The natural vegetation of the Pooncarie 1: 250 000 map

Marianne F. Porteners, Elizabeth M. Ashby and John S. Benson

Porteners, Marianne F., Ashby, Elizabeth M. and Benson, John S., (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, Australia 2000) 1997. The natural vegetation of the Pooncarie 1: 250 000 map. Cunninghamia *5(1): 139–231.* The composition and extent of the present native vegetation covered by the Pooncarie 1: 250 000 map sheet (33°00' to 34°00'S, 142°30' to 144°00'E) is described and mapped from quadrat samples and field traverses, aerial photography and LANDSAT Thematic Mapper satellite imagery. The study area is situated in south-western New South Wales and is almost wholly within the South Far Western Plains botanical subdivision. The landscape is typically continuous sandplains, dunefields and numerous dry lake basins, with a portion of alluvial plain in the south-east. Mallee shrublands and Belah-Rosewood open woodlands are the dominant vegetation types. Chenopod shrubland communities are also widespread. Nineteen vegetation communities are described and 330 species of vascular plants recorded from 62 families. 12% of the species recorded are exotic. The vegetation has been greatly modified and often degraded, principally due to grazing by introduced herbivores for over 150 years and by cropping of lake beds. Some large, relatively undisturbed areas of mallee vegetation still exist, due to their dense structure and inaccessibility. The poor conservation status of many of the vegetation communities is discussed.

Introduction

The Pooncarie 1: 250 000 map area is situated in far south-western New South Wales and contains a variety of semi-arid vegetation communities. A large expanse of mallee country is a major feature, as well as the chenopod shrublands associated with the Willandra Lakes system. These large dry lake beds were recognised for their archaeological values under a World Heritage listing in 1981. The area has a rich and ancient Aboriginal history as well as significant natural values. The major current land use is sheep grazing and other smaller-scale pastoral activities, with tourism to a much lesser extent. Exploration for mining of heavy metals is currently occurring around the Willandra Lakes. Areas of chenopod shrubland, lunette vegetation, Belah-Rosewood and mallee are protected within Mungo National Park, situated in the heart of the study area. Few undisturbed areas of vegetation exist today and many vegetation communities remain poorly represented or unrepresented in any conservation reserve.

Study area

The study area is covered by the Pooncarie Australian 1: 250 000 Topographic Survey sheet (SI 54–8) (Fig. 1). The eastern boundary of the mapped area is at longitude 144°00'E which runs east of Hatfield and west of Ivanhoe and Oxley. The western

boundary runs west of Pooncarie at longitude 142°30'E. The northern boundary is south of the Sydney to Broken Hill railway line, at latitude 33°00'S. To the south, the boundary at latitude 34°00'S runs north of Mildura and Balranald.

The total area mapped is 1 524 900 ha, or approximately 138 × 110 kilometres, and falls within the Western Division of New South Wales. The majority of the land is under leasehold tenure. The only major township is Pooncarie, with a population of less than 100. Some large historical properties occur in the area, including 'Gol Gol', 'Arumpo', 'Mungo', 'Zanci', 'Garnpang' and 'Top Hut'. Mildura is the closest major centre to the study area, situated to the south-west, with the towns of Ivanhoe, Balranald and Wentworth to the north-east, south and south-west respectively. The mapped area is administered by the Balranald, Wentworth and Central Darling Shires. A network of unsealed roads links properties, towns and railway sidings while a small portion of the sealed Menindee Road occurs in the far west.

A dominant feature of the mapped area is the relict Willandra Lakes system, with Willandra Creek entering in the north-east. Large areas of sandplains and dunefields comprising parallel and irregular dunes are also conspicuous features. The area is situated directly west of the Hay Plain, the alluvial plain across which the Murray, Murrumbidgee and Lachlan Rivers flow westward from the eastern highlands. A small portion of the Hay Plain occurs in the south-east corner of the study area. A section of the Darling River also occurs in the far west.

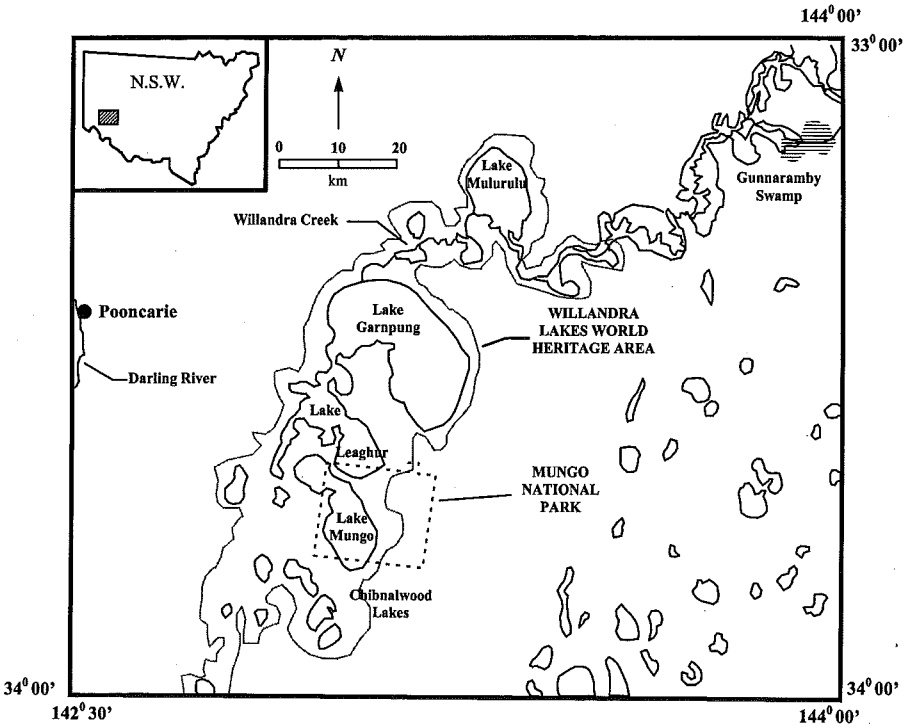

Fig. 1. Locality map of the study area.

Climate

The study area has a semi-arid climate, with hot summer temperatures, mild winters and a winter-dominant rainfall. Climatic averages for Pooncarie, Menindee, Balranald and Ivanhoe are presented in Fig. 2 (Bureau of Meteorology 1996). Daily temperatures fluctuate from hot days and cool nights in summer to mild days and cold nights in winter. The hottest month is January when the average daily temperature ranges from 16.4 to 32.6°C at Balranald. In July, the coldest month, this range is from 3.2 to 15.8°C

The rainfall is usually winter-dominant but can be erratic — the current survey was conducted between May 1994 and April 1995 during a period of severe drought. Follow-up spring rains peak in October, while the months of January, February and March have the lowest number of rain days (Bureau of Meteorology 1996). In south-western New South Wales, rainfall generally decreases northwards and becomes more evenly spread throughout the year. The average annual rainfall for Pooncarie is 267.5 mm, while at Ivanhoe it is 299 mm.

Geology

The study area lies within the Murray Basin of south-eastern Australia and consists of Tertiary and Quaternary sediments with a little rock outcropping (Pels 1969). Water and sediments were carried by Willandra Creek and the Lachlan River from the Eastern Highlands. In the east of the Basin, prior stream and more modern ancestral river deposits of sand, silt and clay, overlay an earlier terrestrial and lacustrine sequence. In the west, where the study area is located, Tertiary marine sediments are covered by a Pleistocene aeolian sequence which is part of the extensive desert dunefield of central Australia.

The Willandra Lakes are relict features from the Pleistocene, once filled by Willandra Billabong Creek, a former distributary of the Lachlan River (Pels 1969). Willandra Creek now diverges from the present Lachlan River near Hillston and continues to the Murrumbidgee near its confluence with the Murray River. The lakes were dry with conditions similar to today prior to about 45 000 years BP, but consequently filled, burying the old lunettes under clean quartz sands (Magee undated). Lake levels remained high until about 25 000 BP and the beach lunettes were vegetated. The sandy soils were formed under much less oxidising conditions than today or previously, and organic matter has been preserved. As a result, this soil contains many hearths and other archaeological material, associating this phase of the lake history with the most intensive human occupation.

Lake levels began to drop and oscillate seasonally after 25 000 BP and conditions became more saline. The region became extremely inhospitable during this drying phase of the last major glaciation, about 20 000 to 16 000 years ago. The lakes became very shallow and saline and thus during this period population levels of animals and humans dropped (Bowler & Magee undated). Accumulation of aeolian clays began from about 17 000 BP (in all but Lake Mulurulu), continuing for about 1500 years, representing the final depositional activity of the lakes.

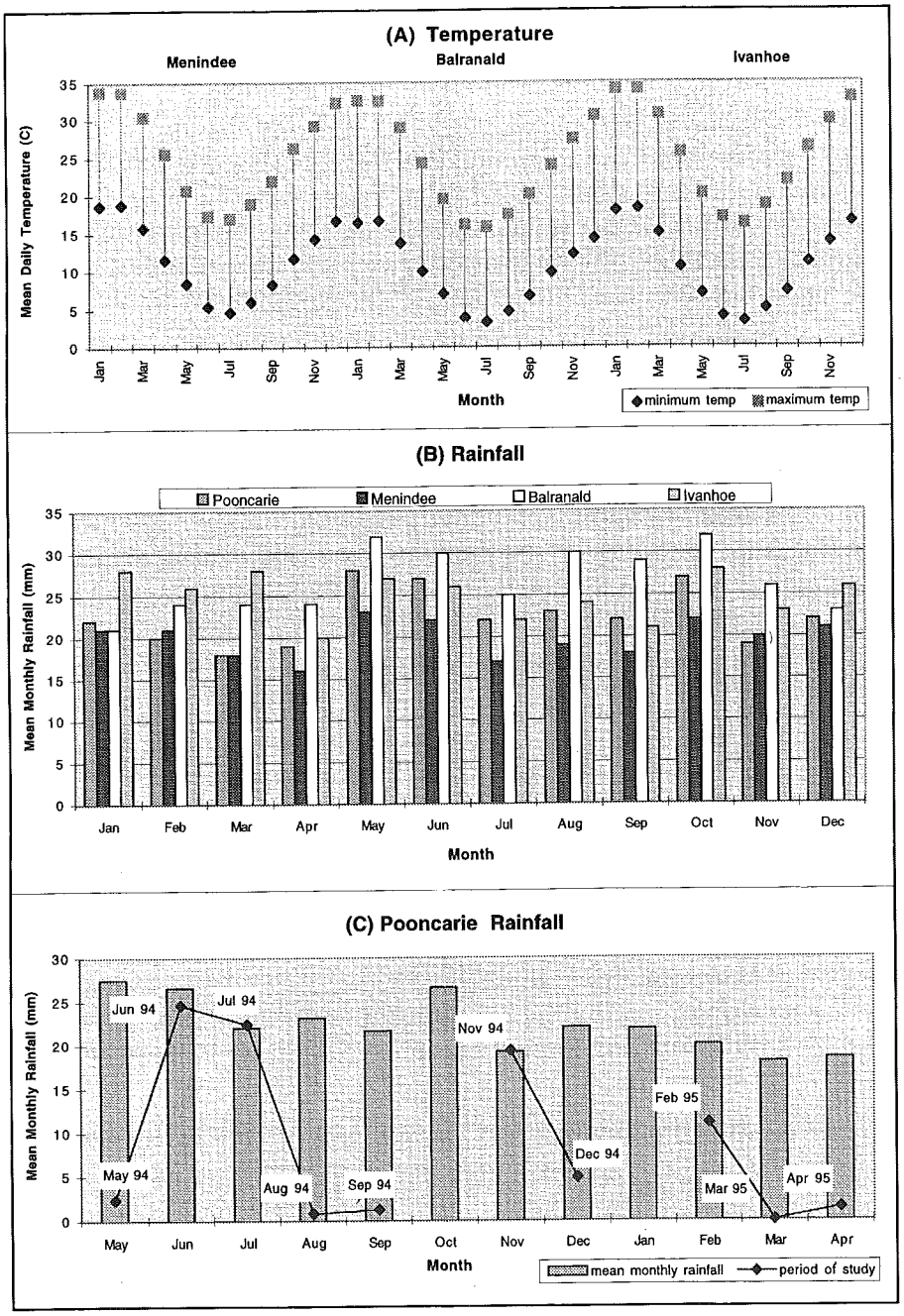

Fig. 2. Temperature and rainfall for the study area. Note that there were no rainfall data available for October 1994 and January 1995.

Concurrently, desert dunes were mobilised and lobes encroached onto lake floors, resulting in a contraction of the southern-most basins with intense deflation of material to form lunettes on their eastern margins. After 15 000 BP the landscape was largely stabilised by vegetation and the prevailing climatic conditions were similar to those of today. Lake Mulurulu experienced a later depositional phase, as it was higher in the drainage system and thus subject to more frequent flooding than downstream lakes. It had a brief high water phase at about 13 000 BP (Magee undated).

Palaeovegetation

Inland Australia was once much wetter, especially in the early part of the Tertiary (65 million years ago) from which rainforest taxa such as *Nothofagus* may be found in pollen assemblages of now arid and semi-arid regions (Martin 1989). Grasses formed only a minor component, there being no evidence of grasslands or open woodlands. Closed forests were present over most of southern and central Australia — the open savannah woodlands and grasslands now so typical of the modern Australian landscape did not become widespread until the Pleistocene, some 1.5 million years ago (Martin 1981).

In the late Miocene (approximately 10 million years ago) there was a profound change with *Nothofagus* disappearing and Myrtaceae becoming dominant. This is thought to coincide with an increase in fire and a decrease in rainfall. Mallee vegetation as we know it today probably did not develop until about Pliocene-Pleistocene (2 million years ago) and it probably reached its present proportions within the last million years (Martin 1989).

Geomorphology

The geomorphology of the study area is varied but dominated by aeolian dunefields and a system of large, dry lake depressions (Fig. 3). The Willandra Lakes system includes six major lake basins, numerous smaller lakes and connecting channels. The largest lake, Lake Garnpung, stretches for 30 km at its longest axis. The lake beds are shallow, sub-elliptical depressions with the long axes oriented north-west to south-east. Some of the lakes (usually those more downstream) have lake floor terracing. The western margin often has a steep bank or escarpment, while the eastern shoreline is marked by a crescent-shaped dune or lunette. The lunettes are formed by deposition of lake material by the prevailing westerly winds and vary in composition from clays to sands, reflecting the hydrology and lithology of the lake bed (Prendergast 1989). Lake Chibnalwood, for example, has a lunette that consists almost entirely of clay (Bowler & Magee 1978). In contrast, the nearby Walls of China lunette at Lake Mungo is made up of layers of quartz sand and saline sandy clay. This was actively eroding when the first European explorers came to the region (Magee undated).

Aeolian dunefields dominate the landscape and comprise both regular, linear dunes and irregular, subparabolic dunes. The dune ridges are relatively low in height and gradient compared to other active dune systems in Australia (Butler et al. 1973). The formation of the linear dunes overlapped with the final phase of lake activity in the region — where the longitudinal dunes intersect the lake margins they are truncated

at the shoreline, indicating no dune activity since before the lakes were at their highest terrace levels (Magee undated). The irregular subparabolic dunes are superimposed on the linear dunefields and transgress onto the floor of the southern-most lake basins. There is also a distinct difference in the height and soil profile of these two dunefield types. Linear dunes, with their east-west alignment, are relatively low (2–6 m high) with gentle slopes, and contain siliceous sediments on the crests but are rich in clay and carbonate below. The steep, subparabolic dunes of irregular dunefields are usually higher than 10 m, with deep siliceous sediments and very small quantities of clay and carbonate in the subsoil (Wasson 1989).

Substantial sandplains also occur throughout the mapped area. Many of these consist of duplex soils with a thin veneer of sand overlying clay, particularly in the east and adjacent to the Darling River in the west. Clays are thought to underlie most, if not all of the sandplain areas (Semple & Eldridge 1989). Deeper sandplains merge into the aeolian dunefields. Sandplain areas are often slightly undulating and are characterised by irregular sand accumulations such as isolated dunes and sandhills. Some of these sandy rises, particularly in the east of the mapped area are derived from the sandy deposits of ancient streams (Butler et al. 1973).

A portion of riverine plain occurs in the south-east of the mapped area, representing its most western extent. The plain was formed during the late Tertiary and comprises clay sediments washed down from the eastern highlands by large, coalescing alluvial

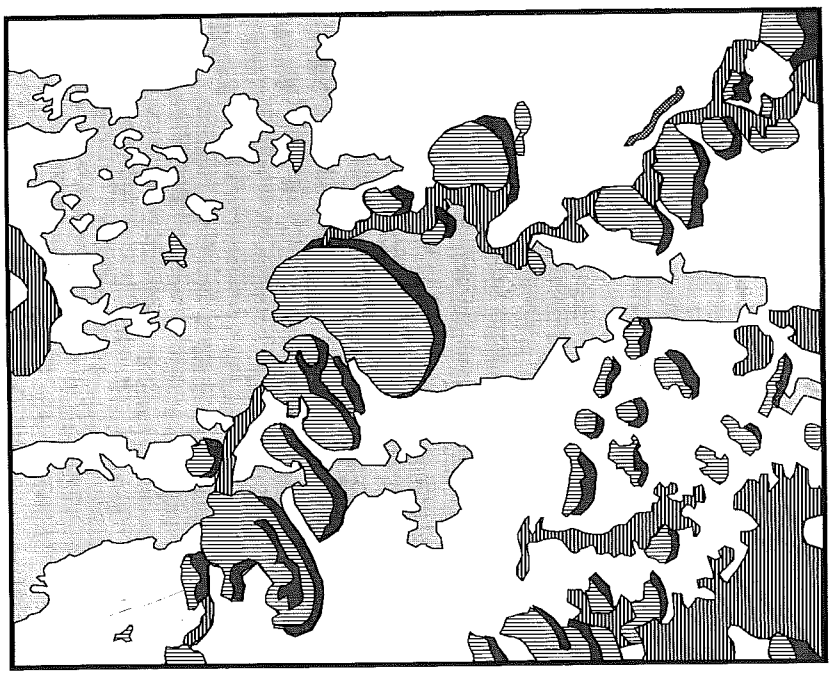

Fig. 3. Simplified physiographic units of the Pooncarie map sheet. Horizontal stripes = dry lake; vertical stripes = alluvial floodplain and riverine plain; checks = rocky outcrop; black = lunette; grey = parabolic and linear dunefield; white = sandplain. Derived from Cameron (1996).

fans (Butler et al. 1973). Within the study area, the plain is characterised by numerous depressions, scalds and isolated rises of sandy duplex soils.

The Darling River channel runs through the far west of the Pooncarie map and is deep and narrow in cross-section with steep banks. This and other rivers and creeks in the area carry a relatively large proportion of their sediment load in suspension, however many of these channels remain dry for years. The active floodplains associated with these contemporary streams are also much smaller in extent than the relict floodplains of the riverine plain.

Rocky outcrops of Palaeozoic sediments mark the edge of the Murray Basin (Semple & Eldridge 1989). The Manfred Range is a low, stony range of Upper Devonian sandstone, lying in the far north-east of the study area. Erosion of these and similar rocks during the Tertiary probably contributed to the quartz sands that comprise the surrounding plains (Bowler & Magee 1978).

Soils

The landscape of the study area is dominated by the red and orange sands of the mallee dunefields and sandplains (Fig. 3). These soils range from calcareous and siliceous sands to deep reddish-brown sands, increasing in carbonate content with depth (Semple & Eldridge 1989). Linear dunefields are composed of weathered sands with a dune core of finer texture, and are high in calcium carbonate. The soils of irregular and subparabolic dune systems are leached, non-calcareous, siliceous sands (Eldridge 1985). Calcareous sands are found more commonly on the flanks of these dunes while siliceous sands occur predominantly on the dune crests (Semple & Eldridge 1989). Characteristically, the crest of the dune has earthy sands grading to solonized brown soils on the flanks, and red-brown earths on adjacent flats which may include areas of grey, brown and red clays (Butler et al. 1983).

Sandy soils are also a common component of the aeolian and alluvial plains. The plains of the study area comprise clays and sands, becoming progressively more sandy and calcareous to the west. Much of the aeolian plain is underlain by clayey calcareous sediments and the upper layer of brown calcareous earths merges into deeper sandy dunefields (Eldridge 1985). Adjacent to the alluvial riverine plain in the east, sandplain areas are of hard-setting red duplex soils, with isolated sandy rises. These soils are highly susceptible to scalding and have high water-holding capacities due to the high clay content in the subsoil. The Manfred Range of Devonian sandstones and quartzites is blanketed in a covering of aeolian material. The soils of these rocky outcrops are shallow and dense, with a loamy and stony texture.

The soils of the riverine plain are grey, brown and red clays which increase in salinity to the west (Magee undated). Lake beds and drainage lines such as Willandra Creek have a thin, recent layer of grey clay merging to red-brown clay and overlying the fluvial and lacustrine clays (Eldridge 1985). The lake floors are dominated by clays, with silts and sands occurring on the eastern downwind margins (Bowler & Magee 1978). The lake floors of Mungo and Mulurulu consist of clays and sandy clays with occasional thin layers of quartz sands (Bowler & Magee undated). Generally the lake

beds and basins of the Willandra Lakes system are composed of grey and yellow-grey cracking clays, with Willandra Creek and the northern and central lakes such as Leaghur, Garnpung and Mulurulu having margins of non-cracking clays. To the south, the clays of the relict lake beds and levees of Lakes Mungo, Arumpo and Chibnalwood are more yellow-grey, with the erosional remnants of duplex soils (Eldridge 1985). Channels and channel regions are characterised by a high percentage of silt, with shallow duplex soils of a red-brown sandy A-horizon, over a relatively impermeable, calcareous, clay-rich B-horizon (Bowler & Magee undated). The Darling River and other active rivers, creeks, floodplains, depressions, swamps and billabongs have beds of heavy, grey cracking clays.

Lunettes can be composed of either sand or clay. Quartz-rich lunettes were formed under full lake conditions by the deflation of sands from active beaches. Clay-rich and gypseous clay lunettes result from the subsequent reduction in the water table during the drying climate, an increase in water salinity resulting in granulation of the clay, strong winds to transport the clay from the drying basin floors and an increase in humidity to stabilise the lunette (Bowler & Magee undated, Eldridge 1985). Sandy lunettes (such as the Walls of China of Lake Mungo) comprise multiple layers of sediment which can be identified with their formative environmental conditions.

Aboriginal history

South-western New South Wales has a rich Aboriginal history, containing some of the oldest archaeological sites found in Australia. The best known lie in the Willandra Lakes World Heritage Region (Fig 1.) and include 30 000 year old campsites, shell middens, cooking pits, grinding stones, ochres and numerous stone tools. The most remarkable finds, however, have been the cremated and buried human remains, representing the world's oldest known ritual burials (Flood 1990).

Aboriginal people have lived in the Willandra Lakes region for at least 40 000 years, back to the Pleistocene when the climate was cooler and the lakes full of fresh water. The Willandra Lakes region showed great cultural continuity up until European contact as evidenced by the complex burial and cremation rituals, consistency in the use of ovens and hearths for cooking and continuity of stone tools (Magee undated). The Aboriginal community lived a subsistence lifestyle adapting to the seasonal changes in the lake resources. Life was concentrated around the lakes during the summer and during the winter the majority of the population was dispersed throughout the semi-arid plains (Magee undated). Tindale (1974) records the people inhabiting mallee lands in south eastern Australia as being highly mobile, unlike the more sedentary people of the rivers. The Darling River was occupied by the Paakintji people and many campsite remains have been found in sand dunes along the river, dated to at least 10 000 years (Lans et al. 1988). A large campsite was established on the river sandhills immediately opposite the present-day Pooncarie cemetery. At the time of European arrival, Pooncarie was known as 'Bilbarka' (Lans et al. 1988).

European exploration, settlement and land use

In 1830, on his second expedition, Captain Charles Sturt entered the lower reaches of

the Darling River. He found it wide and deep, with the banks 'sloping and grassy, and were overhung by trees of magnificent size' (Sturt 1833). In 1836, Major Thomas Mitchell investigated the Darling River up to 30 miles to the north of its confluence with the Murray and 'soon found all the usual features of the Darling; the hills of soft red sand near the river, covered with the same kind of shrubs seen so much higher up' (Mitchell 1839).

It was not until 1844, when Edward John Eyre came to the area, that the lower Darling was explored. He reached a point on the Darling 70 miles north of the Murray — almost as far as Laidley's Ponds (present-day Menindee) — but ill-health forced him to turn back. He reported that '... the banks of the river were lined with most beautiful gum-trees, gracefully overhanging and with a wide-spreading dense foliage to the very ground. I have nowhere seen in Australia so picturesque an effect produced by the eucalypti as was the case along the whole course of the Darling' (reported in Lans et al. 1988). The treacherous nature of the alluvial soils was also noted: '... the strong tenacious character of the soil in the alluvial flats bordering upon the river caused it to open into deep holes and cracks, rendering it both difficult and dangerous to ride over them' (reported in Lans et al. 1988). Later that same year Sturt conducted an exploration of the interior, travelling up the Darling from the Murray to Laidley's Ponds and then heading west.

The lower Darling River was surveyed in 1848 by Surveyor Francis McCabe. At this time there were already squatters occupying land along the river (Lans et al. 1988). One of these squatters was William Campbell who named his run on the Darling River 'Pooncaree', from the Aboriginal *pooncaira* meaning large sandhill (Lans et al. 1988). By 1860, the year the Victorian Overland Expedition headed by Robert O'Hara Burke and William John Wills came to the Darling, most of the river frontage land was taken up and Laidley's Ponds was a village called Menindee. The first successful navigation of a paddle steamer up the Darling River occurred in 1859 and by 1860 they were transporting supplies and wool between Menindee, Pooncarie and Morgan in South Australia (Lans et al. 1988). Pooncarie became a vital link to river transport for the district but there were long periods when the river was dry and overland hauling teams would once again have to be used. Boats were still active on the Darling River up to the early 1900s when railways took over.

Prior to the 1920s there were a number of large pastoral holdings in the Pooncarie and Willandra Lakes district. For example, 'Gol Gol' was originally 200 000 ha. This was subdivided into smaller holdings in 1922 (Magee undated). In the early 1940s settlers were illegally grazing sheep and cattle on the land between the Murrumbidgee and lower Darling Rivers (Lans et al. 1988). Woodcutting was another activity carried out in the River Red Gum forests. Leased holdings were taken up by the late 1940s and existing larger stations such as 'Tarcoola' were divided into smaller leases ranging from 6 000 to 14 000 hectares (including 'Kinross' and 'Birdwood').

Today pastoral leases vary in size from an average of 20 000 hectares up to 70 000 hectares (Magee undated). The main land use activity is still grazing sheep for wool production. An increase in tourism in the area has resulted from the listing of the Willandra Lakes World Heritage Region (226 211 ha total, 208 262 ha of which is on the

Pooncarie map) and the gazetting of Mungo National Park. Interest has been shown in the heavy metal deposits of the sand dunes and exploration for sand mining has been undertaken by mining companies.

Previous botanical surveys

Until recently, the only detailed vegetation map for western New South Wales was the (approximately) 1: 1 000 000 map produced in the late 1940s by Noel Beadle, then botanist for the Soil Conservation Service in Condobolin (Beadle 1948). In the late 1950s and early 1960s Stannard mapped the vegetation of the central-east Darling region (directly north of the current survey area) and the Cobar Peneplain, during erosion surveys of these regions (Stannard 1958, 1963). The Royal Botanic Gardens Sydney have published a series of vegetation maps at 1: 250 000 scale for far south-western New South Wales. These include the maps to the west, south and east of the Pooncarie sheet: the Ana Branch-Mildura (Fox 1991), Balranald-Swan Hill (Scott 1992), Booligal-Hay and Deniliquin-Bendigo maps (Porteners 1993). To the north and north-west of the study area, the Royal Botanic Gardens has published a map at the scale of 1: 1 000 000, showing broad vegetation types (Pickard & Norris 1994). A grassland survey has also been conducted in the southern Riverina to the east of the current study area (Benson et al. 1997). Land Systems Maps have been published for the whole of the Western Division of New South Wales (including the Pooncarie 1: 250 000 map area), describing the recurring patterns of vegetation, soils and topography (Walker 1991).

The Willandra Lakes World Heritage Region (which occupies 13% of the Pooncarie map sheet) has been well documented for its natural and archaeological attributes. The Willandra Lakes were not even shown on locality maps until 1967 — names were chosen based on the properties occupying the greatest area of the lake (Pels 1964, 1969). A series of geomorphic maps were completed by Bowler and Magee (1978) and soils were mapped by Eldridge (1985) soon after. Under the National Estates Program of the Department of Planning, a study of the Willandra Lakes World Heritage Region was conducted and four broad vegetation types were mapped (Rice 1986). More recently, the vegetation of Mungo National Park was mapped at 1: 50 000 scale by Westbrooke and Miller (1995) and fauna surveys were undertaken in mallee areas by the NSW National Parks and Wildlife Service (Western Biodiversity Survey) and the Wilderness Society (Stage 2 of an assessment of wilderness areas in western New South Wales).

Methods

Sampling

Sites were selected to sample combinations of LANDSAT photo patterns, geomorphology, soil type and geology. LANDSAT TM images (1: 100 000 scale) of Arumpo, Hatfield, Mulurulu, Manfred, Pooncarie and Turlee sheets were inspected and broad patterns of vegetation pattern and geomorphology delineated (e.g. mallee on sand dunes, dry lake bed shrubland). The northern edge of the study area was not

covered by the LANDSAT images, so 1: 50 000 scale colour aerial photographs (June 1993) were used for the top of the Manfred, Pooncarie and Mulurulu sheets.

Twenty-seven field days (54 person days) were spent in sampling the vegetation. Forty-six sites were sampled in May 1994, 39 in September 1994 and 25 in March 1995. Sampling times were selected in order to capture maximum species diversity — during the flowering and fruiting periods after the winter rains — although the area was suffering drought at the time of study. A further 7 field days (14 person days) were spent ground truthing boundaries and vegetation descriptions in September 1996.

The vegetation was sampled at 110 sites, each site being a 50 × 20 m quadrat. Detailed locations and the physical attributes of these sites are given in Appendix 1. Most of the primary and secondary roads were traversed in vehicles for extensive ground-truthing of boundaries and community description. The locations of the roads and sites sampled are shown in Fig. 4.

All plant species were recorded in each quadrat and assigned a cover abundance rating based on a modified Braun-Blanquet 6-point scale (Poore 1955) (<1%, 1–5%, 6–25%, 26–50%, 51–75%, 76–100%). The structure of the vegetation was described by the number, height, cover and dominant species of each layer. The soil type was noted for each site, as was an estimate of the degree and type of disturbance.

Plant species nomenclature conforms with that currently recognised by the National Herbarium of NSW and follows Harden (1990–1993).

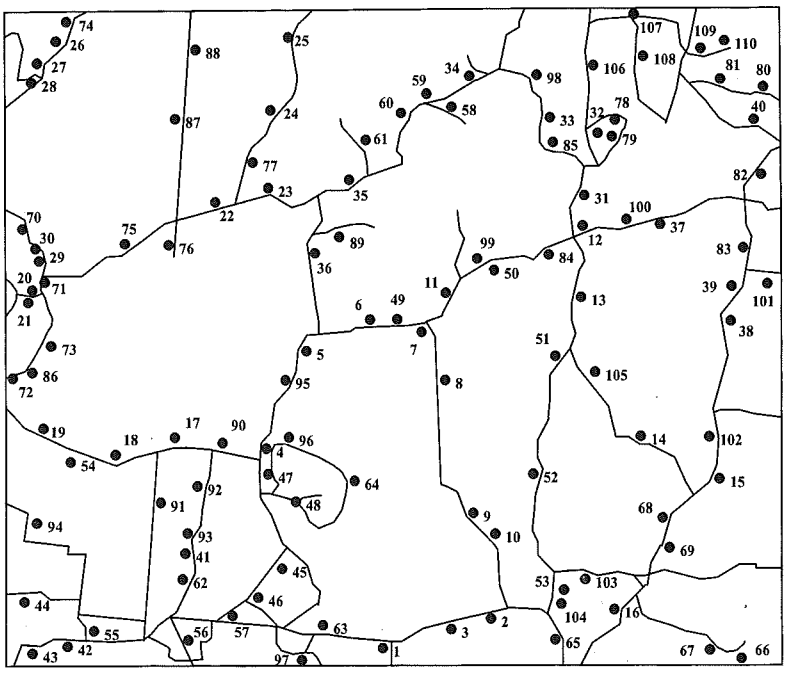

Fig. 4. Map of the study area showing sample sites and roads traversed.

Data analysis and mapping

All site data were entered into the floristic ecological database (Advanced Revelation) used at the National Herbarium of NSW. Data were investigated using multivariate techniques available in PATN (Belbin 1993) and other unpublished software (Bedward pers. comm.). The presence/absence of native species were used for analysis as this data set provided maximum information with minimum noise. Analysis of cover data was also undertaken for comparison.

A hierarchical agglomerative classification was used to describe groupings of species and sites (Belbin 1991). The Kulczynski coefficient of dissimilarity was used for its superiority in ecological applications (Belbin 1993). This coefficient describes the dissimilarity between sites based on their shared species composition; it places less emphasis than other coefficients on the absence of species. This is particularly relevant in a semi-arid rural landscape where species may be absent due to grazing or other past disturbance or immediate climatic conditions, rather than due to an inherent likelihood of occurrence. A hierarchical classification of sites was then derived from a clustering strategy using flexible unweighted pair group arithmetic averaging (UPGMA).

To check for misclassified sites in the resultant groups, a checking routine of nearest neighbours (Bedward, unpublished software) was used. This examines the nearest neighbours of all sites (as measured in the association matrix) and assesses whether any given site is grouped with its nearest neighbours. A misclassified site is one in a group where none of that site's nearest neighbours are present, and where none of the other sites in the group has that site as a nearest neighbour.

Once the groupings were finalised, a measure of fidelity to those groupings was generated for each species within that group (Bedward, unpublished software) to elucidate the contribution each species made to the definition of the group.

After sampling and analysis, further ground-truthing of boundaries and pattern-matching was carried out by traversing most of the primary and secondary roads. Provisional maps were drafted at 1: 100 000 scale and reduced to 1: 250 000 scale for final report and publication. The boundaries of the vegetation types were matched as closely as possible to the adjoining 1: 250 000 vegetation maps to the south (Balranald –Scott 1992) and to the east (Booligal–Porteners 1993). The vegetation map to the west (Ana Branch–Fox 1991) was produced using a different method and depicts pre-European, not present-day, vegetation. Thus, the Pooncarie vegetation boundaries were not closely matched with those on the Ana Branch map.

Results

Data analysis

The resulting dendrogram from the Kulczynski association and UPGMA clustering analysis (adjusted for misclassification) is shown in Fig. 5. Fifteen groupings representing 18 vegetation communities were defined at a dissimilarity measure of 0.75.

Broadly, the dendrogram reveals four main groups — the mallee communities of sandplain and dunefield, woodlands of the sandplain, shrublands of the lake beds and alluvial communities of the riverine plain and other major floodplains. The Mallee sites are most distinct, splitting off at the maximum dissimilarity measure.

The vegetation communities

The eighteen vegetation communities identified on the Pooncarie 1: 250 000 map sheet are summarised in Table 1. Open Areas (OA), Bare Areas (BA) and a cleared unit (C) are also recognised. The map unit names and numbers assigned to the communities follow on from previous mapping work on adjacent sheets (Scott 1992, Porteners 1993). There are, however, two minor differences. Scott (1992) defined Linear Dune Mallee (here denoted as 3b) more finely as Dune Crest and Dune Swale. Similarly, Scott (1992) defined two densities of Black Bluebush (8a and 8b) which is here only recognised as one density of Black Bluebush (8).

Structural types range from open herbfield and tussock grassland, to open forest, with mallee woodland and shrubland dominating. Community structure is based on Walker and Hopkins (1990). An asterisk * indicates an exotic species. The sites sampled within each community are listed; full site location information is given in Appendix 1. The mean number of native and exotic species (± standard deviation) per 50 × 20 m plot is also shown. The total number of native and exotic species recorded from each community is given in Table 2.

The community descriptions list the main, associated and common species found, as well as the soils, distribution, condition and conservation status of each type. **Main species** are mostly those that occurred in 80–100% of the sites in a community and are rarely or never found in another community. However, there are exceptions to both the commonness and exclusivity rules. Rocky Outcrop Woodland Complex (29) did not conform to the 80–100% occurrence rule due to the difficulty in capturing sufficient representative quadrats; the three Mallee communities (3a, 3b and 3d) have considerable species overlap; and Disturbed Shrubland Complex (22) contains disturbance-indicator species which are commonly found in other communities. To a certain extent main species may also be considered 'indicator' species for that particular community. However, that term has not been used due to the occasional species overlap. In most cases main species also define the community. Communities 1, 3a, 3b, 3d, 29 and 30 are also defined by their geomorphological associations and 22 by the condition of the community.

Associated species are those that occurred in 50–80% of the sites in that community. They are listed in descending order of frequency. Associated species usually constitute the understorey or ground-cover layers of the community. **Other common native species** are those that are considered as significant associated species in that community but were recorded in less than 50% of sites for that community (or 50% if only two sites were sampled for that community), or were recorded adjacent to a site. They are also listed in descending order of frequency. **Native species** recorded exclusively from each community are also listed, as well as all recorded **exotic species** in descending order of frequency.

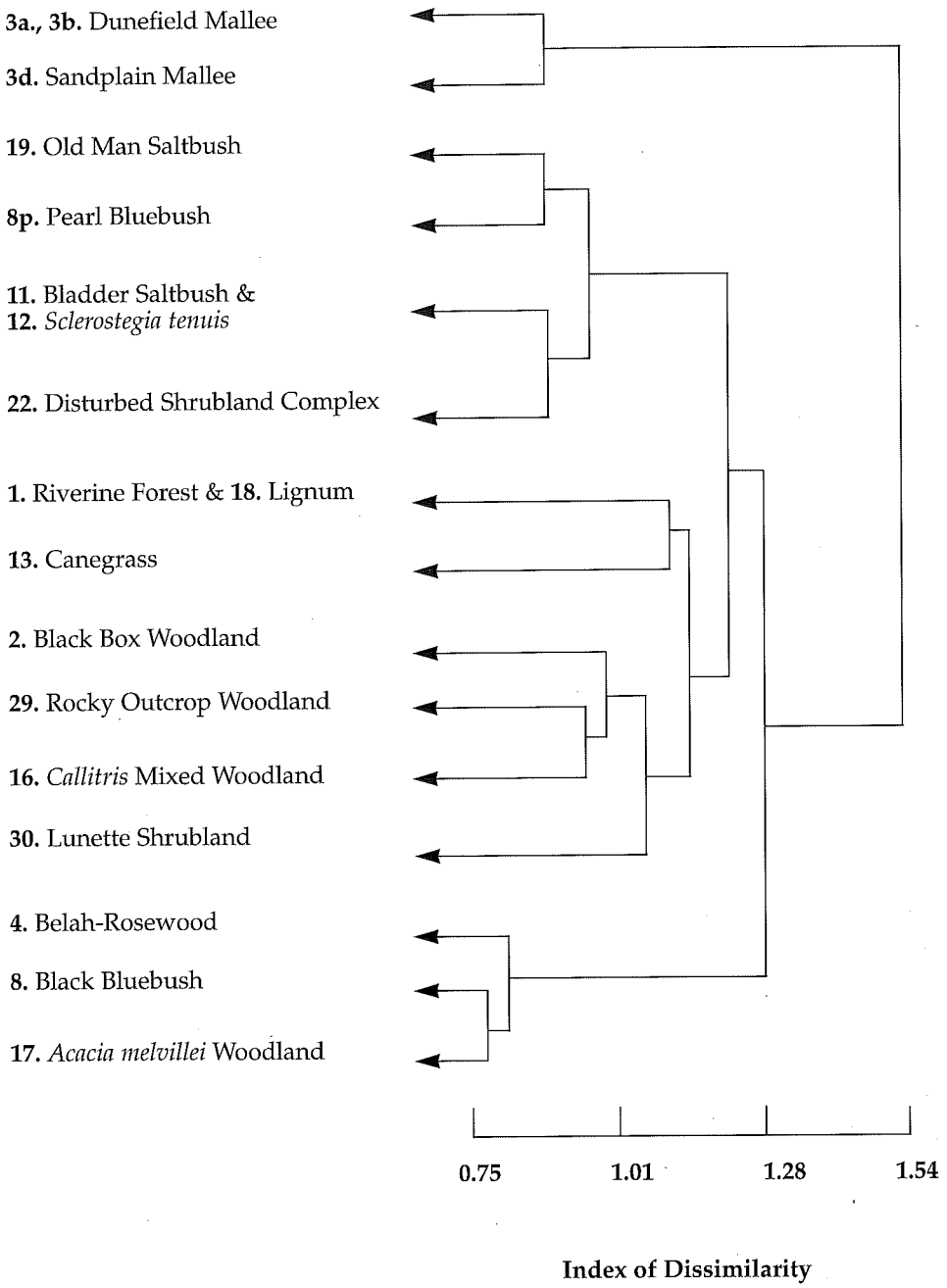

Fig. 5. Dendrogram showing 15 groupings representing 18 plant communities produced from Kulczynski association and UPGMA clustering.

Community descriptions

Vegetation community 1: Riverine Forest (Fig. 6)

Structure: open forest

Sample sites (n = 2): 021, 071

Mean no. native species/site: 16.0 ± 5.7

Mean no. exotic species/site: 6.0 ± 5.7 (27%)

Main species: *Eucalyptus camaldulensis* (River Red Gum)

Associated species: *Acacia stenophylla, Muehlenbeckia florulenta, Chenopodium nitrariaceum, Enchylaena tomentosa, Sclerolaena muricata* var. *muricata, Einadia nutans* subsp. *nutans, Atriplex leptocarpa, Panicum effusum.*

Other common native species: *Eucalyptus largiflorens, Marsilea drummondii, Oxalis perennans, Paspalidium jubiflorum.*

Native species recorded from this community only: *Eucalyptus camaldulensis, Atriplex suberecta, Swainsona greyana, Eclipta platyglossa, Paspalidium jubiflorum, Swainsona phacoides.*

Exotic species: **Heliotropium europaeum, *Cirsium vulgare, *Amsinckia intermedia, *Brassica tournefortii, *Bromus rubens, *Hypochaeris radicata, *Lycium ferocissimum, *Medicago polymorpha, *Sonchus oleraceus, *Vicia sativa* subsp. *angustifolia.*

Landform: River and creek levees, adjacent flats and associated billabongs and swamps, all subject to frequent or periodic flooding.

Soils: Self-mulching to silty grey clays; heavy grey and brown clays.

Distribution: This community occurs along the Darling River in the far central-west of the mapped area. Smaller creeks across the Pooncarie map area tend to be fringed with *Eucalyptus largiflorens* (Black Box), although *Eucalyptus camaldulensis* will occur where there has been periodic flooding.

Condition: Forests subject to manipulated flooding regimes with regeneration greatly affected; most older trees logged, resulting in regrowth of younger age class; weed infestation common; severe bank erosion along the Darling River.

Threats and conservation status: Areas of Riverine Forest along the Darling River are managed under leasehold tenure administered by the Western Lands Commission. The natural regeneration of trees is largely dependent on flooding (Allen 1979). The changes in flooding regimes caused by river regulation has led to a decline in the quality of stands (Margules & Partners et al. 1990). Weed infestation and bank erosion are also major problems exacerbated by current land use. Riverine Forest is not well reserved within New South Wales, being represented only in Kemendok Nature Reserve on the Murray River south-west of the mapped area and Kinchega National Park on the Darling River to the north. It is reserved within Hattah-Kulkyne National Park in north-western Victoria. Some small Crown Reserves contain Riverine Forest

Table 1. Vegetation communities of the Pooncarie 1: 250 000 map sheet showing main species and structural type. Structure is based on Walker and Hopkins (1990).

Vegetation Community	Main Species	Structure
1 Riverine Forest	*Eucalyptus camaldulensis*	open forest
2 Black Box Woodland	*Eucalyptus largiflorens*	woodland–open woodland
3a Irregular Dune Mallee	*Eucalyptus socialis* *Triodia scariosa* subsp. *scariosa*	mallee shrubland– open mallee shrubland
3b Linear Dune Mallee	*Eucalyptus socialis* *Eucalyptus dumosa* *Triodia scariosa* subsp. *scariosa*	mallee shrubland– open mallee shrubland
3d Sandplain Mallee	*Eucalyptus socialis* *Sclerolaena obliquicuspis* *Dissocarpus paradoxus* *Stipa nitida*	mallee shrubland– open mallee shrubland
4 Belah-Rosewood	*Casuarina pauper* *Alectryon oleifolius* subsp. *canescens*	open woodland–isolated clumps
8 Black Bluebush	*Maireana pyramidata*	chenopod shrubland–sparse chenopod shrubland
8p Pearl and Black Bluebushes	*Maireana sedifolia* *Maireana pyramidata*	chenopod shrubland–sparse chenopod shrubland
11 Bladder Saltbush	*Atriplex vesicaria*	chenopod shrubland–open chenopod shrubland
12 *Sclerostegia tenuis*	*Sclerostegia tenuis* *Disphyma crassifolium* subsp *clavellatum*	closed–open chenopod shrubland
13 Canegrass	*Eragrostis australasica*	tussock grassland
16 *Callitris* Woodland	*Callitris glaucophylla*	woodland–isolated clumps
17 *Acacia melvillei* Woodland	*Acacia melvillei*	isolated trees–open woodland
18 Lignum and Nitre Goosefoot	*Muehlenbeckia florulenta* *Chenopodium nitrariaceum*	open–closed shrubland
19 Old Man Saltbush	*Atriplex nummularia*	chenopod shrubland–open chenopod shrubland
22 Disturbed Shrubland Complex	*Dissocarpus paradoxus* *Nitraria billardierei*	shrubland–sparse shrubland
29 Rocky Outcrop Woodland Complex	*Callitris glaucophylla* *Eucalyptus intertexta*	open woodland–isolated trees
30 Lunette Shrubland	*Dodonaea viscosa* subsp. *angustissima*	shrubland–sparse shrubland
OA Open Areas	various grasses, herbs	grassland to forbland and forbs
BA Bare Areas	areas naturally bare of any vegetation	

areas, however these are usually discontinuous and generally not actively managed.

Key sites for conservation: River regulation has severely affected the Darling River and its associated forest within the study area. Blue-green algae outbreaks further upstream have contributed to the degradation of this once-robust river system. Although degraded, this Riverine Forest requires protection and recovery action.

Notes: Only a small area of this community occurs within the Pooncarie map area, and it forms the only forest structural type. Trees may reach heights of 40 m, and leaf and branch litter usually dominates the ground layer. The usually sparse understorey includes scattered shrubs of *Muehlenbeckia florulenta* (Lignum) and *Chenopodium nitrariaceum* (Nitre Goosefoot). *Eragrostis australasica* (Canegrass) may occur at intermittently flooded sites within this community, while areas of semi-permanent still water in oxbows and billabongs may support rushlands of *Typha* spp. and *Juncus* spp. The herbaceous layer varies seasonally and, as well as the species listed, may be

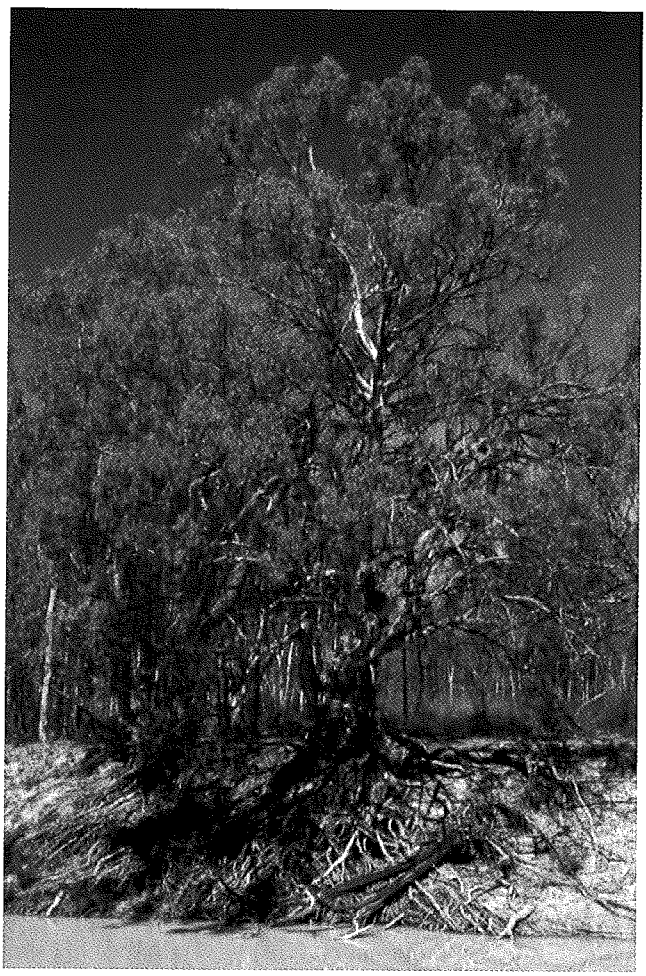

Fig. 6. *Eucalyptus camaldulensis* in Riverine Forest (Community 1) on the banks of the Darling River at Pooncarie.

dominated from year to year by *Alternanthera nodiflora, Eclipta platyglossa, Chamaesyce drummondii, Rumex brownii* and *Swainsona* spp.

Higher areas of red sands occur within the Darling River floodplain. These carry open woodlands and shrublands of *Callitris glaucophylla* and *Dodonaea viscosa* subsp. *angustissima* (See Community 16). Black Box Woodland (Community 2) is closely associated with Riverine Forest, occurring on the higher levels of the floodplain adjacent to the river.

Vegetation community 2: Black Box Woodland

Structure: woodland–open woodland

Sample sites (n = 6): 020, 030, 040, 072, 080, 110

Mean no. native species/site: 20.2 ± 7.8

Mean no. exotic species/site: 2.8 ± 2.6 (13%)

Main species: *Eucalyptus largiflorens* (Black Box)

Associated species: *Enchylaena tomentosa, Einadia nutans* subsp. *nutans, Atriplex semibaccata, Dissocarpus paradoxus, Salsola kali, Osteocarpum acropterum* var. *deminuta, Rhagodia spinescens, Sclerolaena muricata* var. *muricata, Atriplex eardleyae, Sclerolaena brachyptera, Solanum esuriale.*

Other common native species: *Chenopodium cristatum, Maireana brevifolia, Muehlenbeckia florulenta, Chamaesyce drummondii, Chenopodium nitrariaceum, Oxalis perennans.*

Native species recorded from this community only: *Goodenia heteromera, Isolepis australiensis, Juncus flavidus, Myriophyllum verrucosum, Radyera farragei, Ranunculus pumilio* var. *pumilio, Sclerolaena calcarata, Teucrium albicaule, Typha domingensis.*

Exotic species: **Cucumis myriocarpus, *Hordeum leporinum, *Brassica tournefortii, *Bromus rubens, *Carrichtera annua, *Chenopodium murale, *Hypochaeris glabra, *Lycium ferocissimum, *Medicago minima, *Sonchus asper* subsp. *glaucescens, *Spergularia rubra, *Tribulus terrestris, *Verbena supina, *Xanthium spinosum.*

Landform: Uppermost floodplain levels, ephemeral creeks and adjacent flats, dry-lake margins, depressions, drains and channels.

Soils: Silty or cracking, grey and brown clays.

Distribution: Black Box Woodland is not frequent across the mapped area, occurring in depressions, along minor creeks and fringing dry lakes. The greatest densities occur adjacent to *Eucalyptus camaldulensis* open forest on the upper levels of the Darling River floodplain. Black Box occurs in relatively dense stands in Gunnaramby Swamp in the far north-east, and along the channels of Willandra Creek.

Condition: Weed infestation common; understorey generally heavily grazed.

Threats and conservation status: Areas of Black Box Woodland are conserved in

Willandra National Park and Goonawarra National Park on the Hay Plain east of the study area, and in Yanga Nature Reserve near Balranald. Nevertheless, the community is considered poorly conserved in New South Wales (Murray-Darling Basin Ministerial Council 1987). Major threats to the community include disruption of natural flooding regimes needed for regeneration, and overgrazing of seedlings and other elements of the understorey.

Key sites for conservation: Gunnaramby Swamp (sites 040 and 080) in the north-east of the study area, is a notable wetland site containing large stands of Black Box Woodland. Other areas of this community, particularly those adjacent to the Darling River, are generally heavily grazed and cannot be singled out for special conservation action.

Notes: *Eucalyptus largiflorens* grows on the intermittently flooded areas of major river floodplains above the level of the more frequently flooded Riverine Forest. It occurs in ribbon stands along intermittent creeks, dry lakes and as scattered individual trees along drainage lines. The understorey is generally sparse, with chenopod species dominating. Above the Black Box, on the upper floodplain adjacent to the Darling River around Pooncarie, *Acacia victoriae* open woodland occurs, grading into areas of Belah-Rosewood and Sandplain Mallee.

Vegetation community 3: Mallee

Structure: mallee shrubland to open mallee shrubland (rarely open mallee woodland). The Pooncarie mallee is generally of the 'whipstick' type; a low, stunted multi-stemmed growth-form, indicating a sandy soil of low fertility and commonly occurring on the dune crests (Beadle 1948, Noble et al. 1980). 'Bull' mallee, a taller form with fewer stems, occurs in the heavier soils of the swales and is found less commonly on some sandplain areas in the east.

The most common mallee species in the region are *Eucalyptus socialis* (Pointed Mallee), *Eucalyptus dumosa* (Congoo Mallee), *Eucalyptus oleosa* (Glossy-leaved Red Mallee), *Eucalyptus leptophylla* (Narrow-leaved Red Mallee), *Eucalyptus costata* (Ridge-fruited Mallee) and *Eucalyptus gracilis* (Snap and Rattle). The continuous mallee area extends north to Menindee, north-east to Ivanhoe, south into the Murray and Lowan Mallees of Victoria, and west into South Australia. The mallee of central New South Wales (Yathong mallee) forms a large disjunct area between Cobar and Hillston to the north-east of the Pooncarie mallee (Pickard 1987, Pickard & Norris 1994, Conn 1993).

Vegetation community 3a: Irregular Dune Mallee

Sample sites (n = 16): 011, 013, 018, 019, 022, 025, 044, 054, 061, 064, 075, 076, 084, 091,094, 099

Mean no. native species/site: 15.8 ± 4.3

Mean no. exotic species/site: 0.1 ± 0.3 (1%)

Main species: *Eucalyptus socialis* (Pointed Mallee), *Triodia scariosa* subsp. *scariosa* (Porcupine Grass).

Associated species: *Sclerolaena diacantha, Eucalyptus dumosa, Acacia wilhelmiana, Sclerolaena parviflora, Stipa nitida, Dodonaea viscosa* subsp. *angustissima, Podolepis capillaris.*

Other common native species: *Eucalyptus leptophylla, Eucalyptus costata, Eucalyptus gracilis, Eucalyptus oleosa, Halgania cyanea, Lomandra leucocephala* subsp. *robusta, Maireana triptera, Chenopodium desertorum* subsp. *desertorum, Calotis erinacea, Sclerolaena obliquicuspis, Acacia rigens, Bossiaea walkeri, Duboisia hopwoodii, Leptospermum coriaceum, Ptilotus exaltatus* var. *exaltatus.*

Native species recorded from this community only: *Codonocarpus cotinifolius, Hibbertia virgata* subsp. *virgata, Acacia oswaldii, Beyeria opaca, Daviesia arenaria, Exocarpus sparteus, Olearia lepidophylla, Olearia passerinoides* subsp. *passerinoides, Pimelea simplex* subsp. *continua, Plantago cunninghamii, Dicrastylis verticillata, Grevillea pterosperma, Santalum murrayanum.*

Exotic species: **Salvia verbenaca.*

Landform: Dunefields with irregular or discontinuous linear or subparabolic dunes; dunefields of parabolic and unaligned dunes.

Soils: Deep, sandy red soils; leached, non-calcareous siliceous sands.

Distribution: Irregular Dune Mallee is the most common mallee type of the Pooncarie map and occurs throughout the map sheet area; large continuous tracts occur in the central-east and west.

Condition: Some areas cleared or thinned; soil erosion due to goat and rabbit infestation; areas of woody shrubs present; areas subject to wildfire; understorey plants grazed by goats.

Threats and conservation status: Although existing mallee reserves are spread over most of the mallee areas of the state (with the exception of the far west), there is still a need for widespread retention of mallee on Crown Lands held as Western Lands Leases (Brickhill 1988). Prescribed burning in mallee areas, grazing and clearing for dryland cropping are the major current threats to mallee vegetation.

Small areas of both Irregular Dune and Sandplain Mallee exist within Mungo National Park, the only reserve within the study area (Westbrooke & Miller 1995). A number of other reserves within the Central and Western Divisions of New South Wales also contain mallee areas. Mallee Cliffs National Park (58 000 ha) contains 75% mallee (Mabbutt 1982), a small proportion of which is dunefield mallee (16%) with *Triodia scariosa* subsp. *scariosa* understorey (Morcom & Westbrooke 1990). Nombinnie, Round Hill and Yathong Nature Reserves also contain mallee areas, mostly of the dunefield type with *Triodia* understorey (Cohn 1995). Tarawi Nature Reserve (to the west of the Pooncarie map) is a mallee reserve of over 33 000 hectares that contains mostly Irregular and Linear Dune Mallee systems along with Sandplain Mallee and Belah-Rosewood woodlands.

Key sites for conservation: Fine examples of this community occur in the west of the mapped area and form a relatively undisturbed wilderness. These expanses of mallee

remain difficult to access and remote areas such as the locally named 'No Mans Land' paddock, south-east of Pooncarie, can only be reached by following fenceline tracks and firebreaks. This particular area on 'Arumpo' is unwatered, fenced-off and not utilised and has the potential to be an excellent wilderness reserve (Brickhill 1988, Green 1988). Other notable sites sampled during the present survey include 011, 013, 019, 044, 054, 061, 064, 076, 091 and 094.

Notes: Irregular Dune Mallee occurs on deep sands and differs from Linear Dune Mallee in its taller, shrubby understorey and denser *Triodia* layer. *Eucalyptus socialis, Eucalyptus dumosa, Eucalyptus leptophylla* and *Eucalyptus costata* are the dominant mallee species in this community with *Eucalyptus gracilis* and *Eucalyptus oleosa* occurring less frequently. *Eucalyptus oleosa* is more common on flatter country such as sandplains and low dunefields (Brooker & Kleinig 1983). Species such as *Eucalyptus costata, Calotis erinacea, Leptospermum coriaceum, Codonocarpus cotinifolius, Hibbertia virgata* subsp. *virgata, Dicrastylis verticillata* and *Grevillea pterosperma* are associated with the deep, well-drained sandy soils of this mallee community (Cunningham et al. 1981). *Codonocarpus cotinifolius* is a rapid-growing species commonly occurring in the mallee after fire (Harden 1990-93). Its presence may indicate a history of higher fire frequency than in other mallee communities.

Callitris glaucophylla and *Callitris verrucosa* (Mallee Cypress Pine) occur on higher ridges or dunes with deep sandy soils within the mallee. *Casuarina pauper* with *Alectryon oleifolius* subsp. *canescens* can also form local communities within the mallee, particularly in the swales of dunes.

Vegetation community 3b: Linear Dune Mallee (Fig. 7)

Sample sites (n = 9): 001, 008, 009, 043, 055, 063, 077, 088, 097

Mean no. native species/site: 21.6 ± 5.0

Mean no. exotic species/site: 0.2 ± 0.4 (1%)

Main species: *Eucalyptus socialis* (Pointed Mallee), *Eucalyptus dumosa* (Congoo Mallee), *Triodia scariosa* subsp. *scariosa* (Porcupine Grass), *Sclerolaena diacantha* (Grey Copperburr).

Associated species: *Dodonaea viscosa* subsp. *angustissima, Stipa nitida, Eucalyptus gracilis, Acacia colletioides, Enchylaena tomentosa, Eremophila glabra, Sclerolaena parviflora, Maireana triptera, Chenopodium desertorum* subsp. *desertorum.*

Other common native species: *Eucalyptus costata, Eucalyptus leptophylla, Eucalyptus oleosa, Halgania cyanea, Ptilotus exaltatus* var. *exaltatus, Salsola kali, Sclerolaena obliquicuspis, Zygophyllum apiculatum, Acacia wilhelmiana, Atriplex stipitata, Maireana pentatropis, Maireana sclerolaenoides, Vittadinia cuneata* var. *cuneata, Bossiaea walkeri, Chenopodium curvispicatum, Senna artemisioides* subsp. *petiolaris.*

Native species recorded from this community only: *Eutaxia microphylla, Dodonaea bursariifolia, Brachycome multifida* var. *multifida, Cynoglossum australe, Eremophila deserti, Goodenia varia, Grevillea huegelii, Olearia magniflora, Scaevola depauperata, Olearia subspicata, Opercularia turpis.*

Exotic species: **Asphodelus fistulosus, *Brassica tournefortii.*

Landform: Dunefields with continuous, east-west aligned linear dunes or parallel dunes with narrow swales.

Soils: Deep loamy sand to sandy red soil; weathered calcareous sands; calcareous loamy red earths in swales.

Distribution: Linear Dune Mallee occurs throughout the map sheet area, particularly in the central-south and far south-west.

Condition: Areas cleared or thinned; some soil erosion due to rabbit infestation and some scalding in open areas; areas of woody shrubs present; areas subject to wildfire; stands mostly of the 'whipstick' form.

Threats and conservation status: Threats as for Irregular Dune Mallee (3a). Very small

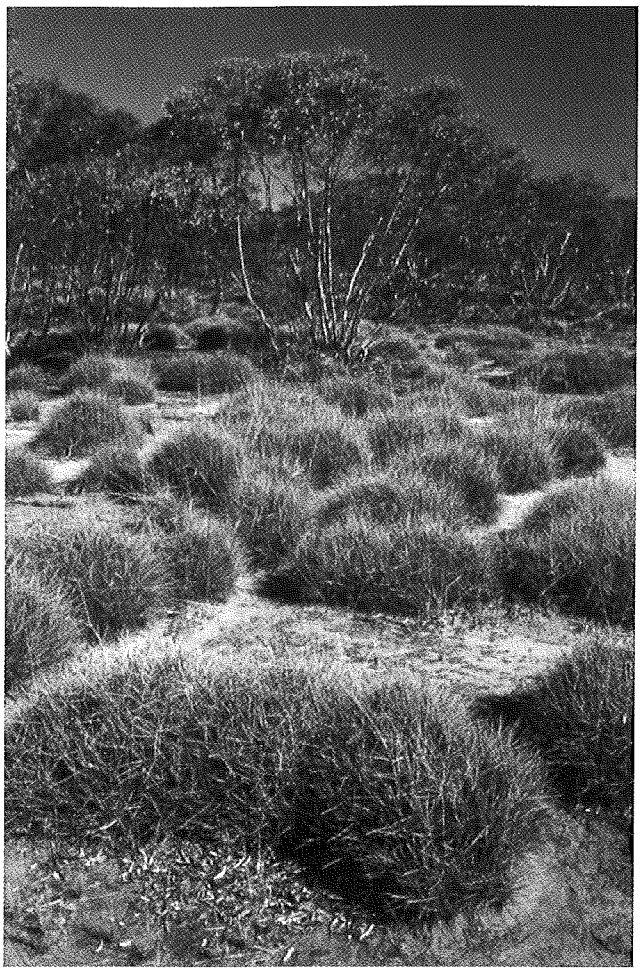

Fig. 7. Mallee on linear sand dunes (Community 3b) with dense *Triodia* hummocks; site 1 at Ryah Box Flat, near Mungo National Park.

areas of Linear Dune Mallee exist within Mungo National Park, but otherwise the community is not conserved within the mapped area (Westbrooke & Miller 1995). Mallee Cliffs National Park to the south contains areas of dune-crest mallee (Scott 1992). Nombinnie, Round Hill and Yathong Nature Reserves also conserve dunefield mallee (Cohn 1995).

Key sites for conservation: Several sites in the south of the mapped area are worthy of protection. Sites 097 and 063 south of 'Turlee' lie within a large continuous area of Linear Dune Mallee in good condition. Sites 008, 009, 043, 055 and 088 are also in good condition, but occur within fragmented mallee areas.

Notes: Linear Dune Mallee occurs on regular, generally east-west running dunes, with a low understorey of *Triodia scariosa* subsp. *scariosa* and mixed shrubs. *Eucalyptus socialis, Eucalyptus dumosa* and *Eucalyptus gracilis* are the dominant mallee species in this community, while *Eucalyptus costata, Eucalyptus oleosa* and *Eucalyptus leptophylla* may be co-dominant with any or all of the above. The understorey has a relatively high diversity of shrub and herb species compared to other vegetation communities. In areas of dense mallee that have remained unburnt for some years, ground litter is often high.

Callitris glaucophylla and *Callitris verrucosa* (Mallee Cypress Pine) occur on higher ridges or dunes with deep sandy soils within the mallee. *Casuarina pauper* with *Alectryon oleifolius* subsp. *canescens* can also form local communities within the mallee, particularly in the swales of dunes.

Vegetation community 3d: Sandplain Mallee (Fig. 8)

Sample sites (n = 11): 026, 027, 034, 039, 047, 052, 057, 070, 073, 098, 105

Mean no. native species/site: 14 .1 ± 3.8

Mean no. exotic species/site: 1.0 ± 1.3 (7%)

Main species: *Eucalyptus socialis* (Pointed Mallee), *Sclerolaena obliquicuspis* (Limestone Copperburr), *Dissocarpus paradoxus* (Cannonball Burr), *Stipa nitida* (Speargrass).

Associated species: *Eucalyptus dumosa, Eucalyptus gracilis, Enchylaena tomentosa, Maireana triptera, Sclerolaena diacantha, Atriplex stipitata.*

Other common native species: *Chenopodium desertorum* subsp. *desertorum, Salsola kali, Zygophyllum apiculatum, Maireana pentatropis, Maireana sclerolaenoides, Marsdenia australis, Sclerolaena patenticuspis, Eucalyptus oleosa.*

Native species recorded from this community only: *Acacia victoriae, Brachycome exilis, Calotis cuneifolia, Minuria denticulata.*

Exotic species: **Asphodelus fistulosus, *Hordeum leporinum, *Brassica tournefortii, *Bromus rubens, *Medicago polymorpha, *Medicago truncatula, *Sonchus oleraceus.*

Landform: Level to undulating sandplains, often with low, discontinuous, linear dunes.

Soils: Calcareous loamy sand to sandy red and brown loams; earths with sandy loam surface and red desert loams derived from aeolian materials.

Distribution: Sandplain mallee occurs throughout the map sheet area but is most common in the eastern half. It also occurs adjacent to the Darling River floodplain in the far west. The community tends to occur on deeper sandplains adjacent to areas of Belah-Rosewood.

Condition: Large areas cleared or thinned; some soil erosion due to rabbit infestation and scalding in open areas; areas of woody shrubs present; prone to weed infestation; some areas subject to wildfire; few old stands remain, mostly of the 'whipstick' form.

Threats and conservation status: Threats and status similar to other mallee types. A small portion occurs within Mungo National Park and fragmented areas within Mallee Cliffs National Park (Westbrooke & Miller 1995, Scott 1992). This particular mallee type is probably not adequately represented in any conservation reserve.

Key sites for conservation: None of the sites visited within this community can be singled out for special conservation recommendation as most were in a poor to average condition when sampled. The community is particularly fragmented and highly disturbed within the mapped area. Its potential for recovery with more favourable seasons is unknown.

Notes: Sandplain Mallee differs floristically from dune-type mallees in its low shrubby chenopod understorey, with little or no *Triodia scariosa* subsp. *scariosa* (Porcupine Grass). Chenopods form an understorey where the soils are higher in clay content, such as on sandplains, duplex plains and swales. Porcupine Grass is associated with the deeper sands of the dunefields. Ground litter is often high in areas that have remained unburnt for some years.

Throughout the mapped area, stands of *Callitris glaucophylla* and Belah-Rosewood occur intermixed with the sandplain mallee and also form local communities within it. *Acacia victoriae* open woodland occurs on the edges of this community, grading into areas of Belah-Rosewood. Large woody shrubs such as *Dodonaea viscosa* subsp. *angustissima*, *Myoporum platycarpum* and *Eremophila sturtii* are common understorey components in the more open and disturbed areas of sandplain mallee, particularly in the north-east of the mapped area. Sandplain or chenopod mallee extends south into the Victorian Murray Mallee and is dominated there by *Eucalyptus gracilis* and *Eucalyptus oleosa* (Conn 1993).

Vegetation community 4: Belah-Rosewood (Fig. 9)

Structure: open woodland–isolated clumps

Sample sites (n = 15): 003, 010, 012, 014, 023, 024, 033, 042, 046, 051, 060, 074, 079, 087, 106

Mean no. native species/site: 14.8 ± 4.0

Mean no. exotic species/site: 0.2 ± 0.4 (1%)

Main species: *Casuarina pauper* (Belah), *Alectryon oleifolius* subsp. *canescens* (Rosewood).

Associated species: *Enchylaena tomentosa, Sclerolaena obliquicuspis, Dissocarpus paradoxus, Stipa nitida, Sclerolaena diacantha, Atriplex stipitata.*

Other common native species: *Maireana triptera, Senna artemisioides* nothosubsp. *coriacea, Geijera parviflora, Myoporum platycarpum* subsp. *platycarpum, Eremophila sturtii, Callitris glaucophylla, Maireana pyramidata, Sclerolaena patenticuspis, Apophyllum anomalum, Dodonaea viscosa* subsp. *angustissima, Exocarpos aphyllus, Rhagodia spinescens, Flindersia maculosa* (in the far north of the mapped area).

Native species recorded from this community only: *Senna artemisioides* nothosubsp. *sturtii, Apophyllum anomalum, Rhagodia ulicina, Amyema miraculosum* subsp. *boormanii, Flindersia maculosa, Lepidium phlebopetalum, Minuria leptophylla, Scleranthus pungens, Acacia loderi, Eremophila maculata, Hakea leucoptera, Hakea tephrosperma, Myoporum montanum, Parsonsia eucalyptophylla.*

Exotic species: **Asphodelus fistulosus, *Salvia verbenaca.*

Landform: Level to undulating sandplains, often with isolated sandy rises.

Soils: Calcareous earths, mainly of red to red-brown loam to loamy sand; solonised brown soils to sandy red earths (Cunningham et al. 1981); reddish-brown sands and texture-contrast (duplex) soils (Scriven 1988).

Distribution: Belah-Rosewood is common throughout the Pooncarie map area. The most dense and continuous stands occur in the north to north-east.

Condition: Scalding and soil erosion, often severe, due to rabbit infestation; trees thinned or cleared in some areas; areas of woody shrubs present; few stands with understorey intact; heavily grazed.

Threats and conservation status: Heavy grazing of belah-rosewood areas has resulted in the thinning and clearing of much of the understorey. Undermining of the sandier soils by rabbits has caused further degradation and the duplex soils are also susceptible to scalding. Belah-Rosewood communities of the region are showing severe stress and dieback with little regeneration due to grazing pressures (Morgan & Terrey 1992).

Clumps of *Casuarina pauper* and *Alectryon oleifolius* subsp. *canescens* often survive by suckering and regeneration is prevented by grazing (Semple & Eldridge 1989). *Casuarina pauper* does not maintain a soil seedbank and must rely on annual seed production and the irregular rainfall to promote germination and establishment (Auld 1995). *Alectryon oleifolius* subsp. *canescens* rarely regenerates from seed and depends on disturbance events such as fire to produce root suckers (Wisniewski & Parsons 1986). Fire frequency may need to be considered in the management of this species to perpetuate stands.

Some small areas of this community are conserved within Mungo National Park and other small reserves, but it is considered inadequately conserved over its range (Benson 1988).

Key sites for conservation: Areas of Belah-Rosewood with intact understoreys should be preserved and protected wherever possible, particularly if regenerating. Sites 010 and 106 in the east of the mapped area were noted as being in good condition.

Fig. 8. Mallee of the sandplain (Community 3d) has an open understorey of chenopod shrubs; site 34 on the Garnpung to Darnick road.

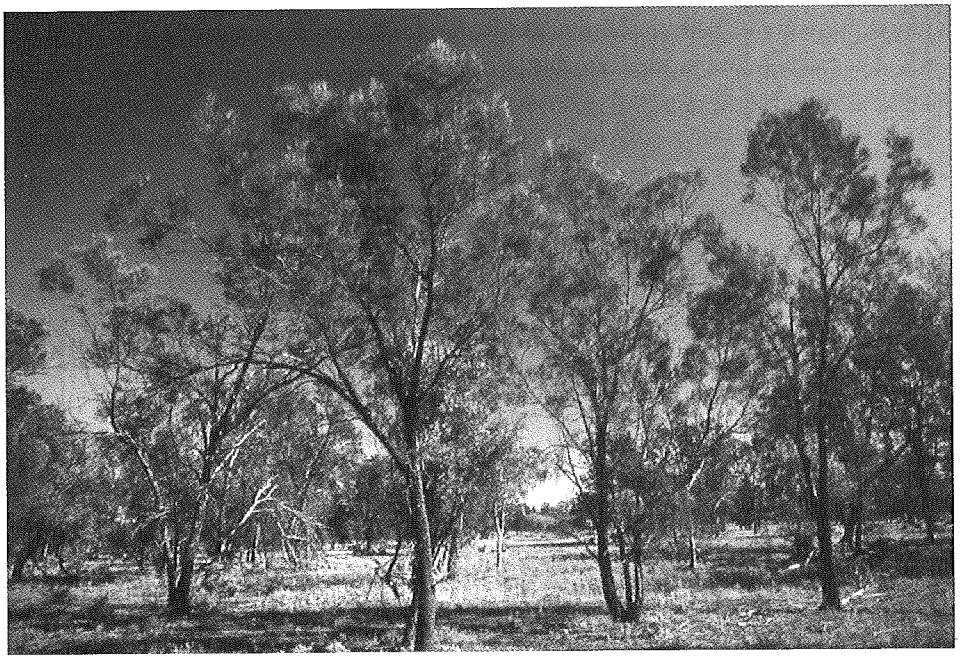

Fig. 9. *Casuarina pauper* trees are a dominant feature of Belah-Rosewood woodland (Community 4) which is distributed widely across the sandplain; site 12 on the Ivanhoe road, east of the Hatfield road.

Notes: Scattered *Flindersia maculosa* and *Acacia loderi* were observed within this community in the far north of the map, representing some of the southern-most populations of these species, which are dominants in communities further north (Pickard & Norris 1994). *Casuarina pauper* also occurs on the lower slopes and surrounding plains of the Manfred Range, a linear series of low rocky outcrops in the far north-east (see Community 29). *Callitris glaucophylla, Hakea leucoptera* and *Hakea tephrosperma* occupy sandier areas of higher elevation within Belah-Rosewood, while *Acacia melvillei* groves occur uncommonly on sandy-loam areas. Mallee may intermix with Belah-Rosewood in deeper sands throughout the mapped area.

The understorey is dominated by chenopod species, usually *Enchylaena tomentosa, Sclerolaena obliquicuspis, Dissocarpus paradoxus* and *Sclerolaena diacantha. Maireana pyramidata* occurs on the shallower sandplains further east, at the transition zone from alluvial to aeolian landscapes. On more calcareous soils at higher elevations, such as the western margins of dry lakes, *Maireana sedifolia* and *Rhagodia ulicina* dominate the understorey, replacing *Maireana pyramidata.*

Vegetation community 8: Black Bluebush (Fig. 10)

Structure: chenopod shrubland–sparse chenopod shrubland

Sample sites (n = 13): 004, 005, 015, 017, 037, 045, 053, 056, 062, 066, 081, 090, 101

Mean no. native species/site: 13.9 ± 5.4

Mean no. exotic species/site: 2.2 ± 1.9 (13%)

Main species: *Maireana pyramidata* (Black Bluebush)

Associated species: *Dissocarpus paradoxus, Stipa nitida, Sclerolaena brachyptera, Atriplex lindleyi, Nitraria billardierei.*

Other common native species: *Rhagodia spinescens, Sclerolaena obliquicuspis, Sclerolaena patenticuspis, Maireana sedifolia.*

Native species recorded from this community only: *Sclerolaena lanicuspis, Dysphania glomulifera* subsp. *eremaea, Tragus australianus, Zygophyllum glaucum.*

Exotic species: **Medicago polymorpha, *Hordeum leporinum, *Cucumis myriocarpus, *Carrichtera annua, *Heliotropium europaeum, *Medicago minima, *Medicago truncatula, *Salvia verbenaca, *Sonchus asper* subsp. *glaucescens, *Asphodelus fistulosus, *Brassica tournefortii, *Centaurea melitensis, *Hypochaeris radicata, *Lamarckia aurea, *Spergularia rubra, *Xanthium spinosum.*

Landform: Level to undulating sandplains, scalded plains, low sandy rises, lunette remnants.

Soils: Red-brown loams and duplex soils with sandy topsoils and clayey subsoils; calcareous sands and loams.

Distribution: This shrubland community is common throughout the mapped area, particularly in the east at the transition from the aeolian landscape to the alluvial Hay Plain. It also occurs on lunettes and raised, scalded, duplex soil areas adjacent to dry lakes.

Condition: Moderate to severe soil erosion due to rabbit infestation with many bare areas; severe scalding on plains and lunettes; heavily grazed.

Threats and conservation status: Bluebush shrubland communities are poorly conserved in the southern sector of the Western Division, particularly on the Hay Plain (Benson 1988, 1989, 1991). Overgrazing of this habitat has resulted in an increase in scalding and other soil erosion, with subsequent vegetation loss. Some areas of Black Bluebush are conserved within Mungo National Park and in Kinchega National Park further north, but the community is considered inadequately conserved over its range.

Key sites for conservation: Several Black Bluebush sites in the east of the mapped area are part of a more continuous area of the community that extends eastwards onto the Hay Plain and could be targeted for conservation. Sites 004, 037 and 101 were noted as being in good condition at the time of sampling.

Notes: *Maireana pyramidata* usually occurs on sandy soils which are alkaline but contain little lime (Dalton 1988). It is a common species on the veneer of aeolian material that indicates the transition from riverine or lacustrine landforms. Bluebush areas tend to be highly susceptible to rabbit infestation, and hence soil erosion, as the loamy soils are ideal for burrowing. *Maireana pyramidata* is a common understorey species to Belah-Rosewood further east, particularly on the Hay Plain. It is often found with *Maireana sedifolia* within the mapped area, and also surrounding low-lying areas of *Atriplex nummularia* (Old Man Saltbush) in the east.

Vegetation community 8p: Pearl and Black Bluebush

Structure: chenopod shrubland–chenopod shrubland

Sample sites (n = 3): 069, 096, 103

Mean no. native species/site: 10.0 ± 2.0

Mean no. exotic species/site: 1.0 ± 1.0 (9%)

Main species: *Maireana sedifolia* (Pearl Bluebush), *Maireana pyramidata* (Black Bluebush)

Associated species: *Dissocarpus paradoxus, Sclerolaena brachyptera, Stipa nitida, Enneapogon avenaceus.*

Other common native species: *Rhagodia ulicina*

Native species recorded from this community only: *Rhodanthe pygmaea*

Exotic species: **Cucumis myriocarpus, *Hordeum leporinum, *Medicago polymorpha.*

Landform: Level to undulating sandplains, scalded plains, low sandy rises, lunette remnants.

Soils: Calcareous red-brown loamy soils. Soil calcareousness determines the distribution of *Maireana pyramidata* and *Maireana sedifolia*. *M. pyramidata* (Black Bluebush) dominates where limestone lies at a depth of 1.2 m or more below the soil surface while soils containing shallower limestone will also support *M. sedifolia* (Pearl Bluebush). Pearl Bluebush tends to occur on calcareous soils where limestone nodules

lie within 60 cm of the surface and dominates where limestone exists within the first 30 cm (Beadle 1948).

Distribution: This shrubland community is uncommon throughout the mapped area, and occurs patchily in the east to south-east, and on lunette remnants of the Willandra Lakes.

Condition: Moderate to severe soil erosion due to rabbit infestation with many bare areas; severe scalding on plains and lunettes; severe gully erosion on lunettes; heavily grazed.

Threats and conservation status: Pearl Bluebush is considered poorly conserved and vulnerable in western New South Wales (Benson 1989, Morgan & Terrey 1992). Some areas of Pearl Bluebush are protected in Mungo National Park. Threats and conservation status as for Black Bluebush (8).

Key sites for conservation: As *Maireana sedifolia* is not common across the mapped area the species should be preserved wherever it occurs. Site 046 is a notable site on the western edge of Chibnalwood Lakes, lying within an area of Belah-Rosewood woodland with an unusual *Maireana sedifolia* and *Rhagodia ulicina* understorey.

Notes: *Maireana sedifolia* becomes the dominant Bluebush species further west on the Nullarbor Plain, where calcareous earths are more common (Beard 1990). In western New South Wales it often occurs as an understorey species in Belah-Rosewood communities, particularly on the sandplains further east of the mapped area on the Hay Plain. Associated species such as *Enneapogon avenaceus* and *Rhagodia ulicina* are common on alkaline or calcareous soils (Cunningham et al. 1981).

Vegetation community 11: Bladder Saltbush (Fig. 11)

Structure: chenopod shrubland - open chenopod shrubland

Sample sites (n = 5): 002, 016, 041, 048, 067

Mean no. native species/site: 11.8 ± 6.6

Mean no. exotic species/site: 0.8 ± 0.4 (8%)**Main species:** *Atriplex vesicaria* (Bladder Saltbush). Subspecies as recognised by Harden (1990-93) have not been identified in this survey.

Associated species: *Sclerolaena brachyptera, Disphyma crassifolium* subsp. *clavellatum, Sclerolaena tricuspis, Sclerostegia tenuis, Osteocarpum acropterum* var. *deminuta, Dissocarpus paradoxus.*

Other common native species: *Dissocarpus biflorus* var. *biflorus, Malacocera tricornis, Minuria cunninghamii, Nitraria billardierei, Atriplex lindleyi, Sclerolaena divaricata, Sclerolaena intricata, Sclerolaena muricata* var. *muricata.*

Native species recorded from this community only: *Alternanthera denticulata, Cynodon dactylon, Sigesbeckia orientalis* subsp. *orientalis.*

Exotic species: **Medicago polymorpha, *Hordeum leporinum, *Medicago praecox.*

Landform: Dry lake beds and level to depressed alluvial plains.

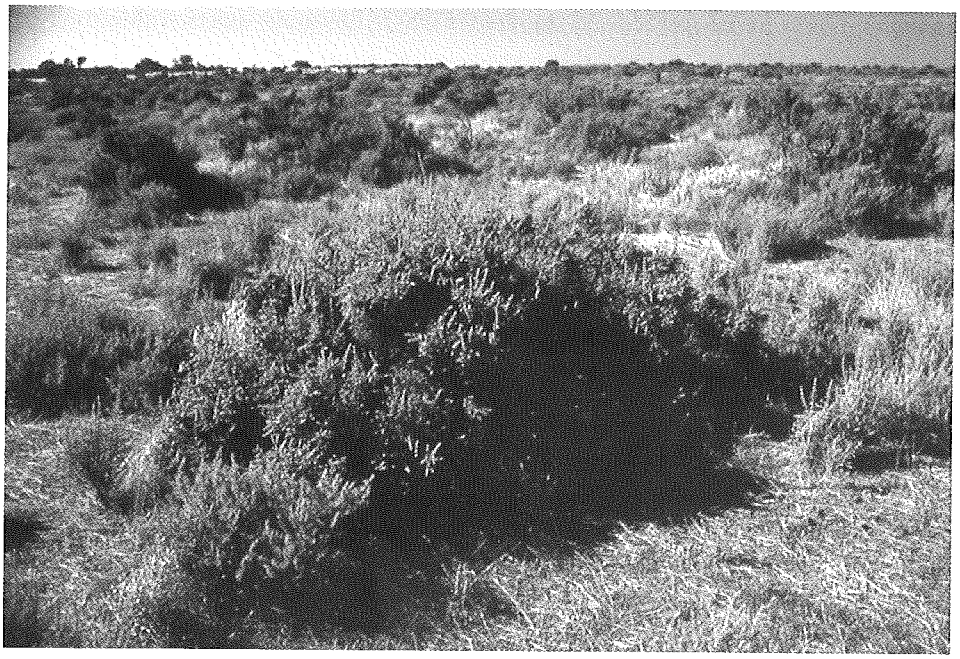

Fig. 10. *Maireana pyramidata* in Black Bluebush chenopod shrubland (Community 8); site 5 on the Ivanhoe road.

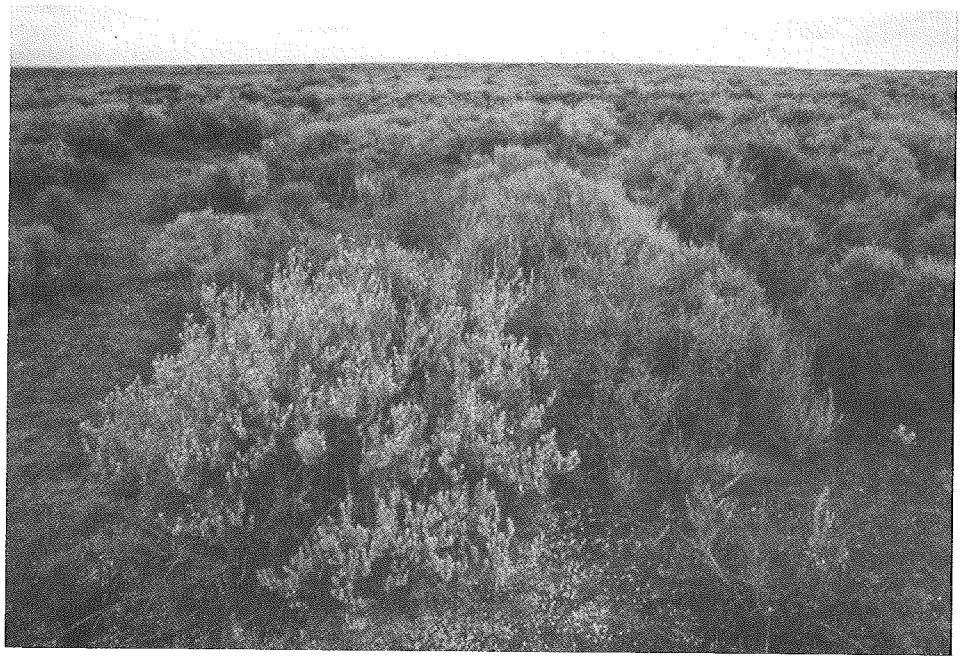

Fig. 11. *Atriplex vesicaria* in Bladder Saltbush shrubland (Community 11); site 41 on the Mildura road.

Soils: Deep, grey, self-mulching and cracking clays to red clay-loam; grey clays and clay-loams to sandy loams overlying clay (Knowles & Condon 1951).

Distribution: *Atriplex vesicaria* shrubland occurs on the alluvial plains in the far south-east of the map sheet area, and in isolated shallow depressions and dry lake beds throughout. Relatively dense stands occur in Lake Mungo within Mungo National Park. The community is no longer intact within the other dry lake beds of the Willandra Lakes system due to overgrazing and clearing.

Bladder saltbush shrubland is most extensive on the Hay Plain east to south-east of the present study area (Porteners 1993). Stands extend east and south from Hatfield, with some smaller areas of the community occurring further west in depressions and on some of the relict lakes of the Willandra Lakes system.

Condition: Previously affected by widespread dieback, presently drought-stressed; moderately to heavily grazed; shrub densities reduced and many areas degraded to copperburr (*Sclerolaena* spp.) shrublands, especially within dry lakes.

Threats and conservation status: The community is considered poorly conserved and vulnerable (Benson 1990). Grazing has drastically affected abundance and altered composition. Mungo National Park contains some good stands of Bladder Saltbush.

Key sites for conservation: Remaining stands of *Atriplex vesicaria* in good condition should be protected in far south-western New South Wales, particularly within dry lakes and depressions as these have been extensively cleared and cropped. Site 041 in the south-east of the study area contains such a stand in good condition.

Notes: Evidence suggests that *Atriplex vesicaria* was recently once more common in the dry lake beds and depressions of the Willandra Lakes (Beadle 1948). The area of Bladder Saltbush has also declined further east on the riverine plain, with overgrazing, drought and dieback events. The area originally occupied by Bladder Saltbush on the riverine plain was estimated at approximately 1.1 million hectares. This decreased to 0.5 million hectares by the end of 1983 after several major dieback events between 1877 and 1983 (Knowles & Condon 1951, Clift et al. 1987, Clift et al. 1989, Semple & Eldridge 1989). In many cases it has been replaced by *Maireana aphylla*, *Sclerolaena* spp., annual saltbush species and introduced grasses. Within the Willandra Lakes area it has been replaced by *Nitraria billardierei*, *Dissocarpus paradoxus*, *Sclerolaena tricuspis*, *Sclerolaena divaricata*, *Sclerolaena intricata*, *Sclerolaena muricata* and *Salsola kali*, species typical of Disturbed Shrubland Complex (22). Degraded communities within Bladder Saltbush shrubland as listed by Beadle (1948) include *Maireana aphylla*, *Atriplex lindleyi*, *Sclerolaena muricata*, annuals and *Nitraria billardierei*.

A species closely associated with *Atriplex vesicaria* is *Sclerostegia tenuis*, which replaces the former in depressed, saline situations (see Community 12). Patches of *Eragrostis australasica* often occur in depressions within both these shrubland communities. In the south-east of the map at the transition from the alluvial Hay Plain to aeolian dune country, Bluebush rises often grade into Bladder Saltbush shrubland at lower levels. *Atriplex vesicaria* often occurs mixed with *Atriplex nummularia* on flat to low-lying sites (see Community 19).

Vegetation community 12: *Sclerostegia tenuis* (Fig. 12)

Structure: closed–open chenopod shrubland

Sample sites (n = 2): 093, 104

Mean no. native species/site: 8.0 ± 0

Mean no. exotic species/site: 0.5 ± 0.7 (6%)

Main species: *Sclerostegia tenuis* (Slender Glasswort), *Disphyma crassifolium* subsp. *clavellatum* (Round-leaf Pigface).

Associated species: *Atriplex vesicaria, Eragrostis australasica, Atriplex lindleyi, Sclerolaena divaricata, Sclerolaena tricuspis, Sclerolaena muricata* var. *muricata.*

Other common native species: *Osteocarpum acropterum* var. *deminuta, Sclerolaena brachyptera.*

Native species recorded from this community only: *Portulaca oleracea.*

Exotic species: **Lamarckia aurea.*

Landform: Saline flats and depressions, depressed alluvial plains.

Soils: Clay soils in saline situations.

Distribution: Occurs in scattered localities within depressed saline flats in the south-east of the mapped area and in the Willandra Lakes region.

Condition: Drought-affected; moderately to heavily grazed; little regeneration.

Threats and conservation status: Not conserved and vulnerable to dieback. Also threatened by grazing and trampling by stock.

Key sites for conservation: Remaining sites of *Sclerostegia tenuis* located within the study area are of very poor condition.

Notes: *Sclerostegia tenuis* often occurs with Bladder Saltbush and dominates in more saline situations. The community is more common further west on the lower alluvium around Lake Victoria and on other dry lakes and saltpans in the area (Fox 1991). It is considered a highly salt-tolerant species, being capable of colonising highly saline environments where no other species will grow (Beadle 1948).

Vegetation community 13: Canegrass (Fig. 13)

Structure: tussock grassland

Sample sites (n = 3): 028, 082, 107

Mean no. native species/site: 9.0 ± 9.5

Mean no. exotic species/site: 1.3 ± 2.3 (13%)

Main species: *Eragrostis australasica* (Canegrass)

Associated species: *Sclerolaena tricuspis*

Other common native species: *Maireana microcarpa, Muehlenbeckia florulenta, Sclerolaena muricata* var. *muricata, Sclerostegia tenuis.*

Native species recorded from this community only: *Amaranthus grandiflorus, Leucochrysum molle, Lepidium pseudohyssopifolium, Maireana microcarpa.*

Exotic species: **Erodium cicutarium, *Hordeum leporinum, *Malva parviflora, *Medicago polymorpha.*

Landform: Swamps, table drains, claypans, alluvial plains with depressions and other low-lying areas subject to intermittent flooding or ponding.

Soils: Slightly saline, compact, heavy grey clays.

Distribution: *Eragrostis australasica* occurs in saline depressions at scattered localities throughout the mapped area.

Condition: Areas cleared, burned and degraded to copperburr (*Sclerolaena* spp.) shrublands; prone to weed infestation.

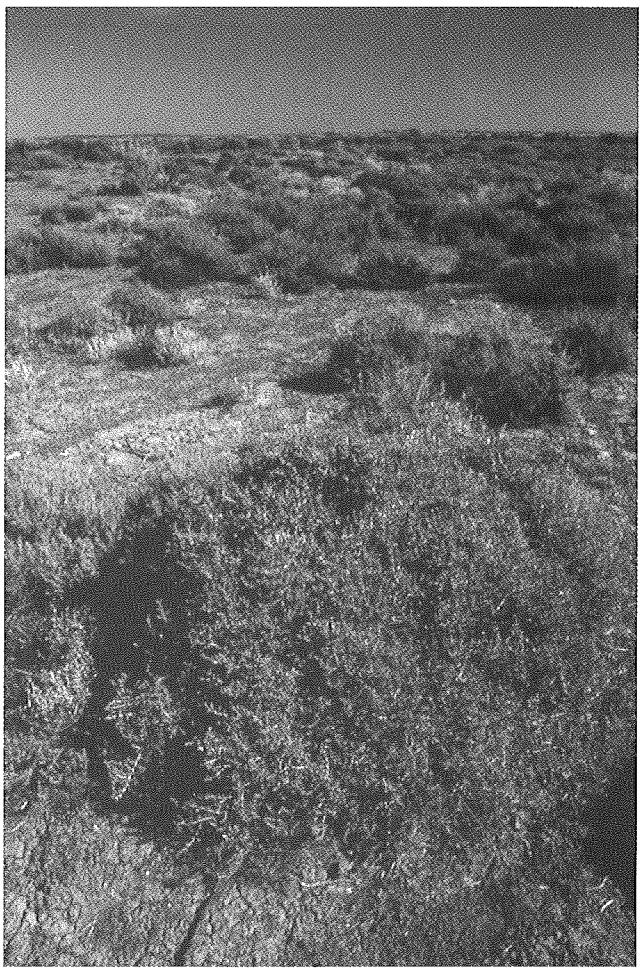

Fig. 12. *Sclerostegia tenuis* shrubland (Community 12) grows in saline flats and depressions; site 67, south-east of Hatfield.

Threats and conservation status: The major threat to this community is dryland cropping with canegrass areas regularly burned and cleared. Swamps are also occupied by feral pig populations which trample, dig up and overgraze the vegetation. The community is inadequately conserved and vulnerable.

Key sites for conservation: Gunnaramby swamp in the far north-east of the study area is an interesting wetland site that contains areas of canegrass. Few other sites in the area have conservation potential. Protection of billabong areas along the Darling River would conserve some canegrass populations.

Notes: *Eragrostis australasica* tolerates regular, but not prolonged flooding, while *Muehlenbeckia florulenta* (Lignum) occupies the wetter areas. It often occurs in depressions within *Atriplex vesicaria, Atriplex nummularia* and *Sclerostegia tenuis*. Many Canegrass swamps were not mapped at the published scale due to their small size.

Vegetation community 16: *Callitris* Woodland (Fig. 14)

Structure: woodland–isolated clumps

Sample sites (n = 5): 007, 050, 083, 086, 092

Mean no. native species/site: 9.6 ± 3.2

Mean no. exotic species/site: 4.8 ± 2.5 (33%)

Main species: *Callitris glaucophylla* (White Cypress Pine)

Fig. 13 Canegrass swamps (Community 13) occur in low-lying areas subject to intermittent flooding and ponding; site 28 at Pambra Tank, north-east of Pooncarie.

Associated species: *Enchylaena tomentosa, Salsola kali, Chenopodium cristatum.*

Other common native species: *Alectryon oleifolius* subsp. *canescens, Dissocarpus paradoxus, Erodium crinitum, Nicotiana velutina, Casuarina pauper, Maireana brevifolia, Maireana pyramidata, Sclerolaena diacantha, Sclerolaena obliquicuspis, Solanum esuriale.*

Native species recorded from this community only: *Actinobole uliginosum, Crassula colorata* var. *acuminata, Rhodanthe moschata, Wurmbea dioica* subsp. *dioica, Acacia salicina, Callitris gracilis* subsp. *murrayensis, Scleranthus minisculus, Wahlenbergia gracilenta.*

Exotic species: **Cucumis myriocarpus, *Asphodelus fistulosus, *Brassica tournefortii, *Chenopodium murale, *Heliotropium europaeum, *Hordeum leporinum, *Alopecurus geniculatus, *Avena fatua, *Echium plantagineum, *Hypochaeris glabra, *Malva parviflora, *Marrubium vulgare, *Medicago minima, *Medicago truncatula, *Nicotiana glauca, *Sonchus oleraceus, *Urtica urens, *Vulpia myuros.*

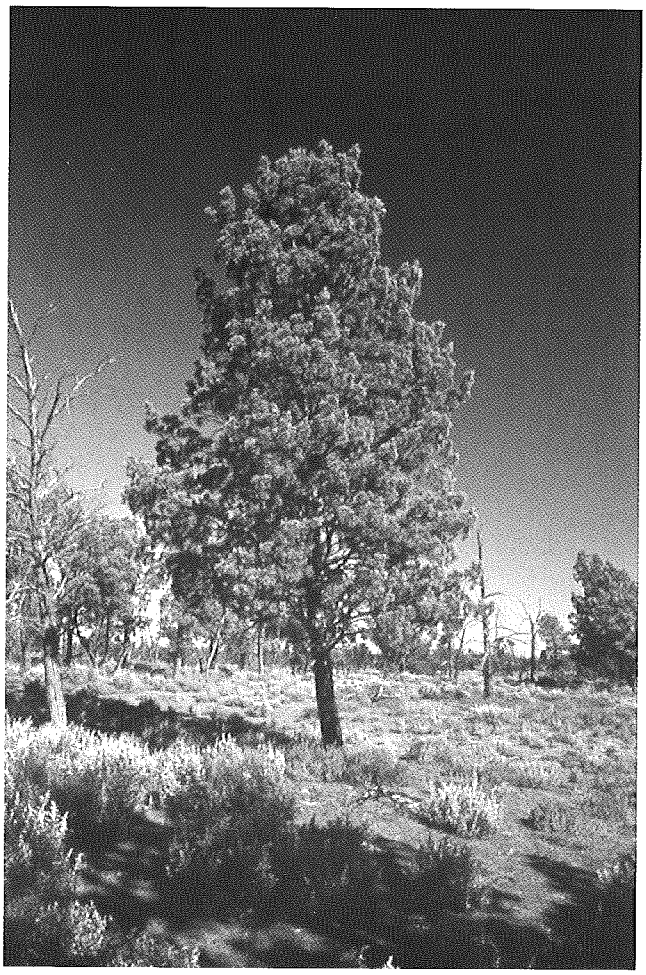

Fig. 14. *Callitris glaucophylla* woodland (Community 16); site 7 on Gol Gol road.

Landform: Raised sandy areas such as low linear dunes, sandhills and ridges.

Soils: Sandy soils; coarse-textured red and brown earths; red-brown sandy-loams.

Distribution: Isolated sandhills with *Callitris* Woodland occur throughout the mapped area, particularly within Belah-Rosewood sandplain areas. The largest area of *Callitris glaucophylla* occurs east of 'Mandleman' and south-east of Mulurulu Lake on a long, continuous sandy ridge extending several kilometres.

Condition: Usually very poor; severe rabbit infestation and scalding; many areas cleared; trees generally thinned; areas of woody shrubs present; few areas with intact shrubby understoreys; little regeneration due to grazing stock and rabbits; prone to weed infestation.

Threats and conservation status: Native Pine communities are amongst the most threatened and vulnerable in western New South Wales, particularly populations of *Callitris verrucosa* (Mallee Cypress Pine) and *Callitris gracilis* subsp. *murrayensis* (Murray Cypress Pine). *Callitris* communities suffer from major clearing and alteration of the understorey, little regeneration and having an older age class over much of their distribution. Rabbit invasion and overgrazing are serious and current threats.

The community is considered endangered in the area and is not conserved. Its relative rarity within the region and the degraded state of remnants gives *Callitris* woodland particular conservation significance. Populations should be protected wherever possible.

Key sites for conservation: Several sites exist within the area that should be targeted for conservation management. Of particular interest is a sandy ridge east of 'Mandleman' which supports a large continuous population of *Callitris glaucophylla* (Site 050). However, much of the vegetation is in poor condition with little regeneration observed. Good stands also exist on the eastern lunette of Lake Garnpung (Site 007).

Notes: Extensive stands of *Callitris glaucophylla* occur further east of the mapped area, extending from Queensland, throughout the slopes and plains of New South Wales, to Victoria. Associated species vary throughout its range. Much of the original understorey has been grazed out but it is thought that common understorey shrubs may have included species of *Dodonaea, Pimelea, Rhagodia, Exocarpos* and *Senna* (Noble & Mulham 1980). Generally the ground cover consists of scattered chenopod shrubs and short-lived grasses and herbs, many of them introduced species. The sandy soils are highly prone to wind erosion and degradation by rabbits. Woody species such as *Dodonaea viscosa* subsp. *angustissima, Eremophila sturtii* and *Senna* species can form dense, low, monospecific scrubs within this community across the mapped area.

Isolated, highly eroded rises carrying *Callitris glaucophylla* occur on the Darling floodplain in the far west of the mapped area. These elevated areas of brown solonised soils which are not subject to flooding, also carry open or scattered *Acacia victoriae*, sometimes with *Eremophila sturtii* (Turpentine), *Dodonaea* spp. (Hopbushes), and Belah-Rosewood (Stannard 1963). Several groves of *Callitris gracilis* subsp. *murrayensis* (Murray Cypress Pine) occur on sandy ridges on the western margin of Lake Mungo and comprise large, old trees.

Callitris Woodland is one of the more vulnerable vegetation types in far-western New South Wales in the context of present land use. It is under serious threat from rabbits and stock with even-aged, often old stands of trees dying out. The coarse-textured soils are susceptible to rabbit infestation, resulting in massive erosion and scalding, and regeneration is prevented due to the grazing out of seedlings. Populations should be preserved wherever possible.

Vegetation community 17: *Acacia melvillei* Woodland (Fig. 15)

Structure: isolated trees–open woodland

Sample sites (n = 2): 059, 085

Mean no. native species/site: 13.5 ± 6.4

Mean no. exotic species/site: 1.5 ± 0.7(10%)

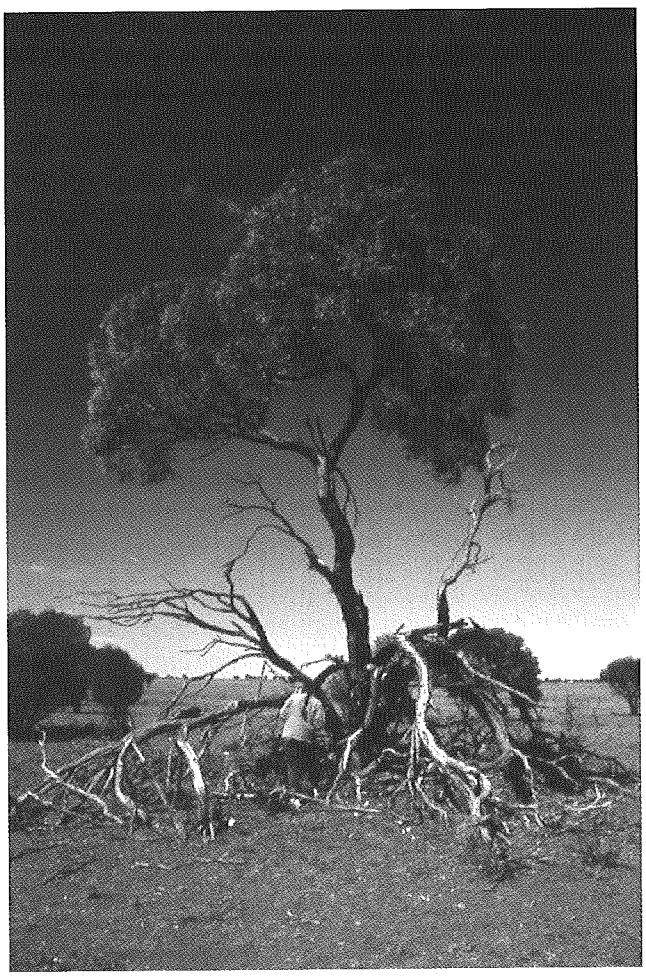

Fig 15. *Acacia melvillei* woodland (Community 17) occurs as isolated trees. Many specimens are senescing with no sign of regeneration; site 59 on the Ivanhoe to Mulurulu road.

Main species: *Acacia melvillei* (Yarran)

Associated species: *Dissocarpus paradoxa, Enchylaena tomentosa, Sclerolaena obliquicuspis, Eremophila sturtii, Stipa nitida.*

Other common native species: *Acacia homalophylla, Sclerolaena diacantha.*

Native species recorded from this community only: *Acacia homalophylla, Ixiolaena tomentosa, Lycium australe.*

Exotic species: **Salvia verbenaca, *Asphodelus fistulosus, *Medicago polymorpha.*

Landform: Level to undulating sandplains.

Soils: Red-brown sandy loam soil; reddish loam flats.

Distribution: Only a few small remnant areas of *Acacia melvillei* occur on the Pooncarie map area. *Acacia melvillei* can occur as groves or small local communities within *Callitris* Woodland (Community 16) and Belah-Rosewood (Community 4).

Condition: Severe scalding and rabbit infestation; most sites heavily grazed; understorey absent or degraded; many areas cleared; some large, old trees present; areas of woody shrubs present.

Threats and conservation status: *Acacia melvillei* woodland is regarded as a highly vulnerable vegetation community which is also unconserved. Inland *Acacia* communities are considered one of the groups with the poorest conservation status in New South Wales (Benson 1989). Immediate threats are grazing by stock and rabbits, resulting in scalding and little or no regeneration of the community. Seedling establishment of *Acacia melvillei* is strongly limited by rabbit browsing and protecting existing populations will require strict rabbit control (Batty & Parsons 1992). Stock grazing pressure is also a threat to regeneration. Profuse root suckering of *Acacia melvillei* can result from root damage by cultivation in dryland cropping areas.

Key sites for conservation: *Acacia melvillei* populations should be protected and conserved wherever found, including sites 059 and 085 within the mapped area. Some excellent stands which should also be targeted for conservation action exist further south around Balranald (Scott 1992).

Notes: This community is very small in extent and forms localised stands in Belah-Rosewood and *Callitris* Woodlands. Only three very open areas have been mapped, all in the north-east of the map area. *Acacia melvillei* is often mistaken for the very similar *Acacia homalophylla*, and the two species often occur together. The community is more extensive, although not common, on the plains and slopes further east.

Vegetation community 18: Lignum and Nitre Goosefoot

Structure: open–closed shrubland

Sample sites (n = 3): 029, 035, 108

Mean no. native species/site: 8.3 ± 2.1

Mean no. exotic species/site: 2.0 ± 0 (20%)

Main species: *Muehlenbeckia florulenta* (Lignum), *Chenopodium nitrariaceum* (Nitre Goosefoot).

Associated species: *Salsola kali, Sclerolaena muricata* var. *muricata, Teucrium racemosum, Marsilea drummondii.*

Other common native species: *Eragrostis australasica*

Native species recorded from this community only: *Amaranthus macrocarpus* var. *macrocarpus, Polygonum plebeium, Senecio runcinifolius.*

Exotic species: **Hordeum leporinum, *Heliotropium supinum, *Medicago polymorpha, *Xanthium spinosum, *Tribulus terrestris, *Verbena officinalis.*

Landform: Intermittently flooded depressions, channels, river-flats and swamps. Flooding is relatively infrequent, but often prolonged.

Soils: Heavy grey to grey-brown cracking clays.

Distribution: This community occurs infrequently throughout the mapped region, in swamps adjacent to the Darling River and Willandra Creek systems and in scattered low-lying depressions.

Condition: Weed infestation; grazed by cattle; swamps used as habitat by feral pigs.

Threats and conservation status: This community is considered poorly conserved. There are no significant stands of Lignum conserved in south-western New South Wales (Benson 1988). It is threatened with clearing for dryland and irrigated cropping and disruption of natural flooding regimes by river regulation.

Key sites for conservation: Conservation of Riverine Forest areas along the Darling River would preserve associated Lignum and *Chenopodium nitrariaceum* understoreys. Gunnaramby Swamp in the north-east of the mapped area also contains significant areas of Lignum which are worth protecting. Some pig control is desirable in swamps across the mapped area.

Notes: *Chenopodium nitrariaceum* exceeds Lignum as the dominant species in this community in occasionally inundated areas with less restricted drainage. It is a common understorey shrub in Riverine Forest and Black Box communities and a common associate species of *Atriplex nummularia* (Old Man Saltbush). *Muehlenbeckia florulenta* can withstand more prolonged flooding, favouring channelled plains and depressions with impeded drainage, and nearly always occurs with *Chenopodium nitrariaceum.*

Vegetation community 19: Old Man Saltbush (Fig. 16)

Structure: chenopod shrubland–open chenopod shrubland

Sample sites (n = 4): 038, 065, 068, 102

Mean no. native species/site: 12.0 ± 4.7

Mean no. exotic species/site: 3.3 ± 2.1 (20%)

Main species: *Atriplex nummularia* (Old Man Saltbush)

Associated species: *Maireana pyramidata, Atriplex lindleyi, Osteocarpum acropterum* var. *deminuta.*

Other common native species: *Chenopodium nitrariaceum, Einadia nutans* subsp. *nutans, Rhagodia spinescens, Salsola kali, Sclerolaena divaricata, Sclerostegia tenuis, Atriplex vesicaria, Sclerolaena tricuspis.*

Native species recorded from this community only: *Pratia concolor.*

Exotic species: **Xanthium spinosum, *Medicago polymorpha, *Heliotropium europaeum, *Centaurea melitensis, *Cucumis myriocarpus, *Hordeum leporinum, *Lamarckia aurea, *Lycium ferocissimum, *Marrubium vulgare, *Sonchus oleraceus, *Verbena officinalis.*

Landform: Level to depressed plains, low-lying areas and depressions.

Soils: Grey-brown loams to grey and brown cracking clays.

Distribution: This community occurs in scattered localities in the east to south-east of the mapped area.

Condition: Largely cleared; heavily grazed with shrubs thinned; some scalding in open areas; little regeneration due to grazing stock, rabbits, goats and kangaroos; some weed and copperburr (*Sclerolaena* spp.) infestation.

Threats and conservation status: This community has an extremely poor conservation status and is extinct in some regions and rare overall (Benson 1989). Grazing, clearing, rabbit infestation and mismanagement of remnants are the current threats.

Key sites for conservation: *Atriplex nummularia* should be protected wherever it occurs. The community is now very rare in the mapped area, and remnants, although highly disturbed, should be fenced-off from stock with rabbit control.

Notes: Old Man Saltbush remnants have been subjected to grazing pressure, rabbit-disturbance and clearing. Larger remnant areas are delineated on the maps but many smaller patches exist, especially around homesteads and in holding paddocks, often consisting of only scattered individuals. The shrub is palatable to both stock and rabbits and does not recover well with constant defoliation under heavy grazing pressure (Cunningham et al. 1981).

Vegetation community 22: Disturbed Shrubland Complex (Fig. 17)

Structure: shrubland or chenopod shrubland–sparse shrubland or sparse chenopod shrubland

Sample sites (n = 6): 006, 031, 036, 095, 100, 109

Mean no. native species/site: 11.7 ± 2.5

Mean no. exotic species/site: 2.5 ± 2.8 (20%)

Main species: *Dissocarpus paradoxus* (Cannonball Burr), *Nitraria billardierei* (Dillon Bush).

Associated species: *Maireana aphylla, Sclerolaena tricuspis, Salsola kali, Atriplex lindleyi, Euphorbia planiticola, Atriplex holocarpa, Chamaesyce* species B, *Panicum decompositum.*

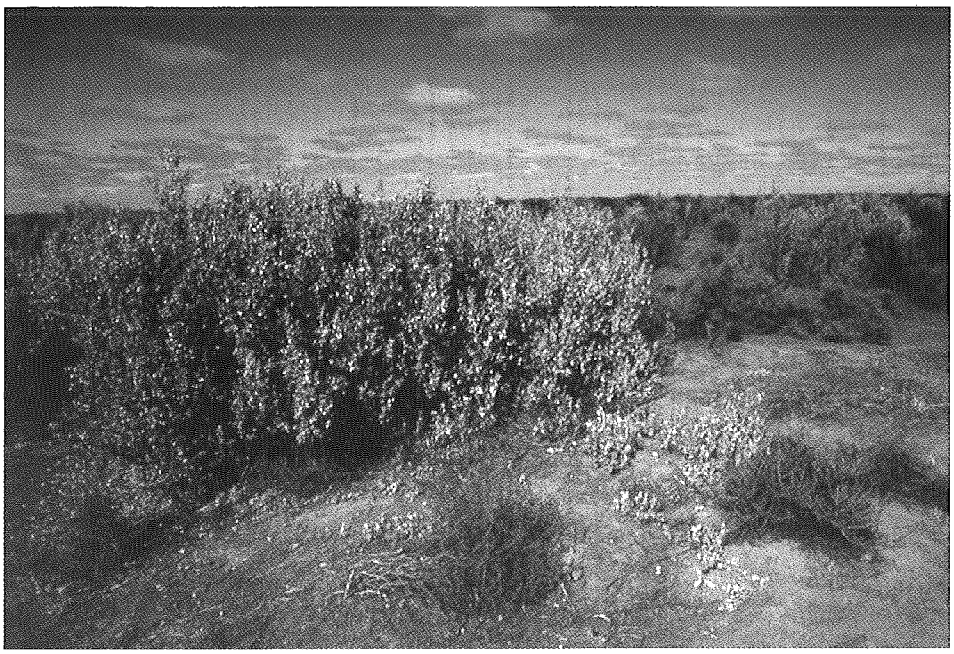

Fig. 16. *Atriplex nummularia* in Old Man Saltbush chenopod shrubland (Community 19); site 65 on the Turlee to Balranald road, south-west of Hatfield.

Fig. 17. In highly disturbed areas, a complex of shrubs will prevail (Community 22); site 6 on Garnpung Lake.

Other common native species: *Danthonia caespitosa, Osteocarpum acropterum* var. *deminuta, Sclerolaena brachyptera,* occasionally remnant *Atriplex vesicaria, Neobassia proceriflora, Sclerolaena divaricata, Sclerolaena intricata, Sclerolaena muricata.* This community occupies disturbed areas and usually comprises a high proportion of introduced and annual species. Other common native species vary depending on the composition of the original vegetation.

Native species recorded from this community only: *Atriplex intermedia, Brachycome heterodonta* var. *heterodonta, Homopholis proluta, Maireana aphylla, Neobassia proceriflora, Panicum laevinode, Vittadinia pterochaeta.*

Exotic species: **Cucumis myriocarpus, *Hordeum leporinum, *Tribulus terrestris, *Hibiscus trionum, *Medicago minima, *Carrichtera annua, *Erodium cicutarium, *Medicago truncatula, *Sonchus asper* subsp. *glaucescens.*

Landform: Disturbed low-lying alluvial plains, floodplains and dry lakebeds.

Soils: Grey to grey-brown clay and loam soils, often saline.

Distribution: This disturbed shrubland predominates on the previously cropped and/or heavily grazed lake beds of the Willandra Lakes system, and also occurs in scattered depressions and dry lakes throughout the mapped area.

Condition: Heavily grazed; occurs on previously cropped, cleared and overgrazed landscapes; overall increase in range and populations; moderate to severe scalding and other soil erosion; provides shelter and habitat for rabbits.

Threats and conservation status: This community is not considered threatened and its distribution is actually increasing as it establishes in disturbed areas once occupied by other chenopod shrublands.

Notes: *Nitraria billardierei* tends to occur in areas of high grazing pressure and in previously cropped areas. Its distribution has increased markedly with the changed land use in the area since European settlement, and severe overgrazing has resulted in the establishment of Dillon Bush in areas once occupied by *Atriplex vesicaria* and *Atriplex nummularia* (Noble & Whalley 1978). Dillon Bush commonly occurs within other chenopod shrubland communities.

Dissocarpus paradoxus is a dominant understorey shrub in most aeolian vegetation communities and a common associate in alluvial communities within the Pooncarie map sheet area. In the present survey it was recorded from every community except Riverine Forest and Rocky Outcrop Woodland Complex, and it occurred in over 50 per cent of sites. It is particularly common in Belah-Rosewood Woodland (4), Sandplain Mallee (3d) and Bluebush shrublands (8 and 8p). Because it increases in overgrazed situations and is often found in abundance to the exclusion of more robust perennial plants, it is regarded as an indicator of poor range condition (Mitchell & Wilcox 1994). Particularly high numbers of rabbits are associated with Dillon Bush on sandy substrates (Fatchen & Fatchen 1989).

Copperburrs (*Sclerolaena* spp.) are also considered weed or increaser species which colonise areas that have been heavily grazed (Cunningham et al. 1981). *Sclerolaena*

tricuspis, *Sclerolaena divaricata* and *Sclerolaena muricata* all colonise over-grazed areas, especially those once dominated by *Atriplex vesicaria* (Leigh & Mulham 1965).

Vegetation community 29: Rocky Outcrop Woodland Complex (Fig. 18)

Structure: open woodland to isolated trees

Sample sites (n = 2): 032, 078

Mean no. native species/site: 25.5 ± 2.1

Mean no. exotic species/site: 5.0 ± 4.2 (16%)

Main species: *Callitris glaucophylla* (White Cypress Pine), *Eucalyptus intertexta* (Western Red Box).

Associated species: *Enchylaena tomentosa*, *Einadia nutans* subsp. *nutans*, *Sida intricata*, *Sclerolaena convexula*, *Solanum ferocissimum*, *Chamaesyce drummondii*, *Erodium crinitum*, *Goodenia fascicularis*, *Phyllanthus fuernrohrii*, *Vittadinia gracilis*.

Other common native species: *Acacia aneura*, *Acacia burkittii*, *Eriostemon linearis*. Ferns such as *Cheilanthes distans*, *Cheilanthes lasiophylla*, *Cheilanthes sieberi* subsp. *sieberi* and *Pleurosorus rutifolius* grow under rocky overhangs and in moist crevices.

Native species recorded from this community only: *Cheilanthes lasiophylla*, *Phyllanthus fuernrohrii*, *Solanum ferocissimum*, *Abutilon fraseri*, *Abutilon halophilum*, *Acacia aneura*, *Acacia burkittii*, *Cheilanthes distans*, *Cheilanthes sieberi* subsp. *sieberi*,

Fig. 18. *Eucalyptus intertexta* is a dominant species of the Rocky Outcrop Woodland Complex (Community 29). As this community is restricted to rocky areas, it is rare on the Pooncarie map; site 32 on Manfred Mountain.

Digitaria brownii, Enteropogon acicularis, Eriostemon linearis, Evolvulus alsinoides var. *decumbens, Glycine canescens, Haloragis odontocarpa, Hibiscus krichauffianus, Pachymitus cardaminoides, Paspalidium constrictum, Pleurosorus rutifolius, Sida cunninghamii, Sigesbeckia australiensis.*

Exotic species: **Asphodelus fistulosus, *Cirsium vulgare, *Cucumis myriocarpus, *Erodium cicutarium, *Hordeum leporinum, *Lamarckia aurea, *Lycium ferocissimum, *Marrubium vulgare, *Medicago minima, *Medicago truncatula, *Salvia verbenaca, *Silene apetala.*

Landform: Footslopes, ridges and crests of low rocky outcrops. Outcropping of quartzite and sandstone, pebbly to conglomeratic in part, siltstone and shale (Norris & Thomas 1991).

Soils: Brown to dark brown sandy loam with surface stones and gravel, overlying a sandstone-conglomerate substrate. Shallow, stony, sandy soils, becoming redder and better developed downslope (Walker 1991). Sandstone lithosols or skeletal soils (which occur where rock is near the surface) comprising shallow sands, loams and clay-loams which are stony or gravelly (Norris & Thomas 1991).

Distribution: Manfred Hill in the Manfred Range, in the far north-east of the Pooncarie map area and south-west of Ivanhoe. This is the only rocky outcrop existing within the mapped area.

Condition: Severe rabbit infestation and grazing and trampling by goats; almost total tree clearing and dieback; high proportion of exotic species.

Threats and conservation status: Rocky outcrops and their associated vegetation are poorly conserved in western New South Wales. Many of these outcrops and ranges are heavily disturbed and represent isolated islands of vegetation amongst tracts of agricultural land. Most are unprotected and, with continued disturbance and the lack of corridors for species dispersal, will continue to degenerate (Norris & Thomas 1991).

Key sites for conservation: Manfred Hill in the north-east of the study area is very degraded but should be protected. The Warranary Range further east on the northern edge of the Hay Plain is a better example of this community and would be well worth targeting for conservation action (Porteners 1993).

Notes: This woodland community is very degraded due to clearing, overgrazing and the proliferation of goats. Few trees remain (scattered *Callitris glaucophylla, Eucalyptus intertexta, Acacia aneura* and *Acacia burkittii*) and the understorey is very sparse, comprising various grazed-down herbs and shrubs. The composition of the understorey and ground cover will vary seasonally. A dense area of *Eriostemon linearis* (Narrow-leaf Waxflower) shrubland was observed growing on a south-west facing slope in the centre of the Manfred Range.

Feral goats are a major problem in rocky areas, causing much damage in high numbers by grazing and trampling native vegetation. Their preferential diet includes a wide range of native species (Norris & Thomas 1991). Rabbits are also a problem in the sandier soils of the footslopes where they undermine root systems and cause massive soil erosion. Goats were observed in large numbers on and around Manfred Hill.

Vegetation community 30: Lunette Shrubland (Fig. 19)

Structure: shrubland–sparse shrubland

Sample sites (n = 3): 049, 058, 089

Mean no. native species/site: 11.7 ± 9.9

Mean no. exotic species/site: 5.3 ± 2.3(29%)

Main species: *Dodonaea viscosa* subsp. *angustissima* (Narrow-leaf Hopbush)

Associated species: *Salsola kali, Stipa nitida, Myriocephalus stuartii.* This community usually comprises a high proportion of introduced and annual species.

Other common native species: *Maireana pyramidata, Acacia ligulata, Pittosporum phylliraeoides.*

Native species recorded from this community only: *Digitaria ammophila, Pimelea trichostachya, Pittosporum phylliraeoides.*

Exotic species: **Asphodelus fistulosus, *Brassica tournefortii, *Bromus rubens, *Chenopodium murale, *Cucumis myriocarpus, *Echium plantagineum, *Hypochaeris glabra, *Hordeum leporinum, *Lamarckia aurea, *Medicago minima, *Medicago polymorpha, *Medicago truncatula, *Nicotiana glauca, *Salvia verbenaca, *Sonchus oleraceus.*

Landform: Lake lunettes, lunette remnants and disturbed areas, usually highly eroded.

Fig. 19. The sandy lunettes on the lake edges support Lunette Shrubland (Community 30). Its species composition and structure is dependent on its disturbance history; site 58 on the edge of Lake Mulurulu.

Soils: White calcareous sands to light red-brown sandy loam.

Distribution: This community occurs on the crescent-shaped lunettes and patchier lunette remnants on the eastern edges of the large dry lakes in the Willandra Lakes system. The lunettes of Garnpung and Mulurulu Lakes carry dense areas of Hopbush. Hopbush also occurs as localised stands within Belah-Rosewood and Mallee, particularly in cleared areas within these and other sandplain communities.

Condition: Heavily eroded; rabbit infestation; moderately grazed; high proportion of exotic species.

Threats and conservation status: This community is not considered threatened as Hopbush is increasing in range and distribution as regrowth in disturbed areas.

Key sites for conservation: The large lunettes associated with the Willandra Lakes are important, naturally eroding landform features. Their degradation has been accelerated with increased grazing and the introduction of rabbits. As well as having significant archaeological values, they support many important and interesting plant species and sites should be preserved and protected in the area. The huge lunette of Lake Garnpung is of particular interest and management plans should include rabbit control.

Notes: *Dodonaea viscosa* subsp. *angustissima* is a widespread and common woody shrub of the arid, semi arid and tableland zones, often forming dense thickets within disturbed and cleared areas. It is considered a pest species by graziers because its dense regrowth interferes with the grazing potential of the land (Cunningham et al. 1981).

Open areas (OA)

These are highly disturbed areas with a vegetation cover of annual or short-lived perennial grasses, herbs, forbs and few shrubs. Open Areas result from intense grazing, erosion, clearing and fire. Introduced pasture species usually predominate, such as **Hordeum leporinum*, **Lamarckia aurea*, **Bromus rubens*, **Avena fatua* and **Medicago* spp. Native grasses may include *Stipa nitida*, *Enneapogon avenaceus*, *Danthonia caespitosa*, *Dactyloctenium radulans* and *Sporobolus caroli*. The composition of annual herbs changes seasonally but may include **Asphodelus fistulosus*, **Salvia verbenaca*, *Erodium* spp., *Ptilotus* spp., *Swainsona* spp., asteraceaeous herbs and annual saltbushes. Open Areas may also carry outbreaks of Narrow-leaf Hopbush (*Dodonaea viscosa* subsp. *angustissima*) and Turpentine (*Eremophila sturtii*). Weeds often dominate the more disturbed Open Areas such as road verges, table drains and heavily used paddocks.

Bare areas (BA)

These areas are naturally bare of any vegetation and include lake lunettes and other isolated and often shifting dunes. The deep, white, calcareous sands of lunette remnants are highly susceptible to erosion and are often completely open with no vegetation cover. Bare areas are not uncommon in the Willandra Lakes area.

Cleared areas (C)

These areas have been almost entirely cleared of natural vegetation and often cultivated for agricultural purposes. Remnant types are indicated on the vegetation map in brackets after the C symbol.

Floristic composition

A total of 330 species (339 taxa) from 62 families were recorded for the mapped area during the present survey. The number of species recorded for the region rises to 497 (509 taxa) from 75 families if other survey records are included. The record is dominated by species from the Chenopodiaceae (59 species or 18 %), Asteraceae (48 species or 15 %) and Poaceae (32 species or 10 %). As the survey was conducted during a period of drought, many annual and other seasonal species were not recorded, hence the relatively low proportions of annual Asteraceae and Chenopodiaceae. A large proportion of species recorded (12 %) are exotic, and two *Eucalyptus* hybrids were also found. A species list for the mapped area compiled from current and past survey data is given in Appendix 2.

The most frequently recorded native species were *Stipa nitida* (60 sites or 55% of sites), *Dissocarpus paradoxa* (59 sites or 54%), *Enchylaena tomentosa* (48 sites or 44%), *Sclerolaena diacantha* (46 sites or 42%), *Salsola kali* (44 sites or 40%) and *Sclerolaena obliquicuspis* (43 sites or 39%). The most frequently recorded exotic species were **Hordeum leporinum* (21 sites or 19% of sites), **Medicago polymorpha* (17 sites or 16%), **Cucumis myriocarpus* (15 sites or 14%) and **Asphodelus fistulosus* (11 sites or 10%).

The species richness and weediness of each community are summarised in Table 2. The highest number of species (87) was recorded from Black Box Woodland (2), followed by Black Bluebush (8) with 77 species and Dune Mallee (3a and 3b) with 74 species each. The communities with the lowest species counts were *Sclerostegia tenuis* (12) with a total of 15 species, Lignum and *Chenopodium nitrariaceum* (18) with 22 species and *Acacia melvillei* Woodland (17) with 23 species. *Callitris* Woodland (16) recorded the highest proportion of exotic species at 35 per cent, followed by Riverine Forest (1) at 30 per cent and Old Man Saltbush (19) at 24 per cent.

In arid and semi-arid communities the composition and turnover of annual and short-lived perennial species varies from year to year. Many of these species are not specific to particular soil types or communities and are very widespread. Species variability within a community was highest in shrublands of Dillon Bush, Cannonball Burr and Copperburr (22), in which the dominant species vary considerably from site to site. Black Bluebush (8) and Lunette Shrubland (30) also showed high species variability. The most homogeneous communities were the mallee and Belah-Rosewood groups (3a, 3b, 3d and 4) which showed high consistency in both overstorey and understorey species.

Several extensions of range were recorded during the survey for a number of species (Appendix 2). Nine species are new records for the Far South Western Plains botanical subdivision of New South Wales (Harden 1990–93). Species of particular conservation

Table 2. Species richness and weediness per community.

Community	No. Sites	Total Species	Native Species	Exotic Species
1	2	33	23	10 (30%)
2	6	87	73	14 (16%)
3a	16	74	73	1 (1%)
3b	9	74	72	2 (3%)
3d	11	62	55	7 (11%)
4	15	67	65	2 (3%)
8	13	77	62	15 (19%)
8p	3	25	22	3 (12%)
11	5	36	33	3 (8%)
12	2	15	14	1 (7%)
13	3	27	23	4 (15%)
16	5	49	32	17 (35%)
17	2	23	20	3 (13%)
18	3	22	17	5 (23%)
19	4	42	32	10 (24%)
22	6	49	41	8 (16%)
29	2	50	40	10 (20%)
30	3	42	29	13 (16%)

significance recorded within the Pooncarie 1: 250 000 map sheet area are listed in Table 3. Six species recorded for the area are nationally listed as rare or threatened Australian plants (ROTAPs) (Briggs & Leigh 1996), while eight are in the schedules of the NSW Threatened Species Conservation Act. Twenty-five species have restricted distributions in the Western Division of New South Wales (Pressey et al. 1990). Seventy-two are listed as rare or threatened plants in Victoria (Gullan et al. 1990) but many of these are common in New South Wales. Therefore, only the species with the highest risk codes in Victoria — vulnerable, endangered or presumed extinct — are considered here.

Leptorhynchos waitzia appears to be very rare and could be added to the national ROTAP list. Due to drought conditions at the time of the survey, other rare herbaceous species may not have been recorded.

Discussion

Distribution of the vegetation communities

There are five main landforms in the mapped area: dunefields, sandplains, relict lakes, alluvial plains, and hills and footslopes (see Figure 3). The landscape is dominated by

the plains and dune systems of the aeolian sandsheets and their characteristic vegetation communities of woodlands and shrublands. The other common landscape feature is the ancient dry lake system and associated lunettes running through the centre of the mapped area. These lacustrine elements principally support shrublands. The riverine plain and its shrublands occupy only a relatively small area in the south-east of the map. The alluvial floodplain associated with the Darling River in the west and the Willandra Creek in the north-east are similarly small in extent, but support forest, woodland and swamp vegetation that are confined to that physiographic element. Similarly, the rocky outcrops of Manfred Hill in the north-east support vegetation unique to that system.

The vegetation patterns observed in the semi-arid regions of south-western New South Wales reflect rainfall and its interactions with soil type and topography. The distribution of plant species has been linked to the distribution of moisture throughout the soil profile (Noy-Meir 1974), which, in turn, is largely determined by soil texture. Soil fertility (as available phosphate and exchangeable calcium) and soil salinity also influence the distribution of vegetation, although to a lesser degree than moisture capacity (Noy-Meir 1974). These soil characteristics are intimately associated with the geomorphology of the landscape.

The deep, red to orange siliceous sands of the dunefields support Irregular Dune Mallee (3a) and Linear Dune Mallee (3b). These woodlands share an understorey dominated by *Triodia scariosa* subsp. *scariosa* and shrubs at various densities. These dunefield mallee systems are spread throughout the map area, but most particularly in a large band from the southwest corner arching across to the central eastern portion. In the level areas between well-spaced dunes, the soil is more calcareous and of a finer grain, similar to the soil types characteristic of the sandplain. Thus, open woodlands of Belah-Rosewood (4) may be found interspersed amongst the dunefield mallee communities.

The calcareous loamy sands and red-brown earths of the sandplain commonly contain Belah-Rosewood open woodland (4), Sandplain Mallee (3d) and Bluebush shrublands (8 and 8p). *Callitris* open woodland (16) is restricted to areas where there are deeper sandy rises such as at the zone between lunettes and the surrounding sandplains. The few small clumps of *Acacia melvillei* woodland (17) are also confined to sandy sections.

Belah-Rosewood woodland is widespread across the survey area. This is an open woodland with an understorey (where present) of chenopods, grasses and shrubs such as *Myoporum* and *Senna* species. The sandplain also supports significant stands of Sandplain Mallee (3d). In contrast to the two other mallee communities, the understorey of this vegetation type is dominated by chenopod shrubs - a feature of soils with a higher clay content. This mallee type is most common in the eastern half of the mapped area, but also occurs adjacent to the Darling River floodplain in the west.

Shrublands of Black Bluebush (8) occur in the eastern portion of the survey area, particularly in the transition zones between sandplain and lacustrine or alluvial landforms. Pearl and Black Bluebush (8p) is more limited in extent in the southeast.

Table 3. Species of particular conservation significance recorded within the Pooncarie 1: 250 000 map sheet area, their conservation status, locations and source of record.

National Conservation Status codes (Briggs & Leigh 1996): **2** = maximum geographic range < 100 km; **3** = distribution of > 100 km; **K** = poorly known; **V** = vulnerable; **C** = present in conservation reserve; **a** = adequately conserved; **i** = inadequately conserved. Status in **New South Wales** (Schedules 1 and 2 of the 1995 NSW Threatened Species Conservation Act) and **Victoria** (Gullan et al. 1990): **e** = endangered, **v** = vulnerable, **Ext** = presumed extinct. Status in the **Western Division** (Pressey et al. 1990)–**Category**: **1** = species occurring only in the Western Division; **2** = species occurring only in NSW with a restricted distribution; **3** = species with a restricted distribution in the Western Division but also occurring interstate; **A** = small range and/or few records; **B** = wide range and/or many records; **X** = presumed extinct; **Priority**: Protection measures in the Western Division will **1** = solely determine; **2** = be very important in; **3** = influence a species' conservation; or **4** is desirable to conserve the genetic variation across its range.

Species	Conservation Status Nat'l	NSW	Vic	West'n Div'n Categ./Prior	Comm.	Sites	Source
Abutilon fraseri			e		29	32	
Acacia acanthoclada		e		3B/4	-	-	Nat Herb
Acacia carnei	3VCi	v		3A/2	-	-	Nat Herb
Acacia loderi			v		4	adj. 106	
Acacia melvillei			v		4,17	59,85, adj. 3	
Amaranthus grandiflorus				3B/4			
Amaranthus macrocarpus var. *macrocarpus*			v		18	108	
Amyema linophyllum subsp. *orientale*			v		-	- -	Westbrooke & Miller('95)
Angianthus brachypappus			v		-		Rice ('86)
Atriplex angulata			v		8, 8p, 19, 22	Many	
Atriplex infrequens	2V	v		1/1	-	-	Nat Herb
Atriplex stipitata			v		4, 17, 3abd, 8	Many	
Boronia caerulescens				3B/4	-	-	Nat Herb
Bossiaea walkeri			e		3ab	Many	
Brachycome exilis				3B/4	3d	52	
Brachycome papillosa	3V	v		2/2	-	-	Nat Herb
Calandrinia disperma				3A/4	-	-	Nat Herb
Ceratogyne obionoides				3B/4	-	-	Rice ('86)
Cheilanthes lasiophylla				3B/4	29	32, 78	
Codonocarpus pyramidalis	3VCi	Ext		3A(X)/2	-	-	
Digitaria ammophila			v		30	adj.89	Rice ('86)
Eleocharis pallens			v		-	-	Rice ('86)
Eremophila sturtii			e		4, 17, 3ad	Many	
Eucalyptus porosa				3B/4	-	-	Nat Herb

Species	Conservation Status Nat'l	NSW	Vic	West'n Div'n Categ./Prior	Comm.	Sites	Source
Euphorbia planiticola			e		8,22	31, 36, 100, 101	
Exocarpos sparteus				3B & 4A/4	3a	44	
Geijera parviflora			e		3a, 4, 29, 30	Many	
Glycine canescens			e		29	32	
Grevillea pterosperma				3B/4	3a	adj.91	
Gyrostemon australasicus				3A/3	-	-	Nat Herb
Haloragis glauca			v		2,3a	80,84	
Ixiolaena tomentosa			v		17	59	
Lepidium phlebopetalum			v		4	42	
Leptorhynchos waitzia		e	v	3B/4	-	-	Rice ('86)
Leucochrysum molle			v		13	82	
Marsdenia australis			v		4, 16, 3abd	Many	
Muehlenbeckia diclina				3B/4	-	-	Nat Herb
Olearia subspicata			v		3b	adj.97	
Opercularia turpis				3B/4	3b	adj.97	
Pachymitus cardaminoides				3B/4	29	78	
Phlegmatospermum eremaeum	3KCi		v	3A(X)/2	-	Westbrooke & Miller('95)	
Pimelea simplex subsp. *continua*				3B/4	3a	11	
Podotheca angustifolia				3B/4	-	-	Nat Herb
Ptilotus nobilis			e		-	-	Rice ('86)
Ptilotus obovatus var. *obovatus*			Ext		4, 17, 3a	33, 58, 18	
Ptilotus polystachyus var. *polystachyus*			e		2,3d	110, 39	
Radyera farragei			v		2	20	
Santalum murrayanum		e		3B/4	3a	adj.99	
Scaevola depauperata			e		3b	8	
Sclerolaena convexula			v		29,3a	32, 78, 44	
Sclerolaena lanicuspis			v		8	15, 37	
Solanum karsense	3VCi	v		1/1	-	-	
Stipa tuckeri			v		-	-	Nat Herb
Swainsona greyana			v		1	71	
Swainsona phacoides			e		1	adj.71	
Vittadinia pterochaeta			e		22	100	

Both of these communities are associated with calcareous soils, with relative dominance depending on limestone content.

The dry lake systems of Willandra Creek have had a freshwater history and have given rise to grey clay, red clay and loamy sandy duplex soils. The dry lakes of the south-east have had a saline history, and have given rise to gypseous or calcareous grey clays. The more mobile sandy soil elements have accumulated in lunettes on the eastern margins of the lake beds. All these lacustrine landforms now support shrublands. Most of the lake beds are disturbed through clearing, cropping and grazing and consequently carry mostly Disturbed Shrubland Complex (22). Bladder Saltbush (11) and Bluebush communities (8 and 8p) are also scattered among this complex. In the more saline environments, *Sclerostegia tenuis* shrubland (12) also occurs. Old Man Saltbush (19) can also be found in the more depressed areas, particularly in the alluvial transition zone in the south-east. The relict lake system is a dominant feature of the survey area stretching across from the north-east to the south-west of the map sheet. The lunettes bordering the lakes carry a Lunette Shrubland (30) dominated by the 'woody weed' *Dodonaea viscosa* subsp. *angustissima*. It is a very disturbed community suffering from high rabbit numbers and erosion. It is in the lunettes of the Willandra Lakes that were found archaeological remains of such significance that the Willandra Lakes World Heritage Region was declared.

In contrast, alluvial systems occupy much less area. The Darling River just loops into the map area in the far west and the riverine plain just overlaps with the south-eastern corner. The only forest community — Riverine Forest (1) — occurs almost exclusively along the immediate floodplain of the Darling River on heavy grey clay soils. *Eucalyptus camaldulensis,* the main species of this community, is also found sporadically in other alluvial situations, but Black Box Woodland (2) is usually dominant along other minor creeks and depressions. This woodland is also found on the higher levels of the Darling River floodplain. In intermittently flooded depressions, areas of Canegrass (13) and Lignum and Nitre Goosefoot (18) occur. These swampy communities are most commonly distributed along the alluvial areas associated with the Willandra Creek, especially in the north-east in the Gunnaramby Swamp.

The only piece of hilly country is in the north-east on Manfred Hill. This sandstone ridge gives rise to shallow sandy and stony soils. The Rocky Outcrop Woodland Complex (29) is confined to this low range and has been much modified due to grazing, particularly by goats.

Modifications induced by European land use

Across Australia, nearly 70% of all native vegetation has been removed or significantly modified since 1788 (State of the Environment Advisory Council 1996). The rate of land clearance has accelerated over time, with as much cleared during the last 50 years as in the 150 years before 1945. On a continental scale, native vegetation is still being cleared at a rate of 600 000 hectares per year, while New South Wales accounts for approximately 150 000 hectares of this figure annually (State of the Environment Advisory Council 1996).

The natural systems of western New South Wales in particular have been altered by European agricultural practices (Pickard 1994). The parlous state of the Western Division at the end of nineteenth century was acknowledged by the appointment of a Royal Commission in 1900. The combination of European land use and the introduction of the rabbit in the fragile soils of western New South Wales caused significant land degradation and led to losses of native plants and animals (Benson 1991, Pickard 1991, Lunney 1994). Pickard (1994) estimated that fencing the properties of the Western Division alone was responsible for the removal of 10^7 trees — mainly *Acacia* and *Callitris* species.

Large scale and rapid modifications occurred last century when sheep numbers were very high. From 1885 to 1897 the average number of sheep carried annually in the Western Division was 13.5 million (Lunney 1994). Gol Gol station (now part of Mungo National Park) was heavily overstocked in the 1860s and large quantities of perennial vegetation were cut for feed (Westbrooke & Miller 1995). These effects were also compounded by the spread of the rabbit and the impact of devastating drought at the end of the 1800s.

The degree of change to plant communities is a result of an interaction between the vegetation type and the timing and intensity of the disturbance. The Riverine Forests have been heavily used for timber and the understorey has been grazed. Regeneration cycles of floodplain communities such as the Riverine Forest and Black Box Woodland are disrupted by the now unnatural, regulated flow of the Darling River. The water quality of the river itself is declining due to increasing siltation from run-off of denuded and eroded areas, turbidity from European carp, inadequate flushing and salinisation (Budd et al. 1990). Other swamp communities — Lignum and Canegrass — also endure degradation through trampling by feral pigs and burning and clearing for cropping.

Clearing for cropping has by far the most damaging effect on native vegetation and is regarded by some conservationists as one of the Western Division's biggest threats (Lembit 1983). Clearing completely removes the native vegetation and prevents regeneration. Cropping activities are principally confined to the heavier soils of the dry lake beds of the Willandra Creek system. Previously cropped paddocks no longer contain Saltbush and Bluebush communities. Instead, they now support Disturbed Shrubland Complex of *Dissocarpus paradoxus, Nitraria billardieri* and *Sclerolaena* species.

Clearing for cropping on lighter soils is less common, but is occurring in the Mallee dunefields of the south-west of the map. As well as loss of vegetation and increased soil erosion, this activity has ramifications for groundwater recharge and increased river salt loads. When Mallee or Belah-Rosewood is cleared in this area, the groundwater recharge rate increases 100-fold (Budd et al. 1990). Because the ancient river system of the sandplain drains this extra groundwater, land salinisation is not expected as a result. However, the mobilised salt load will be deposited in the contemporary river system (Budd et al. 1990).

The significant land degradation consequences of clearing Mallee makes it an unacceptable land use (e.g. Groves & Parsons 1989, Cairnes 1989, Budd et al. 1990). However, a survey of lessees of the Western Division revealed that 34% considered

clearing an improvement of mallee country (Choate 1989). The repercussions of this type of land use must be more effectively communicated to the rural community.

Similarly, there are different interpretations of the effects of grazing in the rangelands with long-term changes often not recognised by graziers. This is not surprising as some plant species live for decades (e.g. *Atriplex vesicaria*) or centuries (e.g. *Maireana sedifolia*) (Muir 1992). Also graziers are often advised that the overriding influences on vegetation are climatic and that good rainfall inevitably leads to regeneration of vegetation (Stanley 1983). This may only be the case in the absence of heavy grazing — management frequently dominates over seasonal variations (Pickard 1991). It is generally acknowledged, however, that continual grazing replaces palatable perennial native species with less desirable, often exotic, annuals (Stanley 1983). Introduced plants are an acute and insufficiently appreciated ecological problem. Approximately 20% of vascular plant species in New South Wales are naturalised exotics (Benson 1991). Even though the survey reported here was conducted at a time of drought, still 12% of the species recorded were exotic.

The lack of recruitment of many woody species has long been recognised as a management problem in arid and semi-arid regions (Harrington et al. 1984). *Heterodendrum oleifolium* — a major component of Belah-Rosewood Woodlands in the study area — has rarely been observed to establish from seed and relies on root suckering for regeneration (Wisniewski & Parsons 1986). It will not regenerate adequately when grazed by stock, but still needs episodic disturbance (such as fire) to stimulate suckering (Wisniewski & Parsons 1986).

The future of other woody species in grazing areas are equally tenuous. *Acacia melvillei*, for example, suffers serious regeneration problems. The few sites of this shrubland community in the survey area contained no understorey (no new recruits of any woody species) due to grazing pressure by sheep and rabbits. Batty and Parsons (1992) reported an almost total failure of *Acacia melvillei* regeneration in pastoral areas studied nearby at Balranald.

Some unpalatable woody species are regenerating, however, and the proliferation of these 'woody weeds' is considered a major land degradation problem. These shrubs are mainly species of *Dodonaea*, *Eremophila* and *Senna* (Muir 1992). Their increase is attributed to changes in the fire regime, the grazing out of competitive pasture species and the disturbance of the soil surface by stock and erosion (Green 1988). Their germination is episodic and the resultant groves lead to a reduction in pasture productivity and general loss of species diversity. The bare ground between individual bushes is then exposed to soil erosion by flow and runoff. In dense stands, however, while the soil surface may be bare, the shrubs can protect the surface from wind erosion (Green 1988).

The presence of other grazers in the system has an accumulative grazing effect on the vegetation. Rabbit densities are highest in sandy country — particularly in sandy rises and lunettes. Goats are mainly found in mallee areas and on the rocky Manfred Hill. The number of feral grazers is significant. A conservative estimate of rabbit grazing load in the Willandra Lakes World Heritage area was 3–4 times that of domestic stock (Fatchen & Fatchen 1989). The increase in the number of watering points throughout

the area has probably also increased the number of native grazers (Red and Western Grey Kangaroos).

Fire is an infrequent yet pivotal event in this landscape. The last extensive wildfire was in the summer of 1974–75 following significant fuel build-up over a number of wetter seasons. There was abundant speargrass (*Stipa* spp.) across open areas linking highly-flammable Mallee communities (Noble 1989) thus allowing for large swathes of country to be burnt. Eventually 340 000 ha was burnt out in the district (Lans et al. 1988). Prior to these big fires, only minor localised fires were known on 'Tapio' and 'Turlee' in 1931 and on 'Garnpung' and 'Wonga' in 1960 (Lans et al. 1988).

The use of fire by Aboriginal people for manipulation of their environment was observed by early European explorers. However, the fire regime — how often and in what seasons they occurred — is a matter for conjecture. In dunefield mallee with an understorey dominated by *Triodia scariosa* subsp *scariosa*, Noble (1989) estimates that it is unlikely that the fire frequency could exceed more than one fire every 15–20 years as it takes this amount of time for sufficient fuel to accumulate. The season of burn is the most critical factor in shaping the species composition of mallee in this area (Noble 1989), so care must be taken in applying it as a management tool.

Conservation of the vegetation

Despite the great changes that have been wrought on the landscape by European agriculture, the future of native vegetation in the Pooncarie district does look promising as there are now significant interests in maintaining the area's natural values. The Pooncarie map contains 92% of the Willandra Lakes World Heritage region. The management strategy for this important area must protect its world heritage values. This should translate into conservative use of the dry lake beds and their fringing lunettes. Mungo National Park attracts large numbers of tourists to the area, which creates public scrutiny of its management. Tourist operators also have an interest in the maintenance of the area's natural values.

The map area contains large expanses of uncleared Mallee country which is largely intact. The major management challenge for this area is to decrease the grazing pressure. This is most easily achieved by reducing the number of watering points.

With the recent introduction of the Rabbit Calicivirus Disease, the future for rabbits is bleak. No live rabbits were observed during the final field traverses in 1996. A crash in the rabbit population may allow for regeneration of many plant species in the sandplains and sandy rises.

In western New South Wales there are now Landcare groups, Total Catchment Management Groups, Save the Bush programmes, salinity action groups and revegetation projects run by organisations such as Greening Australia (Denny 1994). The Royal Botanic Gardens has produced extension material related to this mapping programme in an attempt to encourage an appreciation of native vegetation (Driver & Porteners 1993, Porteners & Ashby 1996). As much of the impetus behind these programmes is community-based, there is a real chance that the landcare philosophy will translate into land use practices.

Perhaps the most encouraging feature of this region is the resilience of the vegetation itself. If the plants are freed from the stresses of inappropriate grazing, inappropriate fire and clearing and cropping, many of the communities have the capacity to return with some vigour when climatic conditions are favourable. It is not known, however, how far a system can be pushed before it loses its inherent recuperative abilities. The precautionary principle should be applied to the land management in this area where the systems are still largely intact.

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Appendix 1. Attributes of sites sampled in the Pooncarie 1: 250 000 map sheet area.

Key: Site = site number; * = site in excellent condition; [B] = site in good condition; Map = 1:100 000 topographic map sheet name; East/North = full Australian Map Grid (AMG) reference (Zone 54); Soil (classified from field observations): Lt = light; Dk = dark; R = red; B = brown; G = grey; W = white; S = sand/sandy; L = loam/loamy; C = clay/clayey; c = cracking; ss = sandstone conglomerate; ca = calcareous; Alt. = altitude (m); Veg. = vegetation community classification; TSP = total number of species; NSP = number of native species; ESP (%) = number of exotic species (percentage of total).

Site	Map	Location	East	North	Soil	Landform	Alt.	Veg.	TSP	NSP	ESP(%)
001	Turlee	Ryah Box Flat	708600	6238500	RLS	dunecrest	80	3b	21	21	0 (0)
002	Turlee	Hatfield Rd E of Ryah Box Flat	726400	6242700	BLC	depression	40	11	23	22	1 (4)
003	Turlee	Hatfield Rd E of Ryah Box Flat	722800	6242100	RBL	sandplain	80	4	18	18	0 (0)
004[B]	Turlee	Northern Lake Mungo	687500	6272800	LtBCL	dry lake	60	8	16	16	0 (0)
005	Turlee	S of 'Garnpung'	695200	6289900	RLS	lunette	80	8	17	14	3 (6)
006	Mulurulu	Garnpung Lake	707100	6292300	GLC	dry lake	60	22	16	15	1 (6)
007[B]	Mulurulu	'Gol Gol'	716500	6292700	RLS	low rise	90	16	18	14	4 (22)
008[B]	Turlee	Balranald Rd E of Garnpung Lake	718900	6285000	RLS	dunecrest	90	3b	19	19	0 (0)
009[B]	Turlee	S of 'Boree Plains'	722600	6260500	RLS	dunecrest	115	3b	18	17	1 (6)
010[B]	Turlee	SE of 'Boree Plains'	725600	6258200	RSL	sandplain	100	4	16	16	0 (0)
011[B]	Mulurulu	NE of 'Gol Gol' on Ivanhoe Rd	720600	6297000	RLS	duneslope	80	3a	16	16	0 (0)
012	Mulurulu	Ivanhoe Rd E of Hatfield Rd	743400	6307200	RBSL	sandplain	70	4	16	16	0 (0)
013*	Manfred	'Binda'- Hatfield Rd	742700	6295300	RLS	dunecrest	80	3a	14	14	0 (0)
014	Hatfield	E of 'Round Plain'	752300	6271700	RSL	sandplain	80	4	12	11	1 (8)
015	Hatfield	Ivanhoe Rd N of Hatfield	765700	6265900	BCL	scald. plain	70	8	17	15	2 (12)
016	Hatfield	Balranald Rd S of Hatfield	748700	6243300	BcC	dry lake	60	11	9	8	1 (11)
017	Arumpo	Durthong Tank	773400	6273200	BLC	dry lake	60	8	22	15	7 (32)
018	Arumpo	Pooncarie Rd W of Lake Mungo	662000	6270800	RS	duneslope	100	3a	19	19	0 (0)
019[B]	Arumpo	SE of Wild Dog Tank	646500	6277900	RS	duneslope	60	3a	20	20	0 (0)

Site	Map	Location	East	North	Soil	Landform	Alt.	Veg.	TSP	NSP	ESP(%)
020	Pooncarie	Darling River S of Pooncarie	644600	6301100	GC	floodplain	45	2	18	16	2 (11)
021	Pooncarie	Darling River S of Pooncarie	645900	6301700	GBcC	riverbank	20	1	14	12	2 (14)
022	Pooncarie	Ivanhoe Rd W of Pooncarie Loop	679000	6313500	RLS	dunecrest	80	3a	12	12	0 (0)
023	Mulurulu	Pooncarie Rd W of Garnpung Lk	689700	6315800	RSL	sandplain	80	4	13	13	0 (0)
024	Mulurulu	S of 'Bulgamurra'	689500	6326700	RBSL	sandplain	60	4	13	13	0 (0)
025	Mulurulu	N of 'Wilkurra'	694800	6339500	RS	dunecrest	65	3a	19	19	0 (0)
026	Pooncarie	SSW of Mitfords Corner	653900	6340000	RBSL	sandplain	60	3d	11	11	0 (0)
027	Pooncarie	NE of Pambra Tank	645000	6332200	RBSL	sandplain	60	3d	10	10	0 (0)
028	Pooncarie	Pambra Tank swamp	644700	6330900	GBcC	depression	50	13	4	4	0 (0)
029	Pooncarie	Darling River N of Pooncarie	645500	6307700	GcC	swamp	40	18	8	6	2 (25)
030	Pooncarie	Menindee Rd N of Pooncarie	645400	6308200	RBLC	floodplain	50	2	20	18	2 (10)
031	Manfred	Willandra Ck on Darnick Rd	744200	6314300	LtBcC	dry lake	70	22	22	14	8 (36)
032	Manfred	Manfred Mountain, highest point	747300	6323000	BLss	ridge crest	160	29	29	27	2 (7)
033	Manfred	NW of 'Melton Grove'	747300	6324600	RBSL	sandplain	80	4	18	18	0 (0)
034	Mulurulu	Darnick Rd SW of 'C Lake'	726100	6333600	RLS	sandplain	70	3d	15	14	1 (7)
035	Mulurulu	Darnick Rd NE of 'Pan Ban'	704700	6316300	GBcC	dry lake	70	18	11	9	2 (18)
036	Mulurulu	Garnpung Lake N of 'Garnpung'	696600	6305600	GBcC	dry lake	70	22	13	11	2 (15)
037[B]	Manfred	Ivanhoe Rd SE of 'Manfred'	759700	6309500	GBC	scald. plain	70	8	25	23	2 (8)
038	Manfred	Ivanhoe Rd S of 'Clare'	767900	6291500	GBLC	alluv. plain	50	19	20	14	6 (30)
039	Manfred	Ivanhoe Rd S of 'Clare'	770900	6297600	RLS	sandplain	70	3d	18	18	0 (0)
040[B]	Manfred	Gunnaramby Swamp, Lake Tank	774700	6324300	GBC	floodplain	60	2	17	17	0 (0)
041[B]	Arumpo	Mildura Rd SE of Mungo Lodge	675400	6255200	BC	depression	60	11	15	15	0 (0)
042	Arumpo	Mildura Rd W of 'Bellnar'	652300	6239700	RBSL	sandplain	90	4	24	23	1 (4)

Site	Map	Location	East	North	Soil	Landform	Alt.	Veg.	TSP	NSP	ESP(%)
043[B]	Arumpo	Mildura Rd W of 'Bellnar'	647400	6239500	RS	dunecrest	100	3b	24	24	0 (0)
044[B]	Arumpo	Petro Mail Rd W of 'Murragi'	641000	6249000	RS	dunecrest	100	3a	17	17	0 (0)
045	Turlee	Chibnalwood Lake	688800	6252100	LtBcaCL	lunette	60	8	21	18	3 (14)
046	Turlee	Lake Mungo Rd NW of 'Turlee'	685600	6245900	LtBcaCL	scald. plain	60	4	13	13	0 (0)
047	Turlee	Garnpung Rd within Mungo NP	687000	6268500	RS	sandplain	80	3d	13	11	2 (15)
048[B]	Turlee	Lake Mungo within Mungo NP	692500	6264000	LtBCL	dry lake	60	11	9	8	1 (11)
049	Mulurulu	E edge of Garnpung Lake	714500	6292500	LtRBL	lunette	90	30	31	23	8 (26)
050	Mulurulu	Ivanhoe Rd SE of 'Mandleman'	730000	6303000	RS	low rise	80	16	19	10	9 (47)
051	Hatfield	'Magenta' Rd on 'Binda'	740000	6286000	RBS	sandplain	100	4	16	16	0 (0)
052	Hatfield	Near Whitties Tank	736000	6267000	RBLS	sandplain	80	3d	23	22	1 (4)
053	Hatfield	Balranald Rd S of 'Magenta'	737000	6247000	BCL	plain	70	8	10	9	1 (10)
054[B]	Arumpo	Pooncarie Rd SE Big 16 Mile Tank	656000	6272500	RS	duneslope	100	3a	17	17	0 (0)
055[B]	Arumpo	Mildura Rd E of Petro Mail Rd	585000	6240500	RS	duneslope	80	3b	29	28	1 (3)
056	Arumpo	Euston Rd SE of Lake Mungo Rd	672500	6241500	RBL	scald. plain	80	8	9	8	1 (11)
057	Arumpo	Hatfield Rd E of Mildura Rd	680000	6243000	RS	duneslope	80	3d	15	15	0 (0)
058	Mulurulu	Lake Mulurulu S of 'C Lake'	722500	6328000	WcaS	lunette	90	30	9	5	4 (44)
059	Mulurulu	Ivanhoe Rd SW of 'C Lake'	718000	6329500	RBSL	sandplain	80	17	19	18	1 (5)
060	Mulurulu	Hughies Bore from Ivanhoe Rd	713500	6328000	RSL	sandplain	90	4	11	11	0 (0)
061	Mulurulu	NW of 'Yarraman'	706000	6321000	RS	dunecrest	80	3a	11	11	0 (0)
062	Arumpo	Mildura Rd SW of Lake Mungo	675000	6252500	GBC	scald. plain	60	8	15	13	2 (13)
063[B]	Turlee	Balranald Rd E of 'Turlee'	697500	6240500	RLS	duneslope	90	3b	29	29	0 (0)
064[B]	Turlee	Mungo NP tourist drive	701500	6269000	LtRBS	dunecrest	80	3a	24	24	0 (0)
065	Hatfield	Turlee Rd SE of 'Langley Dale'	738000	6238000	BcC	depression	70	19	20	17	3 (15)

Site	Map	Location	East	North	Soil	Landform	Alt.	Veg.	TSP	NSP	ESP(%)
066	Hatfield	'Freemount' SE of Hatfield	767000	6239000	GBCL	scald. plain	75	8	7	6	1 (14)
067	Hatfield	'Freemount' SE of homestead	763500	6239500	GBL	alluv. plain	70	11	7	6	1 (14)
068	Hatfield	Ivanhoe Rd N of Hatfield	757000	6257500	GBL	depression	70	19	9	6	3 (33)
069	Hatfield	Ivanhoe Rd N of Hatfield	756000	6254000	RBL	low rise	60	8p	14	12	2 (14)
070	Pooncarie	NNW of Pooncarie	643000	6311500	LtRBSL	sandplain	60	3d	14	12	2 (14)
071	Pooncarie	Darling River S of Pooncarie	646000	6304000	GcC	riverbank	40	1	30	20	10 (33)
072	Arumpo	Wentworth Rd near 'Peaka'	640000	6287000	BLC	floodplain	40	2	17	12	5 (29)
073	Arumpo	Wentworth Rd SW of Pooncarie	646000	6290000	RLS	sandplain	55	3d	17	13	4 (23)
074	Pooncarie	Darnick Rd NE of Pooncarie Rd	658000	6347000	RBLS	sandplain	60	4	9	9	0 (0)
075	Pooncarie	Garnpung Rd NE of Pooncarie	664000	6307000	RLS	dunecrest	75	3a	21	21	0 (0)
076[B]	Pooncarie	S of Ivanhoe Rd E of Pooncarie	674000	6308500	RS	dunecrest	80	3a	11	11	0 (0)
077	Pooncarie	N along Pooncarie Loop Rd	685000	6318000	RS	low dune	70	3b	16	16	0 (0)
078	Manfred	NE end of Manfred Range	750500	6325000	DkBL	ridge crest	140	29	32	24	8 (25)
079	Manfred	SE footslopes of Manfred Range	751000	6324500	RSLss	ridge slope	80	4	17	16	1 (6)
080[B]	Manfred	Gunnaramby Swamp creek	777000	6328500	GcC	creek bed	70	2	41	34	7 (17)
081	Manfred	'Peneena' Rd W of Gunnaramby	770000	6331000	RBL	scald. plain	80	8	22	18	4 (18)
082	Manfred	Ivanhoe Rd N of 'Melton Grove'	775000	6317000	GBcC	depression	70	13	24	20	4 (17)
083	Manfred	Hatfield Rd S of 'Melton Grove'	773000	6304000	RLS	low rise	80	16	16	11	5 (31)
084	Manfred	Pooncarie Rd W 'Melton Grove'	737500	6303500	RS	low dune	75	3a	14	13	1 (7)
085	Manfred	Opposite 'Dockerty'	739000	6321500	RLS	sandplain	80	17	11	9	2 (18)
086	Arumpo	Pooncarie-Wentworth Rd	642500	6287000	RS	low rise	60	16	9	6	3 (33)
087	Pooncarie	Firebreak NE of Swamp Tank	677000	6327000	RBSL	sandplain	80	4	9	9	0 (0)
088[B]	Pooncarie	Firebreak N from Pooncarie Rd	678500	6337000	RS	dunecrest	80	3b	16	16	0 (0)

Site	Map	Location	East	North	Soil	Landform	Alt.	Veg.	TSP	NSP	ESP(%)
089	Mulurulu	Garnpung Lake SE of 'Balmoral'	699000	6307000	WcaS	lunette	90	30	11	7	4 (36)
090	Arumpo	Lake Mungo Rd SE of 'Top Hut'	680000	6272000	BCL	scald. plain	80	8	6	6	0 (0)
091*	Arumpo	Fenceline SW of 'Top Hut'	669500	6263000	RS	dunecrest	85	3a	16	16	0 (0)
092	Arumpo	Mildura Rd S of 'Top Hut'	677500	6267000	RS	low rise	70	16	10	7	3 (30)
093	Arumpo	N of 'Old Arumpo'	675500	6259500	LtBLC	saline plain	60	12	9	8	1 (11)
094[B]	Arumpo	Pipeline track NW of 'Murragai'	646000	6259000	RS	duneslope	80	3a	14	14	0 (0)
095	Turlee	Lake Leaghur	691500	6282500	GcC	dry lake	60	22	9	9	0 (0)
096	Turlee	N edge of Lake Mungo	691000	6274000	GBCL	low lunette	70	8p	8	8	0 (0)
097[B]	Arumpo	Pipeline road SE of 'Turlee'	695000	6236500	RS	dunecrest	80	3b	24	24	0 (0)
098	Manfred	Darnick Rd NW 'Melton Grove'	737500	6331000	RLS	sandplain	70	3d	12	11	1 (8)
099	Mulurulu	Garnpung Rd SW 'Mandleman'	727000	6303000	RLS	dunecrest	85	3a	8	8	0 (0)
100	Manfred	Willandra Ck E 'Melton Grove'	749500	6308500	GBcC	dry lake	70	22	11	9	2 (18)
101[B]	Manfred	E of 'Clare'on road to Cobb Hwy	777000	6299000	RBCL	scald. plain	75	8	22	20	2 (9)
102	Hatfield	Hatfield Rd S of 'Clare' Rd	766000	6271500	GcC	depression	70	19	12	11	1 (8)
103	Hatfield	Hatfield Rd E of 'Magenta'	742500	6249000	RBSL	scald. plain	70	8p	11	10	1 (9)
104	Hatfield	Balranald Rd S of 'Magenta'	737500	6246500	LtBcC	saline plain	60	12	8	8	0 (0)
105	Hatfield	The Vale Rd SE 'Melton Grove'	744000	6282000	RBS	sandplain	80	3d	18	18	0 (0)
106[B]	Manfred	'Girrawheen' Rd	746500	6331500	RSL	sandplain	70	4	20	20	0 (0)
107	Manfred	'Pentola' E of 'Girrawheen'	753500	6343500	GBcC	swamp	60	13	3	3	0 (0)
108	Manfred	Bourkes Tank Swamp SE	756500	6336000	GBcC	swamp	70	18	12	10	2 (17)
109	Manfred	N of 'Peneena'	765000	6375000	GBLC	alluv. plain	80	22	14	12	2 (14)
110	Manfred	Willandra Ana Branch	768500	6338000	LtBSC	creek bed	80	2	25	24	1 (4)

Appendix 2. Species list for communities identified on the Pooncarie 1: 250 000 map sheet area.

Key

Figures show % occurrence of species in sites per community and overall; X = species occurring outside 50x20 metre survey quadrat; F = open forest, W = woodland, M = mallee, S = shrubland, G = grassland, A = all communities; 1 = Riverine Forest, 2 = Black Box Woodland, 3a = Irregular Dune Mallee, 3b = Linear Dune Mallee, 3d = Sandplain Mallee, 4 = Belah-Rosewood, 8 = Black Bluebush, 8p = Pearl Bluebush, 11 = Bladder Saltbush, 12 = *Sclerostegia tenuis*, 13 = canegrass, 16 = *Callitris* Mixed Woodland, 17 = *Acacia melvillei* Woodland, 18 = Lignum and Nitre Goosefoot, 19 = Old Man Saltbush, 22 = Disturbed Shrubland Complex, 29 = Rocky Outcrop Woodland Complex, 30 = Lunette Shrubland; * = exotic species; ◆ = extension of known range in NSW (specimen held at National Herbarium of New South Wales); ✱ = species nationally listed as Rare or Threatened Australian Plants (ROTAP) (Briggs & Leigh 1995); ★ = species listed on Schedules 1 and 2 of the 1995 NSW Threatened Species Conservation Act; ✣ = plant taxon with restricted distribution in the Western Division of NSW (Pressey et al. 1990); ❖ = rare or threatened taxon in Victoria (Gullan 1990); names in square brackets [] are recent synonyms.

Other records:

BR = Rice, B. (1986) Aspects of the vegetation of the Willandra World Heritage Region (Final report to the NSW Department of Environment and Planning on investigations under the National Estates Program)

MW = Westbrooke, M.E. and J.D. Miller (1995) Vegetation of Mungo National Park, western New South Wales. *Cunninghamia (4)1:* 63–80

NH = National Herbarium of New South Wales record.

Pooncarie Species List

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Aizoaceae																			
Disphyma crassifolium subsp. *clavellatum*	-	-	-	-	-	-	-	-	-	-	-	80	100	-	-	-	-	-	6
**Mesembryanthemum crystallinum* MW																			
**Psilocaulon tenue* MW																			
Tetragonia tetragonioides	-	-	-	20	-	50	-	-	-	-	-	-	-	-	-	-	-	33	3
Amaranthaceae																			
Alternanthera denticulata	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	1
Alternanthera nodiflora	50	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
❖*Amaranthus grandiflorus*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	-	1
◆❖*Amaranthus macrocarpus* var. *macrocarpus*	-	-	-	-	-	-	-	-	-	-	-	-	-	33	-	-	-	-	1
Ptilotus atriplicifolius var. *atriplicifolius*	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Ptilotus exaltatus var. *exaltatus*	-	-	-	-	-	50	25	44	18	-	-	-	-	-	-	-	-	-	10
❖*Ptilotus nobilis* [BR]																			
❖*Ptilotus obovatus* var. *obovatus*	-	-	7	-	50	-	6	-	-	-	-	-	-	-	-	-	-	-	3
❖*Ptilotus polystachyus* var. *polystachyus*	-	17	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	2
Ptilotus seminudus [NH]																			
Ptilotus spathulatus [MW]																			
Amaryllidaceae																			
Crinum flaccidum	-	17	-	-	-	-	-	-	-	-	-	X	-	-	-	-	-	-	1
Anthericaceae																			
Corynotheca licrota [BR]																			
Thysanotus baueri [MW]																			
Apiaceae																			
Daucus glochidiatus [NH]																			
Trachymene cyanopetala [NH]																			
Apocynaceae																			
❖*Parsonsia eucalyptophylla*	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Asclepiadaceae																			
❖*Marsdenia australis*	-	-	27	20	-	-	6	11	27	-	-	-	-	-	-	-	-	-	9

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Asparagaceae																			
**Myrsiphyllum asparagoides* MW																			
Asphodeliaceae																			
**Asphodelus fistulosus*	-	-	4	40	X	50	-	11	18	X	-	-	-	-	-	-	100	-	10
Bulbine bulbosa	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	17	-	-	2
Bulbine semibarbata	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	33	1
Aspleniaceae																			
Pleurosorus rutifolius	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Asteraceae																			
Actinobole uliginosum	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
❖*Angianthus brachypappus* BR																			
**Arctotheca calendula* MW																			
Brachycome ciliaris var. *ciliaris*	-	-	-	-	-	-	6	-	-	8	-	-	-	-	-	-	-	-	2
✣❖*Brachycome exilis*	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	1
Brachycome heterodonta var. *heterodonta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	1
Brachycome leptocarpa BR																			
Brachycome lineariloba MW																			
Brachycome multifida var. *multifida*	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	1
✷★✣*Brachycome papillosa* NH																			
Brachycome perpusilla var. *tenella* MW																			
Bracteantha bracteata BR																			

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Calotis cuneifolia	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	1
Calotis cymbacantha BR																			
Calotis erinacea	-	-	-	-	-	-	31	X	9	-	-	-	-	-	-	-	-	-	6
Calotis hispidula	-	-	-	-	-	50	-	-	9	-	-	-	-	-	-	-	33	-	3
Calotis plumulifera BR																			
Calotis scabiosifolia BR																			
**Centaurea melitensis*	-	-	-	-	-	-	-	-	-	8	-	-	-	-	25	-	-	-	2
Centipeda cunninghamii	-	17	-	-	-	-	-	-	-	15	-	20	-	33	25	-	-	-	6
Centipeda minima BR																			
✤*Ceratogyne obionoides* BR																			
Chrysocephalum apiculatum	-	-	-	-	-	-	6	11	-	-	-	-	-	-	-	-	-	-	2
Chthonocephalus pseudevax MW																			
**Cirsium vulgare*	100	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	3
**Cotula bipinnata* BR																			
Craspedia haplorrhiza BR																			
Eclipta platyglossa	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Elachanthus pusillus BR																			
Gnephosis arachnoidea BR																			
Gnephosis tenuissima	-	17	-	40	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
**Hedypnois rhagadioloides* subsp. *cretica* BR																			
Hyalosperma semisterile	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
**Hypochaeris glabra*	-	17	-	20	-	-	-	-	-	-	-	-	-	-	-	-	33	-	3
**Hypochaeris radicata*	50	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	2
Isoetopsis graminifolia MW																			
Ixiolaena leptolepis	-	-	-	-	-	-	-	-	-	X	33	-	-	-	-	-	-	-	1
❖*Ixiolaena tomentosa*	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	-	1
◆❖*Leptorhynchos panaetioides*	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	2
★✣❖*Leptorhynchos waitzia* BR																			
❖*Leucochrysum molle*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	1
Microseris lanceolata BR																			
Millotia greevesii var. *greevesii* NH																			
Millotia macrocarpa NH																			
Millotia perpusilla MW																			
Minuria cunninghamii	-	-	-	-	-	-	-	-	-	31	33	40	X	-	-	17	-	33	8
❖*Minuria denticulata*	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	1
❖*Minuria integerrima*	-	-	-	-	-	-	-	-	-	8	-	-	-	-	25	-	-	-	2
Minuria leptophylla	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Myriocephalus stuartii	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	67	-	3
Olearia lepidophylla	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	1
Olearia magniflora	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	1
Olearia muelleri	-	-	13	-	-	-	-	11	9	-	-	-	-	-	-	-	-	-	4
❖*Olearia passerinoides* subsp. *passerinoides*	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	1

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Olearia pimeleoides	-	-	13	-	-	-	-	11	9	-	-	-	-	-	-	-	-	-	4
❖*Olearia subspicata*	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
**Onopordum acaulon* MW																			
❖*Podolepis canescens* BR																			
Podolepis capillaris	-	-	-	-	-	-	50	33	-	-	-	-	-	-	-	-	-	-	10
❖*Podotheca angustifolia* NH																			
Pogonolepis stricta BR																			
Pseudognaphalium luteoalbum	-	17	-	-	-	-	-	-	-	-	-	-	-	33	-	-	-	-	2
Pycnosorus chrysanthus BR																			
Pycnosorus pleiocephalus	-	-	X	-	-	-	-	-	X	X	-	-	-	-	-	X	-	-	-
Rhodanthe corymbiflora	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-	-
Rhodanthe floribunda	-	X	X	-	-	-	-	-	X	8	-	-	-	-	-	X	X	-	1
Rhodanthe moschata	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
❖*Rhodanthe polygalifolia* BR																			
Rhodanthe pygmaea	-	-	X	-	-	-	-	-	X	-	33	-	-	-	-	-	-	-	1
Rhodanthe stuartiana NH																			
Rhodanthe tietkensii	-	-	X	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-
Rhodanthe uniflora BR																			
Senecio cunninghamii BR																			
Senecio glossanthus NH																			
Senecio gregorii BR																			

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Senecio lautus subsp. *dissectifolius*	-	-	-	-	-	-	6	-	-	X	-	-	-	-	-	-	-	-	1
Senecio runcinifolius	-	-	-	-	-	-	-	-	-	-	-	-	-	33	-	-	-	-	1
Sigesbeckia australiensis	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
Sigesbeckia orientalis subsp. *orientalis*	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	1
**Sonchus asper* subsp. *glaucescens*	-	17	-	-	-	-	-	-	-	15	-	-	-	-	-	17	-	-	4
**Sonchus oleraceus*	50	-	-	20	-	-	-	-	9	-	-	-	-	-	25	-	33	-	5
Vittadinia cervicularis var. *cervicularis*	-	-	7	-	-	-	6	22	18	-	-	-	-	-	-	-	-	-	6
Vittadinia cuneata var. *cuneata*	-	-	-	-	-	-	6	33	-	-	-	-	-	-	-	-	-	-	4
Vittadinia cuneata var. *hirsuta* [NH]																			
Vittadinia cuneata var. *morrisii*	-	-	7	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	2
Vittadinia dissecta var. *hirta*	-	-	-	-	-	-	19	11	9	-	-	-	-	-	-	-	-	-	5
Vittadinia gracilis	-	17	7	-	50	100	-	-	9	23	-	-	-	-	-	-	33	-	9
❖*Vittadinia pterochaeta*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	1
Waitzia acuminata [NH]																			
**Xanthium spinosum*	-	17	-	-	-	-	-	-	-	8	-	-	-	X	50	-	-	-	4
Azollaceae																			
Azolla filiculoides var. *rubra* [BR]																			
Boraginaceae																			
**Amsinckia intermedia*	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Cynoglossum australe	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	1
**Echium plantagineum*	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	33	-	2

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Halgania cyanea	-	-	-	-	-	-	44	44	-	-	-	-	-	-	-	-	-	-	10
**Heliotropium europaeum*	100	-	-	40	-	-	-	-	-	15	-	-	-	-	50	-	-	-	7
**Heliotropium supinum*	-	-	-	-	-	-	-	-	-	-	-	-	-	33	-	-	-	-	1
**Neatostema apulum* NH																			
Omphalolappula concava NH																			
Plagiobothrys plurisepaleus NH																			
Brassicaceae																			
**Alyssum linifolium* NH																			
**Arabidella nasturtium* NH																			
**Brassica tournefortii*	50	17	-	40	-	-	-	11	18	8	-	-	-	-	-	-	67	-	9
**Capsella bursa-pastoris* NH																			
**Carrichtera annua*	-	17	-	-	-	-	-	-	-	15	-	-	-	-	-	17	-	-	4
Geococcus pusillus NH																			
Harmsiodoxa blennodioides NH																			
Harmsiodoxa brevipes NH																			
Lepidium fasciculatum NH																			
Lepidium leptopetalum NH																			
Lepidium papillosum NH																			
❖*Lepidium phlebopetalum*	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Lepidium pseudohyssopifolium	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	1
✤*Pachymitus cardaminoides*	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
Phlegmatospermum cochlearinum NH																			

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
✱✣❖*Phlegmatospermum eremaeum* NH																			
Sisymbrium erysimoides	50	33	7	X	-	X	-	-	-	-	-	-	-	33	25	17	-	-	6
Sisymbrium irio	-	17	-	20	-	50	6	-	-	-	-	-	-	-	-	-	-	33	5
**Sisymbrium orientale* NH																			
Stenopetalum lineare NH																			
Stenopetalum sphaerocarpum NH																			
Campanulaceae																			
Wahlenbergia communis	-	-	7	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	1
Wahlenbergia gracilenta	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Capparaceae																			
Apophyllum anomalum	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Caryophyllaceae																			
**Herniaria hirsuta* NH																			
Scleranthus minisculus	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Scleranthus pungens	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
**Silene apetala*	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
**Spergularia diandra* NH																			
**Spergularia rubra*	-	17	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	2
**Stellaria media* NH																			
Casuarinaceae																			
Casuarina pauper	-	-	100	20	-	X	-	-	-	-	-	-	-	-	-	-	-	-	15

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Chenopodiaceae																			
Atriplex acutibractea subsp. *acutibractea*	-	-	13	-	-	-	6	-	9	-	-	-	-	-	25	-	-	33	6
❖*Atriplex angulata*	-	-	-	-	-	-	-	-	-	31	33	-	-	-	25	X	-	-	6
Atriplex conduplicata NH																			
Atriplex eardleyae	-	50	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	4
Atriplex holocarpa	-	17	-	-	-	-	-	-	-	8	-	-	-	-	-	50	-	33	6
✱★✣*Atriplex infrequens* NH																			
Atriplex intermedia	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	1
Atriplex leptocarpa	100	17	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	4
Atriplex limbata	-	17	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Atriplex lindleyi	-	33	7	-	-	-	-	-	-	62	33	20	50	-	75	67	-	33	20
Atriplex nummularia	-	-	-	-	-	-	-	-	-	-	-	-	X	-	100	-	-	-	4
Atriplex pseudocampanulata	-	33	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	33	5
Atriplex pumilio NH																			
Atriplex semibaccata	-	67	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	4
Atriplex spongiosa NH																			
❖*Atriplex stipitata*	-	-	53	-	50	-	19	33	55	23	-	-	-	-	-	-	-	-	22
Atriplex suberecta	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Atriplex velutinella NH																			
✣*Atriplex vesicaria*	-	-	-	-	-	-	-	-	-	23	-	100	50	-	25	33	-	-	11
**Chenopodium album* NH																			

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Chenopodium cristatum	-	33	-	60	-	-	-	-	-	-	-	-	-	-	-	-	33	-	6
Chenopodium curvispicatum	-	-	33	-	-	-	-	22	9	-	33	-	-	-	25	-	-	-	9
Chenopodium desertorum subsp. *anidiophyllum* BR																			
Chenopodium desertorum subsp. *desertorum*	-	-	27	-	-	-	38	56	46	-	-	-	-	-	-	-	-	-	18
Chenopodium desertorum subsp. *microphyllum*	-	-	-	-	-	-	19	11	-	-	-	-	-	-	-	-	-	-	4
Chenopodium desertorum subsp. *rectum*	-	-	-	-	-	-	13	22	-	-	-	-	-	-	-	-	-	-	4
Chenopodium melanocarpum NH																			
**Chenopodium murale*	-	17	-	40	-	-	-	-	-	-	-	-	-	-	-	-	X	-	3
Chenopodium nitrariaceum	100	17	-	-	-	-	-	-	-	-	-	20	-	100	50	-	-	-	8
Chenopodium pumilio	-	17	-	-	-	-	-	-	-	-	-	-	50	33	25	-	-	-	4
❖*Dissocarpus biflorus* var. *biflorus*	-	-	7	-	-	-	-	-	-	8	-	40	-	-	25	17	-	-	6
Dissocarpus paradoxus	-	67	87	40	100	-	19	22	82	77	67	60	50	X	25	83	33	33	54
Dysphania glomulifera subsp. *eremaea*	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	1
Einadia nutans subsp. *nutans*	100	67	7	20	-	100	-	22	9	8	-	-	-	-	50	-	-	33	16
Enchylaena tomentosa	100	67	100	60	100	100	19	67	64	8	33	-	-	-	25	-	33	-	44
❖*Maireana aphylla*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	1
Maireana appressa	-	-	7	-	-	-	-	11	X	15	33	20	-	-	25	-	-	-	6
Maireana brevifolia	-	33	13	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	5
Maireana erioclada BR																			
Maireana georgei	-	-	-	-	-	-	-	-	-	X	X	X	-	-	X	X	-	-	-
Maireana microcarpa	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	1

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Maireana ovata [NH]																			
Maireana pentatropis	-	-	13	-	-	-	6	33	36	-	-	-	-	-	-	-	-	-	9
Maireana pyramidata	-	33	27	20	50	-	-	-	9	100	100	20	50	-	100	17	33	-	30
Maireana radiata	-	-	-	-	-	-	X	11	-	-	-	-	-	-	-	-	-	-	1
Maireana schistocarpa [NH]																			
Maireana sclerolaenoides	-	-	33	-	50	-	13	33	27	15	-	-	-	-	-	-	-	-	15
Maireana sedifolia	-	-	7	-	-	-	-	-	-	15	100	-	-	-	-	-	-	-	6
Maireana trichoptera	-	-	-	-	-	-	6	11	-	-	-	-	-	-	-	-	-	-	2
❖*Maireana triptera*	-	17	47	-	-	-	44	56	64	-	-	-	-	-	-	-	-	-	25
Maireana turbinata	-	-	7	-	50	-	-	-	9	8	-	-	-	-	-	-	33	-	5
❖*Malacocera tricornis*	-	-	-	-	-	-	-	-	-	15	-	40	-	-	-	17	-	-	5
❖*Neobassia proceriflora*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	1
Osteocarpum acropterum var. *deminuta*	-	67	-	-	-	-	-	-	-	38	33	60	X	-	75	33	-	-	16
Rhagodia spinescens	-	50	13	-	50	50	-	11	-	46	33	20	-	-	50	-	33	33	18
❖*Rhagodia ulicina*	-	-	13	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	2
Salsola kali	-	67	47	60	50	-	25	44	46	23	33	-	-	100	50	67	100	-	40
Scleroblitum atriplicinum [NH]																			
Sclerolaena bicornis var. *bicornis*	-	17	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Sclerolaena brachyptera	-	50	7	-	-	-	-	-	-	69	67	100	X	-	-	33	33	-	21
Sclerolaena calcarata	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
❖*Sclerolaena convexula*	-	-	-	-	-	100	6	-	-	-	-	-	-	-	-	-	-	-	3

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
❖*Sclerolaena decurrens* NH																			
Sclerolaena diacantha	-	33	53	20	50	-	75	100	64	23	33	-	-	-	-	33	-	-	42
Sclerolaena divaricata	-	-	-	-	-	-	-	-	-	31	-	20	50	-	50	17	33	-	9
Sclerolaena intricata	-	-	-	-	-	-	-	-	-	8	-	20	50	-	25	17	-	-	5
❖*Sclerolaena lanicuspis*	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	2
Sclerolaena muricata var. *muricata*	100	50	-	-	-	-	-	-	-	8	-	20	50	67	25	X	33	33	12
Sclerolaena muricata var. *semiglabra*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	1
Sclerolaena muricata var. *villosa*	-	-	-	-	-	-	-	-	-	-	-	20	-	33	-	17	-	-	3
Sclerolaena obliquicuspis	-	-	93	20	100	50	31	44	82	38	33	20	-	-	-	-	-	-	39
Sclerolaena parviflora	-	-	-	-	-	-	63	56	18	-	-	-	-	-	-	-	-	-	16
Sclerolaena patenticuspis	-	33	20	-	50	-	-	-	27	38	-	40	-	-	-	-	-	-	15
Sclerolaena stelligera	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	2
Sclerolaena tricuspis	-	17	-	20	-	-	-	-	-	38	-	80	50	-	25	67	33	100	19
❖*Sclerolaena ventricosa*	-	17	-	-	-	-	-	-	-	15	-	-	-	-	-	-	-	-	3
Sclerostegia tenuis	-	-	-	-	-	-	-	-	-	X	-	60	100	-	50	-	-	33	7
Chloanthaceae																			
Dicrastylis verticillata	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
Colchicaceae																			
Wurmbea dioica subsp. *dioica*	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Convolvulaceae																			
Convolvulus erubescens	-	17	-	-	-	-	-	-	-	31	-	-	-	-	-	33	-	-	6

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
◆*Evolvulus alsinoides* var. *decumbens*	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
Crassulaceae																			
Crassula colorata var. *acuminata*	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Crassula sieberiana [BR]																			
Cucurbitaceae																			
**Citrullus colocynthis* [BR]																			
**Cucumis myriocarpus*	-	50	-	60	-	50	-	-	-	15	33	-	-	-	25	50	33	-	14
Cupressaceae																			
❖*Callitris glaucophylla*	-	-	27	100	-	50	-	X	X	X	-	-	-	-	-	-	X	-	9
Callitris gracilis subsp. *murrayensis*	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
[C. preissii subsp. *murrayensis]*																			
Callitris verrucosa	-	-	-	-	-	-	6	11	-	-	-	-	-	-	-	-	-	-	2
[C. preissii subsp. *verrucosa]*																			
Cyperaceae																			
❖*Eleocharis pallens* [BR]																			
Isolepis australiensis	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Schoenus subaphyllus	-	-	-	20	-	-	19	11	-	-	-	-	-	-	-	-	-	-	5
Dilleniaceae																			
Hibbertia virgata subsp. *virgata*	-	-	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-	2
Euphorbiaceae																			
Beyeria opaca	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	1
Chamaesyce drummondii	50	17	-	20	-	100	13	-	9	38	-	-	-	-	-	17	-	-	13

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
◆*Chamaesyce* species B	-	-	-	-	-	-	-	-	-	8	33	-	-	-	25	50	-	-	6
❖*Euphorbia planiticola*	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	67	-	-	5
Phyllanthus fuernrohrii	-	-	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	2
Poranthera microphylla NH																			
Fabaceae–Caesalpinioideae																			
Senna artemisioides nothosubsp. *coriacea*	-	-	47	X	-	-	-	11	-	-	-	-	-	-	-	-	-	-	7
Senna artemisioides subsp. *filifolia* NH																			
Senna artemisioides subsp. *petiolaris*	-	-	7	-	-	-	-	22	-	-	-	-	-	-	-	-	-	-	3
Senna artemisioides nothosubsp. *sturtii*	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Senna artemisioides subsp. *zygophylla*	-	-	13	-	-	-	13	22	9	-	-	-	-	-	-	-	-	-	6
Fabaceae–Faboideae																			
❖*Bossiaea walkeri*	-	-	-	-	-	-	25	22	-	-	-	-	-	-	-	-	-	-	6
Daviesia arenaria	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	1
Daviesia ulicifolia NH																			
❖*Eutaxia microphylla*	-	-	-	-	-	-	-	22	-	-	-	-	-	-	-	-	-	-	2
❖*Glycine canescens*	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
**Medicago laciniata* NH																			
**Medicago minima*	-	17	-	20	-	50	-	-	-	15	-	-	-	-	-	33	33	-	7
**Medicago polymorpha*	50	-	-	-	50	-	-	-	18	38	33	40	-	33	50	-	33	33	16
**Medicago praecox*	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	1
**Medicago truncatula*	-	-	-	20	-	50	-	-	9	15	-	-	-	-	-	X	33	-	6

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Swainsona burkittii [BR]																			
❖*Swainsona greyana*	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
❖*Swainsona phacoides*	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
**Templetonia egena* [NH]																			
**Vicia sativa* subsp. *angustifolia*	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Fabaceae–Mimosoideae																			
★❖*Acacia acanthoclada* [NH]																			
Acacia aneura	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
Acacia brachybotrya	-	-	-	-	-	-	X	X	-	-	-	-	-	-	-	-	-	-	-
Acacia burkittii	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
Acacia cambagei [NH]																			
★★❖*Acacia carnei* [NH]																			
❖*Acacia colletioides*	-	-	X	-	-	-	13	67	-	-	-	-	-	-	-	-	-	-	7
Acacia continua [NH]																			
Acacia halliana [NH]																			
Acacia homalophylla	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Acacia ligulata	-	-	X	-	-	-	13	X	-	-	-	-	-	-	-	-	X	-	2
❖*Acacia loderi*	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
❖*Acacia melvillei*	-	-	X	-	100	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Acacia montana [NH]																			
Acacia murrayana [NH]																			
❖*Acacia oswaldii*	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	1

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Acacia rigens	-	-	-	-	-	-	25	11	-	-	-	-	-	-	-	-	-	-	5
Acacia salicina	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Acacia sclerophylla var. *sclerophylla* NH																			
Acacia stenophylla	100	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Acacia victoriae	-	-	-	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	1
Acacia wilhelmiana	-	-	-	-	-	-	63	33	-	-	-	-	-	-	-	-	-	-	12
Fumariaceae																			
**Fumaria muralis* MW																			
Gentianaceae																			
Centaurium spicatum BR																			
Geraniaceae																			
**Erodium cicutarium*	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	17	-	33	2
Erodium crinitum	-	-	-	40	-	100	-	11	9	23	33	-	-	-	-	33	-	-	11
Goodeniaceae																			
Goodenia cycloptera NH																			
Goodenia fascicularis	-	33	-	-	-	100	-	-	-	8	-	-	-	-	-	-	33	-	6
Goodenia heteromera	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Goodenia pinnatifida NH																			
Goodenia pusilliflora NH																			
Goodenia varia	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	1
Goodenia willisiana NH																			

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
❖*Scaevola depauperata*	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	1
Gyrostemonaceae																			
Codonocarpus cotinifolius	-	-	-	-	-	-	13	-	-	-	-	-	-	-	-	-	-	-	2
✱★❖*Codonocarpus pyramidalis* [NH]																			
❖*Gyrostemon australasicus* [NH]																			
Haloragaceae																			
❖*Haloragis glauca* forma *glauca*	-	17	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	2
Haloragis odontocarpa	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
Myriophyllum verrucosum	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Juncaceae																			
**Juncus bufonius* [BR]																			
Juncus flavidus	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Juncaginaceae																			
Triglochin calcitrapum [BR]																			
Lamiaceae																			
Ajuga australis [NH]																			
**Marrubium vulgare*	-	-	-	20	-	X	-	-	-	-	-	-	-	-	X	-	-	-	1
Prostanthera striatiflora [NH]																			
**Salvia verbenaca*	-	-	7	-	100	50	6	-	-	15	-	-	-	-	-	-	X	-	6
Teucrium albicaule	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Teucrium racemosum	50	17	-	-	-	-	-	-	-	-	-	20	-	67	-	-	-	-	5

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Westringia rigida	-	-	-	-	-	-	-	11	18	-	-	-	-	-	-	-	-	-	3
Lauraceae																			
Cassytha melantha	-	-	-	-	-	-	13	-	9	-	-	-	-	-	-	-	-	-	3
Linaceae																			
Linum marginale BR																			
Lobeliaceae																			
Pratia concolor	-	-	-	-	-	-	-	-	-	-	-	-	-	-	25	-	-	-	1
Loganiaceae																			
Logania nuda NH																			
Lomandraceae																			
Lomandra collina NH																			
Lomandra effusa	-	-	-	-	-	-	6	11	-	-	-	-	-	-	-	-	-	-	2
Lomandra glauca BR																			
Lomandra leucocephala subsp. *robusta*	-	-	-	-	-	-	44	11	-	-	-	-	-	-	-	-	X	-	7
Loranthaceae																			
❖*Amyema linophyllum* subsp. *orientale* NH																			
Amyema miquelii	50	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Amyema miraculosum subsp. *boormanii*	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Amyema preissii NH																			
Amyema quandang NH																			
Lysiana exocarpi subsp. *exocarpi*	50	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	3
Lysiana exocarpi subsp. *tenuis*	-	-	13	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Lysiana linearifolia [NH]																			
Malvaceae																			
◆❖*Abutilon fraseri*	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
Abutilon halophilum	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
Abutilon otocarpum [BR]																			
Hibiscus krichauffianus	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
**Hibiscus trionum*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	-	-	2
Lavatera plebeia [BR]																			
**Malva parviflora*	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	33	2
❖*Radyera farragei*	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Sida corrugata [NH]																			
Sida cunninghamii	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
Sida filiformis [NH]																			
Sida intricata	-	17	7	-	-	100	-	-	9	8	-	-	-	-	25	-	-	-	6
Sida trichopoda	-	-	-	-	-	-	-	-	-	15	-	-	-	-	-	17	-	-	3
Marsileaceae																			
Marsilea drummondii	50	17	-	-	-	-	-	-	-	-	-	20	-	67	-	-	-	-	5
Myoporaceae																			
❖*Eremophila deserti*	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	1
Eremophila glabra	-	-	-	-	-	-	19	56	-	-	-	-	-	-	-	-	-	-	7
Eremophila longifolia	-	-	7	-	-	-	-	-	9	-	-	-	-	-	-	-	-	-	2
❖*Eremophila maculata*	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
❖*Eremophila oppositifolia* NH																			
❖*Eremophila sturtii*	-	-	33	-	100	-	X	-	18	-	-	-	-	-	-	-	-	-	8
Myoporum montanum	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Myoporum platycarpum subsp. *platycarpum*	-	-	40	-	-	-	6	33	18	-	-	-	-	-	-	-	-	-	11
Myrtaceae																			
Eucalyptus camaldulensis	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
Eucalyptus costata	-	-	-	-	-	-	31	44	X	-	-	-	-	-	-	-	-	-	8
Eucalyptus dumosa	-	-	7	-	-	-	63	89	73	-	-	-	-	-	-	-	-	-	25
Eucalyptus dumosa × *socialis*	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	1
Eucalyptus gracilis	-	-	-	-	-	-	25	67	64	-	-	-	-	-	-	-	-	-	16
Eucalyptus intertexta	-	-	X	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
Eucalyptus largiflorens	50	100	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	6
Eucalyptus leptophylla	-	-	X	-	-	-	44	33	-	-	-	-	-	-	-	-	-	-	9
Eucalyptus oleosa	-	-	-	-	-	-	19	33	18	-	-	-	-	-	-	-	-	-	7
Eucalyptus oleosa × *socialis*	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	1
Eucalyptus populnea subsp. *bimbil* NH																			
✣*Eucalyptus porosa* NH																			
Eucalyptus socialis	-	-	7	-	-	-	94	89	91	-	-	-	-	-	-	-	-	-	31
Leptospermum coriaceum	-	-	-	-	-	-	25	11	-	-	-	-	-	-	-	-	-	-	5
Nyctaginaceae																			
Boerhavia dominii	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	33	-	2
Oleaceae																			

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Jasminum lineare	-	-	7	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	2
Orchidaceae																			
Pterostylis biseta NH																			
Oxalidaceae																			
Oxalis perennans	50	17	-	-	-	50	-	-	9	-	-	-	-	-	-	-	-	33	5
**Oxalis pes-caprae* NH																			
Phormiaceae																			
Dianella revoluta var. *revoluta*	-	-	X	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	1
Pittosporaceae																			
Pittosporum phylliraeoides	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Plantaginaceae																			
Plantago cunninghamii	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	1
Plantago drummondii	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	33	-	2
Plumbaginaceae																			
**Limonium lobatum* BR																			
Poaceae																			
Agrostis avenacea var. *avenacea*	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	-	2
**Alopecurus geniculatus*	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Aristida contorta	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	-	2
**Avena fatua*	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Bromus arenarius NH																			

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
**Bromus rubens*	50	17	-	-	-	-	-	-	9	-	-	-	-	-	-	-	33	-	4
**Bromus tectorum* [NH]																			
Chloris truncata	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	33	-	2
Cynodon dactylon	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	-	-	-	1
❖*Dactyloctenium radulans*	50	17	-	20	-	-	-	-	-	15	-	-	-	-	-	17	-	-	6
Danthonia caespitosa	-	17	7	-	-	-	-	-	-	33	-	-	-	X	-	33	-	-	6
Danthonia setacea	-	-	7	-	-	-	-	X	-	8	-	20	-	-	-	-	-	-	3
◆❖*Digitaria ammophila*	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	X	-	-
Digitaria brownii	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
Elymus scaber [NH]																			
Enneapogon avenaceus	-	-	7	20	-	50	-	-	-	31	67	-	-	-	-	-	33	-	9
Enteropogon acicularis	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
Eragrostis australasica	-	-	-	-	-	-	-	-	-	8	-	20	50	X	25	-	-	100	6
Eragrostis eriopoda	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	33	2
Eragrostis setifolia	-	17	-	-	-	-	-	-	-	31	-	-	-	-	-	-	-	-	5
Homopholis proluta	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	1
**Hordeum leporinum*	-	50	-	40	-	50	-	-	18	23	33	20	-	67	25	50	33	33	19
**Hordeum marinum* [NH]																			
**Lamarckia aurea*	-	-	-	-	-	50	-	-	-	8	-	-	50	-	25	-	33	-	5
❖*Panicum decompositum*	-	-	-	-	-	-	-	-	-	8	-	-	-	33	-	50	-	-	5
Panicum effusum	100	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	3

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Panicum laevinode	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	17	-	-	1
**Parapholis incurva* NH																			
Paspalidium constrictum	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
Paspalidium jubiflorum	50	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
**Phalaris paradoxa* BR																			
Poa fordeana NH																			
**Rostraria pumila* NH																			
**Schismus barbatus* NH																			
◆❖*Sporobolus caroli*	-	17	-	-	-	-	-	-	-	15	-	-	-	-	25	-	-	-	4
Stipa acrociliata NH																			
Stipa blackii NH																			
Stipa drummondii NH																			
Stipa elegantissima NH																			
Stipa eremophila NH																			
Stipa nitida	-	17	67	40	100	-	63	89	82	77	67	40	-	33	-	17	67	-	55
Stipa nodosa	-	33	-	-	-	50	-	-	-	8	-	20	-	-	-	-	-	X	5
❖*Stipa puberula* NH																			
Stipa scabra subsp. *scabra* NH																			
❖*Stipa tuckeri* NH																			
❖*Tragus australianus*	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	1
Triodia scariosa subsp. *scariosa*	-	-	-	20	-	-	100	100	18	-	-	-	-	-	-	-	33	-	26
❖*Triraphis mollis*	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	33	-	1

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Family/Species																			
**Vulpia bromoides* NH																			
**Vulpia muralis* NH																			
**Vulpia myuros*	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Polygonaceae																			
**Acetosa vesicaria* NH																			
**Emex australis* NH																			
✤*Muehlenbeckia diclina* NH																			
Muehlenbeckia florulenta	100	33	-	-	-	-	-	-	-	-	-	-	-	67	-	17	-	33	7
Polygonum plebeium	-	-	-	-	-	-	-	-	-	-	-	-	-	33	-	-	-	-	1
Rumex brownii	50	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	2
**Rumex crispus* NH																			
**Rumex tenax* NH																			
Portulacaceae																			
Calandrinia calyptrata NH																			
✤*Calandrinia disperma* NH																			
Calandrinia eremaea	-	-	X	20	-	-	-	-	X	-	-	-	-	-	-	-	-	33	2
Portulaca oleracea	-	-	-	-	-	-	-	-	-	-	-	-	50	-	-	-	-	-	1
Proteaceae																			
Grevillea huegelii	-	-	-	-	-	-	-	11	-	-	-	-	-	-	-	-	-	-	1
✤*Grevillea pterosperma*	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-
❖*Hakea leucoptera*	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
❖*Hakea tephrosperma*	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Ranunculaceae																			
Clematis microphylla var. *microphylla* [NH]																			
Myosurus minimus var. *australis* [BR]																			
Ranunculus pentandrus var. *platycarpus* [BR]																			
Ranunculus pumilio var. *pumilio*	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Rhamnaceae																			
Cryptandra propinqua [NH]																			
Rubiaceae																			
✤*Opercularia turpis*	-	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-
Rutaceae																			
✤*Boronia caerulescens* [NH]																			
❖*Eriostemon difformis* subsp. *difformis* [NH]																			
Eriostemon linearis	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
Flindersia maculosa	-	-	7	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
❖*Geijera parviflora*	-	-	40	-	-	X	X	-	-	-	-	-	-	-	-	-	X	-	6
Santalaceae																			
Exocarpos aphyllus	-	17	13	-	-	X	-	11	-	-	-	-	-	-	-	-	-	-	4
✤*Exocarpos sparteus*	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	1
❖*Santalum acuminatum*	-	-	-	-	-	-	6	11	-	-	-	-	-	-	-	-	-	-	2
★✤*Santalum murrayanum*	-	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Sapindaceae																			
❖*Alectryon oleifolius* subsp. *canescens*	-	-	93	40	-	X	X	-	X	-	-	-	-	-	-	-	33	-	16
Dodonaea bursariifolia	-	-	-	-	-	-	-	22	-	-	-	-	-	-	-	-	-	-	2
Dodonaea viscosa subsp. *angustissima*	-	-	13	-	-	-	56	89	18	-	-	-	-	-	-	-	100	-	22
Scrophulariaceae																			
Limosella australis [NH]																			
Stemodia florulenta	-	17	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	2
**Veronica peregrina*																			
Simaroubaceae																			
**Ailanthus altissima* [BR]																			
Sinopteridaceae																			
◆*Cheilanthes distans*	-	-	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-
❖◆❖*Cheilanthes lasiophylla*	-	-	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	2
Cheilanthes sieberi subsp. *sieberi*	-	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	1
Solanaceae																			
Duboisia hopwoodii	-	-	7	X	-	-	25	11	9	-	-	-	-	-	-	-	-	-	6
Lycium australe	-	-	-	-	50	-	-	-	-	-	-	-	-	-	-	-	-	-	1
**Lycium ferocissimum*	50	17	-	-	-	50	-	-	-	-	-	-	-	-	25	-	-	-	4
**Nicotiana glauca*	-	-	-	20	-	-	-	-	-	-	-	-	-	-	-	-	33	-	2
Nicotiana occidentalis subsp. *obliqua* [NH]																			
Nicotiana velutina	-	33	-	40	-	50	-	-	-	-	-	-	-	-	-	-	-	-	5

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
❖*Solanum coactiliferum*	-	-	-	-	-	-	13	-	9	8	-	-	-	-	-	-	-	-	4
Solanum esuriale	-	50	-	20	-	50	13	22	9	15	-	-	-	33	-	-	-	-	12
Solanum ferocissimum	-	-	-	-	-	100	-	-	-	-	-	-	-	-	-	-	-	-	2
✱★❖*Solanum karsense* NH																			
Solanum nigrum NH																			
Thymelaeaceae																			
Pimelea microcephala subsp. *microcephala*	-	-	-	-	-	-	6	11	-	-	-	-	-	-	-	-	-	-	2
❖❖*Pimelea simplex* subsp. *continua*	-	-	-	-	-	-	6	-	-	-	-	-	-	-	-	-	-	-	1
Pimelea trichostachya	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	33	-	1
Typhaceae																			
Typha domingensis	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Urticaceae																			
Parietaria debilis MW																			
**Urtica urens*	-	-	-	X	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-
Verbenaceae																			
**Verbena officinalis*	-	-	-	-	-	-	-	-	-	-	-	-	-	33	25	-	-	-	2
**Verbena supina*	-	17	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	-	1
Zygophyllaceae																			
Nitraria billardierei	-	-	X	-	-	-	-	-	-	54	33	40	50	-	25	17	-	33	13
**Tribulus terrestris*	-	17	-	-	-	-	-	-	-	-	-	-	-	33	-	33	-	-	4
Zygophyllum ammophilum NH																			

Family/Species	F 1	W 2	W 4	W 16	W 17	W 29	M 3a	M 3b	M 3d	S 8	S 8p	S 11	S 12	S 18	S 19	S 22	S 30	G 13	A All
Zygophyllum angustifolium NH																			
Zygophyllum apiculatum	-	33	-	-	-	-	6	44	46	-	-	-	-	-	-	17	-	-	12
Zygophyllum aurantiacum	-	-	-	-	-	-	-	22	9	-	-	-	-	-	-	-	-	-	3
❖*Zygophyllum crenatum* NH																			
Zygophyllum eremaeum	-	-	27	-	-	-	-	22	18	-	-	-	-	-	-	-	-	-	7
Zygophyllum glaucum	-	-	-	-	-	-	-	-	-	8	-	-	-	-	-	-	-	-	1
Zygophyllum iodocarpum	-	-	-	-	-	-	-	-	-	-	-	20	-	-	-	17	-	-	2
Zygophyllum ovatum NH																			
Zygophyllum simile NH																			