities present. Further restricted and/or interesting communities recorded during the field survey but not evident from the numeric classification were added to the final classification. Most communities identified from the vegetation classification were mapped at the 1:50,000 scale. Additional vegetation types of restricted occurrence or not evident from the classification were located as points on the map. A species list was compiled for the study area incorporating all vascular plant species recorded from quadrats and additional species recorded opportunistically. The flora list also identifies which vegetation community each of the species was recorded in. For each vegetation community, mean species richness, total species richness and mean numbers of introduced species per quadrat were calculated.

Results

Vegetation

The southern area of the Northern block of Coonavitra consists predominantly of *Casuarina pauper / Alectryon oleifolius* low open woodland with patches of *Eucalyptus populnea* and *Eucalyptus largiflorens* open woodland in low-lying areas. To the north is extensive *Flindersia maculosa* low open woodland on the sandplains surrounding the Greenough Hill range. The range supports *Acacia aneura* tall open shrubland. Extending along the north-western boundary of the block is a large expanse of *Acacia loderi* tall open shrubland. In the south-eastern corner of the block are a few patches of *Eucalyptus socialis* tall open shrubland.

The Emmdale block consists mostly of *Casuarina pauper / Alectryon oleifolius* low open woodland on the sandplain. The north of the block consists of *Acacia loderi* tall open shrubland and *Acacia melvillei* tall open shrubland with patches of *Eucalyptus populnea* open woodland in low-lying areas. Drainage lines support *Eragrostis australasicus* tussock grassland and fringing *Eucalyptus populnea* open woodland. South of this are areas of *Eucalyptus socialis* tall shrubland with *Eucalyptus intertexta* open woodland and *Acacia aneura* tall open shrubland on the rocky hills.

Eighteen communities were recognised and described for the Coonavitra area, 13 for the Northern block and 15 for the Emmdale block (Table 3). While several of these are of limited distribution they add significantly to the conservation values of the Park. Map 1 shows the distribution of each of the vegetation communities. The floristic composition of vegetation communities are outlined later in this section. A total list of flora species recorded for each vegetation community is provided in appendix 1.

Woodlands

Callitris glaucophylla open woodland

Small areas of *Callitris glaucophylla* open woodland (Fig. 5) occur on sandy rises in the south of the Emmdale block. Associated understorey shrubs include *Dodonaea viscosa* subsp. *angustissima*, *Eremophila sturtii*, *Hakea tephrosperma*, *Enchylaena tomentosa*, *Sclerolaena obliquicuspis*, *Salsola kali* var. *kali*, *Chenopodium desertorum* and *Atriplex stipitata*. Ground layer species include *Rhodanthe corymbiflora*, *Austrostipa scabra*, *Gnephosis foliata* and *Harmsiodoxa brevipes* var. *brevipes*.

Fig. 5. *Callitris glaucophylla* open woodland

Casuarina pauper / Alectryon oleifolius low open woodland

Casuarina pauper / Alectryon oleifolius low open woodland (Fig. 6) growing to 10–12 metres tall is widespread on undulating sandplains including a large area in the south of the Northern block. Most commonly associated understorey shrubs are *Dissocarpus paradoxus*, *Sclerolaena obliquicuspis*, *Sclerolaena diacantha*, *Eremophila sturtii*, *Enchylaena tomentosa*, *Chenopodium desertorum*, *Chenopodium curvispicatum* and *Atriplex stipitata*. Commonly associated ground layer species include *Austrostipa scabra*, *Rhodanthe corymbiflora* and *Pycnosorus pleiocephala*.

Fig. 6. *Casuarina pauper / Alectryon oleifolius* low open woodland

Eucalyptus coolabah / Eucalyptus largiflorens open woodland

Small areas of *Eucalyptus coolabah / Eucalyptus largiflorens* open woodland (Fig. 7) (10 m tall) occur on heavy soils surrounding lakes in the south of the Northern block. Understorey shrubs frequently associated include *Dissocarpus paradoxus* and *Enchylaena tomentosa*. Associated ground layer species include *Pycnosorus pleiocephala*, *Rhodanthe floribunda* and *Plantago drummondii*.

Fig 7. *Eucalyptus coolabah / Eucalyptus largiflorens* open woodland

Eucalyptus intertexta open woodland

Eucalyptus intertexta open woodland (Fig. 8) (10 m tall) occurs on the sandy lower slopes of the sandstone hills located in the south of both blocks of the Coonavitra area. *Alectryon oleifolius* subsp. *canescens* is commonly associated. The shrubs *Sclerolaena diacantha*, *Sclerolaena convexula*, *Eremophila sturtii*, *Eremophila longifolia*, *Dodonaea viscosa* subsp. *angustifolia* and *Chenopodium desertorum* are frequently found within this community. Ground layer species frequently associated include *Rhodanthe corymbiflora*, *Waitzia acuminata* and *Austrostipa scabra*.

Fig. 8. *Eucalyptus intertexta* open woodland

Eucalyptus populnea open woodland

This open woodland (10 m tall) dominated by *Eucalyptus populnea* subsp. *bimbil* (Fig. 9) is associated with drainage lines and depressions. Understorey shrub species frequently associated include *Dissocarpus paradoxus*, *Eremophila sturtii*, *Atriplex stipitata*, *Enchylaena tomentosa*, *Dodonaea viscosa* subsp. *angustifolia* and *Sclerolaena obliquicuspis*. Associated ground layer species include *Austrostipa scabra*, *Pycnosorus pleiocephala*, *Einadia nutans*, *Rhodanthe floribunda* and *Rhodanthe corymbiflora*.

Fig. 9. *Eucalyptus populnea* open woodland

Flindersia maculosa low open woodland

Low open woodland dominated by *Flindersia maculosa* (Fig. 10) occurs on low hills and sandplains. *Alectryon oleifolius* subsp. *canescens* and *Apophyllum anomalum* are frequently associated. Associated shrubs include *Dissocarpus paradoxus*, *Sclerolaena obliquicuspis*, *Atriplex stipitata*, *Enchylaena tomentosa*, *Sclerolaena diacantha*, *Eremophila sturtii*, *Maireana pyramidata* and *Salsola kali* var. *kali*. Ground layer species include *Austrostipa scabra*, *Rhodanthe corymbiflora*, *Lepidium oxytrichum* and *Stenopetalum lineare*.

Fig. 10. *Flindersia maculosa* low open woodland

Tall shrublands

Acacia aneura tall open shrubland (hills)

Tall open shrubland dominated by *Acacia aneura* (Fig. 11) occurs on the rocky hills of the Greenough Hill range in the Northern block and the central and southern section of the Emmdale Block. Associated shrubs include *Sclerolaena convexula*, *Enchylaena tomentosa*, *Eremophila longifolia* and *Atriplex stipitata*. Ground layer species include *Rhodanthe corymbiflora*, *Austrostipa scabra*, *Ptilotus polystachyus* var. *polystachyus*, *Ptilotus atriplicifolius* var. *atriplicifolius*, *Lepidium oxytrichum*, *Daucus glochidiatus*, *Thyridolepis mitchelliana*, *Solanum ferocissimum*, *Stenopetalum lineare* and *Goodenia gracilis*.

Fig. 11. *Acacia aneura* tall open shrubland (hills)

Acacia loderi tall open shrubland

Tall open shrubland dominated by *Acacia loderi* (Fig. 12) occurs over large areas of Coonavitra. Common associates are *Casuarina pauper* and *Alectryon oleifolius* subsp. *canescens*. Associated shrubs include *Dissocarpus paradoxus*, *Atriplex stipitata*, *Enchylaena tomentosa*, *Eremophila sturtii*, *Eremophila longifolia* and *Sclerolaena obliquicuspis*. Ground layer species include *Rhodanthe corymbiflora*, *Austrostipa scabra*, *Pycnosorus pleiocephala*, *Gnephosis foliata* and *Einadia nutans*.

Fig. 12. *Acacia loderi* tall open shrubland

Acacia melvillei tall open shrubland

Tall open shrubland dominated by *Acacia melvillei* (Fig. 13) occurs in the north of the Emmdale block of Coonavitra. Common associates are *Acacia loderi*, *Casuarina pauper* and *Alectryon oleifolius* subsp. *canescens*. Most commonly associated understorey shrubs are *Dodonaea viscosa* subsp. *angustifolia*, *Eremophila sturtii*, *Sclerolaena obliquicuspis* and *Dissocarpus paradoxus*. Ground layer species include *Rhodanthe corymbiflora*, *Pycnosorus pleiocephala*, *Brachyscome lineariloba* and *Austrostipa nodosa*.

Fig. 13. *Acacia melvillei* tall open shrubland

Eucalyptus socialis tall open shrubland (shrub understorey)

Tall open shrubland dominated by *Eucalyptus socialis* (Fig. 14) occurs on low aeolian dunes in the south of the Emmdale block of Coonavitra. A small area of this community also occurs east of Coonavitra Homestead adjacent to Coolabah Bore. Understorey shrubs include *Dissocarpus paradoxus*, *Chenopodium desertorum*, *Atriplex stipitata*, *Eremophila sturtii*, *Sclerolaena diacantha*, *Sclerolaena parviflora*, *Senna form taxon 'petiolaris'*, *Maireana pentatropis*, *Pittosporum phylliraeoides*, *Zygophyllum eremaeum* and *Dodonaea viscosa* subsp. *angustifolia*. Ground layer species include *Austrostipa scabra*, *Ptilotus atriplicifolius* var. *atriplicifolius*, *Ptilotus polystachyus* var. *polystachyus* and *Rhodanthe corymbiflora*.

Fig. 14. *Eucalyptus socialis* tall open shrubland (shrub understorey)

Eucalyptus socialis tall open shrubland (Triodia understorey)

On deeper sands of the aeolian dunes tall open shrubland dominated by *Eucalyptus socialis* (Fig. 15) occurs with an understorey dominated by *Triodia scariosa*. Associated understorey shrubs include *Calotis plumulifera*, *Chenopodium desertorum*, *Dodonaea viscosa* subsp. *angustifolia*, *Halgania cyanea*, *Myoporum platycarpum*, *Sclerolaena diacantha*, *S. parviflora*, *Senna form taxon* '*petiolaris'* and *Zygophyllum eremaeum*. Ground layer species include *Austrostipa scabra*, *Corynotheca lateriflora*, *Ptilotus exaltatus* var. *exaltatus*, *Ptilotus polystachyus* var. *polystachyus*, *Rhodanthe corymbiflora* and *Waitzia acuminata*.

Fig. 15. *Eucalyptus socialis* tall open shrubland (*Triodia* understorey)

Hakea leucoptera tall open shrubland

Small patches of tall open shrubland dominated by *Hakea leucoptera* (Fig. 16) occur on sandplains. Associated shrub species include *Sclerolaena convexula*, *S. obliquicuspis*, *Dodonaea viscosa* subsp. *angustifolia*, *Calotis hispidula*, *Dissocarpus paradoxus* and *Enchylaena tomentosa*. Ground layer species include *Austrostipa nitida*, *Rhodanthe corymbiflora*, *Brachyscome lineariloba*, *Bracteantha bracteata*, *Pycnosorus pleiocephala* and *Stenopetalum lineare*.

Fig. 16. *Hakea leucoptera* tall open shrubland

Hakea tephrosperma tall open shrubland

Small patches of tall open shrubland dominated by *Hakea tephrosperma* (Fig. 17) occur on sandplains. Shrub associates include *Dodonaea viscosa* subsp. *angustissima*, *Sclerolaena obliquicuspis*, *S. diacantha*, *Dissocarpus paradoxus* and *Chenopodium desertorum*. Ground layer species include *Pimelea trichostachya*, *Rhodanthe corymbiflora*, *Ptilotus polystachyus* var. *polystachyus* and *Austrostipa scabra*.

Fig. 17. *Hakea tephrosperma* tall open shrubland

Low shrublands

Acacia victoriae open shrubland

Acacia victoriae open shrubland (Fig. 18) occurs on sandy rises. Associated shrub species include *Maireana brevifolia*, *Enchylaena tomentosa* and *Dissocarpus paradoxus*. Ground layer species include *Rhodanthe corymbiflora*, *Austrostipa scabra* and *Pycnosorus pleiocephalus*.

Fig. 18. *Acacia victoriae* open shrubland

Eremophila / Dodonaea open shrubland

On sandy rises are areas of mixed species shrubland in which *Dodonaea viscosa* subsp. *angustissima* and *Eremophila sturtii* are prominent (Fig. 19). This community is commonly associated with *Casuarina pauper* / *Alectryon oleifolius* low open woodland. Other associated shrubs include *Dissocarpus paradoxus*, *Einadia nutans*, *Chenopodium desertorum*, *Sclerolaena obliquicuspis*, *Sclerolaena muricata*, *Sclerolaena diacantha*, *Atriplex stipitata*, *Enchylaena tomentosa* and *Calotis hispidula*. Common ground layer associates include *Austrostipa trichophylla*, *Austrostipa scabra*, *Ptilotus atriplicifolius* var. *atriplicifolius*, *Ptilotus polystachyus* var. *polystachyus*, *Brachyscome lineariloba*, *Rhodanthe floribunda*, *Plantago turrifera*, *Harmsiodoxa brevipes* var. *brevipes* and *Stenopetalum lineare*.

Fig. 19. *Eremophila* / *Dodonaea* open shrubland

Grasslands

Eragrostis australasica grassland

Areas of *Eragrostis australasica* grassland (Fig. 20) occur in shallow lakes and in relic lakes within sandplains. *Muehlenbeckia florulenta* may be associated and other associated low shrubs and herbs include *Pycnosorus pleiocephala*, *Lachnagrostis filiformis*, *Malva australiana*, *Rhodanthe corymbiflora*, *Sclerolaena tricuspis*, *Sclerolaena muricata*, *Plantago drummondii*, *Lepidium pseudohyssopifolium*, *Atriplex lindleyi* and *Myosurus minimus* var. *australis*.

Fig. 20. *Eragrostis australasica* grassland

Herblands

Anthropogenic herbland

Sites which had been subject to significant disturbance through the pastoral history of the properties, including homestead sites, earth tanks (Fig. 21) and yards had a predictably, high proportion of weed species.

Fig. 21. Anthropogenic herbland

Lakebed herbland

As the lakes dry out after flooding an annual herbland develops (Fig. 22). This is dominated by annuals including *Scleroleana* species. It is likely that the species composition of these areas is variable and dependant on seasonality of rainfall events, with grasses becoming more prominent following good summer rainfall. These herblands warrant a more detailed study through several seasons.

Fig. 22. Lakebed herbland

Plant species

A total of 261 vascular plant species from 50 families were recorded during this study of the Coonavitra area (appendix 1). Of the plant species recorded from the Park, 37 (14%) are introduced. The sampling effort in each vegetation community, mean and total native and introduced species richness is shown in Table 4.

Discussion

Mapping communities

There are a number of inherent problems in mapping vegetation: vegetation mapping assumes discontinuities between communities which may not exist; the constraints of cartography determine the minimum area that can clearly be distinguished; it is generally not feasible to groundtruth the whole of an area, thus parts of the map assume a consistent relationship between the vegetation and other features such as soil type and topography.

Beadle's (1948) map of western NSW (at approximately 1:1 000 000 scale) includes two units for the Coonavitra area. James's (1960) map of the Paroo-Upper Darling shows three vegetation units and Milthorpe (1991) 1:500 000 map of north western NSW shows five units. Pickard and Norris's (1994) 1:1 000 000 map of north-western NSW shows nine. In our 1:50 000 scale map, 14 units are mapped and a further three indicated by point location. It was difficult to separate the two *Eucalyptus socialis* tall open shrubland communities (i.e. shrub understorey and *Triodia* understorey) and areas supporting *Eucalyptus socialis* tall open woodland are mapped as one unit. The map suffers from the limitations noted above. The smallest area that could be mapped was 100 m wide. Some areas remote from tracks may include small patches of a different vegetation unit from that mapped.

During the survey over 200 km of driven and walked transects were traversed, and given the association of many vegetation communities with landscape features, boundaries could be drawn with some confidence. Current mapping technology enables changes to be readily incorporated, and it is hoped that the map will be refined following further botanical survey.

Distribution of communities

The distribution and species composition of vegetation communities within Paroo Darling National Park is largely determined by variation in topography, landform position and soil type. Eucalypt species open woodlands are associated with texture contrast soils of the major creeklines. Shrubland dominated by *Acacia aneura* occurs on the lithosols of the quartzite and sandstone hills with *Eucalyptus intertexta* woodland on the red earths that occur on the footslopes. Woodlands variously dominated by *Casuarina pauper*, *Acacia aneura* and *Flindersia maculosa* occur on desert loams. Other factors, notably past grazing history, have also played a role in determining the present distribution and floristic composition of the communities present.

Vegetation condition

Whilst this was not intended to be a detailed assessment of vegetation condition, regeneration of overstorey and perennial understorey species was noted. Species richness

Table 4. Sampling intensity, species richness and weediness of vegetation communities of the Coonavitra area

Vegetation community	No. of quads.	Native species richness		Introduced species richness	
		Mean	Total	Mean	Total
Woodlands					
Callitris glaucophylla open woodland	1	17.0	17	3.0	3
Casuarina pauper / Alectryon oleifolius low open woodland	15	18.1	81	3.1	14
Eucalyptus coolabah / Eucalyptus largiflorens open woodland	2	9.0	14	4.5	6
Eucalyptus intertexta open woodland	5	18.6	56	2.8	10
Eucalyptus populnea open woodland	8	15.1	47	4.1	10
Flindersia maculosa low open woodland	9	19.8	69	3.6	12
Tall shrublands					
Acacia aneura tall open shrubland (hills)	9	21.1	85	1.7	11
Acacia loderi tall open shrubland	12	17.5	73	3.7	11
Acacia melvillei tall open shrubland	2	19.5	31	7.0	10
Eucalyptus socialis tall open shrubland (shrub understorey)	4	16.3	38	1.8	5
Eucalyptus socialis tall open shrubland (*Triodia* understorey)	2	29.0	40	1.0	1
Hakea leucoptera tall open shrubland	1	16.0	16	4.0	4
Hakea tephrosperma tall open shrubland	1	15.0	15	3.0	3
Low shrublands					
Acacia victoriae open shrubland	1	7.0	7	6.0	6
Eremophila / Dodonaea open shrubland	2	15.5	26	4.5	5
Grasslands					
Eragrostis australasica hummock grassland	5	12.0	33	5.4	13
Herblands					
Anthropogenic herbland	4	11.0	30	10.0	21
Lakebed herbland	2	12.0	21	7.5	12

Table 5. Conservation status of vegetation communities on Coonavitra based on Benson (2006)

Vegetation community	Area (ha) approx	Equivalent Benson (2006) vegetation community I.D	Conservation status (Benson 2006)
Woodlands			
Callitris glaucophylla open woodland	12	246	Least Concern
Casuarina pauper / Alectryon oleifolius low open woodland	14,067	58	Near Threatened
Eucalyptus coolabah / Eucalyptus largiflorens open woodland	56	38	Least Concern
Eucalyptus intertexta open woodland	140	108	Least Concern
Eucalyptus populnea open woodland	1,194	207	Least Concern
Flindersia maculosa low open woodland	4,230	144	Near Threatened
Tall shrublands			
Acacia aneura tall open shrubland (hills)	2,728	120	Near Threatened
Acacia loderi tall open shrubland	4,771	128	Endangered (*Threatened Species Conservation Act 1995*)
Acacia melvillei tall open shrubland	565	23	Endangered (*Threatened Species Conservation Act 1995*)
Eucalyptus socialis tall open shrubland	898	173/193	Near Threatened/Endangered
Hakea leucoptera tall open shrubland	1	199	Near Threatened
Hakea tephrosperma tall open shrubland	1	199	Near Threatened
Low shrublands			
Acacia victoriae open shrubland	37	139	Vulnerable
Eremophila / Dodonaea open shrubland	340	143	Least Concern
Grasslands			
Eragrostis australasica hummock grassland	61	24	Least Concern
Herblands			
Anthropogenic herbland	12	N/A	N/A
Lakebed herbland	67	166	

and weediness are additional factors which give some measure of vegetation condition. The communities of the Emmdale block are overall in very good condition despite the history of domestic grazing and suggests that this part of the Park has previously been subject to a relatively conservative grazing regime.

Conservation status of vegetation communities

The communities mapped correspond to those listed by Benson (1989) and Benson (2006) and nine of the communities recorded are listed as Endangered, Near Threatened or Vulnerable (Table 5).

Acacia loderi tall open shrubland and *Acacia melvillei* tall open shrubland are listed as Endangered Ecological Communities under the NSW *Threatened Species Conservation Act 1995*. Both communities are severely degraded over most of their range with old senescing trees and little regeneration (Benson 2006). The area of *Acacia loderi* within the northern block is almost certainly the largest intact example within a conservation reserve. There is evidence of regeneration of the overstorey which is rare over much of its range.

Eucalyptus socialis tall open shrubland is listed as Near Threatened and the area in the south of the Emmdale block is one of the northernmost occurrences. A small area consisting of very tall trees east of Coonavitra Homestead is probably an example of the extremely tall "tree mallee" Community 199 described by Benson (2006).

Acacia victoriae open shrubland is regarded as Vulnerable due to continual grazing by stock and rabbits and loss of the original *Callitris* overstorey (Benson 2006).

A number of woodland communities are regarded as Near Threatened largely due to past timber harvesting and lack of regeneration. These include *Casuarina pauper / Alectryon oleifolius* low open woodland, *Flindersia maculosa* low open woodland, *Acacia aneura* tall open shrubland (hills), and *Hakea leucoptera / Hakea tephrosperma* tall open shrubland.

The presence of these communities means that this part of Paroo Darling National Park makes a significant contribution to conservation of plant communities in NSW.

Plant species

236 species of vascular plants were recorded during this study. Though this survey was undertaken following three years of severe drought, good winter rains meant that a range of herbs and grass were recorded, but it is likely that many more species are still to be recorded.

The highest representation of these species recorded for the Coonavitra area was from the family Asteraceae (42) followed closely by Chenopodiaceae (39). The highest levels of introduced species were in communities subject to the greatest influence from water and disturbance. These include the Anthropogenic herblands around earth tanks, the Lakebed herbland associated with the Gulguy Waterholes and areas of *Eragrostis australasica* grassland associated with the natural wetlands of the Emmdale block. This is in accord with Westbrooke (1990) who found a high negative correlation between occurrence of introduced species and distance from water in studies at Mallee Cliffs National Park and Nanya Station. Whilst relatively large numbers of introduced species were also recorded for *Acacia victoriae* open shrubland and *Acacia melvillei* tall open shrubland, the number of quadrats sampled was limited.

None of the species recorded during this study are listed under the Commonwealth Government *Environment Protection and Biodiversity Conservation Act 1999* or the NSW *Threatened Species Conservation Act 1995*.

Acknowledgements

This work was carried out under the conditions of Licence S10283 of the New South Wales National Parks and Wildlife Service (NSW NPWS). We acknowledge the support of the NSW NPWS in the conduct of this survey, in particular Paul Burton for his hospitality and friendship. We would also like to thank Sara Munawar, Kate Callister, Singarayer Florentine, Rosie Grundell, Andrew Warnock and Grant Palmer for their assistance with the field survey and Janet Leversha for assistance throughout the project

References

Abraham, N. A. (1991) Geomorphology. In: *Lands of the North-West Corner of NSW – Technical Report No. 12.* Ed. P.L. Milthorpe, Soil Conservation Service of NSW.

Beadle, N.C.W. (1945). *Vegetation Map of Western New South Wales*. Soil Conservation Service, Sydney.

Beadle, N.C.W. (1948). *The Vegetation and Pastures of Western New South Wales with Special Reference to Soil Erosion*. Government Printer, Sydney.

Benson, J. (1989). Establishing priorities for the conservation of rare or threatened plants and plant associations in New South Wales. In: *The Conservation of Threatened Species and Their Habitats – Occasional Paper No. 2: 17–82*. Eds. M. Hicks and P. Eiser. Australian Committee for IUCN, Canberra.

Benson, J. S. (2006) New South Wales vegetation classification and assessment: Introduction – the classification, database, assessment of protected areas and threat status of plant communities. *Cunninghamia* 9(3): 331–382.

Benson, J. S., Allen, C. B., Togher, C. and Lemmon, J. (2006) New South Wales vegetation classification and assessment: Part 1 plant communities of the NSW Western Plains. *Cunninghamia* 9(3): 383– 450.

Belbin, L. (1993). *PATN Manuals*. CSIRO Wildlife and Ecology, Lyneham, ACT.

Clewett, J. F., Clarkson, N. M., Owens, D. T. and Abrecht, D. G. (1994). *Australian Rainman: Rainfall Information for Better Management.* Department of Primary Industries, Brisbane.

Edwards, K. (1979). *Rainfall in New South Wales – With Special Reference to Soil Conservation – Technical Handbook No. 3.* Soil Conservation Service of New South Wales, Sydney.

Hardy, B. (1969). *West of the Darling*. Rigby, Adelaide.

Hazelton, P. (1977). *Wilcannia Land Systems Series Sheet SH 54–16*. New South Wales, Soil Conservation Service.

Heathcote, R. L. (1965). *Back of Bourke: A Study of Land Appraisal and Settlement in Semi-arid Australia*. Melbourne University Press, Carlton.

Hunter, J. and Fallavollita, E. (2003). *Vegetation and Floristics of Paroo Darling National Park – Thilta Karra Section*. Report to the New South Wales National Parks and Wildlife Service.

James, J. W. (1960). Erosion survey of the Paroo-Upper Darling region. Part III. Journal *of Soil Conservation Service of NSW* 16: 185–206.

Jervis, J. (1948). The west Darling country: its exploration and development. *Royal Australian Historical Society* 34: 65–88.

Kershaw, K. A. and Looney, J. H. H. (1985). *Quantitative and Dynamic Plant Ecology*. Edward Arnold, Caufield East, Victoria.

Knight, R. (1994). *Flora, Fauna and Wilderness Values of the Mount Glass and Peery Lake areas, Western New South Wales*. Report by the Wilderness Society to the Australian Heritage Commission, Sydney.

Lembit, R. (1993). *NSW Wilderness Review Stage II – Wilderness Area Investigation, Peery Lake and Mount Glass Study Areas – Botanical Survey Report*. Report to the Wilderness Society, Sydney.

Milthorpe, P. L. (1991). Vegetation. In: *Lands of the North–West Corner of NSW – Technical Report No. 12.* Ed. P.L. Milthorpe, Soil Conservation Service of NSW.

Morton, J. G. G. (1991). Geology. In: *Lands of the North-West Corner of NSW – Technical Report No. 12.* Ed. P.L. Milthorpe, Soil Conservation Service of NSW.

NPWS (2000). *File F/2835/vol. III – Peery*. New South Wales National Parks and Wildlife Service.

Pickard, J. and Norris, E. H. (1994). The natural vegetation of north-western New South Wales: notes to accompany the 1:1 000 000 vegetation map sheet. *Cunninghamia* 3(3): 423–464.

Pickard, J. (1990). Analysis of stocking records from 1884 to 1988 during the subdivision of Momba, the largest property in semi-arid New South Wales. *Proceedings of the Ecological Society of Australia* 16: 245–253.

Specht, R. L. (1970). Vegetation. In: *The Australian Environment*. Ed. G. W. Leeper. Melbourne University Press, Melbourne.

Stanley, R. J. (1991). Land settlement and development. In: *Lands of the North-West Corner of NSW – Technical Report No. 12*. Ed. P. L. Milthorpe. Soil Conservation Service of NSW.

Walker, P. (1972). *Barnato Land Systems Series Sheet SH 55–13*. New South Wales, Soil Conservation Service.

Westbrooke, M. E. (1990). Effects of grazing pressure on weediness in mallee communities: studies at Mallee Cliffs National Park and Nanya Station, south-western New South Wales. In: *The Mallee Lands: A Conservation Perspective*. Eds J. C. Noble, P. J. Joss and G.K. Jones. CSIRO, Melbourne.

Westbrooke, M., Gowans, S., Gibson, M., Callister, K., Palmer, G., Florentine, S., O'Keefe, M., Warnock, A. and Grundell, R. (2006). *The Vegetation of the Mount Murchison and Wilga areas, Paroo Darling National Park, Western New South Wales*. Report prepared for the New South Wales National Parks and Wildlife Service by the Centre for Environmental Management, University of Ballarat.

Westbrooke, M., Leversha, J., Gibson, M., Milne, R., Gowans, S., Harding, C., Callister, K. and O'Keefe, M. (2002). *The Vegetation of Peery National Park Western New South Wales*. Report prepared for the New South Wales National Parks and Wildlife Service by the Centre for Environmental Management, University of Ballarat, Victoria.

Westbrooke, M., Leversha, J., Gibson, M., O'Keefe, M., Milne, R., Gowans, S., Harding, C. and Callister, K. (2003). The vegetation of Peery Lake area, Paroo Darling National Park, western New South Wales. *Cunninghamia* 8(1): 111–128.

Manuscript accepted 4 November 2010

Appendix 1: Flora species recorded within the Coonavitra area with frequency (%) of occurrence in communities

Nomenclature is according to Harden (1990–1993). * denotes introduced species.

Vegetation communities

Woodlands

1 *Callitris glaucophylla* open woodland
2 *Casuarina pauper / Alectryon oleifolius* low open woodland
3 *Eucalyptus coolabah / Eucalyptus largiflorens* open woodland
4 *Eucalyptus intertexta* open woodland
5 *Eucalyptus populnea* open woodland
6 *Flindersia maculosa* low open woodland

Tall shrublands

7 *Acacia aneura* tall open shrubland (hills)
8 *Acacia loderi* tall open shrubland
9 *Acacia melvillei* tall open shrubland
10 *Eucalyptus socialis* tall open shrubland (shrub understorey)
11 *Eucalyptus socialis* tall open shrubland (*Triodia* understorey)
12 *Hakea leucoptera* tall open shrubland
13 *Hakea tephrosperma* tall open shrubland

Low shrublands

14 *Acacia victoriae* open shrubland
15 *Eremophila / Dodonaea* open shrubland

Grasslands

16 *Eragrostis australasica* hummock grassland

Herblands

17 Anthropogenic herbland
18 Lakebed herbland

		Vegetation communities																	
	Taxon, family and name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
	Number of quadrats	**1**	**15**	**2**	**5**	**8**	**9**	**9**	**11**	**2**	**4**	**2**	**1**	**1**	**1**	**2**	**5**	**4**	**2**
	CONIFERS																		
	Cupressaceae																		
	Callitris glaucophylla	100	7																
	FERNS																		
	Adiantaceae																		
	Cheilanthes austrotenuifolia							33											
	Cheilanthes lasiophylla							22											
	Cheilanthes spp.							11											
	MONOCOTYLEDONS																		
	Amaryllidaceae																		
	Crinum flaccidum					13													
	Asphodelaceae																		
*	*Asphodelus fistulosus*								8										
	Bulbine alata							11											
	Bulbine bulbosa							11			25								
	Cyperaceae																		
	Eleocharis pallens																20		
	Phormiaceae																		
	Corynotheca lateriflora											100							
	Poaceae																		
	Aristida spp.																20		
	Austrostipa eremophila				20														
	Austrostipa nitida		7			13	22		17				100						
	Austrostipa nodosa							11		100									
	Austrostipa platychaeta						11												
	Austrostipa scabra	100	93		60	100	89	78	75		100	100		100	100	50			50

		Vegetation communities																
	Taxon, family and name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
	Number of quadrats	**1**	**15**	**2**	**5**	**8**	**9**	**9**	**11**	**2**	**4**	**2**	**1**	**1**	**1**	**2**	**5**	**4**	**2**
	Austrostipa scabra ssp *scabra*							11	8										
	Austrostipa spp.					13	11		17										
	Austrostipa trichophylla		7				11	11	8							50			
	Brachyachne ciliaris											50							
	Elymus scaber var. *scaber*		7					11											
	Eragrostis australasica																100		
	Eragrostis dielsii	100	7		20			11	8			50					20		
	Eragrostis eriopoda							11											
	Eragrostis setifolia				20	13													
*	*Hordeum leporinum*		7	50		25	11								100	100	80	50	100
	Lachnagrostis filiformis																80	75	50
	Monachather paradoxa				40			33											
*	*Schismus barbatus*		47	100	20	25	33								100	50			50
	Thyridolepis mitchelliana				40			44											
	Triodia scariosa										25	100							
*	*Vulpia muralis*				20			11									20		
*	*Vulpia* spp.				20			11											
	Xanthorrhoeaceae																		
	Lomandra spp.											50							
	DICOTYLEDONS																		
	Aizoaceae																		
	Tetragonia eremaea		7				11		17								20		50
	Amaranthaceae																		
	Alternanthera nodiflora																20		
	Ptilotus atriplicifolius var. *atriplicifolius*		27			25	22	44	33	50	50	50				50			
	Ptilotus exaltatus var. *exaltatus*				20			11		50	25	100							
	Ptilotus gaudichaudii							11											
	Ptilotus gaudichaudii var. *goudchaudiii*							22											
	Ptilotus nobilis var. *nobilis*					13													
	Ptilotus polystachyus var. *polystachyus*	100	20		40		11	67			50	100		100		50			
	Apiaceae																		
	Daucus glochidiatus							44				50							
	Asclepiadaceae																		
	Leichardtia australis		7		20		11	11	8										
	Rhyncharrhena linearis					13			8										
	Asteraceae																		
	Actinobole uliginosum		7													50			
	Brachyscome ciliaris var. *lanuginosa*							11											
	Brachyscome lineariloba		33			38	22	11	25	100		50	100	100		50			50
	Bracteantha bracteata					13	11	11			25		100				20		
	Calotis hispidula		20					22					100			50			
	Calotis plumulifera		7		20							100							
	Calotis scapigera							11											
	Calotis spp.		7				22	22	17	100						50			
*	*Carthamus lanatus*						11											50	
*	*Centaurea melitensis*				20	13	11	11	33	50					100		60	100	50
	Centipeda cunninghamii																20	75	
	Centipeda spp.																	25	
	Centipeda thespidioides																20		
	Chthonocephalus pseudevax		20																
*	*Cirsium vulgare*				20												20	50	
	Euchiton spp.																	25	
	Gnephosis foliata	100	27			13	22	11	42										
*	*Hedypnois rhagadioloides* ssp *cretica*										25								
	Helipterum hyalospermum							11											
	Helipterum moschatum		7	50															
	Ixiolaena leptolepis								8	50									
*	*Lactuca serriola*																	25	
	Leucochrysum molle							11											
	Minuria cunninghamii					13													
	Minuria integerrima																20		
	Olearia pimeleoides										25								
	Pseudognaphalium luteoalbum		7					11						100			20	25	
	Pycnosorus pleiocephala		53	50	20	63	33		50	100	25		100	100			80	25	100
	Pycnosorus pleiocephalus		20			13	22		25						100		20		
	Rhodanthe corymbiflora	100	60		100	50	78	100	100	100	50	100	100	100	100		60	25	100

		Vegetation communities																	
	Taxon, family and name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
	Number of quadrats	**1**	**15**	**2**	**5**	**8**	**9**	**9**	**11**	**2**	**4**	**2**	**1**	**1**	**1**	**2**	**5**	**4**	**2**
	Rhodanthe floribunda		13	50		50		11	8							50		75	
	Senecio glossanthus		13		20													25	
	Senecio quadridentatus																	25	
	Senecio spp.																	25	
*	*Sonchus asper* subsp. *glaucescens*								8										
*	*Sonchus oleraceus*						11											50	
	Sonchus spp.		13														20		
	Vittadinia cuneata		20				11	11		50									
	Vittadinia dissecta											50							
	Vittadinia spp.		7			13						50							
	Waitzia acuminata		13		60		11	22			25	100							
*	*Xanthium spinosum*																	75	
	Boraginaceae																		
*	*Echium plantagineum*	100	7		20		11	22	8					100			20	100	50
	Halgania cyanea											100							
	Heliotropium curassavicum																	25	
	Heliotropium europaeum																	25	
*	*Heliotropium supinum*																	25	
	Omphalolappula concava		7																
	Brassicaceae																		
*	*Alyssum linifolium*		13	50		38	22		25	100			100			100	20		50
	Arabidella trisecta				20				8										
*	*Brassica tournefortii*	100	47		60	50	56	22	17	100	75	100	100	100		100	80	50	50
*	*Carrichtera annua*	100	47	50	40	38	78	11	83	100	25		100				80	75	50
	Harmsiodoxa brevipes var. *brevipes*	100	40		40	13		11		50						50			
	Lepidium hyssopifolium				20													25	
	Lepidium muelleri-ferdinandi											50							
	Lepidium oxytrichum		33			25	56	67	25			50							
	Lepidium papillosum								8	50									
	Lepidium pseudohyssopifolium																60	25	50
	Lepidium spp.		7						33								20		50
*	*Sisymbrium erysimoides*		47	100		88	67		67	50					100		20	25	100
*	*Sisymbrium irio*					13			17									50	50
*	*Sisymbrium orientale*		7																
*	*Sisymbrium* spp.									50									
	Stenopetalum lineare		20		20	25	44	44	17	50	25		100			50			
	Caesalpiniaceae																		
	Senna form taxon 'artemisioides'		7		20			22	8			50							
	Senna form taxon 'coriacea'								8										
	Senna form taxon 'filifolia'		7		20		11				25								
	Senna form taxon 'petiolaris'						11		17		50	100							
	Campanulaceae																		
	Wahlenbergia spp.							33											
	Capparidaceae																		
	Apophyllum anomalum		33	50	20	38	56		17										
	Caryophyllaceae																		
*	*Spergularia rubra*		7			25		11			25						40	25	50
	Casuarinaceae																		
	Casuarina pauper		93				33		17										
	Chenopodiaceae																		
	Atriplex angulata																20		
	Atriplex eardleyae									50									50
	Atriplex holocarpa								8										
	Atriplex limbata		27	50	20	13	11		25	50									
	Atriplex lindleyi																40	25	
	Atriplex spp.		7			13											80		
	Atriplex stipitata	100	47		20	75	78	56	75	50	75					50		25	
	Chenopodium cristatum								8										
	Chenopodium curvispicatum		47		20	13	22	11	33			50							
	Chenopodium desertorum	100	53		60		33	33	17	50	75	100		100		50	20		
	Chenopodium melanocarpum		7																
	Dissocarpus paradoxus		80	100	40	100	100		92	100	100	50	100	100	100	100			
	Einadia nutans		40		40	63	11	33	42							100			
	Enchylaena tomentosa	100	67	100	20	63	78	67	67		25	50	100		100	50	20	50	
	Maireana brevifolia					13	11		8						100				
	Maireana georgei									50									
	Maireana microcarpa								8								20		
	Maireana pentatropis						11				50								
	Maireana pyramidata		7				44		33		25								

		Vegetation communities																
	Taxon, family and name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
	Number of quadrats	**1**	**15**	**2**	**5**	**8**	**9**	**9**	**11**	**2**	**4**	**2**	**1**	**1**	**1**	**2**	**5**	**4**	**2**
	Maireana spp.						33	22	17										
	Maireana triptera							11											
	Maireana villosa							11											
	Salsola kali var. *kali*	100	33			25	44		25	50		50		100					
	Sclerochlamys brachyptera								8										
	Sclerochlamys spp.																	25	
	Sclerolaena bicornis							11											
	Sclerolaena convexula		7		60			78				50	100						
	Sclerolaena decurrens		7																
	Sclerolaena diacantha		67		80	25	67	22			75	100		100		50			
	Sclerolaena divaricata								8								20		
	Sclerolaena intricata		7				11		17									50	50
	Sclerolaena lanicuspis								17										
	Sclerolaena longicuspis																		50
	Sclerolaena muricata						11									50	40	50	50
	Sclerolaena obliquicuspis	100	73		20	50	78	11	58	100	25		100	100		50			50
	Sclerolaena parviflora				20						50	100					20		
	Sclerolaena spp.			50			11		8							50			
	Sclerolaena stelligera						11												
	Sclerolaena tricuspis		7				22										60	25	50
	Convolvulaceae																		
*	*Convolvulus arvensis*		7																
	Convolvulus clementii		7				11												
	Convolvulus spp.		7						8	50			100						50
	Crassulaceae																		
	Crassula colorata								8										
	Crassula spp.		27			13			8							50			
	Fabaceae																		
*	*Medicago laciniata*		53	100	40	100	33	33	92	100	25		100	100	100	100	60	50	100
*	*Medicago minima*							11		50									50
*	*Medicago polymorpha*		13														20	25	
	Templetonia aculeata				20				8										
	Templetonia egena										25								
	Gentianaceae																		
*	*Centaurium spicatum*																20		
*	*Centaurium tenuiflorum*		7																
	Geraniaceae																		
*	*Erodium cicutarium*							11		50									
	Erodium crinitum							11	8										50
	Erodium spp.							11											
	Goodeniaceae																		
	Goodenia cycloptera	100																	
	Goodenia gracilis							44									20		
	Goodenia pinnatifida				20			22											
	Goodenia spp.							11	17	50									50
	Haloragaceae																		
	Myriophyllum spp.																	25	
	Myriophyllum verrucosum																	50	
	Lamiaceae																		
*	*Marrubium vulgare*																	25	
	Prostanthera striatiflora							33											
*	*Salvia verbenaca*		7		20				8	50					100			75	
	Teucrium albicaule								8										
	Teucrium racemosum		7			38												75	
	Teucrium spp.					25													
	Lauraceae																		
	Cassytha spp.				20														
	Loranthaceae																		
	Amyema lucasii						56												
	Amyema miquelii										50								
	Amyema quandang var. *quandang*					25	11		33										
	Lysiana exocarpi						11												
	Malvaceae																		
	Abutilon calliphyllum				20														
	Abutilon fraseri		7		40		11	22											
	Abutilon spp.							11	8										
	Hibiscus sturtii spp. *sturtii*				20														
	Malva australiana		13	50			11										60	50	100
*	*Malva parviflora*																	25	

	Vegetation communities																	
Taxon, family and name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
Number of quadrats	**1**	**15**	**2**	**5**	**8**	**9**	**9**	**11**	**2**	**4**	**2**	**1**	**1**	**1**	**2**	**5**	**4**	**2**
Sida cunninghamii				20			11											
Sida intricata		7		40			33	17	50		50							
Sida petrophila							11											
Sida spp.		7					11	8							100			
Mimosaceae																		
Acacia aneura		13		20		22	100				50							
Acacia colletioides										25								
Acacia loderi		13			13	22		100										
Acacia melvillei						11			100									
Acacia oswaldii		13		20		11												
Acacia tetragonophylla							22											
Acacia victoriae						22		25						100			25	
Myoporaceae																		
Eremophila duttonii							11											
Eremophila freelingii							11											
Eremophila glabra											50							
Eremophila goodwinii				20														
Eremophila longifolia				60		22	67	42		25	50							
Eremophila mitchellii							22											
Eremophila serrulata				20			22											
Eremophila spp.				20	13		22	8		25								
Eremophila sturtii	100	67		80	100	67	33	58	50	75								
Myoporum platycarpum		13				11					100							
Myrtaceae																		
Eucalyptus coolabah subsp. *coolabah*			50															
Eucalyptus intertexta				100														
Eucalyptus largiflorens			100		25													
Eucalyptus populnea subsp. *bimbil*			50		100													
Eucalyptus socialis										100	100							
Oleaceae																		
Jasminum lineare				20														
Oxalidaceae																		
Oxalis perennans						11	11											
Oxalis spp.											50							
Papaveraceae																		
* *Argemone ochroleuca* subsp. *ochroleuca*																	25	
Pittosporaceae																		
Pittosporum phylliraeoides				20	13					50								
Plantaginaceae																		
Plantago cunninghamii					13													
Plantago drummondii			50		13	11	11		50							60		50
Plantago turrifera		20		20		22	33								50			
Polygonaceae																		
Muehlenbeckia florulenta																20		
Rumex crystallinus																	25	50
Proteaceae																		
Grevillea huegelii											50							
Hakea leucoptera												100						
Hakea tephrosperma	100												100					
Ranunculaceae																		
Myosurus minimus var. *australis*																40		
Rutaceae																		
Eriostemon linearis							11											
Flindersia maculosa		7				100												
Geijera parviflora		7																
Santalaceae																		
Santalum acuminatum		7																
Sapindaceae																		
Alectryon oleifolius subsp. *canescens*		100		60	50	67		75	50			100	100		50			
Atalaya hemiglauca		7				11												

		Vegetation communities																
	Taxon, family and name	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**
	Number of quadrats	**1**	**15**	**2**	**5**	**8**	**9**	**9**	**11**	**2**	**4**	**2**	**1**	**1**	**1**	**2**	**5**	**4**	**2**
	Dodonaea viscosa subsp. *angustifolia*		33	50	60	50		22	25	50	50	100	100			100			
	Dodonaea viscosa subsp. *angustissima*	100	13		20		22	11	8		25			100				25	
	Scrophulariaceae																		
	Stemodia florulenta																	50	
	Solanaceae																		
	Lycium australe						11												
*	*Lycium ferocissimum*						11	11											
*	*Nicotiana glauca*																	25	
	Nicotiana velutina									50			100						
	Solanum ellipticum							22											
	Solanum esuriale							11	17										
	Solanum ferocissimum				40			44	8			50							
	Solanum spp.						22	22	8	50									
	Thymelaeaceae																		
	Pimelea spp.															50			
	Pimelea trichostachya	100	13					11						100					
	Zygophyllaceae																		
	Zygophyllum ammophilum		7				11				25								
	Zygophyllum apiculatum										25								
	Zygophyllum aurantiacum								8		25								
	Zygophyllum eremaeum		7		20	13	22	11	17	50	50	100							
	Zygophyllum iodocarpum																		50
	Zygophyllum ovatum		7								25								
	Zygophyllum simile		7																
	Zygophyllum spp.		13				11		8										

Appendix 2: Vegetation map of Coonavitra area, Paroo Darling National Park