The natural vegetation of the Ana Branch – Mildura 1:250 000 map sheet (New South Wales)

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Abstract

Fox, Marilyn D. (National Herbarium of New South Wales, Royal Botanic Gardens, Sydney, Australia 2000) 1991. The natural vegetation of the Ana Branch – Mildura 1:250 000 map sheet (New South Wales).* Cunninghamia *2(3): 443–493.* A vegetation map of the Ana Branch and New South Wales portion of the Mildura 1:250 000 topographic maps (SI 54-7 and SI 54-11) is presented. The area is in semi-arid south-eastern Australia (lat. 33°S and south to the Murray River, long. 141°–142°30'E). The vegetation is described and related to soils and geomorphology. A total of 299 species have been recorded from a variety of communities which comprise fifteen map units. Although there are several significant plant communities in the region that are inadequately reserved and seven species are known to be rare or endangered, less than 1% of the area (19,000 km^2) is currently in a formal conservation reserve.

Introduction

Location

The Ana Branch – Mildura map comprises the Australian topographic 1:250 000 Ana Branch sheet (SI 54-7) and the New South Wales portion of the adjacent Mildura sheet (SI 54-11). Figure 1 shows the location of the study area in south-western New South Wales. Although the accepted spelling of the noun anabranch, meaning an alternative or subsidiary course of a river, is as one word, the name of the map sheet is two words. The latter will only be used when referring to the actual map sheet. Figure 2 shows the relevant section of the 1:250 000 map grid, the major rivers and place or homestead/station names. The western boundary of the map is the NSW – South Australian border (141°00'E) while the eastern boundary is 142°30'E which runs just west of Pooncarie to just east of Tarpaulin Bend on the Murray River. The northern boundary is 33°00'S which runs through 'Loch Lilly' near the South Australian border to just north of 'Cuthero' on the Darling River. The southern boundary is the Victorian border along the Murray River, and although politically the border is taken as the southern bank of the river, the vegetation is mapped to the southern extent of the riverine forest. All of the mapped area (with the exception of the Victorian riverine forest) falls within the Western Division of New South Wales. The total area of the map sheet is approximately 19 000 km^2.

The dominant features of the mapped area are the major rivers, the River Murray which flows from the eastern Great Divide to empty into the sea at the Coorong, South Australia and the Darling flowing down from the far north. The divergence of the Darling and its Great Anabranch is only 12 km north of the map. The Darling meets the Murray at Wentworth, the Anabranch follows a more direct southerly bearing and joins the Murray 15 km west of the Darling–Murray confluence.

The many lakes associated with the Anabranch are an important feature of the landscape of this region. Most of the lakes are dry and, after ephemeral flooding,

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some are opportunistically cropped. One of them, Nearie Lake is a Nature Reserve. There is only one lake associated with the Darling River segment covered by this map, it is small Yartla Lake west of Coona Point. The only lakes associated with the River Murray across the Mildura sheet are Lake Victoria in the far west and the Gol Gol swamp and Lake Gol Gol near Mildura.

The principal road north and south is the Silver City Highway which follows the course of the Anabranch and then continues northwards to Broken Hill. The Sturt Highway follows the course of the Murray from the east to the large regional centre of Mildura in Victoria. It then continues due west south of the river. The area is criss-crossed with minor roads and station tracks, most of which are shown on the topographic sheet. A measure of the relative remoteness of this region is that there are no towns on the Ana Branch sheet and only small settlements on the northern bank of the Murray River.

The area is very flat; the average slope is of the order of 1–2 cm /km (Shiel 1980). In general the terrain slopes downwards from north to south and east to west. The regional relief is flat but there are local high and low features. The 250 ft (76 m) contour cuts through the top northwestern corner of the map. Spot elevations printed on the topographic map are Travellers Lake 150 ft (46 m), Nearie Lake 123 ft (38 m) and at the top of Lake Victoria, 102 ft (31 m). The highest point is The Nob 18 km east of Nearie Lake at 176 ft (54 m).

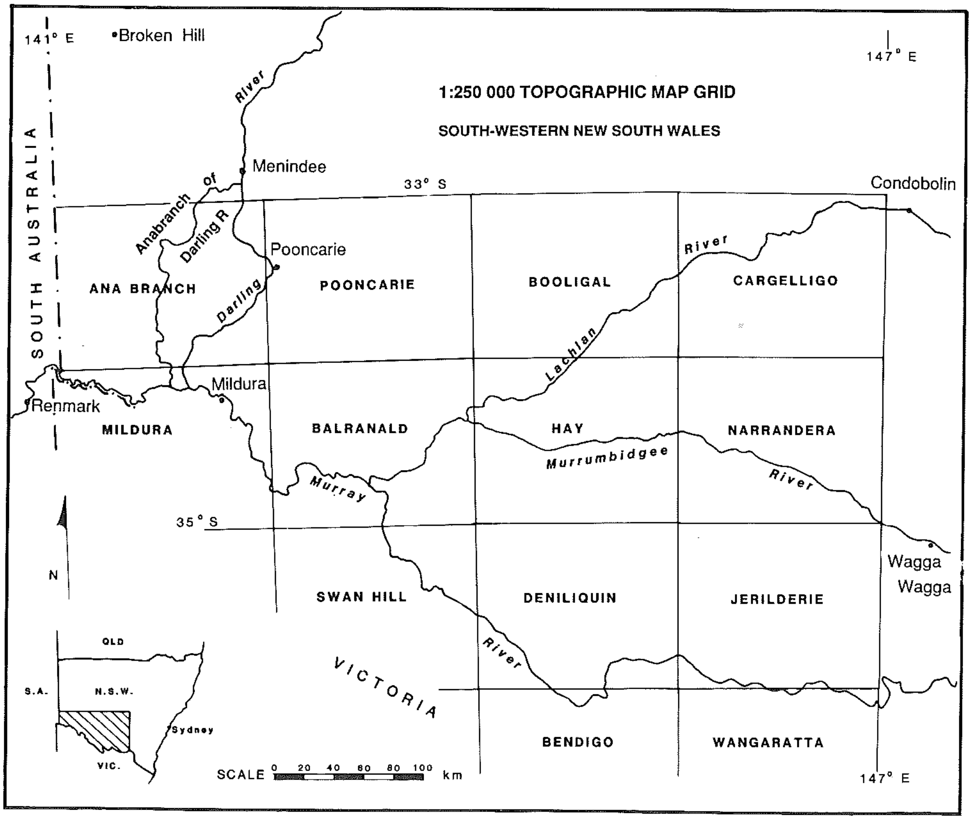

Figure 1. Part of the 1:250 000 map grid showing the mapped sheets and those adjacent to them.

Tectonic history

The entire map area is enclosed within the Murray Basin, a structural basin of 135,000 km^2 evolved from a Tertiary epicontinental basin and Mesozoic and Permian infra-basins (Scheibner 1974). The effective basement of the basin was built in the west by the Adelaide and Kanmantoo Fold Belts and in the east by the Lachlan Fold Belt. There are major faults on the northern and western margins. The study area does not

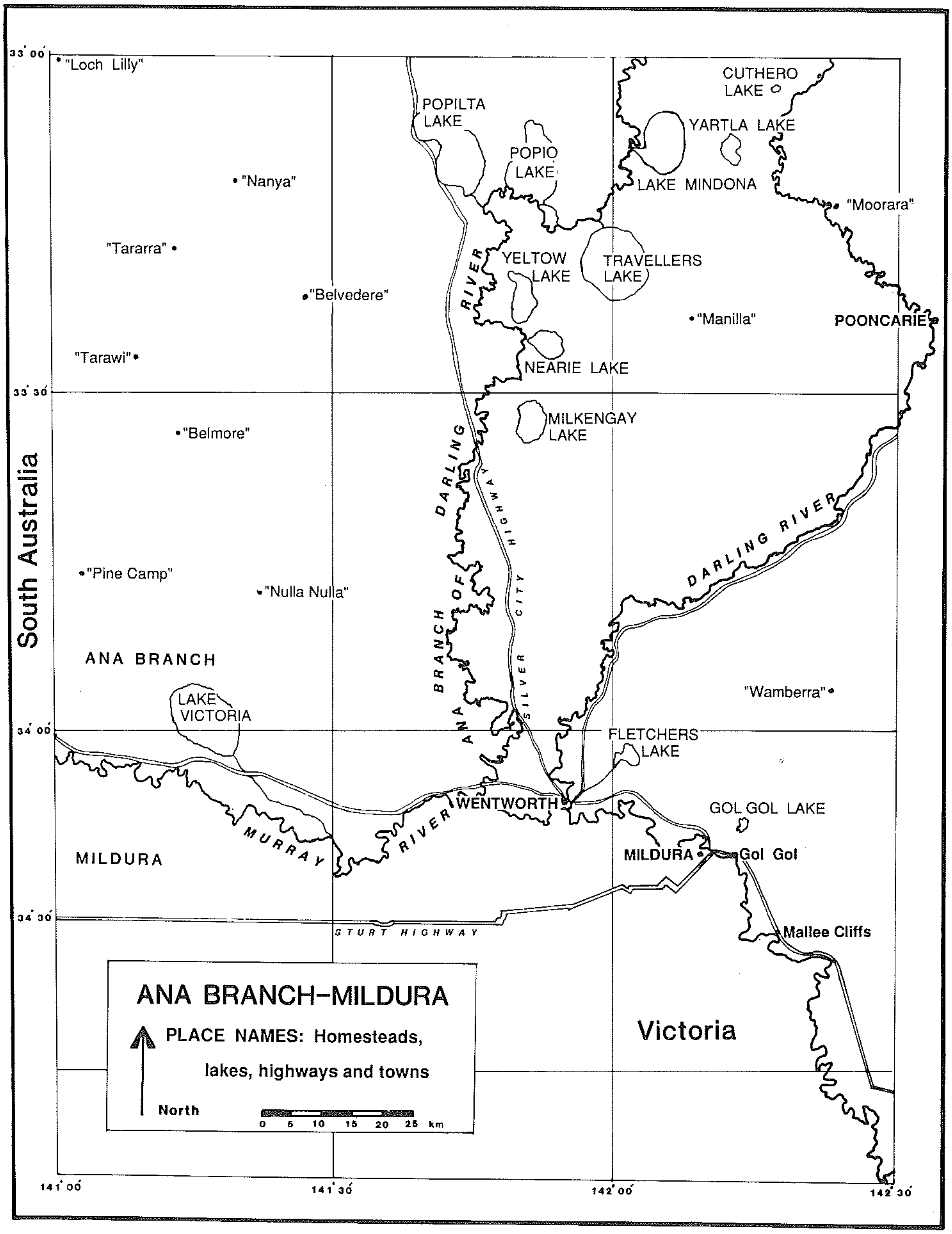

Figure 2. The mapped area comprises two 1:250 000 sheets: Ana Branch and the northern half of Mildura. Major highways, towns and homesteads are shown.

contain any rocky hills or ridges. North of the northern border (south of Broken Hill) there are Cambrian and Precambrian rocks.

The present configuration of the basin has been caused by subsidence and then active sedimentation during the Cainozoic Era. The sediments are extremely thick. A drill-hole near Lake Victoria penetrated bedrock at a depth of 677 m, while nearer Wentworth another went through Permian shale with sand lenses to a conglomerate base at 650 m depth (Pels 1969). On the eastern edge of the Basin are deposits of Tertiary lignites and non-marine, carbonaceous clays up to 360 m thick (Martin 1984). The present landform is a relict Quaternary landform and the contemporary rivers have had little impact (Pels 1969).

The present surface of the mapped area is of entirely Quaternary deposits, principally sands and clays. There are some gypsum deposits near the junction of the Great Anabranch and the Murray. In the far south-west there are some Tertiary outcrops along the Murray River (Pels 1969). A provisional geological map is available (H.N. Ray 1988). The predominant stratigraphy is of Quaternary material comprising fluvial and aeolian deposits. The only other older material are some isolated outcrops of Tertiary sands associated with Murray River and Darling River cliffs.

There are three major aquifers in the sediments of the Murray Basin; these represent glacial peaks and the interbedded clays represent the interglacials (Pels 1969). The hydraulic gradients indicate a general westward and south-westerly direction of groundwater movement.

Palaeohistory

The low-lying area now referred to as the Murray Basin was inundated by shallow marine incursions in the Miocene. These marine transgressions extended as far east as the Willandra lakes (Bowler & Magee 1978). In the Murray Basin the final regression was in the lower Pliocene (Bowler 1982). Following this stage the Murray River was dammed in eastern South Australia producing a large lake, Lake Bungunnia (Firman 1965). The study area falls within the presumed extent of Lake Bungunnia. Palaeomagnetic studies indicate that Lake Bungunnia drained perhaps 700,000 years ago (Bowler 1980a). This would have led to the reworking of the saline basins by both wind and water leading to the present-day aeolian, fluvial and lacustrine landforms.

Over the last major glacial cycle covering the last 120,000 years the south-western region experienced profound changes with the changing precipitation and temperature regimes. From 50,000 to 25,000 years B.P., the increased runoff with reduced evaporation resulted in high groundwater levels and full lakes. About 25,000 years ago the wet phase ended and the lakes shrank and became shallow, saline environments (Bowler 1980a, 1980b). This stage saw the reworking of lake-bed deposits to produce the clay-rich gypseous dunes or lunettes associated with the lakes. At the same time the longitudinal sand dunes were reactivated (Bowler 1976); the last major phase of dune growth was about 15,000 years ago (Bowler 1982). Maximum aeolian activity coincided with the height of glaciation 18,000–16,000 years B.P. (Bowler 1980b, 1982). This extensive aeolian erosion and deposition period, spanning approximately 10,000 years, is the last phase of the shaping of the present-day mallee landforms of the study area.

In the period 15,000 to Present there have been minor oscillations in the hydrologic budget but their effects on landscape development have been subdued. This period saw a general trend to dune stabilisation.

Palaeovegetation

The Miocene-Pliocene interval saw the expansion of the Myrtaceae, Chenopodiaceae and grasslands, together with the contraction of the rainforests (Singh 1982). Myrtaceous fruits occur in Miocene macrofossils, including *Eucalyptus, Leptospermum, Melaleuca, Callistemon* and *Angophora* (Lange 1978). Rainforest with *Nothofagus brassii* persisted in western New South Wales until the end of the Miocene and then was replaced by vegetation rich in Myrtaceae and Casuarinaceae (Martin 1978). The only Pleistocene assemblages found contain much chenopod and composite pollen (Martin 1978), although elsewhere this more open vegetation made its first appearance in the late Pliocene (Truswell & Harris 1982).

Over the past 50,000 years there has been a relationship between high lake levels and high densities of sclerophyll tree vegetation (Dodson 1977). A rise in lake levels 10,000 years ago saw the replacement of eucalypt woodlands by *Allocasuarina verticillata,* and elsewhere *Melaleuca* and *Leptospermum* expanded at the expense of the more open vegetation.

Geomorphology

The present-day landscape is a combination of aeolian, riverine and lacustrine elements. Figure 3 shows the geomorphology of the study area and is based on a map by Bowler and Magee (1978).

The rivers

The major rivers carry water from wetter areas in the north and east, there is no contribution from local surface runoff and hence no eroded channels. Both the Murray and Darling Rivers lose water as they flow westwards. In the past some of the rivers further east, such as the Murrumbidgee, incised prior stream courses and cut over 10 m below the present plain. These incised channels were then filled with Holocene sediments so that now the river beds are only just below the level of the surrounding plain (Pels 1969). Such deposits continue along the Murray River but it is interesting to note that they do not occur along the course of the Darling. The Darling also differs from the Murray and from its own Anabranch by having fewer associated shallow lakes and billabongs. This may reflect a more recent course for the Darling, its previous course being the Great Anabranch.

Linear dunes

These are the stabilised eastern extent of the fossil dunefields of central Australia (Bowler 1980a). The dunes are relatively straight and aligned east-west. They exhibit fairly uniform spacing from 0.2–1.2 km apart and vary in length, but are typically about 3 km long. The linear dunes are quite subdued, commonly with a height differential of only 2–6 m from swale to crest, although in places such as west of the Darling they can be up to 10 m in height. The dunes are composed of reddish-brown sandy clay and sand overlying grey clay. The clay content of the dunes can be as high as 20% in the swales, but is on average half that (Churchward 1963). The carbonate content is on average 5% (Bowler & Magee 1978).

In section the dunes are composed of a series of calcareous palaeosols (Churchward 1961) which represent successive phases of aeolian reactivation. The most recent major phase of dune growth was about 15,000 years ago (Bowler 1982). The long period of stability was maintained by thick vegetation cover. When that was removed by fire and clearing with settlement of the region some of the dunes were reactivated.

Irregular sub-parabolic dunes

These are steep, irregular siliceous dunes, sometimes called jumbled dunes. These are still influenced by prevailing westerly winds so that the apex of the parabola points east. Irregular dunes crests are commonly more than 10 m above the swales and their flanks are steep. Although their spacing is irregular these dunes are closer than the linear dunes. There are some irregular sub-parabolic dunes south of Pooncarie, east of the Darling River.

Sand plains

On the Ana Branch – Mildura map sheet there is a discontinuous belt of sand plain following the Darling and Anabranch and this is typical of the Interactive Zone of Mabbut (1980). This represents the zone of overlap and interaction between the aeo-

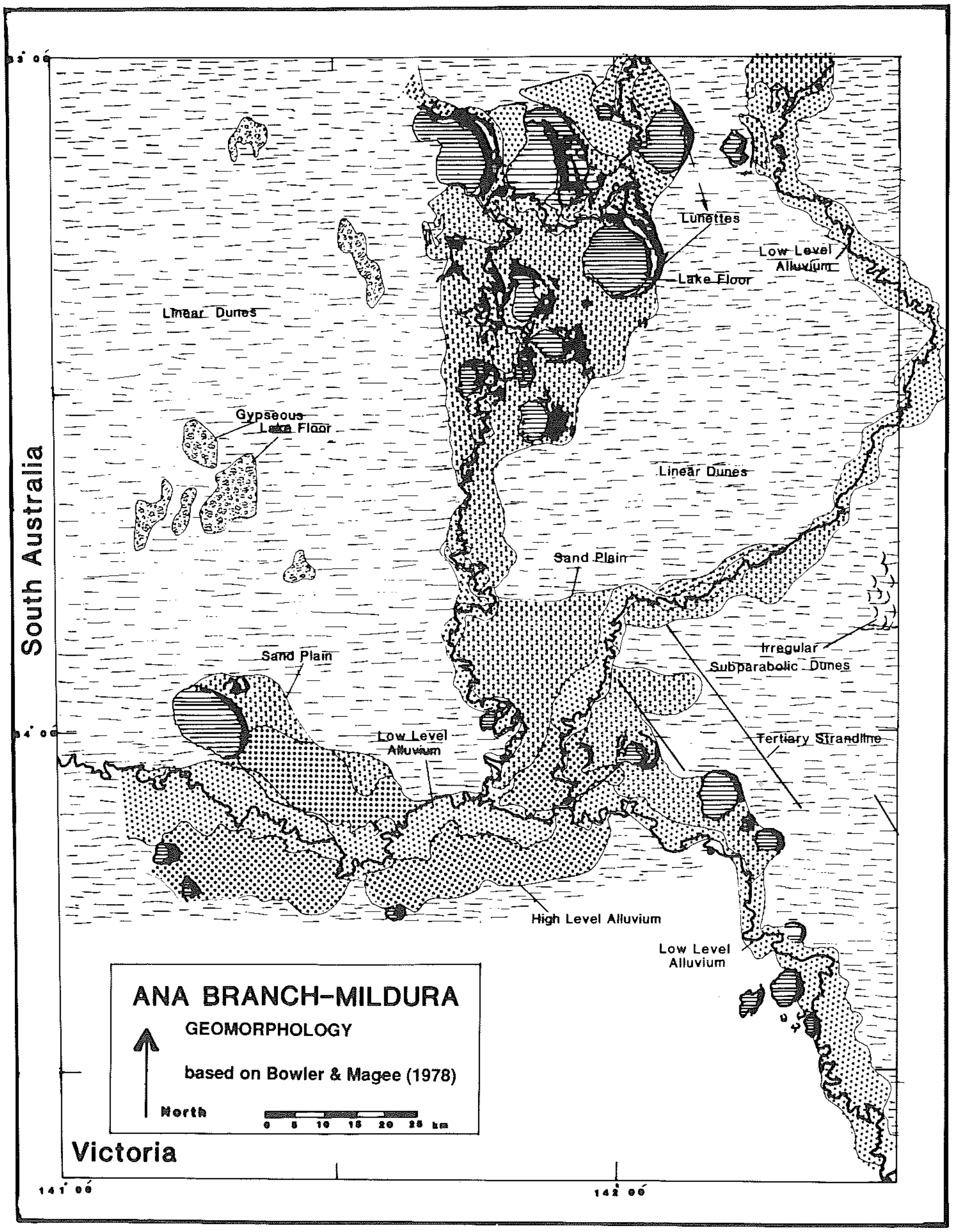

Figure 3. The geomorphology of the mapped area based on a map by Bowler & Magee (1978). The most extensive unit is the linear dunefield. A series of alluvial units is associated with the rivers and lakes.

lian and fluvial systems. It comprises irregular sand accumulations which are roughly circular mounds from less than 100 m to over 3 km in diameter. The larger mounds can be over 30 m in elevation. These are more similar to the linear dunes in composition, comprising sands and sandy clays with layered palaeosols and catenary profile differentiation (Rowan & Downes 1963).

Lunettes

These distinctive structures are smooth crescentic transverse dunes on the eastern and south-eastern sides of lake basins. Lunettes commonly have a 'core' of clean quartz sand which was deposited when the lake was full (e.g. Bowler 1980). Then saline gypseous clay mantled the sand core when the lake dried out. The last episode of lunette building was 19,000–15,000 BP (Bowler & Magee 1978). The lunette height and size is proportional to the size of the lake. On the Ana Branch – Mildura sheet there are well-developed lunettes on Popiltah, Popio and Mindona Lakes, but all the smaller lakes associated with the Anabranch also have defined lunettes. The lunette on Travellers Lake is composed entirely of quartz sand. It never experienced the suitable dry saline conditions necessary to deposit the gypseous clay layer over the sand.

Lake floors

The lakes of the south-west are well defined by the sharp break in slope on their western margin and a lunette on the eastern side. The lakes are typically smoothly elliptical or often kidney-shaped with the long axis aligned roughly north-south.

On the Murray river the principal lake is Lake Victoria near the South Australian border. This is now used as water storage as part of the water conservation-irrigation system of the lower Murray. The Anabranch has an important chain of lakes associated with it which are subject to occasional flooding. However, most of the time the lakes are dry and the lake floors comprise fine-grained clays with silts and sands more prominent in the deposits of the eastern down-wind margins. The dry lake floors are commonly criss-crossed by large dessication cracks. The salt content of the floor is high, supporting a salt-tolerant vegetation.

Gypseous lake floor

West of the Anabranch there are some large, irregular, low-lying areas that have been sites of groundwater evaporation. A preliminary shallow groundwater and salinity map of the Murray Basin (Evans 1988) shows these. For example, the Huntingfield groundwater discharge basins north of Lake Victoria total 443 km^2 and comprise highly saline, gypseous and calcareous clays, with lunettes of cemented siliceous sands (Eldridge 1985). However, not all gypseous lake floor areas have well-defined lunettes and they are usually in regions remote from drainage lines. Large areas of active groundwater discharge are termed boinkas (Macumber 1980).

Alluvium

Near the junction of the Darling and Murray Rivers there are high level alluvial terraces that post-date the linear dunefields. The laminated deposits are dominantly fluviatile and are of mixed ages. Lower level alluvium comprises the modern floodplain and follows the major drainage channels throughout the region. West (downstream) of Wentworth the Lower Alluvium forms a flat alluvial plain below the level of the older Upper Alluvium (Figure 2).

Clay plain and clay plain with sand cover

These features occur east of the dunefields in the large areas between major drainage lines such as between the Darling and the Great Anabranch.

Soils

The Ana Branch – Mildura region is part of the Murray–Darling Plains (VII) of Butler, Blackburn & Hubble (1983). More specifically it is part of their Soil Landscape Province 3, the Murravian Gulfland. Butler (1980) presents a detailed account of the soils of the Mildura region. The aeolian soils of south-western New South Wales has been described by the Soil Conservation Service of NSW (Eldridge 1985). A series of 1:250 000 soils maps is incorporated with detailed notes on the 32 soil-landform associations identified. Figure 4 is based on the Ana Branch and Mildura maps from Eldridge (1985). The figure is considerably simplified but shows the distribution of the eight main soil groups.

The **calcareous sands** (Unit 1, Figure 4), on longitudinal dunefield are restricted to the north-western corner of the linear dunes unit of Figure 3, and to an area west of Lake Victoria. The other soil units associated with the linear dunes are Unit 6 (brown calcareous earths), Unit 7 (grey-brown calcareous earths) and Unit 8 (brown sands/ calcareous earths). Units 6 and 7 are found mainly west and east of the Anabranch of the Darling, but not east of the Darling. Unit 8 is found principally east of the Darling and not west of the Anabranch. The siliceous sands (Unit 2) on sub-parabolic dunes correspond to the irregular sub-parabolic dunes in the far east of the map.

The **saline and gypseous clays** (Unit 4) are found on the gypseous lake floor areas principally west of the Anabranch.

The **red duplex soil** (Unit 5) partly corresponds to the sand plain of Bowler & Magee (1978, Figure 3), and is associated with the Anabranch lakes and with the confluence of the rivers. The river course itself, principally the low level alluvium of Figure 3, is shown here as Unit 3, the grey cracking clays. This unit follows the rivers and includes the lake beds.

All the soils are coarse-textured and prone to wind erosion when the vegetative cover is removed. Where the soils are irrigated there is a problem with salinization as deeper saline waters are drawn to the surface. There are associated changes in floristic composition with the spread of weeds, the loss of useful native perennial species and the increase in some unproductive native shrubs. With cropping there are changes in soil structure and loss of soil nutrients. All of these changes associated with cultivation are addressed in Lievers & Luke 1980, Eldridge & Semple 1982, Stanley 1982, and Walker 1982.

Land systems

The land systems of western New South Wales have been mapped by the Soil Conservation Service of New South Wales. Descriptions of land systems typically comprise combinations of landform, soil and vegetation. Lawrie & Stanley (1980) present an overview of the land system mapping program and describe the eight land systems representative of the mallee lands. The Ana Branch land system map (Eldridge 1985) shows four geomorphological classes: sandplains, dunefields, alluvial plains and playas or basins with respectively 10, 7, 5 and 7 units.

Climate

The climate of the Murray Darling Region has been summarised in the Bureau of Meteorology's Climatological Survey: Region 19 (1955). This summarises information on temperature, evaporation, rainfall and sunshine for the mapped area and to east of the Lachlan River. The region is also covered in a publication on rainfall with special reference to soil conservation (Edwards 1979).

The mapped area falls within the semi-arid region of south-eastern Australia. Rainfall is highest in the south-east (long-term average rainfall Mildura 295 mm, Wentworth

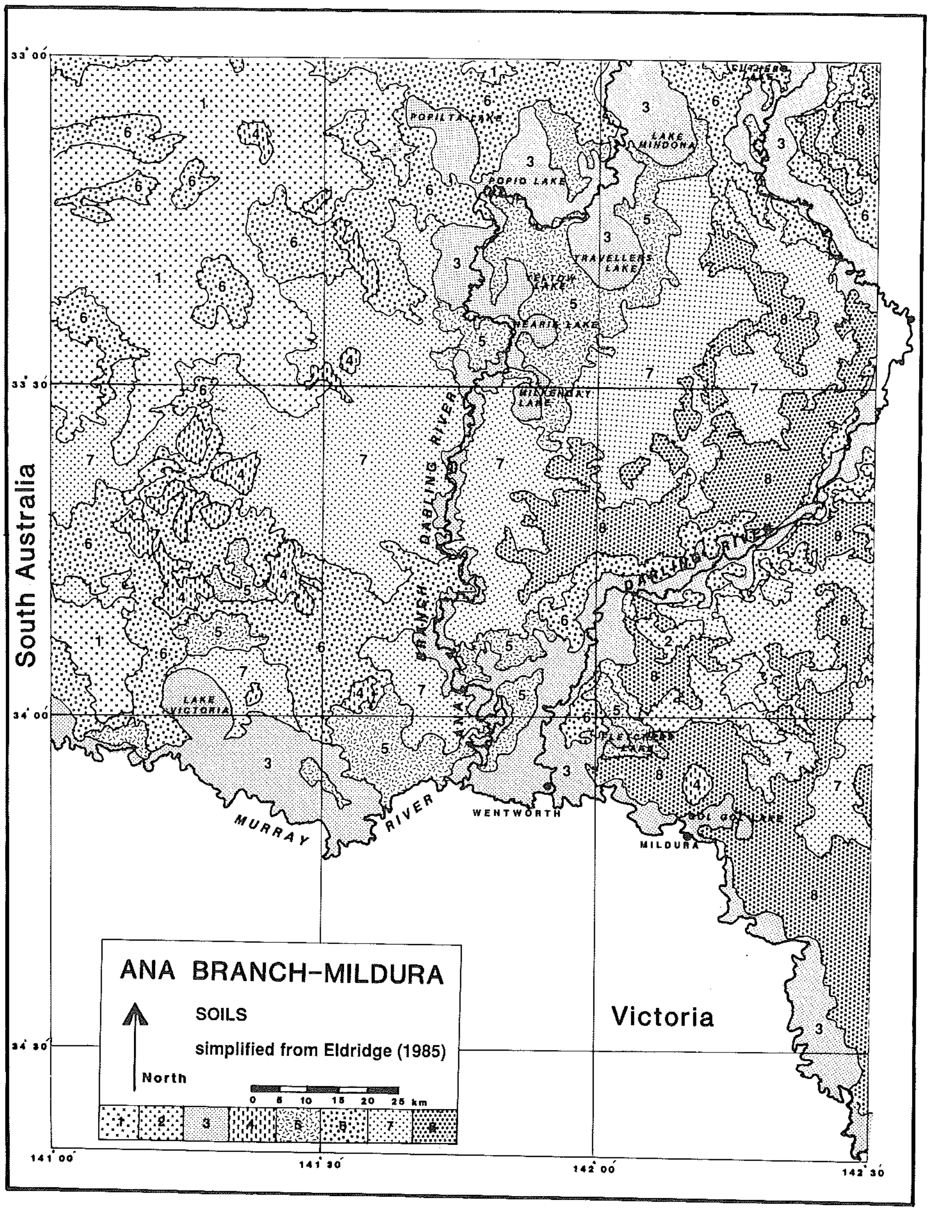

Figure 4. The soils of the mapped area based on maps in Eldridge (1985). **1.** Calcareous sand, dunefield. **2.** Siliceous sand, sub-parabolic dunes. **3.** Grey cracking clays. **4.** Saline and gypseous clays. **5.** Red duplex soil. **6.** Brown calcareous earths. **7.** Grey-brown calcareous earths. **8.** Brown sand/calcareous earths on aligned dunes.

289 mm) and diminishes gradually to the north (Cuthero 247 mm, Broken Hill 249 mm and Menindee 237 mm). Figure 5 shows the long-term (all available records) pattern of rainfall distribution for seven stations on or close to the mapped area. Whereas they all have long-term averages of 200–300 mm, they have received a variable annual amount of rain from less than 100 mm to more than 450 mm, in exceptional years with over 700 mm. This variability in annual rainfall is illustrated in Figure 6 for two of these stations. The long-term average is shown as a dashed line

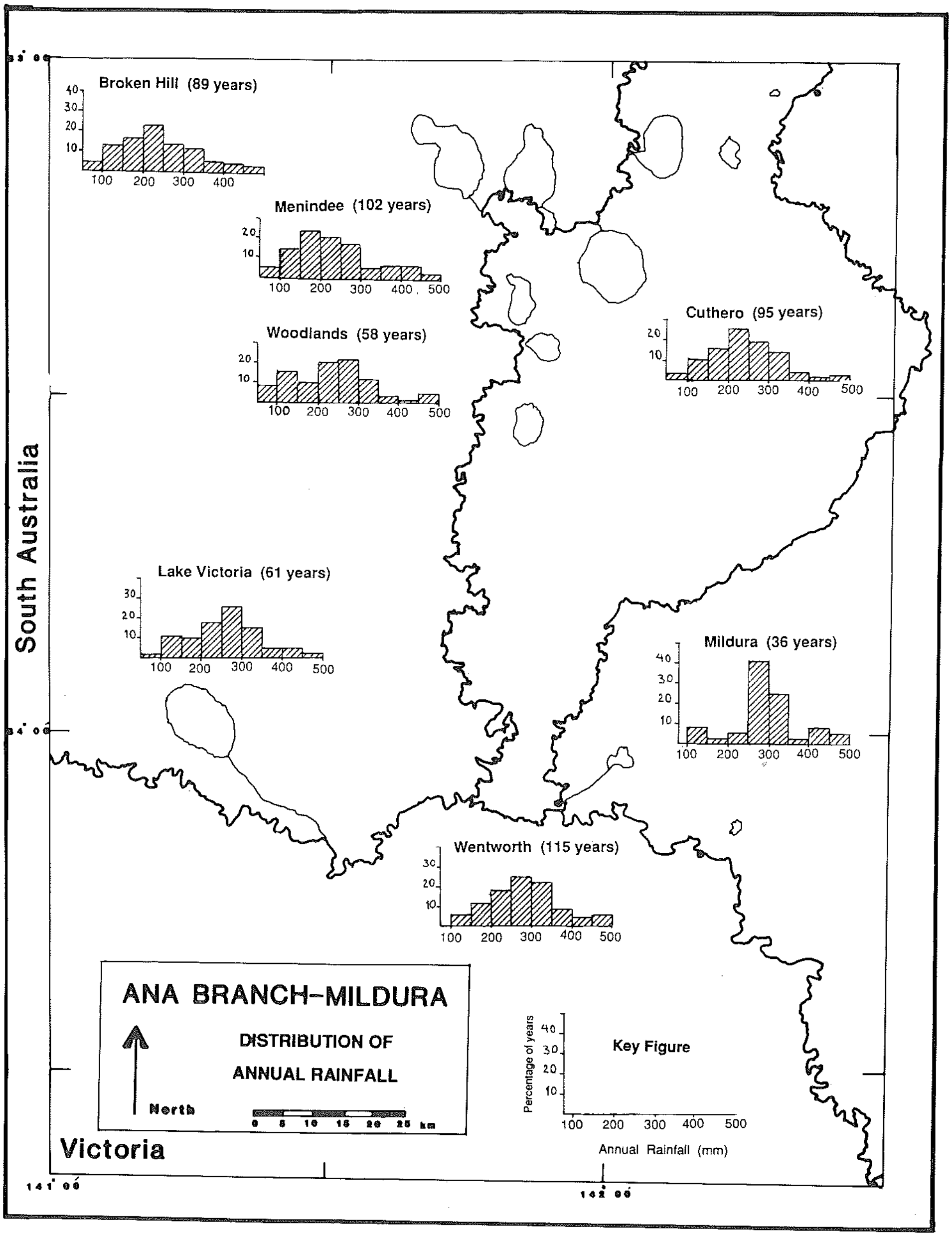

Figure 5. The long-term distribution of rainfall for seven stations on or close to the mapped area (all available data from Bureau of Meterology).

and the yearly values are illustrated. Years of high rainfall such as 1974 are exceptional and may be twice or three times the average annual value.

Figure 7 illustrates the climatograms for five stations on or near the map sheet. Climatograms are designed to show the seasonal fluctuation in water availability (e.g. Walter & Lieth 1967). The average temperature is plotted on the left hand axis and the monthly rainfall on the right hand axis. The stippled portions of the figure

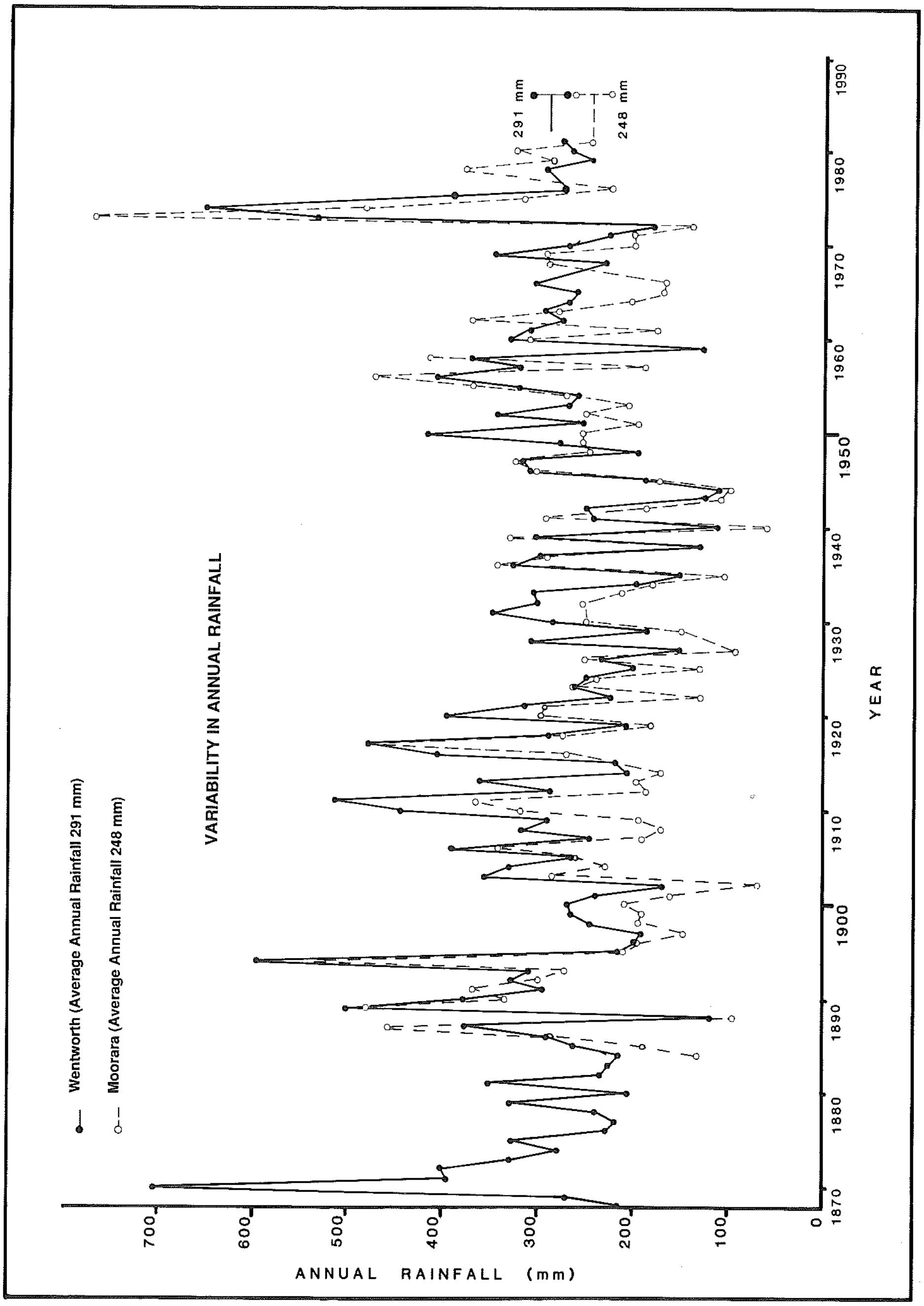

Figure 6. Long-term rainfall record for two stations on the mapped area illustrate the high year-to-year variability.

represent the time of high temperature (and therefore high evaporation) and low rainfall when vegetation would experience moisture deficits. The vertical hatched portion is the winter period when rainfall (especially in the south) is adequate and temperatures are low. All stations may receive rainfall in any month but there is a winter influence in the south which becomes stronger towards Adelaide in the true 'Mediterranean' climatic regions of southern Australia.

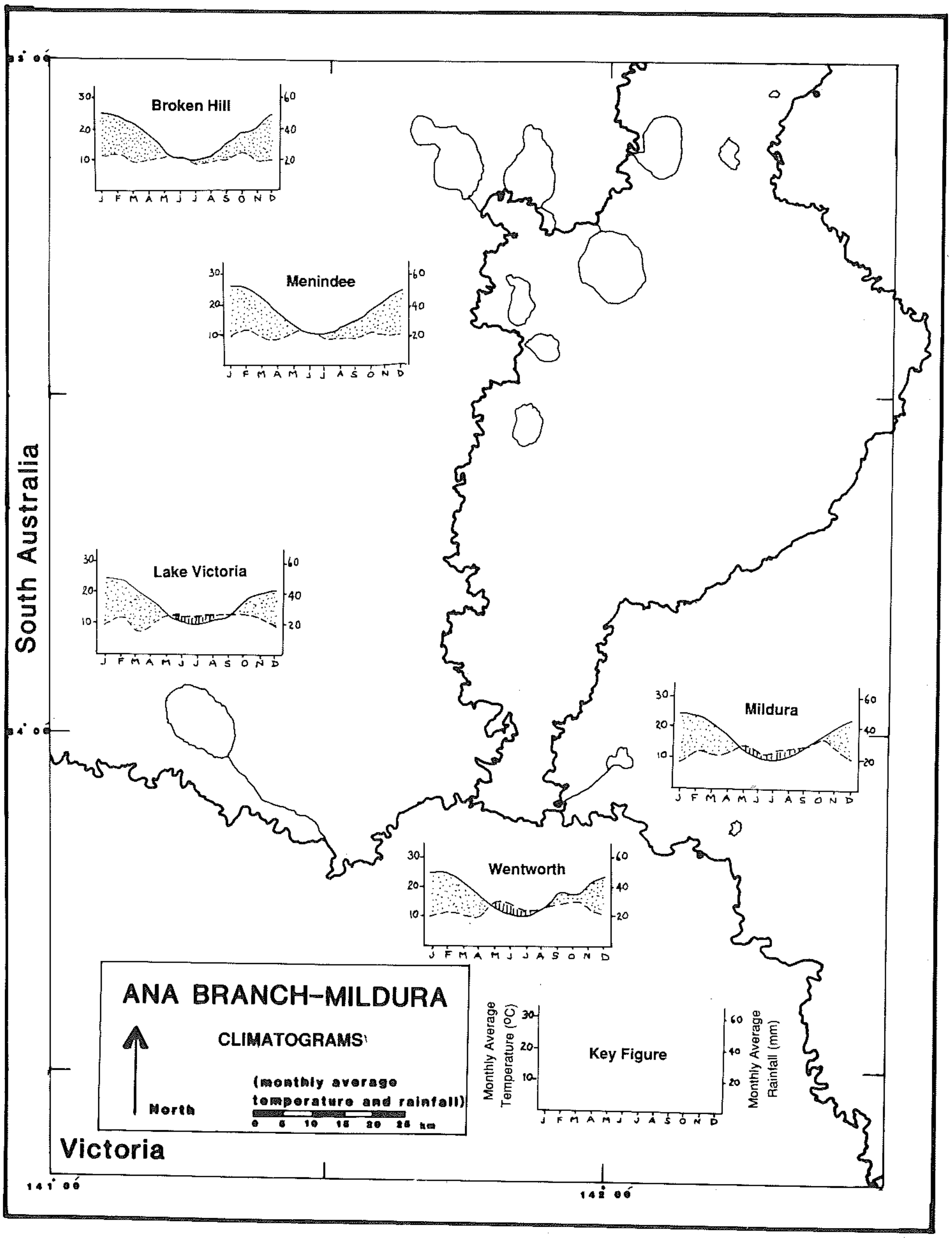

Figure 7. Climatograms for five of the weather stations on or near the mapped area. The figures plot monthly average temperature and rainfall and demonstrate the relatively wet winters in the south of the mapped area.

The region experiences high summer temperatures and high incident radiation, resulting in high evaporation. Winter temperatures do go below freezing point at night and frosts may occur on 10% of winter nights. Effective rainfall occurs in the winter months but absolute amount and distribution varies from year to year.

Vegetation

The natural vegetation of the mapped area has received some treatment in the scientific literature. Cambage (1914) presented an early treatment of the flora of the west Darling country. Beadle (1948) prepared a comprehensive account of the whole of the Western Division which includes this mapped area. He also produced the only published vegetation map of the Western Division (Beadle 1945). A section of his map is reproduced in Figure 8. Two principal vegetation types predominate, and both are associated with the linear dunefield and sub-parabolic dunes. These are mallee (Unit 1, Figure 8) and *Casuarina* woodland (Unit 2). Along the river alluvium is the third unit, a *Eucalyptus* woodland. Shrublands dominated by members of the Chenopodiaceae occur on the sandplain and high level alluvium (Figure 3). These comprise one association of species of *Maireana* (Unit 4) and one of *Atriplex vesicaria* (Unit 5). This is an over-simplification of the range of vegetation types present but serves to illustrate the basic simplicity of the system. Just as there are relatively few geomorphological units, there are relatively few vegetation types. The vegetation comprises structurally simple, low woodlands or shrublands; the only tall forest vegetation is a narrow band of riverine *Eucalyptus* forest along the rivers and associated channels.

Aboriginal history

Four tribal groups occupied country covered by the Ana Branch – Mildura map. These were the Wilyali from the far northwest of the area, the Bolali from west of the Anabranch, and further south, the Yu-Yu from near Lake Victoria. To the north of Pooncarie were the Bagundji (Moore 1979). The Bagundji's territory extended along much of the course of the Darling river and to the west of it (Allen 1979). Allen lists the following tribes as belonging to this tribal group: Bagundji, Barindji, Danggali, Bolali, Wilyagali, Bandjigali, Wanywalgu and Baruńdji. (Some of these are alternative spellings for the tribes listed by Moore 1979.) These all belonged to the Wiradhuri nation (Moore 1979). This group of tribes occupied the basins of the Murray, Murrumbidgee and Lachlan rivers.

The Darling River region supported a large Aboriginal population. The river and plains offered abundant resources and Aboriginal groups were larger and less nomadic than those in higher rainfall areas further east (Allen 1979). Aboriginal use of native plants is only partially known, but the use of the rhizomes of *Typha* spp. is well documented, as is the harvesting and preparation of seed from Native Millet, *Panicum decompositum* (Allen 1979). Seeds of Pigweed, *Portulaca* sp., and the sporocarps of Nardoo, *Marsilea drummondii*, were also used. During winter the seeds of Saltbush (*Atriplex* spp.), Wattles (*Acacia* spp.) and Flax plants (*Linum marginale*) were eaten (Cribb & Cribb 1974). Allen (1979) lists 24 plants eaten by the Aborigines of the Darling Basin.

The main evidence of pre-European Aboriginal activities are the 'canoe' trees, usually River Red Gum, *Eucalyptus camaldulensis*, but also Black Box, *E. largiflorens*. These trees are scarred by the removal of large ovals of bark and sapwood for the manufacture of small canoes and coolamons for carrying babies or food. Since there are no rock outcrops in the mapped area there are few rock-associated artefacts, although imported stone tools have been found.

Creamer (1979) maps two massacre sites close to and just east of Lake Victoria. Burial mounds may have occurred but have been obliterated over time. Oxley excavated several mounds near the Lachlan River in 1820. These were sometimes surrounded by decorated trees.

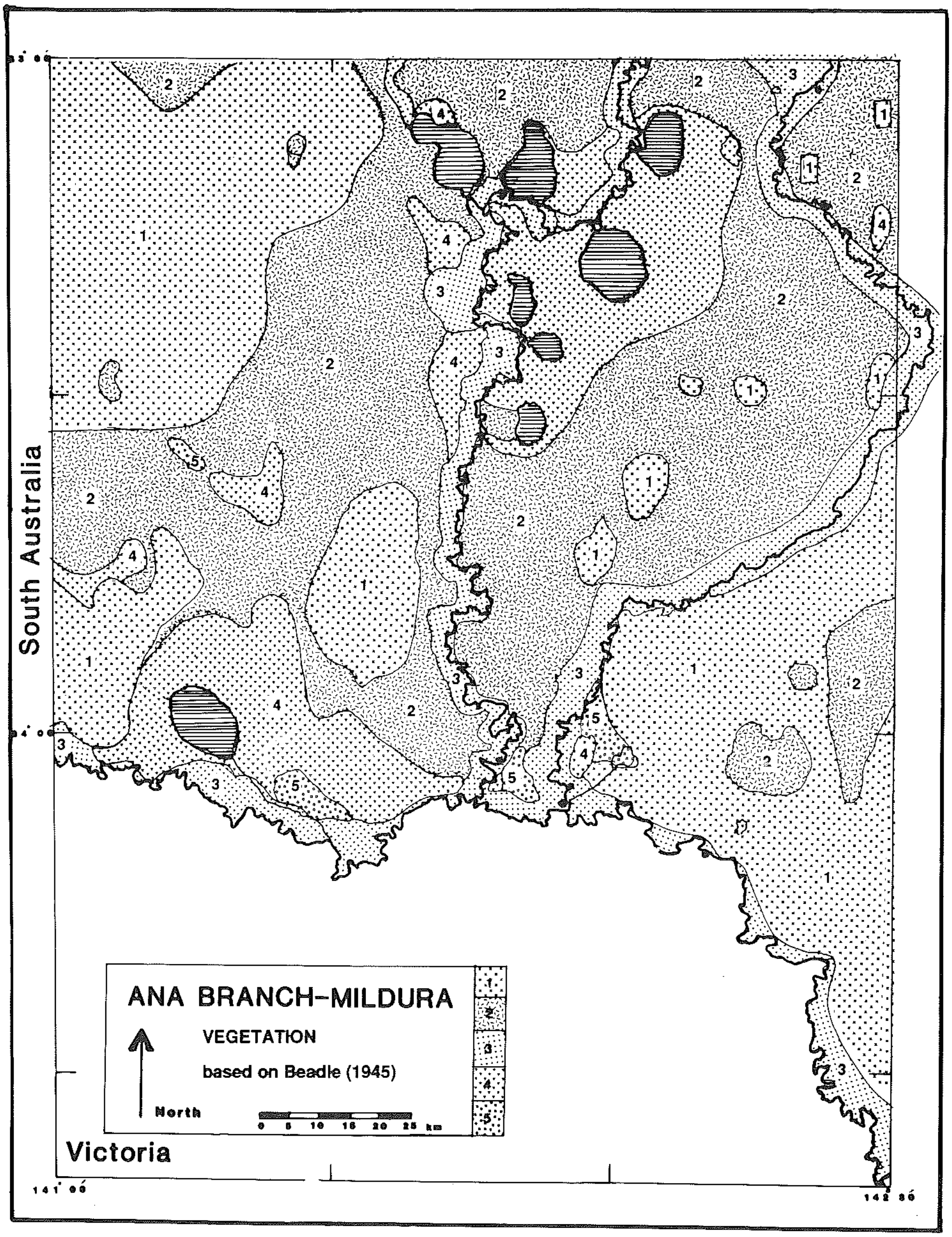

Figure 8. The vegetation of the mapped area based on a map by Beadle (1945). **1.** *Eucalyptus socialis – E. dumosa* association. **2.** *Casuarina–Alectryon* association. **3.** *E. largiflorens* association. **4.** *Maireana pyramidata – M. sedifolia* association. **5.** *Atriplex vesicaria* association.

Within the mapped area there is a very significant archaeological site in the lunette of Lake Victoria (Marshall 1973). Two other sites are located just north of the mapped area in the lunette of Lake Tandou and Lake Menindee. Here fossils of extinct Pleistocene animals such as *Diprotodon*, *Protemnodon*, *Sthenurus* and *Procoptodon* have been found (Merrilees 1973). To the east are the famous sites associated with the Willandra lakes. The best-dated faunal material from the late Pleistocene of semi-arid Australia has been derived from lunettes in western New South Wales (Hope 1982).

European settlement

The history of European occupation of the Far Western Plains of New South Wales began with the exploration along the river courses by British explorers. Captain Charles Sturt explored along the length of the Murray River in 1828 and 1830. Sturt reached the Darling in 1829 and named it in honour of Governor Ralph Darling, although the river had been crossed in its upper reaches by Allan Cunningham in 1827. Major Thomas Mitchell explored the northern half of the Darling in 1835 and later confirmed Sturt's assertion that it joined the Murray.

Pastoral settlement spread slowly west from Sydney and northwards from the more fertile areas of Victoria. The whole of the mapped area falls within the 1858 Police District of Balranald (Robinson 1976) which was subdivided by 1865 to a number of smaller districts of which Wentworth covers most of the mapped area. An indication of the rate of settlement comes from the wheat harvests for each Police District. The figures for Balranald are nil (1861), 7 acres (1866), 14 acres (1871), nil (1876) and 385 acres (1879). No acreage is given for Wentworth during this period. The land had largely been settled by 1860 and the principal pursuit was, and still is, running sheep. In the 1870s seasonal conditions were good and there was a rapid increase in sheep numbers. By 1877–1891 stock numbers had increased to two to three times those of today. A prolonged drought that ended in 1902 saw numbers crash to half of present levels. A Royal Commission was held into the western leasehold pastoral lands in 1901. It found that the low rainfall, extensive rabbit infestation, overstocking and subsequent erosion combined with high rentals, low wool prices, property depreciation and financing difficulties were all factors contributing to the plight of Crown Tenants in the Western Division. The Western Lands Act of 1901 arose from the recommendations of the Commission. An overview of the history of pastoralism is given in Condon (1983).

In an area with low and unpredictable rainfall the land away from the rivers could only be used in periods of good rain until the introduction of well sinking and tank formation in the late 1860s. Until the introduction of windmills, water was pumped by people or horsepower (Condon 1976). Quite early in the history of settlement there were ambitious schemes to irrigate the land away from the rivers and the Chaffey brothers introduced irrigation schemes at Mildura and Renmark in the 1880s.

Previous vegetation surveys

There have been a number of previous vegetation surveys covering part or whole of the mapped area beginning with Cambage (1914). In 1923 Albert Morris, famed for his revegetation of the environs of Broken Hill, published an account of the flora between the Darling River and Broken Hill (Morris 1923); this relates mainly to the vegetation to the north of the map sheet but is relevant to the region. Also in 1923, Marjorie Collins published the first of a series of papers on the vegetation of arid and semi-arid New South Wales (Collins 1923). Again this paper, on the vegetation of the Barrier District, deals with a region largely north of that treated here.

The most comprehensive treatise on the vegetation of western New South Wales is 'The Vegetation and Pastures of Western New South Wales' (Beadle 1948) with an accompanying coloured vegetation map at a scale of 1" = 16 miles (c. 1:1 000 000)(Beadle 1945). More recently, Beadle (1981) includes chapters that describe the vegetation communities of the west in his book on the vegetation of Australia. Other general accounts of major vegetation types are chapters by Johnson & Burrows (Acacia communities), Parsons (mallee) and Leigh (chenopod shrublands), in Groves (1981). Noble & Mulham (1980) summarise the features of the mallee communities. A more quantitative account of the vegetation of the semi-arid region of south-eastern Australia was published by Noy-Meir (1971) and an unpublished vegetation map (1:1 000 000) was produced by the same author in the course of his work (Noy-Meir 1981).

To the east of the map sheet lies Mallee Cliffs National Park and a recent publication has mapped its vegetation and described the communities (Morcom & Westbrook 1990). Further south of the mapped area, in north-western Victoria, Connor (1966) reported on the vegetation of the Beulah–Hopetoun area in a series on the vegetation of the north-west of Victoria. Also in northwestern Victoria, Gullan (1991) describes the practicalities of floristic mapping in the Victorian mallee, the region due south of the Ana Branch – Mildura map.

The flora of the region

Several published species lists cover the map area. Semple (1985) lists the vascular plants of the mallee communities of south-western New South Wales. Semple (1986) lists the vascular plant species for the riverine plain, many of which occur on the alluvial landforms of the mapped area.

The book 'Plants of Western New South Wales' (Cunningham, Mulham, Milthorpe & Leigh 1981) includes an account of the vegetation of the region as well as photographs and notes on the flora of the area. The book describes 2027 species of vascular plants, including 19 species of ferns. These species represent 635 genera from 129 families. The most abundant families are the Poaceae (297 species), Asteraceae (265 species), Chenopodiaceae (146 species), Faboideae (137 species) and Mimosoideae (80 species). The authors also describe 407 species which are established in natural communities but are not native to Australia. This compilation is for the whole of the Western Division which cover four botanical subdivisions (see map at back of issue), viz the North Western Plains (NWP), South Western Plains (SWP), North Far Western Plains (NFWP) and South Far Western Plains (SFWP). The Ana Branch – Mildura map sheet falls within the last of these. Table 1 lists the total number of species in six broad categories for the four botanical subdivisions.

There are a number of interesting features in the tallies shown in Table 1. In each division the northern subdivision is richer in all groups than is its southern counterpart, except for conifers, which are richer in the south. The other gross pattern is the greater richness of the Western Plains compared with the more arid Far Western Plains. There are also proportionally more monocotyledons to dicotyledons in the Western Plains subdivisions (0.33 N and 0.30 S) than in the Far Western Plains (0.22 N and 0.16 S). This is largely influenced by the grasses of which there are 215 species in the Western Plains and only 121 in the Far Western Plains.

Some families are better represented in the Far Western Plains. For instance the chenopods (Chenopodiaceae) number 104 species in the Western Plains and 134 species in the Far Western Plains. Other families such as the Fabaceae or other groups such as Mimosoideae (Fabaceae) have over twice as many species on the Western Plains (84 species) as on the Far Western Plains (37 species). Some families are almost

Table 1. The number of plant species in broad taxonomic categories for the four Botanical Subdivisions in western New South Wales (numbers based on Jacobs & Pickard 1981, ferns from Cunningham et al. 1981).

Plant group	**Botanical sub-division**				**Total all Western Plains**
	NFWP	**SFWP**	**NWP**	**SWP**	
Cycads	0	0	1	0	1
Conifers	2	3	3	4	4
Monocotyledons	154	80	306	217	405
Dicotyledons	710	512	936	727	1370
Exotic monocots	37	(37)	108	(108)	117
Exotic dicots	134	(134)	284	(284)	310
Total native species (excluding ferns)	866	595	1246	948	1775
Total exotic spp.					427
Total ferns (Cunningham et al. 1981)					19
Total vascular plant species					**2226**

equally abundant in the two divisions, especially when the larger area of the Western Plains is taken into account. The Asteraceae are represented by 182 species in the Western Plains and 150 species in the Far Western Plains. The subdivision in which the map sheet falls has a total of 595 species recorded in Jacobs & Pickard (1981).

Structural vegetation types

Vegetation types are described by structural attributes, principally height of the tallest stratum and percent foliage cover (Specht 1981). The floristic associations are then used to further distinguish the vegetation unit. Table 2 lists the structural formations and floristic alliances represented in south-western New South Wales (from Specht et al. 1974). The height range and foliage cover range for each alliance are given.

Methods

Vegetation mapping

Initial air photo interpretation employed composite photomosaics (1:50 000) based on 1964–65 aerial photos (NSW Department of Lands). Different photopatterns were recognised and marked directly on the mosaics. These were then traced onto film and reduced to the provisional mapping scale of 1:100 000. These boundaries were transferred to topographic maps at the same scale. These topographic maps are particularly useful, showing most station tracks and locations of dams and bores accurately. By comparison with the only published vegetation map of the region (Beadle 1945) tentative names were assigned to the photopatterns and then confirmed or reassigned after field inspection. Because of the scale of vegetation patterns in the mapped region and the flatness of the terrain, it was considered inappropriate to use stereoscopic pairs of air photographs.

Table 2. Structural formations and floristic alliances represented in south-western New South Wales (from Specht et al. 1974). The height range (m) and foliage cover range (%) for each alliance are given.

Structural formation	Floristic alliance	Height. (m)	Cover (%)
Open-forest			
Swamp sclerophyll forest	*Eucalyptus camaldulensis*	10–30	30–70
Woodland			
Savannah woodland	*Eucalyptus largiflorens*	10–30	10–30
Low open-forest			
Mallee	*Eucalyptus socialis – E. dumosa*	5–10	30–70
Low woodland			
Fringing woodland	*Eucalyptus camaldulensis*	5–10	10–30
Fringing woodland	*E. largiflorens*	5–10	10–30
Low open woodland			
Fringing woodland	*Eucalyptus largiflorens*	5–10	<10
Closed shrub			
Lignum swamp	*Muehlenbeckia cunninghamii*	2–8	70–100
Open shrub			
Mallee	*Eucalyptus socialis – E. dumosa*	2–8	30–70
Arid shrubland	*Casuarina pauper – Alectryon oleifolius*	2–8	30–70
Tall shrubland			
Mallee	*Eucalyptus socialis – E. dumosa*	2–8	10–30
Arid shrubland	*Casuarina pauper – Alectryon oleifolius*	2–8	10–30
Open heath			
Saltbush	*Atriplex vesicaria*	0–2	30–70
	Maireana spp.	0–2	30–70
	Chenopodium nitrariaceum – Eremophila maculata	0–2	30–70
	Atriplex inflata	0–2	30–70
Low shrubland			
Saltbush	*Atriplex vesicaria*	0–2	10–30
	Maireana spp	0–2	10–30
	Chenopodium nitrariaceum – Eremophila maculata	0–2	10–30
	Atriplex inflata	0–2	10–30
Saltpan	*Sclerostegia tenuis – Minuria cunninghamia*	0–2	10–30
Low open-shrubland			
Saltbush	*Atriplex vesicaria*	0–2	<10
	Maireana spp.	0–2	<10
Herbfield/grassland			
Canegrass swamp	*Eragrostis australasica*	0–2	30–70
Sedgeland			
Swamp	*Azolla* sp.	0–2	30–70
Saltpan	*Sclerostegia tenuis*	0–2	30–70
Arid herbfield	Ephemerals	0–2	30–70
Open sedgeland			
Saltpan	*Sclerostegia tenuis*	0–2	10–30

Survey techniques

Field surveys were conducted over a period from late 1979 to 1989 in a variety of seasons. Figure 9 shows the principal field traverses along roads and station tracks. As well as these, excursions were made on foot to areas that were difficult to reach by vehicle.

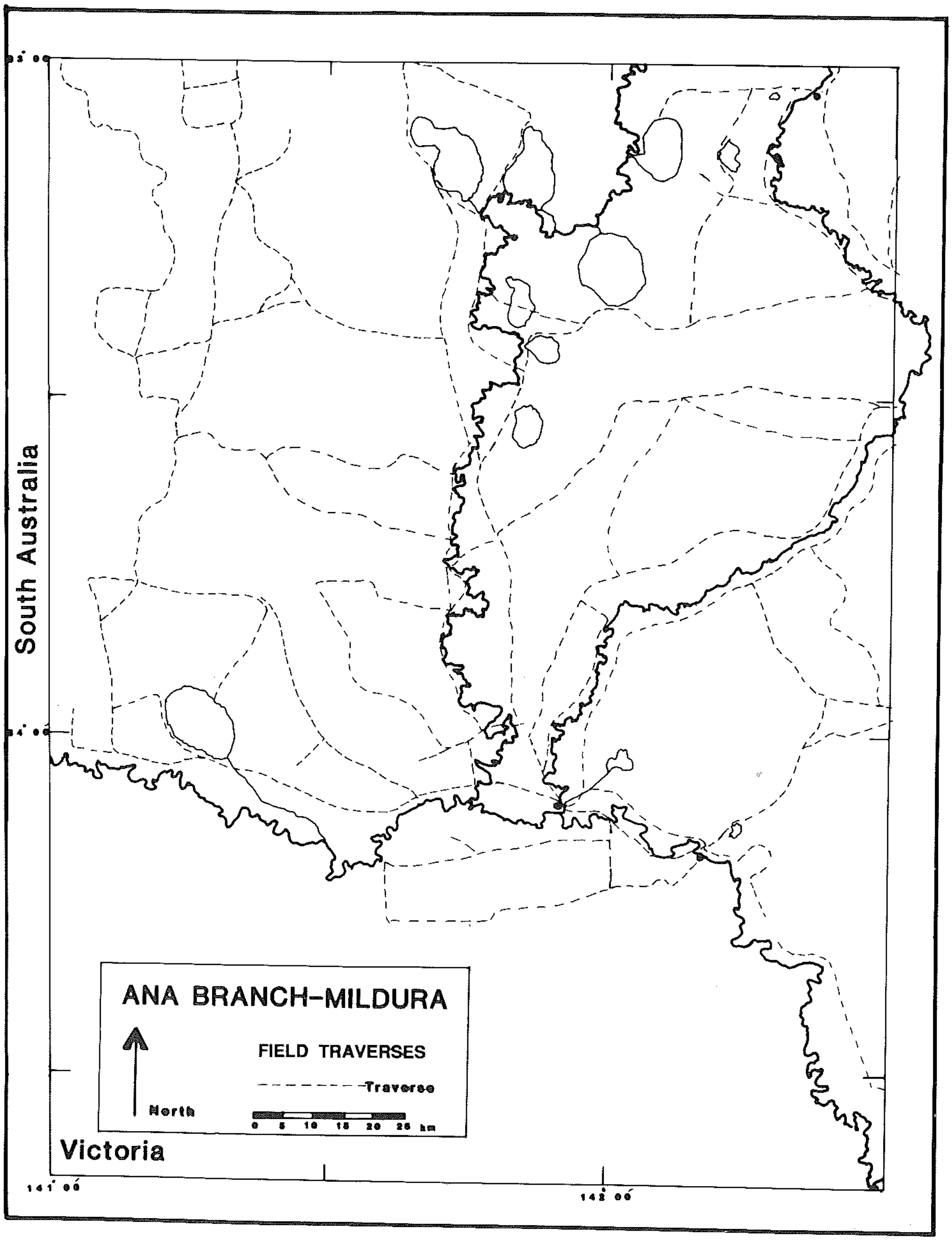

Figure 9. Location of major field traverses completed in the vegetation survey of the mapped area.

Table 3. Map unit descriptions

No.	Code	Structure	Main species	Dominant plant community
1	eM3F	Open-forest	*Eucalyptus camaldulensis*	Riverine Forest
2	eM2S	Low open woodland	*Eucalyptus largiflorens* *Atriplex nummularia*	Black Box Woodland
3	eS2H	Tall shrubland	*Eucalyptus socialis* *E. dumosa*	Dune Mallee
4	cS2Z	Tall shrubland	*Casuarina pauper* *Alectryon oleifolius* subsp. *canescens*	Arid Shrubland
5	eS2H/ cS2Z	Tall shrubland	Mosaic of 3 with 4	Arid Shrubland
6	cS2Z/ eS2H	Tall shrubland	Mosaic of 4 with 3	Arid Shrubland
7	cS2Z/ eS2H/ kZ2F	Tall shrubland	Mosaic of 4, 3 & 8	Arid Shrubland
8	kZ2F	Low shrubland	*Maireana pyramidata* *Rhagodia spinescens*	Black Bluebush
9	kZ2F	Low shrubland	*Maireana sedifolia* *Erodium* spp.	Bluebush
10	kZ2F	Low shrubland	*Maireana pyramidata* *Atriplex* spp.	Lunette Shrubland
11	kZ1F	Low open-shrubland	*Atriplex vesicaria* *Sclerostegia tenuis*	Bladder Saltbush
12	kZ1F	Low open-shrubland	*Sclerostegia tenuis* *Atriplex* spp.	Pigface-Samphire
13	yG3F	Grassland	*Eragrostis australasica*	Canegrass Swamp
14	gG3F	Sedgeland	*Eleocharis pallens*	Sedge Swamp
15	kF2F	Open herbland	*Disphyma clavellatum* *Sclerostegia tenuis*	Saltpan, Lakebed

Plant communities too small to be shown as separate map units

Code	Structure	Main species	Dominant plant community
eS2H	Tall shrubland	*Eucalyptus oleosa*	Sand Plain Mallee
eS2H	Tall shrubland	*Eucalyptus gracilis*	Swale Mallee
pM2S	Open woodland	*Callitris glaucophylla*	Mixed Woodland
wS3F	Tall shrubland	*Acacia victoriae*	Acacia Shrubland
xS4F	Closed shrubland	*Muehlenbeckia cunninghamii*	Lignum Swamp
kS3F	Tall shrubland	*Atriplex nummularia*	Old Man Saltbush

Map units show original vegetation cover before European settlement, as interpreted from aerial photography and field survey. Present vegetation has been affected by widespread grazing and localised clearing.

After the initial mapping stages, provisional maps (at 1:100 000) were taken into the field and checked. Sites were established in all the map units so as to characterise the vegetation. A set of permanent sites was established in the drought year of 1982 across south-western NSW, some of these were in Kinchega National Park just north of the mapped area. Sites usually comprised a rectangular quadrat 100 m long by 40 m (0.4 ha). This was searched methodically and all identifiable vascular plant species recorded. Specimens were taken for verification and these are lodged in the National Herbarium of NSW. The structure of the vegetation was recorded as the height of the different strata and their respective projected foliage cover. Notes were made on the condition of the vegetation, the soil type, any evidence of fire, grazing, weed infestations, erosion. At a subset of sample points, soil samples were collected from the top 40 cm and analysed by the NSW Department of Agriculture's chemistry laboratory for exchangeable cations, pH and electrical conductivity.

Results

The vegetation types

The principal structural formation is the shrubland, either low open-shrublands dominated by members of the Chenopodiaceae, or tall shrublands dominated by mallee eucalypts and *Casuarina pauper*. The only tall forests are the River Red Gum forests fringing the rivers. Elsewhere on the periodically flooded flats are extensive woodlands of *Eucalyptus largiflorens*. Table 3 provides a concise description of the fifteen units mapped.

The distribution of these map units is shown on the vegetation map (back pocket). The map shows vegetation as it is assumed to have been before European setlement. Map units do not always correspond with single communities. There are vast areas with mixtures of two or more communities which cannot be separated at this mapping scale. The reason for the amount of intermingling is the nature of the landscape with, for example, shallow sand mantling heavier clay alluvium. In such a case there may be linear patches of mallee on the sand and *Casuarina* woodland in deflated areas where the heavier soil is exposed. There are other plant communities whose occurrences are always too small to map at this scale. They are described in the section on Plant Communities.

Map units are coded by the alphanumeric code used by Carnahan (1989). This is a four-character code, with the first three characters for the tallest stratum and the last one for the lower stratum. For example eS2H signifies that the predominant genus in the tallest stratum is *Eucalyptus* (e), the growth form is tall shrub (S) with 10–30% foliage projective cover (2), and the lower stratum is dominated by hummock grasses (H). In other words, this unit is mallee with *Triodia* understorey. The full key and explanation are given on Carnahan (1989).

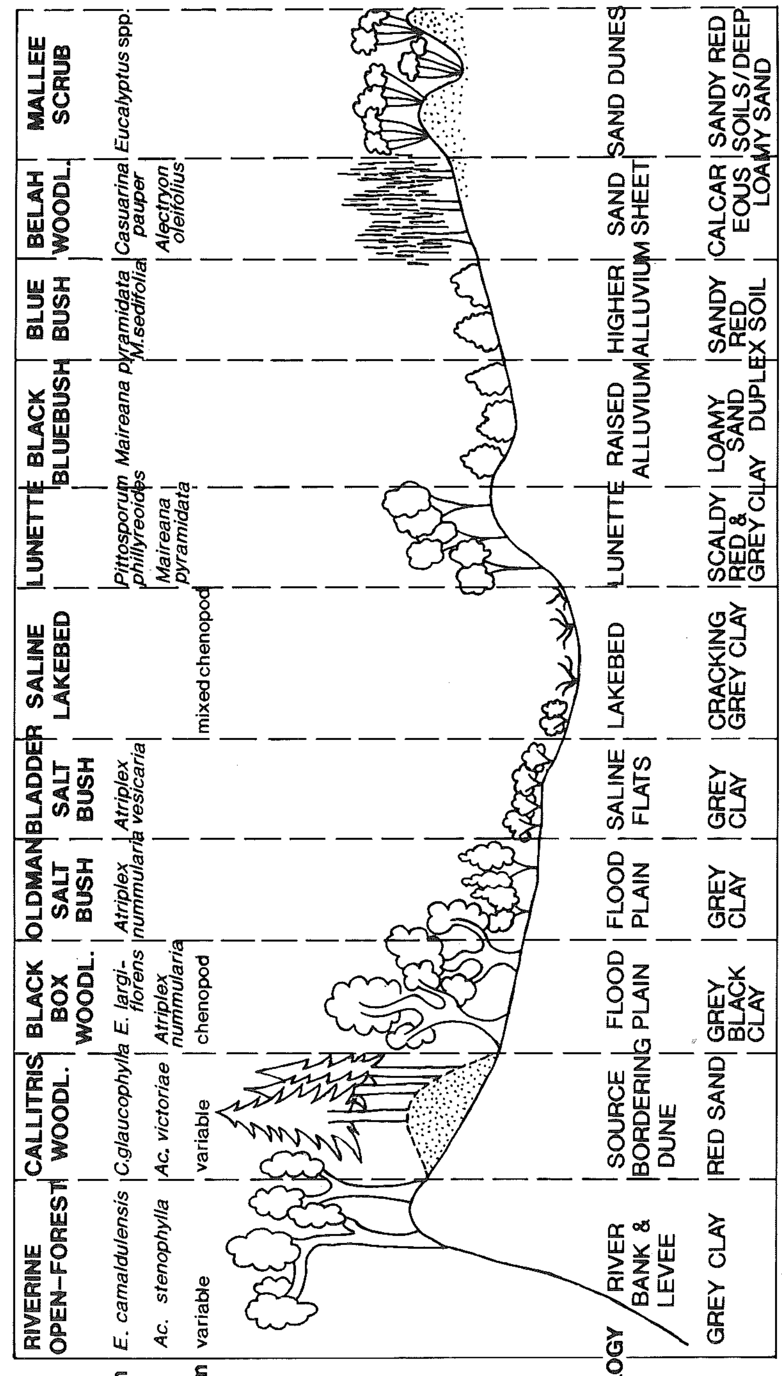

Figure 10. Idealised vegetation continuum from river to sand dunes showing relative topographic arrangement of major vegetation types.

The plant communities

Figure 10 is a highly simplified and stylized profile of the landscape to show the relative occurrences of the plant communities.

1. Riverine Forest, River Red Gum Forest

Map units: 1 (2)
Code: eM3F
Structural formation: Open-forest
Height: 25–40 m
Cover: 30–70%
Dominant species: *Eucalyptus camaldulensis* on levees: *E. largiflorens* on flats and along smaller streams.
Understorey species: *Acacia stenophylla, Chenopodium nitrariaceum, Melaleuca lanceolata.*
Ground layer: Mix of herbaceous species, many exotics
Species richness: (0.1 ha) 23.4 ± 4.1 (n=5)
Landform: River levees and flats between braided streams.
Habitat (photopattern): Often concentric linear photopatterns with oxbows
Soil: Heavy grey alluvium
Degradation/regeneration: Subject to frequent and prolonged flooding, major regeneration occurs as floods subside leading to 'wheatfield' regeneration of extremely dense seedling growth which gradually thin out as plants grow. Very fine stands of Riverine Forest occur along the upper reaches of the Anabranch and along the Murray River. Elsewhere they usually form a narrow band following the major streams. (Figure 11).

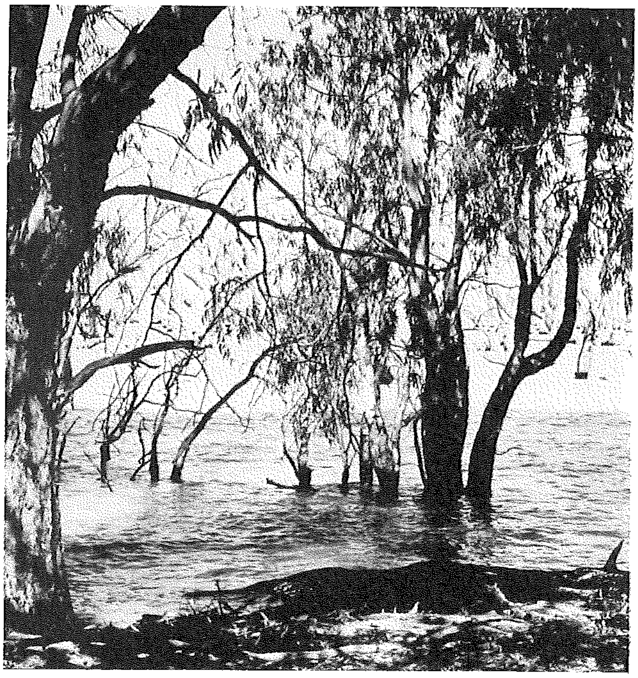

Figure 11. River Red Gum (*E. camaldulensis*) flooded by the Darling River near Pooncarie.

2. Black Box Woodland

Map units: 2 (11, 12, 15)
Code: eM2S
Structural formation: Low open-woodland
Height:10–20 m
Cover: 10–30% (Basal area 0.5 m^2ha^{-1})
Dominant species: *Eucalyptus largiflorens*
Understorey species: *Atriplex nummularia, Chenopodium nitrariaceum.*
Ground layer: *Osteocarpum acropterum* var. *deminutum, Boerhavia diffusa, Chamaesyce drummondii, Scleroblitum atriplicinum*
Species richness: (0.1 ha) 36.6 ± 3.0 (n=7)
Landform: Floodplains beyond major rivers and dry lake margins
Habitat (photopattern): Along creek lines and less dense than Riverine Forest
Soil: Heavy grey clay
Degradation/regeneration: Subject to periodic inundation, major regeneration occurs as floods subside. Most stands contain trees of similar size (age) and may represent past establishment patterns. The Black Box Woodlands are prime grazing country and the understorey is affected by this land use. In particular much of the previously extensive *Atriplex nummularia* stands that formed a shrub layer under and between the Black Box trees have now been lost. (Figure 12).

3. Dune Mallee

Map units: 3 (5, 6, 7)
Code: eS2H
Structural formation: Tall shrubland
Height: 2–10 m (function of time since fire)
Cover: 10–30% (Basal area 5m^2 ha^{-1})
Dominant species: *Eucalyptus socialis, E. costata, E. dumosa*
Understorey species: *Triodia irritans, Beyeria opaca, Podolepis capillaris, Chenopodium curvispicatum, Stipa nitida, Enchylaena tomentosa*
Species richness: (0.1 ha) 25.4 ± 0.8 (n= 5)
Landform: Longitudinal east-west dunes up to 10 m in height
Habitat (photopattern): Forms prominent small-grained photopattern
Soil: Calcareous red sand overlying grey clay
Degradation/regeneration: The dunes may become active with a wind-blown sandy surface if highly disturbed. Whereas the mallee eucalypts can resprout from lignotubers, *Triodia* is killed and new plants germinate soon after fire. Seedling eucalypts were rarely noted. Some areas of mallee have been cleared in the past. (Figure 13).

4. Arid Shrubland, Belah-Rosewood

Map units: 4 (5, 6, 7)
Code: cS2Z
Structural formation: Tall shrubland
Height: 8–12 m
Cover:10–30% (Basal area 2.5 m^2ha^{-1})
Dominant species: *Casuarina pauper, Alectryon oleifolius* subsp. *canescens.*
Understorey species: *Maireana pyramidata, Olearia pimeleoides, Enchylaena tomentosa, Sclerolaena* spp., *Aristida contorta.*

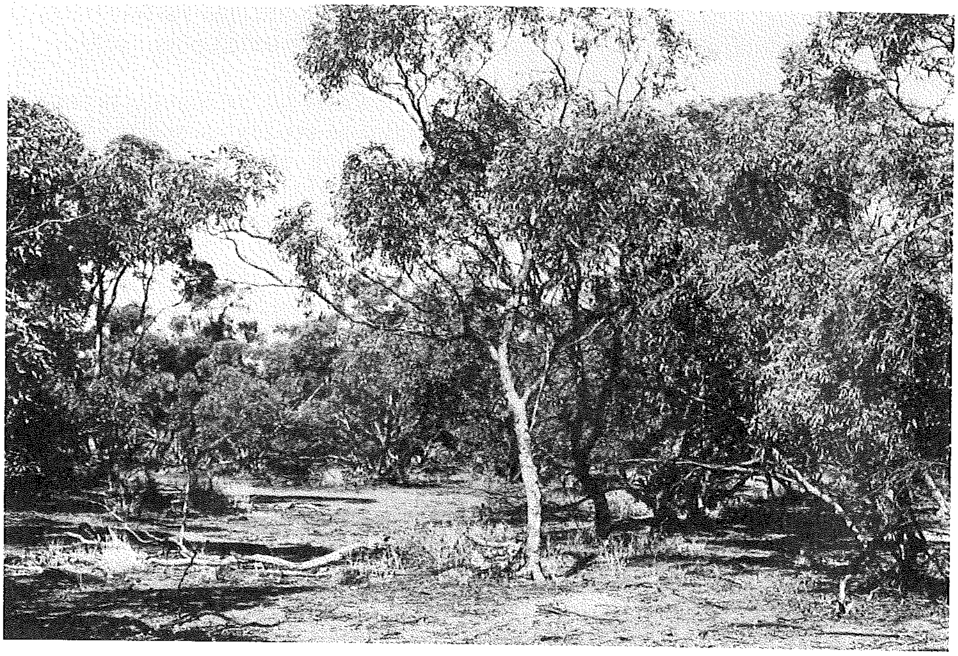

Figure 12. Black Box (*Eucalyptus largiflorens*) Woodland just south of Pooncarie on the Darling River.

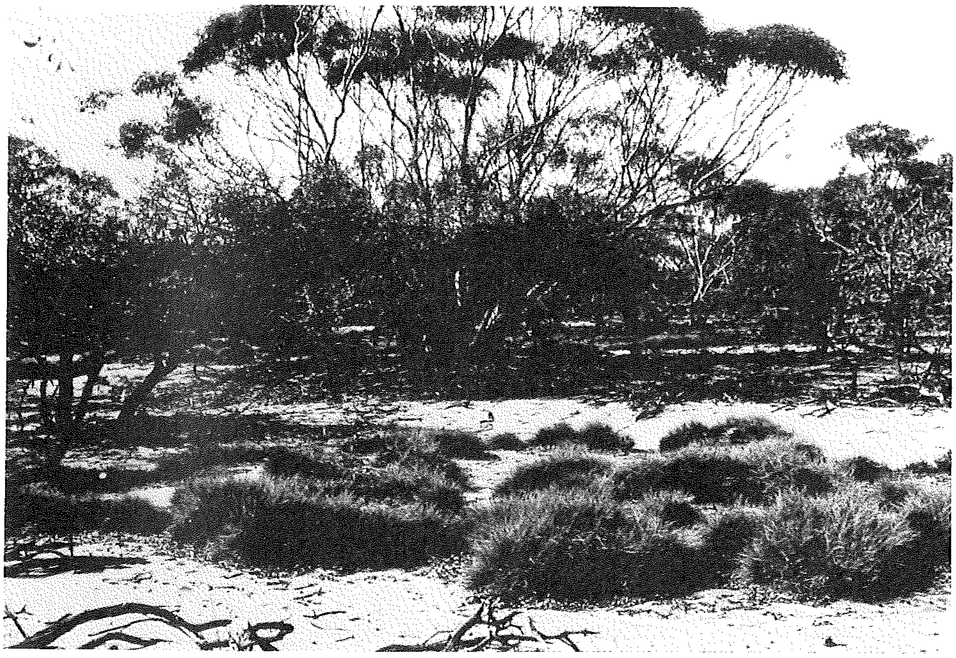

Figure 13. Dune Mallee with *Eucalyptus costata* and *Triodia irritans* on Nagaela homestead west of the Anabranch.

Species richness: (0.1 ha) 39.7 ± 4.6 (n= 6)
Landform: Raised areas of highly calcareous heavy soils with calcrete fragments
Habitat (photopattern): No dunes apparent and uniform mottled photopattern
Soil: Fine red sandy loam with calcrete nodules
Degradation/regeneration: Preferentially cleared because of its slightly better soil and because the dominant species do not resprout as readily as mallee does.The dominant species form clumps and this creates a mosaic pattern. *Alectryon* flowers irregularly and no seedlings were observed. Root suckers develop around parent plants but are highly palatable to sheep and rabbits and are kept grazed down. (Figure 14).

5. Arid Shrubland (mosaic of map unit 3 with 4)

Code: eS2H/cS2Z
Height: 8–12 m
Cover: 10–30%
Dominant species: Mosaic of Dune Mallee (3) with Belah-Rosewood (4)
Habitat (photopattern): At least 70% of the area is dunefield but widely spaced with 4 in swales

6. Arid Shrubland (mosaic of map unit 4 with 3)

Code: cS2Z/eS2H
Height: 8–12 m
Cover: 10–30%
Dominant species: Mosaic of Belah-Rosewood (4) with Dune Mallee (3)
Habitat (photopattern): Finer grained photopattern than 5, predominately 4, may have some dunes with mallee but too small to map

7. Arid Shrubland (mosaic of map units 4, 3 & 8)

Code: cS2Z/eS2H/kZ2F
Height: 8–12 m
Cover: 10–30%
Dominant species: Mosaic of Belah-Rosewood (4) with Dune Mallee (3) and Black Bluebush (8)
Habitat (photopattern): Quite irregular, more patchy than 4 and with occasional open patches (8), each component too small to map separately

8. Black Bluebush

Map units: 8 (9, 10)
Code: kZ2F
Structural formation: Low shrubland
Height: 1–2 m
Cover: 10–30 %
Dominant species: *Maireana pyramidata, Rhagodia spinescens*
Understorey species: *Sclerolaena* spp., *Osteocarpum acropterum* var. *deminutum, Atriplex* spp.
Species richness: 35.4 ± 2.7 (n= 9)

Figure 14. Stand of *Casuarina pauper.*

Figure 15. *Maireana pyramidata* shrubland on 'Nulla' homestead north of Lake Victoria.

Landform: Clay plain
Habitat (photopattern): Some scattered clumps of 4
Soil: Calcareous red loamy sand, red-brown loam, consistently with calcretions in top 40 cm
Degradation/regeneration: Under grazing no regeneration occurs. Sheep browse these perennial shrubs but goats and rabbits are more damaging, often ring-barking the main stems and excavating and eating the roots. Degraded areas may be invaded by *Nitraria billardieri*. (Figure 15).

9. Bluebush, Pearl Bluebush

Map unit: 9
Code: kZ2F
Structural formation: Low shrubland
Height: 1–2 m
Cover: 10–30 %
Dominant species: *Maireana sedifolia*
Understorey species: *Erodium* spp., *Tetragonia tetragonioides, Sclerolaena* spp.
Species richness: (0.1 ha) 24.7 ± 1.1 (n= 5)
Habitat (photopattern): More open than 8, some clumps of 4
Landform: Typically upslope of Black Bluebush on clay plain
Soil: Red sandy loam with nodules of calcrete in the top horizon
Degradation/regeneration: As for Black Bluebush. This shrubland also occurs with a mallee overstorey in restricted areas west of the Anabranch. (Figure 16).

10. Lunette Shrubland

Map unit: 10
Code: kZ2F
Structural formation: Low shrubland
Height: 0.8–2 m
Cover: 10–30 %
Dominant species: *Maireana pyramidata, M. appressa*
Understorey species: *Sclerolaena* spp., *Atriplex* spp.
Species richness: (0.1 ha) No estimate
Habitat (photopattern): Gypseous dunes associated with lakes, including lunettes
Landform: Gypseous dunes associated with lakes, including lunettes
Soil: Saline gypseous clay mantling sand core
Degradation/regeneration: These landforms can erode to create spectacular features such as the Walls of China at Lake Mungo. Such erosion usually follows periods of over-grazing and trampling. Few perennial plants persist on lunettes and no regeneration was observed. (Figure 17).

11. Bladder Saltbush

Map units: 11 (12, 15)
Code: kZ2F
Structural formation: Low shrubland
Height: 0.2–1 m
Cover: 10–30 %

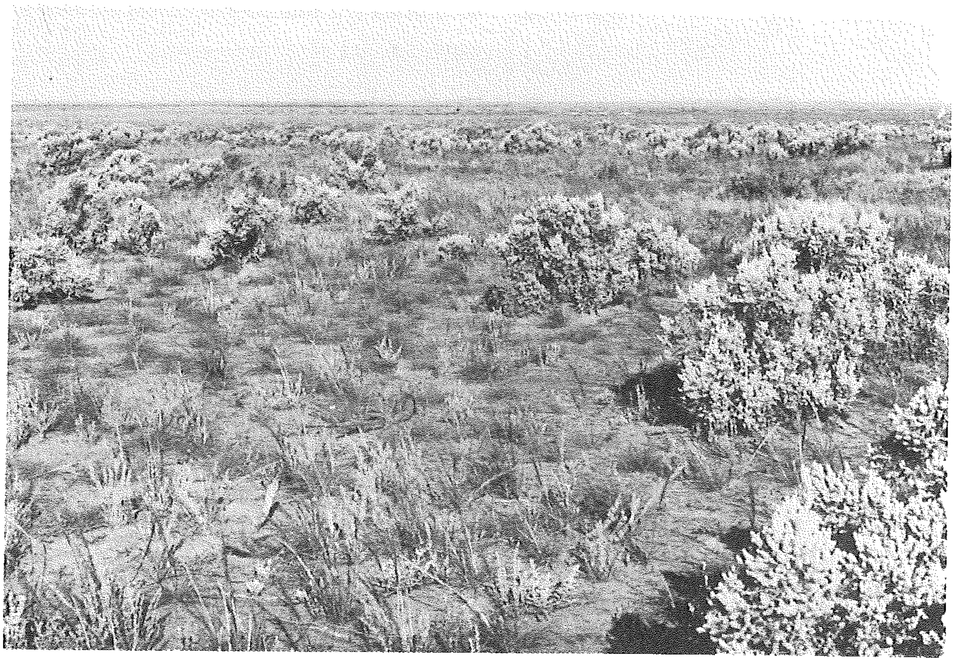

Figure 16. A stand of Bluebush (*Maireana sedifolia*) north-east of Lake Victoria.

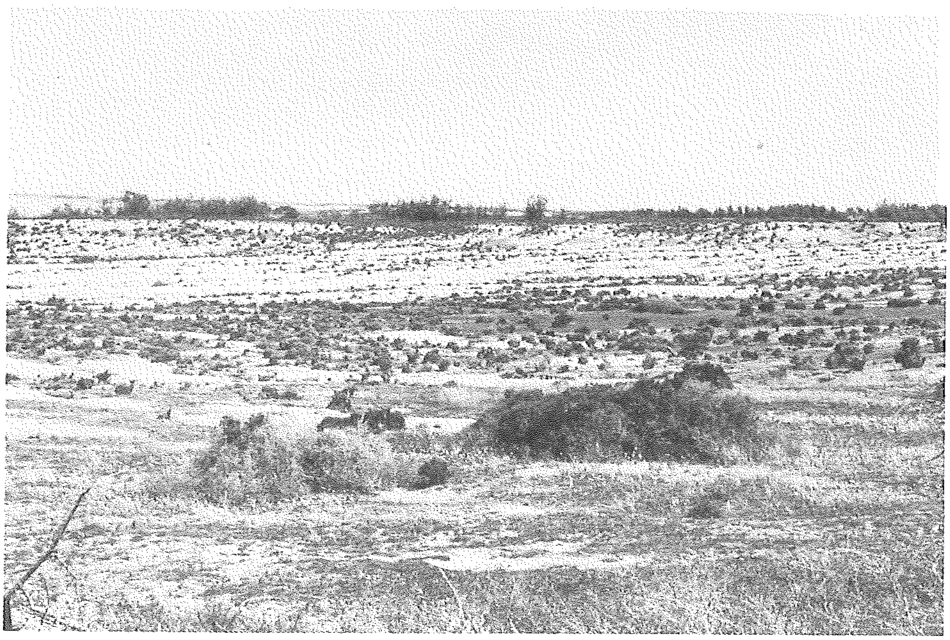

Figure 17. Lunette of Lake Victoria with scattered shrubs of *Maireana pyramidata*.

Dominant species: *Atriplex vesicaria*
Understorey species: *Sclerostegia tenuis, Pachycornia triandra, Osteocarpum acropterum* var. *deminutum, Disphyma clavellatum*
Species Richness: (0.1 ha) 18.1 ± 2.1 (n= 5)
Landform: Lower Alluvium, alluvial plains
Habitat (photopattern): Fine-grained, often with pronounced curvilinear patterns from paleochannels
Soil: Grey-brown clay loam, surface cracked
Degradation/regeneration: Often heavily grazed, affecting the shrub vitality and cover. No seedling regeneration was observed in the study area throughout the survey period. Degraded areas may be invaded by *Nitraria billardieri*. (Figure 18).

12. Pigface – Samphire

Map units: 12 (11, 15)
Code: kZ1F
Structural formation: Low open-shrubland.
Height: 0.1–0.4 m
Cover: <10%
Dominant species: *Disphyma clavellatum, Sclerostegia tenuis* [may have overstorey of *E. largiflorens*]
Understorey species: *Annual Atriplex, Sclerolaena* spp.
Species richness: No estimate
Landform: Saline flats
Habitat (photopattern): Associated with 15
Soil: Pale cream-grey cracking clay
Degradation/regeneration: It is generally considered that *Disphyma clavellatum* is now much reduced in abundance since settlement, due to grazing and trampling (Cunningham et al. 1981). This community may grade into saltpan. (Figure 19).

13. Canegrass Swamp

Map units: 13 (11, 15)
Code: yG3F
Structural formation: Grassland
Height: 1–3 m
Cover: 30–70 %
Dominant species: *Eragrostis australasica, Muehlenbeckia cunninghamii*
Understorey species: Usually absent
Species richness: (0.1 ha) No estimate
Landform: Depressions in clay plain
Habitat (photopattern): With scattered trees of *Eucalyptus largiflorens*
Soil: Grey cracking clay
Degradation/regeneration: Subject to intermittent flooding where water remains several months. May have scattered trees of *Eucalyptus largiflorens*. Important wildlife habitat particularly for nesting waterbirds, although it can also harbour feral pigs.

14. Sedge Swamp

Map unit: 14
Code: gG3F.

Figure 18. *Atriplex vesicaria* stand with *Sclerostegia tenuis* just west of Wentworth.

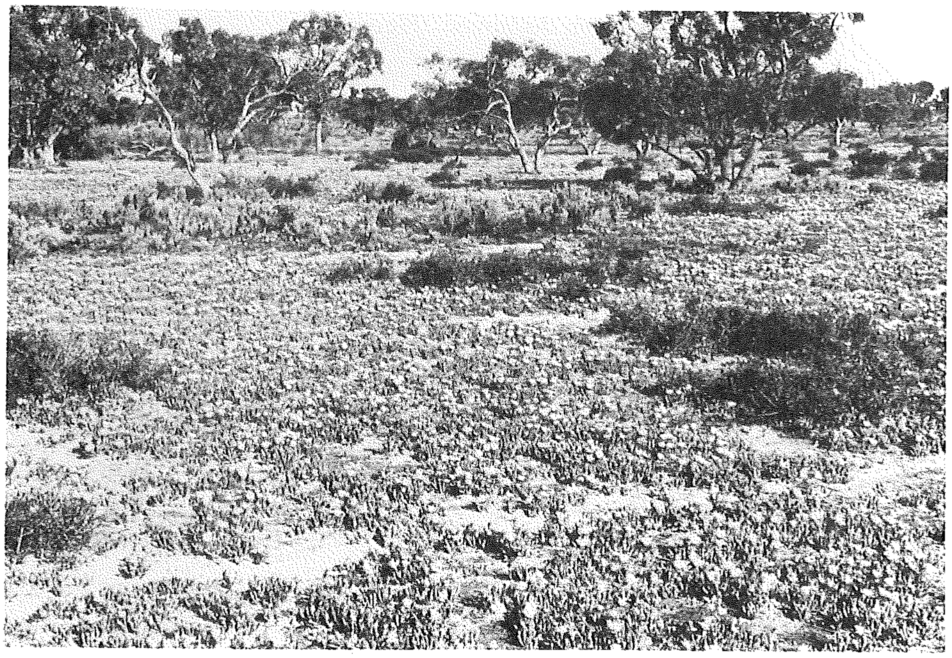

Figure 19. Pigface *Disphyma clavellatum* in flower with scattered plants of Samphire *Sclerostegia tenuis* with Black Box *Eucalyptus largiflorens.*

Structural formation: Sedgeland
Height: 0–0.5 m
Cover: 30–70 %
Dominant species: *Eleocharis pallens*
Understorey species: Usually absent
Species richness: (0.1 ha) No estimate
Landform: Flats or depressions within Riverine Forest, margins of swamps, claypans and lakebeds
Habitat (photopattern): Flats within RiverineForest
Soil: Variety of clay soil.
Degradation/regeneration: Responds quickly to rain and grows throughout the year if water is available. Only is grazed by stock if other more palatable species are unavailable.

15. Saltpan, Lakebed

Map units: 15, Lake
Code: kF2F
Structural formation: Open herbland
Height: 0–0.2 m
Cover: 10–30 %
Dominant species: *Sclerostegia tenuis, Muehlenbeckia cunninghamii, M. horrida* (edges)
Understorey species: *Atriplex leptocarpa, A. pseudocampanulata, Disphyma clavellatum*
Species richness: (0.1 ha) No estimate
Landform: Saltpan or clay flat often areas of groundwater discharge, some lakebeds
Habitat (photopattern): Saltpan or clay flat
Soil: Highly saline gypseous flats, fine-grained clay, large desiccation cracks
Degradation/regeneration: Many of the larger lakes are now cultivated and in such cases, all native vegetation has been destroyed. (Figure 20).

Plant communities too small to be shown as separate map units

Sand Plain Mallee

Map units: 3, 5, 6, 7
Code: eS2H
Structural formation: Tall shrubland
Height: 6–10 m
Cover:10–30 %
Dominant species: *Eucalyptus oleosa, E. socialis, E. gracilis*
Understorey species: *Chenopodium curvispicatum, Ptilotus exaltatus* var. *exaltatus, Olearia muelleri*
Species richness: (0.1 ha) 23.7 ± 1.1 (n= 5)
Landform: Sand plain, sand ridges
Soil: Calcareous sandy red earth, red duplex soil
Degradation/regeneration: More easily cleared than Dune Mallee because of flatter topography and heavier soil. No eucalypt seedling regeneration noted.

Figure 20. Edge of Salt Lake north of Lake Victoria with *Muehlenbeckia horrida* around margin.

Figure 21. Swale mallee with *Eucalyptus gracilis* in flower.

Swale Mallee

Map units: 3, 5, 6, 7
Code: S2H
Structural formation: Tall shrubland
Height: 2–10 m
Cover: 10–30 %
Dominant species: *Eucalyptus gracilis, E. dumosa*
Understorey species: *Enchylaena tomentosa, Dissocarpus paradoxus, Senna artemisioides, Sclerolaena* spp.
Species richness: (0.1 ha) 34.2 ± 1.4 (= 5)
Landform: Swales between sand dunes and deflated sand plains
Soil: Calcareous red sand
Degradation/regeneration: More subject to clearing than the dune mallee. Often the sites for watering points and ground tanks and therefore prone to trampling and over-grazing. (Figure 21).

Mixed Woodland, Callitris Woodland

Map units: 4, 11
Code: pM2S
Structural formation: Open woodland
Height: 8–12 m
Cover: 10–30 %
Dominant species: *Callitris glaucophylla, Hakea leucoptera, Hakea tephrosperma, Myoporum platycarpum*
Understorey species: *Maireana pyramidata*
Species richness: no estimate
Landform: Sandy rises adjacent to riverine flats, source-bordering dunes
Soil: Deep loose sandy soil. On sandhills along the Murray and lowermost part of the Darling, Murray Pine, *Callitris preissii* subsp. *murrayensis* occurs and also much *C. preissii–C. glaucophylla* hybridisation (L.A.S. Johnson pers. comm.)
Degradation/regeneration: often cleared for valuable timber trees and only identifiable by the landform and scattered remnant trees. Further east of the mapped area this landform is often cultivated for wheat and other cereal crops. Similar woodland may be found on sandy rises on the western sides of lakes as well, for example west of Popiltah Lake. Such stands are always of small area and cannot be mapped at the scales employed here.

Acacia Shrubland

Map units: 1, 2, 4
Code: wS3F
Structural formation: Tall shrublan
Height: 2–6 m
Cover: 30–70%
Dominant species: *Acacia victoriae, Dodonaea, Acacia oswaldii*
Understorey species: *Sclerolaena* spp., *Maireana* spp.
Species richness: No estimate
Landform: Sandy rises such as source-bordering dunes which extend along rivers and major streams, creek beds and banks in a variety of landforms

Soil: Red sandy soil
Degradation/regeneration: Remnant trees of *Myoporum platycarpum, Hakea leucoptera, Hakea tephrosperma, Callitris glaucophylla* and *Callitris preissii* subsp. *murrayensis* may occur. This may represent highly disturbed areas that previously supported *Callitris* woodland. The dominant species may be mainly the 'woody weeds' which are invasive, colonising, native species.

Lignum Swamp

Map units: 2, 12, 14
Code: xS4F
Structural formation: Closed scrub
Height: 2–8 m
Cover: 70–100 %
Dominant species: *Muehlenbeckia cunninghamii* (*Eucalyptus camaldulensis, E. largiflorens* around edges)
Understorey species: Usually absent
Species richness: (0.1 ha) No estimate
Landform: Depressions with impounded water
Soil: Heavy clay
Degradation/regeneration: Very important wildlife habitat particularly for nesting waterbirds. Regenerates readily under favourable flood conditions. (Figure 23).

Figure 22. Acacia Shrubland on a source-bordering dune on the eastern bank of the Darling River northwest of Pooncarie.

Figure 23. A small Lignum (*Muehlenbeckia cunninghamii*) swamp ringed by River Red Gums (*Eucalyptus camaldulensis*).

Figure 24. Stand of Old Man Saltbush (*Atriplex nummularia*) near the junction of the Darling and Murray rivers.

Old Man Saltbush

Map units: 2
Code: kS3F
Structural formation: Tall shrubland
Height: 1–2 m
Cover: 30–70 %
Dominant species: *Atriplex nummularia, Rhagodia spinescens,* [*Eucalyptus largiflorens*]
Understorey species: *Atriplex* spp., *Sclerolaena* spp.
Species richness: (0.1 ha) No estimate.
Landform: River flat
Soil: Clay soils
Degradation/regeneration: Grades into *Maireana pyramidata* shrubland away from the river. These deeply rooted shrubs can withstand severe drought and also tolerate flooding, but can be decimated by heavy continuous grazing. Only small relict stands remain of what were more extensive stands (Cunningham et al. 1981). (Figure 24).

Floristic composition

Appendix I contains the list of flowering plant species identified from sites or collections on the Ana Branch – Mildura map sheet area. The families are arranged alphabetically within orders, and genera alphabetically within families, and the species alphabetically within genera. An asterisk indicates an exotic species. Authorities are not given and can be found in Harden (1990), Jacobs & Lapinpuro (1986) or Jacobs & Pickard (1981).

Table 4 lists the floristic composition of broad vegetation categories for the mapped area. The table is modified from an earlier table (Fox 1984) which was based on a set of sites on the mapped area. The totals shown in the first column are the original site totals and in brackets the total recorded for all sites and collections for the map sheet. A total of 266 native species and exotic species were recorded for the map sheet area. This is 44% of the total expected for the Far South Western Plains (Table 1). The incidence of exotics, at 11% of the total, is relatively low compared to disturbed sites in the east (see Table 1, Fox & Fox 1986). The total species pool comes from 6o families of vascular plants however, ten families account for 86% of this richness. Principal among these are the Chenopodiaceae (78 species), Asteraceae (51 species) and Poaceae (40 species).

The total species data for the broad vegetation types in Table 4 indicate their relative richness. Mallee is markedly richer than the other types although it does not have proportionally more genera or families represented. Also these totals are composites from several sites. Single site collections for mallee can be quite low, depending on seasonal rainfall.

Table 4. Summary of floristic data from Ana Branch – Mildura map (from Fox 1984), with updated totals shown in the first column in brackets.

	Total		Mallee	Chenopod shrubland	Lakebed	Riverine forest	Casuarina woodland	Acacia shrubland
Species	188	(299)	96	55	44	37	33	30
Exotic	13	(33)	4	5	1	3	3	4
Genera	99	(191)	54	28	31	21	26	21
Spp./gen.	1.9	(1.6)	1.8	2	1.4	1.8	1.3	1.4
Families	37	(60)	27	10	13	10	15	14
Gen./fam.	2.7	(3.2)	2	2.8	2.4	2.1	1.7	1.5
Chenopodiaceae	62	(78, 26.3%)	26%	65.5%	43.2%	67.6%	33.0%	30.0%
Asteraceae	20	(51, 17.2%)	12.5	10.9	11.4	2.7	6.1	6.7
Fabaceae	19	(27, 9.1%)	11.5	5.5	4.6	8.1	12.1	20.0
Poaceae	19	(40, 13.5%)	9.4	9.1	11.4	2.7	12.1	6.7
Myrtaceae	10	(13, 4.4%)	6.3	-	6.8	5.4	-	3.3
Myoporaceae	5	(8, 2.7%)	5.2	-	-	-	3	3.3
Solanaceae	5	(8, 2.7%)	2.1	-	2.3	-	3	3.3
Amaranthaceae	4	(7, 2.4%)	3.1	-	2.3	-	-	-
Zygophyllaceae		(11, 3.7%)	-	-	-	-	-	-
Brassicaceae		(12, 4.0%)						
Sub-total	144	(255, 85.9%)	76.1	91.0	82.0	86.5	69.3	70.0

Modifications to the vegetation

Grazing

It was not within the scope of this study to incorporate a detailed investigation into the impact of grazing on the vegetation of the region. However, with grazing being the principal pastoral activity for much of the mapped area, it would be an oversight not to comment on observed impacts. Clearly there has been a deleterious impact on the vegetation of the region from the millions of both husbanded and feral animals that now graze and browse where once smaller nomadic populations of native grazers and browsers had limited impact. The provision of additional water supplies for the husbanded animals has also led to heightened populations of both feral and native animals through good and dry times. Perhaps most destructive of all has been the sustained high numbers of rabbits throughout the study area. Even in periods of drought, although their numbers are much reduced, foci of reinvasion persist and as soon as the country improves their numbers explode. Rabbits and goats are particularly destructive to native perennial plants because, as well as foliage, they eat bark and roots, commonly leading to the death of the plants.

In Kinchega National Park, north of the mapped area, the New South Wales National Parks and Wildlife Service conducted a long-term investigation of the interactions of kangaroos and sheep (Caughley, Shepherd & Short 1987). Within the National Park, large exclosures were maintained and the biomass and composition of the vegetation monitored. Similar plots were maintained on an adjacent property on Lake Tandou. Robertson (1987) found that in terms of biomass, extreme weather events overshadow the impact of grazing. There was no significant difference in composition between pasture grazed by kangaroos alone and by sheep and kangaroos, however trends may be blurred by the long history of sheep at all sites.

Fire

The usual fire frequency in arid and semi-arid rangelands is every 10 to 15 years (McArthur 1972). However, after years of above-average rainfall, fuel accumulates quickly. There have been several recorded extensive fires in western NSW, all following periods of above-average rainfall. Most of the mapped area showed no evidence of recent fire. East of the Darling there were extensive fires in 1974 but these did not spread west of the river. Recently there have been some experimental fires in the mallee west of the Anabranch of the Darling to promote the long-term survival of the mallee fowl.

Many species of plants in the region are resistant to fire, in that they have the ability to resprout. However, the important grass of much of the mallee country, *Triodia irritans*, is killed by fire and must regenerate from seed in the soil to persist at the site. CSIRO has had a long-term fire research program underway just east of Pooncarie (east of the mapped area) (Noble 1989).

Flooding and drought

Parts of the area, adjacent to the major streams, are subject to flooding from the major rivers. This has a direct impact on the vegetation, particularly on the River Red Gum forests and the Black Box woodlands. Recruitment of both dominant tree species only occurs in the conditions immediately after flooding.

The composition of the annual or short-lived perennial species in the ground layer is largely determined by the amount and seasonal distribution of rainfall (Fox in press). In drought years this stratum of the vegetation may be missing. With the onset of rain, seed stored in the soil germinates and quickly establishes a herbaceous ground layer. The composition of this herb stratum is determined by the duration and amount of rain in the season and the follow-up conditions. Most of the weed species found in the region are herbaceous plants that may dominate the ground stratum in good seasons.

Soil chemistry

Appendix II is modified from Table 2 in Fox (1984), it summarizes the chemical status of soil collected at a range of sites in the south-west of New South Wales, including sites on the Ana Branch – Mildura map sheet area. These give an indication of the regional trend in soil chemistry, related to broad vegetation types. Additional sites sampled subsequently on the map area are included in italics.

There is considerable variation in the chemical composition of all the soils sampled. In particular, the calcium content fluctuates widely. The vegetation types used in Appendix II are arranged in roughly increasing concentration of lime in the soil. Highest calcium content is found in the soil under Black Box, *Eucalyptus largiflorens*, however, it is also the most variable.

The soil pH is generally around neutrality (7.0), the most alkaline soil was that under *Alectryon* shrubland (mean 7.8 ± 0.2), and the most acidic soil was associated with *Callitris* woodland (5.96 ± 0.30).

Conservation of vegetation

As stated in the Introduction, there is only one nature reserve in the mapped area, that is Nearie Lake Nature Reserve, gazetted in 1973 and 4347 ha in area. There is also one national park and it extends onto part of the eastern edge of the Mildura sheet. This is Mallee Cliffs National Park, gazetted in 1977 with extensions in 1978 and 1983 to a total of 57,969 ha. North of the Ana Branch sheet is Kinchega National Park, first gazetted in 1967 with extensions in 1968, 1972, 1974 and1982, and totalling 44,182 ha in area. As a proportion of the mapped area the formal reservations (Nearie Lake and about one eighth of Mallee Cliffs National Park) represent less than 1% of the area. For the whole of the Western Division formal reserves (six national parks, eight nature reserves, two historic sites and one Aboriginal area) total over 760,000 ha. Recent acquisitions will bring the total to 940,000 ha, or almost 3% of the Western Division (Pressey & Nicholls 1991). This indicates the discrepancy between reserves in the north of the Division and the paucity of reserves in the south. East of the mapped area, and within the Western Division, is also Mungo National Park, but all of the other reserves are north of 33°S.

Pressey & Nicholls (1991) have considered the adequacy of the reserve system in north-western NSW. Using land systems maps, they estimated that nearly 6% of their study area (north-western NSW) was needed for at least one representation of each land system. Given that there are unique associations such as the Bladder Saltbrush (*Atriplex vesicaria*) with Samphire (*Sclerostegia tenuis*) found only in south-western NSW, which are currently not represented in the reserve system, there is an urgent need to identify and acquire suitable sites there.

Significant vegetation types

Although very widespread through much alluvial country of southern Australia, the woodlands of *Eucalyptus largiflorens* are of scientific interest because they comprise stands of single species of *Eucalyptus* trees. The usual pattern in most woodlands and forests dominated by eucalypts is for a mixture of at least two, and commonly more, species occurring together.

The mixed woodlands with species of *Callitris*, *Acacia*, *Hakea*, *Myoporum*, etc. that previously occurred on source-bordering dunes and other sandy rises, have been considerably reduced by clearing. In a landscape with very little good timber, these trees were a source of material for fence posts, sheds and houses.

The stands of *Atriplex nummularia* (Old Man Saltbush), either as understorey to *E. largiflorens* woodland or as tall shrublands, are now much reduced from their previous extent. However, some very fine stands occur at the junction of the Darling and the Murray Rivers. Their decline is in part a result of grazing, but also a consequence of a past clearing program because they harbour rabbits. Isolated individual shrubs are testament to their previous wider distribution.

The low shrubland of *Atriplex vesicaria* with *Sclerostegia tenuis* and *Pachycornia triandra* is particularly well developed on the lower alluvium west of Wentworth. It is not represented in any conservation reserve.

Rare species

Table 5 lists the species from the Far South West Plains that are considered rare or endangered (Leigh et al. 1981, Briggs & Leigh 1988). Recently the restricted species of the Western Division have been reexamined (Pressey, Cohn & Porter 1990), and their Category and Priority classes are also given in Table 5.

Table 5. Species of flowering plants, occurring in the Far South Western Plains, and listed as being rare or endangered by Briggs & Leigh (1988). Those in square brackets were listed by Leigh, et al. 1981), the Risk Codes[1] are as follows: **2** maximum geographic range of 100 km, **3** range over 100 km but restricted to highly specific habitats, **X** Presumed extinct, **E** Endangered species in serious risk of disappearing, **V** Vulnerable species, at risk over a longer period; **R** Rare species, not currently considered endangered or vulnerable; **C** Species known to be represented within a National Park or other proclaimed reserve; **a** adequately reserved; **-** adequacy of reservation unknown; and [2] Category and Priority according to Pressey et al. (1990).

Family	Species	Risk Code[1]	Category[2]	Priority[2]
Asteraceae	*Acanthocladium dockeri*	3X	3A(X)	2
Chenopodiaceae	*Atriplex papillata*	[3RC]	3A	3
Eriocaulaceae	*Eriocaulon australasicum*	2VCa		
Fabaceae (Faboideae)	*Swainsona laxa*	3VCa	3A	2
Gyrostemonaceae	*Codonocarpus pyramidalis*	3RC-	3A(X)	2
Fabaceae (Mimosoideae)	*Acacia carnei*	3RC-	3A	2
	Acacia rivalis	[3RC]	3A	3

The Categories recognised by Pressey et al. (1990) combine both the species geographic range and the status of its populations. 3A is 'restricted distribution in the Western Division and also occurring interstate, with small range and/or few records interstate'. (X) is presumed extinct in the Western Division.

Acanthocladium dockeri (Spiny Everlasting) is a small rigid shrub only collected during the last century from sandhills near the lower Darling River, it is probably extinct. *Atriplex papillata* is a prostrate forb. The few collections of this species are from the extreme south-west of the South Western Plains (not FSWP as previously thought) where it occurs around the margins of salt lakes. *Eriocaulon australasicum* (Pipewort) is a small annual forb known only from one collection in 1853 from near Balranald, east of the mapped area. *Swainsona laxa* (Yellow Darling Pea) has been recorded from Menindee, north of the mapped area and from Euston, just east of the mapped area on the Murray River. It has also been collected from Mount Hope in central NSW *Codonocarpus pyramidalis* (Native Poplar) is a tall shrub or small tree. It was collected from the Pooncarie district, just east of the mapped area, earlier this century and has not been recorded since. Both species of *Acacia*, *A. carnei* and *A. rivalis* are from near Broken Hill, to the north of the mapped area.

Conclusions

The far southwest of New South Wales, covered by the Ana Branch – Mildura vegetation map, is an alluvial landscape with relatively few plant communities. Some communities are restricted to either aeolian, fluvial or lacustrine landforms but there is considerable sharing of species. Fifteen map units were recognised but some communities were unmappable because their small areal extent precludes them from representation at this scale.

The vegetation of western New South Wales is relatively poorly conserved in reserves compared with that of the eastern portion of the state, and the southwest is not as well served by vegetation reserves as the north. Of the area mapped less than one percent is in a conservation reserve. This is in spite of several significant vegetation types and the more pervasive need to conserve representative samples of all our vegetation types before they are too degraded by the combined assaults of domestic and feral animals.

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APPENDIX I

Flowering plants recorded from the Ana Branch – Mildura map sheet area. Names are those currently in use by the National Herbarium of New South Wales and authorities are given in Harden (1990), Jacobs & Lapinpuro (1986) or Jacobs & Pickard (1981) except as given in the text.

GYMNOSPERMS

CUPRESSACEAE
Callitris glaucophylla
Callitris preissii subsp. *verrucosa*
Callitris preissii subsp. *murrayensis*

ANGIOSPERMS – DICOTYLEDONS

AIZOACEAE
Disphyma clavellatum
Mesembryanthemum nodiflorum
Mollugo cerviana
Psilocaulon tenue
Sarcozona praecox
Tetragonia tetragonoides
Tranthema triquetra
Zaleya galericulata subsp. *galericulata*

AMARANTHACEAE
Alternanthera denticulata
Amaranthus grandiflorus
Amaranthus macrocarpus
Ptilotus exaltatus var. *exaltatus*
Ptilotus obovatus
Ptilotus polystachyus
Ptilotus seminudus

APIACEAE
Daucus glochidiatus

ASCLEPIADACEAE
Leichhardtia australis

ASTERACEAE
Actinobole uliginosum
Angianthus tomentosus
Brachycome ciliaris var. *ciliaris*
Brachycome ciliaris var. *lanuginosa*
Brachycome heterodonta var. *heterodonta*
Brachycome lineariloba
Calendula arvensis
Calocephalus sonderi
Calotis cuneifolia
Calotis cymbacantha
Calotis hispidula
Carthamus tinctorius
Centaurea melitensis
Centipeda cunninghamii
Centipeda thespedioides
Chthonocephalus pseudevax
Craspedia pleiocephala
Craspedia uniflora
Dittrichia graveolens
Eriochlamys behrii
Gnaphalium sphaericum
Helichrysum semipapposum
Helipterum corymbifolium
Helipterum floribundum
Helipterum jessenii
Helipterum moschatum
Helipterum pygmaeum
Helipterum uniflorum
Hypochoeris glabra
Isoetopsis graminifolia
Ixiolaena leptolepis
Millotia greevesii subsp. *greevesii* var. *greevesii*
Minuria cunninghamii
Myriocephalus stuartii
Olearia muelleri
Olearia pimeleoides var. *pimeleoides*
Olearia subspicata
Onopordum acanthium
Onopordum acaulon
Podolepis capillaris
Rutidosis helichrysoides
Senecio glossanthus
Senecio gregorii
Senecio quadridentatus
Sonchus asper
Sonchus oleraceus
Toxanthes perpusilla
Vittadinia triloba/cuneata complex
Vittadinia cuneata subsp. *cuneata* f. *cuneata*
Vittadinia cuneata var. *morrisii*
Waitzia acuminata
Xanthium occidentale

BORAGINACEAE
Echium plantagineum
Halgania cyanea
Heliotropium curassavicum
Heliotropium supinum
Omphalolappula concava
Plagiobothrys plurisepaleus

BRASSICACEAE
Alyssum linifolium
Arabidella nasturtium
Arabidella trisecta
Blennodia canescens
Brassica tournefortii

*Carrichtera annua
Geococcus pusillus
Harmsiodoxa blennodiodes
Lepidium phlebopetalum
Phlegmatospermum cochlearinum
*Sisymbrium erysimoides
Stenopetalum lineare

CACTACEAE
*Opuntia paraguayensis

CAMPANULACEAE
Wahlenbergia fluminalis
Wahlenbergia gracilenta
Wahlenbergia tumidifructa

CAPPARIDACEAE
Apophyllum anomalum

CARYOPHYLLACEAE
Scleranthus minusculus
*Spergularia rubra
Stellaria angustifolia

CASUARINACEAE
Casuarina pauper

CHENOPODIACEAE
Atriplex acutiloba
Atriplex angulata
Atriplex conduplicata
Atriplex eardleyae
Atriplex holocarpa
Atriplex leptocarpa
Atriplex limbata
Atriplex lindleyi
Atriplex nummularia
Atriplex pseudocampanulata
Atriplex pumilio
Atriplex semibaccata
Atriplex spongiosa
Atriplex stipitata
Atriplex suberecta
Atriplex velutinella
Atriplex vesicaria subsp. *calcicola*
Atriplex vesicaria subsp. *vesicaria*
Chenopodium cristatum
Chenopodium curvispicatum
Chenopodium desertorum subsp. *anidiophyllum*
Chenopodium desertorum subsp. *desertorum*
Chenopodium desertorum subsp. *microphyllum*
Chenopodium nitrariaceum
Chenopodium pumilio
Dissocarpus biflorus var. *biflorus*
Dissocarpus paradoxus
Dysphania glomulifera
Einadia hastata
Einadia nutans subsp. *nutans*
Enchylaena tomentosa
Halosarcia pergranulata subsp. *divaricata*
Maireana appressa
Maireana brevifolia
Maireana ciliata
Maireana coronata
Maireana decalvans
Maireana erioclada
Maireana georgei
Maireana microphylla
Maireana pentagona
Maireana pentatropis
Maireana pyramidata
Maireana radiata
Maireana schistocarpa
Maireana sclerolaenoides
Maireana sedifolia
Maireana trichoptera
Maireana triptera
Maireana turbinata
Malacocera tricornis
Osteocarpum acropterum var. *deminutum*
Pachycornia triandra
Rhagodia spinescens
Rhagodia ulicina
Salsola kali var. *kali*
Scleroblitum atriplicinum
Sclerolaena bicornis
Sclerolaena brachyptera
Sclerolaena calcarata
Sclerolaena decurrens
Sclerolaena diacantha
Sclerolaena divaricata
Sclerolaena intricata
Sclerolaena muricata var. *muricata*
Sclerolaena muricata var. *villosa*
Sclerolaena obliquicuspis
Sclerolaena parviflora
Sclerolaena patenticuspis
Sclerolaena stelligera
Sclerolaena tricuspis
Sclerolaena ventricosa
Sclerolaena stelligera
Sclerostegia tenuis
Threlkeldia proceriflora

CHLOANTHACEAE
Dicrastylis verticillata

CONVOLVULACEAE
*Convolvulus arvensis
Convolvulus erubescens

CRASSULACAEAE
Crassula colorata var. *acuminata*
Crassula peduncularis
Crassula sieberiana subsp. *tetramera*

CUCURBITACEAE
**Cucumis myriocarpus*
Zehneria micrantha

EUPHORBIACEAE
Bertya cunninghamii
Beyeria opaca
Chamaesyce drummondii
Phyllanthus lacunarius

FABACEAE – Caesalpinoideae
Senna artemisioides nothosubsp. *coriacea*
Senna artemisioides subsp.*filifolia*
Senna artemisioides subsp. *petiolaris*

FABACEAE–Faboideae
Eutaxia microphylla var. *microphylla*
Glycyrrhiza acanthocarpa
Lotus cruentus
**Medicago minima*
**Medicago polymorpha*
Psoralea patens group.
Swainsona microphylla
Swainsona phacoides subsp. *phacoides*
Templetonia egena

FABACEAE–Mimosoideae
Acacia aneura
Acacia bivenosa subsp. *wayi*
Acacia brachystachya
Acacia burkittii
Acacia colletioides
Acacia havilandiorum
Acacia jennerae
Acacia ligulata
Acacia loderi
Acacia nyssophylla
Acacia oswaldii
Acacia stenophylla
Acacia wilhelmiana
Acacia tetragonophylla
Acacia victoriae

FRANKENIACEAE
Frankenia foliosa

GERANIACEAE
Erodium cicutarium
Erodium crinitum

GOODENIACEAE
Goodenia cycloptera
Goodenia fascicularis
Goodenia pinnatifida
Goodenia pusilliflora
Scaevola spinescens

GYROSTEMONACEAE
Codonocarpus cotinifolius

HALORAGACEAE
Haloragis glauca

LAMIACEAE
Mentha australis
**Salvia verbenaca*
Teucrium racemosum
Westringia rigida

LORANTHACEAE
Amyema linophyllum subsp. *orientale*
Amyema miquellii
Amyema preissii
Lysiana exocarpi subsp. *diamantinensis*

MALVACEAE
Abutilon otocarpum
Lawrencia glomerata
Radyera farragei
Sida ammophila
Sida filiformis
Sida intricata
**Sida rhombifolia*

MYOPORACEAE
Eremophila glabra
Eremophila latrobei
Eremophila maculata
Eremophila oppositifolia
Eremophila polyclada
Eremophila scoparia
Eremophila sturtii
Myoporum platycarpum

MYRTACEAE
Eucalyptus camaldulensis
Eucalyptus dumosa
Eucalyptus leptophylla
Eucalyptus gracilis
Eucalyptus largiflorens
Eucalyptus largiflorens x *E. populnea* subsp. *bimbil*
Eucalyptus costata
Eucalyptus incrassata
Eucalyptus oleosa
Eucalyptus oleosa x *E. socialis*
Eucalyptus populnea subsp. *bimbil*
Eucalyptus porosa
Eucalyptus socialis
Melaleuca lanceolata

NYCTAGINACEAE
Boerhavia coccinea
Boerhavia dominii

OXALIDACEAE
Oxalis perennans

PITTOSPORACEAE
Pittosporum phillyreoides

PLANTAGINACEAE
Plantago cunninghamii
Plantago drummondii
Plantago turrifera

PLUMBAGINACEAE
**Limonium lobatum*

POLYGONACEAE
**Emex australis*
Muehlenbeckia cunninghamii
Muehlenbeckia florulenta
Muehlenbeckia diclina
Muehlenbeckia horrida
**Rumex crystallinus*
Rumex tenax

PORTULACACEAE
Calandrinia eremaea
Calandrinia pumila
Calandrinia volubilis
Portulaca intraterranea
Potulaca oleracea

PROTEACEAE
Grevillea huegelii
Hakea leucoptera
Hakea tephrosperma

RANUNCULACEAE
Myosurus minimus
Ranunculus pentandrus var. *platycarpus*
Ranunculus pumilio

RHAMNACEAE
Cryptandra amara var. *longiflora*

RUTACEAE
Geijera parviflora

SANTALACEAE
Exocarpos aphyllus
Santalum acuminatum

SAPINDACEAE
Alectryon oleifolius subsp. *canescens* [formerly *Heterodendrum*]
Atalaya hemiglauca
Dodonaea attenuata
Dodonaea bursariifolia
Dodonaea cuneata
Dodonaea triquetra
Dodonaea viscosa subsp. *angustissima*

SCROPHULARIACEAE
Morgania floribunda

SOLANACEAE
Duboisia hopwoodii
Lycium australe
**Nicotiana glauca*
Nicotiana simulans
Nicotiana velutina
Solanum coactiliferum
Solanum esuriale
Solanum nigrum

THYMELAEACEAE
Pimelea microcephala subsp. *microcephala*
Pimelea pauciflora
Pimelea trichostachya

URTICACEAE
Parietaria debilis

VERBENACEAE
**Phyla nodiflora*
**Verbena supina*

ZYGOPHYLLACEAE
Nitraria billardieri
Tribulus terrestris
Zygophyllum ammophillum
Zygophyllum apiculatum
Zygophyllum aurantiaceum
Zygophyllum glaucum
Zygophyllum eremaeum
Zygophyllum iodocarpum
Zygophyllum ovatum
Zygophyllum paradoxa
Zygophyllum simile

ANGIOSPERMS – MONOCOTYLEDONS

AMARYLLIDACEAE
Crinum flaccidum

ANTHERICACEAE
Thysanotus baveri

ASPHODELACEAE
Bulbine alata
Bulbine semibarbata

CYPERACEAE
Bulboschoenus medianus
Cyperus exaltatus
Cyperus gymnocaulos

JUNCACEAE
**Juncus acutus*

JUNCAGINACEAE
Triglochin calcitrapa

LOMANDRACEAE
Lomandra effusa

POACEAE
Agrostis avenacea
Amphipogon caricinus var. *caricinus*
Aristida contorta
Bromus arenarius
**Bromus rubens*
Chloris divaricata
Chloris truncata
Dactyloctenium radulans
Danthonia caespitosa
Danthonia eriantha
Diplachne fusca
Enneapogon avenaceus
Enneapogon nigricans
Enneapogon polyphyllus
Enteropogon acicularis
Eragrostis australasica
Eragrostis dielsii var. *pritzelii*
Eragrostis parviflora
Eriochloa crebra
Eriochloa pseudoacritricha
**Hordeum leporinum*
**Lamarckia aurea*
Paspalidium jubiflorum
Rostraria pumila
**Schismus barbatus*
Stipa elegantissima
Stipa mollis
Stipa nitida
Stipa nodosa
Stipa platychaeta
Sporobolus mitchellii
Tragus australianus
Triodia irritans
Tripogon loliiformis
Triraphis mollis
**Vulpia bromoides*
**Vulpia myuros*
Zygochloa paradoxa

TYPHACEAE
Typha domingensis

APPENDIX II

Summary of cation content, electrical conductivity and pH of vegetation sites. Exchangeable cations (Ca, Mg, K and Na) are expressed as m.e./100g, electrical conductivity (E.C.) is based on 1:2 mS/cm (modified from Fox 1984). Entries in *italics* are for sites sampled since 1984 on the map area. (mean ± s.e.)

Veg. Type	n	Ca	Mg	K	Na	Ca/ Total Cations	E.C.	pH ($CaCl_2$)
Mallee - Triodia	5 *5*	3.0±0.5 *3.0+0.5*	0.6±0.1 *0.6+0.1*	0.3±0.1 *0.3+0.1*	0.01±0 *0.01+0*	0.8±0.02 *0.8+0.02*	0.05±0.01 *0.05+0.01*	6.84±0.33 3 *6.8±0.33*
***Callitris* woodland**	5 -	4.2±0.4 -	0.9±0.2 -	0.6±0.1 -	0.02±0.01 -	0.8±0.03 -	0.04±0.01 -	5.96±0.30 0 -
***Alectryon* shrubland**	5 *5*	5.6±1.5 *5.6+1.5*	1.2±0.3 *1.2+0.3*	0.8±0.1 *0.8+0.1*	0.02±0.01 *0.02+0.01*	0.7±0.01 *0.7+0.01*	0.07±0.02 *0.07+0.02*	7.8±0.2 *7.8+0.2*
***Dodonaea* shrubland**	2 *2*	5.8±1.8 *5.8+1.8*	0.8±0.04 *0.8+0.04*	0.6±0.1 *0.6+0.1*	0.01±0 *0.01+0*	0.8±0.1 *0.8+0.1*	0.11±0.03 *0.11+0.03*	7.65±0.15 5 *7.65+0.2*
***Maireana* shrubland**	17 *5*	7.5±1.2 *8.8+1.3*	2.3±0.3 *2.5+0.7*	1.1±0.1 *1.3+0.2*	0.3±0.1 *0.4+0.2*	0.6±0.02 *0.7+0.04*	0.11±0.01 *0.13+0.01*	6.59±0.29 9 *7.4+0.27*
***Casuarina* woodland**	14 *5*	9.0±1.6 *2.8+0.1*	3.2±0.6 *1.3+0.1*	1.0±0.1 *0.7+0.1*	0.3±0.1 *0.1+0.1*	0.7±0.03 *0.6+0.02*	0.15±0.03 *0.05+0.01*	6.97±0.12 2 *7.0+0.09*
***A. vesicaria* shrubland**	8 *4*	9.7±0.5 *10.1+2.5*	8.2±1.5 *10.4+3.5*	1.6±0.2 *1.6+0.4*	1.7±0.5 *2.0+1.2*	0.5±0.03 *0.5+0.08*	0.66±0.29 *0.88+0.6*	5.98±0.37 7 *7.0+0.21*
Mallee - chenopod	14 *5*	11.2±2.3 *7.0+2.1*	2.5±0.3 *1.4+0.3*	0.8±0.1 *0.5+0.1*	0.1±0.03 *0.1+0.1*	0.7±0.03 *0.7+0.04*	0.11±0.02 *0.09+0.03*	6.94±0.24 4 *7.04+0.3*
Black Box woodland	20 *5*	13.7±1.2 *19.8+1.7*	7.5±0.9 *13.5+0.5*	1.5±0.2 *2.7+0.2*	0.9±0.2 *1.9+0.2*	0.6±0.02 *0.5+0.03*	0.22±0.03 *0.37+0.03*	6.02±0.20 0 *7.2+0.22*

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