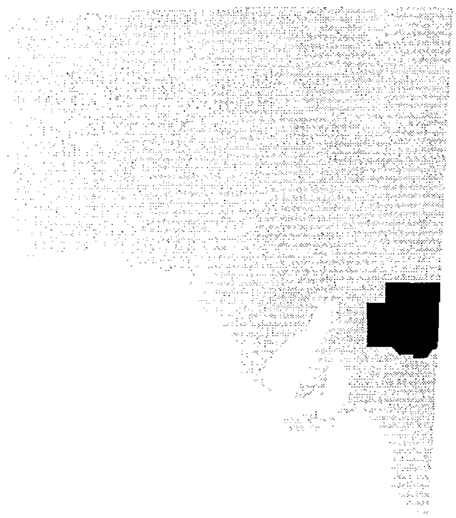
A BIOLOGICAL SURVEY
of the
SOUTH OLARY PLAINS
SOUTH AUSTRALIA

1991 - 1992



BIOLOGICAL SURVEY
SOUTH AUSTRALIA

Editors

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Biological Survey and Research
Natural Resources Group
Department of Environment and Natural Resources, South Australia

1996

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Cover Photograph:
Blackoak and Pearl Bluebush habitat typical of the South Olary Plains
Photo: L.R. Forward

Abstract

In July and August 1991, four weeks were spent surveying the vegetation of the South Olary Plains area to the north of the River Murray and west of the New South Wales, South Australian border. In September, October and November 1992, six weeks were spent sub-sampling a representative selection of the vegetation sites for vertebrate fauna. This resulted in the recognition of:

- 34 floristic vegetation groups, and the production of a map showing 20 primary vegetation mapping units.
- 876 plant species.
- 4 communities of small ground mammals with 32 mammal species recorded overall (8 introduced).
- 4 bird communities with 257 species (8 introduced).
- 5 reptile communities with 78 reptile and 10 amphibian species.

There are clear distinctions between the plant and animal communities of the southern open tree mallee formations and the chenopod shrublands in the north of the survey area. Within these major habitat types however patterns are quite subtle reflecting the relatively small amount of variation in rainfall and soil type over the survey area.

The survey has recognised many significant species and sites over the survey area which gives us a more detailed understanding of it's conservation importance. At present only the southern mallee has significant conservation reserves established. The northern chenopod shrublands are contiguous with the pastoral country to the north of the present study area and a detailed consideration of their overall conservation significance will await the completion of a biological survey in this area which was begun in 1995. The results of the South Olary Plains survey however have clearly identified species and areas which will begin to provide a conservation focus for particular pastoral lessees in their property management planning.

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Acknowledgments

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Introduction

by L. R. Forward[1]

BACKGROUND

Since 1971 the South Australian Department of Environment and Natural Resources has been conducting systematic biological surveys of the vegetation and vertebrate fauna of large regions of the state as part of the Biological Survey of South Australia. The aim of these surveys is to document the range of biological variation across the state to improve long-term natural resource management.

Up to 1990, eight major regions had been studied by the Department: Offshore Islands (1971-1982), Cooper Creek (1983,1991), South East Coast (1982-1983), Nullarbor (1984), Gawler Ranges (1985), Yellabinna (1987), Kangaroo Island (1989-1990), and Murray Mallee (1990-1991). Since then surveys have been conducted of the Strzelecki Dunefields (1988-1992) and Diamantina River area (1994). Generally the boundaries of these surveys have been based on the environmental regions of South Australia as delineated by Laut *et al.* (1977). Vegetation-only surveys have also been completed in conjunction with the Department of Housing and Urban Development for the Mt Lofty Ranges (1985), South East (1991), the Western Murray Flats (1992), the Mid North (1992), Burra Hills (1994) and Yorke peninsula (1994). Ongoing vegetation and vertebrate surveys are being conducted in the Anangu-Pitjantjatjara Lands of north-western S.A.(1992-), the Stony Deserts (1994-), and the North Olary Plains (1995-). Vegetation surveys are currently underway for Southern Eyre Peninsula (1995-). In addition, the same methods have been used for numerous smaller-scale surveys conducted by various non-government organisations.

Surveys are overseen by the South Australian Biological Survey Co-ordinating Committee which comprises representatives from the South Australian Museum, the Departments of Housing and Urban Development, Environment and Natural Resources and Primary Industries. These surveys are producing a comprehensive biological data base with information now encompassing a large area of the state.

In 1990 the Biological Conservation Branch of the then South Australian National Parks and Wildlife Service received a grant from the Murray-Darling Basin Natural Resources Management Strategy (NRMS) to conduct the project, *A Biological Survey of the South Olary Plains Environmental Region.* This project was part of a three-state *Mallee Fire Ecology* project administered in conjunction with the then Victorian Department of Conservation and Environment, the New South Wales National Parks and Wildlife Service, and CSIRO Divisions of Plant Industry and Wildlife and Ecology, Canberra.

The Murray-Darling River Basin in South Australia comprises areas to the north, south and west of the River Murray (Fig. 1). In 1990 the Murray Mallee vegetation (south and east of the river) was surveyed with support from the Save the Bush Programme of the then Australian National Parks and Wildlife Service. The Western Murray Flats were subsequently surveyed in April 1992 on a Murray-Darling Basin NRMS grant and the vertebrate fauna survey for this and the Murray Mallee was completed in spring 1991 under a National Estate Grant from the Australian Heritage Commission. Thus, including the current South Olary Plains survey (north of the river), the vegetation and vertebrate fauna of the Murray-Darling Basin in South Australia have now been extensively sampled (Figs 2 & 3).

OBJECTIVES

The principal aim of the Biological Survey of South Australia is to systematically sample a variety of sites chosen to represent the range of biological variation over each study area and across the state, in order to enhance integrated land management and conservation and to support, with scientific data, government strategies for biodiversity conservation and ecologically sustainable development.

The specific objectives of the South Olary Plains biological survey were:

1. To observe, collect and identify the species of plants and vertebrate fauna present in the area during July-August 1991 and September-November 1992 respectively, by sampling an array of fixed quadrats representing the geographical and biological diversity of the region.

[1]L. R. Forward, SA Department of Environment and Natural Resources, PO Box 1047, ADELAIDE, SA 5001

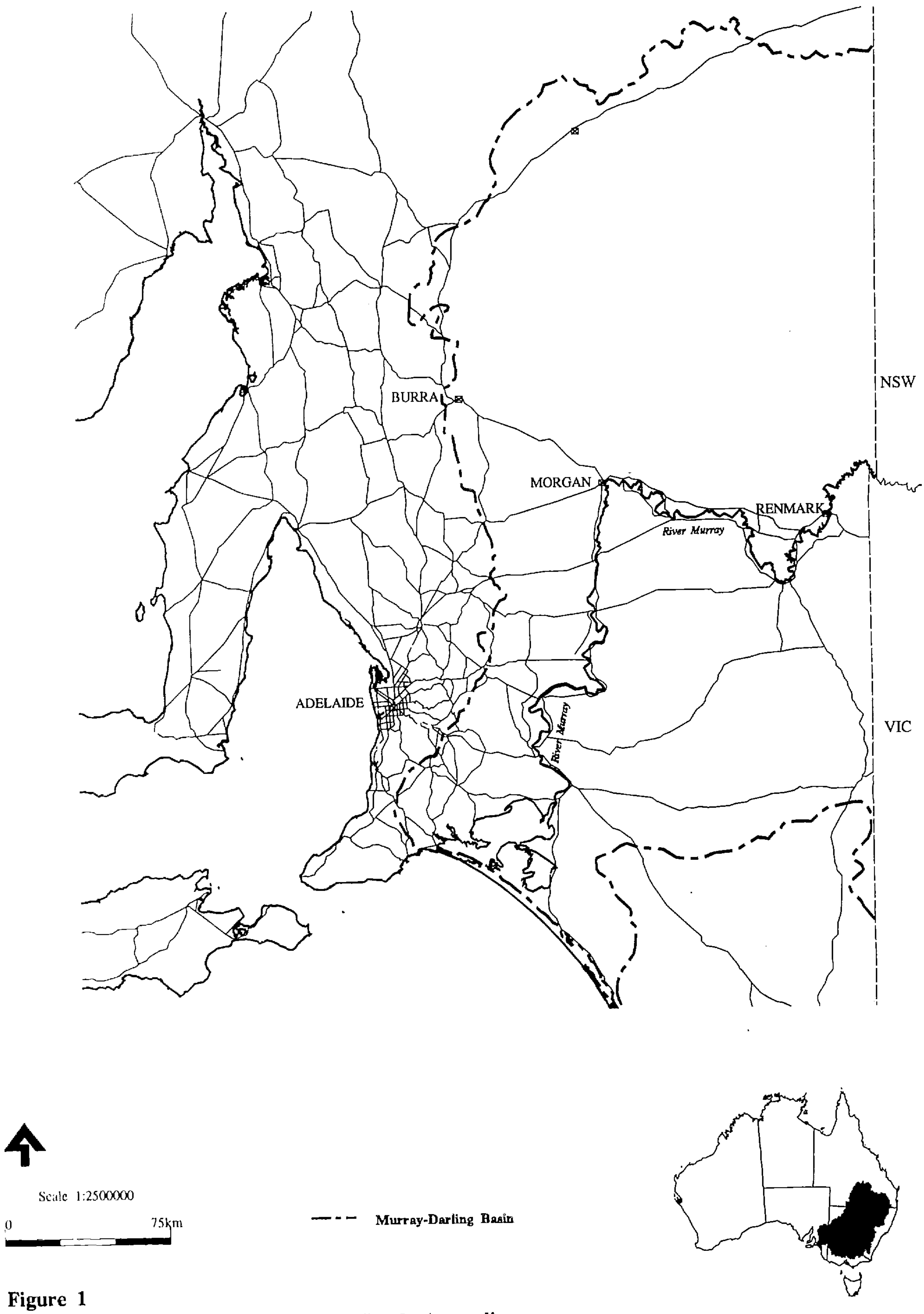


Figure 1
The Murray-Darling River Basin in South Australia

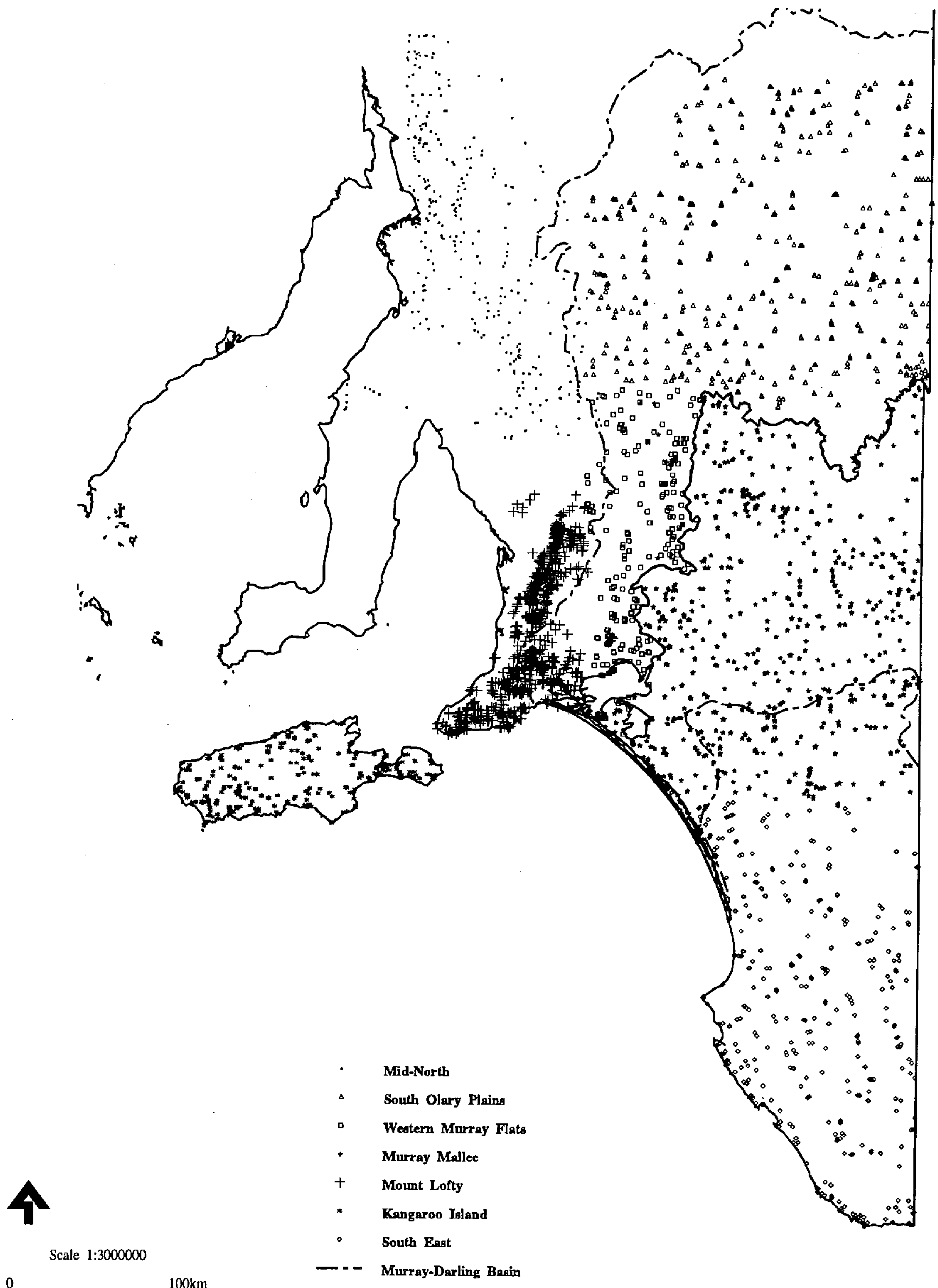


Figure 2
Vegetation survey sites in south-eastern South Australia

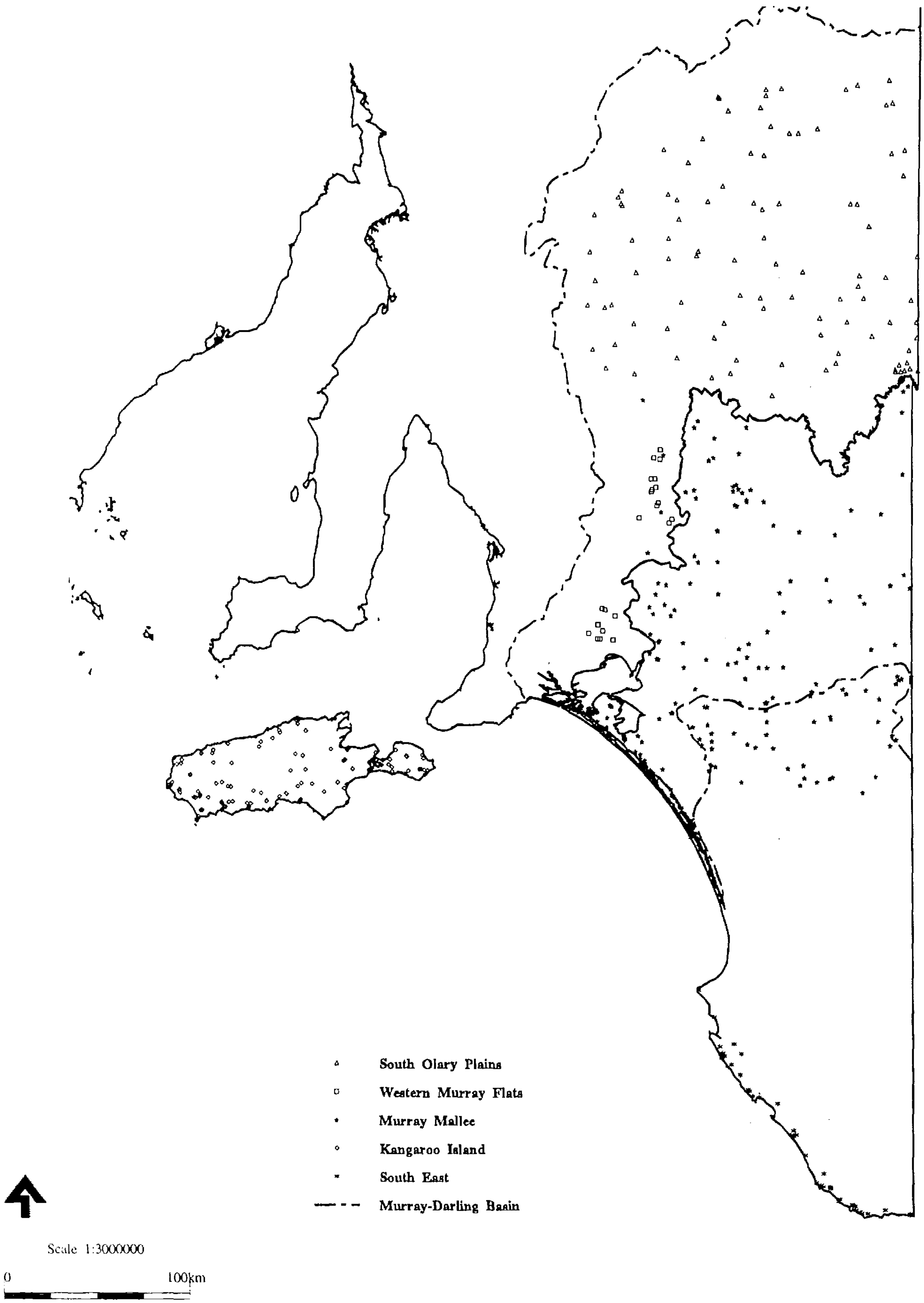


Figure 3
Fauna survey sites in south-eastern South Australia

2. To establish a comprehensive data base of the flora and associated vertebrate communities of the northern Murray-Darling Basin in South Australia which is amenable to analyses involving direct ecological comparisons, and compatible with similar data collected from adjacent areas in South Australia, Victoria and New South Wales.

3. To document and classify the patterns of species and communities across the region and their relationship with parameters of the physical environment.

4. To compile a structural vegetation map of the area contiguous with maps of adjoining areas in S.A., Victoria and N.S.W.

5. To evaluate the conservation status of species and communities typical of the South Olary Plains, as a basis for recommendations for natural resource management and conservation strategies.

6. To provide the State Herbarium and South Australian Museum with collections representative of the diversity of plants and vertebrates in the area in 1991-1992 and to provide material for taxonomic and other scientific studies related to wildlife protection.

7. To establish a long term monitoring system and associated database to enable subsequent sampling and measurement of seasonal effects, recovery after fire and other disturbances, and ongoing ecological processes with a view to further understanding of the general and fire ecology of the region.

8. To provide baseline biological data for future research by government and non-government organisations.

The overall objectives of the joint *Mallee Fire Ecology* project were:

1. To gain a comprehensive understanding of the effects of fires (including prescribed fires imposed for fire protection and pastoral production) on flora and fauna through the development of a practical and effective monitoring system strategy that serves to improve mallee vegetation management.

2. To complete the systematic documentation and mapping of the vegetation and fire history patterns of the Murray-Darling Basin in S.A., Victoria and parts of N.S.W..

Details of this joint project and the South Australian component are contained in the Mallee Fire Ecology Chapter of this report.

THE SURVEY AREA

The South Olary Plains survey area covers the northern Murray-Darling Basin in South Australia, from the edge of the Murray River flood-plain north to the Olary Spur, west to the northern Mt Lofty Ranges and east to the N.S.W. state border. The area includes the 1:250 000 mapsheet coverages of 'Chowilla', the southern half of 'Olary', the eastern third of 'Burra' and the section north of the River Murray on 'Renmark' (Fig. 4). The survey area was delineated by the boundary of the South Olary Plains Environmental Region as described by Laut *et al.* (1977), but the outer limits were extended to the River Murray flood-plain in the south and the edges of the 1:100 000 mapsheet coverage in the north and west.

The South Olary Plains Environmental Region (number 5.1) is an area of 20 510 km^2 containing nine environmental associations (Fig. 5). Laut *et al.* (1977) describe the region as comprising undulating calcrete plains with shallow soils supporting low woodlands or tall open shrublands with chenopod understorey (Fig. 6), overlain in places by low dunes or sand sheets with degraded mallee (*Eucalyptus* spp.) over saltbush (*Atriplex* spp.) or porcupine grass (*Triodia irritans*). Relict alluvial terraces with low open woodland of blackoak (*Casuarina pauper*) form well-defined flat-topped ridges, rising 5 - 20m above the plain. Near the western margin is a transition zone of fans shed from the ranges with a very low open shrubland cover of bluebush (*Maireana sedifolia*) and saltbush. Some of the fan streams extend as floodouts into the plains. Beyond the northern and western borders are the hills and ranges of the Olary Spur and the northern Mount Lofty Ranges respectively, outliers of which occur in the survey area (Figs 6, 7, 8).

The southern boundary of the area, at the outer edge of the River Murray flood-plain, extends into the Laut *et al.* (1977) Upper Murraylands Environmental Region (2.4). Similarly the north-eastern corner extends just into the Southern Frome Basin Region (5.3), the north-western segment into the Olary Spur Region (5.2) and the south-eastern corner into the footslopes of the Burra Hills in the North Wheatlands Region (3.3).

The total survey area is 29 000 km^2.

Figures 9 - 19 show the variation in environments of the area.

Most of the survey area supports a continuous expanse of native vegetation and, being under pastoral leasehold, is grazed by sheep. The western and southern edges extend into the agricultural perpetual leasehold areas where the vegetation is substantially modified and fragmented. A large section in the east is contained in Danggali Conservation Park which is now part of the larger, recently acquired, Bookmark Biosphere Reserve.

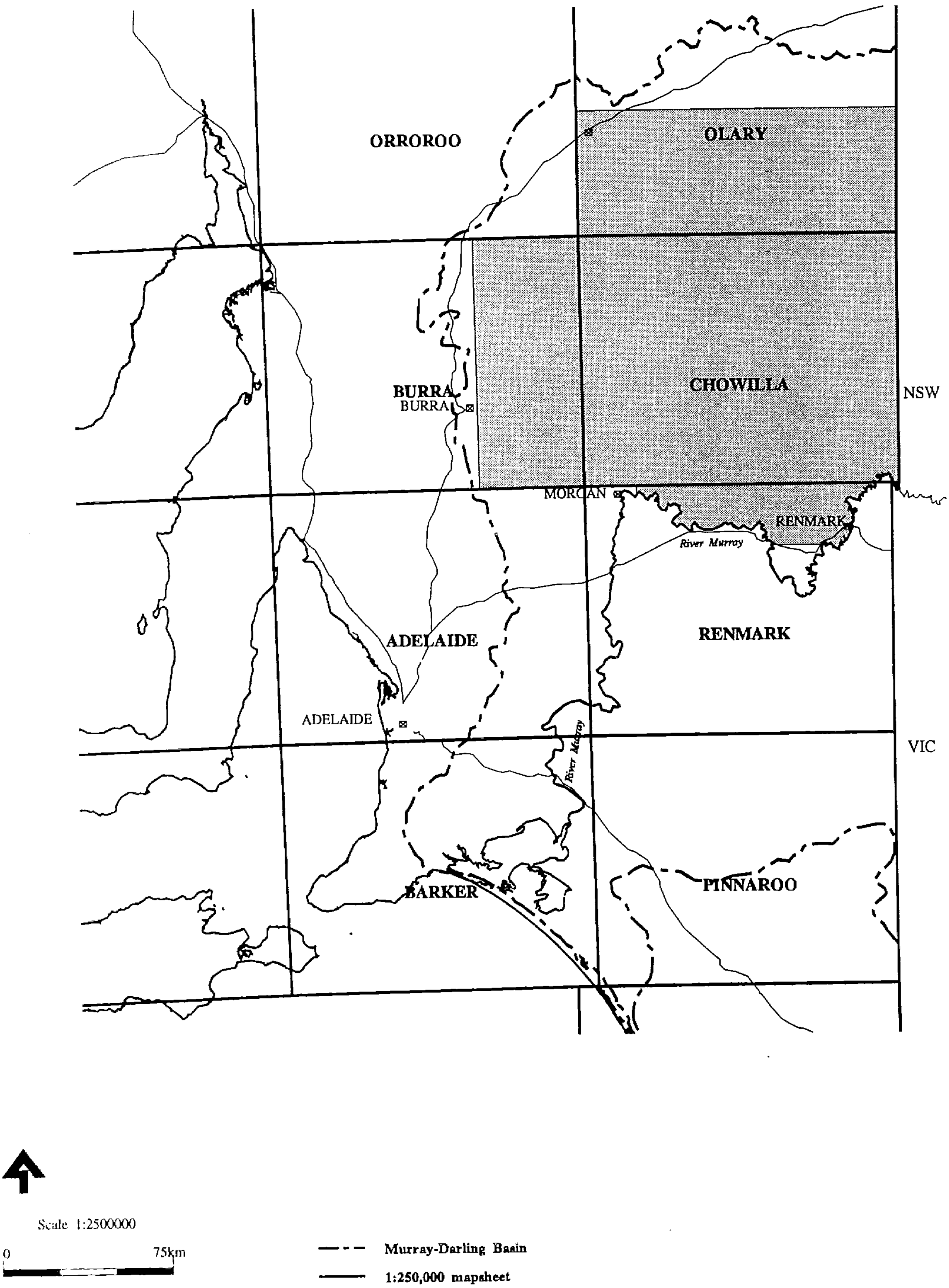


Figure 4
The South Olary Plains survey area showing 1:250,000 mapsheets

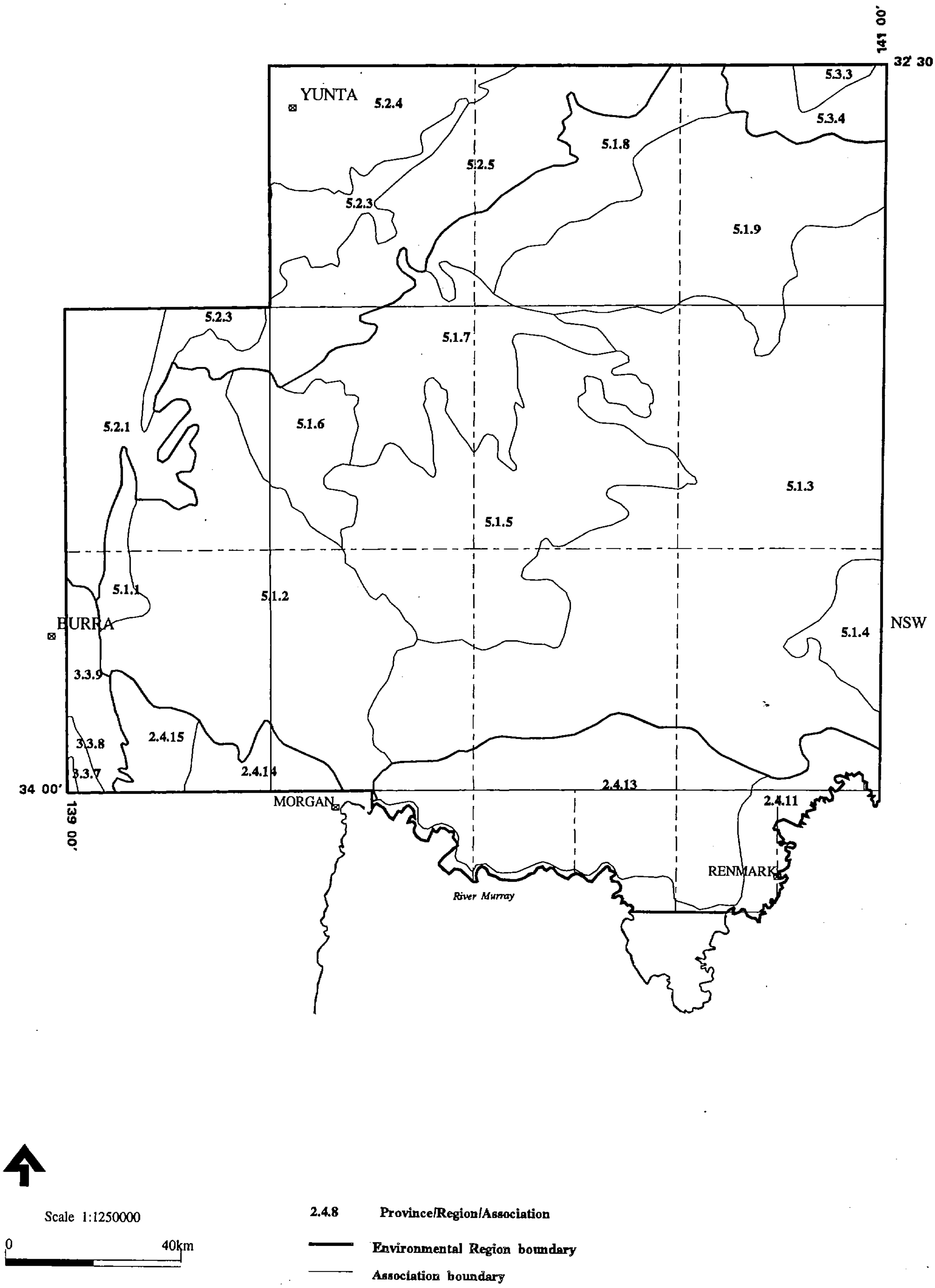


Figure 5
The South Olary Plains survey area showing Laut et al. (1977) environmental associations

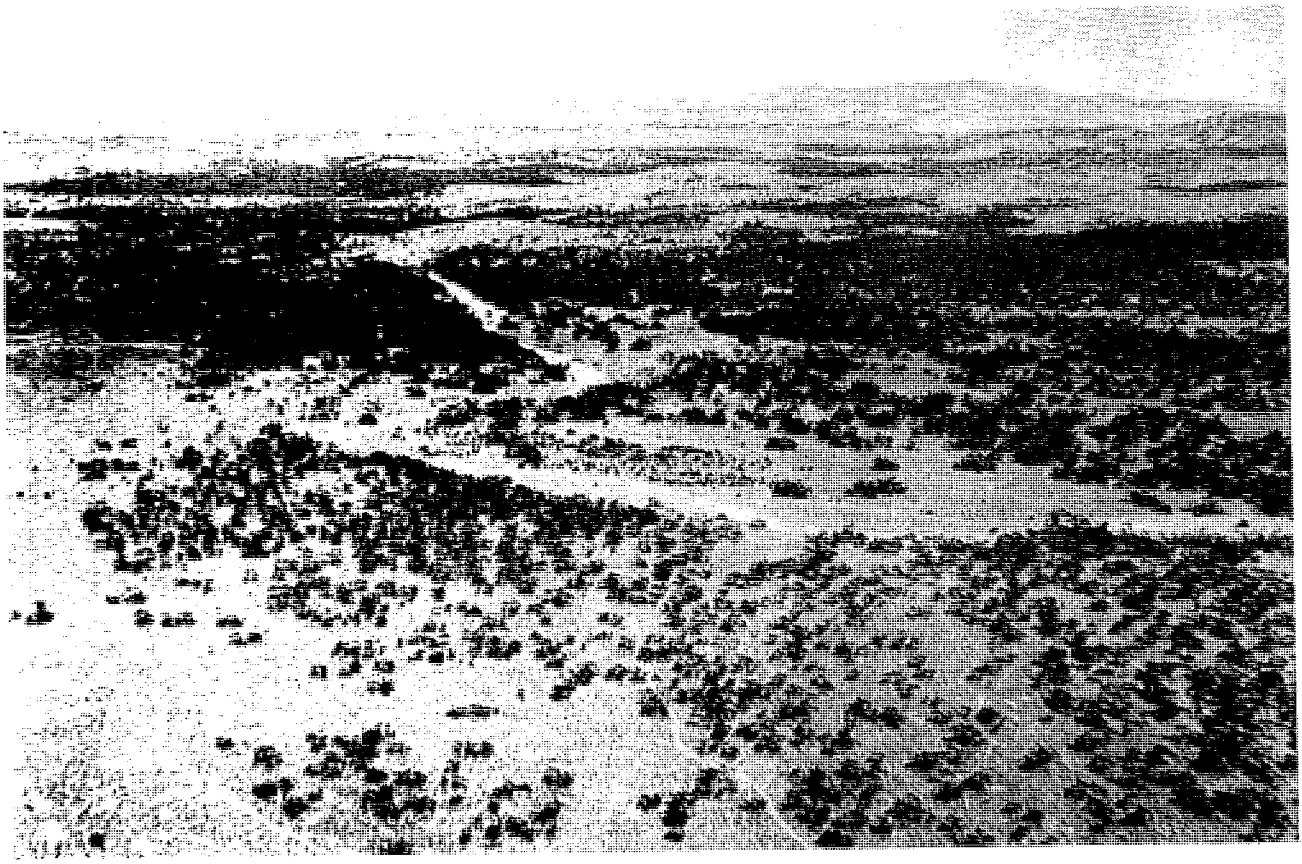


Figure 6
Aerial view of plains looking towards the northern Mt Lofty Ranges in the west of the South Olary Plains survey area
Photo: P. Canty

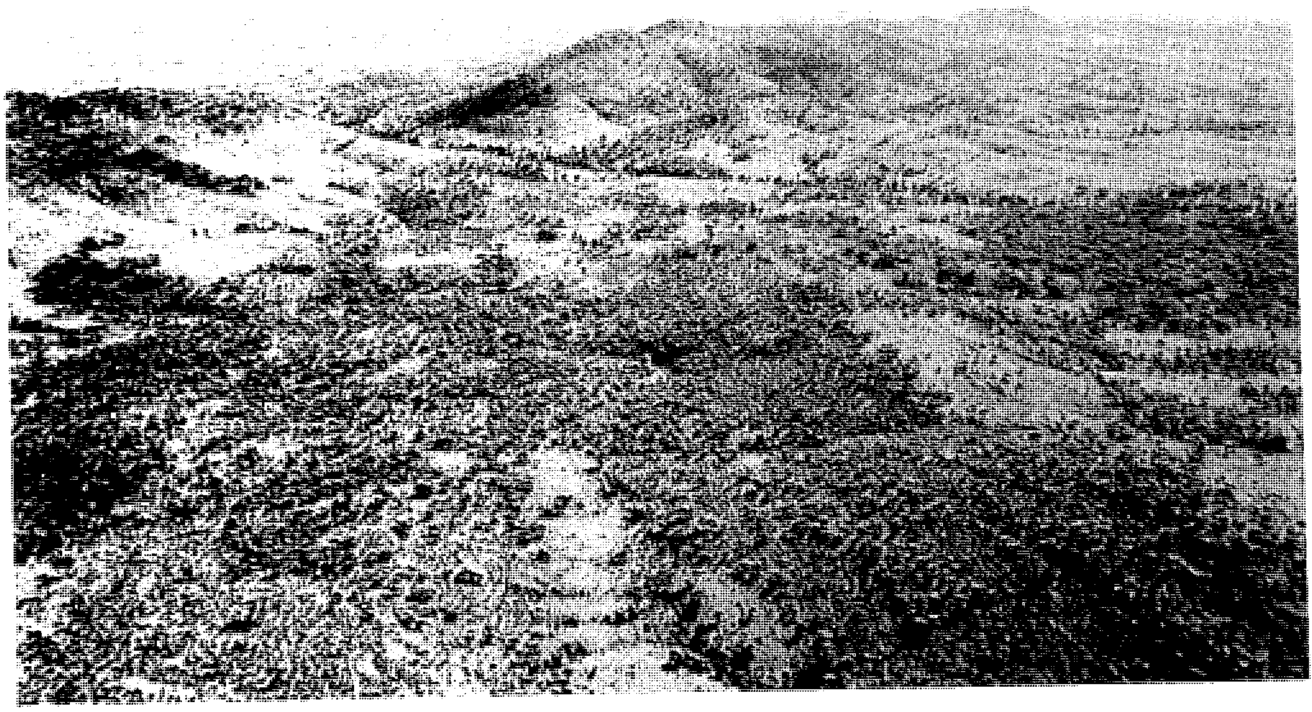


Figure 7
Aerial view of outliers of the Olary Spur in the north of the South Olary Plains survey area
Photo: P. Canty

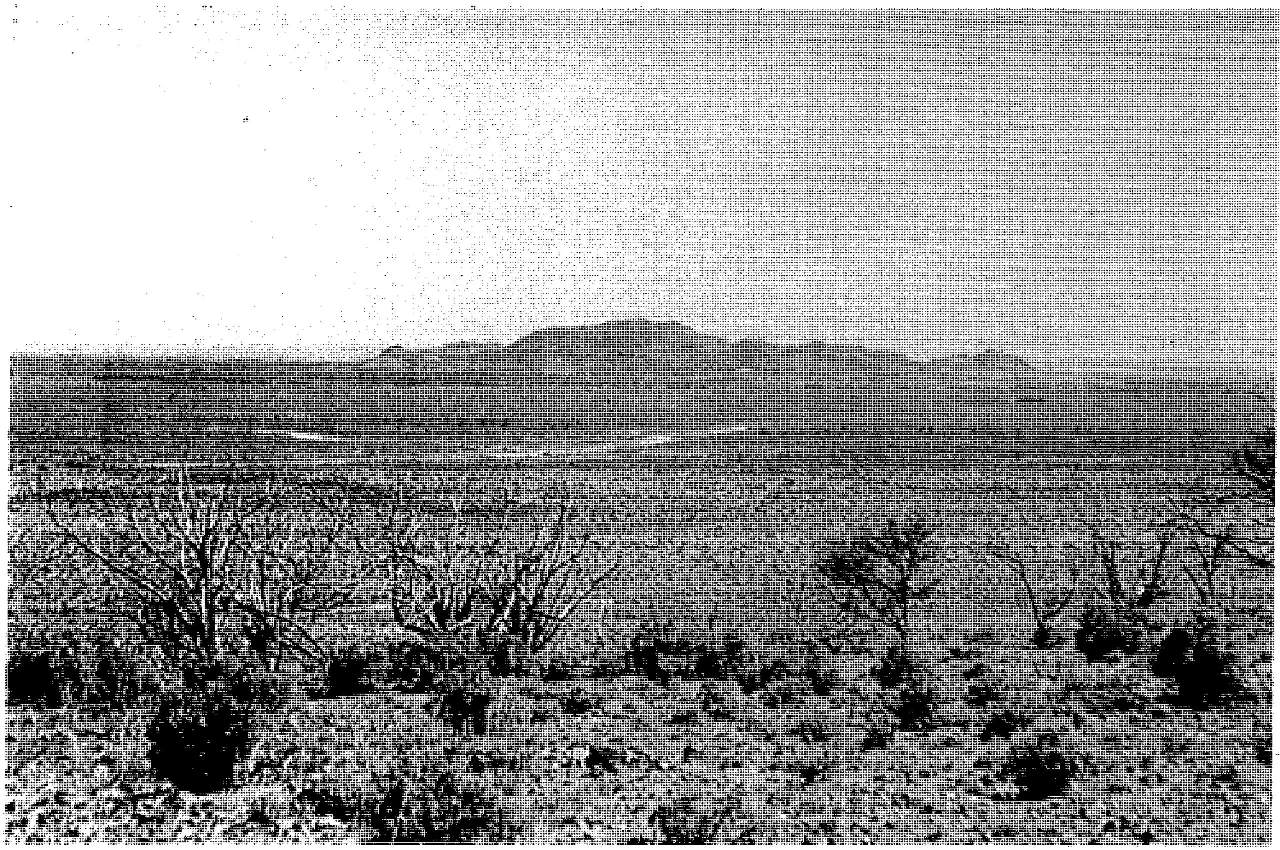


Figure 8
A view of Anabama Hill on Lilydale Station
Photo: L. Forward

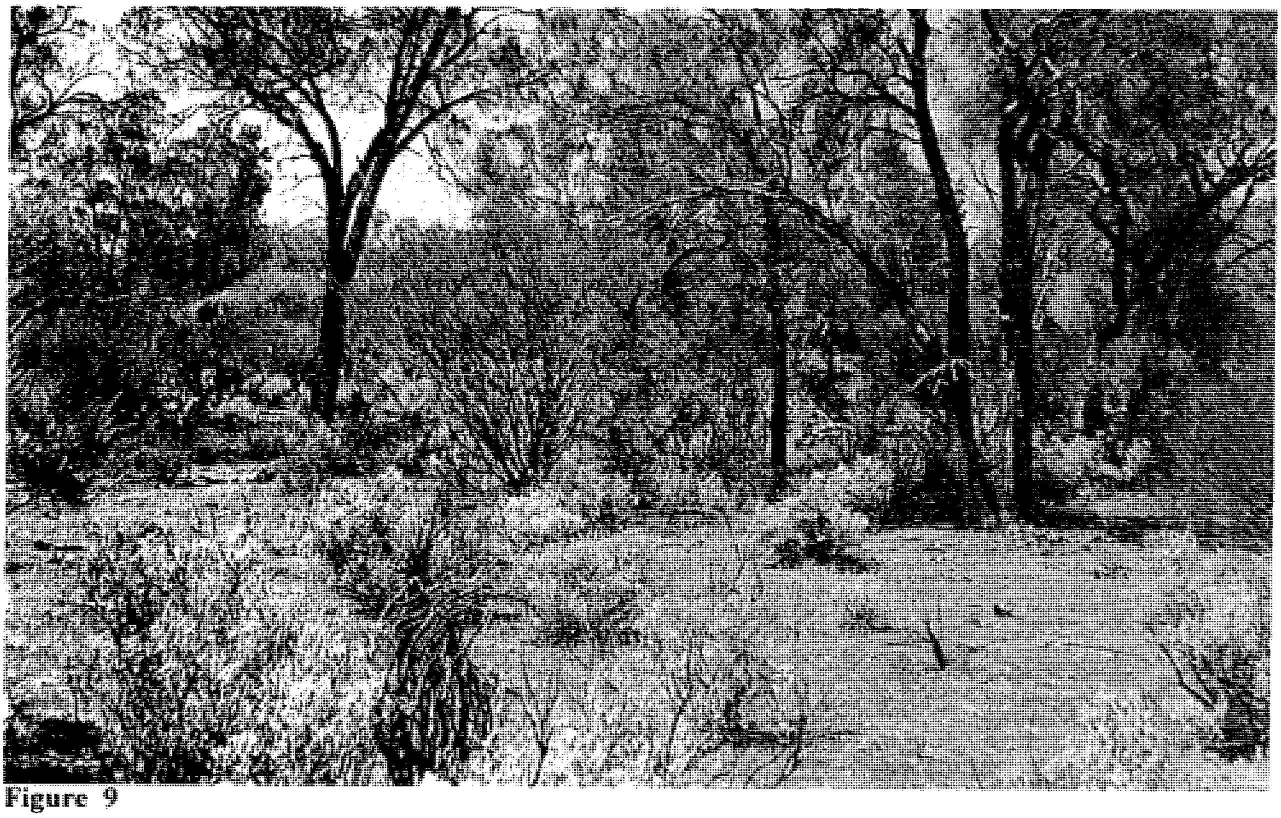


Figure 9
Blackoak woodland with a chenopod understorey on Oakvale Station
Photo: L. Forward

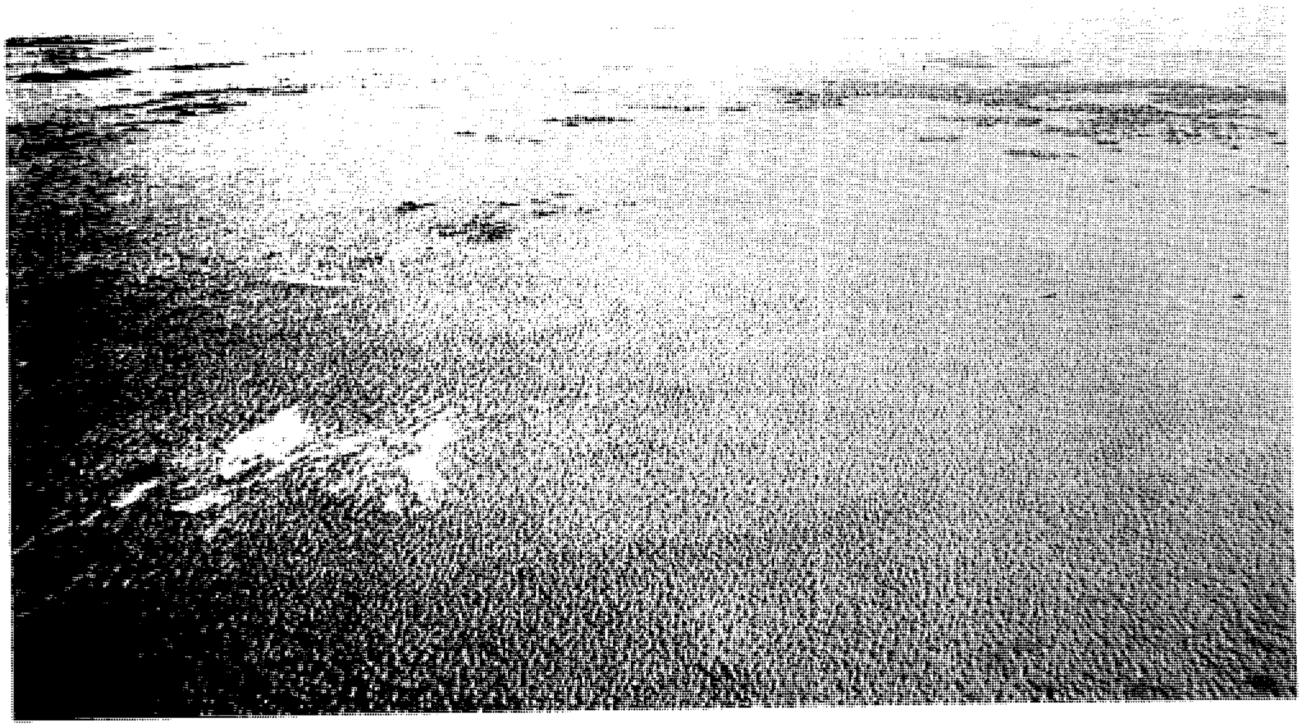


Figure 10
Aerial view of saltbush shrubland on Mutooroo Station
Photo: P.Canty

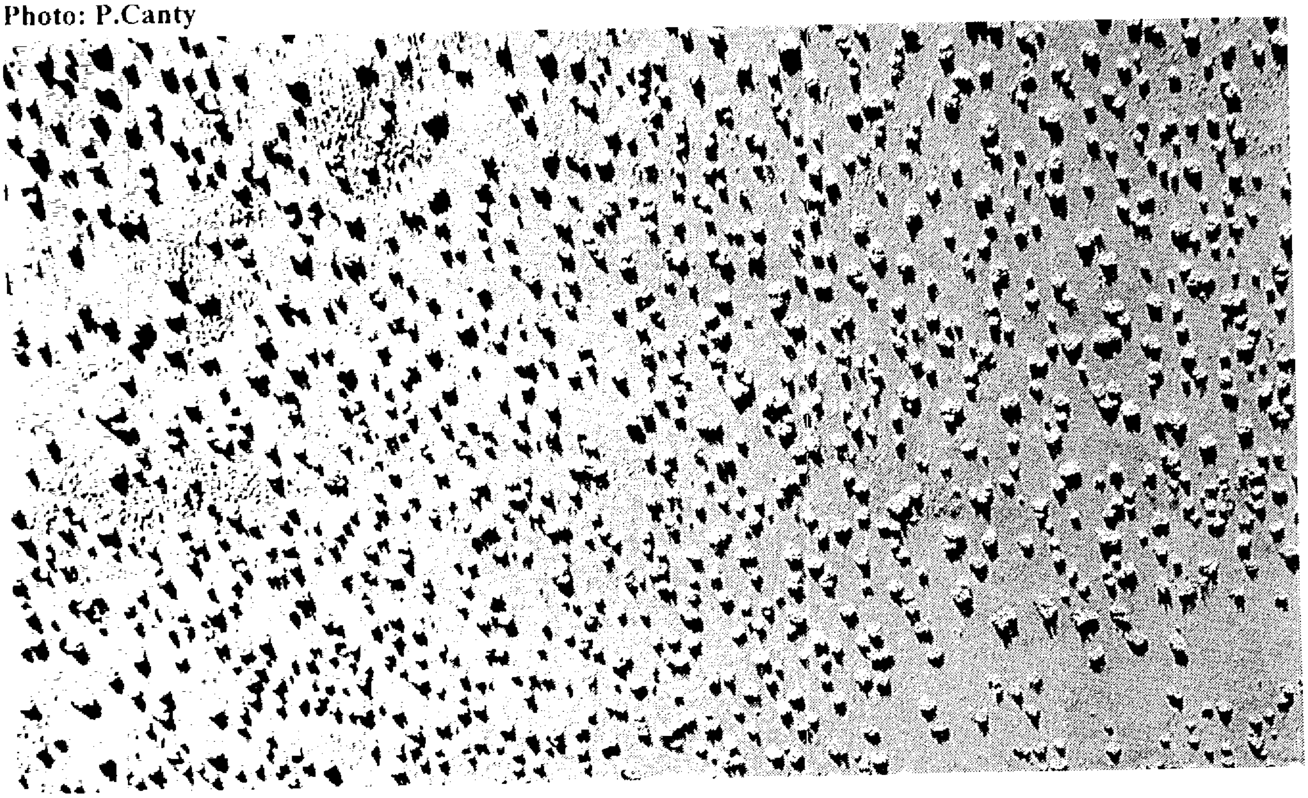


Figure 11
Vertical aerial view of saltbush shrubland on Mutooroo Station
Photo: P. Canty

Figure 12
Saltbush low open shrubland on Mutooroo Station
Photo: L. Forward

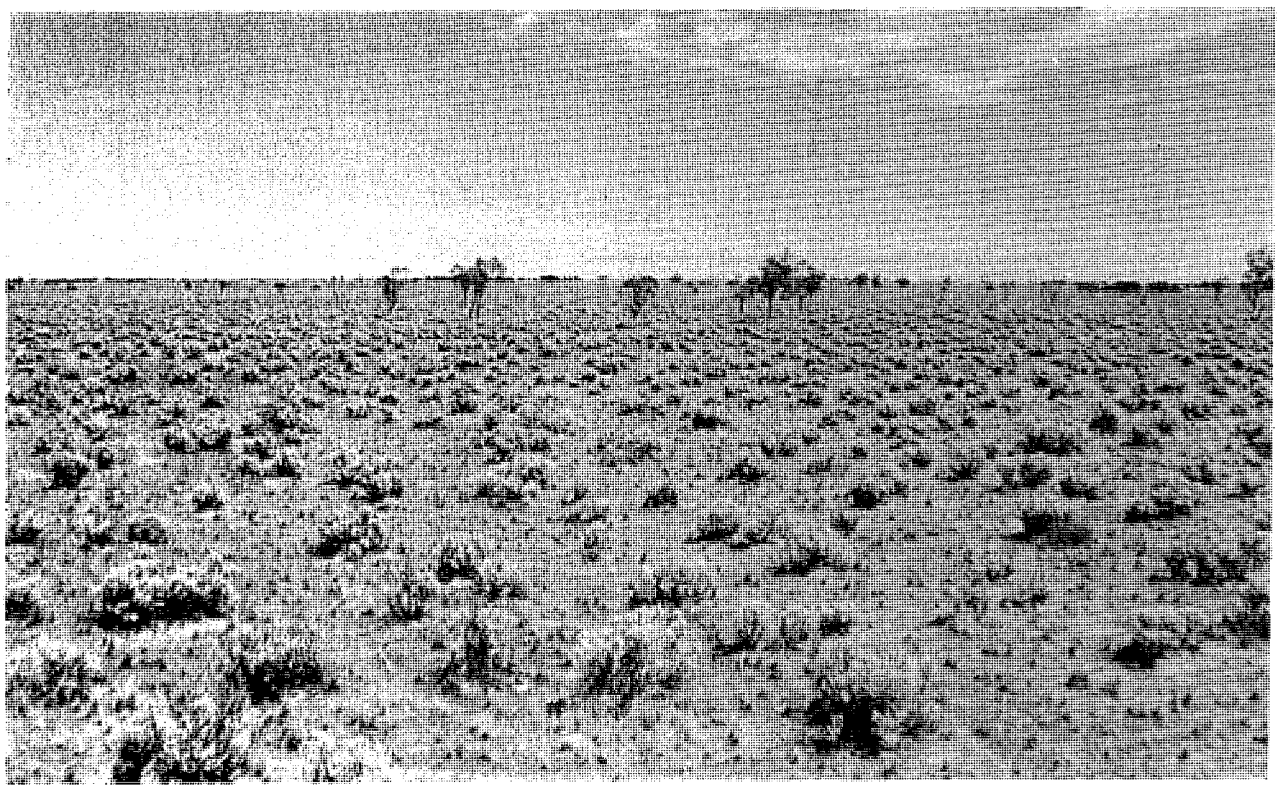


Figure 13
Bluebush low open shrubland on Balah Station
Photo: L. Forward

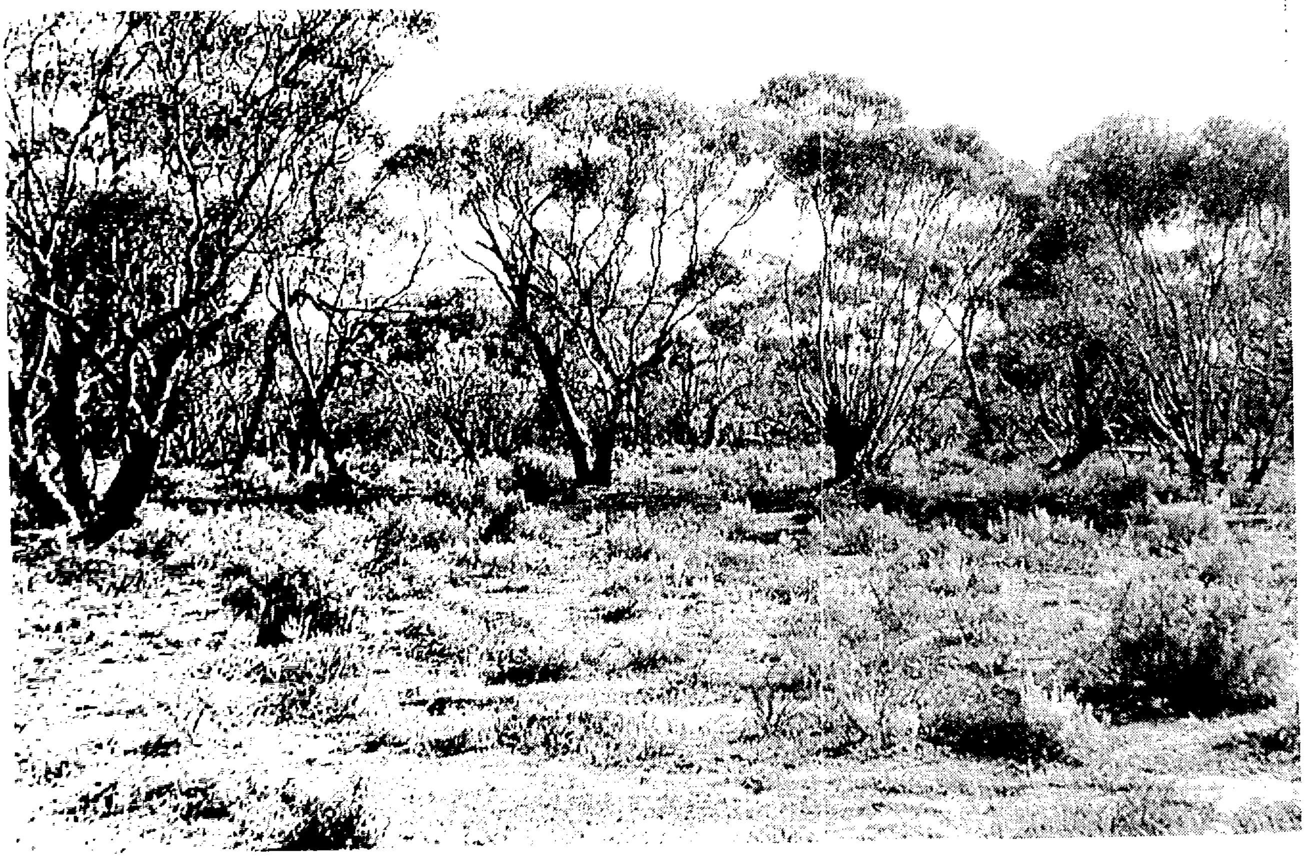


Figure 14
Open tree mallee with a chenopod understorey west of Pine Creek
Photo: L. Forward

Figure 15
Open tree mallee with a spinifex understorey on Danggali Conservation Park
Photo: L. Forward

Figure 16
River Red Gum lined West Creek on Mutooroo Station
Photo: A. Robinson

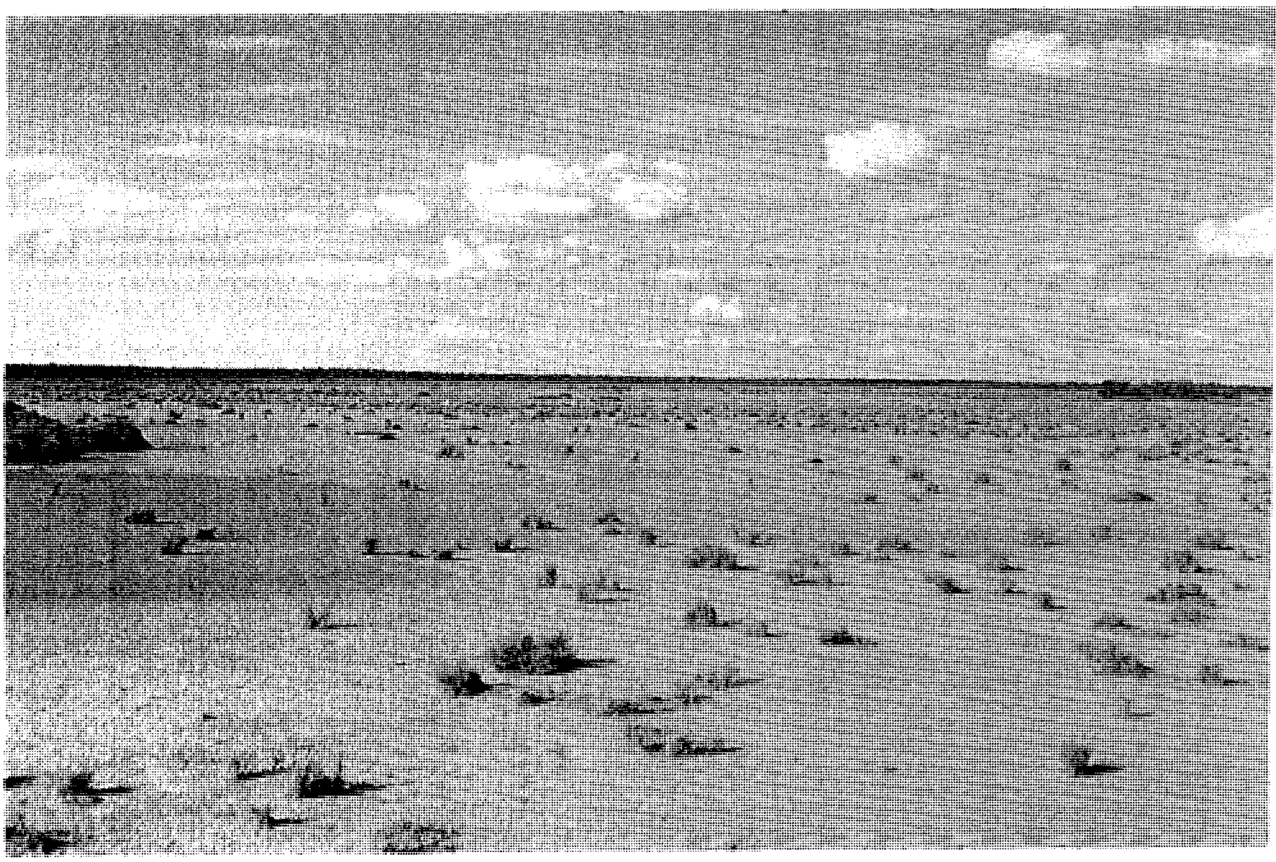


Figure 17
Claypans on Pine Valley Station
Photo: L. Forward

Figure 18
A Black Box swamp on Quondong Station
Photo: A. Robinson

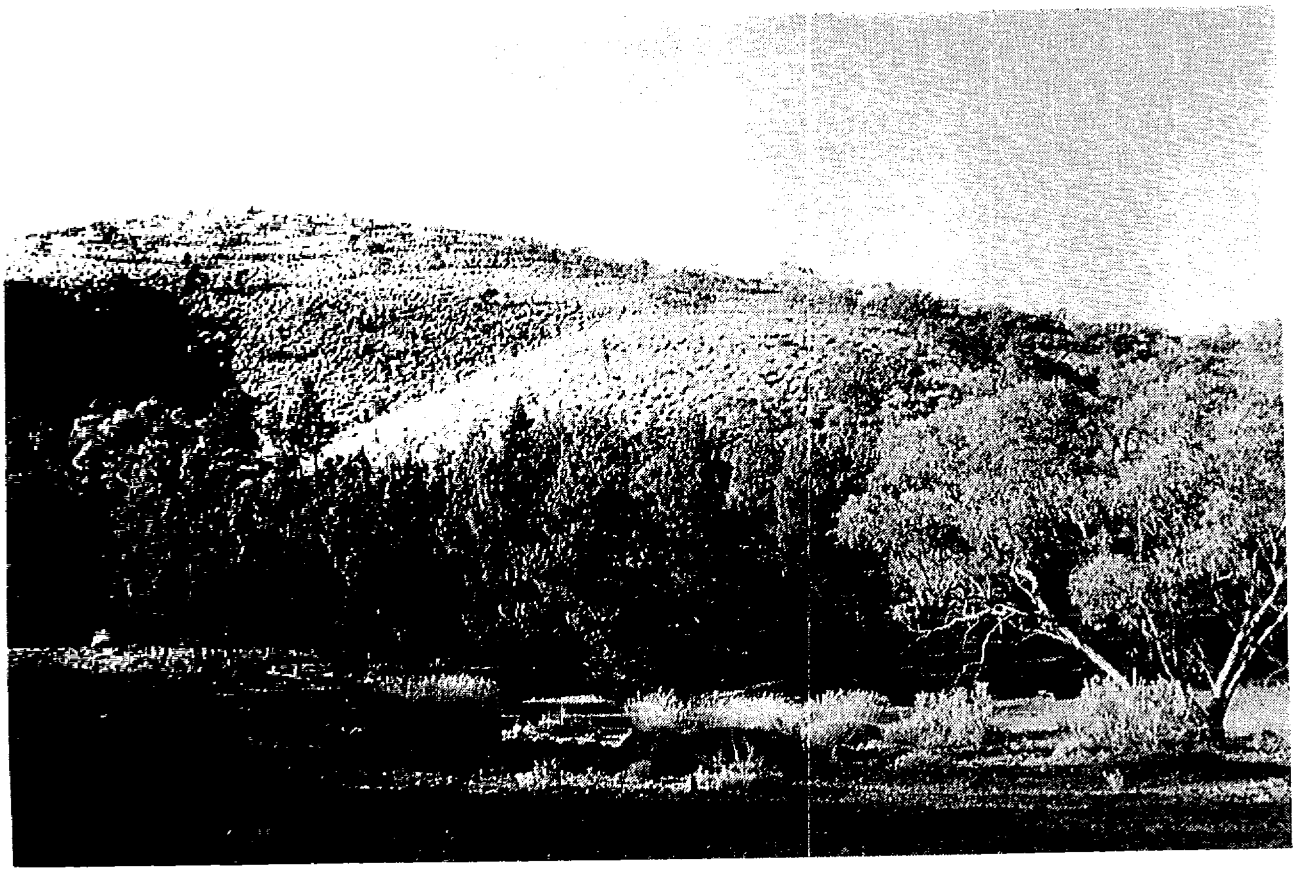


Figure 19
Spinifex covered hills and native pine woodland on Oolnina Park Station
Photo: L. Forward

Background

CLIMATE

by E. Shaw and L. R. Forward[1]

The climate of the South Olary Plains region is warm to hot in summer and cool to cold in winter. The variation in diurnal and seasonal temperatures can be significant. The area is in the rain-shadow of the Mount Lofty Ranges and as such rainfall is unreliable and shows no distinct seasonal pattern (Laut *et al.*, 1977). The nature of the climate has led to the area being considered the southernmost extension of the arid zone in South Australia (Department of Environment and Natural Resources, 1993a, b; Laut *et al.*, 1977).

The lack of weather recording stations equipped with temperature recording equipment within the area has made it necessary to utilise data from stations that are close to the region. However, there are numerous rainfall records available from within the area.

Annual rainfall within the area is low and irregular, varying between 170 mm and 280 mm but averaging 225mm per annum (based on records from 23 stations within the region) (Table 1). There is a slight predominance of rainfall in the winter and spring months.

Temperatures tend to peak in January and February and then drop from May until September. Throughout the study area temperatures are generally warm, however continentality is reflected in high seasonal and diurnal ranges (Laut *et al.*, 1977). Monthly trends in mean rainfall and mean daily maximum temperature from Renmark and Yunta are shown in Figure 20.

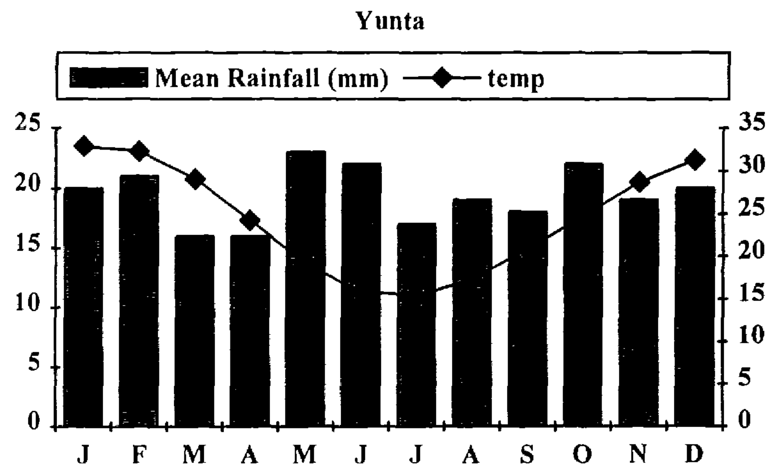
The cooler air temperatures in the winter months result in higher relative humidity values than those recorded in the summer months. For example, at Yunta, mean monthly relative humidities at 1500 hours range from 23% in January to 54% in June. These figures are higher at 0900 hours, with a figure of 36% in January to 83% in June.

Instrumented wind data for Yunta shows that during summer, winds are most frequently from the south-east, while during the winter months south-west to northerly winds are more prevalent. The wind speeds are generally less than 30 km/h (Laut *et al.*, 1977).

Table 1
Mean annual rainfall at stations and centres throughout the South Olary Plains.
Source: S.A. Bureau of Meterology

Locality	Mean rainfall per annum (mm)
Canegrass	250
Sturt Vale	186
Quondong	236
Braemar	255
Canopus	278
Hypurna	247
Faraway Hill	171
Braeside	226
Morgan Post Office	238
Overland Corner	251
Caroona	205
Old Koomooloo	213
Koomooloo	203
Florieton (Bundey Bore)	231
Netley Gap	227
Wadnaminga	238
Lilydale	185
Panaramitee	222
Mutooroo	207
Oakbank	233
Oulina	218
Yunta Post Office	233
Winnininnie	223

[1] E. Shaw & L. R. Forward, S.A. Department of Environment and Natural Resources, PO Box 1047, ADELAIDE, SA 5001



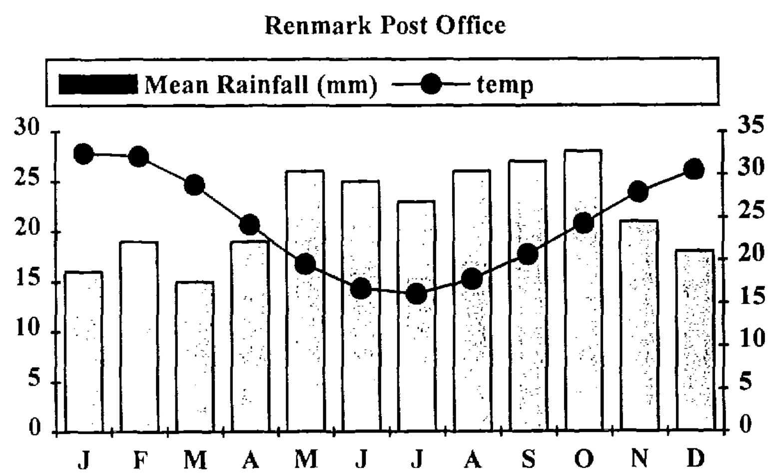


Figure 20
Mean monthly rainfall and mean daily maximum temperatures recorded at Yunta and Renmark Post Offices
Temperatures from 29 and 34 years of records respectively (recorded at 1500hrs). Rainfall from 102 years of records.

GEOLOGY AND GEOMORPHOLOGY

by S.R. Barnett[1]

GEOLOGICAL HISTORY

The South Olary Plains occupies a considerable area of the northwest Murray Basin. The geological history of the Murray Basin is a long one, beginning about 90 million years ago when Australia separated from Antarctica and began its very slow northward journey to its present position, moving at an average rate of 6 cm/year by a process called continental drift. Since that time, a variety of sediments have been deposited in the basin under widely different environmental conditions. Several of these sediment groups play an important role in the development of the present landscape. Figure. 22 shows the palaeo-geographic environment of the South Olary Plains at various times in the geologic past.

The oldest sediments were deposited between 60 and 30 million years ago when the climate was much wetter and more humid than at present. Rainforest covered the area and there were extensive rivers, lakes and wetlands. The sediments laid down in this environment were interlayered sands, silts and clays with occasional lignite beds formed by the 'composting' of the abundant vegetation. These sediments comprise the Renmark Group which lies on average, about 150 metres below the ground surface (Fig. 21).

Between 30 and 12 million years ago, sea levels rose around the world and the Murray Basin was flooded to as far inland as Swan Hill in Victoria. During this period marine sediments were deposited over much of the basin in South Australia and Victoria. These sediments vary in South Australia from south to north in response to a gradual change in the environment of deposition as shown in Figure 21. In the south, a fossiliferous limestone was deposited in shallow temperate seas. Called the Mannum Limestone (Fig. 22), it can be seen forming spectacular cliffs bordering the River Murray downstream of Overland Corner. Further north, the seas became shallower and more restricted and instead of limestone, the finer grained marls of the Winnambool Formation were formed in lagoonal environments. Further north still, the typical black clays of tidal flats were deposited and are known as the Geera Clay. Analysis of fossil pollen spores in this clay by Truswell *et al.* (1985) indicated the presence of evergreen rainforest with abundant myrtaceous trees and high year-round precipitation.

About 12 million years ago, the sea retreated due to a gradual build-up of ice in the Antarctic icecap which resulted in the land surface being exposed for another 6 million years. Then a shallow sea invaded the basin for a second time. Because of a different climate, limestones were not deposited and instead, as the sea retreated about 3 million years ago, extensive sand deposits were laid down. These sands are called the Loxton-Parilla Sands and are exposed in cliffs upstream of Overland Corner. It is thought that the ancestral River Murray began flowing at this time, along a course which approximately follows the present one.

About 2 million years ago, the coastal dune barriers deposited by the retreating sea eventually blocked the River Murray to the south of Swan Reach. Together with a wetter climate, this led to the formation of a giant freshwater lake called Lake Bungunnia which extended over 30 000 square kilometres into Victoria and NSW in the central part of the Murray Basin. Within this lake, the very fine grained sediments of the Blanchetown Clay were deposited. The barrier was breached about 700 000 years ago leading to the rapid draining of the lake.

The climate over the last 500 000 years has been generally dry which has led to a transition in the vegetation cover from rainforest to open woodland throughout the Murray Basin. However, there have been four or five major climatic changes from dry to moderately wet during this period. During the dry periods, strong westerly winds eroded the landscape and created the linear east-west red-brown sand dunes of the Woorinen Formation which are prominent in the present landscape (Fig 23).

During the last Ice Age, about 20 000 years ago, the sea level was about 150 metres lower than it is today. The ancestral River Murray flowed out across the continental shelf some 200 kilometres south of the present coastline. The lowered sea level also caused the river to cut deeply into the Murray Group limestone to form a spectacular gorge which is up to 100 metres deep below the ground surface in places.

As the climate became warmer and the ice caps and glaciers melted, sea level began to rise again to a maximum

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about 7 000 years ago which was several metres higher than the present sea level. This caused the River Murray to adjust its profile by depositing alluvium on its valley floor with an average thickness of 30 to 40 metres.

STRUCTURE AND LANDFORM

Figure 22 shows a north-south geological cross-section close to the SA/NSW border. It shows a very simple geological structure of flat-lying sediments which deepen and thicken towards the deepest part of the Murray Basin in the Renmark area, containing over 500 m of sediments. Settlement and compaction of these sediments has resulted in low ground surface elevation. Consequently, the topography of the South Olary Plains falls gently with minor variations from the bordering Mt Lofty Ranges and Olary Highlands toward Renmark and the River Murray. The cross-section also shows some faulting in the basement rocks, but it has very little if any surface expression.

There are however, some remnants of the last marine regression about 3 million years ago. These take the form of stranded beach sand deposits of the Loxton - Parilla Sands which form broad arcuate ridges to the east of 'Canopus', and also NW-SE trending linear ridges further north toward 'Oakbank'.

SURFACE GEOLOGY

Recent geological history obviously has a strong influence over the surface geology and soils and consequently also over the characteristics of the landscape. Aeolian (wind deposited) and colluvial processes (deposited by water, debris flows and landslides) have dominated the South Olary Plains landscape for the past 500 000 years or so. The simplified surface geology map (Figure 24) shows three major units with minor exposures of others.

The Woorinen Formation consists of unconsolidated red-brown silty sands and occasionally sandy clays which form extensive dunefields of discontinuous east-west dunes separated by broad swales and sand plains. The sands were deposited in an aeolian environment which was probably slightly more arid than at present, and typically reach a thickness of up to five metres.

The 'unnamed sand plain unit' forms extensive flat to gently undulating plains and consists of unconsolidated red-brown clayey sands which have been modified by soil processes resulting in the presence of calcrete nodules and layers. It is a thin unit with a maximum thickness of a few metres and occurs between the colluvial footslopes of the Pooraka Formation and the dune systems of the Woorinen Formation. Aeolian processes were responsible for its deposition.

The Pooraka Formation consist of red-brown, poorly sorted clayey sand and gravel which form extensive low angle alluvial fans and high angle scree slopes. These colluvial deposits include residual material from weathered basement rocks which form the margin of the Murray Basin, and are up to five metres thick.

Other units shown on the map include alluvial deposits which consist of unconsolidated gravel, sand and clay deposited in drainage lines by intermittent streams which flow only occasionally from the highlands out onto the plains (Fig. 25). In isolated low-lying deflation hollows, the removal of the overlying sand by wind action has exposed the Blanchetown Clay surrounding flat-lying claypans (Fig. 26). In the southern part of the South Olary Plains, some of these claypans contain gypsiferous clay and gypsum - sand mixtures of the Yamba Formation which were derived from evaporite beds found at the top of the Blanchetown Clay. Areas of calcrete represent fossil soil horizons formed by the precipitation of calcium carbonate under semi-arid conditions.

Published geological maps and explanatory notes are available from Mines and Energy S.A. for the whole of the survey area at a scale of 1:250 000. The geological maps have been digitized and consequently, maps of any area can be reproduced at any desired scale. A comprehensive and detailed summary of the geology of the Murray Basin as a whole has been written by Brown and Stephenson (1991) as part of a joint Commonwealth/State project.

ECONOMIC GEOLOGY

Because of the relatively young age of the sediments beneath the South Olary Plains, it may seem at first glance that the area is not prospective for economic minerals. However, this is not the case. Exploration companies have been searching for a variety of minerals which are not widely known. For example, there has been drilling into the stranded beach ridges for economic concentrations of heavy minerals such as rutile, zircon and monazite - so far without success.

Some years ago, an unsuccessful search was made in the northern margins of the plains for sedimentary uranium which may have been eroded from deposits in the Olary Highlands (such as Radium Hill) and transported out onto the plains by ancient streams.

Drilling for low grade brown coal or lignite found in the Renmark Group has been carried out in the western half of the area of interest. Elsewhere, these sediments are too deep for economic development. No deposits of sufficiently high grade or volume were found. In the south, between Renmark and Overland Corner, several petroleum wells have been drilled in the Renmark Trough to depths of 3 000 m without detecting any traces of hydrocarbons.

There are several isolated gypsum deposits (Morgan, Parcoola) which contain relatively large reserves of crystalline gypsum found in old lake floors together with finer grained seed and flour gypsum which form wind-deposited lunettes adjacent to the lakes. Rogers (1978) and Forbes (1991) contain further information and references on all of the above aspects of economic geology.

Groundwater is an important resource for the pastoral industry. Several aquifers exist below the plains which contain underground water moving very slowly southwards. Most of the water table is quite salty, however deeper aquifers, such as the Mannum Limestone and the Renmark Group, contain water suitable for stock over most of the area (10 000 to 14 000 mg/L). Hydrogeological maps (Barnett, 1991, 1994) show details of groundwater salinities and depths for the South Olary Plains area and are available from Mines and Energy S.A.

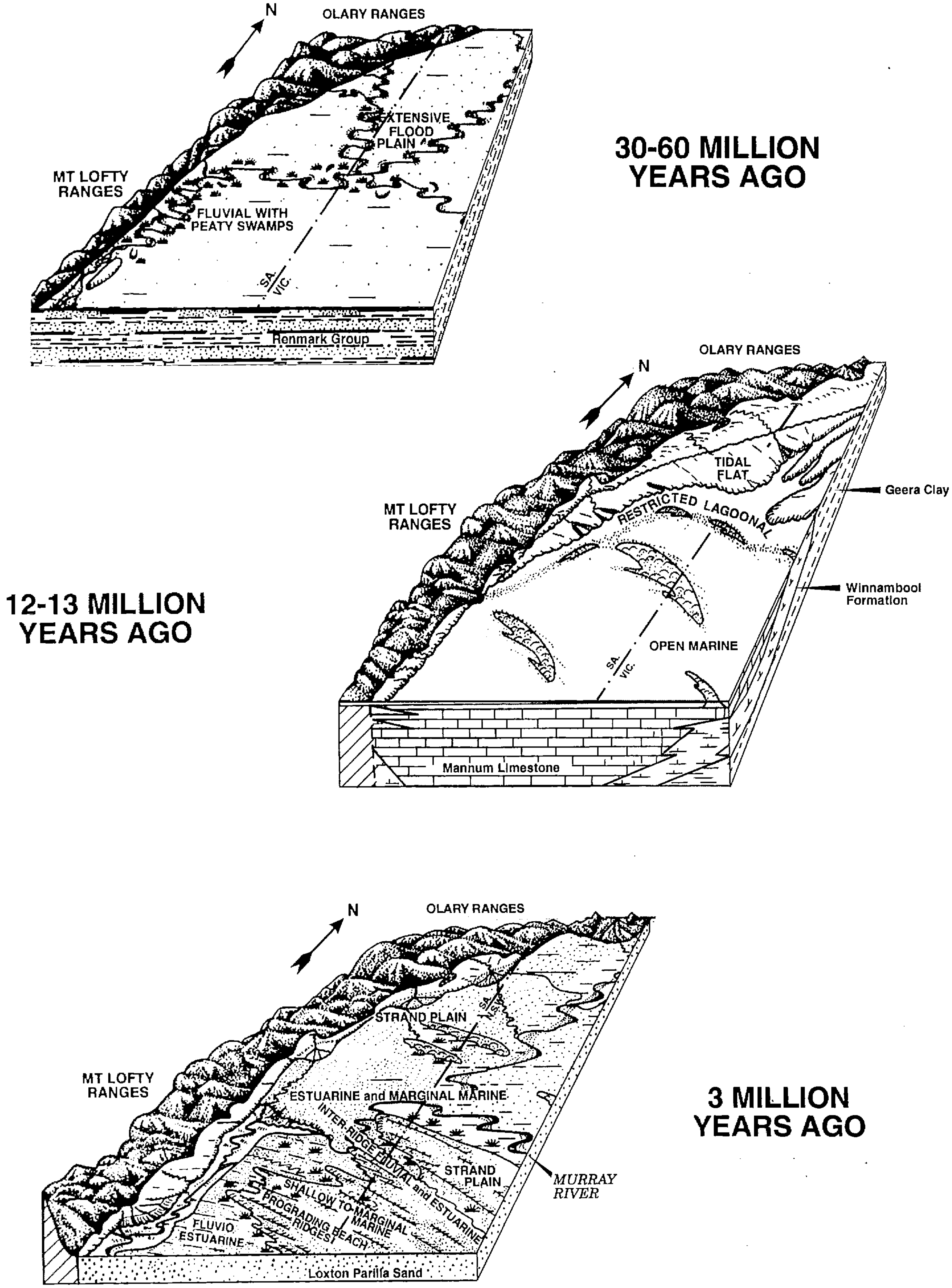

Figure 21
Palaeo-geographic environments of the South Olary Plains

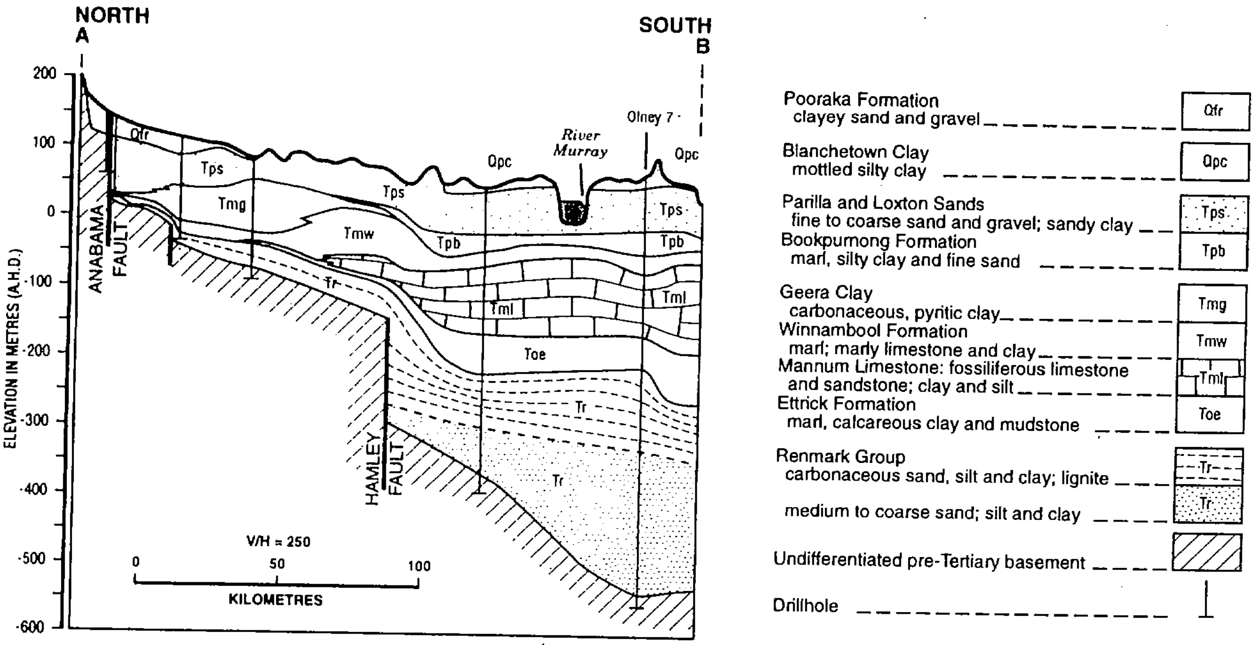

Figure 22
Geological cross section (north-south) of the South Olary Plains

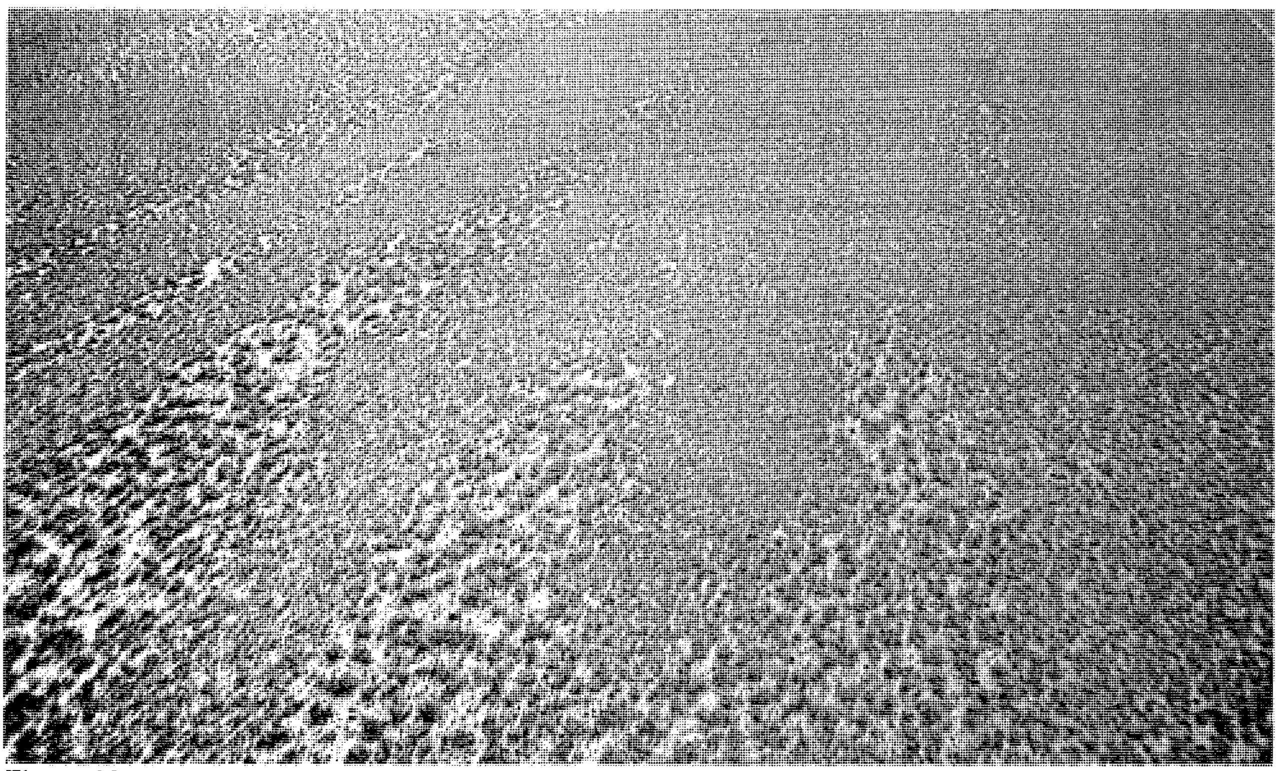

Figure 23
The extensive dunefields of the Woorinen Formation in the south-eastern South Olary Plains
Photo: P. Canty

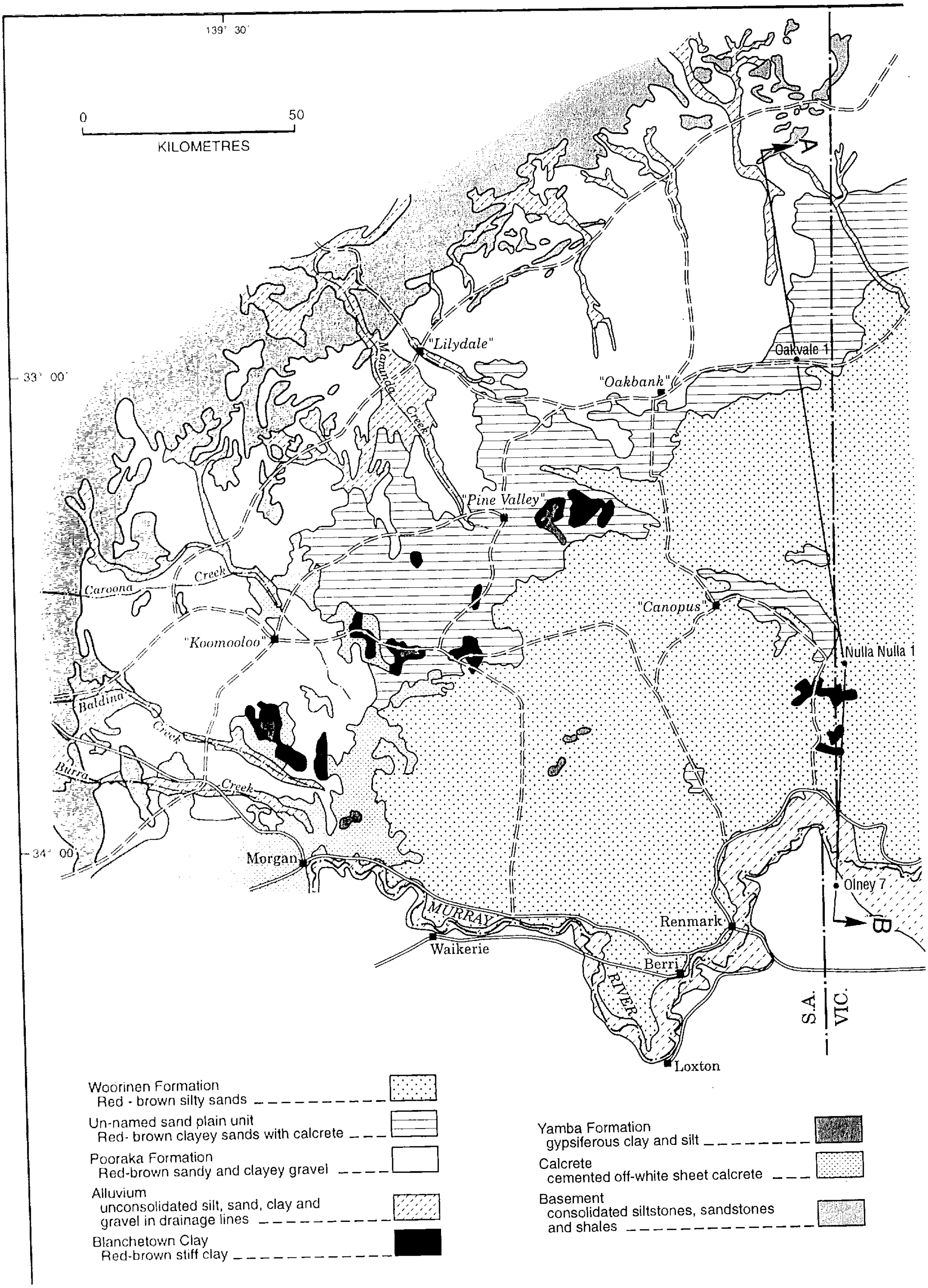

Figure 24
Simplified surface geology of the South Olary Plains

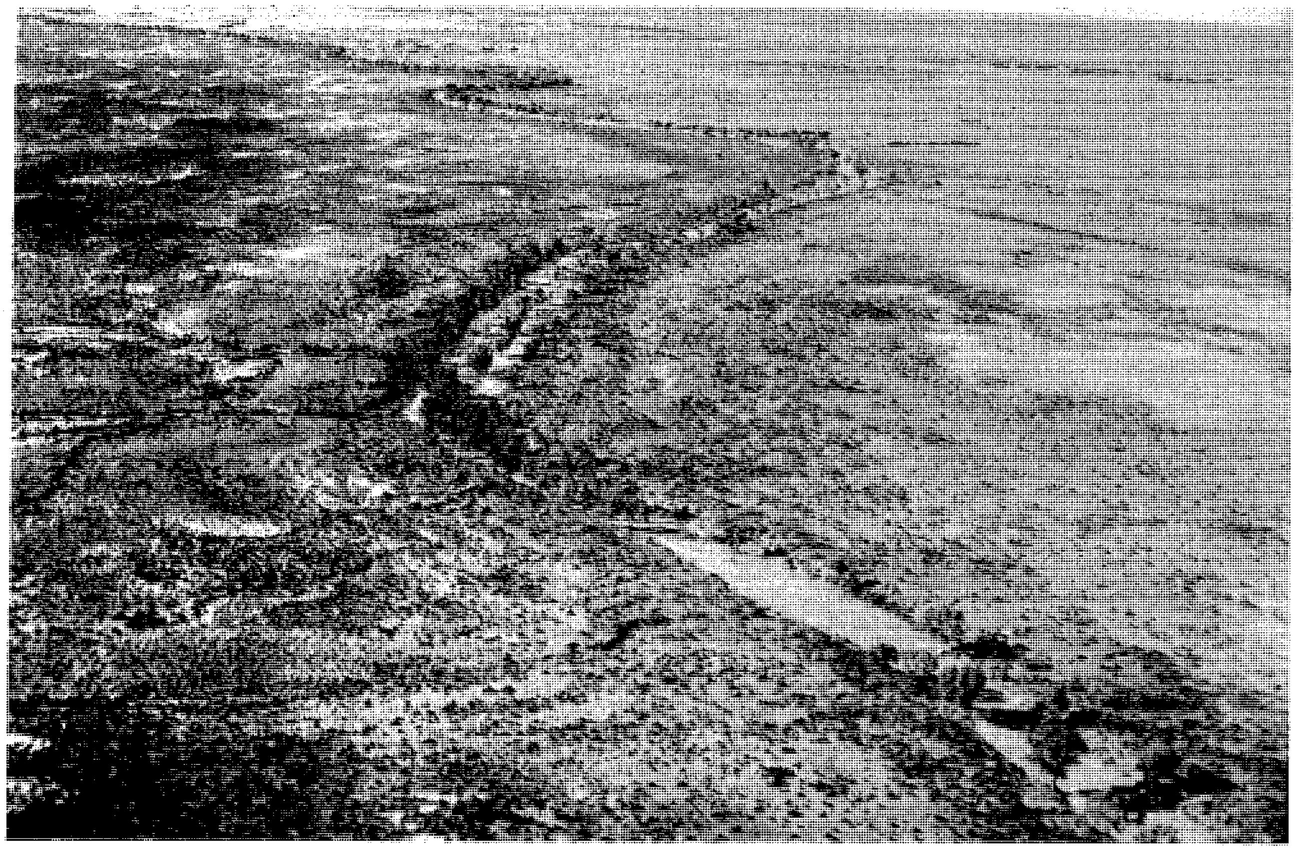

Figure 25
Manunda Creek drainage line and floodout
Photo: P. Canty

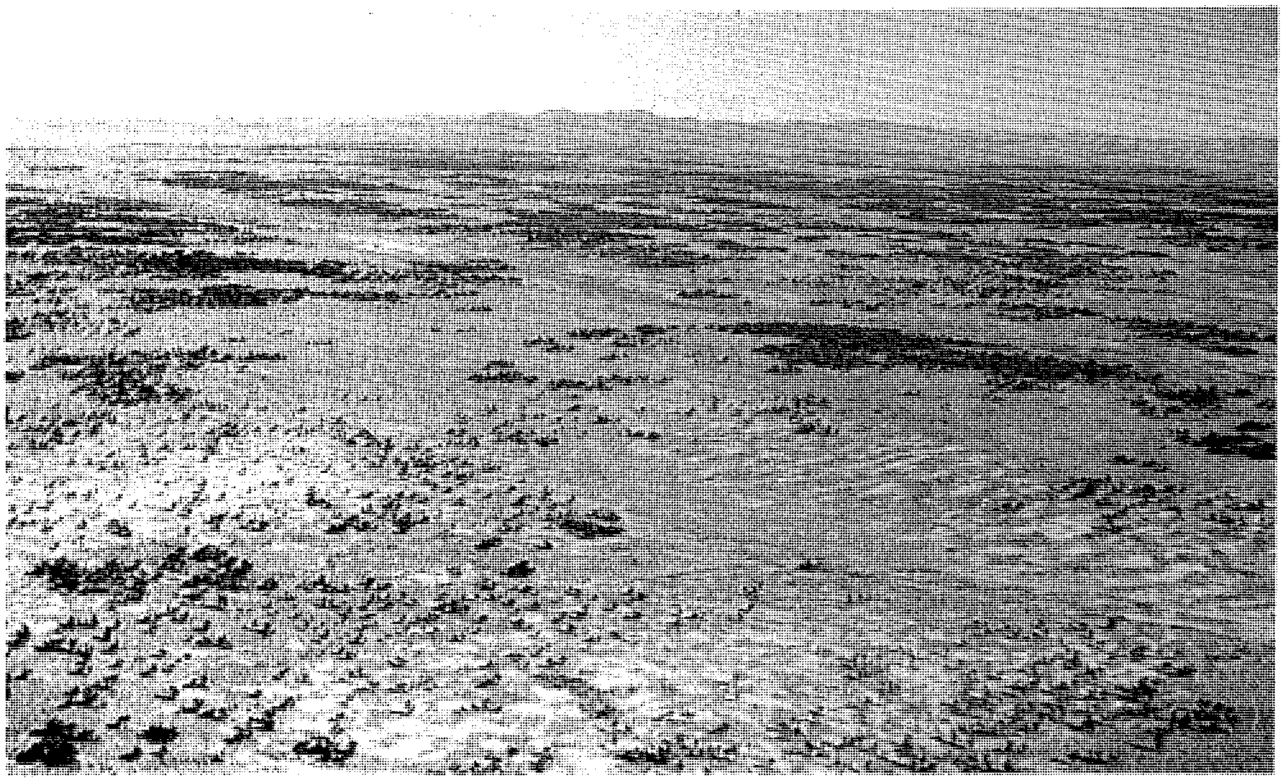

Figure 26
Deflated hollows with claypans north east of Mt. Bryan
Photo:P.Canty

LAND-USE HISTORY

by E.Shaw and A.C. Robinson[1]

ABORIGINAL HISTORY:

There is a long Aboriginal history in the South Olary Plains with rock engravings or petroglyphs from the Karolta site just N of the present survey area revealing a continuous and largely unchanged tradition of rock art from 30 000 to 1 400 years B. P. (Before the Present) (Nobbs and Dorn, 1988). At this time people were also known to be living in the arid zone in the vicinity of the Willandra Lakes some 200 km to the S.E. There has been continuing discussion of the validity of the dating used at the Karolta site (see Watchman, 1989, 1992) but it is clear that Aboriginal occupation of this part of Australia is of great antiquity.

A preliminary report on Aboriginal sites of the upper River Murray region of South Australia indicates the Chowilla region (in the south-east of the South Olary Plains) is rich in Aboriginal sites (V. Edmunds, pers. comm., in Department of Environment and Natural Resources, 1993). It appears the history of Aboriginal occupation dates back 12 000 years to the Pleistocene era but it has not yet been determined if this was a continuous occupation through to historic times.

The South Olary Plains area is rich in archaeological and ethnographic material. When Europeans arrived there were eight tribal areas within the region and these have been mapped by Tindale (1974) (Fig. 27). These tribes utilised the area as described below.

European diseases such as smallpox and influenza spread down the River Murray and caused significant loss of Aboriginal lives, even before they actually had direct contact with Europeans. Later, conflicts with overlanders and settlers over land ownership led to even more deaths and today there are no known descendants of some of the original tribes (Department of Environment and Natural Resources, 1993).

Danggali:

Encompassing a large portion of the central South Olary Plains, this group occupied the plains to the South-west of Broken Hill, predominantly in more arid country extending eastward to the Darling River. Within the South Olary region the Danggali people concentrated mainly around the clay plans to the south of Morganvale. However, there is little evidence of occupation in the remainder of the study area (Department of Environment and Land Management, 1993b; Tindale, 1974).

The Danggali people were scrub dwellers depending on the water available from *Eucalyptus oleosa* and *Hakea* roots, except when droughts forced them to move to major water ways (Tindale, 1974).

In 1864 a young man Nanja, argued with his tribe and was forced to flee after killing a man in a droving camp. Troops were sent out to capture him, however, he escaped into Danggali territory taking several other Aborigines with him. Nanja and his group lived in the Canopus area for 30 years relatively undetected. It was not until the early 1890's that this group were persuaded to come into the Avoca Station (Showell, 1978; Tindale, 1974).

Ngadjuri:

The tribal area of the Ngadjuri people is located in the north-western corner of the survey area . An alternate name for this group was Wirameju (['wira] = gum tree, ['meju] = men) indicating that they inhabited gum forest areas (Tindale, 1974). Prior to the arrival of Europeans in the area, the Ngadjuri people were the instigators of aggressive attempts to impose the circumcision rite on the River people near Morgan (Tindale, 1974). The last few members of the Ngadjuri lived at Quorn, at Riverton, and on Willochra Creek. The Mimbara horde (name of the most northern horde) is believed to be one of the last remaining "wild" groups in South Australia, until they finally disappeared in 1905 (Tindale, 1974).

Ngaiawang:

The Ngaiawang tribal area extended along the Murray River from Herman Landing to Penn Reach and then westwards to the scarp of the Mount Lofty Ranges. in the south-western corner of the South Olary study area. Eyre encountered about ten hordes of this tribe at Lake Bonney (Tindale, 1974).

Ngawait:

Located on the banks of the Murray River between Boggy Flat and Penn Reach to near Loxton (Tindale, 1974).

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Erawirung:
The tribal area of the Erawirung people extended on the eastern bank of the Murray River above Paringa to Loxton and approximately 40 kilometres south into the sandy country and on the western bank, from Rufus Creek west to near Overland Corner . Shaw (see Taplin, 1879) noted that the Erawirung possessed mines of chert stone at Springcart Gully and to the south of Renmark; and they actively defended this important resource (Tindale, 1974).

Ngintait:
The Ngintait predominantly inhabited the southern side of the Murray River from above Paringa to near Mildura. However, their territory did include the northern side of the river around Salt Creek and between Chowilla and Hunchee Islands (Department of Environment and Natural Resources, 1993; Tindale, 1974).

Maraura:
The tribal area of the Maraura people extended from Wentworth on the northern side of the Murray River down to Chowilla and Ral Ral. The members of this tribe had a semi-permanent lifestyle (Department of Environment and Natural Resources, 1993), in the summer they remained at Lake Victoria, while in winter they moved to the back plains, where small water holes had filled with rain water (Tindale, 1974). In the 1830's the Maraura people challenged the overlanders driving sheep and cattle into South Australia (Tindale, 1974).

Wiljakali:
The tribal area of these people extended to the west of Olary. Howitt (1904) indicates that the Wiljakali resisted the Ngadjuri who were actively trying to enforce the rite of circumcision.

EUROPEAN HISTORY:

Early history and Overland Corner
The European history of the South Olary Plains Survey Area began in 1830 when Charles Sturt travelled down the Murray. Landing at Herons Bend he climbed the cliffs to see the direction of river flow (Sturt, 1833 in Harris, 1982).

It was not until 1838 that the next Europeans passed through this area. Joseph Hawdon and his partner Charles Bonney, the first overlanders, drove 300 head of cattle from Howlong on the Murray in New South Wales to Adelaide. Once they had crossed the border they followed the northern bank of the River Murray down to Overland Corner. From there they moved on to the Nor'West Bend (now known as Morgan) and then into Adelaide. The route of Hawdon and Bonney was soon recognised as the "overland route" to the new capital city of Adelaide (Woolmer, 1978).

By 1839 there were large numbers of sheep overlanded from New South Wales to South Australia using this route. For example Alexander Buchanan and seven other men combined to form a party to drove their own flock as well as 5,000 other sheep for Frederick Dutton of Mount Dispersion Station (later called Anlaby) near Kapunda (Woolmer, 1978). The large number of overlanding parties using the route led to conflict with Aboriginal groups in the area and the inevitable reprisals. In 1841 Major O'Halloran and his party passed through Overland Corner on their way to Rufus River, near Lake Victoria. Their mission was to deal with a group of Maraura Aborigines who had attacked an overlanding party near the river. The "Battle of the Rufus River" occurred a few days after they had passed through Overland Corner (Woolmer, 1978).

By the 1860's Overland Corner was the major centre serving this area and had become an important staging post on the mail run from Wentworth. Packhorses were originally used to link with the mail coach terminus at Wentworth. The Packhorse service travelled from Overland Corner to Kapunda via Blanchtown. However, by 1866 the packhorse was superseded by a mail coach service that ran to Overland Corner to Blanchtown and then on to Freeling. The mail was then carried into Adelaide by rail (Cooper, 1978; Woolmer, 1978).

The popularity of Overland Corner as a droving overnight camping place continued to grow, as the river flats provided good stock grazing and water. By the 1870's there could be up to 30 000 sheep and several herds of cattle in the area on a single night (Cooper, 1978; Woolmer, 1978).

By the beginning of the early 1900's the importance of Overland Corner had began to fade. The drovers had disappeared, the Police Station closed (1894) and the hotel ceased to hold a licence (1897). In 1899, there was a chance of resurrecting the town with a Silver Mine by a group of Cornish miners. However, within a short period of time the mine had "petered out" (Woolmer, 1978)

The growth of agriculture and pastoralism
During the 1840's, grazing and farming activities spread from around Adelaide and the areas to the west of the Mt Lofty Ranges were soon fully occupied and expansion into the drier mallee areas to the east began in earnest.

In the Mid-North, the first Europeans occupying this area, leased land and established stations such as Anlaby and Koonoona. After 1850, the land was surveyed and divided into smaller blocks. This opened the way for more settlers to move in. Township areas such as Lapford on the Burra Creek were surveyed to support this more intensive settlement but no town ever became established (Robertstown District Council, 1986).

The areas east of the River Murray were leased for pastoralism until 1870 when Hundreds were proclaimed and agricultural development began (Williams, 1974). Large areas were cleared for crops but in the northern Murray Mallee the lower rainfall produced unfavourable results and many areas reverted back to grazing (Jessup, 1948).

The early pastoralists had to rely entirely on natural surface waters so early grazing in the South Olary Plains was confined to areas along the River Murray, in swampy areas on a few other watercourses and around permanent rockholes in the Olary Spur (north-north-east of the Plains).

In the late 1850's and 60's a number of pastoral runs were established along the main part of the Olary Ranges under a British Act of Parliament to control "wastelands in the Australian Colonies" (Tiver, 1994). Because of water scarcity, the South Olary Plains (south-east of the ranges) were not used for pastoralism until after 1870. Sheep and cattle were initially stocked but sheep were soon found to be more successful (Tiver, 1994).

Chowilla Station

The development of the Chowilla pastoral lease is an example of a property gradually expanding from the permanently watered areas along the River Murray. The following account of the history of Chowilla Station is paraphrased from an article by J. Chappel in Barrett and Choate (1983).

In the late 1860's, Richard Holland, a notable breeder of horses, cattle and sheep leased land south of the River Murray. North of the river on land that today comprises the properties of Chowilla and Calperum and the town of Renmark, he established a property called Bookmark for his three step sons (the Robertsons).

Cattle were initially run on the properties but the Robertsons soon turned to the more profitable sheep grazing. Tally books detailing the number of sheep shorn show that in October 1869 (the oldest record) 11 807 sheep were shorn by 15 shearers. In 1881, the biggest tally was recorded with 70 250 sheep being shorn by 30 blade shearers. Up until 1963 bales were stored in the woolshed until the river was high enough for steamers to reach the station frontage.

William Robertson, one of the three sons, left the partnership in 1887. It was in the same year that the S. A. Government excised 30 000 acres from the Bookmark lease for a local irrigation scheme. The town of Renmark was laid out on this land in 1886

In 1896 Bookmark was divided into Calperum and Chowilla, with the name Bookmark no longer being used. The two remaining sons, Robert and John, lived at Calperum and Chowilla respectively. The Calperum lease changed hands twice more but Chowilla stayed with Robert Robertson, his wife and their descendants, who still hold the property, and have made Chowilla Station a large successful pastoral holding.

Over the years four homesteads and two shearing facilities have been built, one on the river and a second twenty miles north to serve the back country. Eighty five kilometres of pipeline were laid, in the 1950's, to supply the back country with a permanent supply of good quality stock and domestic water from the Murray. A number of attempts have been made to diversify the holding, from being solely a pastoral enterprise. The first, the Orangery, was established in 1911, while in the 1970's' an Angora Goat Stud was set up. However, the Merino Stud is still by far the most successful enterprise.

In 1963 the River Murray Commission acquired 184 square kilometres of the Chowilla flood plain. It was proposed to use this land to construct a dam, which would act as a major water storage site for South Australia.. The Chowilla Dam project never eventuated due to problems associated with shallow waters and high salinity levels. The proposal was replaced by upstream water storage and controlled water releases to South Australia (Department of Environment Natural Resources, 1993).

It was during the delay pending a final decision on the Chowilla Dam project, that the Company of Robertson - Chowilla Pty. Ltd. was able to secure a short term lease back arrangement of the land in question. In 1992, following extensive public consultation by the Murray - Darling Basin Commission and State Government agencies, it was decided to finally abandon the Chowilla Dam project and to release the land. The final decision was that the site should revert to public land to be managed within a conservation framework. However, provision was made for the continuation of sheep grazing. In 1993, a lease agreement was drawn up to clarify grazing and ownership rights prior to the establishment of the Chowilla Regional Reserve (Department of Environment and Natural Resources, 1993).

Other stations of the South Olary Plains

Pastoral development of the poorly watered mallee lands away from the River Murray was slower. The land on which Danggali Conservation Park is now located was not settled until the start of this century. In 1916, Henry Martin established Canopus Station which was to become the largest out of four in the area. The other three stations were: Hypurna, Morgan Vale and Postmark (Department of Environment and Land Management, 1993b; Showell, 1978). Many individuals and many companies bought and sold land in this area.

From the time of the establishment of Canopus in 1916 by Henry Martin to 1960, 66 dams were constructed. In this area the ground water is approximately 150 metres below the surface and is very salty making the construction of such a large number of dams the only option to successfully maintain stock. Oxen, horses, bulldozers and tractors were utilised in dam construction. Although soil structure and the high evaporation rate meant that many of the dams could not provide reliable stock water throughout the year, most of the dams held adequate water in all but the driest years.

Further north out of the mallee and into the chenopod shrublands sheep grazing developed later than areas with a river frontage. Quondong Station was first taken up in 1873 and its subsequent development as a grazing property has been summarised by Barker (1970). The first water and hence the first stock, on Quondong were based on Woolshed Dam which was dug into a natural drainage area in 1876. By 1880 seven more dams were complete and by 1890 a further 8 had been developed. Initial grazing using shepherds was carried out in the wash country around the homestead and Surveyor General George Goyder, who had the opportunity to see the changes in the country over this period of intense early stocking stated that the practice of shepherding was much more destructive than the later practice of allowing sheep to range freely within fenced paddocks.

In spite of the development of dams and fencing, problems with severe overgrazing by rabbits, loss of stock to dingoes and drought forced the abandonment of stocking on all but the best portions of the Quondong lease by 1890. A picture of just how bad this drought was can be found in Whitington (1897). He describes the land he passed through in this region as 'parched and thirsty looking. There was not a particle of herbage in any shape or form. The bush in some places was killed altogether in other places only black sticks remained of it and even where stock could not get at it was dusty and dry looking .' He describes in some detail the problems the pastoralists in this North East country were having with dingoes and rabbits and pleads for a new approach to pastoralism involving conservation of the native perennial vegetation and substantial reduction in stocking rates following the breaking of the drought.

Whitington ends, in the style of his time, 'on the wings of sleep I was carried twenty years into the future, and I travelled over the same country which I visited in 1897. Queen Mab kindly provided a good season. The fields were waving with feed, the dams were full, the runs had been vermin fenced, the paddocks sub-divided, water conserved and the country "brought back". Mr Whitington would no doubt be pleased with the present pastoral industry in this area but the legacy of those terrible early years of overstocking and drought have changed the face of this country irrevocably and land managers today are managing land that is a pale shadow of that which produced the massive profits 'mined' from this country in the late 1800's

Land degradation and clearance

When sheep grazing was introduced to arid Australia in the nineteenth century, its impact on the native shrublands was both sudden and disastrous. In the early days of pastoralism, very heavy stocking led to severe degradation or even total removal of the native vegetation in many areas, particularly around water points (Wood, 1937). This subsequently caused severe erosion and enormous loss of topsoil, which was particularly devastating during droughts. In more recent years, stocking rates have been reduced and management practices changed, in recognition of the inherent cycle of drought in the arid zone and the need for sustainability of the native vegetation.

The drought years around the turn of the century wiped out many of the smaller farms in the southern and western areas of the South Olary Plains survey region and considerable consolidation of holdings took place. Fifty years of clearing and farming however left extensive severely degraded areas, the legacy of which still effect today's landholders in the area.

Intermittent clearing of areas of native vegetation in these southern and western zones continued into the late 1970,s. The last two decades however, have witnessed the introduction of an extensive land acquisition program for parks and reserves, and also the establishment of clearance controls in conjunction with a scheme aimed at encouraging farmers to manage vegetation for conservation purposes (Dendy and Robertson, 1987). Today, broad-acre clearance of native vegetation in South Australia has effectively ceased under the *Native Vegetation Act 1991* (S.A). Table **2** shows the extent of native vegetation clearance within the South Olary Plains Survey Area.

Figure 27 shows the Hundreds in and around the South Olary Plains survey area, which are mostly under perpetual leasehold and agricultural management.

Figure 29 shows the pastoral leases of the area.

Table 2

Remnant vegetation figures for South Olary Survey Area (1986).

The definition of native vegetation included samphire, mangroves, spear grass plains and chenopod shrubland. Scattered trees, roadside vegetation and blocks of vegetation less than 25 hectares were excluded. The values for National Parks and Wildlife Reserves are shown separately (Native Vegetation Management Branch, 1987). Refer to Fig. 28 for location of Hundreds

Hundred	County	Area (Ha)	Remnant Vegetation (Ha)	Remnant Vegetation %
Baldina	Burra	28878	19001	65.8
Bright	Burra	24087	6985	29.0
Bundey	Burra	29267	24994	85.4
Hallett	Burra	34965	20699	59.2
Hardy	Kimberly	37493	37493	100.0
Ketchowla	Kimberly	42058	42058	100.0
King	Burra	30562	30562	100.0
Lindley	Burra	40145	40145	100.0
Markaranka	Young	38332	23804	62.1
Maude	Burra	29785	29785	100.0
Mongolata	Burra	24087	24087	100.0
Parcoola	Young	22274	10001	44.9
Parnaroo	Kimberly	32893	32893	100.0
Pooginook	Young	37814	11003	29.1
Rees	Burra	26018	26018	100.0
Stuart	Young	26418	26418	100.0
Tomkinson	Burra	41244	41244	100.0
Wonna	Kimberly	34706	34706	100.0

CONSERVATION

Five conservation parks (Pooginook, Pandappa, White Dam, Danggali and Cooltong) and one regional reserve (Chowilla) are located in the South Olary Plains area (Fig. 30).. Recently, the latter three, the Calperum pastoral lease and the Chowilla Game Reserve have been joined to form the Bookmark Biosphere Reserve.

Danggali Conservation Park is located in the Murray Basin, approximately 70 kilometres north of Renmark. The 253 380 hectares of the park originally comprised four adjoining pastoral properties: Canopus, Morganvale, Hypurna and Postmark. The four properties were purchased with Federal funds in 1975, and then combined in 1976 to form what is now known as Danggali Conservation Park (Department of Environment and Natural Resources, 1995).

Danggali is the only park in South Australia in the Canopus, Pine Valley, Gairloch Dam and Hypurna Environmental Associations (Laut *et al.* 1977) and the park therefore protects the largest remaining samples of these associations.

In 1977, Danggali was made Australia's first Biosphere Reserve under UNESCO's Man and Biosphere Program. The aim of this program is to develop a world wide network of reserves representing examples of principal ecosystems and gene pools (Department of Environment and Natural Resources, 1995).

Pooginook Conservation Park covering 2852 ha is situated on the Northern side of the Murray River, 12 kilometres north east of Waikerie and was dedicated in 1970 It is located in the Upper Murrayland Environmental Region of Laut *et al.* (1977) and acts as an important refuge area for a number of fauna species, in particular for the hairy nosed wombat (*Lasiorhinus latifrons*) and the mallee fowl (*Leiopoa ocellata*) (Department of Environment and Land Management, 1994).

Pandappa Conservation Park, dedicated in 1973, is 40 kilometres south east of Peterborough and covers an area of 1057 ha. It lies in the Terowie Environmental Association of the Olary Spur Environmental Region (Laut *et al.*, 1977)

Most of this region has been cleared for grazing and cropping, with only a few scattered remnants of native vegetation surviving. The park is a valuable reserve for local vegetation communities and acts as a refuge for native fauna.

White Dam Conservation Park is located on the Morgan - Burra Road, eight kilometres north west of Morgan. The park covers an area of 911 ha. and was dedicated in 1969, being originally part of a stock route (Department of Environment and Natural Resources, 1994). It is situated just inside the Upper Murraylands Environmental Region of Laut *et al.* (1977) and is contained within the Mt. Mary Environmental Association. Most of the region's vegetation has been substantially altered by sheep grazing so this small park is a valuable asset.

Chowilla Regional Reserve occupies the former Chowilla pastoral lease immediately south of Danggali Conservation Park. The river floodplains at the southern end of the reserve are designated Chowilla Game Reserve and are bounded in the south by the River Murray

.

The establishment of the Chowilla Regional Reserve, in 1993, was the direct result of the Murray-Darling Basin Commission's Chowilla Resource Management Plan (Murray-Darling Basin Commission's Chowilla Resource Management Plan, 1992). By declaring Chowilla a Regional Reserve, the area could be used for multiple activities while still being managed within a conservation framework. Sheep grazing, mining and tourism can still continue providing it is in accordance with the strict guidelines laid down (Department of Environment and Natural Resources, 1993). The Regional Reserve Management Plan also recommended the establishment of a Game Reserve which resulted in the flood plain area being declared the Chowilla Game Reserve.

Bookmark Biosphere Reserve comprises Danggali and Cooltong Conservation Parks, Chowilla Regional Reserve, Chowilla Game Reserve, Calperum pastoral lease and seven other smaller parks and reserves along the River Murray, totalling 603 342 ha. UNESCO's Man in the Biosphere Program developed the concept of Biosphere Reserves to facilitate the rational use of the world's limited natural resources. These reserves are areas where the conservation of ecosystems and their biodiversity is combined with sustainable use of natural resources for the mutual benefit of local communities, scientific organisations and the environment (Murraylands Conservation Trust, 1995)

Bookmark Biosphere Reserve is managed by the Murraylands Conservation Trust which comprises representatives of the local community and land management agencies. This Trust and the Reserve represent a unique form of conservation management, a first for South Australia.

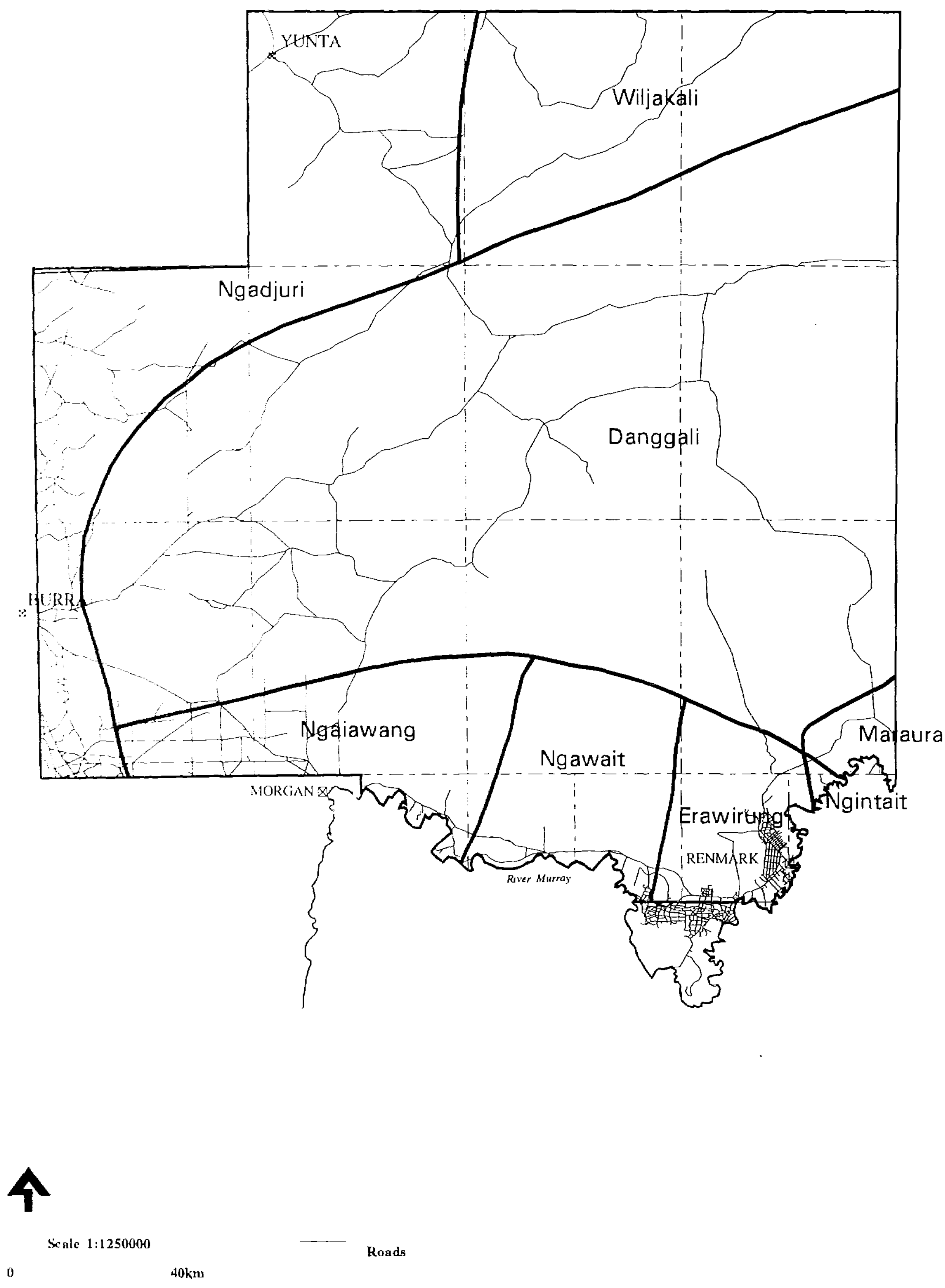

Figure 27
Aboriginal tribal boundaries in the South Olary Plains (adapted from Tindale, 1974)

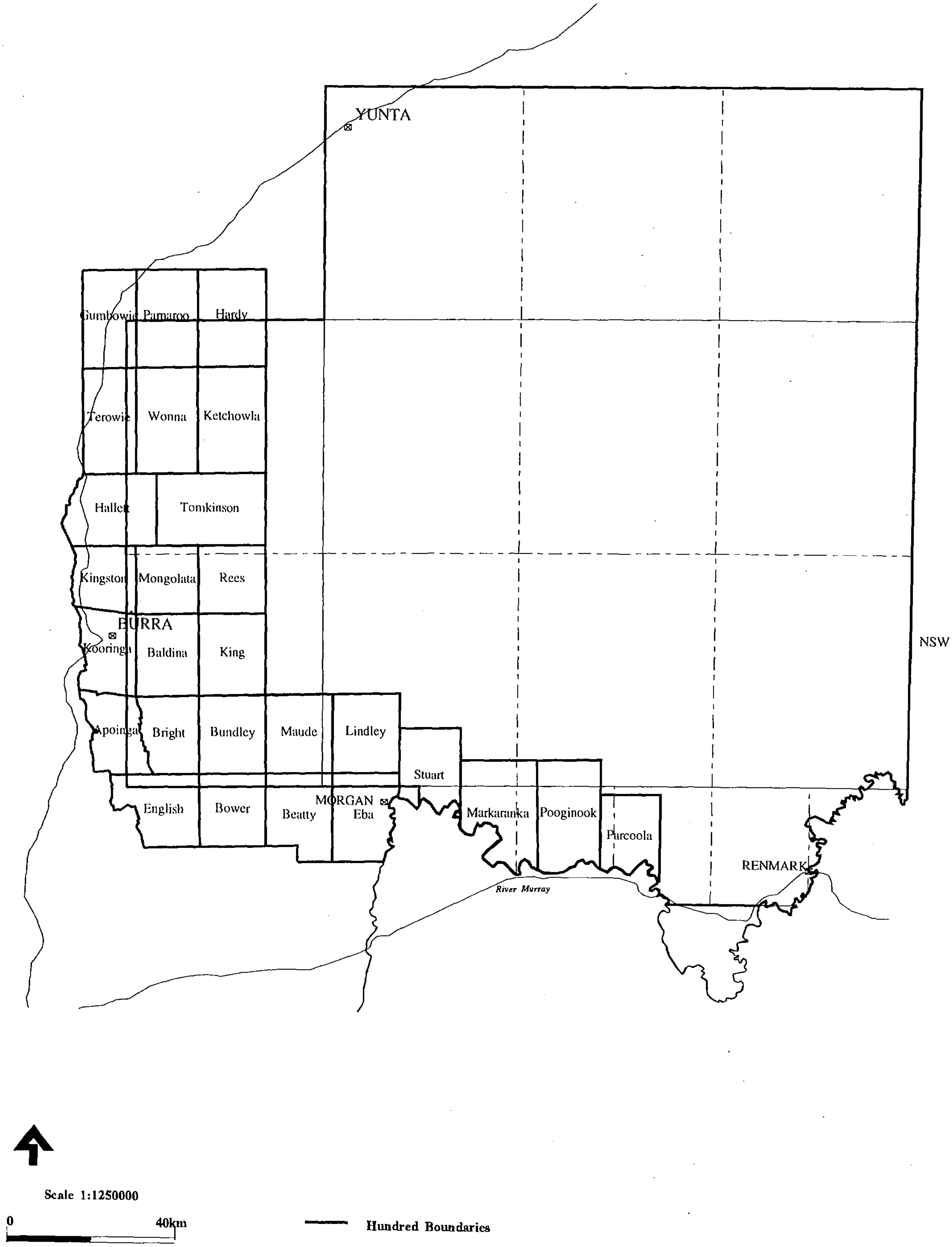

Figure 28
Hundreds in the South Olary Plains survey area

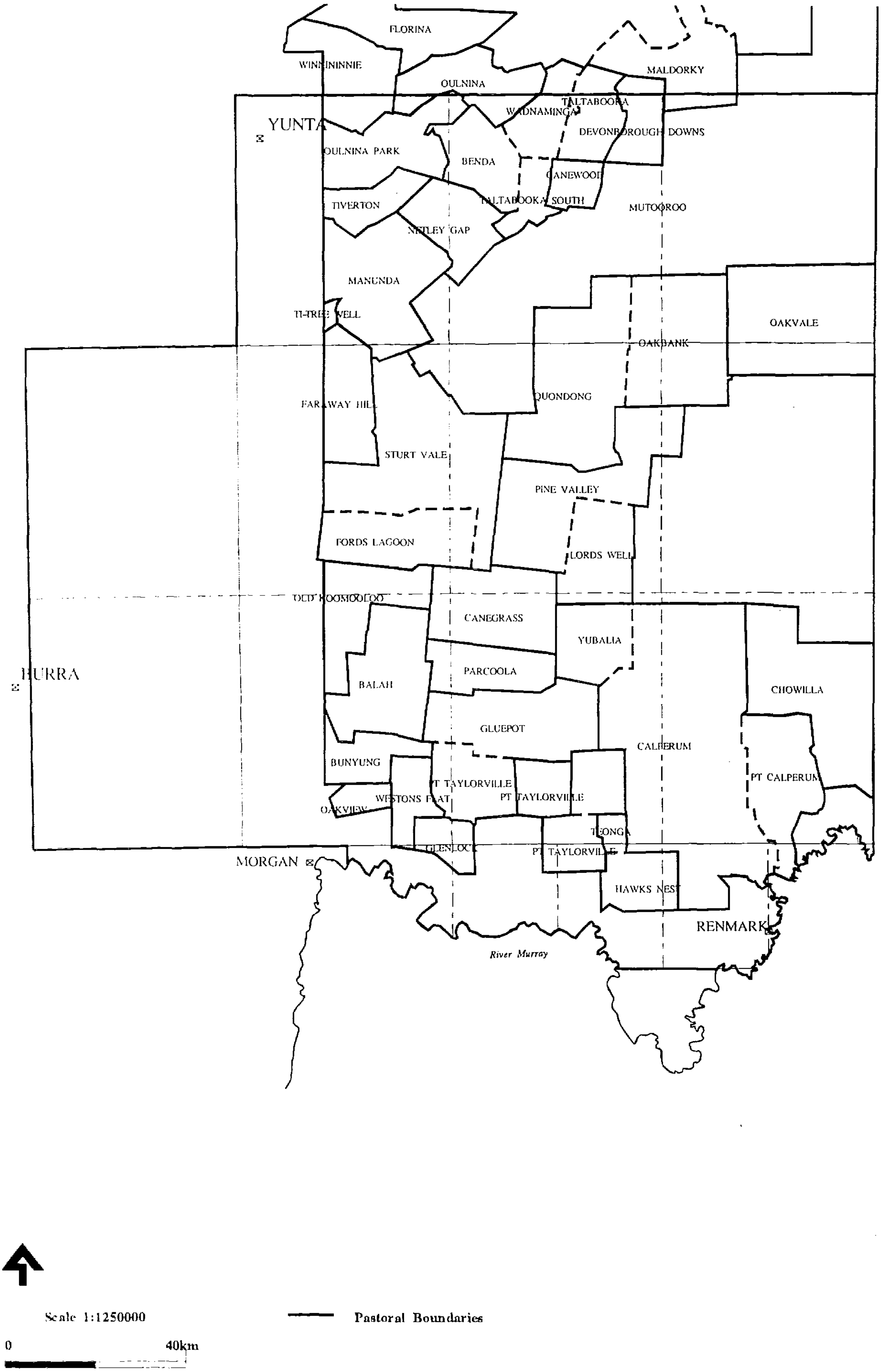

Figure 29
Pastoral leases in the South Olary Plains survey area

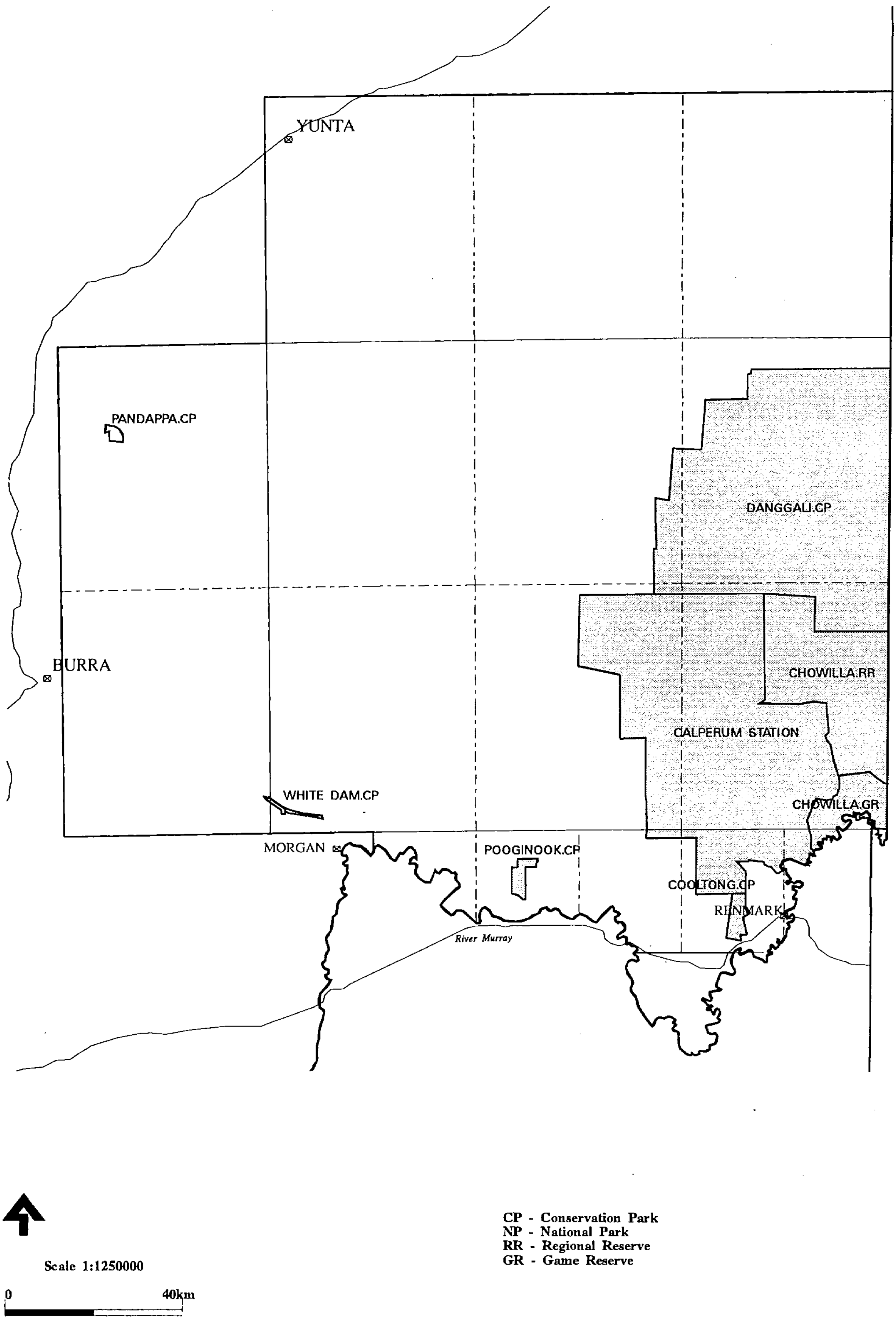

Figure 30
Conservation Parks in the South Olary Plains survey area

PREVIOUS BIOLOGICAL STUDIES

by L. R. Forward and E.Shaw[1]

A number of early botanical studies in South Australia produced vegetation maps of the whole state (Prescott, 1929; Wood, 1937; Specht, 1972) but very little work was conducted on a regional basis. In the South Olary Plains numerous small studies, mostly botanical, have been undertaken more recently on one or a few individual properties at a time, but very little comprehensive biological survey work has been conducted over the whole region.

In the earliest work, Jessup (1948) listed plant species, mapped the vegetation and documented the effects of overgrazing on species distribution and abundance in the counties of Burra, Kimberley and Eyre (of which the first two are on the western edge of the South Olary Plains survey area). It was not until twenty years later that Barker and Lange (1969a, b) studied the effects of sheep stocking on the arid zone vegetation of Quondong Station (in the centre of the current study area). Barker (1970) produced extensive species lists and a vegetation map for the property, and assessed the effects of historical factors on pastures.

Noy Meir (1971) systematically surveyed 240 000 square kilometres of the semi-arid winter rainfall zone of south-eastern Australia, conducting extensive floristic multivariate analyses. Twenty six of these sites were in the southern part of the present survey area. Sparrow (1989, 1990) surveyed the mallee belt of South Australia to floristically analyse and classify the vegetation. Only a few of his sites are along the southern edge of the present survey area.

In 1976 and 1977 Reid and Vincent (1979) coordinated a general ornithological survey of South Australian National, Conservation and Recreation Parks and Game Reserves, and several of these are in the South Olary Plains. Davies (1982) determined the conservation status of the major plant associations in South Australia by assessing all previously documented surveys in parks and reserves. This work was updated by Neagle (1995).

Moore (1985a, b) compiled a summary of the distribution and conservation status of the terrestrial vertebrates and vascular plants of the South Australian Murray mallee. The northern limit of this study (Counties Burra, Young and Hamley) are at the southern edge of the present survey area.

From 1980 onwards, a number of more specific projects have been conducted within the survey area. In 1981, the Naracoorte College of Further and Technical Education compiled an extensive plant and bird species list for Danggali Conservation Park and Chowilla Station.

In 1982 the Land Resource Management Division of the then Department of Lands conducted a flora and fauna survey of about 7 500 ha of land between Berri and Renmark in the Riverland which was surrendered from the Calperum pastoral lease due to it's poor grazing potential and problems with proximity to towns (Department of Lands, 1982). This land has since been gazetted as Cooltong Conservation Park.

Barratt and Choate (1983) produced the then Department of Lands, Pastoral Land Management Branch's first pastoral lease assessment manual for Chowilla Station. It involved land system mapping, type site and reference site sampling and the establishment of photographic monitoring points. From the same group, Barber and Linton (1989) mapped and described the land systems of the Olary 1:250 000 mapsheet, the southern half of which includes the present survey area. Recently, Barrat and White (1993) re-assessed Chowilla Station and Barratt and Kutsche (1994) have assessed Calperum Station. These studies have been combined to produce a land systems map for the whole Bookmark Biosphere Reserve.

The Chowilla Dam proposal of the 1960's and 70's produced several studies confined to the river floodplain (National Environmental Consultancy, 1988; Murray-Darling Commission Working Group, 1992; O'Malley and Sheldon, 1990). Margules and Partners Pty Ltd et al., (1990) surveyed the riparian (riverine) vegetation of the River Murray in S.A., Victoria and N.S.W.

A 1:250 000 landscape map of the Olary mapsheet and areas further north was produced by Tongway and Hindley (1984) in order to enable the relationships between Landsat reflectance data and soil and vegetation attributes to be determined.

Brett (1990) investigated the effect of land tenure on range management by comparing properties on either side of the boundary between pastoral and perpetual (agricultural) leasehold areas in an area from Morgan to Yunta.

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Tiver (1994) extensively surveyed the eastern pastoral district recording vegetation alliances and associations and edaphic and topographic data on which multivariate and regression analyses were conducted. Half the present study area was covered by this study but the different field data collection methods used, pre-cluded utilising Tiver's base data in this survey.

Since 1986 students of the University of South Australia (Salisbury Campus) Conservation and Park Management course have been undertaking annual habitat assessment and monitoring of various areas of Danggali Conservation Park (University of South Australia (1988-1993). These studies have included vegetation mapping and studies of vertebrate and invertebrate fauna and soils at a number of sites. Many of the methods used were based on current Biological Survey of South Australia standards and so part of these data sets are directly comparable with the present survey. A number of major student projects have addressed the effect of fire on plant species (Morelli, 1990) and vegetation (Donovan, 1990) in the park.

Basic flora and fauna species lists have been compiled for most of the parks in the area but none have been published. Management Plans have been published for Chowilla Regional and Game Reserve, Pooginook, Pandappa and White Dam Conservation Parks and Danggali Conservation Park (Department of Environment and Natural Resources, 1993, 1994, 1995).

The Native Vegetation Management Section of the Department of Environment and Natural Resources has made numerous assessments of native vegetation clearance applications on the western and southern edges of the present survey area and a plant species list and bird notes are available for each assessment.

The mammal, reptile and botany clubs of the South Australian Field Naturalists Association have conducted field trips to conservation parks and private properties in the survey area over the last 30 years and lists are available from these trips. The South Australian Ornithological Association also has many bird records from the area. Several private naturalists have compiled extensive personal bird, reptile and plant lists, particularly in the Riverland and towards Burra.

The areas covered by previous major studies is shown in Figure 31.

Surveys in adjacent areas which were a part of the Biological Survey of South Australia were listed in the Introduction. Additional work has been carried out in adjacent areas of N.S.W. by M Westebrooke (pers. comm.), Fox (1991), (vegetation mapping), Eldridge (1988) (land system mapping) and Morecombe and Westbrooke (1990) (vegetation map of Mallee Cliffs National Park, 100 km east of Chowilla). The Murray Mallee Review (vegetation and fauna) has been completed in north-western Victoria (Land Conservation Council, 1987; Emisson and Bren, 1989; Robertson *et al.*, 1989; Yen *et al.*, 1990).

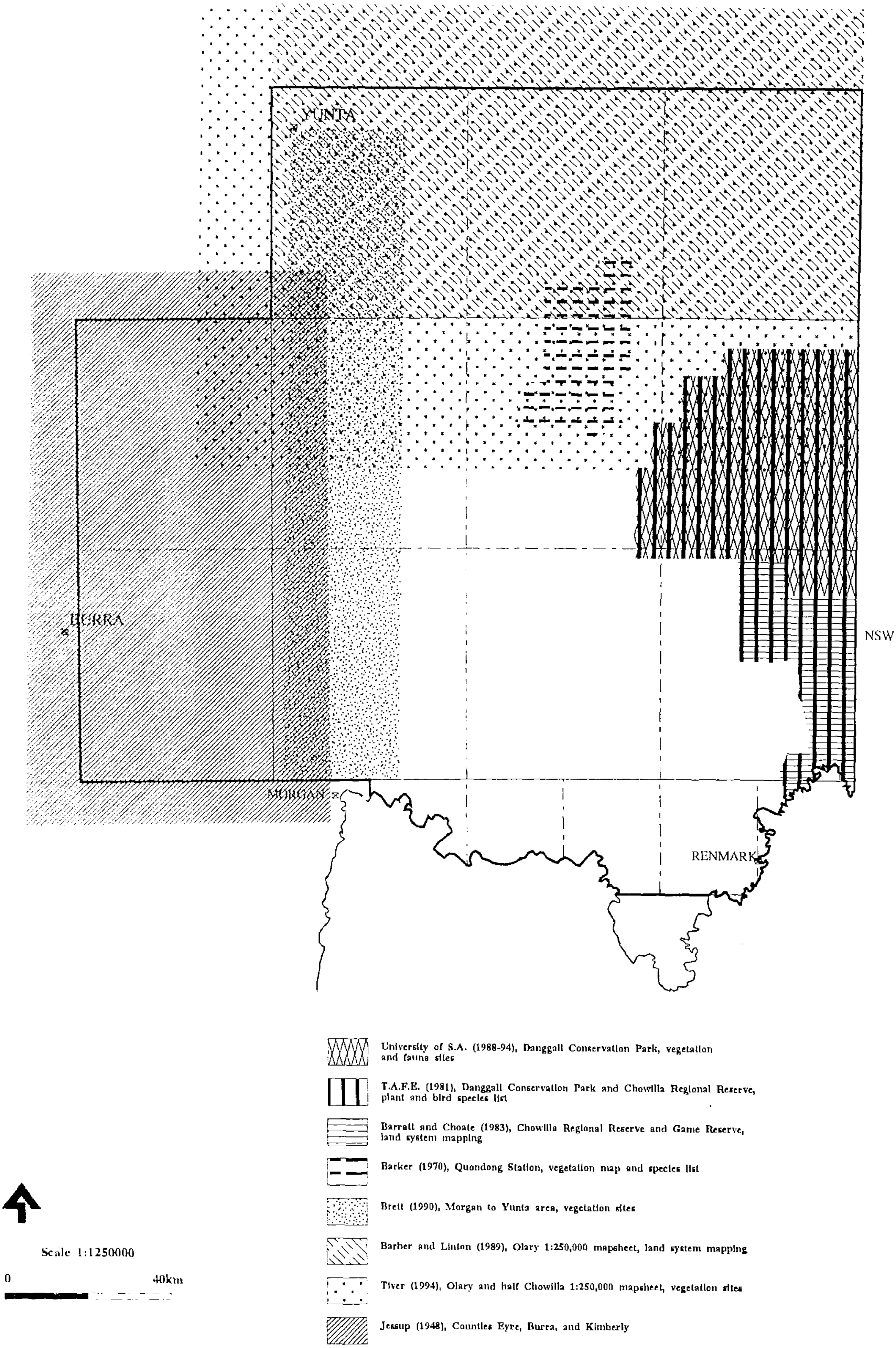

Figure 31
The South Olary Plains survey area showing nature and coverage of previous biological studies

Methods

by L.R. Forward[1]

SITE SELECTION

Previous surveys in the agricultural zones of the South Australian and Victorian Murray Mallee have been conducted at a quadrat density of one quadrat per 1300 hectares of vegetation, which is equivalent to one quadrat per 4000 ha of total land area. As the South Olary Plains survey area is largely pastoral grazing lands where the natural vegetation is more homogeneous and generally continuous, a sampling intensity of one quadrat per 8000 ha was used.

As for the previous regional surveys in South Australia, sample sites were selected to represent the biological and geographical diversity of the study area. In addition, the location of sites where biological data had already been collected were taken into consideration to avoid duplicating sampling effort.

Reconnaissance trips throughout the survey area enabled assessment of the range of community types present and assisted aerial photograph interpretation. Using the environmental association and land unit information in Laut *et al.* (1977) and 1:50,000 and 1:100,00 black and white aerial photo mosaics, sites were selected to represent the range of geographical formations and vegetation patterns visible on aerial photography throughout the area. A relatively even distribution of sites across mapsheets, environmental associations and rainfall gradients was sought.

At each site a series of quadrats were selected to reflect the representative land-forms and observed vegetation types present within an area of about one square kilometre. The number of quadrats at each site varied from one to five depending on the heterogeneity of the site, with each quadrat being placed in a homogeneous patch of vegetation.

Sites and quadrats were systematically named and coded in a hierarchical manner as follows. Groups of sites, called *site-areas*, were named after a local geographic feature or property, using a two letter code (the site-area code) e.g. DA = Danggali site-area. Within each site-area, individual *sites* were sequentially numbered and given a four digit code (the site code) comprising the site-area code and sequence number e.g. DA01, DA02 are Danggali site-area, sites number 1 & 2. At each site the *quadrats* were then sequentially numbered e.g. DA0101, DA0102, DA0201, DA0202 etc.

(This nomenclature is different to that used for previous pastoral area surveys where the hierarchical terminology has been '*camp, quadrat, patch*', as opposed to '*site-area, site, quadrat*'. The levels of these hierarchies are analagous - only the terminology has been changed.)

Additional factors affecting site location included landowner permission and accessibility, especially during wet weather. The final location of each quadrat was determined in the field by the survey workers.

Data collection methods were designed to be compatible with those used on adjacent surveys in South Australia, Victoria and N.S.W..

VEGETATION SURVEY

During four weeks from 21st July to 17th August 1991, five pairs of botanists and assistants sampled 221 sites using a total of 470 quadrats. In addition, data from four sites (ten quadrats) surveyed in Danggali Conservation Park by staff and students of the University of South Australia, Salisbury Campus, Conservation and Park Management course, were included in the final survey analysis, making a total of 480 quadrats from 225 sites. The distribution of these quadrats is shown in Figure 32 (More detailed information on the location, physical environment and final classified vegetation type of each quadrat are shown in Appendix III).

At each quadrat detailed descriptions of the location (using topographic maps, aerial photographs and hand drawn 'mud' maps), physical environment (landform elements and patterns, surface soil texture (both according to Speight, 1990) and disturbance) and vegetation within a 100 x 100 metre area were recorded using standard data sheets. All vascular plant species present were recorded and evaluated using a measure of cover/abundance adapted from Braun-Blanquet (1964, in Gullan *et al.*, 1976) and the structural classification of lifeform/height class and percent 'canopy' cover adapted from Muir (1977) (see below). These adapted Muir and Braun-Blanquet classifications are tabulated in Appendix I. A general vegetation association description, structural summary and overstorey measurements were also recorded for each quadrat.

When using Muir's (1977) classification in this survey, percent cover was defined as the area of ground covered by a solid vertical projection of the species' or lifeform's total crown area (i.e. to the periphery of the crown) as a

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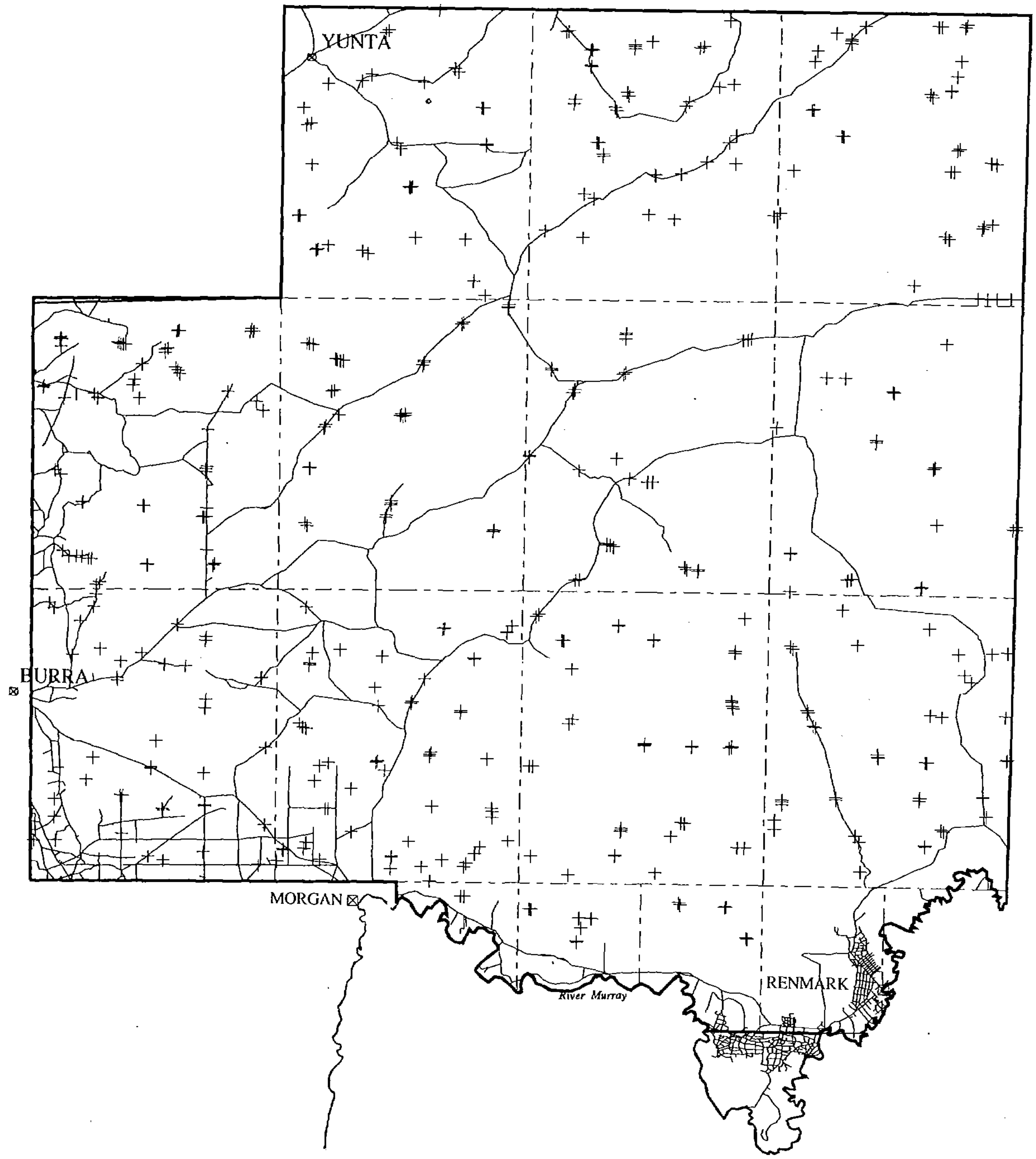
percentage of the total ground area of the quadrat, which is correctly termed the *crown* cover (Walker and Hopkins, 1990). This was considered easier to estimate in the field by a variety of workers than Muir's definition



Scale 1:1250000

0 40km

+ Vegetation survey quadrat

—— Roads

Figure 32
South Olary Plains vegetation survey sites

of *canopy* cover which takes into account only the area of individual foliage clumps within one tree/shrub's crown and therefore not including the open spaces for example within a mallee's widely spaced foliage clumps. Similarly, *projective foliage* cover (Specht *et al.*, 1974, in Walker and Hopkins, 1990) (which includes projected cover of leaves and branches but not spaces in between open foliage) was also considered too time consuming and subjective.

Muir's (1977) height distinction of greater than or less than eight metres tall for mallee trees and mallee shrubs respectively was changed to three metres for the previous Murray Mallee survey (Department of Environment and Natural Resources, in prep.), once again considered more appropriate for the South Australian habitat, particularly the semi-arid and arid zones.

The Braun-Blanquet (1964, in Gullan *et al.*, 1976) cover/abundance classification was also used as it incorporates an abundance element and has more classes at the lower end of the scale (as opposed to Muir's (1977) four broad cover classes) and thus were considered more appropriate for mallee and semi-arid vegetation types. Muir's four classes were used for the structural summary of the whole community strata.

In the current survey, the Braun-Blanquet classification (which was originally designed for European forests) was modified for use in the arid zone by dividing the lowest category into three i.e. isolated plants (R), isolated clumps (L) and isolated plants (I), which are appropriate for many arid species in very open vegetation types. (Most of the species surveyed were in the lowest four categories of Braun-Blanquet hence the adapted classification improved community differentiation at the lower end of the scale.

Herbarium specimens of every plant species encountered in each major area sampled were collected for later verification and incorporation into the State Herbarium collection (Fig. 34). An expert taxonomist was available each week of the survey to assist with field determinations.

Each quadrat was marked and labelled on site with a jarrah stake and photographed.

Any interesting species observed outside the specified quadrats were recorded as 'opportunistic' on separate data sheets with location details only.

FAUNA SURVEY

A sub-set of 91 vegetation survey sites were sampled for vertebrate fauna over a period of six weeks from 27th September to 7th November 1992 using three teams of three to four workers each week. Each team included a mammalogist, an ornithologist and a herpetologist. Fauna data from the same four University of S.A. Danggali sites were used in the final fauna analysis.

The number of quadrats in the fauna survey is less than that used in the vegetation survey because more time and effort is needed to adequately sample fauna. Single quadrats were selected from the vegetation sites to proportionately represent the 23 vegetation groups detected in a preliminary analysis of the vegetation data, ensuring an even distribution of quadrats across the area and that the geographical distribution of each vegetation group was sampled.

At any one vegetation survey site the quadrat used for fauna sampling was generally in the dominant vegetation type, although at some sites more minor vegetation types were sampled. In this way all significant representative habitat types in each geographical area were sampled. In only two cases were two quadrats from one site sampled, i.e. where the vegetation types were quite different or unique. Thus the total number of quadrats sampled for fauna was 93.

The distribution of the fauna survey quadrats is shown in Figure 32 and individual quadrats are highlighted on the maps and lists in Appendix III.

At each quadrat reptiles and small mammals were sampled using two fenced pitfall lines, each 50m long and comprising six pitfall traps ten metres apart with each pit 15cm in diameter and 40cm deep. One pitline was established on the original vegetation quadrat (trapline A) and the other at least 200m away in the same vegetation type to minimize interaction (trapline B). A separate line of 15 Elliott traps and two cage traps was run in association with each pitline, about 20m away. Where rock prevented digging of some or all pits, either a reduced depth pit was used or extra Elliott traps were set and additional effort put into physical searching and spotlighting. Each quadrat was sampled for four days and four nights.

Mammals and reptiles were also recorded by active searching for individuals or signs for one to two hours at each quadrat. Spotlight searches were made at night where time and habitat permitted. Birds were observed and recorded for one to two hours during early morning and late afternoon at least one day at each quadrat.

All information was recorded on standard data sheets and included location, method of capture or sighting, microhabitat, numbers of individuals and weight for small mammals.

Fauna encountered outside the specified quadrats were recorded as 'opportunistic' sightings on separate data sheets. These records enabled compilation of a more thorough inventory of the biota of each area, including species' use of smaller or more heterogeneous habitat types not sampled by the quadrats.

Systematic methods are generally inappropriate for catching bats as suitable locations near water, roosts or flyways are needed. Using mist nets and harp traps, attempts were made to sample bats on or near designated survey sites but usually other locations were more suitable. Hence most bat records were opportunistic. Mist nets were erected and monitored for a few hours in the evenings, in suitable weather conditions, and harp traps (Fig. 39) were left up all night.

Generally one specimen of each small reptile and mammal species from each campsite was preserved as a museum specimen depending on the abundance or rarity of the species and the advice of museum curators. Standard ethical collection and killing methods were employed with approval from the then Department of Agriculture Animal Ethics Committee. Samples of liver tissue were taken from all specimens collected and stored in liquid nitrogen for the South Australian Museum Evolutionary Biology Unit. Specimens and samples are permanently stored at the museum for future taxonomic studies.

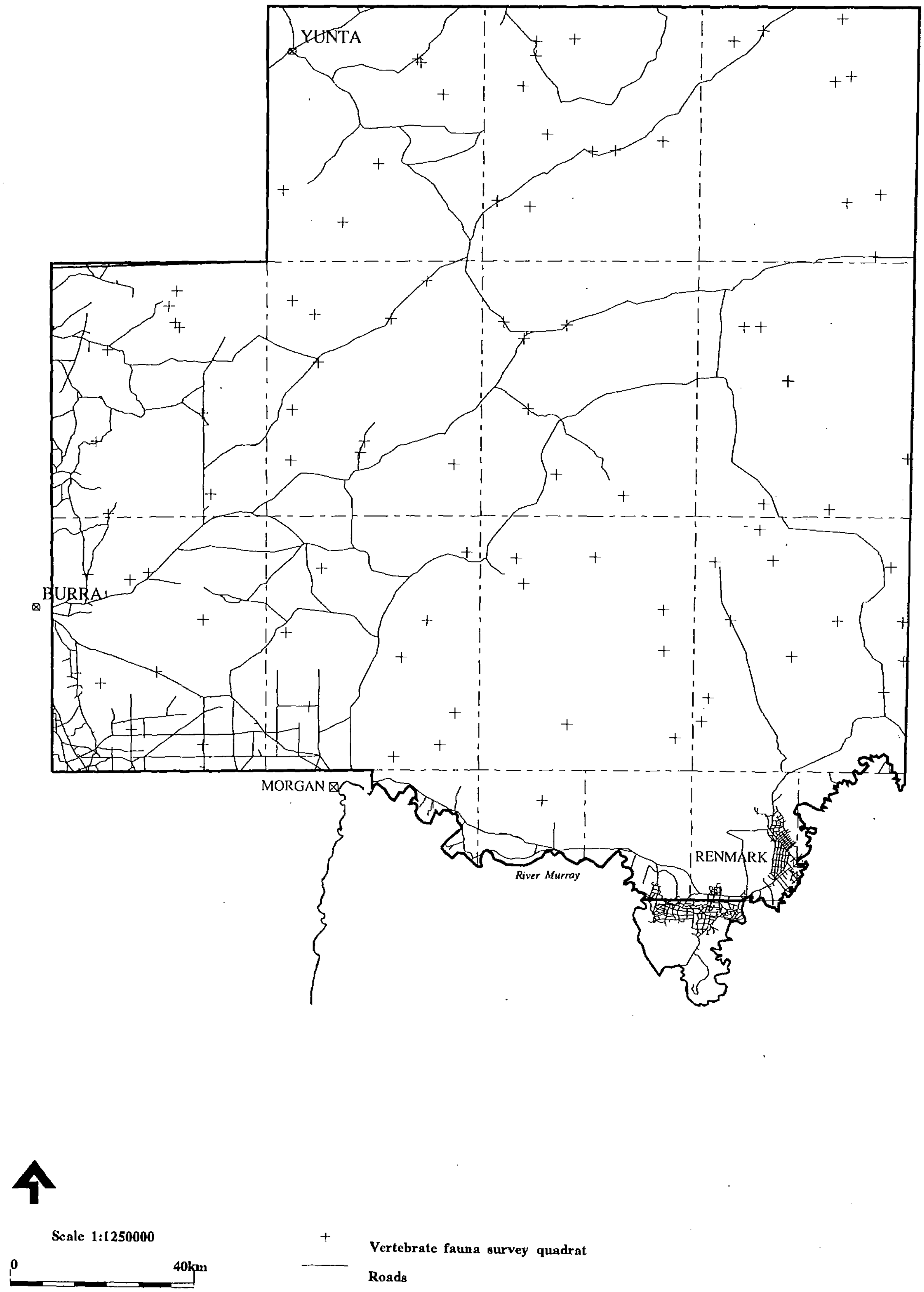


Figure 33
South Olary Plains vertebrate fauna survey sites

A line of micro-pitfall plastic vials (2cm diameter, 10cm deep, filled with 70% alcohol) was laid parallel to each macro-pitfall line to collect invertebrates for the S.A. Museum. Likewise any invertebrates found in the macro-pitfalls were preserved for later identification. Invertebrate data did not however form part of the data base analysed in this survey.

A summary of the trapping effort is shown in Table 3 and the daily minimum and maximum air temperatures recorded at each campsite are tabulated in Appendix II. Examples of field work in progress are depicted in Figures 34 - 39

Table 3
Trapping effort during the South Olary Plains Vertebrate Fauna Survey, September- November 1992.

Week	Group	Base Camp	Pit trap nights	Elliot trap nights	Cage trap nights	Mistnet hours	Harp trap nights
1	1	Tiverton	204	570	68	0	0
	2	Pooginook	240	600	80	0	0
	3	Mutooroo	240	604	80	0	2
2	1	Braemar	162	465	62	0	0
	2	Anabama Hut	216	600	80	0	0
	3	Oakvale	204	510	68	0	1
3	4	Redcliffe	240	585	80	6	2
	5	Redcliffe	192	480	64	6	0
	6	Lilydale	252	630	84	22	4
4	4	Tuilkilkey	246	607	86	0	0
	5	Caroona	240	600	80	3	2
	6	Kia-Ora	240	600	80	0	1
5	7	Calperum	240	600	80	7.5	5
	8	Calperum	240	600	80	4	5
	9	Pine Valley	264	660	88	18	3
6	7	Chowilla	240	600	80	4	5
	8	Benda	240	592	36	3	3
	9	Canegrass	256	600	84	6	4
Total (hours)			**4 036**	**10 505**	**1 360**	**73.5**	**37**

PHOTOGRAPHIC MONITORING POINTS

At each fauna survey quadrat a permanent photographic monitoring point was established according to the South Australian Biological Survey protocol. This comprised two 1.4m galvanised steel poles (a camera post and a target post) erected ten metres apart, at or near trapline A, to provide a representative view of the vegetation. Stereo pairs of photographs were taken at a height of 1.5 metres from the tagged camera post aimed towards a graduated 1.5m target post.

Details of the physical environment, vegetation type and locations of all vegetation survey quadrats are shown by 1:100,000 mapsheets in Appendix III, with fauna and photopoint quadrats indicated. Many of the vegetation quadrat photographs and some photopoints are shown in the vegetation chapter, within the vegetation group descriptions.

DATA MANAGEMENT AND TAXONOMY

Survey data are stored in a relational data base *Interbase* (Borland) on a Hewlett-Packard mainframe computer, accessed via *Powerhouse* software (Cognos). Data were extensively cross-checked and edited which was particularly crucial considering the large volume of data collected and the numerous observers of varying experience that were used during the intensive survey periods.

All taxonomy was thoroughly checked. The greatest accuracy of identifications was sought by considering the known geographical distributions of species.

Vegetation

Three and a half thousand plant voucher specimens were collected. A standard system of voucher number usage on data sheets enabled later updating with correct identifications. On the survey, the taxonomy used was according to Jessop (1989) but has since been updated from Jessop (1993).

At the time of the survey a number of species, mostly being sterile, could not be consistently differentiated so where there were only two possibilities, 'slashed' categories were created. These were:

Carpobrotus modestus/rossii
Convolvulus remotus/microcephalus
Crassula colorata/sieberana
Erodium crinitum/cygnorum
Ixiolaena leptolepis/tomentosa
Lepidium oxytrichum/papillosum
Maireana georgei/turbinata
Parietaria debilis/cardiostegia
Tetragonia eremaea/tetragonoides

inconsistent depending on development and fertility. Therefore, prior to analysis, a number of subspecies were grouped into their specific designation. These were:

Atriplex lindleyi ssp.
Atriplex vesicaria ssp.
Brachycome ciliaris var.
Chenopodium desertorum ssp.
Crassula colorata ssp./sieberana ssp.

Subspecies classification of many specimens was

Daviesia benthamii ssp.
Eindia nutans ssp.
Erodium crinitum/cygnorum ssp.
Harmsiodoxa brevipes var.
Salvia verbenaca form.
Vittadinia cuneata var.

Similarly, a number of taxonomic changes occurred between the time of the survey and the completion of the Herbarium identifications. Some were simple direct changes but for those that weren't the new and old names were grouped together before analysis. These direct taxonomic changes and groupings due to new taxonomy are detailed in Appendix IV.

All species that were grouped are indicated on the total survey plant species frequency list (Table 5) in the vegetation chapter.

As the survey was conducted in winter, many grasses could only be identified to genus. Therefore, prior to analysis, a number of grass species were also grouped:

Danthonia caespitosa, D. geniculata, D. sertacea var. setacea and *D. tenuior* - grouped with *Danthonia sp.*
Stipa eremophila and *S. mollis* - grouped with *Stipa sp.*
Stipa nitida, S. nitida group, *S. nodosa* and *S. scabra ssp. scabra* - grouped as *Stipa scabra* group

Records of *Sclerolaena uniflora* were changed to *S. diacantha* as the taxonomy of this complex is as yet unresolved.

Fauna

A similar system of voucher number usage to that used for plants enabled later verification or correction of collected fauna specimens' identifications. Vertebrate fauna taxonomy is according to Watts (1990).

Only one reptile species required a 'slashed' category (*Cryptoblepharus carnabyi/plagiocephalus*) as these two species are very difficult to differentiate in the field.

As acurate identification of bird subspecies is often difficult and cannot be validated without collecting specimens, no subspecific designations were used in the analysis and reporting.

DATA ANALYSIS

The vegetation and fauna quadrat data were analysed by classification and ordination techniques using PATN exploratory data analysis software (Belbin, 1987) to detect trends and patterns in the data. Vegetation, mammal, bird and reptile data were separately extracted from the survey data base as listings of sites and species, on which the discussed taxonomic standardisation's were performed. These data were then formatted into quadrat by species matrices for input into PATN using a specially written FORTRAN program PATNMAT.

Too few amphibian species were recorded to warrant any analysis. Opportunistic data, being non site-specific, also could not be analysed, but are still discussed in the results.

Vegetation

The Braun-Blanquet cover/abundance scores for each species were assigned ranked numeric values prior to matrix formation. The initial data matrix of all vegetation species and all quadrats consisted of 479 rows (quadrats) and 569 columns (species) (a total of 12 648 records). (For an unknown reason, one quadrat, TM0302, was later found to have been lost in the original data extraction.) At this stage the raw matrix still contained some taxa that had only generic or family designations.

As the vegetation survey was conducted in winter, and as seasons can be erratic in the arid zone, only perennial species were used in the analysis. The PATN modules of PRAM and LABN were used to initialise the matrix and MASK to select the species required for analysis.

The criteria 'not consistently detectable' was used in the masking process in preference to 'annual' as some perennial species are not easily detectable in winter (e.g. Liliaceae). Conversely some annual species' structures persist long after death, rendering them easily detectable (e.g. Ward's weed, *Carrichtera annua*) and hence they provide suitable data for analysis. Additionally, some species do not consistently exhibit the same life cycle pattern across variable seasons or geographic ranges. Thus, the criteria of 'consistently detectable or not' was applied to each species with consideration of the geographical area and season and advice from a taxonomist.

Taxa of only family or genus designation were also masked out, however, some genus-only designations were retained if they had a high frequency or very few species within the genus that were identified to species. These genera were considered to potentially exhibit ecologically meaningful patterns in the results. The 'Genus sp.' taxa masked out and the 'not consistently detectable' species are annotated in Table 4B in the vegetation chapter. After this direct masking the matrix contained 314 species.

Also within the MASK module, indirect masking was applied to exclude any quadrats with only one perennial species and any species with a frequency of one to remove noisy (superfluous) data. Only one quadrat, SW0201, had one perennial species. Thus the final matrix contained 478 rows (quadrats) and 245 columns (species).

Classification

An association matrix was created with the PATN module ASO, using the Bray-Curtis coefficient of dissimilarity, then clustered with FUSE using flexible UPGMA (unweighted pair group arithmetic averaging). This is an hierarchical clustering technique that provides the best fit between association measures and the distances shown on a dendrogram. A beta value of -0.1 was used to cause a slight dilation in the clustering process (Belbin, 1991).

The DEND routine displays a dendrogram that summarises the results of the hierarchical clustering, showing the relationship of all quadrats to each other. The dendrogram can be cut at any level of dissimilarity to display a desired number of groupings. A number of cuts of the dendrogram were tried until the vegetation types represented by the quadrats in these groupings reflected ecologically meaningful groups. The purpose of the classification is to identify vegetation types in which many species commonly and repeatedly occur together due to particular environmental factors.

The GDEF module was used to define the composition of the chosen groupings, listing the quadrats in each group. Then GSTA (using all attributes (species)) was used to list the proportion of occurrence of each species in each group and their average cover/abundance rating (which in this case this is not actually a true average as cover/abundance was ranked in classes).

A post-processor GROUPSTAT has been specifically written in-house to produce a report showing species composition, the distribution of cover/abundance ratings recorded for each species and the proportion of occurrence of each species within the group, and an indication of their importance in defining the group. The latter is derived by calculating the deviation of the proportion of occurrence of each species from expected values if the species were equally distributed amongst all groups (i.e. the chi-square (X^2) value). The greater this deviation (the X^2) the greater the probability that the species is not distributed by chance alone.

A good group was considered to have a few dominant species that showed high X^2 values, high proportion of occurrence within the group and medium to high cover/abundance ratings. With a number of different groupings tried, groups that maintain a constant complement of sites and species are deemed to be robust. In PATN analysis, the groups that occur towards the top and bottom of the dendrogram tend to be the more robust ones.

With the first run of the perennial vegetation analysis a number of different cuts of the dendrogram consistently produced quite robust groups in the top and bottom thirds of the dendrogram, but the middle third contained a number of variable 'loose' groups consisting of only a few quadrats each. Different cuts of the dendrogram did not improve these central groupings.

As PATN tends to dump unusual or species-impoverished quadrats into artificial groups with little florisitic similarity and no ecological meaning, the analyses were repeated, successively masking out species and quadrats with frequencies of two and three or less, to reduce the confusing influence of species-poor quadrats and rare or irregularly distributed species. The subsequent masked analyses, however, did not improve the groups, actually making them worse.

On closer inspection of the problem groups, three erratic quadrats were identified. BF0101, in a group on its own, comprised *Allocasuarina verticillata - Acacia pycnantha* woodland and was located in the Burra Hills on the far western edge of the survey area. As this was not actually on the true South Olary Plains, and was obviously a quite different vegetation type (but valid for the hills area) the site was deleted from the analysis.

In another problem group, only one species, *Callitris verrucosa*, was shared in common between the two member sites. One, GL0502, had only five species and the other, HW0104, eleven. These quadrats must have had extremely unusual combinations of species for them not to have been included in any other groups and be lumped together on the basis of only one species. Thus they were also masked out. No other specifically problematic sites could be identified with just reasons to delete.

The final matrix, with quadrat and species frequencies greater than one, comprised 475 quadrats and 245 species. From this, the best ecologically meaningful cut of the dendrogram produced 34 floristic groups.

(In PATN a further step to assist assessment of the best grouping is to produce a two-way table of species incidence by quadrat, but with such a large dataset from the current survey this was not a practical option.)

Group definition

Each floristic group was described using overstorey dominant species and a structure, sub-dominant overstorey species, understorey dominant species and indicator species (if appropriate).

Indicator species were defined as species that particularly characterised a group (i.e. had a low occurrence in other groups and a high X^2) and thus were significant factors in the classification process. (The number of groups that each species occurred in was calculated by another in-house routine, GLIST.) As these species are indicators of a particular vegetation type's presence at the member quadrats, they consequently must have a relatively high proportion of occurrence within the group (i.e. greater than 0.5). It must be stressed that an indicator species on its own does not indicate a specific vegetation type. It is the presence of that species in association with other characteristic species that suggest the presence of a particular vegetation type.

The aim in naming vegetation groups was to accurately describe each group such that at each member quadrat in the field the inclusion of that quadrat in that vegetation type is easily recognisable. Thus, the group names incorporated the range of species compositions inherent in each group.

Floristic group descriptions were derived from the GROUPSTAT group species lists using the following criteria:

1. One or two *overstorey dominant species* which had a high within group proportion of occurrence (preferably of one or greater than 0.8), a high X^2 (generally greater than 2.0) and medium to high cover/abundance values (generally more than 50% are greater than 1 or preferably 2).

2. A *structure* of the overstorey dominants, determined from their 'average' cover/abundance and 'average' life form, and named from the vegetation structural formation table in Appendix V.

3. *Indicator species* (overstorey or understorey) which had a a low number of groups in which they occurred (i.e. less than a third of the groups, and therefore had a high X^2) and a within group proportion of occurrence greater than 0.5.

4. *Sub-dominant overstorey* and *dominant understorey* species which had a medium to high proportion of occurrence (>0.5), a relatively high X^2 (>1.0) and not too low cover/abundance values. (Or if a very common species with a low X^2 must have a proportion of occurrence > 0.8).

The vegetation structural formation table in Appendix V has been adapted from Specht (1972) and Muir (1977). Muir's full table, as used on the field data sheets, was considered too detailed because in the present survey each floristic group name represents the 'average' of a range of life forms and percent covers. However, some Muir classes and terminology were adopted and added to Specht's table. These additions were the mallee tree and mallee shrub categories, considered to be significant life forms in South Australian vegetation, and the category of trees less than five metres tall and shrubs less than one metre (from Laut *et al*, 1977) deemed necessary for arid zone classifications.

The array of environmental parameters recorded on the survey and extra vegetation measurements of the overstorey were extracted from the survey database and stored in a *Paradox* (Borland) database, to which the 34 group classifications for each quadrat were appended. From this, trends in various parameters were assessed and used in interpretation of the 34 vegetation groups.

The distribution of quadrats within each floristic vegetation group were plotted using Arc Info and Arc View (ESRI).

Ordination

The ordination technique of multi-dimensional scaling was used to further assess the clustering of sites and highlight overall trends or gradients. Using the PATN module KYSP, the multi-dimensional distribution of quadrats around species axes is reduced to two or three dimensions to best show the relative dissimilarity between them. Within KYSP, a hybrid type ordination was appropriate (Belbin, 1987) and about 100 iterations were run until the stress stabilised.

Having a large number of quadrats the initial ordination was too cluttered to interpret. Thus the data matrix was divided into three according to the three sections of the dendrogram i.e. the top mallee groups, the mixed central groups and the bottom chenopod/Blackoak groups, which were then each ordinated into three dimensions. The resulting data was plotted in three dimensions using *Statistica* (StatSoft).

From these three dimension *Statistica* plots for the mallee, chenopod/Blackoak and central groups the validity of the 34 vegetation grouping was assessed by observing quadrats' within- and between-group proximity. Trends in physical parameters also assisted interpretation.

In PATN the GDEF module produces a centroid file which creates a typical (or 'average') site for each group by using attribute (species) means. For analyses with large numbers of objects (sites), Belbin (1987) recommends that the groups are ordinated by way of an inter-group association matrix (rather than inter-object). The vegetation analysis centroid file was therefore treated as a data file and analysed using ASO, FUSE and KYSP. A three dimension plot was produced using *Statistica* to show the spacial relationships between the 34 vegetation groups (i.e. by only plotting the group centroid position). Environmental trends were then used to assist interpretation of this plot.

Sub-groups identification

On closer inspection of the final dendrogram and 34 groupings, it appeared that the five mallee groups at the top of the dendrogram and the eight chenopod and Blackoak groups at the bottom could be further divided into quite clear sub-groups. As described earlier the middle section of the dendrogram could not be sub-divided any further, so, using the mallee and chenopod/Blackoak quadrats listed on the dendrogram, the final data matrix was masked to produce mallee-only and chenopod/Blackoak-only matrices which were then re-analysed and divided into ecologically meaningful sub-groups.

Fauna

Presence/absence data were used in the fauna analyses as abundance data were not recorded in a systematic manner.

The same PATN analysis pathways were used for the mammal, reptile and bird data separately i.e. PRAM, LABN, MASK (see separate descriptions below), ASO, FUSE (UPGMA with beta = -0.1), DEND, GDEF and GSTA. The most ecologically meaningful cut of each dendrogram was selected by assessing the fauna species present in each quadrat group and the known vegetation type at each quadrat.

Each matrix was then transposed using DATN, and the resultant species by quadrat matrix analysed using ASO (but using the 'two step' option), FUSE, DEND, GDEF and GSTA (to determine species groupings). TWAY was then used to produce a two-way table showing the incidence of species by quadrats and the designated groupings of both. (Another specially designed routine, TWALIST, was used to add full species name labels to this table rather than the eight letter abbreviations produced by PATN.) The two-way table was then assessed to check the validity of the quadrat and species groupings, which could subsequently be changed if necessary. Each two-way table was discussed in terms of the species groups and the quadrat groups.

An in-house post-processor similar to GROUPSTAT, GLIST, was used to list the species present in each quadrat group (as the data was presence/absence data). In this routine a standardised residual was calculated to indicate the reason for a high X^2. A high positive residual indicates a proportion of occurrence greater than expected, suggesting the species may be an important indicator for that group. Conversely, a high negative residual indicates a proportion of occurrence less than expected, suggesting that it is the lower than expected occurrence of that species that is important.

Being generally associated with broad vegetation types, the fauna quadrat groups are fewer and larger than the vegetation groups, and less well defined (i.e. X^2 values are lower). Thus it is not appropriate to identify specific dominant and indicator species. Rather, the quadrat groups were discussed in terms of the vegetation types present and the following classifications of species:

Frequent, characteristic species - frequent and characteristic species of the vegetation type,

generally with a proportion of occurrence greater than 0.25 and X^2 greater than 0.2.
Frequent species - species frequently found in that vegetation type but which are not specifically characteristic of it (i.e. are more generalist across other habitats as well). Generally proportion of occurrence is greater than 0.3 and X^2 less than 0.2.
Rarer, significant species - rarer but significant species that are characteristic of the vegetation type, from a knowledge of general species habitat preferences. Tend to have lower proportion of occurrence and X^2. (Although known to be characteristic species these often showed a low X^2 in the current data - maybe due to inadequate sampling, seasonal or weather conditions or just the fact that they are generally rarer species.)
Other notable species - fairly common but less frequent species of the groups' vegetation type (generally proportion of occurrence greater than 0.15) but are characteristic of variants of the vegetation type (and thus only have a low X^2 for the whole group).

The reptile and bird data were ordinated using KYSP and the results plotted using *Statistica*. (Mammal data was insufficient for ordination.)

Classification and ordination results were interpreted in relation to the environmental parameters recorded and floristic vegetation types identified, using the tables created in *Paradox*.

In the above analyses different masking routines were used for each fauna taxonomic group, as outlined below.

Mammals

The initial mammal data matrix contained 393 records; 29 species and 89 quadrats. (No mammals were recorded for four fauna sites, but probably due to observer failure to adequately search for tracks and traces.)

Several suites of species were masked out of the matrix for various reasons: all domestic ungulates (cows, sheep and goats) being common but irregularly distributed; bats, due to non-systematic sampling; species that were difficult to detect consistently (hare, fox, domestic cat and echidna); all 'Genus sp.'; and ubiquitous species (rabbits and kangaroos), resulting in a matrix of 58 quadrats and 7 species. Single frequency species were not masked out as the overall diversity was so low.

Reptiles

The initial reptile matrix contained 93 quadrats and 59 species (552 records). Several species were masked out: large snakes and goannas (as not caught in traps or seen easily or often); legless lizards (generally only observed in humid weather) and species with a frequency of one. Quadrats with only one species after this mask were also omitted. Thus the final matrix contained 89 quadrats and 37 species.

Birds

The complete bird matrix contained 1 872 records; 127 species and 93 quadrats. All 'Genus sp.' records were masked out, as were any species that are very mobile, high flying, seasonal, nomadic, migratory, ubiquitous or highly irregular in occurrence (i.e. species that generally are not very habitat-specific). Additionally, one quadrat, TP0102, was masked out as it formed a single-quadrat group, indicating a very unusual mixture of species (and being surveyed by the University of S.A. students, may have not been selected or sampled correctly). Thus the final matrix contained 82 species and 92 quadrats.

VEGETATION MAPPING

Rationale

As the floristic analysis shows, plant species tend to naturally occur in particular assemblages or associations. The occurrence of these is usually repeated across the landscape in response to a complex pattern of interacting environmental factors (i.e. landform, soil type, rainfall) to which the suites of species are adapted. The aim in mapping is to identify regions in which plant species, or groups of species, commonly occur.

The vegetation patterns visible on aerial photography generally reflect underlying changes in soils and landforms. Variation in these three factors (vegetation, soil and landform), although detectable from aerial photography, are not easily assessable or quantifiable as discrete separate parameters. Therefore aerial photo interpretation and mapping is the delineation of patterns created by a combination of all these factors. It is not an exact science but none the less is a valuable process for broadly assessing large areas of varying plant communities.

From knowledge of the vegetation at an array of specific sites and recognition of the associated photo patterns, mapping of vegetation types can be extrapolated across unsurveyed areas, given the above assumptions about species distribution and patterns of associated environmental factors. Mapping the distribution of these different plant assemblages and their associated landforms and soils enables the distribution of individual plant species and communities to be inferred, and possibly the occurrence of certain associated animal species to be predicted.

As species composition and the associated environmental factors normally gradually change along a gradient between vegetation types, mapped boundaries represent this ecotonal area. Therefore, no boundary line should be accepted as highly accurate but treated as an indicator of significant local vegetation and environmental change.

The area within any particular mapped unit should likewise be treated as a probability; an area where a certain suite of species, possible in various combinations, is most likely to occur, given the physical features shown on aerial photography and previous observations and measured associations.

The most common basis for delineating vegetation types is the change in the type, height and cover of the overstorey species as reflected in the varying aerial photo patterns. However, sometimes a characteristic landform or soil type can identify a known associated vegetation change (e.g. claypans, dunecrests).

The most basic vegetation mapping unit, the structural formation, incorporates only upperstorey life form and percent cover (as in Specht, 1972). Such vegetation mapping units can usually be linked to a group of floristic associations identified from a classification and ordination analysis by considering visible structure and associated environmental factors. Occasionally an overstorey dominant species exhibits a unique aerial photographic signature, such as *Casuarina pauper*, and more rarely understorey species can be identified (e.g. *Triodia* spp.). Usually though, a possible suite of upper- and understorey species can be inferred from the combination of distinctive associated species, landform and/or soils known to be present.

This is tending towards vegetation alliance mapping (i.e. life form, percent cover, related upperstorey species, and possible understorey species (Specht, 1972)) although the lifeform and cover is often just an 'average' as it is not easy to distinguish between different cover and height classes (at scales such as used in the present study - see below).

Mapping methodology

Prior to mapping the South Olary Plains vegetation, all topographic features such as roads, tracks, dams and buildings were digitised from 1:50,000, 1:100,000 and 1:250,000 topographic mapsheets (for southern, middle and northern regions of the survey area respectively) using the Environmental Systems Research Institute's Arc/Info Geographical Information System (GIS) software.

In the mapping process, additional site information from previous studies conducted in and around the region were used to supplement the survey data (i.e. from Tiver (pers. comm.), Barber and Linton (1989), Barratt and Kutsche (1994), Barratt and White (1993), Davies (1982) and University of South Australia (1988-93)).

Using a stereoscope and 1:86,600 colour aerial photographs annotated with the florisitic analysis results and site information from previous studies, distinct changes in vegetation types were identified and delineated. (This mapping was designated to be at a scale of 1:100 000.)

Recognition of different vegetation types were based on visible changes in colour, pattern and texture on the aerial photographs. The basic life form formations of woodland, mallee, shrubland, low shrubland and grassland/herbland could be identified using these criteria but height class divisions within these were generally not possible at this scale. Variations in canopy size and canopy separation could be seen but varied too much to be mapped accurately.

The 34 floristic vegetation types identified in the PATN analysis were grouped into life form groups and matched to the identified aerial photo patterns. These groups were then subdivided into species suites (or alliances) (usually a group of floristic types) using known associated landforms or soils (from the physical parameters recorded for each floristic group) that could be identified on the aerial photos. Some species suites could be identified by particular species which exhibited a characteristic texture or colour on the aerial photos.(eg *Triodia* spp, *Maireana sedifolia*). Other sites could only be identified by knowing the species composition at a particular point on the ground, at a nearby site, or by inference from the surrounding vegetation types and a field knowledge of the area's typical vegetation patterns. It was considered worthwhile still identifying these latter suites but recognising that their total distribution could not be accurately assessed. Each species suite thus constituted a mapping unit.

Mapping units

Within each species suite, a range of two to three Muir's (1977) height classes and one to two canopy cover classes were known to occur, so an 'average' or the most common was used when naming the mapping units. Units were named using the structural formation table in Appendix V and dominant or characteristic species identified from the aerial photos or surmised from the floristic analysis groups.

In this manner *primary* (or 'pure') mapping units were identified. However, as usually occurs in nature, stands of vegetation are rarely homogeneous but exhibit a complex mosaic of several vegetation types. At this mapping scale much of the area comprised vegetation mosaics which were too intricate to map by primary units. Thus *secondary* mapping units were identified, each comprising a mosaic of two vegetation types, and *tertiary* units each containing three vegetation types. Secondary units were defined as comprising a mix of 25-75% of each of the two vegetation types and tertiary units a 25-50% mix of each. All units were allowed to contain patches of other vegetation types which covered less than 25 percent of the total area, being considered too minor to be included as part of the mosaic. In mosaics no dominance was attributed to any of the vegetation types.

Mapped vegetation boundaries were transferred onto transparent mylar overlays onto which the digitised topographic features had been plotted. The vegetation polygons were then digitised using ARC/INFO.

Each mapping unit was described using information from the floristic groups and field knowledge. The aerial photo patterns used to classify the units and the inherent variations in such were also described where appropriate.

As numerous secondary and tertiary mapping units were identified (as well as primary ones) (totalling greater than 60 units) a simplified map legend was designed, incorporating a hierarchy of systematically assigned colours and symbols . Primary units were represented by plain colours and each assigned a symbol that was used with other primary vegetation colours to indicate a secondary mosaic of the two (e.g. brown with crosses = mosaic of Blackoak woodland and bluebush shrubland). The colours chosen had no particular meaning i.e. dominance of one of the units. Tertiary units were similarly constructed with one colour and two symbols representing the three component vegetation types.

The final South Olary Plains vegetation mapping units were compared with those of other mapping projects completed in or adjacent to the area.

Figure 34
Botanists at work
Photo: P. Canty

Figure 35
Establishing pitfall traplines at SM0202
Photo: P. Copley

Figure 36
Processing specimens and data sheets
Photo: L. Forward

Figure 37
Herpetologist T. Morley with a Mulga Snake
Photo: L. Forward

Figure 38
Emu chicks observed at quadrat MC0102
Photo: P. Copley

Figure 39
Collecting bats from harp trap
Photo: J. Davis

Results

VEGETATION

by L.R. Forward[1]

INTRODUCTION

Specht's (1972) vegetation map of South Australia shows the South Olary Plains as containing five basic vegetation types: *Eucalyptus socialis - E. gracilis* open scrub, *Casuarina cristata* (now *C. pauper*) low woodland, *Myoporum platycarpum* low woodland, *Atriplex vesicaria - Maireana sedifolia* low shrubland and *Dodonaea-Eremophila-Cassia* tall shrubland. Carnahan's (1976) vegetation map of Australia depicts the same vegetation types but in eight categories which include different specifications of percent cover and understorey species composition.

The western edge of the current survey area was similarly described by Jessup (1948) into five associations but the Eucalypt group was divided into *E. oleosa - E. gracilis* and *E. oleosa - E. brachycalyx,* there was no separate chenopod group and the tall shrublands included *Acacia* spp.. On Quondong Station Barker (1970) also identified the two major vegetation types as *Casuarina cristata (pauper)* woodland and *Eucalyptus oleosa - E. gracilis* mallee but included three minor localised communities. Understorey species of the two dominant vegetation types also occurred as minor patches (i.e. *Maireana sedifolia, Atriplex vesicaria* and *Triodia irritans* (now *T. scariosa*)).

From casual observations, these early classifications of the South Olary Plains vegetation are quite correct but very general. It is only recently that works by the University of South Australia (1988-1993), Barber and Linton (1989), Brett (1990) and Tiver (1994) describe in detail the species and floristic communities of particular sections of the South Olary Plains. The South Australian State Herbarium has extensive records from the area but as these records are not yet computerised compilation of the data is impossible. However, many of the specimens would have been collected in the above studies.

Thus the South Olary Plains biological survey provides the first comprehensive species list, floristic vegetation association classification and detailed vegetation alliance/association map for the south-eastern pastoral districts of South Australia.

TOTAL SPECIES

A complete list of all plant taxa recorded from the South Olary Plains in the current and previous studies is detailed in Appendix VI. The total number of taxa listed is 1092 but minus the species annotated as non-current, questionable, possibly outside the area and incomplete or redundant data results in 876 final taxa.

A total of 540 viable taxa were found on the South Olary Plains survey, of which 512 were recorded at survey sites with the additional 28 species being found only opportunistically. Table 4. summarises these totals and includes the number of taxa designated 'consistently detectable' or not and whether they are indigenous or introduced.

Table 4

Total number of plant taxa found on the South Olary Plains biological survey.

Figures in brackets indicate the number of species found *only* opportunistically (which are included in the number preceding).

	Indigenous	Introduced	Total
Consistently detectable	338 (19)	14 (1)	352 (20)
Not consistently detectable	127 (1)	61 (7)	188 (8)
Total	465 (20)	75 (8)	540 (28)

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Frequencies of all taxa that occurred at more than one site are listed in Table 5. Non-final taxa such as incomplete identifications or redundant data are printed in normal rather than italic typeface (and not included in the totals stated above). Introduced and 'not consistently detectable' designations are also annotated. Thus, from this table, all species used in the final floristic analysis can be identified as those in italics without a 'not consistently detectable' annotation, taking into consideration species (or subspecies) that were grouped together for analysis (also annotated).

The 28 species found only opportunistically were all single occurrences and, with the site-based single occurrence species, are included in the complete species list in Appendix VI.

Table 5
Plant species frequencies recorded on the South Olary Plains biological survey

Total number of quadrats surveyed was 480. Species of frequency less than two are not shown but are included in the complete species list in Appendix VI.

Taxa shown in normal rather than italic typeface were considered unsuitable for analysis i.e. incomplete identification or redundant data (see methods chapter for details).

- * Introduced species
- \+ Species designated 'not consistently detectable' and therefore excluded from the floristic analysis.

(nv) Non-current taxonomy

G Subspecies (or species) that were grouped into species (or slashed) categories respectively for analysis, or new taxonomy grouped back to old or special taxonomic groupings (see methods text).

	Species	Frequency
	Enchylaena tomentosa var. *tomentosa*	287
	Lichen sp.	282
	Maireana sedifolia	245
	Moss sp.	237
	Maireana pyramidata	195
	Sclerolaena obliquicuspis	190
	Stipa sp.	187
+	*Tetragonia eremaea/tetragonoides*	177
*	*Carrichtera annua*	175
	Myoporum platycarpum ssp.	171
+*	*Sonchus oleraceus*	158
+	*Brachycome lineariloba*	150
+*	*Sisymbrium erysimoides*	147
	Alectryon oleifolius ssp. *canescens*	145
	Sclerolaena diacantha	139
	Rhagodia spinescens	135
	Atriplex vesicaria ssp.	131
	Eriochiton sclerolaenoides	126
	Eucalyptus socialis	125
	Casuarina pauper	124
+	*Crassula colorata/sieberana*	119
+	*Senecio glossanthus*	119
+	*Erodium crinitum/cygnorum*	119
	Maireana georgei/turbinata	112
	Danthonia sp.	111
	Rhagodia ulicina	107
	Chenopodium curvispicatum	103
	Maireana trichoptera	102
	Atriplex stipitata	101
+	*Rhodanthe pygmaea*	100
	Lycium australe	99
	Senna artemisioides nothossp. *coriacea*	99
	Exocarpos aphyllus	97
+*	*Erodium cicutarium*	95
	Senna artemisioides ssp. *petiolaris*	94
+*	*Hypochaeris glabra*	92

	Species	Frequency
	Gramineae sp.	92
+*	*Alyssum linifolium*	92
	Eucalyptus gracilis	91
+	*Omphalolappula concava*	90
	Maireana pentatropis	90
+	*Actinobole uliginosum*	90
	Olearia muelleri	88
	Daucus glochidiatus	88
	Rhagodia parabolica	87
	Eucalyptus oleosa	86
	Acacia colletioides	83
	Ptilotus obovatus var. *obovatus*	81
	Olearia pimeleoides ssp. *pimeleoides*	79
+*	*Medicago minima* var. *minima*	79
	Grevillea huegelii	78
	Dodonaea viscosa ssp. *angustissima*	74
	Eremophila glabra ssp.	74
	Triodia irritans complex	74
	Acacia nyssophylla	73
	Einadia nutans ssp.	72
	Oxalis perennans	72
	Dissocarpus paradoxus	71
	Eucalyptus dumosa	67
+	*Calotis hispidula*	67
+	*Isoetopsis graminifolia*	64
+	*Calandrinia* sp.	63
	Zygophyllum apiculatum	63
	Goodenia fascicularis	62
	Sclerolaena patenticuspis	62
	Eremophila sturtii	60
	Eremophila scoparia	59
+*	*Sisymbrium* sp.	59
	Senna artemisioides ssp. *filifolia*	57
+	*Zygophyllum ovatum*	53
	Westringia rigida	51
	Maireana brevifolia	50
+*	*Erodium aureum*	50
+	*Salsola kali*	46
*	*Asphodelus fistulosus*	46
	Maireana erioclada	46
+	*Tetragonia* sp.	45
+	*Goodenia pusilliflora*	45
+	*Euphorbia drummondii*	44
	Convolvulus microsepalus/remotus	42
+	*Geococcus pusillus*	42
	Lysiana exocarpi ssp. *exocarpi*	41
	Maireana astrotricha	41
+*	*Medicago polymorpha* var. *polymorpha*	41
+	*Thysanotus baueri*	41
+	*Plantago* sp.	40
	Templetonia egena	40
	Vittadinia sp.	40
+*	*Critesion* sp.	38
+*	Medicago sp.	37
	Compositae sp.	36
	Scaevola spinescens	36
	Crassula sp.	36
	Minuria cunninghamii	34
+*	*Bromus* sp.	33
	Arabidella trisecta	33
+	*Zygophyllum iodocarpum*	32
	Acacia oswaldii	32
+	*Stenopetalum lineare*	31
	Sida petrophila	31
+	Erodium sp.	31
	Santalum acuminatum	30
	Zygophyllum billardierei (nv)	29
	Brachycome ciliaris var. *lanuginosa* G	29
	Beyeria opaca	29
	Atriplex acutibractea ssp. *acutibractea*	28
	Sida corrugata var.	28
+	*Nicotiana goodspeedii*	28
+*	*Sonchus* sp.	28
	Acacia burkittii	27
+*	*Schismus barbatus*	27
+	*Podolepis capillaris*	26
+	*Plagiobothrys plurisepaleus*	26
	Nitraria billardierei	26
	Chenopodium desertorum ssp. *desertorum* G	26
	Brachycome ciliaris var.	26
+*	*Echium plantagineum*	26
*	*Marrubium vulgare*	26
	Dissocarpus biflorus var. *biflorus*	26
	Stipa elegantissima	26
	Maireana radiata	26
	Vittadinia cuneata var.	26
+	*Ptilotus spathulatus* forma *spathulatus*	25
	Danthonia caespitosa G	24
	Zygophyllum sp.	24
	Vittadinia cuneata var. *cuneata* forma *cuneata*	24
*	*Salvia verbenaca form*	24
	Sclerolaena divaricata	24
	Sclerolaena sp.	24
	Sclerolaena brachyptera	23
	Sida sp.	23
	Convolvulus sp.	23
	Eremophila oppositifolia var. *oppositifolia*	22
	Eremophila deserti	22
	Goodenia sp.	22
	Solanum petrophilum	22
+*	*Critesion murinum* ssp. *glaucum*	21
*	*Salvia verbenaca form B* G	21
	Stipa scabra group	21
	Maireana appressa	21
	Senna artemisioides nothossp. *artemisioides*	21
	Sida intricata	21
	Senecio quadridentatus	21
	Pittosporum phylliraeoides var. *microcarpa*	20
+*	*Rostraria pumila*	20
	Acacia victoriae ssp. *victoriae*	20
	Maireana turbinata G	20
	Ixiolaena leptolepis/tomentosa	20
	Cheilanthes lasiophylla	20
	Solanum ellipticum	19

	Species	Frequency
+	*Brachycome ciliaris* var. *ciliaris* G	19
	Wahlenbergia sp.	19
	Erodiophyllum elderi	19
*	*Lycium ferocissimum*	19
	Lepidium leptopetalum	19
	Daviesia benthamii ssp. *benthamii* G	19
+	*Rhodanthe floribunda*	18
	Ptilotus sp.	18
	Stipa nitida G	18
+	*Lepidium oxytrichum/papillosum*	18
	Eucalyptus leptophylla	18
+	*Calandrinia eremaea*	18
	Chenopodium desertorum ssp.	17
	Olearia decurrens	17
+*	*Brassica tournefortii*	17
	Acacia sclerophylla	17
+	*Hyalosperma demissum*	17
+	*Wurmbea dioica* ssp. *dioica*	17
	Minuria sp.	17
	Dodonaea lobulata	17
	Zygophyllum aurantiacum G	17
	Zygophyllum angustifolium G	16
+	*Lepidium papillosum* G	16
	Sclerolaena cuneata	16
	Atriplex angulata	16
+*	*Bromus rubens*	16
	Chrysocephalum semipapposum	16
	Herb sp.	15
	Ixiolaena leptolepis G	15
+*	*Medicago truncatula*	15
	Abutilon fraseri	15
	Sida fibulifera	15
+	*Rhodanthe microglossa*	15
	Geijera linearifolia	15
+*	*Carthamus lanatus*	15
	Maireana aphylla	15
+	Brachycome sp.	15
	Cratystylis conocephala	15
+	*Plantago drummondii*	14
	Myoporum platycarpum ssp. *platycarpum* G	14
	Oxalis sp.	14
	Pimelea microcephala ssp. *microcephala*	14
	Eucalyptus incrassata	14
	Nicotiana sp.	14
	Eucalyptus porosa	14
+	*Atriplex lindleyi* ssp. *inflata* G	14
+*	*Calendula arvensis*	13
	Eremophila glabra ssp. *glabra* G	13
+*	*Centaurea melitensis*	13
	Acacia rigens	13
+	*Chthonocephalus pseudevax*	13
	Atriplex vesicaria ssp. *macrocystidia* G	13
+	*Millotia macrocarpa*	13
	Stipa acrociliata	13
	Lomandra leucocephala ssp. *robusta*	12
	Cassinia laevis	12
+	*Lotus cruentus*	12

	Species	Frequency
	Minuria leptophylla	12
+	Millotia sp.	12
+	*Zygophyllum crenatum*	12
	Ptilotus exaltatus var. *exaltatus*	12
	Callitris verrucosa	12
	Lawrencia squamata	12
	Eremophila longifolia	12
+	*Erodium crinitum* G	11
+	Lepidium sp.	11
	Maireana integra	11
	Eremophila alternifolia	11
	Chrysocephalum semicalvum ssp. *semicalvum*	11
+	*Millotia perpusilla*	11
	Atriplex sp.	11
	Marsdenia australis	11
	Hakea leucoptera	11
+	*Harmsiodoxa* sp.	11
	Atriplex vesicaria ssp. *calcicola* G	11
	Eremophila crassifolia	11
	Osteocarpum sp.	11
	Dodonaea bursariifolia	11
	Maireana georgei G	11
	Sclerolaena ventricosa	11
	Eragrostis dielsii var. *dielsii*	11
	Rhyncharrhena linearis	11
	Maireana sp.	10
	Acacia ligulata	10
	Disphyma crassifolium ssp. *clavellatum*	10
+	*Menkea australis*	10
	Glycine clandestina var. *sericea*	10
	Frankenia serpyllifolia	10
	Sclerolaena uniflora G	10
	Sclerolaena parviflora	10
	Amyema miquelii	10
	Melaleuca lanceolata	10
	Acacia wilhelmiana	10
	Maireana triptera	10
+	*Lemooria burkittii*	10
*	Trifolium sp.	10
+	*Parietaria cardiostegia/debilis*	10
	Eremophila serrulata	9
	Eutaxia microphylla var. *microphylla*	9
	Convolvulus erubescens	9
*	*Hypochaeris radicata*	9
+	*Zygophyllum ammophilum* (nv)	9
	Acacia calamifolia	9
	Amyema preissii	9
	Chenopodiaceae sp.	9
+	*Rhodanthe corymbiflora*	9
+	*Hyalosperma semisterile*	9
	Scleranthus pungens	9
+	*Parietaria cardiostegia* G	9
+	*Chrysocephalum apiculatum*	8
	Zygophyllum glaucum	8
	Bursaria spinosa	8
	Eremophila maculata var. *maculata*	8
	Teucrium racemosum	8

Species	Frequency
Lomandra effusa	8
+* *Malva parviflora*	8
Amyema sp.	8
Dodonaea baueri	8
+* Rostraria sp.	8
+ Pterostylis sp.	8
Dianella revoluta var.	8
Vittadinia cuneata var. *morrisii* G	8
+ *Rhodanthe polygalifolia*	8
Brachycome trachycarpa	7
Dodonaea stenozyga	7
Prostanthera striatiflora	7
Olearia magniflora	7
Enneapogon intermedius	7
Convolvulus remotus G	7
+ *Astragalus* sp.	7
Goodenia willisiana	7
Sclerolaena lanicuspis	7
+ *Arabidella procumbens*	7
Callitris glaucophylla	7
Cheilanthes sieberi ssp. *sieberi*	7
+ *Crassula sieberiana* ssp. *tetramera* G	7
+ *Arabidella nasturtium*	7
Vittadinia gracilis	7
+ *Rhodanthe stricta*	7
+ *Hypoxis glabella* var. *glabella*	7
Malacocera tricornis	7
Zygophyllum eremaeum	7
Daviesia benthamii ssp.	7
+ *Zygophyllum simile* G	7
Paspalidium constrictum	7
Pleurosorus rutifolius	7
Baeckea crassifolia	6
Olearia subspicata	6
* Centaurea sp.	6
Sclerostegia tenuis	6
Stipa platychaeta	6
+ *Craspedia pleiocephala*	6
Olearia passerinoides ssp. *passerinoides*	6
+* *Herniaria cinerea*	6
Cymbopogon ambiguus	6
Galium migrans	6
Stipa scabra ssp. *scabra*	6
+* *Onopordum acaulon*	6
Calotis sp.	6
+ Hyalosperma sp.	6
Eucalyptus brachycalyx	6
Euphorbia tannensis ssp. *eremophila*	6
+ *Lepidium phlebopetalum*	5
Digitaria sp.	5
Cruciferae sp.	5
+ *Crassula colorata* var. *acuminata* G	5
Acacia brachybotrya	5
+ *Harmsiodoxa brevipes* var. *brevipes* G	5
Solanum esuriale	5
+* *Sisymbrium irio*	5

Species	Frequency
Galium sp.	5
Zygophyllum aurantiacum (nv)	5
+ *Haloragis aspera*	5
+ *Erodium cygnorum* ssp. *glandulosum* G	5
+ *Pogonolepis muelleriana*	5
Stipa nodosa G	5
Helichrysum leucopsideum	5
Sida trichopoda	5
+ *Asteridea athrixioides* forma *athrixioides*	5
Enneapogon sp.	5
+ *Parietaria debilis* G	5
Boraginaceae sp.	5
+ *Elachanthus pusillus*	5
Chenopodium sp.	5
Centipeda sp.	5
Enneapogon avenaceus	5
Lavatera plebeia	5
+* *Heliotropium europaeum*	4
Isotoma petraea	4
Prostanthera aspalathoides	4
Danthonia setacea var. *setacea* G	4
+ *Myriocephalus* sp.	4
+* *Xanthium spinosum*	4
+ *Gnephosis arachnoidea*	4
Daviesia benthamii ssp. *humilis* G	4
+ *Phlegmatospermum cochlearinum*	4
+ *Chamaescilla corymbosa* var. *corymbosa*	4
+ *Atriplex holocarpa*	4
Cassinia arcuata	4
Chenopodium nitrariaceum	4
Logania nuda	4
Senecio lautus	4
Abutilon halophilum	4
Abutilon malvaefolium	4
Acacia pycnantha	4
Amyema miraculosum ssp. *boormanii*	4
+ *Hyalosperma glutinosum* ssp. *glutinosum*	4
Chenopodium desertorum ssp. *anidiophyllum* G	4
Beyeria lechenaultii	4
+ *Vittadinia dissecta* var. *hirta*	4
+ *Podolepis tepperi*	4
Zygophyllum confluens G	4
Acacia loderi	4
+ *Harmsiodoxa brevipes* var.	4
Cassytha melantha	3
Caryophyllaceae sp.	3
+ *Aristida contorta*	3
+ *Cheilanthes austrotenuifolia*	3
Eragrostis sp.	3
+* *Dittrichia graveolens*	3
Eragrostis australasica	3
Muehlenbeckia florulenta	3
Centipeda thespidioides	3
Liliaceae sp.	3
Cryptandra amara var. *longiflora*	3

Species	Frequency
Olearia brachyphylla (nv)	3
Halgania cyanea	3
Acacia aneura (nv)	3
Arabidella sp.	3
Acacia hakeoides	3
+ *Bulbine semibarbata*	3
Leptospermum coriaceum	3
Senna artemisioides ssp.	3
Halosarcia sp.	3
+ *Plantago turrifera*	3
Convolvulus microsepalus G	3
Glycine canescens	3
+* *Solanum nigrum*	3
+ *Podotheca angustifolia*	3
Olearia lepidophylla	3
+* *Reichardia tingitana*	3
Acacia notabilis	3
+ *Zygophyllum ammophilum* G	3
Schoenus subaphyllus	3
+* *Mesembryanthemum nodiflorum*	3
+* *Plantago bellardii*	3
+ *Goodenia pinnatifida*	3
Senecio sp.	3
Acacia aneura var. *aneura* G	3
Olearia calcarea	3
Senecio anethifolius	3
Solanum coactiliferum	3
+ *Rhodanthe moschata*	3
Sauropus rigens	2
+* Silene sp.	2
Acacia tetragonophylla	2
+ *Swainsona oliveri*	2
Rhagodia sp.	2
+ *Triptilodiscus pygmaeus*	2
Sclerolaena intricata	2
Euphorbia sp.	2
+ *Harmsiodoxa blennodioides*	2
+ *Pterostylis biseta*	2
Gonocarpus tetragynus	2
+* *Gynandriris setifolia*	2
+ *Phlegmatospermum eremaeum*	2
+* *Emex australis*	2
Wahlenbergia communis	2
Centipeda cunninghamii	2
+ *Triglochin centrocarpum*	2
Frankenia sp.	2
Rhagodia crassifolia	2
+ *Atriplex lindleyi* ssp.	2
Goodenia robusta	2
Grevillea pterosperma	2
+ *Chenopodium cristatum*	2
+ Gnephosis sp.	2
Danthonia geniculata G	2
Eragrostis laniflora	2
+ *Swainsona stipularis*	2
* *Psilocaulon tenue*	2
Stipa eremophila G	2
Myoporaceae sp.	2
+* *Sonchus tenerrimus*	2
* *Nicotiana glauca*	2
Osteocarpum acropterum var. *acropterum*	2
Cryptandra propinqua	2
Eremophila glabra ssp. *murrayana* G	2
Callitris preissii	2
Acacia sp.	2
Abutilon sp.	2
+ *Ranunculus pentandrus* var. *platycarpus*	2
Schoenus sp.	2
+ *Stenopetalum sphaerocarpum*	2
Grammosolen dixonii	2
Allocasuarina verticillata	2
+ *Rhodanthe stuartiana*	2
+ *Bulbine* sp.	2
+ *Brachycome perpusilla*	2
* Salvia sp.	2
* Hypochaeris sp.	2
Hibbertia virgata	2
Ixiolaena sp.	2
Clematis microphylla	2
+ *Brachycome goniocarpa*	2
Carpobrotus modestus/rossii	2
+ *Vittadinia cervicularis* var. *cervicularis*	2
Solanum sp.	2
Sclerolaena tricuspis	2
Eucalyptus camaldulensis var. *camaldulensis*	2
Santalaceae sp.	2
Lomandra sp.	2
Acacia ayersiana var. *latifolia* G	2
+* *Verbena supina*	2
Haeckeria punctulata	2
Gahnia lanigera	2
Lomandra multiflora ssp. *dura*	2
Cheilanthes distans	2
+ Helipterum sp. (nv)	2
+* *Neatostema apulum*	2
Boronia coerulescens ssp. *coerulescens*	2
Myoporum montanum	2
+ *Euphorbia australis*	2
+ *Heliotropium undulatum*	2
+* *Erodium botrys*	2
Eremophila duttonii	2
Amyema linophyllum ssp. *orientale*	2
Spyridium phlebophyllum	2
Geranium sp.	2

Of the 876 species recorded for the area from all studies, 71 (6.5%) were found only on the South Olary Plains survey. All of these species were vouchered or identified by a reputable botanist. [Some of these species may be first records for the South Olary Plains but this cannot be verified unless the South Australian Herbarium records are thoroughly checked. Most are, however, already known from the Eastern or Murray Mallee areas, according to Jessop (1993)]. Most of these 'new' (or unique to the current survey) records occurred in the western section of the survey area which had only been previously studied by Jessup (1948) and in part by Brett (1990) and Tiver (1994). Additionally, approximately fifteen 'unique' species were found in the northern third of the survey area and about ten in the central and southern regions.

From the frequency table it is evident that most species had a quite low overall frequency: only 5.7% (31 species) had a frequency of greater than 20% (i.e. at 96 quadrats) and only two species (0.37%) occurred in greater than 50% (240) of the quadrats. In other words, the majority of species (i.e. 87%) occurred at less than 10% of the quadrats. This, however, probably reflects the wide variety of habitats and vegetation types that occur in the area.

Of the total species recorded on the South Olary Plains survey, 13.9% were alien but of the species with frequency greater than 20%, 16.7% were weeds, indicating that a number of weed species are quite common [i.e. *Carrichtera annua* (Ward's Weed) - 36.5% frequency; *Sonchus oleraceus* (Common Sow-thistle) - 32.9% and *Sisymbrium erysimoides* (Smooth mustard) - 30.6%]. [The next three most common weeds were *Erodium cicutarium* (Common Stork's Bill) - 19.8%; *Hypochaeris glabra* (Smooth Catsear) - 19.8% and *Alyssum linifolium* (Flax-leaf Alyssum) - 19.2%].

Of the species recorded from *all* the South Olary Plains studies 18% were weeds. This is much greater than the 8% and 12% recorded for the Yellabinna and Gawler Ranges survey areas respectively but probably reflects the fact that the South Olary Plains area is nearer larger human populations and agricultural practices. However, from the Gawler Ranges survey results, 18% of the species with greater than 20% frequency were weeds which is comparable with the current survey's figure of 16.7% for common species.

FLORISTIC ANALYSIS

Classification

The pattern analysis was conducted on 245 'consistently detectable' species from 475 quadrats.

The most ecologically meaningful grouping of these quadrats from the resultant dendrogram was into 34 floristic vegetation types. The dendrogram is too long to be presented here but Table 6 lists the 34 vegetation types as they appear down the dendrogram and indicates the size of each group. The floristic vegetation group for each site is listed in Appendix III.

The mallee and chenopod/blackoak groups were further subdivided into 12 and 14 sub-groups respectively which appeared to have ecological meaning. These are discussed after the ordination results are considered.

Table 6
Floristic vegetation groups resulting from the PATN analysis.

Groups are listed in the order that they appeared on the dendrogram.

1. *Eucalyptus gracilis* Open Tree Mallee (26 quadrats)
2. *Eucalyptus oleosa* Open Tree Mallee (39 quadrats)
3. *Eucalytpus oloesa / Eucalyptus socialis* Open Tree Mallee (24 quadrats)
4. *Eucalyptus socialis* Open Tree Mallee (18 quadrats)
5. *Eucalyptus dumosa / Eucalyptus socialis* Open Tree Mallee (42 quadrats)

MALLEE GROUPS

6. *Stipa scabra* group Open Grassland (7 quadrats)
7. *Maireana trichoptera* Low Open Shrubland (5 quadrats)
8. *Salvia verbenaca* Open Herbland (4 quadrats)
9. *Enneapogon intermedius* Open Grassland (2 quadrats)
10. *Atriplex angulata / Maireana brevifolia* (3 quadrats)
11. *Casuarina pauper / Eucalyptus dumosa* Low Open Woodland (6 quadrats)
12. *Sclerolaena diacantha* Low Very Open Shrubland (3 quadrats)
13. *Eucalyptus oleosa* Very Open Tree Mallee (3 quadrats)
14. *Eremophila sturtii / Acacia burkittii* Open Shrubland (9 quadrats)
15. *Sida petrophila / Ptilotus obovatus* var. *obovatus* Low Open Shrubland (4 quadrats)
16. *Rhagodia ulicina / Maireana sedifolia* Low Open Shrubland (5 quadrats)
17. *Lycium australe* Open Shrubland (4 quadrats)
18. *Danthonia* sp. Open Grassland (8 quadrats)
19. *Stipa* sp. Open Grassland (10 quadrats)
20. *Maireana aphylla / Nitraria billardierei* (3 quadrats)
21. *Eucalyptus brachycalyx* Open Tree Mallee (3 quadrats)
22. *Dodonaea viscosa* ssp. *angustissima* Open Shrubland (7 quadrats)
23. *Eucalyptus porosa* Open Tree Mallee (5 quadrats)
24. *Rhagodia parabolica / Dodonaea lobulata* Open shrubland (7 quadrats)
25. *Asphodelus fistulosus* Open Herbland (9 quadrats)
26. *Sclerolaena obliquicuspis* Low Open Shrubland (6 quadrats)

MINOR GROUPS

Grasslands
Herblands
Minor Chenopods
Minor Woodlands
Tall Shrublands
Claypans

27. *Atriplex vesicaria* ssp. Low Open Shrubland (39 quadrats)
28. *Maireana astrotricha / Atriplex vesicaria* ssp Low Open Shrubland (7 quadrats)
29. *Maireana pyramidata* Low Open Shrubland (24 quadrats)
30. *Maireana pyramidata /Atriplex vesicaria* ssp. Low Open Shrubland (11 quadrats)
31. *Carrichtera annua* Herbland (30 quadrats)
32. *Maireana sedifolia* Low Open Shrubland (52 quadrats)

CHENOPOD GROUPS

33. *Casuarina pauper* Low Woodland (with *M. sedifolia*) (38 quadrats)
34. *Casuarina pauper* Low Woodland (with *Senna artemisioides* sspp.)(12 quadrats)

BLACKOAK GROUPS

The 34 Floristic Vegetation Groups

The 34 floristic vegetation groups are individually described below with a map, significant species, environmental data and statistics for each group. Group numbers from Table 6 are retained but group descriptions are listed by super-groups i.e. mallee, blackoak, chenopods and minor types.

Each group title includes the dominant overstorey species, general structure and the number of members (quadrats) in the group. The small survey area map for each group shows the distribution of quadrats at which that vegetation type was found (large dots). (Small dots indicate the location of all sites surveyed). The site code for any particular quadrat shown on the vegetation group maps can be determined from Appendix III where site codes are plotted and listed by mapsheet and vegetation types indicated.

The dominant overstorey species, sub-dominant overstorey species, indicator species and dominant understorey species listed for each group were selected according to the criteria stated in the methods chapter.

These species, listed in order of 'importance' determined by considering their proportion of occurrence within the group and their X^2 value, were selected from the group's species list and associated statistics (derived from the GSORT & GROUPSTAT reports) which appears on the second page of each group description.

Introduced species and indicator species are annotated with '*' and '†' respectively. It must be stressed that an indicator species on its own does not necessarily indicate a specific vegetation type; it is the presence of the indicator species in association with the other significant species that *suggests* the presence of a particular vegetation type. Many groups have no indicator species as there were no species unique enough to the group [i.e. that occurred in less than one third (i.e. < 11) of all the groups]. Nevertheless, the listed species and structure still characterise the group.

At times, a consistent dominant overstorey species could not be identified, particularly in very variable groups, in which case a characteristic species (which fitted the criteria of having a high X^2, proportion of occurrence and cover/abundance) was more appropriate for the group title. For example, in the grassland groups, many sites had a variety of shrubs and/or trees present but it is the grass species which are the linking factors between quadrats within the group.

The average number of plant species (including annuals) per quadrat is listed for each group and followed by an array of environmental parameters. Where average figures have been calculated the range is also shown to indicate the often quite wide variability of the parameters within the group.

Many parameters were very difficult to summarise and can only provide a general view of the group's characteristics. The overstorey measurements were only estimated in the field and the vegetation condition subjectively scaled into five categories (i.e. virtually no cover, undisturbed natural, disturbed natural, degraded natural and highly degraded) so these parameters are fairly general.

The group species list shows the frequency of cover/abundance categories recorded for each species at quadrats within the group. (The categories R, I, T & 1 - 5 are explained in Appendix I). This species list shows all species that occurred at greater than one third of the quadrats in that vegetation group (i.e. proportion of occurrence > 3) and is listed in order of proportion of occurrence (i.e. most common species first). [The proportion of occurrence is the proportion of quadrats in the group at which that species was recorded (e.g. a species with a prop'n occur. = 1 occurred at all sites in that group)].

The X^2 for each species is calculated on the proportion of occurrence (i.e. on the presence or absence of a species at a quadrat, *not* on how abundant it was). Therefore the cover/abundance values must also be considered when assessing the 'importance' of a species within a group. (See methods chapter for explanation of X^2).

The number of other groups in which each species occurs is also listed to give an indication of the uniqueness of each species to the group - a criteria used in designating indicator species.

A series of photographs follow each group description to show the range of vegetation structures which may occur in the group.

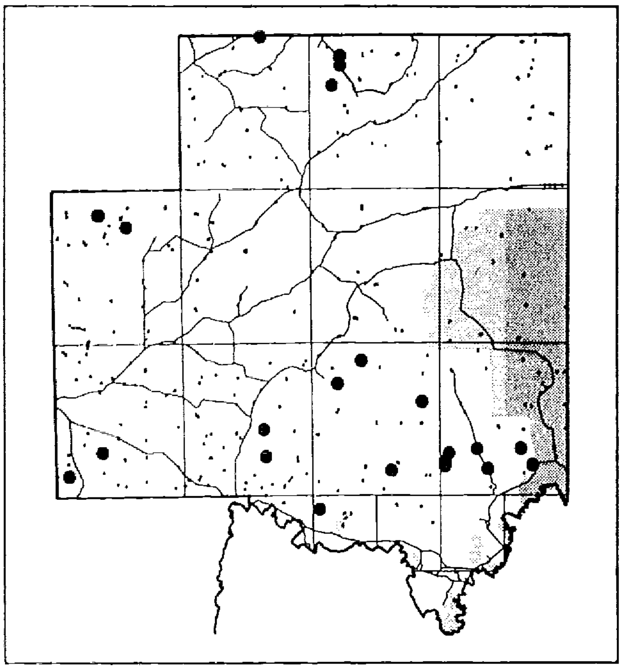
An alphabetic listing of scientific names and common names can be found in Appendix VII.

In the description notes for each group, comments on palatability and 'increaser' species (i.e. those species that are known to increase in abundance under degraded conditions) are from Cunningham *et al.*, 1992 and Barratt and Choate, 1983.

MALLEE COMMUNITIES

Floristic Group 1. *Eucalyptus gracilis* OPEN TREE MALLEE

26 members



Dominant Overstorey Species:

Eucalyptus gracilis (Yorrell)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Eucalyptus socialis
Zygophyllum aurantiaum
Enchylaena tomentosa var. *tomentosa*
and variety of shrubs

Average Number of Plant Species (&range):

31.4 (5 - 45)

Vegetation Condition: Disturbed natural to degraded natural

Representative Quadrat(s): HW0102 (Figure40) BN0201 (Figure41)

Structural Data:

Overstorey Life Form (all species)	Mallee trees
Overstorey Percent Canopy (crown) Cover	10 - 50%
Average Overstorey Height (& range)	5.7 m (4 - 8)
Average Overstorey Canopy Diameter (& range)	5.2 m (3 - 8)
Average Overstorey Gap between canopies (& range)	7.1 m (1 - 10)

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains*, sandplains, dunes & rises
Landform Elements	Plains*, dunes & hills
Surface Soil Texture	Sand - sandy loam* to clay & loam
Geological Surface Type	QPO - Woorinen Formation & various
Surface Strew & Cover	Nil to pebbles < 10%

Description:

Occurs mostly in the southern sandplains and dunefields but also in a small area to the north, in the Benda Range, and to the west on the eastern edge of the Burra Hills. Understorey variable from quite bare to sparse *Zygophyllum* spp. (Twinleaf) to chenopods or larger shrubs.

Species	R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
	Cover/Abundance										
Eucalyptus gracilis	0	0	0	0	18	8	0	0	1.00	4.32	22
Enchylaena tomentosa var. *tomentosa*	0	7	8	2	0	0	0	0	0.65	0.00	34
Eucalyptus socialis	0	1	0	0	15	0	0	0	0.62	0.76	23
Zygophyllum aurantiacum	1	4	5	0	6	0	0	0	0.62	1.06	19
Myoporum platycarpum ssp.	5	7	1	0	0	0	0	0	0.50	0.05	26
Maireana pentatropis	1	3	3	1	1	0	0	0	0.35	0.20	20
Sclerolaena diacantha	2	3	4	0	0	0	0	0	0.35	0.02	26
Stipa sp.	0	5	4	0	0	0	0	0	0.35	0.00	30
Atriplex stipitata	1	2	2	0	2	1	0	0	0.31	0.05	23
Maireana sedifolia	2	3	3	0	0	0	0	0	0.31	0.05	30
Rhagodia spinescens	1	5	2	0	0	0	0	0	0.31	0.00	29

Figure 40
***Eucalyptus gracilis* Open tree mallee at quadrat HW0102**

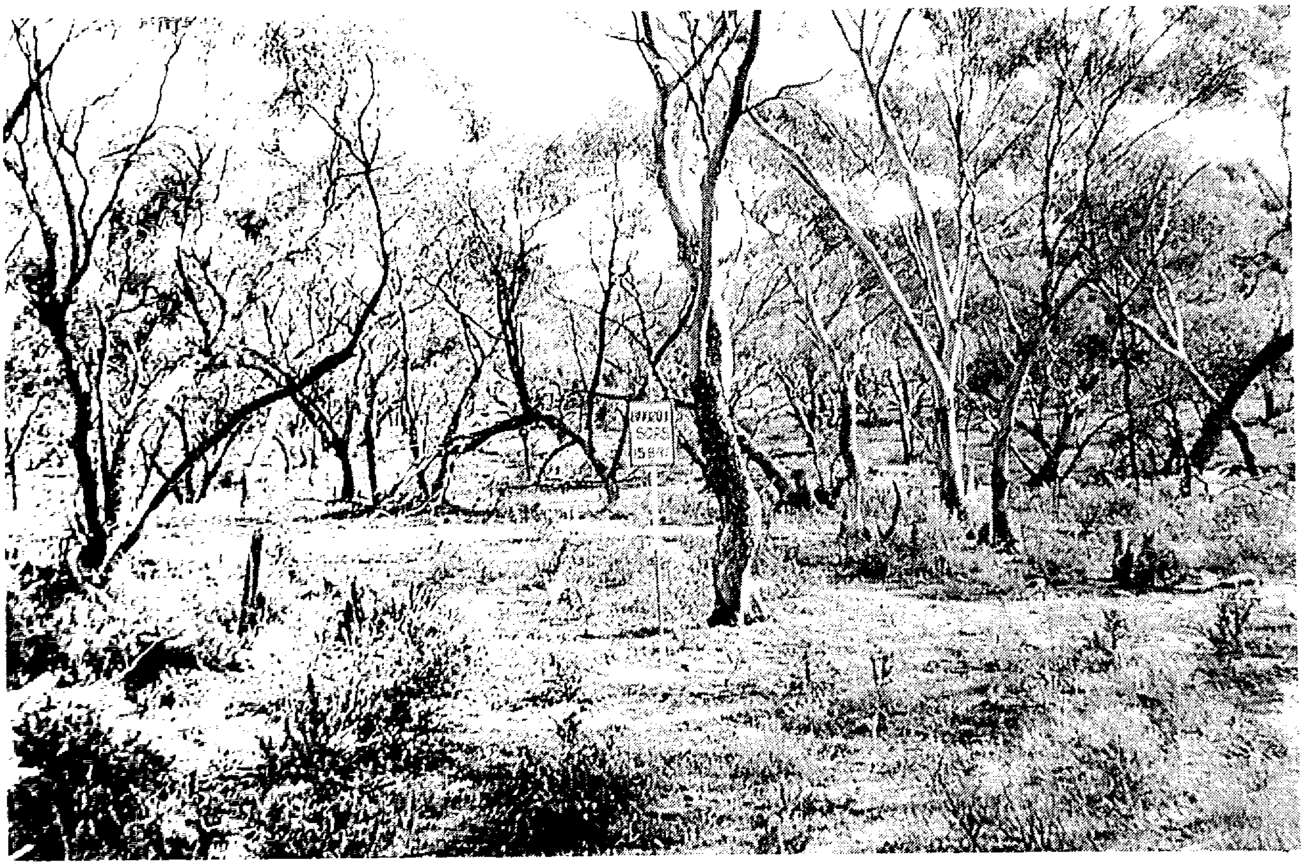
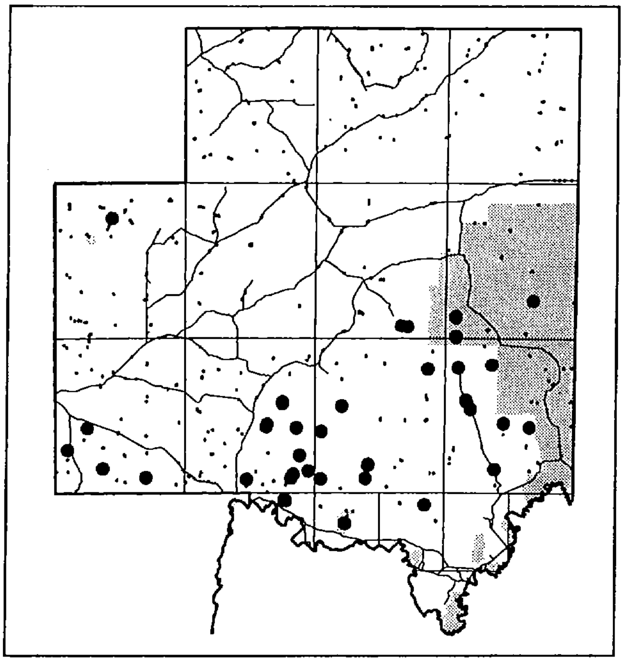


Figure 41
***Eucalyptus gracilis* Open tree mallee at quadrat BN0201**

Floristic Group 2. *Eucalyptus oleosa* OPEN TREE MALLEE

39 Members



Dominant Overstorey Species:

Eucalyptus oleosa (Red Mallee)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Zygophyllum aurantiacum
Grevillea huegelii
Olearia muelleri
Enchylaena tomentosa var. *tomentosa*

Average Number of Plant Species (&range):

23.5 (10 - 37)

Vegetation Condition: Disturbed natural to degraded natural

Representative Quadrat(s):
OA0201 (Figure42)
PK0401 (Figure 43)
ST0201 (Figure44)

Structural Data:

Overstorey Life Form (all species)	Mallee trees
Overstorey Percent Canopy (crown) Cover	5 - 50%
Average Overstorey Height (& range)	6.2 m (4 - 10)
Average Overstorey Canopy Diameter (& range)	5.3 m (2.5 - 9)
Average Overstorey Gap between canopies (& range)	8.5 m (2.5 - 15)

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains*, dunes, sandplains
Landform Elements	Plains, swales
Surface Soil Texture	Sand - sandy clay to sandy loam & clay loam
Geological Surface Type	QPO - Woorinen Formation
Surface Strew & Cover	Nil to pebbles < 10%

Description:

A large group, dominating the south and south-eastern sandplains and dunefields with a small pocket in the south-western agricultural area. Understorey variable from very sparse to sparse *Zygophyllum* spp., chenopods or large shrubs. Understorey generally more shrubby than Group 1 but variable.

Species	Cover/Abundance								Prop.	Chi	No.
	R	I	T	1	2	3	4	5	Occur.	Squ.	Gps
Eucalyptus oleosa	0	0	0	0	32	7	0	0	1.00	5.12	16
Zygophyllum aurantiacum	1	3	13	9	8	1	0	0	0.90	2.88	19
Enchylaena tomentosa var. *tomentosa*	0	10	19	3	0	0	0	0	0.82	0.05	34
Grevillea huegelii	1	17	8	1	0	0	0	0	0.69	2.71	13
Olearia muelleri	1	3	15	2	2	0	0	0	0.59	1.34	13
Maireana pentatropis	0	10	7	3	0	0	0	0	0.51	0.74	20
Myoporum platycarpum ssp.	4	13	3	0	0	0	0	0	0.51	0.06	26
Rhagodia ulicina	1	8	7	2	0	0	0	0	0.46	0.19	25
Eremophila scoparia	2	3	10	2	0	0	0	0	0.44	1.13	15
Sclerolaena obliquicuspis	0	5	12	0	0	0	0	0	0.44	0.03	23
Senna artemisioides ssp. *filifolia*	0	2	7	7	1	0	0	0	0.44	1.79	12
Zygophyllum apiculatum	0	4	8	4	1	0	0	0	0.44	0.61	17
Eremophila glabra ssp.	1	5	9	1	0	0	0	0	0.41	0.56	16
Senna artemisioides ssp. *petiolaris*	1	5	7	3	0	0	0	0	0.41	0.36	18
Acacia colletioides	2	7	5	0	1	0	0	0	0.38	0.42	16
Sclerolaena diacantha	0	6	8	1	0	0	0	0	0.38	0.04	26
Acacia nyssophylla	2	5	5	2	0	0	0	0	0.36	0.38	18
Eucalyptus gracilis	0	0	1	0	13	0	0	0	0.36	0.24	22
Senna artemisioides nothossp. *coriacea*	0	3	8	1	2	0	0	0	0.36	0.19	20
Maireana sedifolia	1	6	4	0	2	0	0	0	0.33	0.04	30
Olearia pimeleoides ssp. *pimeleoides*	0	7	6	0	0	0	0	0	0.33	0.22	18
Rhagodia parabolica	2	7	4	0	0	0	0	0	0.33	0.13	23

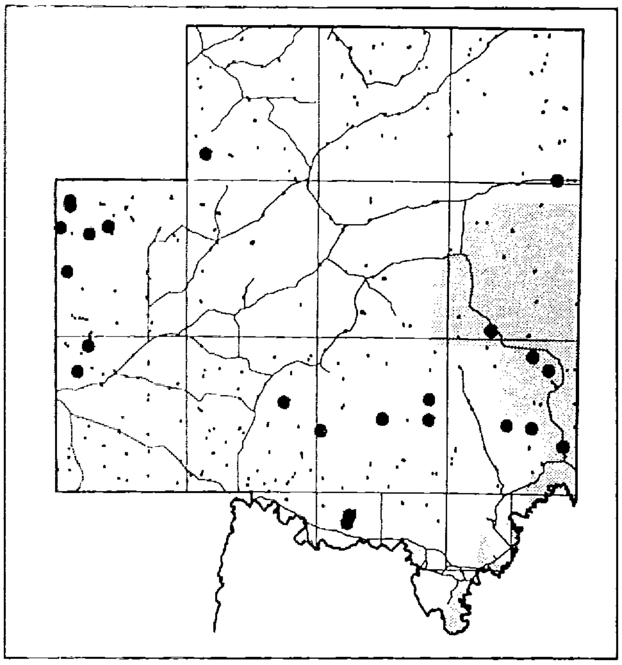
Figure 42
***Eucalyptus oleosa* Open tree mallee at quadrat OA0201**

Figure 43
Eucalyptus oleosa **Open tree mallee at qudarat PK0401**

Figure 44
Eucalyptus oleosa **Open tree mallee at qudarat ST0201**

Floristic Group 3. *Eucalyptus oleosa / Eucalyptus socialis* OPEN TREE MALLEE

24 members



Dominant Overstorey Species:

Eucalyptus oleosa (Red Mallee)
Eucalyptus socialis (Beaked Red Mallee)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Eucalyptus gracilis
Westringia rigida†
Olearia muelleri
Zygophyllum apiculatum
Zygophyllum aurantiacum

Average Number of Plant Species (&range):

27.8 (11 - 53)

Vegetation Condition:	Disturbed natural
Representative Quadrat(s):	HY0401 (Figure45 SE0201 (Figure46) SD0102 (Figure47)

Structural Data:

Overstorey Life Form (all species)	Mallee trees
Overstorey Percent Canopy (crown) Cover	10 - 50%
Average Overstorey Height (& range)	6.3 m (4 - 9)
Average Overstorey Canopy Diameter (& range)	5.0 m (3 - 8)
Average Overstorey Gap between canopies (& range)	5.1 m (2 - 10)

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Dunes*, plains
Landform Elements	various
Surface Soil Texture	Sand to loamy sand to silty clay loam
Geological Surface Type	QPO - Woorinen Formation & various
Surface Strew & Cover	Nil to pebbles < 10%

Description:

Scattered throughout dunefields in the south-eastern half of the area and on hills in the west. Understorey variable from very sparse *Zygophyllum* spp. to sparse to medium dense chenopods and larger shrubs, generally denser than in Groups 1 and 2. Similarly trees larger and more dense.

Species	Cover/Abundance								Prop.	Chi	No.
	R	I	T	1	2	3	4	5	Occur.	Squ.	Gps
Eucalyptus oleosa	0	0	0	0	22	1	0	0	0.96	4.63	16
Eucalyptus socialis	0	0	0	0	22	1	0	0	0.96	2.60	27
Olearia muelleri	1	6	5	1	4	0	0	0	0.71	2.15	17
Eucalyptus gracilis	0	4	2	0	8	0	0	0	0.58	1.09	22
Sclerolaena diacantha	0	4	7	0	3	0	0	0	0.58	0.33	26
Zygophyllum aurantiacum	0	2	5	6	1	0	0	0	0.58	0.91	19
Enchylaena tomentosa var. *tomentosa*	0	3	8	1	1	0	0	0	0.54	0.01	34
Zygophyllum apiculatum	1	0	11	1	0	0	0	0	0.54	1.13	17
Westringia rigida	0	6	5	1	0	0	0	0	0.50	2.34	11
Eremophila glabra ssp.	0	7	3	1	0	0	0	0	0.46	0.78	16
Maireana pentatropis	1	6	4	0	0	0	0	0	0.46	0.53	20
Acacia colletioides	1	4	5	0	0	0	0	0	0.42	0.54	16
Olearia pimeleoides ssp. *pimeleoides*	0	4	5	1	0	0	0	0	0.42	0.47	18
Triodia irritans complex	1	1	1	1	4	2	0	0	0.42	1.01	10
Eremophila scoparia	1	2	2	1	2	1	0	0	0.38	0.76	15
Myoporum platycarpum ssp.	0	8	1	0	0	0	0	0	0.38	0.00	26
Senna artemisioides ssp. *petiolaris*	2	2	4	1	0	0	0	0	0.38	0.26	18
Eucalyptus dumosa	0	1	1	0	6	0	0	0	0.33	0.68	11
Exocarpos aphyllus	2	5	1	0	0	0	0	0	0.33	0.08	24
Grevillea huegelii	0	4	4	0	0	0	0	0	0.33	0.38	13
Senna artemisioides nothossp. *coriacea*	1	3	2	2	0	0	0	0	0.33	0.14	20

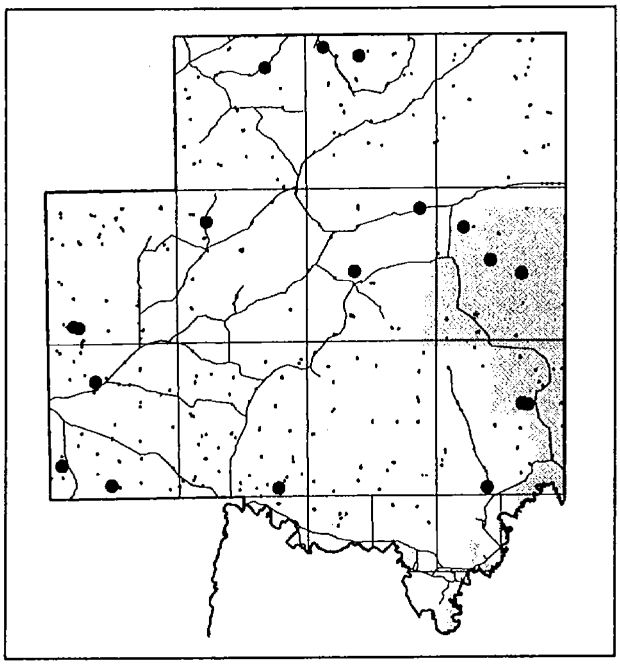
Figure 45
***Eucalyptus oleosa* / *Eucalyptus socialis* Open tree mallee at quadrat HY0401**

Figure 46
Eucalyptus oleosa / Eucalyptus socialis **Open tree mallee at quadrat SE0201**

Figure 47
Eucalyptus oleosa / Eucalyptus socialis **Open tree mallee at quadrat SD0102**

Floristic Group 4. *Eucalyptus socialis* OPEN TREE MALLEE

18 members



Dominant Overstorey Species:

Eucalyptus socialis (Beaked Red Mallee)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Myoporum platycarpum spp.
Enchylaena tomentosa var. *tomentosa*
& various shrubs

Average Number of Plant Species (&range):

28.6 (15 - 49)

Vegetation Condition:	Disturbed natural
Representative Quadrat(s):	NK0202 (Figure48 DA0401 (Figure 49

Structural Data:

Overstorey Life Form (all species)	Mallee trees
Overstorey Percent Canopy (crown) Cover	5 - 50%
Average Overstorey Height (& range)	5.0 m (3 - 8)
Average Overstorey Canopy Diameter (& range)	4.8 m (2 - 8)
Average Overstorey Gap between canopies (& range)	8.3 m (0.5 - 18)

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Dunes & plains
Landform Elements	Plains & various
Surface Soil Texture	Sandy to sandy loam & clay loam
Geological Surface Type	various
Surface Strew & Cover	Nil to pebbles 10 - 30%

Description:

Scattered throughout the survey area on a variety of landforms and soils. Overstorey species a little smaller and more open than in Groups 1 - 4 but understorey similarly variable and shrubby as in Group 3. One site, on Oulnina Park (OP0102), was dominated by White Cypress Pine (*Callitris glaucophylla*) but must have been included in this group on the basis of the understorey.

Species	R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
	Cover/Abundance										
Eucalyptus socialis	0	0	1	0	13	3	1	0	1.00	2.90	23
Enchylaena tomentosa var. *tomentosa*	0	10	3	1	0	0	0	0	0.78	0.03	34
Myoporum platycarpum ssp.	0	6	2	0	3	0	0	0	0.61	0.16	26
Exocarpos aphyllus	3	5	0	2	0	0	0	0	0.56	0.60	24
Maireana sedifolia	2	7	1	0	0	0	0	0	0.56	0.02	30
Dodonaea viscosa ssp. *angustissima*	0	2	6	0	0	0	0	0	0.44	0.33	20
Rhagodia parabolica	0	5	2	1	0	0	0	0	0.44	0.38	23
Chenopodium curvispicatum	1	3	3	0	0	0	0	0	0.39	0.17	21
Sclerolaena diacantha	0	5	1	1	0	0	0	0	0.39	0.04	26
Sclerolaena obliquicuspis	0	2	4	1	0	0	0	0	0.39	0.01	23
Stipa sp.	0	2	5	0	0	0	0	0	0.39	0.00	30
Triodia irritans complex	0	1	3	2	1	0	0	0	0.39	0.84	10
Maireana pentatropis	0	1	4	0	1	0	0	0	0.33	0.17	20
Maireana pyramidata	0	4	2	0	0	0	0	0	0.33	0.04	31
Maireana trichoptera	0	4	2	0	0	0	0	0	0.33	0.11	22
Rhagodia spinescens	1	4	1	0	0	0	0	0	0.33	0.00	29
Senna artemisioides nothossp. *coriacea*	0	1	0	1	4	0	0	0	0.33	0.14	20

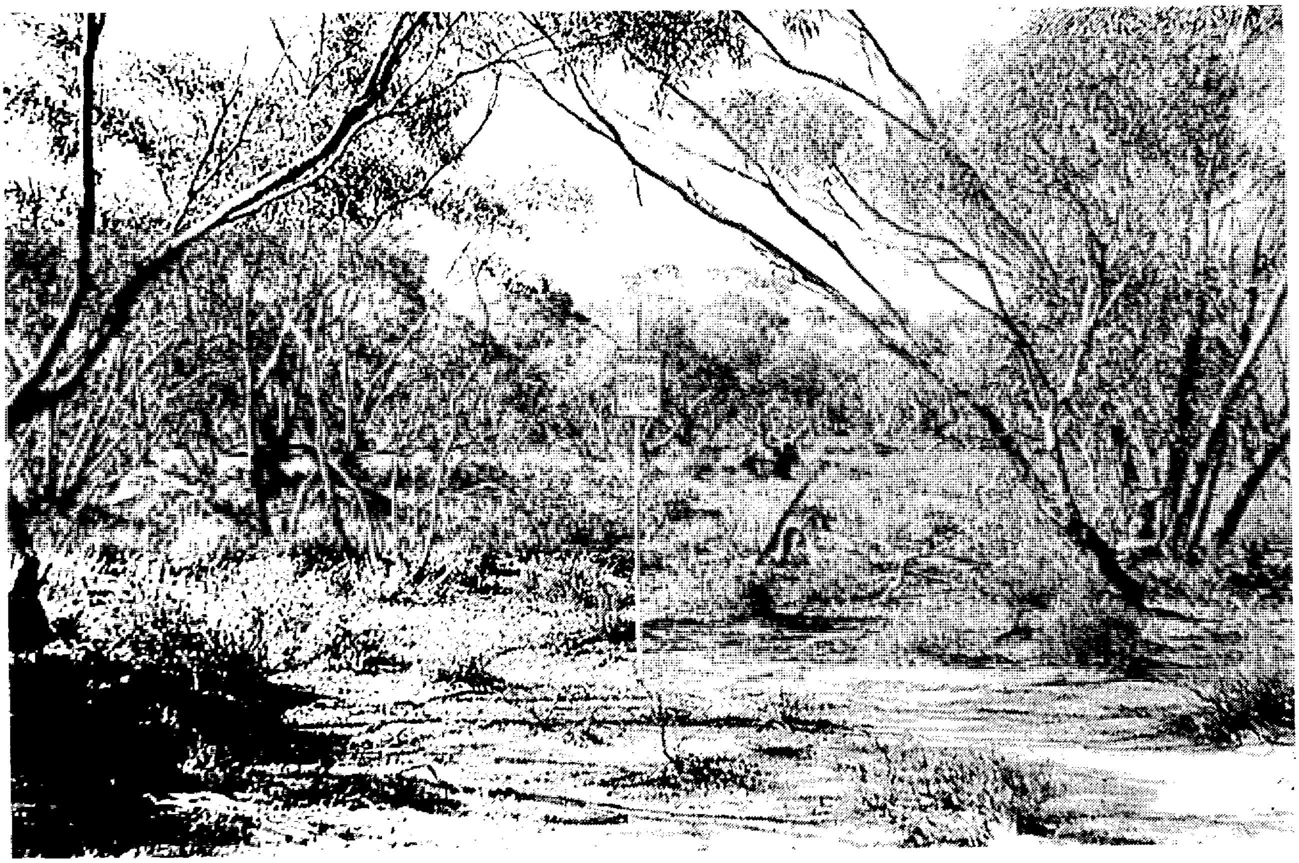


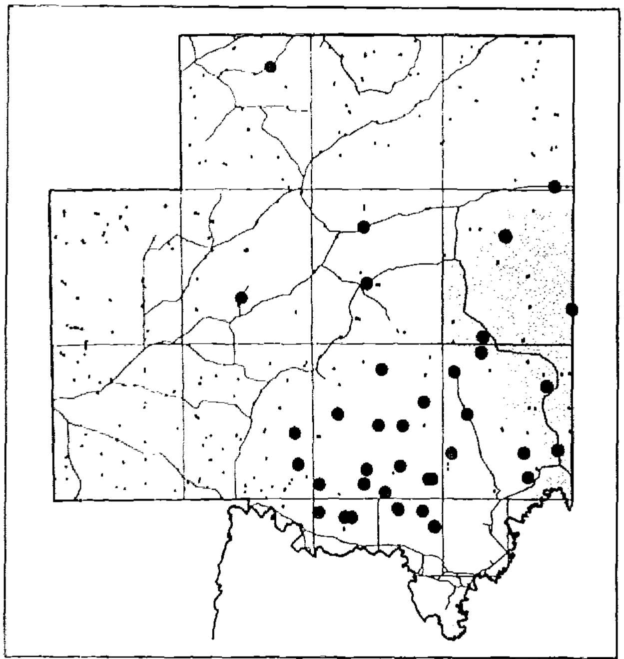
Figure 48
***Eucalyptus socialis* Open tree mallee at quadrat NK0202**

Figure 49
Eucalyptus socialis **Open tree mallee at quadrat DA0401**

Figure 50
Eucalyptus dumosa / Eucalyptus socialis **Open tree mallee at quadrat PK0201**

Floristic Group 5. *Eucalyptus dumosa / Eucalyptus socialis* OPEN TREE MALLEE

42 members



Dominant Overstorey Species:

Eucalyptus dumosa† (White Mallee)
Eucalyptus socialis (Beaked Red Mallee)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Triodia irritans var.†
Beyeria opaca†
Eremophila glabra spp.

Average Number of Plant Species (&range):

27.7 (10 - 44)

Vegetation Condition:	Disturbed natural
Representative Quadrat(s):	PK0201 (Figure 50) TV0801 (Figure 51)

Structural Data:

Overstorey Life Form (all species)	Mallee trees
Overstorey Percent Canopy (crown) Cover	1 - 30%
Average Overstorey Height (& range)	5.2 m (2.5 - 7)
Average Overstorey Canopy Diameter (& range)	4.8 m (3 - 9)
Average Overstorey Gap between canopies (& range)	10.6 m (2 - 20)

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Dunes*, some plains
Landform Elements	Dunes, some swales
Surface Soil Texture	Sand*, loamy sand to clay loam
Geological Surface Type	QPO - Woorinen Formation
Surface Strew & Cover	Nil

Description:

A large, strong group confined mainly to the south-eastern dunefields with sandy soils. The lowest in height of the mallee groups, being almost shrub mallee, with small canopies and more open overstory. Ranges from *E. dumosa* or *E. socialis* dominant over nearly pure *Triodia irritans* var. (Spinifex) to *E. dumosa* over shrubs with no *Triodia*. Several other Eucalypt species are common, including *E. leptophylla* (Narrow-leaf Red Mallee) and *E. incrassata* (Ridge-fruit Mallee) in the far south, the latter of which occurs on dune crests in very sandy areas where *E. dumosa* occurs more in the swales, contrary to *E. dumosa* almost exclusively being on dunes further north.

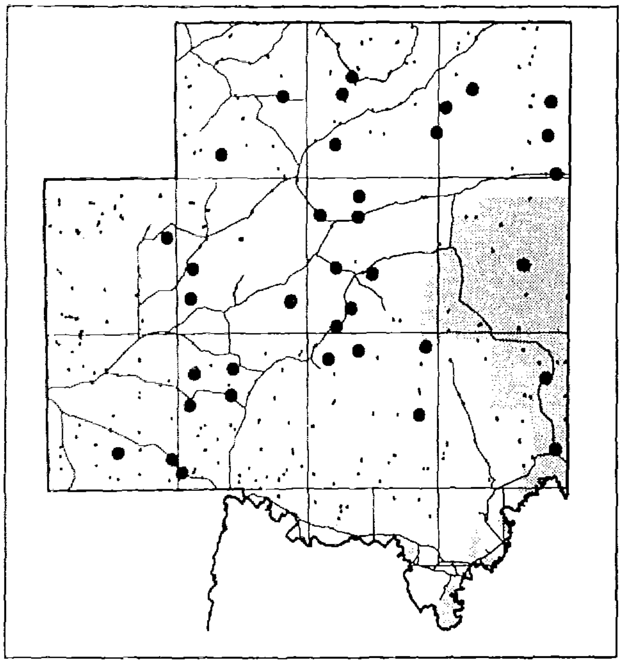
Species	Cover/Abundance								Prop.	Chi	No.
	R	I	T	1	2	3	4	5	Occur.	Squ.	Gps
Triodia irritans complex	1	1	4	5	23	4	1	0	0.93	6.91	10
Eucalyptus dumosa	0	0	0	1	30	3	0	0	0.81	5.88	11
Eucalyptus socialis	1	0	3	0	28	2	0	0	0.81	1.67	23
Myoporum platycarpum ssp.	3	8	11	1	0	0	0	0	0.55	0.09	26
Beyeria opaca	1	4	7	4	4	2	0	0	0.52	7.14	5
Eremophila glabra ssp.	5	8	8	0	1	0	0	0	0.52	1.12	16
Grevillea huegelii	5	8	4	0	0	0	0	0	0.40	0.67	13
Senna artemisioides nothossp. *coriacea*	3	7	1	2	3	0	0	0	0.38	0.24	20
Eucalyptus leptophylla	0	1	4	0	10	0	0	0	0.36	4.93	4
Westringia rigida	1	8	4	2	0	0	0	0	0.36	1.03	11
Dodonaea viscosa ssp. *angustissima*	4	2	6	0	2	0	0	0	0.33	0.11	20
Maireana pentatropis	1	7	5	1	0	0	0	0	0.33	0.17	20
Sclerolaena diacantha	1	3	9	1	0	0	0	0	0.33	0.01	26
Olearia muelleri	1	6	5	1	0	0	0	0	0.31	0.18	13

Figure 51
***Eucalyptus dumosa / Eucalyptus socialis* Open tree mallee at quadrat TV0801**

BLACKOAK WOODLAND COMMUNITIES

Floristic Group 33. *Casuarina pauper* LOW WOODLAND (with chenopod understorey)

38 members



Dominant Overstorey Species:

Casuarina pauper (Blackoak)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Maireana sedifolia
Enchylaena tomentosa var. *tomentosa*
Sclerolaena diacantha

Average Number of Plant Species (&range):

32.3 (9 - 58)

Vegetation Condition: Disturbed natural

Representative Quadrat(s): SM0202 (Figure 52)
BR0602 (Figure 53)

Structural Data:

Overstorey Lifeform	Trees 5 - 10 m
Overstorey Percent canopy (crown) Cover	5 - 50%
Average Overstorey Height (and range)	5.9 m (3 - 10)
Average Overstorey Canopy Diameter (and range)	3.7 m (1.5 - 6)
Average Overstorey Gap between canopies	7.9 m (3 - 20)

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains
Landform Elements	Plains* and various
Surface Soil Texture	Sand to loam to clay
Geological Surface Type	QP - Transitional sands, QPP - Pooraka formation and various.
Surface Strew	Nil to pebbles 1 - 30%

Description:

A very widely scattered group, mostly occurring on plains but on a variety of soils. Understorey variable from pure Pearl Bluebush (*M. sedifolia*) to various shrubs and isolated other tree species.

Species	Cover/Abundance								Prop.	Chi	No.
	R	I	T	1	2	3	4	5	Occur.	Squ.	Gps
Casuarina pauper	0	0	1	0	18	17	2	0	1.00	3.02	23
Maireana sedifolia	3	5	1	0	14	11	0	0	0.89	0.40	30
Enchylaena tomentosa var. *tomentosa*	1	11	16	2	0	0	0	0	0.79	0.04	34
Alectryon oleifolius ssp. *canescens*	4	14	5	0	1	0	0	0	0.63	0.26	30
Maireana trichoptera	1	12	8	1	0	0	0	0	0.58	0.82	22
Sclerolaena diacantha	0	10	10	2	0	0	0	0	0.58	0.32	26
Eriochiton sclerolaenoides	1	11	9	0	0	0	0	0	0.55	0.42	24
Chenopodium curvispicatum	2	10	5	0	1	0	0	0	0.47	0.36	21
Rhagodia ulicina	1	8	5	1	3	0	0	0	0.47	0.21	25
Sclerolaena obliquicuspis	0	8	10	0	0	0	0	0	0.47	0.05	23
Senna artemisioides nothossp. *coriacea*	2	5	5	4	2	0	0	0	0.47	0.51	20
Stipa sp.	1	8	6	2	0	0	0	0	0.45	0.01	30
Exocarpos aphyllus	2	7	5	1	0	0	0	0	0.39	0.17	24
Maireana pyramidata	1	6	4	2	2	0	0	0	0.39	0.01	31
Myoporum platycarpum ssp.	4	6	3	2	0	0	0	0	0.39	0.00	26
Lycium australe	0	4	6	2	2	0	0	0	0.37	0.13	23
Maireana georgei/turbinata	1	7	5	1	0	0	0	0	0.37	0.01	26
Senna artemisioides ssp. *petiolaris*	3	3	5	1	1	0	0	0	0.34	0.19	18
Atriplex stipitata	2	5	4	0	1	0	0	0	0.32	0.06	23
Carrichtera annua *	0	5	3	2	2	0	0	0	0.32	0.02	31
Ptilotus obovatus var. *obovatus*	1	3	5	3	0	0	0	0	0.32	0.04	23
Rhagodia spinescens	1	8	3	0	0	0	0	0	0.32	0.00	29

Figure 52
***Casuarina pauper* Low woodland at quadrat SM0202**

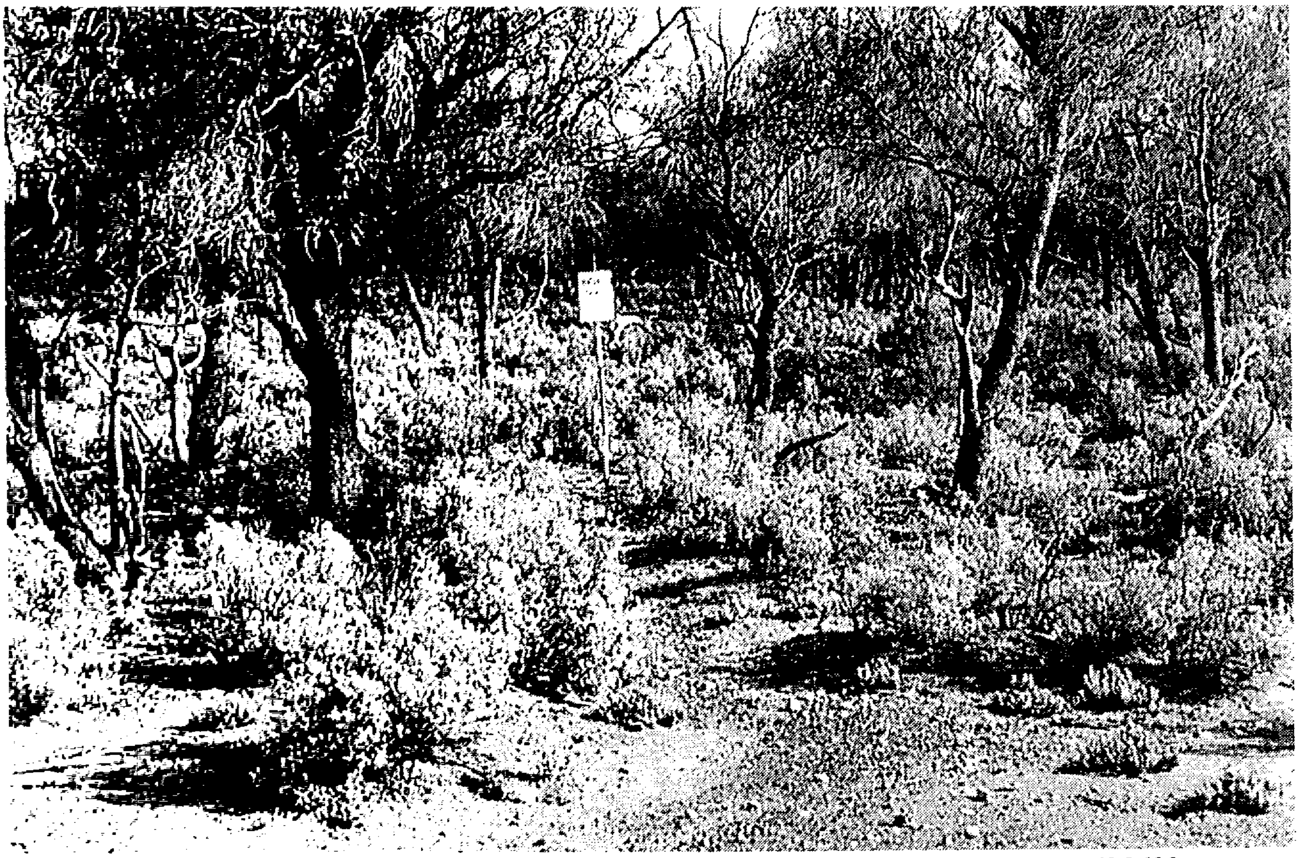


Figure 53. *Casuarina pauper* Low woodland (with chenopod understorey) at quadrat BR0602

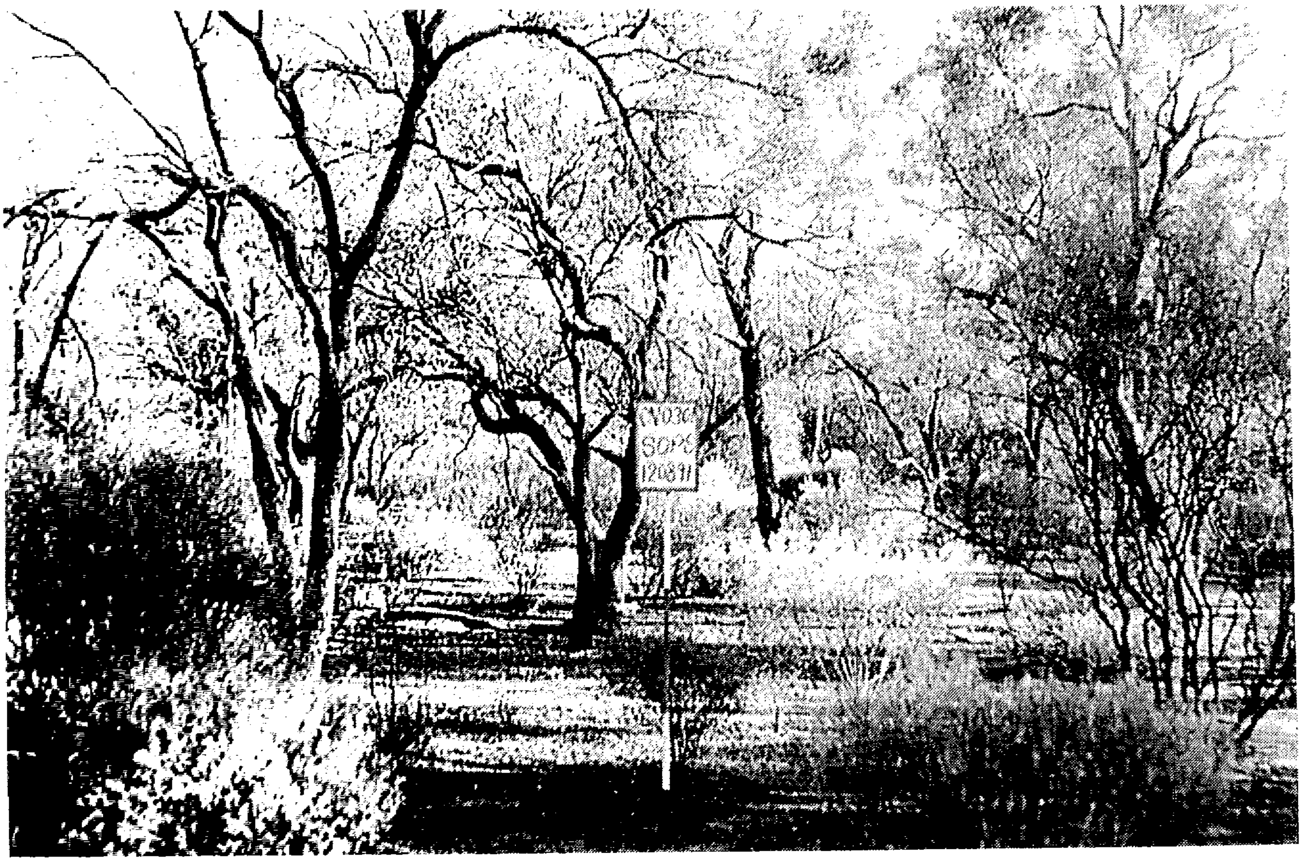
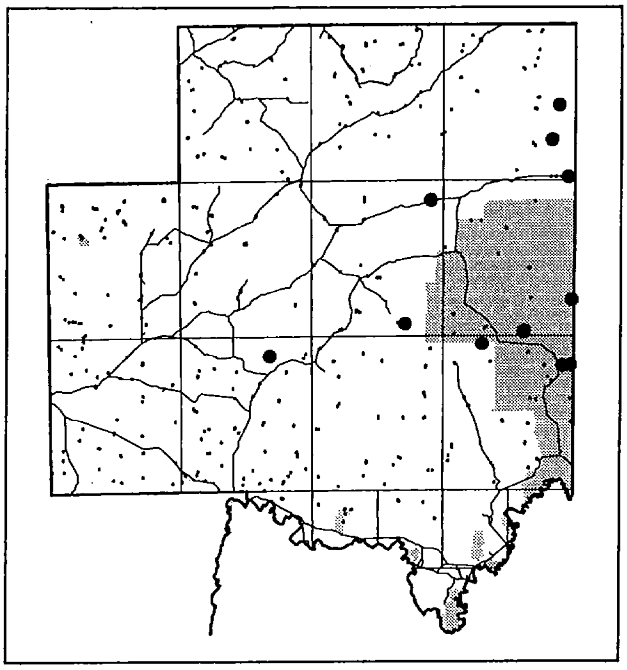


Figure 54
Casuarina pauper Low woodland (with sclerophyllous understorey) at quadrat OV0301

Floristic Group 34. *Casuarina pauper* LOW WOODLAND (with sclerophyllous understorey)

12 members



Dominant Overstorey Species:

Casuarina pauper (Blackoak)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Senna artemisoides nothossp. *coriacea*
Alectryon oleifolius spp. *canescens*
Myoporum platycarpum spp.
Olearia muelleri
Olearia pimeleoides spp. *pimeleoides*
Senna artemisioides spp. *petiolaris*
Eremophila sturtii
Dodonaea viscosa ssp. *angustissima*
Senna artemisioides ssp. *filifolia*

Average Number of Plant Species (&range):

39.4 (21 - 66)

Vegetation Condition: Disturbed natural

Representative Quadrat(s): OV0301 (Figure54)

Structural Data:

Overstorey Lifeform	Trees 5 - 10 m
Overstorey Percent canopy (crown) Cover	2 - 50%
Average Overstorey Height (and range)	4.7 m (1.8 - 9)
Average Overstorey Canopy Diameter (and range)	3.1 m (1.5 - 6)
Average Overstorey Gap between canopies	12.3 m (5 - 50)

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains* and dunes
Landform Elements	Plains and various
Surface Soil Texture	Sandy loam and various
Geological Surface Type	QP - transitional sands and various
Surface Strew	Nil to pebbles < 10%

Description:

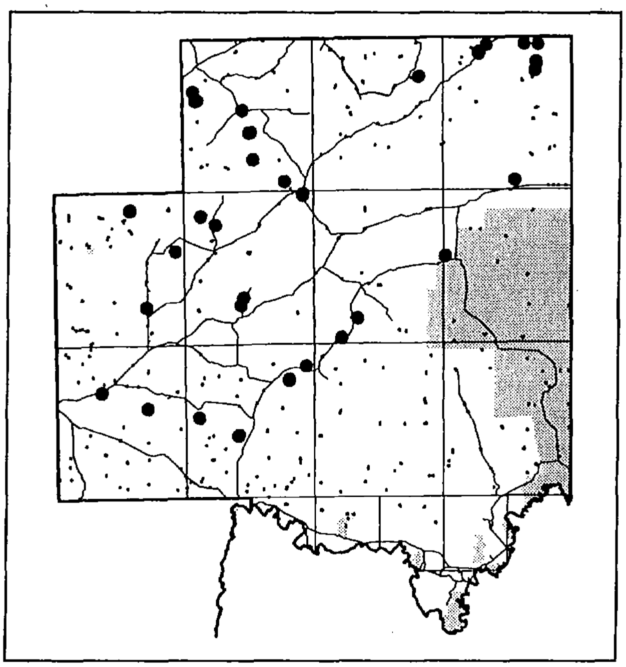
A small, scattered group with many species with a high X^2. This group is very similar to the *Casuarina pauper* Low Woodland group of the Murray Mallee survey (Department of Environment and Natural Resources, unpublished data.), also ocurring on sandy loams, although the latter had no *Eremophila sturtii.* It is possible that some quadrats in this current group may represent degraded sites of Group 33 (*C. pauper/M. sedifolia*) due to the presence of 'increaser' species such as *E. sturtii* (Turpentine), *Dodonaea viscosa* ssp. *angustissima* (Narrow-leaved Hop-Bush) and *Senna artemisioides* ssp.(Desert Senna) which may have replaced the more palatable Pearl Bluebush.

Species	Cover/Abundance								Prop.	Chi	No.
	R	I	T	1	2	3	4	5	Occur.	Squ.	Gps
Senna artemisioides nothossp. *coriacea*	0	0	1	1	10	0	0	0	1.00	3.88	20
Alectryon oleifolius ssp. *canescens*	1	3	6	1	0	0	0	0	0.92	1.00	30
Casuarina pauper	0	1	1	0	6	3	0	0	0.92	2.42	23
Enchylaena tomentosa var. *tomentosa*	0	4	4	2	0	0	0	0	0.83	0.06	34
Myoporum platycarpum ssp.	2	1	5	1	1	0	0	0	0.83	0.58	26
Olearia muelleri	1	0	4	3	2	0	0	0	0.83	3.21	13
Olearia pimeleoides ssp. *pimeleoides*	1	3	2	3	1	0	0	0	0.83	3.08	18
Eremophila sturtii	1	2	3	1	2	0	0	0	0.75	2.16	20
Maireana georgei/turbinata	0	3	5	0	1	0	0	0	0.75	0.65	26
Maireana sedifolia	2	3	2	0	2	0	0	0	0.75	0.18	30
Senna artemisioides ssp. *petiolaris*	0	0	4	0	5	0	0	0	0.75	2.05	18
Dodonaea viscosa ssp. *angustissima*	0	0	4	1	3	0	0	0	0.67	1.18	20
Ptilotus obovatus var. *obovatus*	1	2	4	1	0	0	0	0	0.67	0.89	23
Sclerolaena diacantha	0	4	2	2	0	0	0	0	0.67	0.53	26
Atriplex stipitata	0	4	2	1	0	0	0	0	0.58	0.69	23
Chenopodium curvispicatum	0	5	2	0	0	0	0	0	0.58	0.71	21
Eriochiton sclerolaenoides	0	1	4	2	0	0	0	0	0.58	0.50	24
Exocarpos aphyllus	0	4	2	1	0	0	0	0	0.58	0.69	24
Maireana trichoptera	0	1	3	3	0	0	0	0	0.58	0.84	22
Senna artemisioides ssp. *filifolia*	0	0	2	2	3	0	0	0	0.58	3.53	12
Acacia colletioides	0	2	3	0	1	0	0	0	0.50	0.92	16
Einadia nutans ssp.	0	6	0	0	0	0	0	0	0.50	0.46	24
Eremophila glabra ssp.	0	4	2	0	0	0	0	0	0.50	0.99	16
Rhagodia spinescens	1	1	3	1	0	0	0	0	0.50	0.13	29
Sclerolaena obliquicuspis	0	3	3	0	0	0	0	0	0.50	0.07	23
Vittadinia cuneata var.	0	4	2	0	0	0	0	0	0.50	1.24	22
Lysiana exocarpi ssp. *exocarpi*	0	5	0	0	0	0	0	0	0.42	0.87	15
Maireana pentatropis	0	2	3	0	0	0	0	0	0.42	0.39	20
Templetonia egena	1	3	1	0	0	0	0	0	0.42	1.95	14
Zygophyllum aurantiacum	0	2	1	2	0	0	0	0	0.42	0.32	19
Acacia nyssophylla	0	2	1	1	0	0	0	0	0.33	0.30	18
Acacia oswaldii	0	4	0	0	0	0	0	0	0.33	1.10	15
Dissocarpus paradoxus	0	1	2	1	0	0	0	0	0.33	0.24	23
Eremophila deserti	1	2	1	0	0	0	0	0	0.33	2.01	11
Grevillea huegelii	0	4	0	0	0	0	0	0	0.33	0.38	13
Rhagodia ulicina	0	1	2	1	0	0	0	0	0.33	0.03	25

CHENOPOD SHRUBLAND COMMUNITIES

Floristic Group 27. *Atriplex vesicaria* ssp. LOW OPEN SHRUBLAND

39 members



Dominant Overstorey Species:

Atriplex vesicaria ssp. (Bladder Saltbush)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Sclerolaena obliquicuspis
Maireana pyramidata
Maireana sedifolia

Average Number of Plant Species (&range):

26.8 (10 - 48)

Vegetation Condition:	Disturbed to degraded natural
Representative Quadrat(s):	CC0202 (Figure 55 CK0201 (Figure 56) FL0201 (Figure 57

Structural Data:

Overstorey Lifeform	Shrubs < 1 m (or trees 5 - 10 m)
Overstorey Percent canopy (crown) Cover	5 - 60% (1 - 50%)
Average Overstorey Height (and range)	variable
Average Overstorey Canopy Diameter (and range)	variable
Average Overstorey Gap between canopies	variable

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains* and various
Landform Elements	Plains* and various
Surface Soil Texture	Sand to loam* to clay loam* to clay
Geological Surface Type	QPP - Pooraka Formation, recent deposits and various
Surface Strew	Nil to pebbles 10 - 30%

Description:

A large, widely distributed group occurring across the plains of most of the area, dominated by Bladder Saltbush (*A. vesicaria* ssp.). Associated species vary from other chenopods to grasses and herbs to a significant overstorey of Blackoak.

Species	Cover/Abundance								Prop.	Chi	No.
	R	I	T	1	2	3	4	5	Occur.	Squ.	Gps
Atriplex vesicaria ssp.	0	0	0	2	30	6	1	0	1.00	1.51	26
Maireana pyramidata	4	5	10	3	7	1	0	0	0.77	0.18	31
Sclerolaena obliquicuspis	0	2	7	6	10	0	0	0	0.64	0.26	23
Maireana sedifolia	1	6	10	1	6	0	0	0	0.62	0.05	30
Carrichtera annua *	0	8	3	2	4	1	1	0	0.49	0.02	31
Enchylaena tomentosa var. *tomentosa*	0	9	5	4	1	0	0	0	0.49	0.04	34
Stipa sp.	0	4	10	2	3	0	0	0	0.49	0.03	30
Maireana georgei-turbinata	2	3	11	1	0	0	0	0	0.44	0.06	26
Danthonia sp.	0	5	8	2	1	0	0	0	0.41	0.03	28
Daucus glochidiatus	1	7	4	1	0	0	0	0	0.33	0.08	23
Casuarina pauper	0	0	0	0	9	2	1	0	0.31	0.05	23

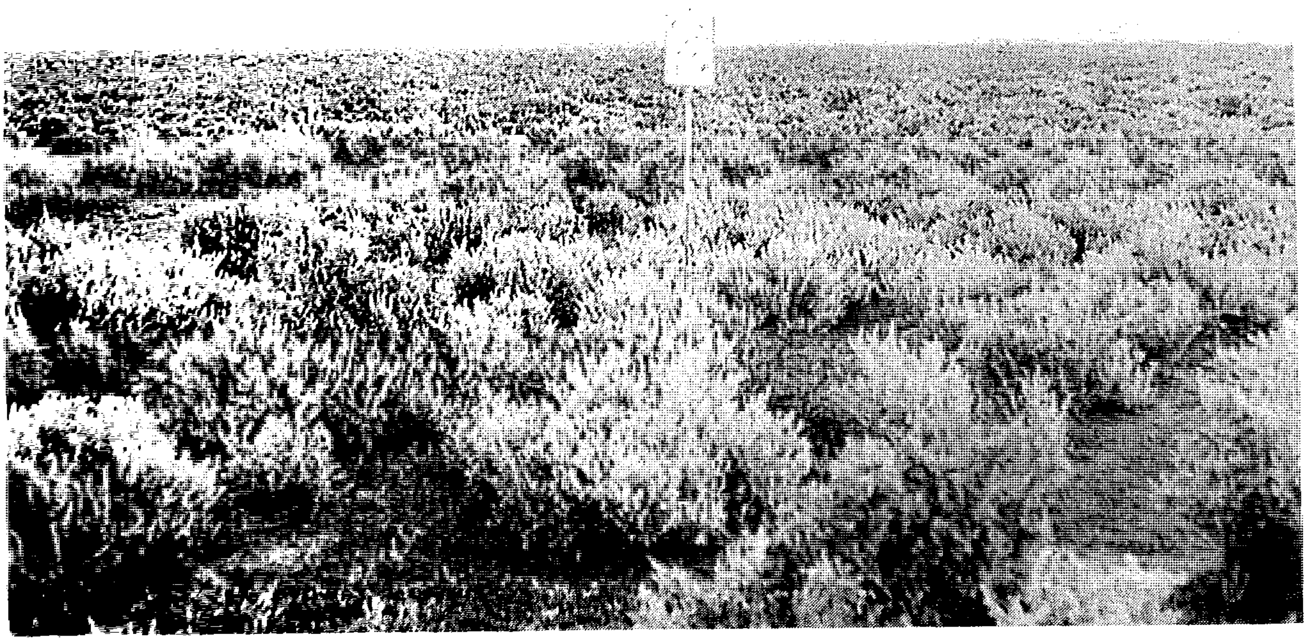


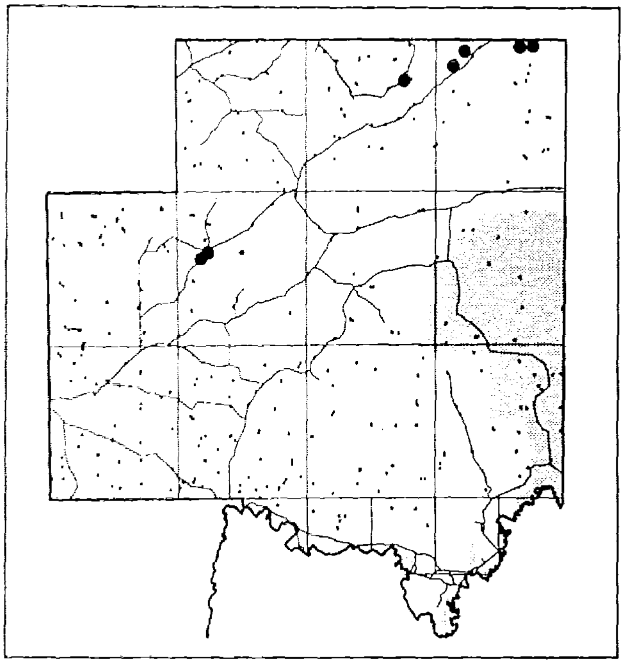
Figure 55
***Atriplex vesicaria* ssp. Low open shrubland at quadrat CC0202**

Figure 56
***Atriplex vesicaria* ssp. Low open shrubland at quadrat CK0201**

Figure 57
***Atriplex vesicaria* ssp. Low open shrubland (with Blackoak and Pearl Bluebush) at quadrat FL0201**

Floristic Group 28. *Maireana astrotricha / Atriplex vesicaria* ssp. LOW OPEN SHRUBLAND

7 members



Dominant Overstorey Species:

Maireana astrotricha† (Grey Bluebush)
Atriplex vesicaria ssp. (Bladder Saltbush)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Daucus glochidiatus
Sclerolaena obliquicuspis

Average Number of Plant Species (&range):

38.7 (22 - 51)

Vegetation Condition: Disturbed natural

Representative Quadrat(s): BR0401 (Figure 58

Structural Data:

Overstorey Lifeform	Shrubs < 1 m
Overstorey Percent canopy (crown) Cover	5 - 50%
Average Overstorey Height (and range)	0.4 m (0.2 - 0.5)
Average Overstorey Canopy Diameter (and range)	0.7 m (0.1 - 1)
Average Overstorey Gap between canopies	1.6 m (1 - 3)

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains
Landform Elements	Plains
Surface Soil Texture	Loam*, silty clay loam
Geological Surface Type	QPP - Poorka Formation and various
Surface Strew	Pebbles 1 - 30%

Description:

A small but strong group, confined to the low hills in the north-east and on Braemar Station. Often associated with fan deposits, gilgais and quartz gravels. Isolated trees (Blackoak) may occur.

Species	Cover/Abundance R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
Atriplex vesicaria ssp.	1	0	0	1	5	0	0	0	1.00	1.51	26
Maireana astrotricha	0	0	0	0	5	1	1	0	1.00	9.28	12
Daucus glochidiatus	0	2	1	2	0	0	0	0	0.71	1.26	23
Maireana pyramidata	1	2	1	1	0	0	0	0	0.71	0.12	31
Sclerolaena obliquicuspis	0	0	5	0	0	0	0	0	0.71	0.41	23
Chenopodium curvispicatum	0	2	2	0	0	0	0	0	0.57	0.66	26
Danthonia sp.	0	1	1	2	0	0	0	0	0.57	0.21	28
Oxalis perennans	0	2	2	0	0	0	0	0	0.57	0.53	27
Stipa sp.	0	1	3	0	0	0	0	0	0.57	0.10	30
Convolvulus microsepalus/remotus	0	2	1	0	0	0	0	0	0.43	0.49	19
Dissocarpus biflorus var. *biflorus*	0	1	0	2	0	0	0	0	0.43	2.84	11
Maireana georgei/turbinata	0	1	2	0	0	0	0	0	0.43	0.05	26
Rhagodia spinescens	0	2	1	0	0	0	0	0	0.43	0.05	29
Sclerolaena brachyptera	0	1	2	0	0	0	0	0	0.43	2.10	10
Sclerolaena diacantha	0	0	2	1	0	0	0	0	0.43	0.08	26
Sclerolaena divaricata	0	2	1	0	0	0	0	0	0.43	1.41	12
Sclerolaena ventricosa	0	1	2	0	0	0	0	0	0.43	7.83	4

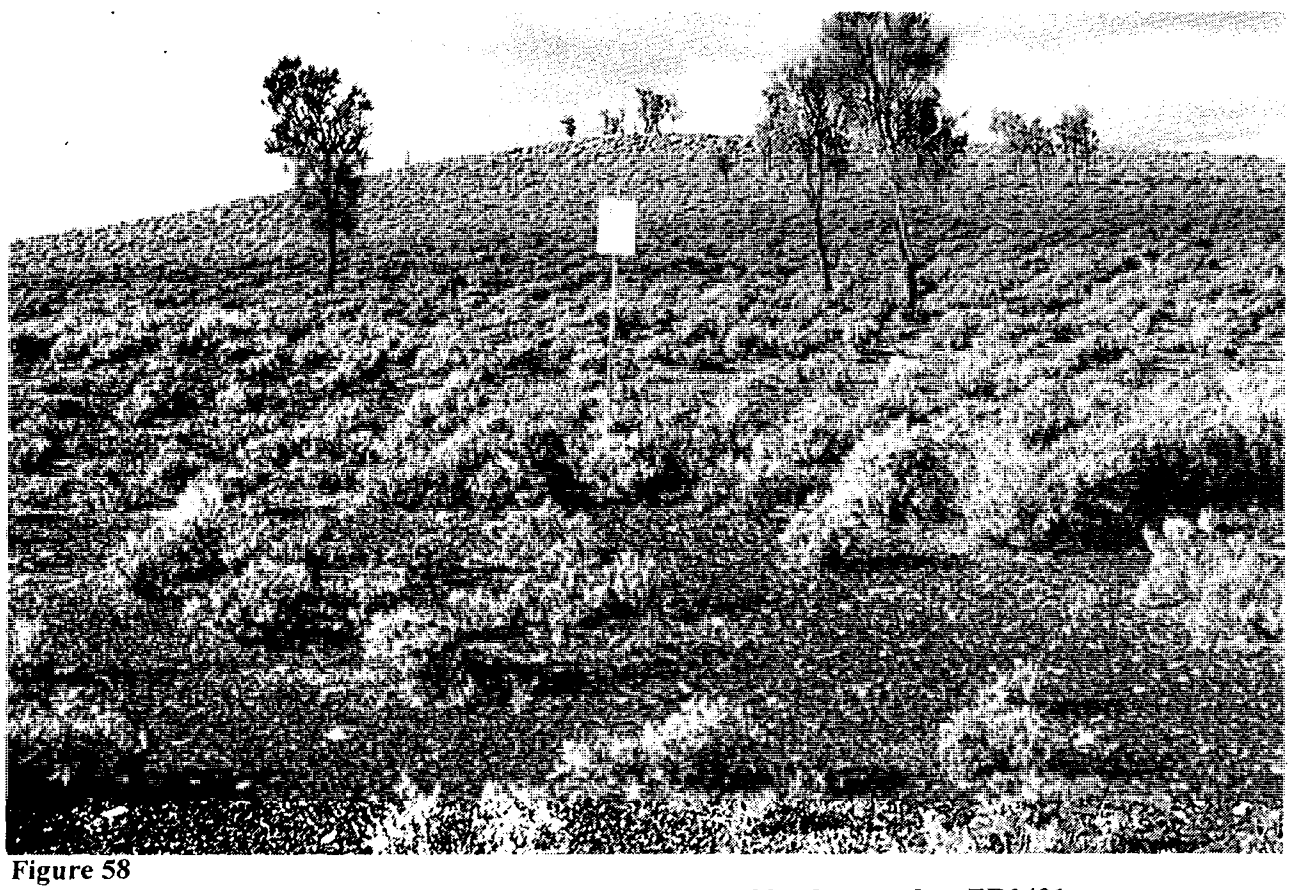
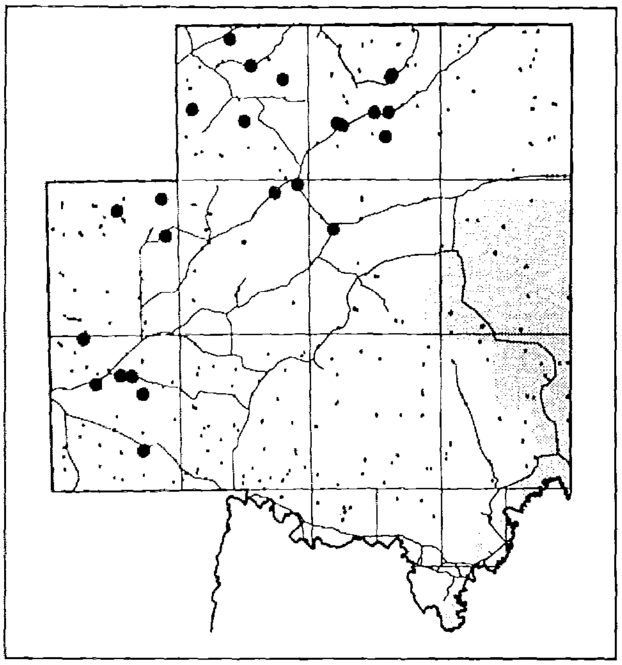


Figure 58
***Maireana astrotricha / Atriplex vesicaria* ssp. Low open shrubland at quadrat BR0401**

Floristic Group 29. *Maireana pyramidata* LOW OPEN SHRUBLAND

24 members



Dominant Overstorey Species:

Maireana pyramidata (Black Bluebush)

Sub-dominant Overstorey, Indicator[†] and Dominant Understorey Species:

Stipa sp.
*Carrichtera annua**

Average Number of Plant Species (&range):

26.5 (8 - 48)

Vegetation Condition: Disturbed to degraded natural

Representative Quadrat(s): TI0102 (Figure 59

Structural Data:

Overstorey Lifeform	Shrubs < 1 m
Overstorey Percent canopy (crown) Cover	5 - 50%
Average Overstorey Height (and range)	0.8 m (0.4 - 1.5)
Average Overstorey Canopy Diameter (and range)	1.1 m (1 - 2)
Average Overstorey Gap between canopies	5.0 m (1 - 30)

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains, floodplains and various
Landform Elements	Plains*, hill footslopes and various
Surface Soil Texture	Sandy loam to silty loam to clay
Geological Surface Type	QPP - Poorka Formation, recent despsits and various
Surface Strew	Pebbles 1 - 30%

Description:

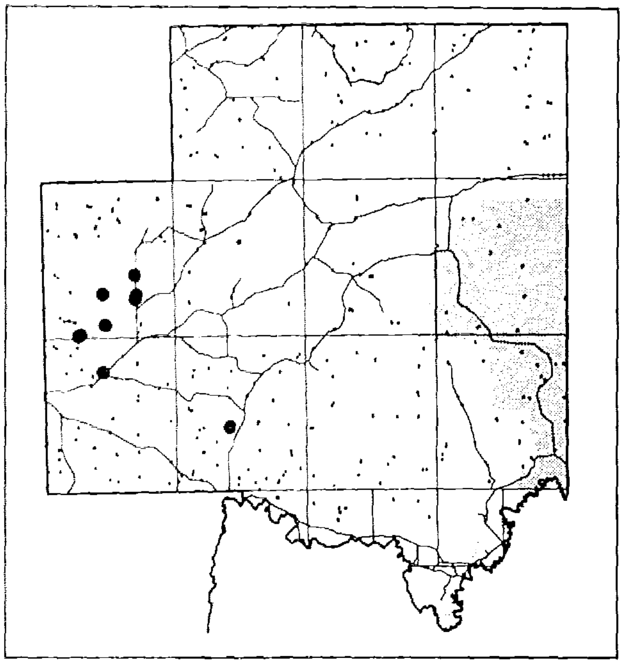
A group that is consistently dominated by Black Bluebush (*M. pyramidata*) with a variety of understorey species and occasionally isolated trees. Occurs throughout the plains and low hills of the west, north-east and northern parts of the survey area.

Species	R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
	Cover/Abundance										
Maireana pyramidata	0	0	0	1	20	3	0	0	1.00	0.57	31
Stipa sp.	0	1	12	3	0	0	0	0	0.67	0.22	30
Carrichtera annua *	0	1	4	5	0	4	0	0	0.58	0.08	31
Maireana georgei/turbinata	2	4	6	2	0	0	0	0	0.58	0.26	26
Sclerolaena obliquicuspis	0	5	6	2	0	0	0	0	0.54	0.12	23
Maireana sedifolia	0	8	4	0	0	0	0	0	0.50	0.00	30
Enchylaena tomentosa var. *tomentosa*	0	5	6	0	0	0	0	0	0.46	0.05	34
Rhagodia spinescens	0	7	2	0	0	0	0	0	0.38	0.02	29
Danthonia sp.	0	1	3	3	1	0	0	0	0.33	0.00	28
Eriochiton sclerolaenoides	0	4	0	4	0	0	0	0	0.33	0.04	24
Ptilotus obovatus var. *obovatus*	3	1	3	1	0	0	0	0	0.33	0.05	23

Figure 59
Maireana pyramidata **Low open shrubland at quadrat TI0102**

Floristic Group 30. *Maireana pyramidata / Atriplex vesicaria* sps. LOW OPEN SHRUBLAND

11 members



Dominant Overstorey Species:

Maireana pyramidata (Black Bluebush)
Atriples vesicaria ssp. (Bladder Saltbush)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Maireana georgei/turbinata
various

Average Number of Plant Species (&range):

24.9 (16 - 46)

Vegetation Condition:	Disturbed to degraded natural
Representative Quadrat(s):	CA0202 (Figure 60

Structural Data:

Overstorey Lifeform	Shrubs < 1 m
Overstorey Percent canopy (crown) Cover	5 - 30%
Average Overstorey Height (and range)	1.1 m (0.4 - 1.2)
Average Overstorey Canopy Diameter (and range)	0.9 m (0.3 - 1)
Average Overstorey Gap between canopies	2.8 m (0.7 - 8)

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains and various
Landform Elements	various
Surface Soil Texture	Sandy loam to clay loam to silty loam
Geological Surface Type	Recent alluvial deposits
Surface Strew	Pebbles 1 - 30%

Description:

A small but strong group concentrated on the plains and footslopes to the east of the Burra Hills in the west of the survey area. Understorey is very sparse and variable.

Species	R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
				Cover/Abundance							
Atriplex vesicaria ssp.	0	0	0	10	1	0	0	0	1.00	1.51	26
Maireana pyramidata	0	0	2	4	5	0	0	0	1.00	0.57	31
Enchylaena tomentosa var. *tomentosa*	0	5	2	0	0	0	0	0	0.64	0.00	34
Maireana georgei/turbinata	0	2	5	0	0	0	0	0	0.64	0.36	26
Maireana sedifolia	1	5	1	0	0	0	0	0	0.64	0.06	30
Daucus glochidiatus	0	3	2	0	0	0	0	0	0.45	0.30	23
Oxalis perennans	0	5	0	0	0	0	0	0	0.45	0.23	27
Rhagodia parabolica	1	1	2	0	0	0	0	0	0.36	0.18	23
Sclerolaena patenticuspis	0	2	2	0	0	0	0	0	0.36	0.28	21
Stipa elegantissima	0	4	0	0	0	0	0	0	0.36	2.60	11

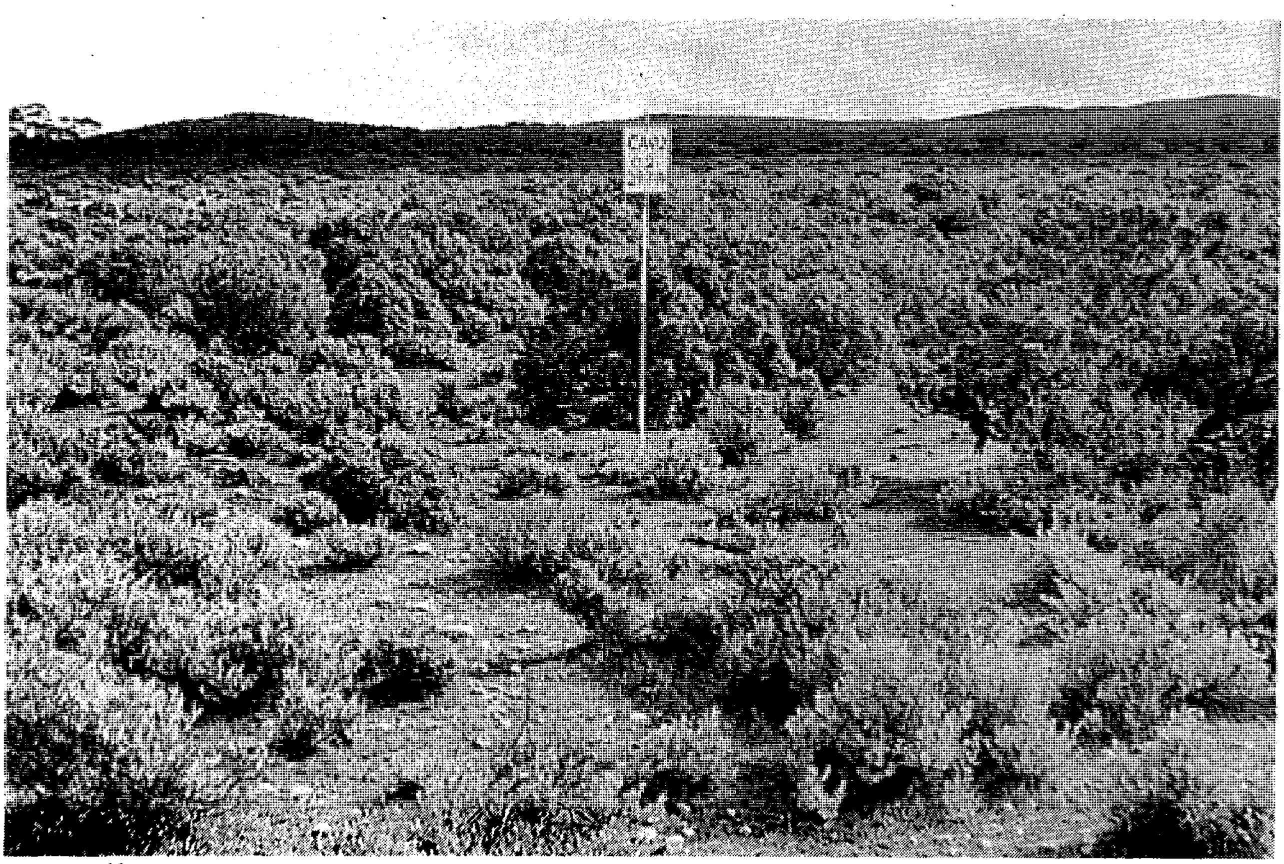
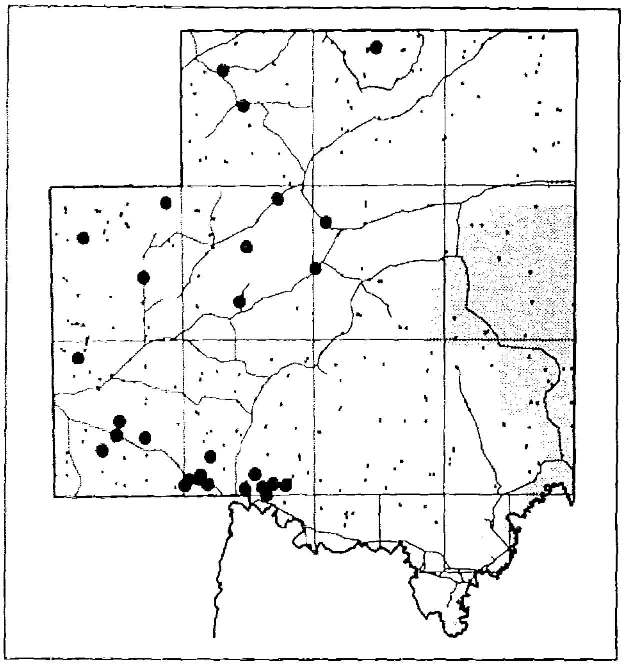


Figure 60
***Maireana pyramidata / Atriplex vesicaria* ssp. Low open shrubland at quadrat CA0202**

Floristic Group 31. *Carrichtera annua* HERBLAND

30 members



Dominant (or Characteristic) Overstorey Species:

*Carrichtera annua** (Wards Weed)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Maireana sedifolia (Pearl Bluebush)
various shrubs

Average Number of Plant Species (&range):

21.8 (12 - 38)

Vegetation Condition:	Degraded natural
Representative Quadrat(s):	CL0301 (Figure 61 LN0201 (Figure 62

Structural Data:

Overstorey Lifeform	Shrubs < 1 m (or trees 5 - 10 m)
Overstorey Percent canopy (crown) Cover	1 - 50% (or 1 - 20%)
Average Overstorey Height (and range)	variable
Average Overstorey Canopy Diameter (and range)	variable
Average Overstorey Gap between canopies	variable

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains* and various
Landform Elements	Plains* and various
Surface Soil Texture	Sandy loam to clay loam* to clay
Geological Surface Type	QCA - Bakara calcrete
Surface Strew	QPP - Pooraka formation & various
	Pebbles 1 - 30%

Description:

A large, variable group scattered throughout the western half of the survey area. Characterised by Ward's Weed (*Carrichtera annua*) indicating areas degraded by grazing. Overstorey species mostly Pearl Bluebush (*M. sedifolia)* but also often Black Bluebush (*M. pyramidata*), Blackoak (*C. pauper*) and sometimes Eucalypts and various other shrubs.

Species	R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
	Cover/Abundance										
Carrichtera annua *	0	0	0	0	9	13	8	1	1.00	0.87	31
Maireana sedifolia	0	3	1	1	6	9	0	0	0.67	0.09	30
Enchylaena tomentosa var. *tomentosa*	0	10	8	0	0	0	0	0	0.60	0.00	34
Myoporum platycarpum ssp.	0	12	3	0	0	0	0	0	0.50	0.05	26
Casuarina pauper	0	8	2	0	3	0	0	0	0.43	0.25	23
Maireana pyramidata	0	5	2	5	1	0	0	0	0.43	0.00	31
Rhagodia spinescens	0	7	5	1	0	0	0	0	0.43	0.06	29
Sclerolaena obliquicuspis	0	6	6	0	0	0	0	0	0.40	0.01	23
Stipa sp.	0	5	6	1	0	0	0	0	0.40	0.00	30
Alectryon oleifolius ssp. *canescens*	0	10	1	0	0	0	0	0	0.37	0.00	30
Atriplex vesicaria ssp.	1	4	4	1	0	0	0	0	0.33	0.00	26

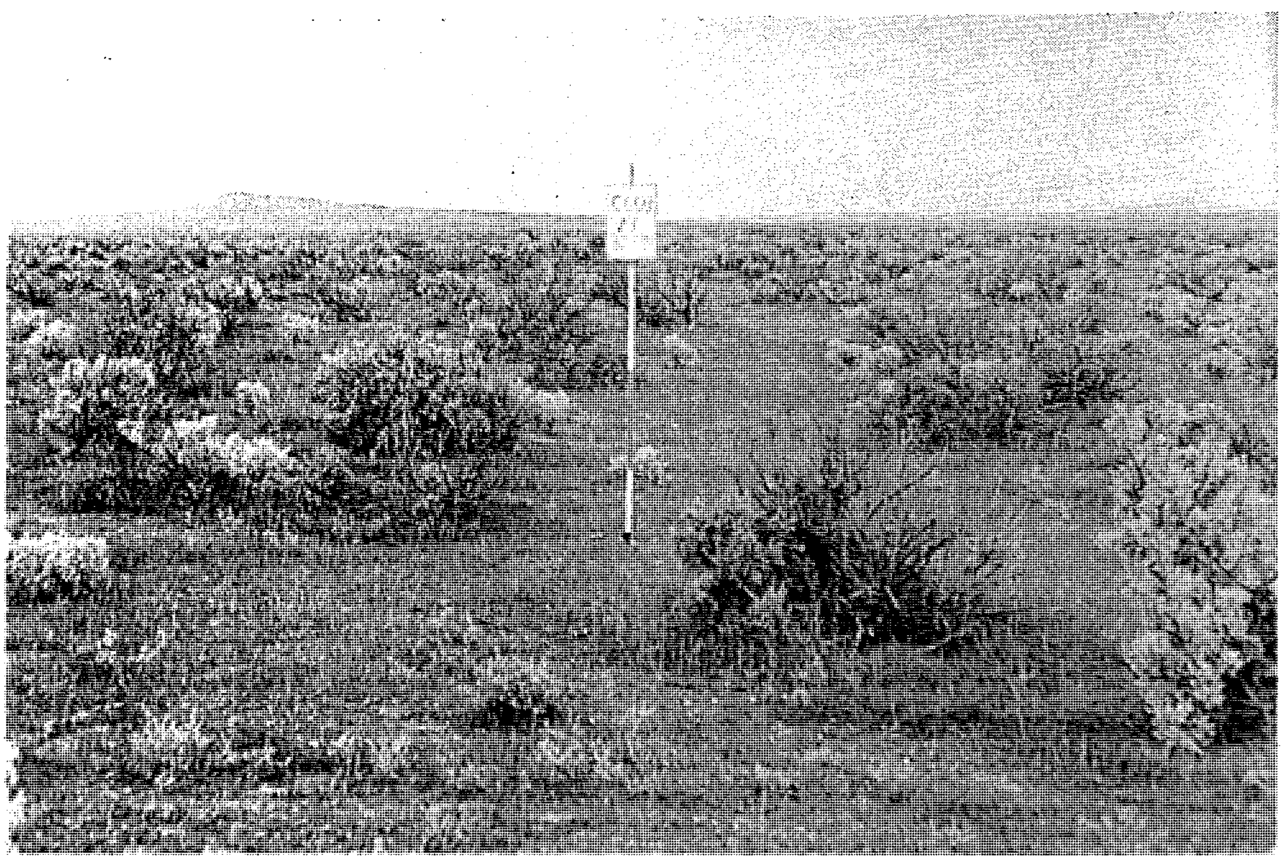
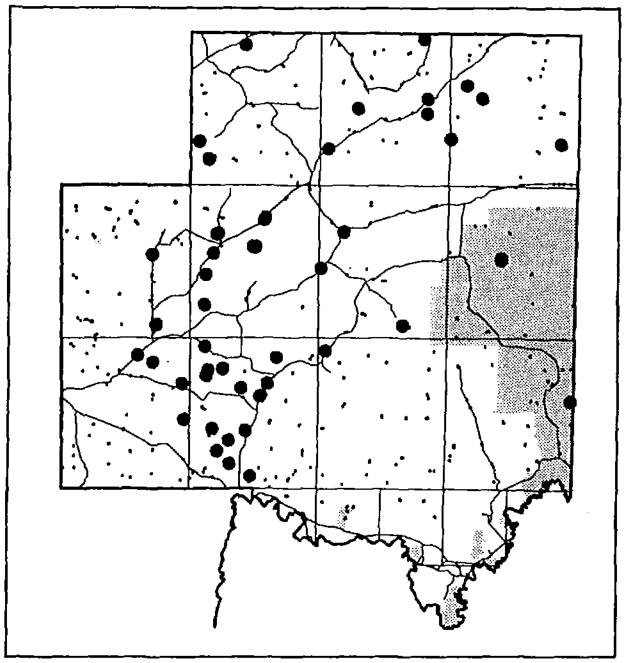


Figure 61
Carrichtera annua **Herbland (with Pearl Bluebush) at quadrat CL0301**

Figure 62
Carrichtera annua **Herbland (with Pearl Bluebush & Blackoak) at quadrat LN0201**

Floristic Group 32. *Maireana sedifolia* LOW OPEN SHRUBLAND

52 members



Dominant Overstorey Species:

Maireana sedifolia (Pearl Bluebush)

Sub-dominant Overstorey, Indicator[†] and Dominant Understorey Species:

Stipa sp.
Sclerolaena obliquicuspis
Maireana pyramidata
and various

Average Number of Plant Species (&range):

25.5 (11 - 54)

Vegetation Condition: Disturbed to degraded natural

Representative Quadrat(s):

KO0201 (Figure 63
BE0201 (Figure 64
TB0101 (Figure 65

Structural Data:

Overstorey Lifeform	Shrubs < 1 m (or trees 5 - 10 m)
Overstorey Percent canopy (crown) Cover	5 - 50% (1 - 10%)
Average Overstorey Height (and range)	variable
Average Overstorey Canopy Diameter (and range)	variable
Average Overstorey Gap between canopies	variable

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains* and various
Landform Elements	Plains* and various
Surface Soil Texture	Clay loam* - loam & various
Geological Surface Type	QPP - Pooraka Formation and various
Surface Strew	Nil to pebbles 1 - 30%

Description:

The largest group, spread throughout the area (except in the dunefields). Understorey is variable from grass to shrubs and occasionally there is an overstorey of Blackoak.

Species	Cover/Abundance R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
Maireana sedifolia	0	0	0	2	37	12	1	0	1.00	0.62	30
Sclerolaena obliquicuspis	0	15	15	1	0	0	0	0	0.60	0.19	23
Stipa sp.	0	5	13	8	5	0	0	0	0.60	0.12	30
Enchylaena tomentosa var. *tomentosa*	0	22	7	1	0	0	0	0	0.58	0.01	34
Eriochiton sclerolaenoides	0	9	14	3	0	0	0	0	0.50	0.29	24
*Carrichtera annua**	0	6	10	8	0	0	0	0	0.46	0.01	31
Maireana pyramidata	1	9	6	1	7	0	0	0	0.46	0.00	31
Danthonia sp.	0	6	8	7	1	0	0	0	0.42	0.04	28
Lycium australe	1	15	4	1	1	0	0	0	0.42	0.24	23
Casuarina pauper	1	10	5	1	1	0	0	0	0.35	0.09	23
Maireana georgei-turbinata	0	11	6	0	0	0	0	0	0.33	0.00	26
Daucus glochidiatus	0	5	9	2	0	0	0	0	0.31	0.05	23
Myoporum platycarpum ssp.	1	11	4	0	0	0	0	0	0.31	0.01	26

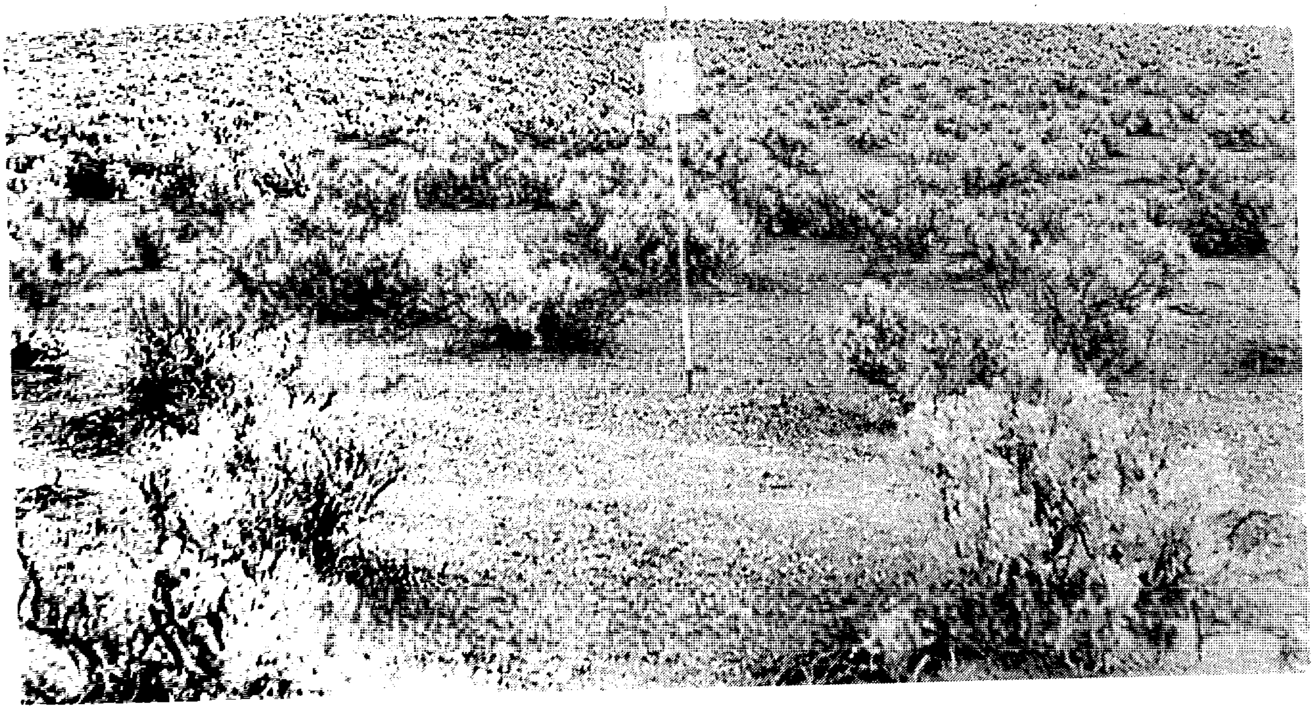


Figure 63
Maireana sedifolia Low open shrubland at quadrat KO0201

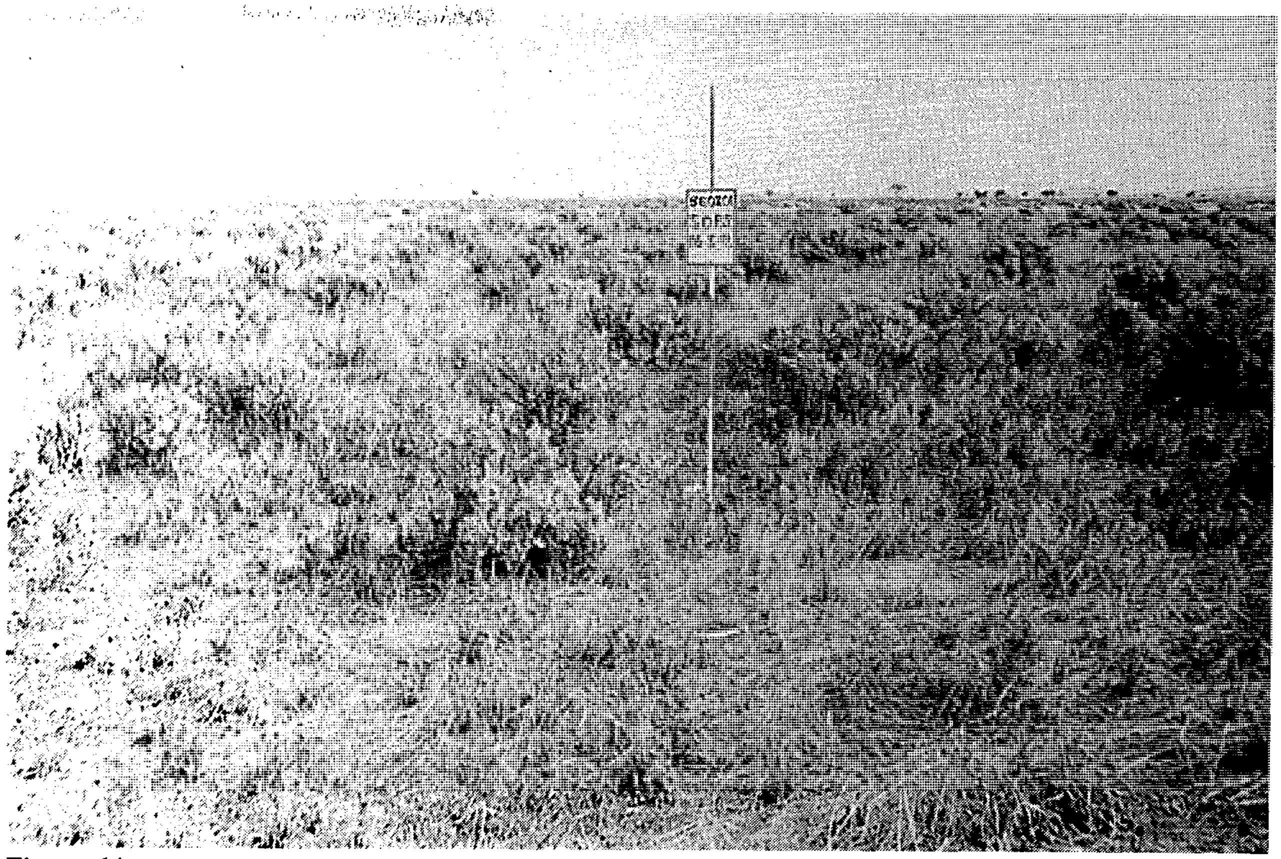


Figure 64
Maireana sedifolia **Low open shrubland at quadrat BE0201**

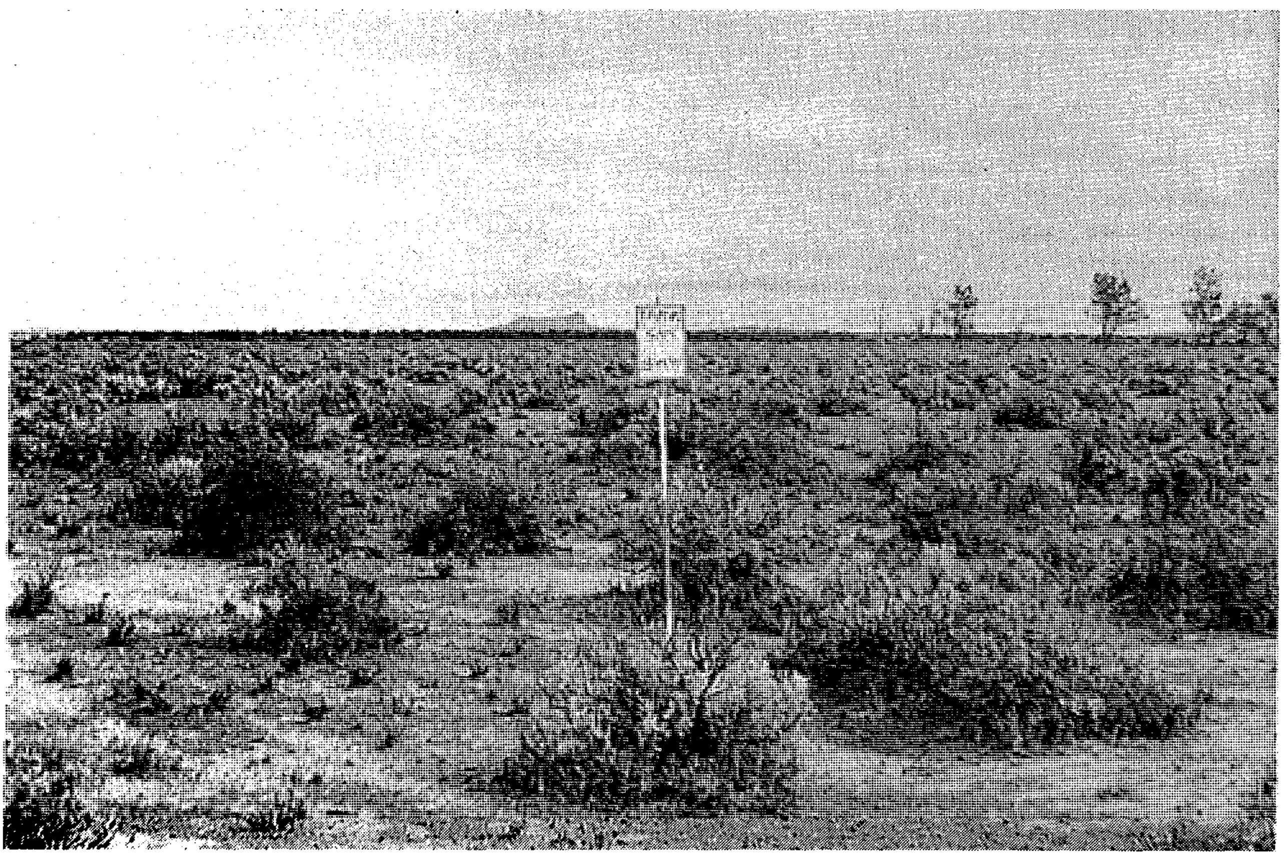
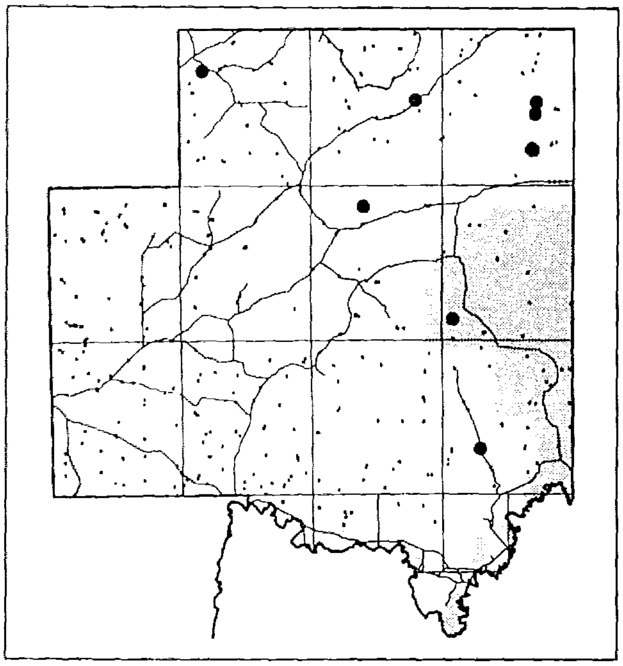


Figure 65
Maireana sedifolia **Low open shrubland at quadrat TB0101**

TALL SHRUBLAND COMMUNITIES

Floristic Group 14. *Eremophila sturtii / Acacia burkittii* OPEN SHRUBLAND

9 members



Dominant Overstorey Species:

Eremophila sturtii (Turpentine)
Acacia burkittii† (Pin-bush Wattle)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Maireana pyramidata
Sclerolaena obliquicuspis
Senna artemisioides spp. *petiolaris*
Dissocarpos paradoxus

Average Number of Plant Species (&range):

37.0 (21 - 65)

Vegetation Condition: Disturbed and degraded natural to highly degraded

Representative Quadrat(s): OV0401 (Figure 66)

Structural Data:

Overstorey Lifeform	Shrubs 1 - 2 m (or trees 5 - 10 m)
Overstorey Percent canopy (crown) Cover	5 - 40% (1 - 5%)
Average Overstorey Height (and range)	variable
Average Overstorey Canopy Diameter (and range)	variable
Average Overstorey Gap between canopies	variable

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Drainage lines, floodouts & various plains
Landform Elements	Channel and floodplain elements
Surface Soil Texture	Loamy sand to medium clay
Geological Surface Type	QPP - Poorka Formation
Surface Strew	Nil to pebbles < 10%

Description:

A widespread group which occurs in highly disturbed and degraded areas, particularly along drainage lines, floodouts and around dams. Four of the species [*E. sturtii* (Turpentine), *S. artemisioides* spp. *petiolaris* (Flat-stalk Senna), *D. paradoxus* Cannon Ball) and *M. pyramidata* (Black Bluebush)] are known as 'increaser' species [i.e. grow in disturbed areas (Choate and Barratt, 1983)]. Overstorey can include *Eucalyptus* at times.

Species	R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
	Cover/Abundance										
Eremophila sturtii	0	1	0	0	6	1	0	0	0.89	3.30	20
Acacia burkittii	0	4	1	0	2	0	0	0	0.78	9.35	9
Enchylaena tomentosa var. *tomentosa*	0	6	1	0	0	0	0	0	0.78	0.03	34
Lysiana exocarpi ssp. *exocarpi*	3	4	0	0	0	0	0	0	0.78	4.11	15
Maireana pyramidata	0	3	1	1	1	0	0	0	0.67	0.08	31
Myoporum platycarpum ssp.	2	3	1	0	0	0	0	0	0.67	0.24	26
Sclerolaena obliquicuspis	0	1	3	2	0	0	0	0	0.67	0.31	23
Alectryon oleifolius ssp. *canescens*	3	2	0	0	0	0	0	0	0.56	0.14	30
Atriplex stipitata	0	3	2	0	0	0	0	0	0.56	0.59	23
Dissocarpus paradoxus	0	3	1	1	0	0	0	0	0.56	1.16	23
Rhagodia spinescens	0	3	1	1	0	0	0	0	0.56	0.21	19
Senna artemisioides ssp. *petiolaris*	0	1	0	2	2	0	0	0	0.56	0.91	18
Danthonia sp.	1	1	1	0	1	0	0	0	0.44	0.05	28
Einadia nutans ssp.	0	4	0	0	0	0	0	0	0.44	0.31	23
Erodiophyllum elderi	0	0	0	0	4	0	0	0	0.44	5.16	8
Exocarpos aphyllus	2	2	0	0	0	0	0	0	0.44	0.28	24
Olearia pimeleoides ssp. *pimeleoides*	1	0	3	0	0	0	0	0	0.44	0.57	18
Acacia colletioides	0	2	1	0	0	0	0	0	0.33	0.26	16
Carrichtera annua *	0	0	0	2	1	0	0	0	0.33	0.01	31
Casuarina pauper	0	3	0	0	0	0	0	0	0.33	0.08	23
Chenopodium curvispicatum	0	3	0	0	0	0	0	0	0.33	0.08	21
Daucus glochidiatus	0	3	0	0	0	0	0	0	0.33	0.08	23
Lycium australe	0	2	1	0	0	0	0	0	0.33	0.08	23
Maireana brevifolia	0	2	0	1	0	0	0	0	0.33	0.17	23
Maireana georgei/turbinata	0	1	2	0	0	0	0	0	0.33	0.00	26
Maireana sedifolia	1	2	0	0	0	0	0	0	0.33	0.04	30
Oxalis perennans	0	1	1	1	0	0	0	0	0.33	0.05	27
Ptilotus obovatus var. *obovatus*	0	3	0	0	0	0	0	0	0.33	0.05	23
Stipa scabra group	0	2	0	0	1	0	0	0	0.33	0.32	20

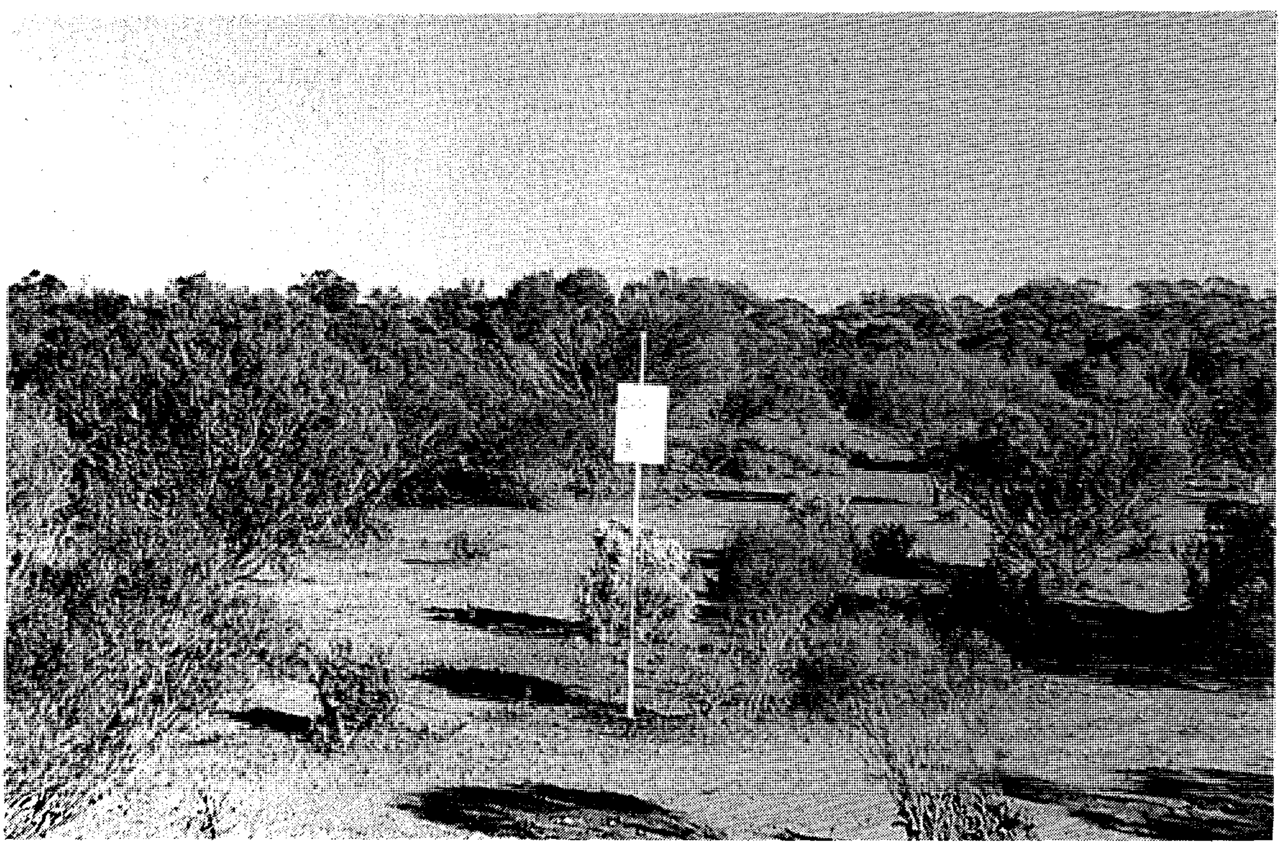
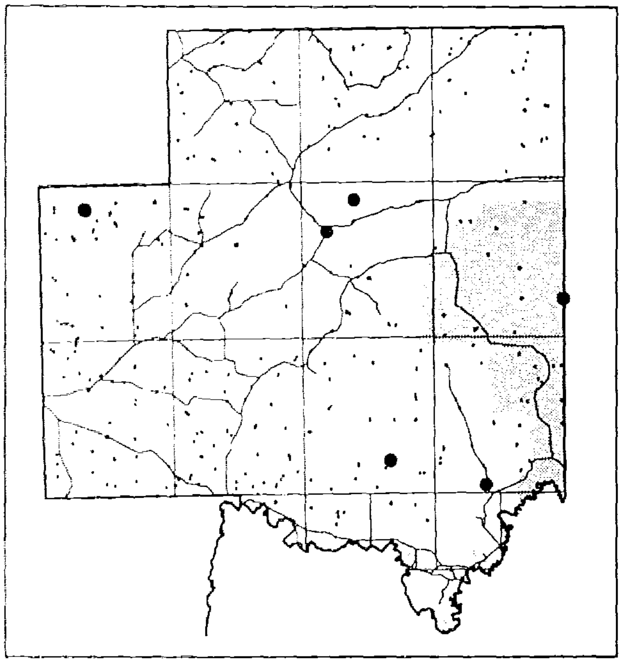


Figure 66
***Eremophila sturtii / Acacia burkittii* Open shrubland at quadrat OV0401**

Floristic Group 22. *Dodonaea viscosa* spp. *angustissima* OPEN SHRUBLAND

7 members



Dominant Overstorey Species:

Dodoncaea viscosa spp. *angustissima*
(Narrow-leaved Hop-bush)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Einadia nutans spp.
Acacia colletioiodes
Olearia pimelioides spp. *pimelioides*
Sclerolaena diacantha

Average Number of Plant Species (&range):

32.6 (18 - 47)

Vegetation Condition: Disturbed natural

Representative Quadrat(s): SV0102 (Figure 67)

Structural Data:

Overstorey Lifeform	Shrubs 1 - 2 m (or mallee trees)
Overstorey Percent canopy (crown) Cover	10 - 30% (or 5 - 25%)
Average Overstorey Height (and range)	variable
Average Overstorey Canopy Diameter (and range)	variable
Average Overstorey Gap between canopies	variable

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	various
Landform Elements	various
Surface Soil Texture	variable, sand to clay loam
Geological Surface Type	various
Surface Strew	various

Description:

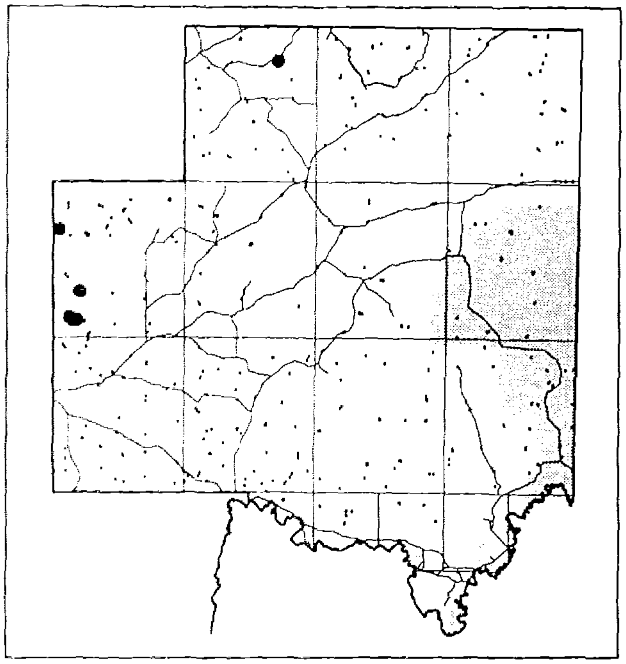
A widely scattered group with overstorey structure varying from shrubs and tall shrubs to mallee trees (four possible species). Understorey also variable in species content.

Species	R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
	Cover/Abundance										
Dodonaea viscosa ssp. *angustissima*	0	0	0	0	7	0	0	0	1.00	3.42	20
Einadia nutans ssp.	0	2	3	0	0	0	0	0	0.71	1.34	23
Enchylaena tomentosa var. *tomentosa*	0	4	0	0	1	0	0	0	0.71	0.01	34
Acacia colletioides	2	0	2	0	0	0	0	0	0.57	1.32	16
Alectryon oleifolius ssp. *canescens*	0	3	1	0	0	0	0	0	0.57	0.16	30
Olearia pimeleoides ssp. *pimeleoides*	0	2	2	0	0	0	0	0	0.57	1.17	18
Sclerolaena diacantha	0	1	2	1	0	0	0	0	0.57	0.30	26
Arabidella trisecta	0	1	2	0	0	0	0	0	0.43	1.25	16
Beyeria opaca	0	2	1	0	0	0	0	0	0.43	4.63	5
Danthonia sp.	0	0	2	1	0	0	0	0	0.43	0.04	28
Exocarpos aphyllus	0	3	0	0	0	0	0	0	0.43	0.24	24
Maireana pyramidata	0	2	0	0	1	0	0	0	0.43	0.00	31
Myoporum platycarpum ssp.	0	3	0	0	0	0	0	0	0.43	0.01	26
Rhagodia spinescens	0	3	0	0	0	0	0	0	0.43	0.05	29
Stipa sp.	0	0	3	0	0	0	0	0	0.43	0.01	30

Figure 67
***Dodonaea viscosa* ssp. *angustissima* Open shrubland at quadrat SV0102**

Floristic Group 24. *Rhagodia parabolica / Dodonaea lobulata* OPEN SHRUBLAND

7 members



Dominant Overstorey Species:

Rhagodia parabolica (Mealy Saltbush)
Dodonaea lobulata† (Lobe-leaved Hop-bush)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Acacia calamifolia†
Olearia decurrens†
Dodonaea viscosa spp. *angustissima*
Chrysocephalum semipapposum†
Danthonia sp.
Stipa sp.
Oxalis perennans
Senecio quadridentatus†
Wahlenbergia sp. †

Average Number of Plant Species (&range):

37.3 (31 - 51)

Vegetation Condition:	Disturbed natural
Representative Quadrat(s):	TR0101 (Figure 68)

Structural Data:

Overstorey Lifeform	Shrubs 1 - 2 m (or mallee trees)
Overstorey Percent canopy (crown) Cover	5 - 50%
Average Overstorey Height (and range)	variable
Average Overstorey Canopy Diameter (and range)	variable
Average Overstorey Gap between canopies	variable

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Hills
Landform Elements	Hillslopes and ridges
Surface Soil Texture	Silty loam to silty clay
Geological Surface Type	various
Surface Strew	Cobble 30 - 70%

Description:

A very strong group, with a large number of high frequency and indicator species although overstorey species is sometimes mallee trees. Concentrated on the hills on the far western edge of the survey area but also on Oulnina Park in the north.

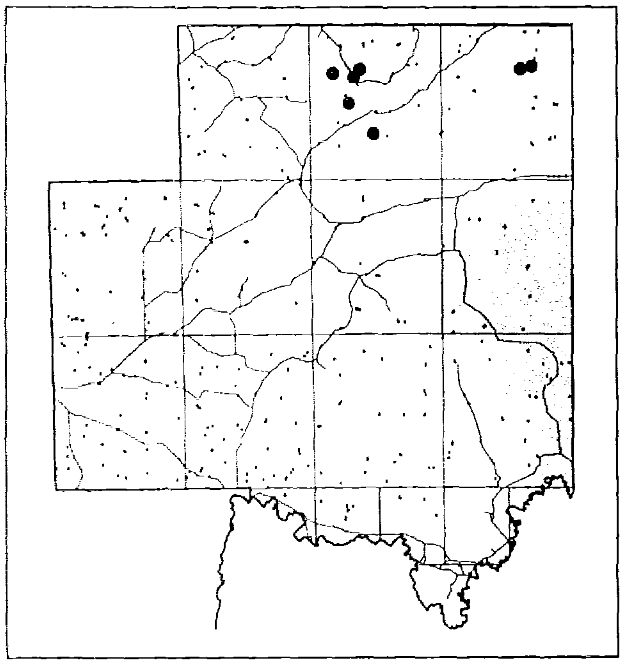
Species	Cover/Abundance								Prop.	Chi	No.
	R	I	T	1	2	3	4	5	Occur.	Squ.	Gps
Chrysocephalum semipapposum	0	1	4	2	0	0	0	0	1.00	13.04	6
Danthonia sp.	0	1	4	2	0	0	0	0	1.00	1.51	28
Oxalis perennans	0	4	3	0	0	0	0	0	1.00	2.65	27
Rhagodia parabolica	0	0	3	2	2	0	0	0	1.00	3.69	23
Stipa sp.	0	0	6	1	0	0	0	0	1.00	1.01	30
Dodonaea lobulata	0	1	1	0	4	0	0	0	0.86	9.57	10
Enchylaena tomentosa var. *tomentosa*	0	3	3	0	0	0	0	0	0.86	0.07	34
Acacia calamifolia	0	2	1	0	2	0	0	0	0.71	14.99	4
Dodonaea viscosa ssp. *angustissima*	0	0	2	1	2	0	0	0	0.71	1.43	20
Olearia decurrens	0	0	2	2	1	0	0	0	0.71	5.82	9
Senecio quadridentatus	0	3	2	0	0	0	0	0	0.71	4.38	10
Wahlenbergia sp.	0	3	2	0	0	0	0	0	0.71	5.56	11
Convolvulus microsepalus/remotus	0	4	0	0	0	0	0	0	0.57	1.13	19
Daucus glochidiatus	0	3	1	0	0	0	0	0	0.57	0.65	23
Goodenia fascicularis	0	2	2	0	0	0	0	0	0.57	0.91	22
Zygophyllum apiculatum	0	3	1	0	0	0	0	0	0.57	1.30	17
Acacia wilhelmiana	0	1	2	0	0	0	0	0	0.43	8.85	4
Alectryon oleifolius ssp. *canescens*	0	3	0	0	0	0	0	0	0.43	0.03	30
Bursaria spinosa	1	2	0	0	0	0	0	0	0.43	5.12	3
Eremophila serrulata	0	3	0	0	0	0	0	0	0.43	3.28	5
Glycine clandestina var. *sericea*	0	3	0	0	0	0	0	0	0.43	3.87	7
Scleranthus pungens	1	2	0	0	0	0	0	0	0.43	4.83	5

Figure 68
***Rhagodia parabolica* / *Dodonaea lobulata* Open shrubland at quadrat TR0101**

GRASSLAND COMMUNITIES

Floristic Group 6. *Stipa scabra* group OPEN GRASSLAND

7 members



Dominant Overstorey (or Characteristic) Species:

Stipa scabra group (Falcate-awn or Rough Spear-grass)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Maireana pyramidata
Ptilotus obovatus var. *obovatus*
Eriochiton sclerolaenoides

Average Number of Plant Species (&range):

40.6 (28 - 52)

Vegetation Condition: Disturbed natural

Representative Quadrat(s): DL0102 (Figure 69)

Structural Data:

Overstorey Lifeform	Tussock grasses or shrubs < 1 m
Overstorey Percent canopy (crown) Cover	5 - 40% or 5 - 25% respectively
Average Overstorey Height (and range)	n/a
Average Overstorey Canopy Diameter (and range	n/a
Average Overstorey Gap between canopies	n/a

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains & low hills
Landform Elements	Plains & various
Surface Soil Texture	Loam to clay loam sandy
Geological Surface Type	various
Surface Strew	various

Description:

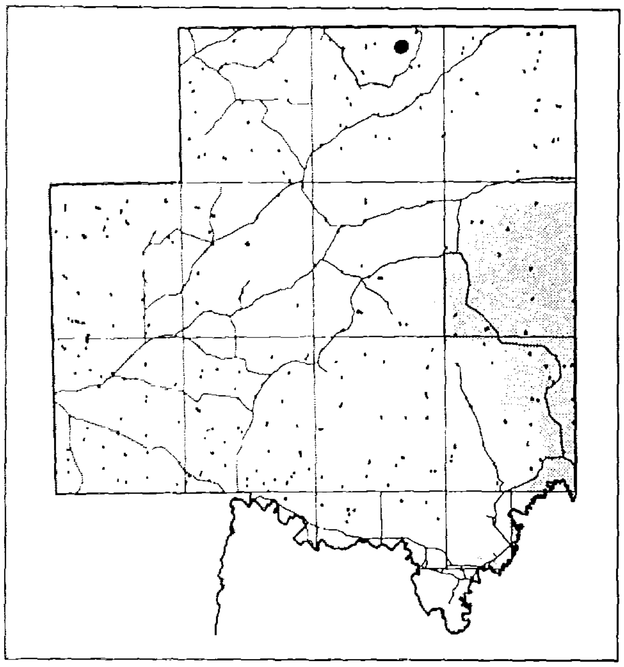
A small but strong group, localised in the north and north-eastern areas. Variable in structure from grassland with isolated trees to chenopod shrubland with grasses but the linking combination is and Black Bluebush (*Maireana pyramidata*) and Rough Speargrass (*Stipa scabra* group) (which in this case includes *Stipa scabra* ssp. *scabra*, *Stipa nitida* and *Stipa nodosa*).

Species	Cover/Abundance								Prop.	Chi	No.
	R	I	T	1	2	3	4	5	Occur.	Squ.	Gps
Maireana pyramidata	1	4	0	0	2	0	0	0	1.00	0.57	31
Stipa scabra group	0	0	0	0	5	2	0	0	1.00	5.85	20
Eriochiton sclerolaenoides	0	1	0	4	0	0	0	0	0.71	0.96	24
Maireana georgei/turbinata	0	4	0	1	0	0	0	0	0.71	0.55	26
Ptilotus obovatus var. *obovatus*	1	3	0	0	1	0	0	0	0.71	1.09	23
Carrichtera annua *	1	3	0	0	0	0	0	0	0.57	0.07	31
Convolvulus microsepalus/remotus	1	3	0	0	0	0	0	0	0.57	1.13	19
Danthonia sp.	0	2	1	1	0	0	0	0	0.57	0.21	28
Enchylaena tomentosa var. *tomentosa*	0	4	0	0	0	0	0	0	0.57	0.01	34
Maireana sedifolia	0	2	1	1	0	0	0	0	0.57	0.03	30
Sclerolaena obliquicuspis	1	2	0	1	0	0	0	0	0.57	0.16	23
Acacia victoriae ssp. *victoriae*	0	2	1	0	0	0	0	0	0.43	1.23	12
Alectryon oleifolius ssp. *canescens*	1	2	0	0	0	0	0	0	0.43	0.03	30
Atriplex stipitata	0	3	0	0	0	0	0	0	0.43	0.24	23
Goodenia fascicularis	1	1	1	0	0	0	0	0	0.43	0.37	22
Maireana trichoptera	0	2	1	0	0	0	0	0	0.43	0.31	22
Myoporum platycarpum ssp.	0	3	0	0	0	0	0	0	0.43	0.01	26
Rhagodia spinescens	0	1	0	1	1	0	0	0	0.43	0.05	27
Salvia verbenaca form	0	1	1	0	1	0	0	0	0.43	0.69	18
Sclerolaena patenticuspis	1	0	1	0	1	0	0	0	0.43	0.47	21

Figure 69
***Stipa scabra* group Open grassland at quadrat DL0102**

Floristic Group 9. *Enneapogon intermedius* OPEN GRASSLAND

2 members



Dominant Overstorey (or Characteristic) Species:

Enneapogon intermedius† (Tall Bottle-washers)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Stipa acrociliata†
Sida fibulifera†
Sclerolaena patenticupis
Myoporum platycarum spp.

Average Number of Plant Species (&range):

37.3 (27 - 42)

Vegetation Condition: Disturbed natural

Representative Quadrat(s): DB0201 (Figure 70)

Structural Data:

Overstorey Lifeform	variable
Overstorey Percent canopy (crown) Cover	variable
Average Overstorey Height (and range)	n/a
Average Overstorey Canopy Diameter (and range)	n/a
Average Overstorey Gap between canopies	n/a

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Lowlands
Landform Elements	Hillslope
Surface Soil Texture	Loam
Geological Surface Type	PNBI - Mintaro Shale
Surface Strew	various

Description:

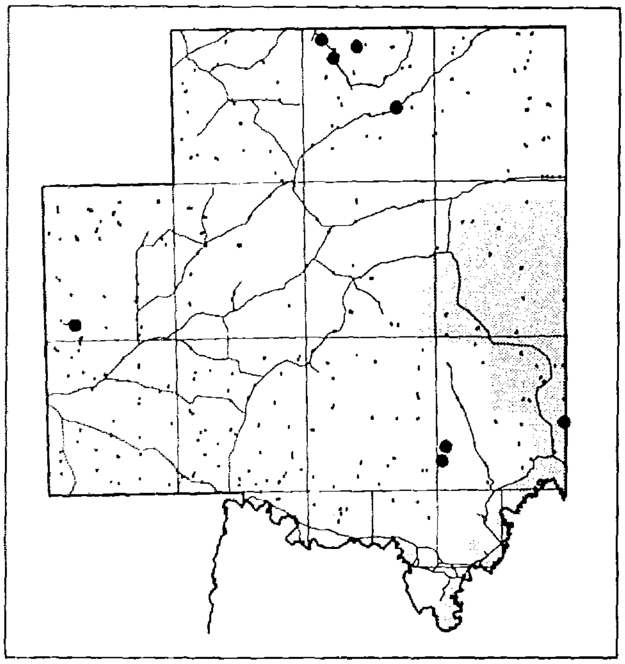
The smallest group, having only two members, but appears to be a true group, characterised by native grasses *E. intermedius* and *S. acrociliata* (Graceful Spear-grass). Overstory is variable from none to shrubs to trees.

Species	Cover/Abundance								Prop.	Chi	No.
	R	I	T	1	2	3	4	5	Occur.	Squ.	Gps
Carrichtera annua *	0	2	0	0	0	0	0	0	1.00	0.87	31
Enchylaena tomentosa var. *tomentosa*	0	2	0	0	0	0	0	0	1.00	0.20	34
Enneapogon intermedius	0	0	0	0	2	0	0	0	1.00	20.92	6
Maireana pyramidata	1	1	0	0	0	0	0	0	1.00	0.57	31
Maireana sedifolia	2	0	0	0	0	0	0	0	1.00	0.62	30
Myoporum platycarpum ssp.	1	1	0	0	0	0	0	0	1.00	1.08	26
Sclerolaena patenticuspis	0	0	0	1	1	0	0	0	1.00	4.56	21
Sida fibulifera	0	2	0	0	0	0	0	0	1.00	13.79	10
Stipa acrociliata	0	0	0	2	0	0	0	0	1.00	16.44	9
Abutilon fraseri	1	0	0	0	0	0	0	0	0.50	3.82	9
Acacia tetragonophylla	0	1	0	0	0	0	0	0	0.50	15.17	2
Acacia victoriae ssp. *victoriae*	1	0	0	0	0	0	0	0	0.50	1.80	12
Alectryon oleifolius ssp. *canescens*	0	1	0	0	0	0	0	0	0.50	0.08	30
Cheilanthes lasiophylla	0	1	0	0	0	0	0	0	0.50	1.83	14
Chenopodium curvispicatum	0	1	0	0	0	0	0	0	0.50	0.43	21
Convolvulus microsepalus/remotus	0	1	0	0	0	0	0	0	0.50	0.77	19
Cymbopogon ambiguus	0	1	0	0	0	0	0	0	0.50	5.44	4
Dissocarpus paradoxus	0	1	0	0	0	0	0	0	0.50	0.87	23
Eremophila sturtii	0	1	0	0	0	0	0	0	0.50	0.72	20
Eriochiton sclerolaenoides	0	0	0	1	0	0	0	0	0.50	0.29	24
Eucalyptus socialis	0	0	0	0	1	0	0	0	0.50	0.39	23
Goodenia fascicularis	1	0	0	0	0	0	0	0	0.50	0.61	22
Lycium australe	0	1	0	0	0	0	0	0	0.50	0.43	23
Lysiana exocarpi ssp. *exocarpi*	0	1	0	0	0	0	0	0	0.50	1.40	15
Maireana brevifolia	1	0	0	0	0	0	0	0	0.50	0.68	23
Maireana georgei/turbinata	0	1	0	0	0	0	0	0	0.50	0.13	26
Maireana pentatropis	0	0	0	1	0	0	0	0	0.50	0.69	20
Marrubium vulgare *	1	0	0	0	0	0	0	0	0.50	2.12	13
Ptilotus obovatus var. *obovatus*	1	0	0	0	0	0	0	0	0.50	0.35	23
Rhagodia spinescens	0	1	0	0	0	0	0	0	0.50	0.13	29
Salvia verbenaca form	0	0	0	1	0	0	0	0	0.50	1.05	18
Sida petrophila	0	0	0	0	0	0	1	0	0.50	1.12	16
Solanum ellipticum	0	0	0	0	1	0	0	0	0.50	2.73	11

Figure 70
***Enneapogon intermedius* Open grassland at quadrat DB0201**

Floristic Group 18. *Danthonia* spp. OPEN GRASSLAND

8 members



Dominant Overstorey (or Characteristic) Species:

Danthonia spp. (Wallaby Grass)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Myoporum platycarpum spp.
Alectryon olefolius spp. *canescens*
Sclerolaena obliquicuspis
Eriochiton sclerolaenoides
Stipa sp.

Average Number of Plant Species (&range):

31.1 (22 - 36)

Vegetation Condition:	Disturbed to degraded natural
Representative Quadrat(s):	BN0102 (Figure 71)

Structural Data:

Overstorey Lifeform	Tussock grasses (or shrubs < 1 m)
Overstorey Percent canopy (crown) Cover	5 - 30% (1 - 10%)
Average Overstorey Height (and range)	variable
Average Overstorey Canopy Diameter (and range)	variable
Average Overstorey Gap between canopies	variable

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains* & low hills
Landform Elements	Plains* & various
Surface Soil Texture	Loamy sand to clay loam
Geological Surface Type	various
Surface Strew	Nil to pebbles 10 - 30%

Description:

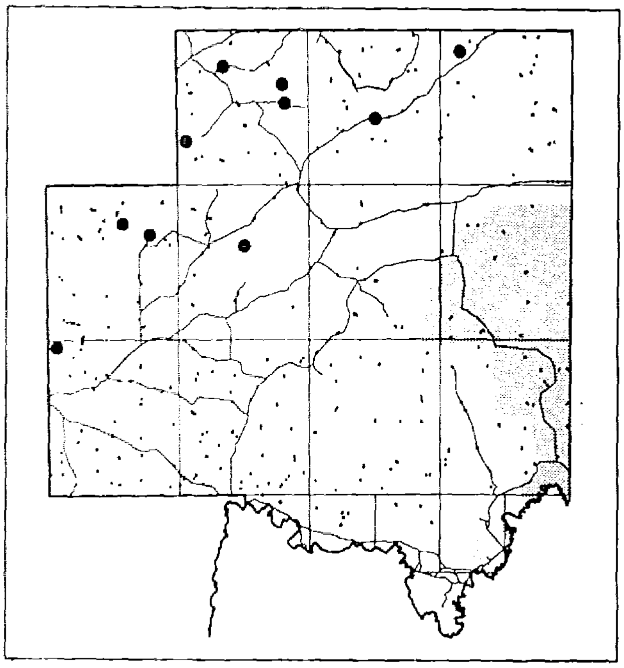
A loose group mostly linked together by Wallaby Grass (*Danthonia* sp.) (which in this case includes all possible Danthonia species for the area). Sites scattered across the survey area. Overstorey very variable, some with shrubs or trees.

Species	Cover/Abundance								Prop.	Chi	No.
	R	I	T	1	2	3	4	5	Occur.	Squ.	Gps
Danthonia sp.	0	0	0	4	4	0	0	0	1.00	1.51	28
Myoporum platycarpum ssp.	0	6	0	0	0	0	0	0	0.75	0.39	26
Sclerolaena obliquicuspis	0	2	2	1	1	0	0	0	0.75	0.49	23
Alectryon oleifolius ssp. *canescens*	0	3	2	0	0	0	0	0	0.63	0.25	30
Enchylaena tomentosa var. *tomentosa*	0	4	1	0	0	0	0	0	0.63	0.00	34
Eriochiton sclerolaenoides	0	2	1	2	0	0	0	0	0.63	0.63	24
Maireana pyramidata	0	3	2	0	0	0	0	0	0.63	0.05	31
Carrichtera annua *	0	1	0	3	0	0	0	0	0.50	0.02	31
Stipa sp.	0	0	1	0	1	2	0	0	0.50	0.04	30
Acacia nyssophylla	2	1	0	0	0	0	0	0	0.38	0.43	18
Atriplex acutibractea ssp. *acutibractea*	0	1	0	2	0	0	0	0	0.38	1.64	12
Daucus glochidiatus	0	3	0	0	0	0	0	0	0.38	0.14	23
Maireana georgei/turbinata	1	2	0	0	0	0	0	0	0.38	0.02	26
Maireana sedifolia	0	3	0	0	0	0	0	0	0.38	0.02	30
Rhagodia spinescens	2	1	0	0	0	0	0	0	0.38	0.02	29
Sida corrugata var.	1	2	0	0	0	0	0	0	0.38	1.85	14

Figure 71
***Danthonia* spp. Open grassland at quadrat BN0102**

Floristic Group 19. '*Stipa* sp.'[1] OPEN GRASSLAND

10 members



Dominant Overstorey (or Characteristic) Species:

'*Stipa* sp.'[1] (Spear-grass)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Maireana pyramidata
*Carrichtera annua**
Atriplex vesicaria spp.

Average Number of Plant Species (&range):

22.4 (16 - 35)

Vegetation Condition:	Disturbed natural to highly degraded
Representative Quadrat(s):	PN0101 (Figure 72) GR0202 (Figure 73)

Structural Data:

Overstorey Lifeform	Tussock grasses (or shrubs < 1 m)
Overstorey Percent canopy (crown) Cover	5 - 50% (or 1 - 30%)
Average Overstorey Height (and range)	variable
Average Overstorey Canopy Diameter (and range)	variable
Average Overstorey Gap between canopies	variable

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains, floodplains and various
Landform Elements	various
Surface Soil Texture	Loam, sandy clay loam to medium clay
Geological Surface Type	various
Surface Strew	Pebble and cobble 1 - 30%

Description:

A variable group scattered throughout the north-western part of the area. Sites are linked by the presence of Black Bluebush (*M. pyramidata*) and significant growth of Spear Grass ('*Stipa* sp.'[1]) Overstorey can vary from none to shrubs to Mallee.

[1] In this case '*Stipa* sp.' includes *Stipa* sp., *Stipa mollis* and *Stipa eremophila* (see methods chapter).

Species	Cover/Abundance R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
Stipa sp.	0	0	0	4	4	1	1	0	1.00	1.01	30
Maireana pyramidata	0	1	3	1	4	0	0	0	0.90	0.37	31
Carrichtera annua *	0	1	1	1	1	2	0	0	0.60	0.09	31
Atriplex vesicaria ssp.	0	0	3	1	1	0	0	0	0.50	0.11	26
Sclerolaena obliquicuspis	0	1	4	0	0	0	0	0	0.50	0.07	23
Maireana georgei/turbinata	0	1	3	0	0	0	0	0	0.40	0.03	26
Maireana sedifolia	1	1	2	0	0	0	0	0	0.40	0.01	30
Rhagodia spinescens	1	1	2	0	0	0	0	0	0.40	0.03	29
Sclerolaena patenticuspis	0	0	2	1	1	0	0	0	0.40	0.38	21

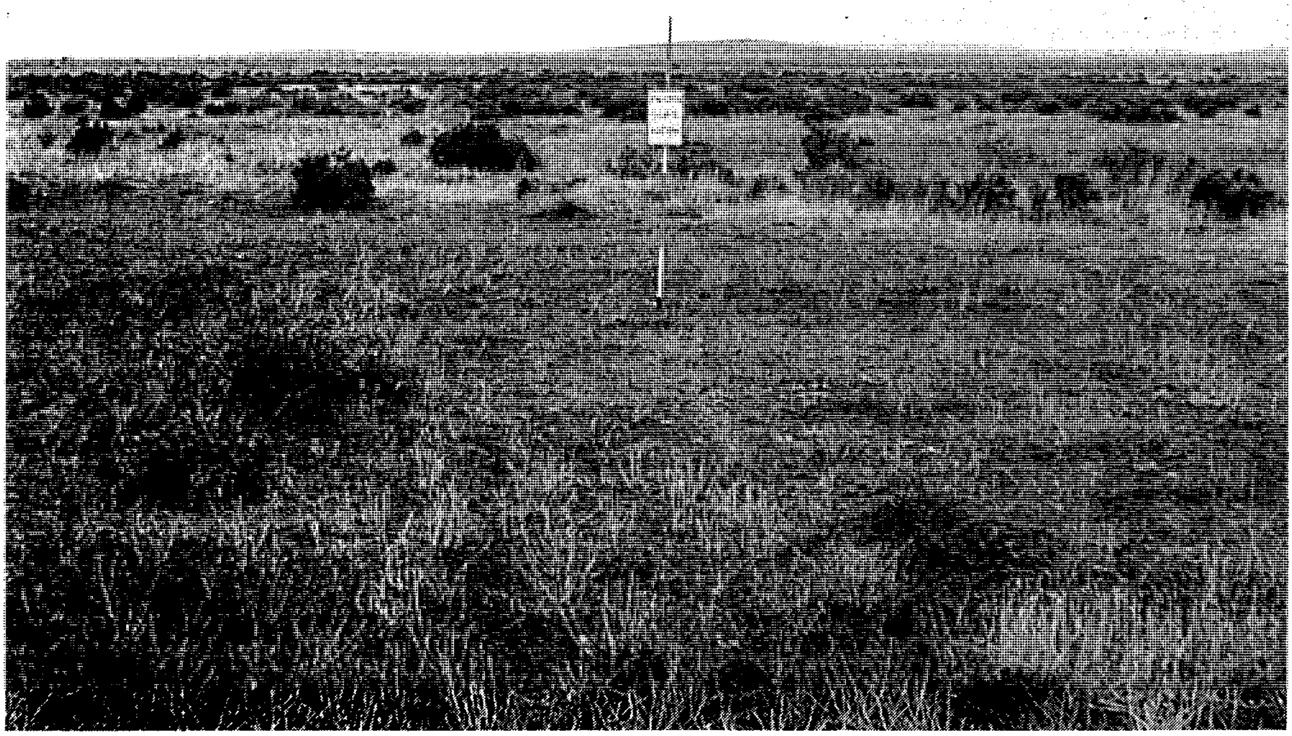


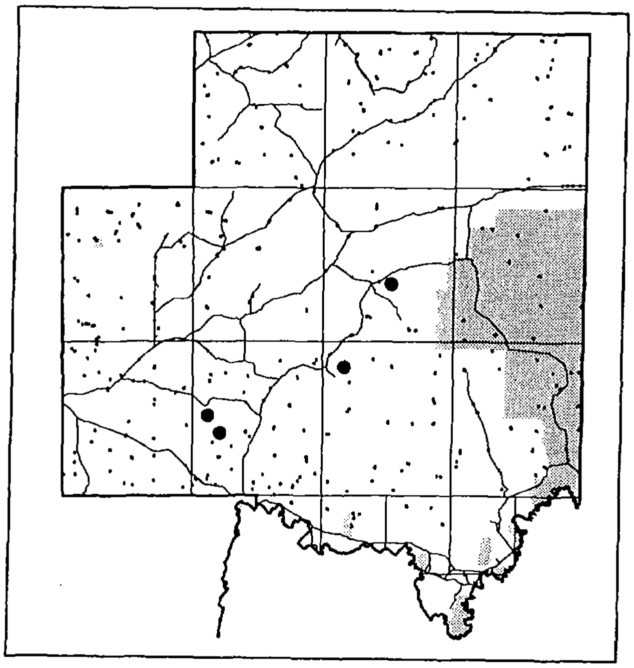
Figure 72
***Stipa* sp. Open grassland at quadrat PN0101**

Figure 73
***Stipa* sp. Open grassland (with chenopod shrubs) at quadrat GR0202**

CLAYPAN/SALINE COMMUNITIES

Floristic Group 17. *Lycium australe* OPEN SHRUBLAND

4 members



Dominant Overstorey Species:

Lycium australe (Australian Boxthorn)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Sclerostegia tenuis†
Disphyma crassifolium spp. *clavellatum*†
Sclerolaena brachyptera
Minuria cunninghamii
Malacocera tricornis†
Nitraria billardierei

Average Number of Plant Species (&range):

28.8 (15 - 41)

Vegetation Condition:	Disturbed to degraded natural
Representative Quadrat(s):	CN0401 (Figure 74

Structural Data:

Overstorey Lifeform	Shrubs 1 - 2 m
Overstorey Percent canopy (crown) Cover	5 - 50%
Average Overstorey Height (and range)	variable
Average Overstorey Canopy Diameter (and range)	variable
Average Overstorey Gap between canopies	variable

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Playa plains
Landform Elements	Pans
Surface Soil Texture	Light to heavy clays
Geological Surface Type	QHL - Lake & Playa deposits, QPH - Blanchetown Clay
Surface Strew	Nil

Description:

A strong group occuring exclusively on clay plans and saline areas.

Species	Cover/Abundance R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
Disphyma crassifolium ssp. *clavellatum*	0	0	1	1	2	0	0	0	1.00	27.50	2
Lycium australe	0	1	0	1	1	1	0	0	1.00	3.13	23
Sclerostegia tenuis	0	0	0	1	2	1	0	0	1.00	30.37	2
Minuria cunninghamii	0	1	0	1	1	0	0	0	0.75	7.04	11
Sclerolaena brachyptera	0	0	3	0	0	0	0	0	0.75	7.43	10
Atriplex vesicaria ssp.	0	1	0	0	0	1	0	0	0.50	0.11	26
Casuarina pauper	1	1	0	0	0	0	0	0	0.50	0.41	23
Frankenia serpyllifolia	0	2	0	0	0	0	0	0	0.50	7.36	4
Maireana sedifolia	1	1	0	0	0	0	0	0	0.50	0.00	30
Malacocera tricornis	0	1	1	0	0	0	0	0	0.50	10.52	4
Nitraria billardierei	0	0	0	1	0	1	0	0	0.50	2.27	13
Rhagodia ulicina	1	0	0	1	0	0	0	0	0.50	0.26	25
Sclerolaena diacantha	0	0	2	0	0	0	0	0	0.50	0.17	26
Sclerolaena divaricata	0	1	1	0	0	0	0	0	0.50	2.05	12

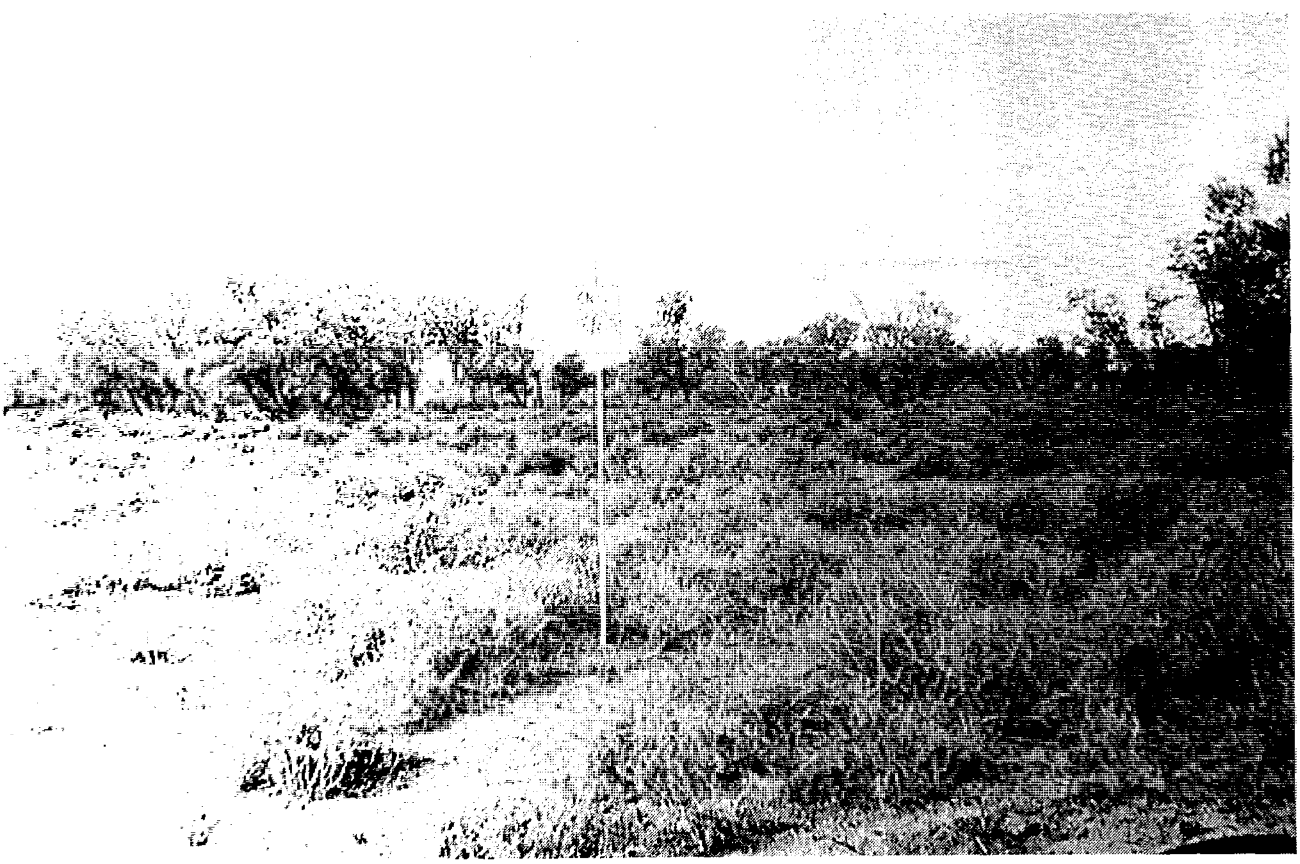
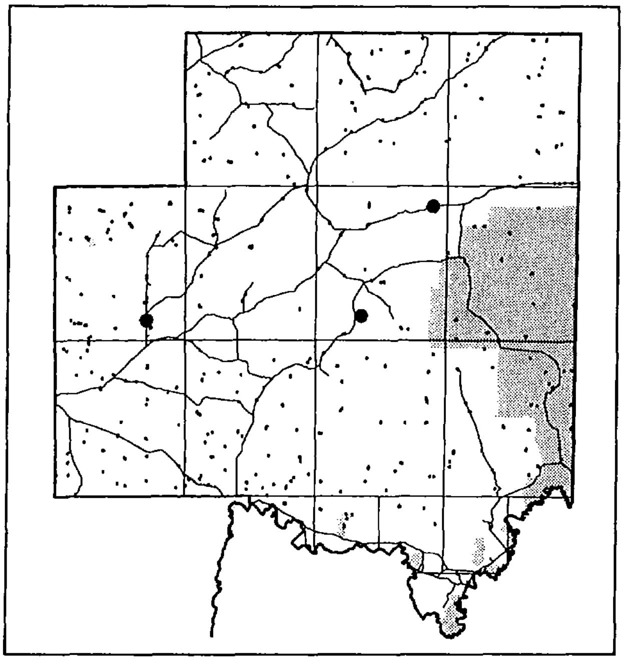


Figure 74
***Lycium australe* Open shrubland at quadrat CN0401**

Floristic Group 20. *Maireana aphylla / Nitraria billardierei* LOW OPEN SHRUBLAND

3 members



Dominant Overstorey Species:

Maireana aphylla† (Cotton-bush)
Nitraria billardierei (Nitre-bush)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Lycium australe
Maireana pyramidata
Goodenia fasicularis

Average Number of Plant Species (&range):

27.9 (14 - 44)

Vegetation Condition: Disturbed to degraded natural

Representative Quadrat(s): OB0102 (Figure 75)

Structural Data:

Overstorey Lifeform	Shrubs < 1 m
Overstorey Percent canopy (crown) Cover	5 - 30%
Average Overstorey Height (and range)	0.9 m (0.8 - 1)
Average Overstorey Canopy Diameter (and range)	1.0 m (0.6 - 1.5)
Average Overstorey Gap between canopies	2.8 m (1.5 - 5)

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains
Landform Elements	Plains & pans
Surface Soil Texture	Clays
Geological Surface Type	various
Surface Strew	Nil

Description:

A very small group, difficult to describe accurately, with only 3 members and no species occurring at all three sites. However, structure and environmental parameters consistantly depict claypan shrublands. Species content is variable - some sites also contain Lignum (*Muehlenbeckia cunninghamii*) and Canegrass (*Eragrostis australasica*) which are typical of intermittently inundated areas.

Species	R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
	Cover/Abundance										
Carrichtera annua *	0	2	0	0	0	0	0	0	0.67	0.17	30
Goodenia fascicularis	0	1	1	0	0	0	0	0	0.67	1.40	22
Lycium australe	0	0	2	0	0	0	0	0	0.67	1.06	23
Maireana aphylla	0	0	0	0	2	0	0	0	0.67	11.00	6
Maireana pyramidata	0	0	0	2	0	0	0	0	0.67	0.08	31
Nitraria billardierei	0	0	0	0	2	0	0	0	0.67	4.41	13
Rhagodia spinescens	1	1	0	0	0	0	0	0	0.67	0.44	29
Atriplex vesicaria ssp.	0	0	0	0	1	0	0	0	0.33	0.00	26
Centipeda thespidioides	0	0	0	1	0	0	0	0	0.33	7.37	3
Chenopodium nitrariaceum	0	1	0	0	0	0	0	0	0.33	5.00	4
Convolvulus erubescens	0	0	1	0	0	0	0	0	0.33	3.39	7
Enchylaena tomentosa var. *tomentosa*	0	1	0	0	0	0	0	0	0.33	0.15	34
Eragrostis australasica	0	1	0	0	0	0	0	0	0.33	5.55	3
Eremophila maculata var. *maculata*	0	0	1	0	0	0	0	0	0.33	3.47	7
Frankenia serpyllifolia	0	1	0	0	0	0	0	0	0.33	3.06	4
Ixiolaena leptolepis/tomentosa	0	1	0	0	0	0	0	0	0.33	0.86	14
Maireana astrotricha	0	1	0	0	0	0	0	0	0.33	0.67	12
Maireana georgei/turbinata	0	1	0	0	0	0	0	0	0.33	0.00	26
Maireana sedifolia	0	1	0	0	0	0	0	0	0.33	0.04	30
Muehlenbeckia florulenta	0	0	0	0	1	0	0	0	0.33	5.55	3
Osteocarpum sp.	0	1	0	0	0	0	0	0	0.33	2.37	9
Oxalis perennans	0	1	0	0	0	0	0	0	0.33	0.05	27
Sclerolaena brachyptera	0	1	0	0	0	0	0	0	0.33	1.15	10
Sclerolaena divaricata	0	1	0	0	0	0	0	0	0.33	0.73	12
Sida intricata	0	1	0	0	0	0	0	0	0.33	1.77	10
Stipa sp.	0	0	0	1	0	0	0	0	0.33	0.01	30
Teucrium racemosum	0	1	0	0	0	0	0	0	0.33	4.13	6
Vittadinia cuneata var.	0	1	0	0	0	0	0	0	0.33	0.40	22

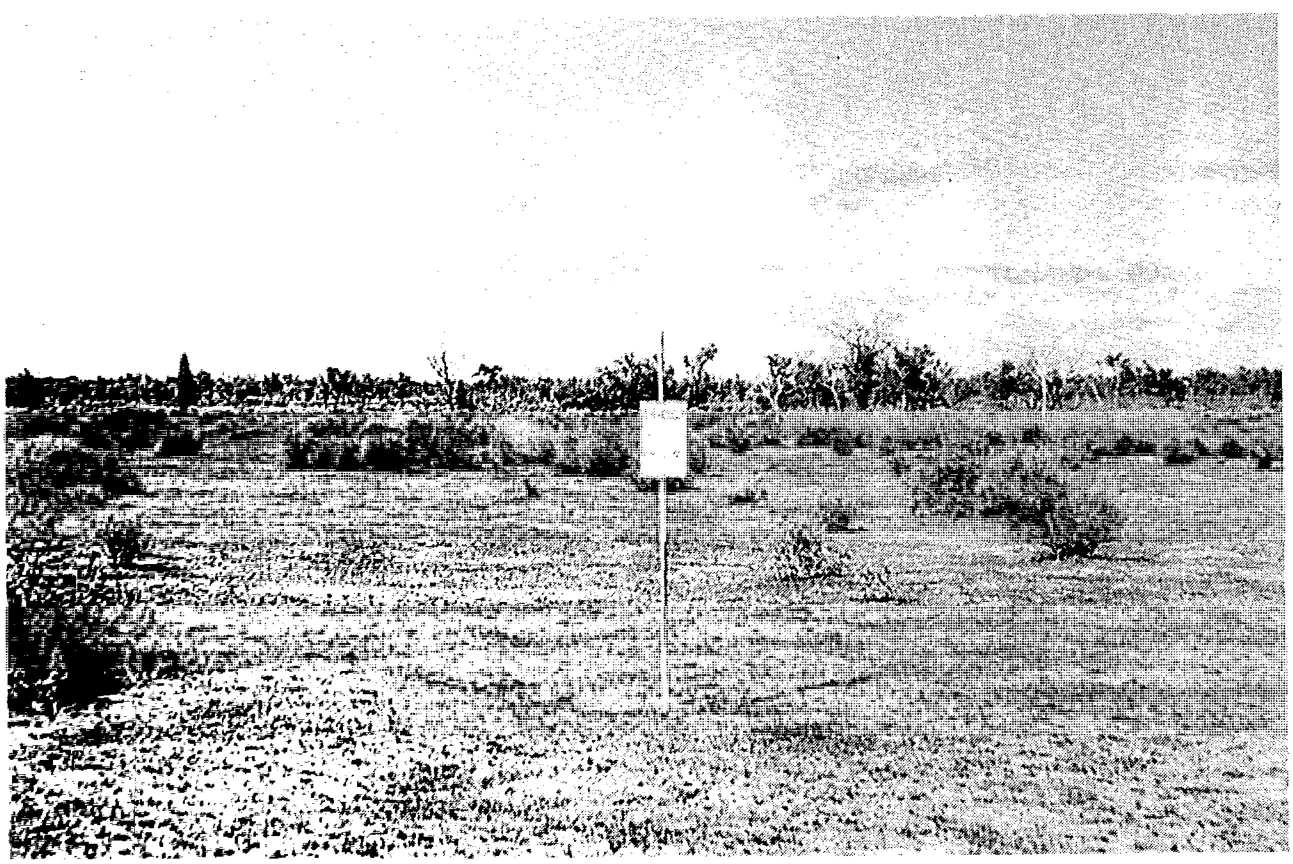
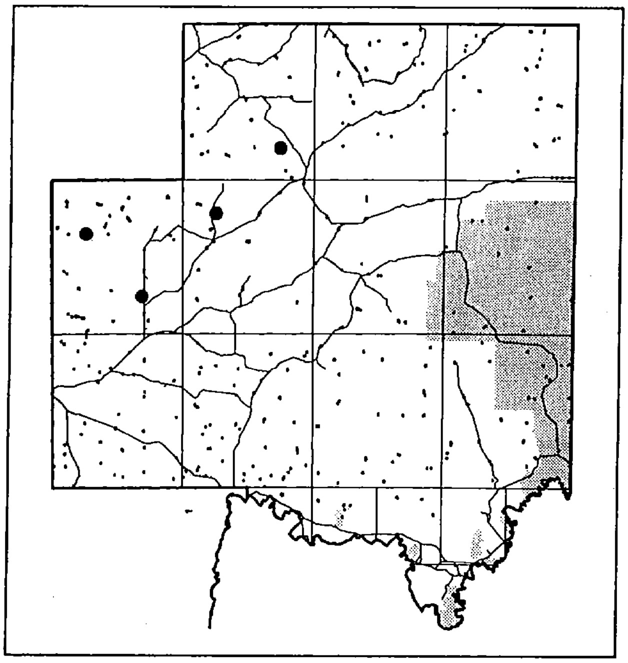


Figure 75
***Maireana aphylla / Nitraria billardierei* Low Open shrubland at quadrat OB0102**

ROCKY RIDGE/HILLTOP COMMUNITIES

Floristic Group 15. *Sida petrophila / Ptilotus obovatus* var. *obovatus* LOW OPEN SHRUBLAND

4 members



Dominant Overstorey Species:

Sida petrophila (Rock Sida)
Ptilotus obovatus var. *obovatus*
(Silver Mulla Mulla / Silver Tails)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Prostanthera striatiflora†
Cheilanthes lasiophylla
Oxalis perennans
Cheilanthes sieberi spp. *sieberi*†
Chenopodium curvispicatum

Average Number of Plant Species (&range):

37.7 (34 - 41)

Vegetation Condition:	Disturbed natural
Representative Quadrat(s):	HB0101 (Figure 76)

Structural Data:

Overstorey Lifeform	Shrubs < 1 m or 1 - 2 m
Overstorey Percent canopy (crown) Cover	1 - 30%
Average Overstorey Height (and range)	variable
Average Overstorey Canopy Diameter (and range)	variable
Average Overstorey Gap between canopies	variable

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Hills
Landform Elements	Ridges
Surface Soil Texture	Sandy loam to skeletal
Geological Surface Type	PNYP - Pualco Tillite
Surface Strew	Boulder and cobble 30 - 70%

Description:

A small group restricted to hilltops and ridges. Some sites have isolated trees.

Species	Cover/Abundance								Prop.	Chi	No.
	R	I	T	1	2	3	4	5	Occur.	Squ.	Gps
Cheilanthes lasiophylla	0	3	1	0	0	0	0	0	1.00	9.05	14
Enchylaena tomentosa var. *tomentosa*	0	2	2	0	0	0	0	0	1.00	0.20	34
Oxalis perennans	0	3	1	0	0	0	0	0	1.00	2.65	27
Ptilotus obovatus var. *obovatus*	0	0	1	1	2	0	0	0	1.00 .	2.71	23
Sida petrophila	0	2	0	2	0	0	0	0	1.00	6.12	16
Atriplex vesicaria ssp.	0	3	0	0	0	0	0	0	0.75	0.61	26
Carrichtera annua *	0	2	1	0	0	0	0	0	0.75	0.29	31
Cheilanthes sieberi ssp. *sieberi*	0	3	0	0	0	0	0	0	0.75	13.70	5
Chenopodium curvispicatum	0	3	0	0	0	0	0	0	0.75	1.46	21
Prostanthera striatiflora	0	0	3	0	0	0	0	0	0.75	14.29	4
Alectryon oleifolius ssp. *canescens*	1	1	0	0	0	0	0	0	0.50	0.08	30
Arabidella trisecta	0	1	0	1	0	0	0	0	0.50	1.83	16
Chrysocephalum semicalvum ssp. *semicalvum*	1	0	0	1	0	0	0	0	0.50	4.65	8
Daucus glochidiatus	0	0	1	1	0	0	0	0	0.50	0.42	23
Einadia nutans ssp.	0	2	0	0	0	0	0	0	0.50	0.46	23
Eremophila serrulata	1	1	0	0	0	0	0	0	0.50	4.61	5
Olearia decurrens	1	1	0	0	0	0	0	0	0.50	2.59	9
Paspalidium constrictum	0	1	1	0	0	0	0	0	0.50	9.65	5
Pleurosorus rutifolius	1	1	0	0	0	0	0	0	0.50	6.26	4
Rhagodia spinescens	2	0	0	0	0	0	0	0	0.50	0.13	29
Rhagodia ulicina	0	0	0	0	2	0	0	0	0.50	0.26	25
Rhyncharrhena linearis	0	2	0	0	0	0	0	0	0.50	5.85	8
Sclerolaena diacantha	0	0	2	0	0	0	0	0	0.50	0.17	26
Senecio anethifolius	1	0	1	0	0	0	0	0	0.50	12.93	2
Solanum ellipticum	0	0	1	0	1	0	0	0	0.50	2.73	11
Stipa scabra group	0	0	1	1	0	0	0	0	0.50	1.06	20
Stipa sp.	0	2	0	0	0	0	0	0	0.50	0.04	30
Wahlenbergia sp.	1	1	0	0	0	0	0	0	0.50	2.46	11

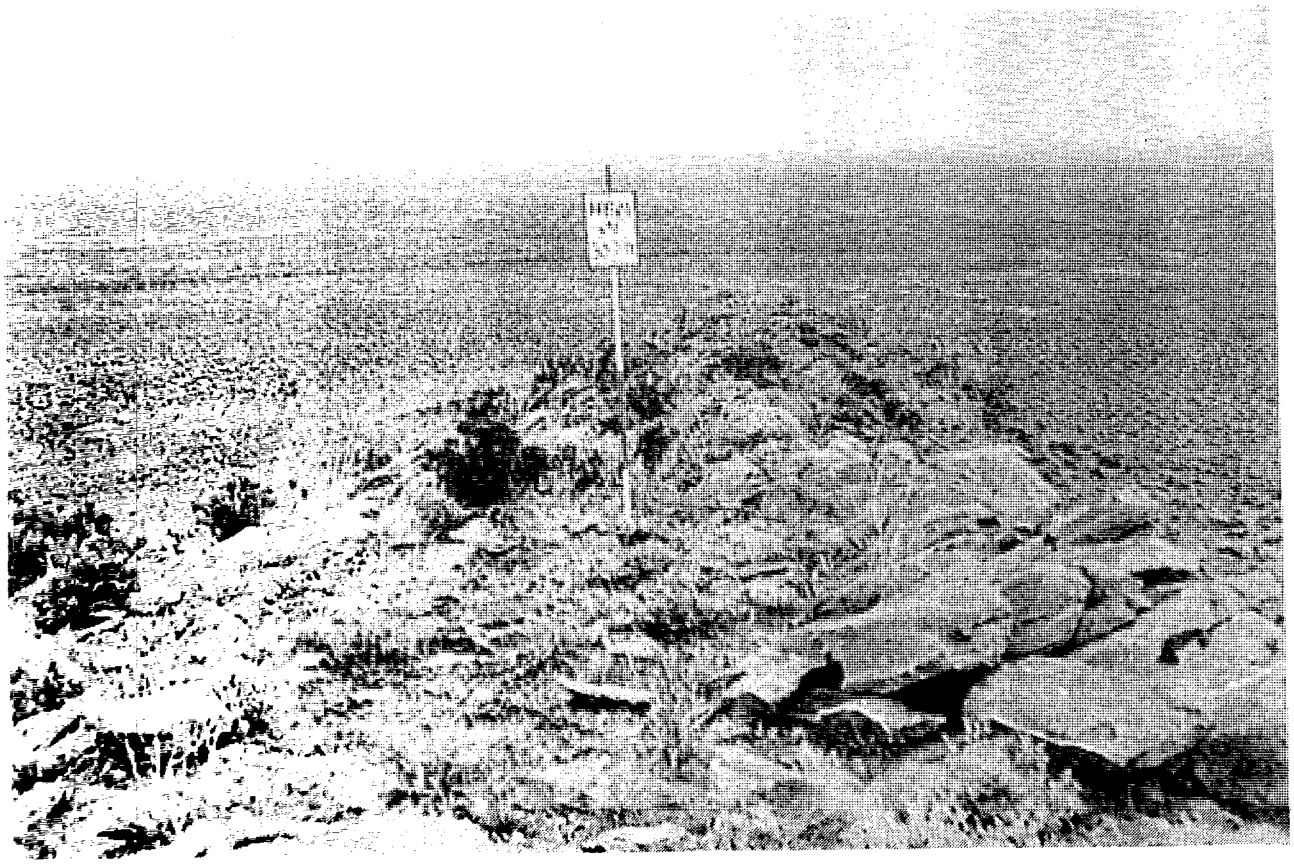
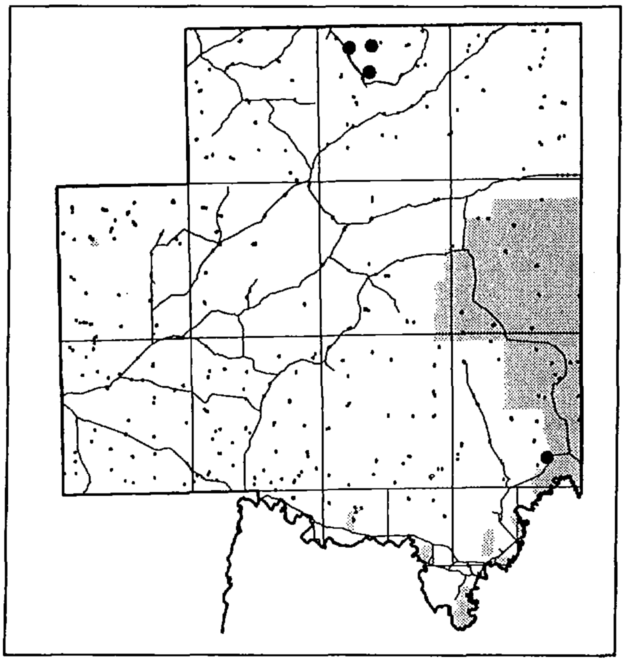


Figure 76
***Sida petrophila / Ptilotus obovatus* var. *obovatus* Low open shrubland at qudarat HB0101**

HERBLAND COMMUNITIES

Floristic Group 8. *Salvia verbenaca* OPEN HERBLAND

4 members



Dominant Overstorey (or Characteristic) Species:

Salvia verbenaca form* (Wild Sage)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Acacia victoriae spp. *victoriae*
Lavatera plebeia†
*Marrubium vulgare**
*Asphodelus fistulosus**
Eremophila sturtii

Average Number of Plant Species (&range):

35.0 (10 - 55)

Vegetation Condition:	Degraded natural to highly degraded
Representative Quadrat(s):	BN0202 (Figure 77.)

Structural Data:

Overstorey Lifeform	variable
Overstorey Percent canopy (crown) Cover	variable
Average Overstorey Height (and range)	n/a
Average Overstorey Canopy Diameter (and range)	n/a
Average Overstorey Gap between canopies	n/a

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	various
Landform Elements	various
Surface Soil Texture	various & clay loam
Geological Surface Type	various
Surface Strew	various

Description:

A variable group which is difficult to describe due to the low number of members (quadrats) but seems to occur in degraded areas. Characterised by a sparse to medium-dense herbaceous and grass stratum with a high weed content [i.e.Wild Sage, Horehound (*Marrubium vulgare*) & Onion Weed (*Asphodelus fistulosus*)] but may also have significant low or tall shrubs and/or isolated trees. Native 'increaser' species [i.e. Prickly Wattle (*Acacia victoriae)* and Turpentine (*Eremophila sturtii*)] are common.

Species	Cover/Abundance R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
Salvia verbenaca form*	0	0	0	1	2	1	0	0	1.00	5.82	18
Acacia victoriae ssp. *victoriae*	0	2	1	0	0	0	0	0	0.75	4.69	12
Asphodelus fistulosus *	0	2	1	0	0	0	0	0	0.75	2.51	19
Eremophila sturtii	1	2	0	0	0	0	0	0	0.75	2.16	20
Lavatera plebeia	1	1	1	0	0	0	0	0	0.75	14.13	3
Marrubium vulgare *	0	1	1	0	1	0	0	0	0.75	5.42	13
Atriplex acutibractea ssp. *acutibractea*	1	1	0	0	0	0	0	0	0.50	3.20	12
Convolvulus microsepalus/remotus	1	0	0	1	0	0	0	0	0.50	0.77	19
Cymbopogon ambiguus	0	1	1	0	0	0	0	0	0.50	5.44	4
Danthonia sp.	0	1	1	0	0	0	0	0	0.50	0.11	28
Einadia nutans ssp.	1	1	0	0	0	0	0	0	0.50	0.46	23
Enchylaena tomentosa var. *tomentosa*	0	2	0	0	0	0	0	0	0.50	0.03	34
Eriochiton sclerolaenoides	2	0	0	0	0	0	0	0	0.50	0.29	24
Maireana brevifolia	0	1	0	1	0	0	0	0	0.50	0.68	23
Maireana georgei/turbinata	0	2	0	0	0	0	0	0	0.50	0.13	26
Maireana pyramidata	1	1	0	0	0	0	0	0	0.50	0.00	31
Myoporum platycarpum ssp.	1	1	0	0	0	0	0	0	0.50	0.05	26
Rhagodia spinescens	0	2	0	0	0	0	0	0	0.50	0.13	29
Sclerolaena obliquicuspis	0	1	0	1	0	0	0	0	0.50	0.07	23
Senecio quadridentatus	2	0	0	0	0	0	0	0	0.50	1.89	10
Stipa sp.	0	1	0	0	1	0	0	0	0.50	0.04	30

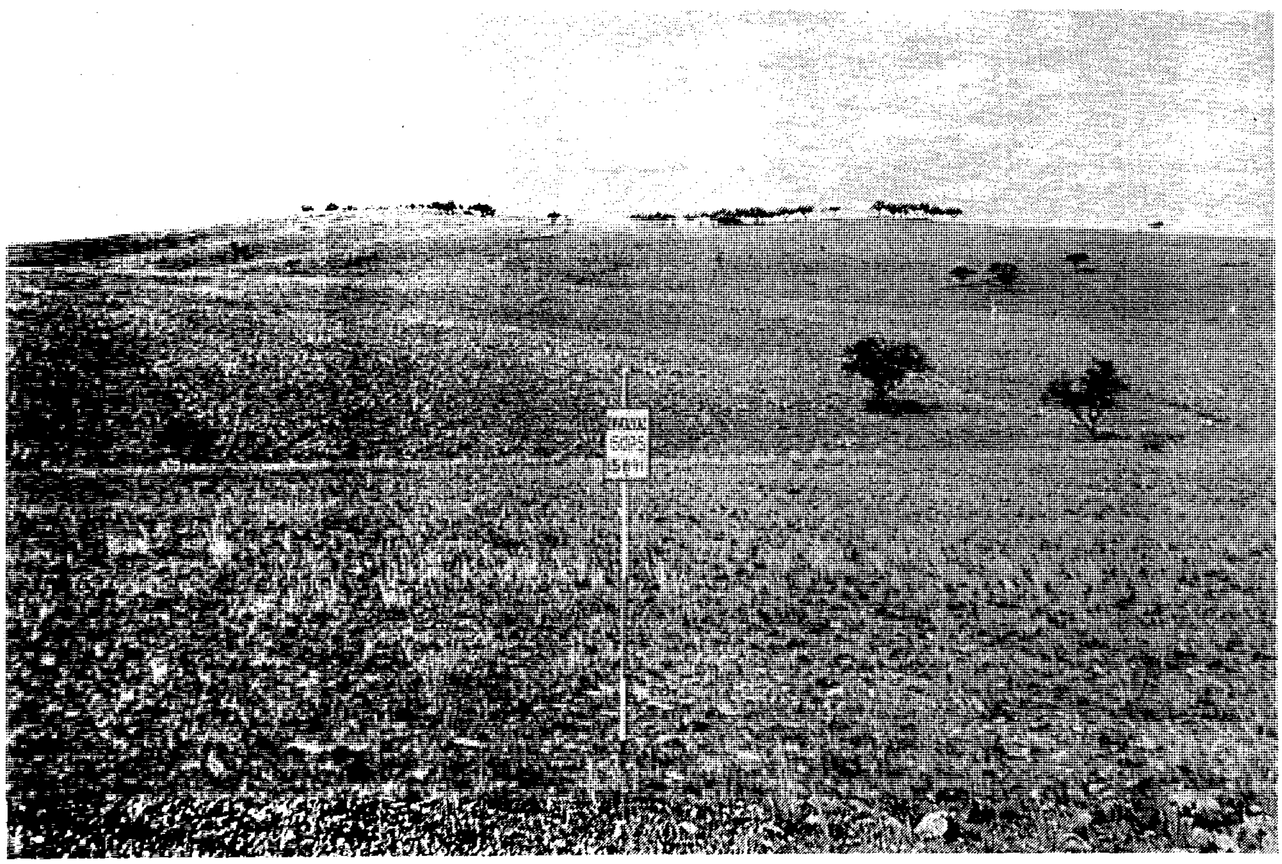
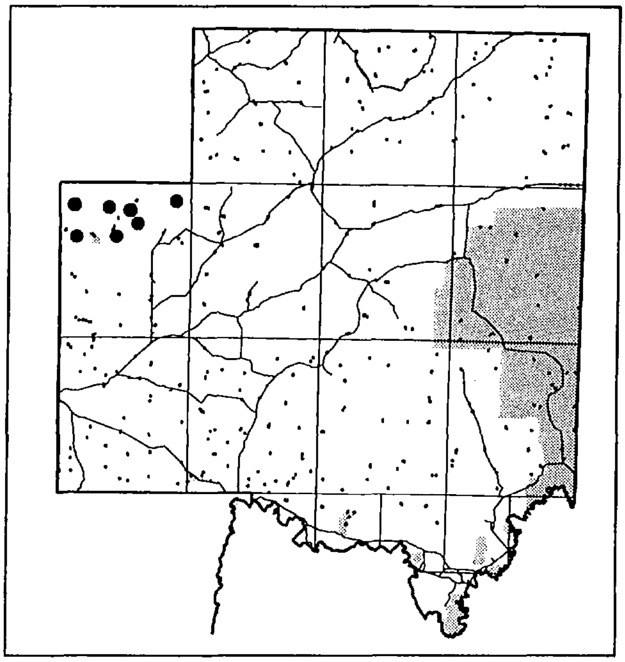


Figure 77
***Salvia verbenacea* form Open herbland at quadrat BN0202**

Floristic Group 25. *Asphodelus fistulosus* OPEN HERBLAND

9 members



Dominant Overstorey (or Characteristic) Species:

*Asphodelus fistulosus** (Onion Weed)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Danthonia sp.
Enchylaena tomentosa var. *tomentosa*

Average Number of Plant Species (&range):

28.5 (10 - 37)

Vegetation Condition: Degraded natural to highly degraded

Representative Quadrat(s): SE0203 (Figure 78)

Structural Data:

Overstorey Lifeform	variable
Overstorey Percent canopy (crown) Cover	variable
Average Overstorey Height (and range)	n/a
Average Overstorey Canopy Diameter (and range)	n/a
Average Overstorey Gap between canopies	n/a

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains and hills
Landform Elements	various
Surface Soil Texture	Sandy loam to silty clay loam
Geological Surface Type	PNFT - Tapley Hill Formation and various
Surface Strew	Pebbles 1 - 30%

Description:

A highly variable group restricted to degraded pastures in the western-north-western corner of the area. This group is virtually solely characterized by Onion Weed *(A. fistulosus)* with a variety of trees, shrubs and chenopods constituting sparse overstories. Not a quite true vegetation type - more a conglomeration of degraded 'other' vegetation types.

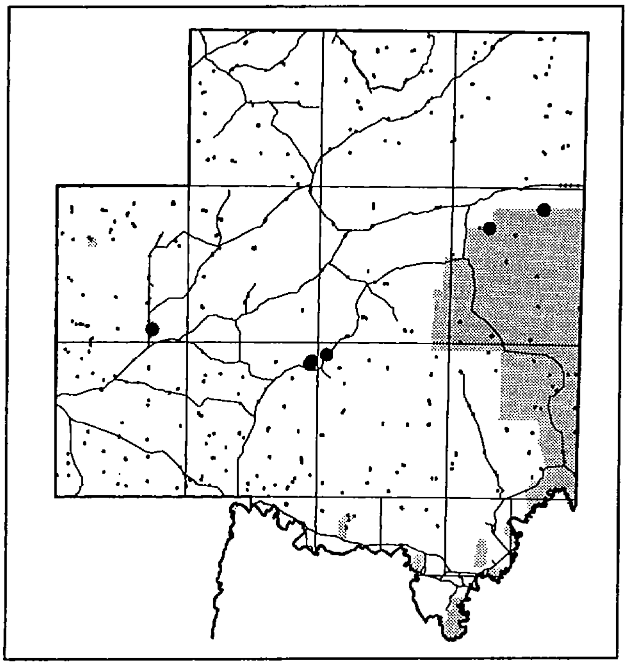
Species	Cover/Abundance								Prop.	Chi	No.
	R	I	T	1	2	3	4	5	Occur.	Squ.	Gps
Asphodelus fistulosus *	0	0	0	3	6	0	0	0	1.00	5.02	19
Danthonia sp.	0	3	1	1	0	0	0	0	0.56	0.19	28
Enchylaena tomentosa var. *tomentosa*	0	3	2	0	0	0	0	0	0.56	0.01	34
Maireana brevifolia	0	3	1	0	0	0	0	0	0.44	0.47	23
Oxalis perennans	0	2	2	0	0	0	0	0	0.44	0.21	27
Solanum petrophilum	0	2	2	0	0	0	0	0	0.44	1.65	14
Arabidella trisecta	0	1	2	0	0	0	0	0	0.33	0.64	16
Carrichtera annua *	0	0	1	0	1	1	0	0	0.33	0.01	31
Einadia nutans ssp.	0	1	2	0	0	0	0	0	0.33	0.09	23
Exocarpos aphyllus	1	2	0	0	0	0	0	0	0.33	0.08	24
Myoporum platycarpum ssp.	0	2	1	0	0	0	0	0	0.33	0.00	26
Pleurosorus rutifolius	0	2	1	0	0	0	0	0	0.33	2.58	4
Ptilotus obovatus var. *obovatus*	0	1	1	1	0	0	0	0	0.33	0.05	23
Sida petrophila	1	0	1	1	0	0	0	0	0.33	0.35	16
Stipa sp.	0	1	1	1	0	0	0	0	0.33	0.01	30
Wahlenbergia sp.	0	3	0	0	0	0	0	0	0.33	0.91	11

Figure 78
***Asphodelus fistulosus* Open herbland at quadrat SE0203**

MINOR WOODLAND COMMUNITIES

Floristic Group 11. *Casuarina pauper / Eucalyptus dumosa* LOW OPEN WOODLAND

6 members



Dominant Overstorey Species:

Casuarina pauper (Blackoak)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Eucalyptus dumosa†
Maireana sedifolia
Olearia pimeleoides spp. *pimeleoides*
Sclerolaena obliquicuspis
Chenopodium desertoruim spp.
Maireana pentatropis

Average Number of Plant Species (&range):

34.8 (22 - 55)

Vegetation Condition: Disturbed natural

Representative Quadrat(s): CN0302 (Figure 79)

Structural Data:

Overstorey Lifeform	Trees 5 - 10 m and/or Mallee trees
Overstorey Percent canopy (crown) Cover	1 - 10%
Average Overstorey Height (and range)	5.6 m (0.8 - 10)
Average Overstorey Canopy Diameter (and range)	3.3 m (0.8 - 5)
Average Overstorey Gap between canopies	14.5m (7 - 20)

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	various
Landform Elements	various
Surface Soil Texture	Sand - silty loam to sandy clay
Geological Surface Type	QP - Transitional sands and various
Surface Strew	various

Description:

A widely distributed, diverse group. Overstorey variable from none to Blackoak *(C. pauper)* and/or White Mallee *(E. dumosa)* and with a wide range of very sparse to shrubby understoreys.

Species	Cover/Abundance								Prop.	Chi	No.
	R	I	T	1	2	3	4	5	Occur.	Squ.	Gps
Maireana sedifolia	1	1	4	0	0	0	0	0	1.00	0.62	30
Casuarina pauper	1	2	1	0	1	0	0	0	0.83	1.88	23
Enchylaena tomentosa var. *tomentosa*	0	1	4	0	0	0	0	0	0.83	0.06	34
Olearia pimeleoides ssp. *pimeleoides*	0	2	3	0	0	0	0	0	0.83	3.08	18
Sclerolaena obliquicuspis	0	1	4	0	0	0	0	0	0.83	0.71	23
Alectryon oleifolius ssp. *canescens*	1	1	2	0	0	0	0	0	0.67	0.32	30
Chenopodium curvispicatum	0	1	3	0	0	0	0	0	0.67	1.05	21
Chenopodium desertorum ssp.	0	0	4	0	0	0	0	0	0.67	3.96	16
Dodonaea viscosa ssp. *angustissima*	0	1	3	0	0	0	0	0	0.67	1.18	20
Exocarpos aphyllus	2	0	2	0	0	0	0	0	0.67	1.03	24
Maireana georgei/turbinata	0	2	2	0	0	0	0	0	0.67	0.43	26
Maireana pentatropis	0	1	3	0	0	0	0	0	0.67	1.54	20
Acacia colletioides	0	1	2	0	0	0	0	0	0.50	0.92	16
Atriplex vesicaria ssp.	0	0	3	0	0	0	0	0	0.50	0.11	26
Danthonia sp.	0	0	3	0	0	0	0	0	0.50	0.11	28
Einadia nutans ssp.	2	0	1	0	0	0	0	0	0.50	0.46	23
Eremophila sturtii	0	1	2	0	0	0	0	0	0.50	0.72	20
Eriochiton sclerolaenoides	0	2	1	0	0	0	0	0	0.50	0.29	24
Eucalyptus dumosa	0	0	1	2	0	0	0	0	0.50	1.92	11
Ptilotus obovatus var. *obovatus*	0	0	2	1	0	0	0	0	0.50	0.35	23
Rhagodia ulicina	0	0	3	0	0	0	0	0	0.50	0.26	25
Senna artemisioides nothossp. *coriacea*	0	2	1	0	0	0	0	0	0.50	0.60	20
Senna artemisioides ssp. *petiolaris*	0	1	2	0	0	0	0	0	0.50	0.67	18
Acacia burkittii	0	0	2	0	0	0	0	0	0.33	1.38	9
Acacia nyssophylla	0	2	0	0	0	0	0	0	0.33	0.30	18
Atriplex stipitata	0	0	2	0	0	0	0	0	0.33	0.08	23
Daucus glochidiatus	0	1	1	0	0	0	0	0	0.33	0.08	23
Eremophila glabra ssp.	0	1	1	0	0	0	0	0	0.33	0.29	16
Eremophila scoparia	0	0	2	0	0	0	0	0	0.33	0.55	15
Eucalyptus gracilis	0	1	1	0	0	0	0	0	0.33	0.18	22
Grevillea huegelii	0	1	1	0	0	0	0	0	0.33	0.38	13
Lycium australe	0	0	2	0	0	0	0	0	0.33	0.08	23
Maireana brevifolia	0	0	2	0	0	0	0	0	0.33	0.17	23
Maireana erioclada	0	0	2	0	0	0	0	0	0.33	0.55	18
Maireana triptera	0	2	0	0	0	0	0	0	0.33	3.58	7
Myoporum platycarpum ssp.	1	0	1	0	0	0	0	0	0.33	0.00	26
Olearia muelleri	1	0	1	0	0	0	0	0	0.33	0.24	13
Sclerolaena diacantha	0	0	2	0	0	0	0	0	0.33	0.01	26
Zygophyllum apiculatum	0	2	0	0	0	0	0	0	0.33	0.26	17
Zygophyllum billardierei	1	0	1	0	0	0	0	0	0.33	0.79	16

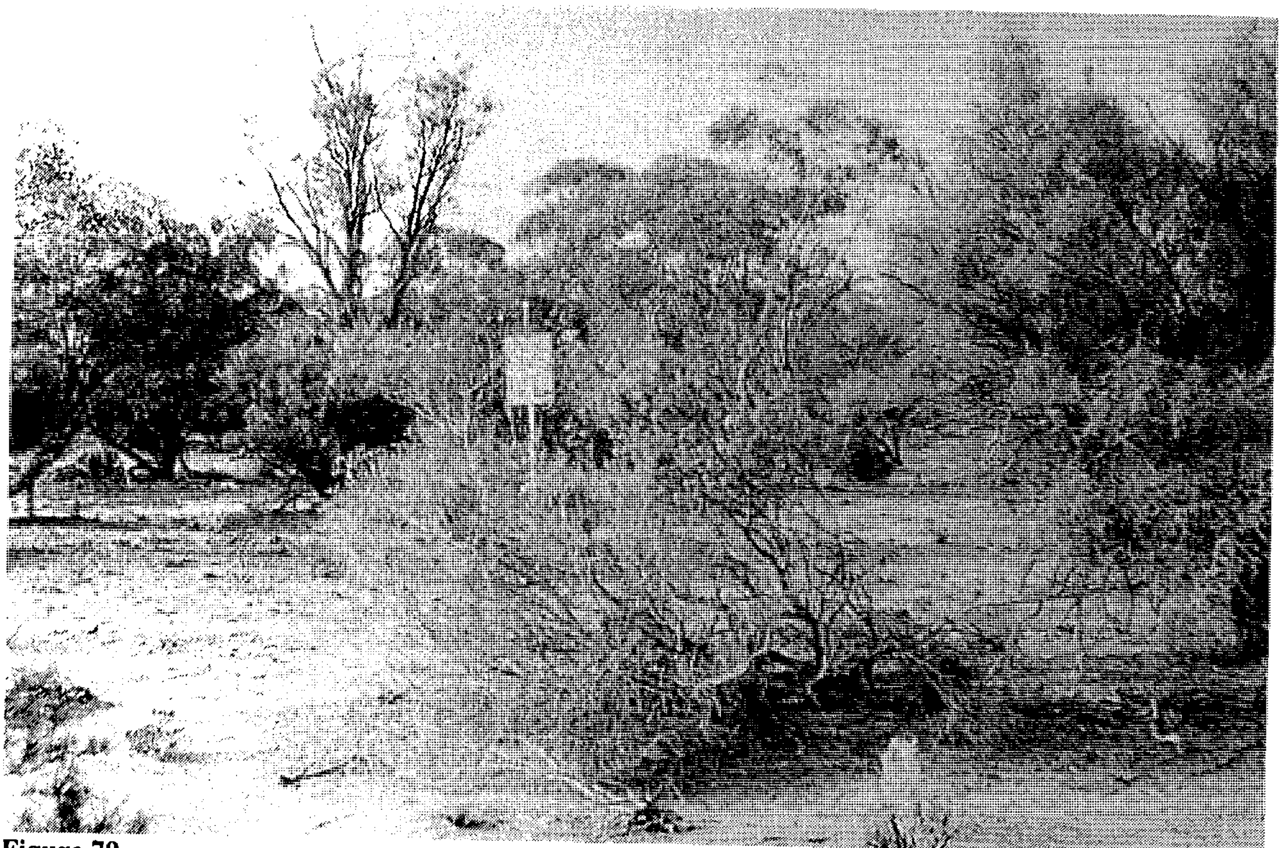
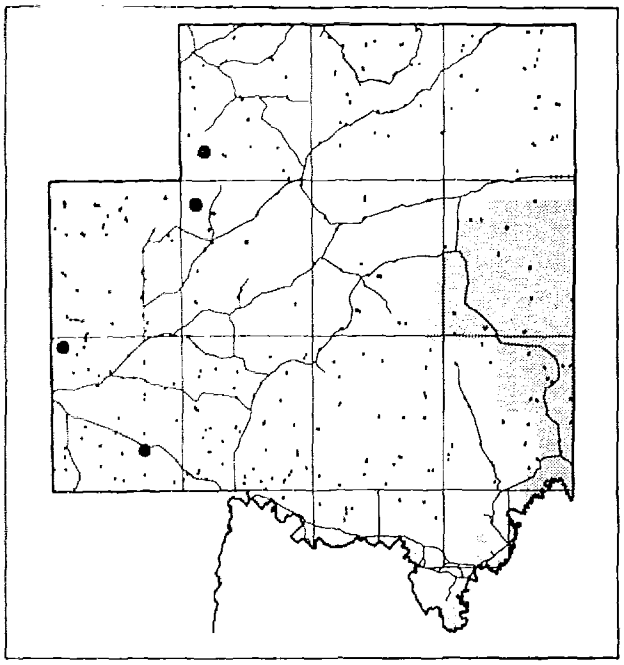


Figure 79
Casuarina pauper* / *Eucalyptus dumosa **Low open woodland at quadrat CN0302**

Figure 80
Eucalyptus porosa **Open tree mallee at quadrat BR0201**

Floristic Group 23. *Eucalyptus porosa* OPEN TREE MALLEE

5 members



Dominant Overstorey Species:

Eucalyptus porosa† (Mallee Box)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Rhagodia parabolica
Enchylaena tomentosa var. *tomentosa*
Cassinia laevis†
Olearia decurrens†
Chrysocephalum semipapposum†
Solanum petrophilum

Average Number of Plant Species (&range):

36.1 (13 - 50)

Vegetation Condition: Disturbed natural

Representative Quadrat(s): BR0102 (Figure 80)

Structural Data:

Overstorey Lifeform	Mallee trees
Overstorey Percent canopy (crown) Cover	5 - 30%
Average Overstorey Height (and range)	5.7 m (2 - 10)
Average Overstorey Canopy Diameter (and range)	3.8 m (1.5 - 6)
Average Overstorey Gap between canopies	8.4 m (2 - 20)

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Hills
Landform Elements	Hillslopes, ridge
Surface Soil Texture	Sandy loam and various
Geological Surface Type	various
Surface Strew	various

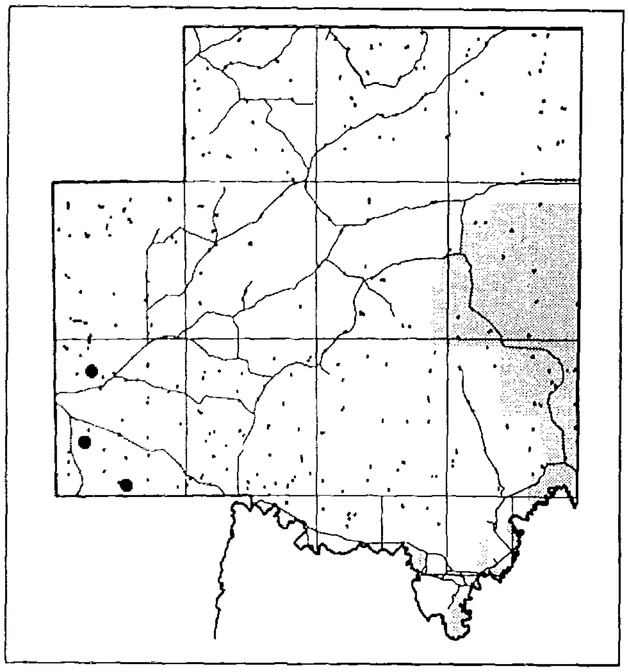
Description:

A small group scattered throughout the western edge of the area on hills. Overstorey consistent but understorey variable.

Species	Cover/Abundance R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
Enchylaena tomentosa var. *tomentosa*	0	1	3	1	0	0	0	0	1.00	0.20	34
Eucalyptus porosa	0	0	0	0	4	1	0	0	1.00	14.99	8
Rhagodia parabolica	0	0	2	1	1	0	0	0	0.80	2.11	23
Atriplex stipitata	0	2	1	0	0	0	0	0	0.60	0.75	23
Cassinia laevis	0	0	1	1	1	0	0	0	0.60	7.63	9
Chrysocephalum semipapposum	0	0	2	0	1	0	0	0	0.60	4.26	6
Danthonia sp.	0	0	3	0	0	0	0	0	0.60	0.26	28
Dodonaea viscosa ssp. *angustissima*	0	1	1	1	0	0	0	0	0.60	0.87	20
Einadia nutans ssp.	0	1	2	0	0	0	0	0	0.60	0.81	23
Maireana pyramidata	1	0	1	0	1	0	0	0	0.60	0.03	31
Olearia decurrens	0	0	3	0	0	0	0	0	0.60	3.94	9
Oxalis perennans	0	0	2	0	1	0	0	0	0.60	0.62	27
Ptilotus obovatus var. *obovatus*	0	1	1	0	0	1	0	0	0.60	0.64	23
Sclerolaena diacantha	0	1	2	0	0	0	0	0	0.60	0.36	26
Solanum petrophilum	0	1	2	0	0	0	0	0	0.60	3.37	14
Stipa sp.	0	0	2	1	0	0	0	0	0.60	0.13	30
Abutilon fraseri	0	0	2	0	0	0	0	0	0.40	2.30	9
Alectryon oleifolius ssp. *canescens*	1	0	1	0	0	0	0	0	0.40	0.01	30
Bursaria spinosa	1	1	0	0	0	0	0	0	0.40	4.41	3
Carrichtera annua *	0	1	1	0	0	0	0	0	0.40	0.00	31
Cheilanthes lasiophylla	0	1	1	0	0	0	0	0	0.40	1.04	14
Chenopodium curvispicatum	0	0	2	0	0	0	0	0	0.40	0.19	21
Chrysocephalum semicalvum ssp. *semica*lvum	0	1	1	0	0	0	0	0	0.40	2.83	8
Dodonaea lobulata	0	0	1	0	1	0	0	0	0.40	1.71	10
Eremophila serrulata	0	0	1	1	0	0	0	0	0.40	2.81	5
Lomandra multiflora ssp. *dura*	1	0	1	0	0	0	0	0	0.40	12.81	1
Lycium ferocissimum *	0	1	1	0	0	0	0	0	0.40	2.31	12
Maireana sedifolia	0	1	1	0	0	0	0	0	0.40	0.01	30
Pittosporum phylliraeoides var. *microcarp*a	1	1	0	0	0	0	0	0	0.40	2.18	14
Sida petrophila	0	0	2	0	0	0	0	0	0.40	0.60	16
Solanum ellipticum	0	1	1	0	0	0	0	0	0.40	1.61	11
Spyridium phlebophyllum	1	0	1	0	0	0	0	0	0.40	12.81	1
Triodia irritans complex	0	0	2	0	0	0	0	0	0.40	0.91	10
Vittadinia cuneata var.	0	0	2	0	0	0	0	0	0.40	0.68	22

Floristic Group 21. *Eucalyptus brachycalyx* OPEN TREE MALLEE

3 members



Dominant Overstorey Species:

Eucalyptus brachycalyx† (Gilga)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

*Carrichtera annua**
Enchylaena tomentosa var. *tomentosa*
Rhagodia ulicina
Eremophila scoparia

Average Number of Plant Species (&range):

16.6 (16 - 18)

Vegetation Condition: various

Representative Quadrat(s): LG0101 (Figure 81

Structural Data:

Overstorey Lifeform	Mallee trees
Overstorey Percent canopy (crown) Cover	10 - 30%
Average Overstorey Height (and range)	6.0 m (6 - 6)
Average Overstorey Canopy Diameter (and range)	4.3 m (4 - 5)
Average Overstorey Gap between canopies	3.7 m (3 - 4)

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	various
Landform Elements	various
Surface Soil Texture	various
Geological Surface Type	various
Surface Strew	various

Description:

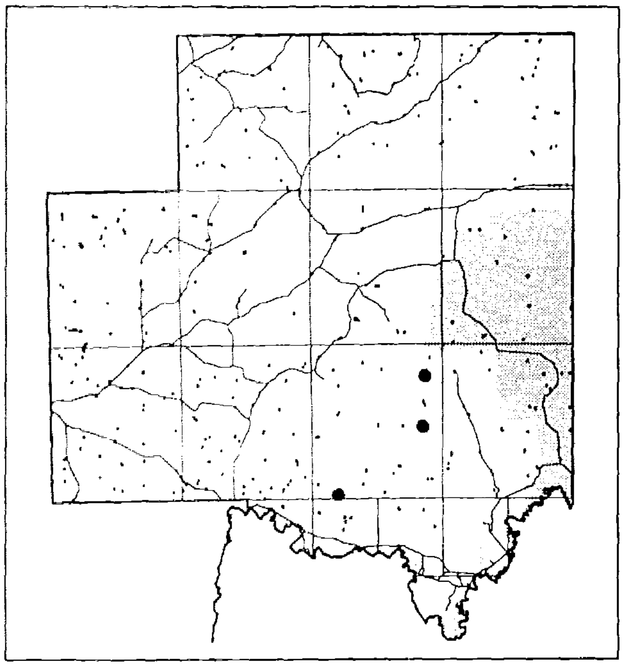
A small but true group occurring in the south-western corner of the survey area, just on the edge of the southern Burra Hills. Understorey comprises variable low shrub species, generally of low cover/abundance.

Species	R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
	Cover/Abundance										
Carrichtera annua *	1	1	1	0	0	0	0	0	1.00	0.87	31
Enchylaena tomentosa var. *tomentosa*	0	3	0	0	0	0	0	0	1.00	0.20	34
Eucalyptus brachycalyx	0	0	0	0	3	0	0	0	1.00	27.89	3
Eremophila scoparia	1	1	0	0	0	0	0	0	0.67	3.22	15
Maireana pyramidata	1	1	0	0	0	0	0	0	0.67	0.08	31
Maireana sedifolia	2	0	0	0	0	0	0	0	0.67	0.09	30
Rhagodia ulicina	1	0	1	0	0	0	0	0	0.67	0.72	25
Stipa sp.	0	2	0	0	0	0	0	0	0.67	0.22	20
Atriplex vesicaria ssp.	0	0	0	0	1	0	0	0	0.33	0.00	26
Einadia nutans ssp.	0	1	0	0	0	0	0	0	0.33	0.09	23
Eucalyptus oleosa	0	1	0	0	0	0	0	0	0.33	0.25	16
Exocarpos aphyllus	0	1	0	0	0	0	0	0	0.33	0.08	24
Grevillea huegelii	0	1	0	0	0	0	0	0	0.33	0.38	13
Maireana brevifolia	0	1	0	0	0	0	0	0	0.33	0.17	23
Maireana erioclada	0	1	0	0	0	0	0	0	0.33	0.55	18
Maireana trichoptera	0	1	0	0	0	0	0	0	0.33	0.11	22
Olearia pimeleoides ssp. *pimeleoides*	0	1	0	0	0	0	0	0	0.33	0.22	18
Senecio lautus	0	1	0	0	0	0	0	0	0.33	4.74	4
Westringia rigida	0	1	0	0	0	0	0	0	0.33	0.86	11
Zygophyllum apiculatum	0	0	1	0	0	0	0	0	0.33	0.26	17
Zygophyllum aurantiacum	0	0	0	0	1	0	0	0	0.33	0.13	19
Zygophyllum billardierei	0	1	0	0	0	0	0	0	0.33	0.79	16

Figure 81
***Eucalyptus brachycalyx* Open tree mallee at quadrat LG0101**

Floristic Group 13. *Eucalyptus oleosa* VERY OPEN TREE MALLEE

3 members



Dominant Overstorey Species:

Eucalyptus oleosa (Red Mallee)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Myoporum platycarpum ssp.
Olearia muelleri
Eremophila glabra ssp.
Zygophyllum apiculatum
Zyophyllum aurantiacum

Average Number of Plant Species (&range):

17.5 (14 - 23)

Vegetation Condition:	Degraded natural
Representative Quadrat(s):	TV0701 (Figure 82)

Structural Data:

Overstorey Lifeform	Mallee trees (or shrubs < 1 m)
Overstorey Percent canopy (crown) Cover	1 - 10%
Average Overstorey Height (and range)	variable
Average Overstorey Canopy Diameter (and range)	variable
Average Overstorey Gap between canopies	variable

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	various
Landform Elements	various
Surface Soil Texture	Sandy to sandy clay
Geological Surface Type	QPO - Woorinen Formation
Surface Strew	various

Description:

A small group occuring in the central south region of the survey area. May sometimes have no overstorey, just shrubs. All species are of very low cover/abundance. May just be a modified or degraded form of Group 2.

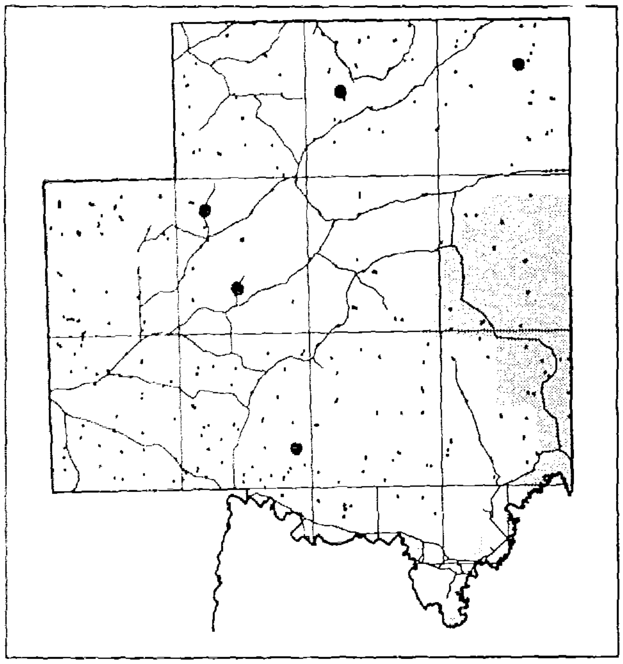
Species	Cover/Abundance R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
Eucalyptus oleosa	0	2	1	0	0	0	0	0	1.00	5.12	16
Myoporum platycarpum ssp.	2	0	1	0	0	0	0	0	1.00	1.08	26
Olearia muelleri	2	0	1	0	0	0	0	0	1.00	4.96	13
Eremophila glabra ssp.	1	0	1	0	0	0	0	0	0.67	2.10	16
Zygophyllum apiculatum	0	1	1	0	0	0	0	0	0.67	1.94	17
Zygophyllum aurantiacum	0	1	1	0	0	0	0	0	0.67	1.33	19
Acacia colletioides	0	1	0	0	0	0	0	0	0.33	0.26	16
Acacia nyssophylla	0	1	0	0	0	0	0	0	0.33	0.30	18
Alectryon oleifolius ssp. *canescens*	1	0	0	0	0	0	0	0	0.33	0.00	30
Casuarina pauper	1	0	0	0	0	0	0	0	0.33	0.08	23
Chenopodium desertorum ssp.	1	0	0	0	0	0	0	0	0.33	0.72	16
Daviesia benthamii ssp.	0	1	0	0	0	0	0	0	0.33	1.86	8
Dodonaea stenozyga	0	0	1	0	0	0	0	0	0.33	6.72	5
Enchylaena tomentosa var. *tomentosa*	1	0	0	0	0	0	0	0	0.33	0.15	34
Eucalyptus dumosa	0	1	0	0	0	0	0	0	0.33	0.68	11
Eucalyptus gracilis	0	0	1	0	0	0	0	0	0.33	0.18	22
Maireana georgei/turbinata	1	0	0	0	0	0	0	0	0.33	0.00	26
Maireana pentatropis	0	0	1	0	0	0	0	0	0.33	0.17	20
Rhagodia spinescens	0	1	0	0	0	0	0	0	0.33	0.00	29
Rhagodia ulicina	0	0	1	0	0	0	0	0	0.33	0.03	25
Scaevola spinescens	1	0	0	0	0	0	0	0	0.33	1.16	14
Sclerolaena diacantha	0	1	0	0	0	0	0	0	0.33	0.01	26
Senna artemisioides nothossp. *coriacea*	0	0	1	0	0	0	0	0	0.33	0.14	20
Senna artemisioides ssp. *petiolaris*	1	0	0	0	0	0	0	0	0.33	0.17	18
Stipa sp.	0	0	1	0	0	0	0	0	0.33	0.01	30
Triodia irritans complex	0	1	0	0	0	0	0	0	0.33	0.55	10

Figure 82
***Eucalyptus oleosa* Very open tree mallee at quadrat TV0701**

MINOR CHENOPOD COMMUNITIES

Floristic Group 7. *Maireana trichoptera* LOW OPEN SHRUBLAND

5 Members



Dominant Overstorey (or Characteristic) Species:

Maireana trichoptera (Mallee Bluebush)

Sub-dominant Overstorey (or Indicator† and Dominant Understorey Species:

Maireana sedifolia
Sclerolaena patenticuspis
Atriplex spp.
Eriochiton scleroleanoides

Average Number of Plant Species (&range):

35.9 (22 - 46)

Vegetation Condition:	Disturbed natural
Representative Quadrat(s):	BRO204 (Figure 83)

Structural Data:

Overstorey Lifeform	Shrubs < 1 m (or mallee trees)
Overstorey Percent canopy (crown) Cover	5 - 30% (1 - 5%)
Average Overstorey Height (and range)	n/a
Average Overstorey Canopy Diameter (and range)	n/a
Average Overstorey Gap between canopies	n/a

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains
Landform Elements	Plains
Surface Soil Texture	Sandy loam to loam
Geological Surface Type	various
Surface Strew	various

Description:

A very small, widely distributed group, predominantly of very low shrubs but sometimes with isolated trees and larger shrubs.

Species	Cover/Abundance R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
Maireana sedifolia	1	3	1	0	0	0	0	0	1.00	0.62	30
Maireana trichoptera	0	0	1	0	4	0	0	0	1.00	3.54	22
Sclerolaena obliquicuspis	0	0	2	2	0	0	0	0	0.80	0.62	23
Atriplex vesicaria ssp.	0	0	2	0	1	0	0	0	0.60	0.26	26
Carrichtera annua *	0	1	1	1	0	0	0	0	0.60	0.09	31
Enchylaena tomentosa var. *tomentosa*	0	1	2	0	0	0	0	0	0.60	0.00	34
Eriochiton sclerolaenoides	0	1	0	0	2	0	0	0	0.60	0.55	24
Maireana georgei/turbinata	0	2	1	0	0	0	0	0	0.60	0.29	26
Maireana pyramidata	1	2	0	0	0	0	0	0	0.60	0.03	31
Myoporum platycarpum ssp.	1	1	1	0	0	0	0	0	0.60	0.14	26
Acacia nyssophylla	0	0	0	1	1	0	0	0	0.40	0.53	18
Atriplex stipitata	0	1	1	0	0	0	0	0	0.40	0.18	23
Danthonia sp.	0	0	1	0	0	1	0	0	0.40	0.02	28
Dissocarpus paradoxus	0	1	0	0	1	0	0	0	0.40	0.45	23
Eucalyptus gracilis	0	1	1	0	0	0	0	0	0.40	0.35	22
Exocarpos aphyllus	0	2	0	0	0	0	0	0	0.40	0.18	24
Grevillea huegelii	0	1	1	0	0	0	0	0	0.40	0.65	13
Ptilotus obovatus var. *obovatus*	1	1	0	0	0	0	0	0	0.40	0.14	23
Rhagodia spinescens	0	2	0	0	0	0	0	0	0.40	0.03	29
Rhagodia ulicina	0	0	2	0	0	0	0	0	0.40	0.10	25
Scaevola spinescens	1	0	1	0	0	0	0	0	0.40	1.80	14
Sclerolaena patenticuspis	0	0	1	1	0	0	0	0	0.40	0.38	21
Senna artemisioides ssp. *petiolaris*	1	1	0	0	0	0	0	0	0.40	0.33	18
Stipa scabra group	0	0	0	1	0	1	0	0	0.40	0.56	20
Stipa sp.	0	1	1	0	0	0	0	0	0.40	0.00	30

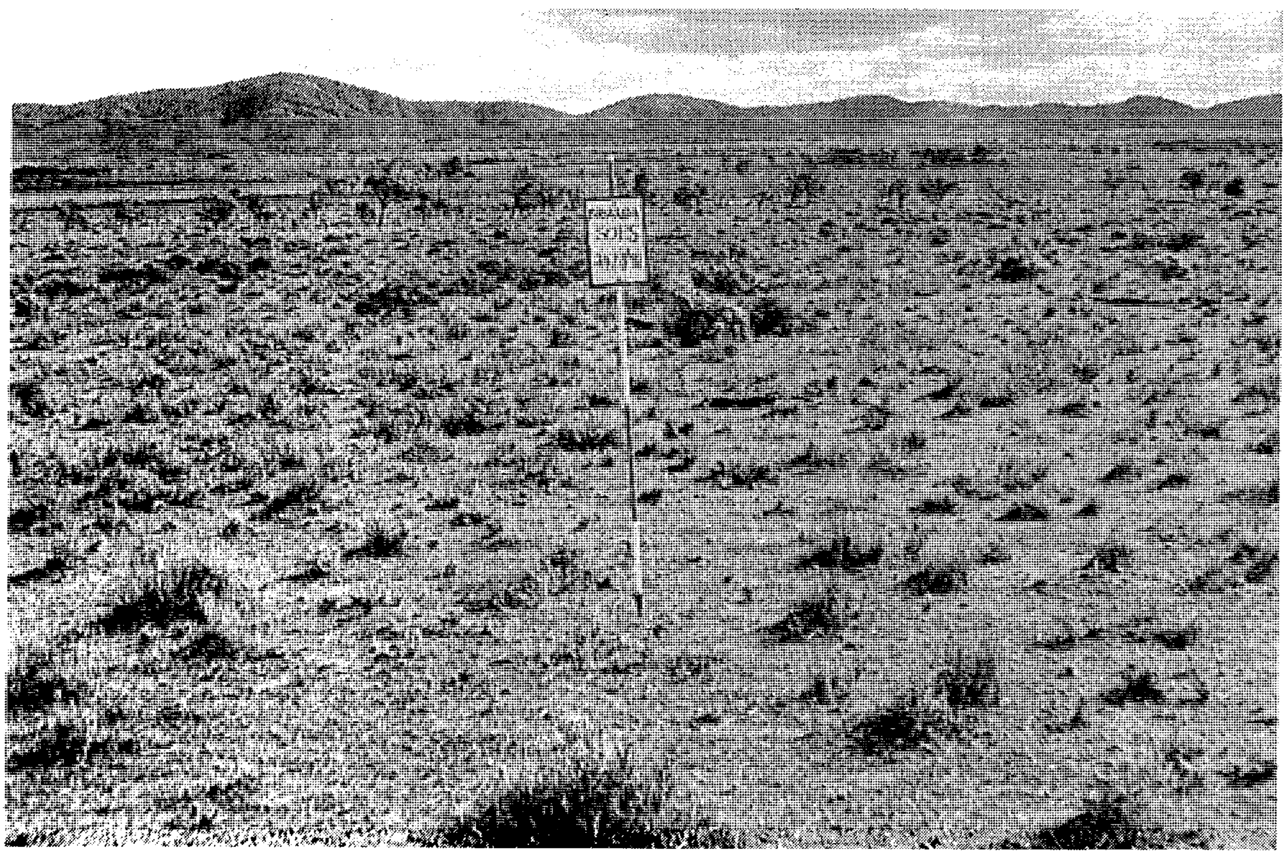
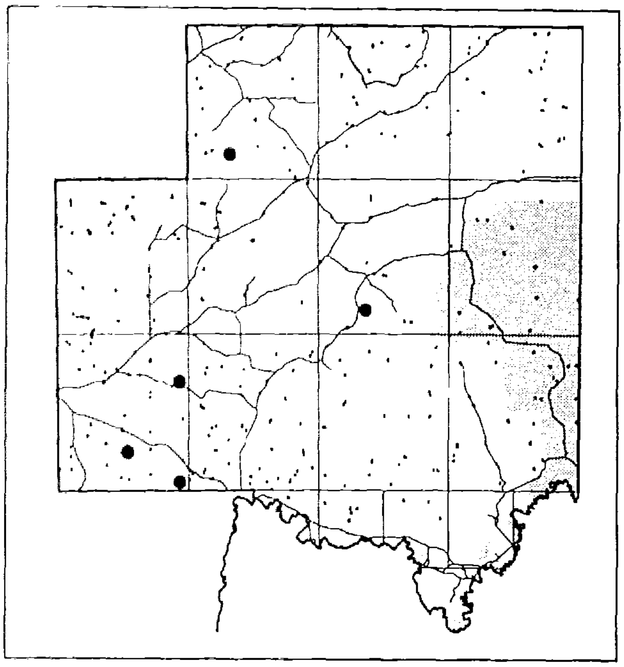


Figure 83
***Maireana trichoptera* Low open shrubland at quadrat BR0204**

Floristic Group 16. *Rhagodia ulicina / Maireana sedifolia* LOW OPEN SHRUBLAND

5 members



Dominant Overstorey Species:

Rhagodia ulicina (Intricate Saltbush)
Maireana sedifolia (Pearl Bluebush)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Alectryon oleifolius spp. *canescens*
Daucus glochidiatus
*Carrichtera annua**
Lycium australe
Maireana pyramidata

Average Number of Plant Species (&range):

25.0 (15 - 42)

Vegetation Condition: Disturbed to degraded natural

Representative Quadrat(s): SD0301 (Figure 84

Structural Data:

Overstorey Lifeform	Shrubs < 1 m (or trees 5 - 10 m)
Overstorey Percent canopy (crown) Cover	15 - 40% (5 - 30%)
Average Overstorey Height (and range)	n/a
Average Overstorey Canopy Diameter (and range)	n/a
Average Overstorey Gap between canopies	n/a

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains
Landform Elements	Plains
Surface Soil Texture	Sandy loam
Geological Surface Type	various
Surface Strew	Pebbles < 10%

Description:

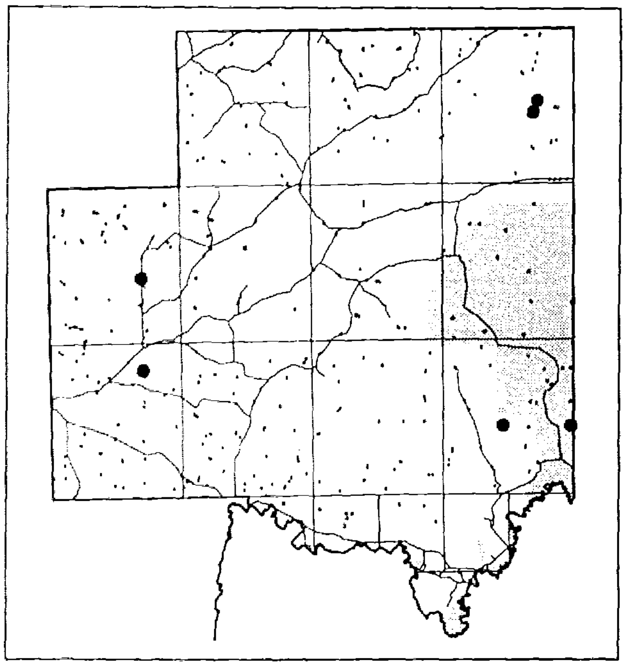
A scattered, small group which appears to occur in degraded areas. The presence of three unpalatable species [*R. ulicina* (Intricate Saltbush), *L. australe* (Australian Boxthorn) and *M. pyramidata* (Black Bluebush)] and one weed (*C. annua* - Wards Weed) suggests this is a damaged chenopod shrubland but not too severely damaged as the palatable *M. sedifolia* (Pearl Bluebush) is still present. Isolated trees are also common.

Species	Cover/Abundance								Prop.	Chi	No.
	R	I	T	1	2	3	4	5	Occur.	Squ.	Gps
Daucus glochidiatus	0	1	2	0	2	0	0	0	1.00	3.07	23
Maireana sedifolia	0	0	1	1	0	3	0	0	1.00	0.62	30
Rhagodia ulicina	0	0	0	0	5	0	0	0	1.00	2.31	25
Alectryon oleifolius ssp. *canescens*	1	1	1	0	1	0	0	0	0.80	0.64	30
Carrichtera annua *	0	2	0	1	0	0	1	0	0.80	0.38	31
Enchylaena tomentosa var. *tomentosa*	0	1	2	0	0	0	0	0	0.60	0.00	34
Lycium australe	0	0	0	0	3	0	0	0	0.60	0.78	23
Maireana pyramidata	0	0	0	1	2	0	0	0	0.60	0.03	31
Stipa sp.	0	3	0	0	0	0	0	0	0.60	0.13	30
Acacia nyssophylla	0	2	0	0	0	0	0	0	0.40	0.53	18
Casuarina pauper	0	0	1	0	1	0	0	0	0.40	0.18	23
Eremophila sturtii	0	2	0	0	0	0	0	0	0.40	0.36	20
Lysiana exocarpi ssp. *exocarpi*	1	1	0	0	0	0	0	0	0.40	0.78	15
Myoporum platycarpum ssp.	1	0	0	0	1	0	0	0	0.40	0.00	26

Figure 84
***Rhagodia ulicina* / *Maireana sedifolia* Low open shrubland at quadrat SD0301**

Floristic Group 26. *Sclerolaena obliquiscuspis* LOW OPEN SHRUBLAND

6 members



Dominant Overstorey Species:

Sclerolaena obliquicuspis
(Oblique-spined Bindyi / Limestone Copperburr)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

various

Average Number of Plant Species (&range):

22.8 (5 - 32)

Vegetation Condition: Degraded natural to highly degraded

Representative Quadrat(s): PA0102 (Figure 85)

Structural Data:

Overstorey Lifeform	Shrubs < 1 m
Overstorey Percent canopy (crown) Cover	5 - 30%
Average Overstorey Height (and range)	0.6 m (0.2 - 1)
Average Overstorey Canopy Diameter (and range)	0.7 m (0.3 - 1)
Average Overstorey Gap between canopies	2.9 m (0.5 - 10)

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	Plains and floodplains/drainage lines
Landform Elements	Plains and various
Surface Soil Texture	Sand to clay loam
Geological Surface Type	various
Surface Strew	Nil

Description:

A widely scattered loose group with Limestone Copperburr (*S. obliquicuspis*) the only species occurring at all sites. Other species are very variable but mostly low chenopods. Seems to occur in disturbed areas so this group may just be a conglomeration of disturbed 'other' vegetation types that are now dominated by the unpalatable Copperburr.

Species	Cover/Abundance								Prop.	Chi	No.
	R	I	T	1	2	3	4	5	Occur.	Squ.	Gps
Sclerolaena obliquicuspis	0	0	0	2	4	0	0	0	1.00	1.27	23
Alectryon oleifolius ssp. *canescens*	2	1	0	0	0	0	0	0	0.50	0.08	30
Atriplex stipitata	0	1	1	0	1	0	0	0	0.50	0.42	23
Enchylaena tomentosa var. *tomentosa*	1	2	0	0	0	0	0	0	0.50	0.03	34
Maireana pyramidata	0	3	0	0	0	0	0	0	0.50	0.00	31
Maireana sedifolia	0	2	0	0	1	0	0	0	0.50	0.00	30
Goodenia fascicularis	0	0	1	1	0	0	0	0	0.33	0.15	22
Rhagodia spinescens	1	1	0	0	0	0	0	0	0.33	0.00	29
Senecio quadridentatus	2	0	0	0	0	0	0	0	0.33	0.67	10
Senna artemisioides ssp. *petiolaris*	0	2	0	0	0	0	0	0	0.33	0.17	18

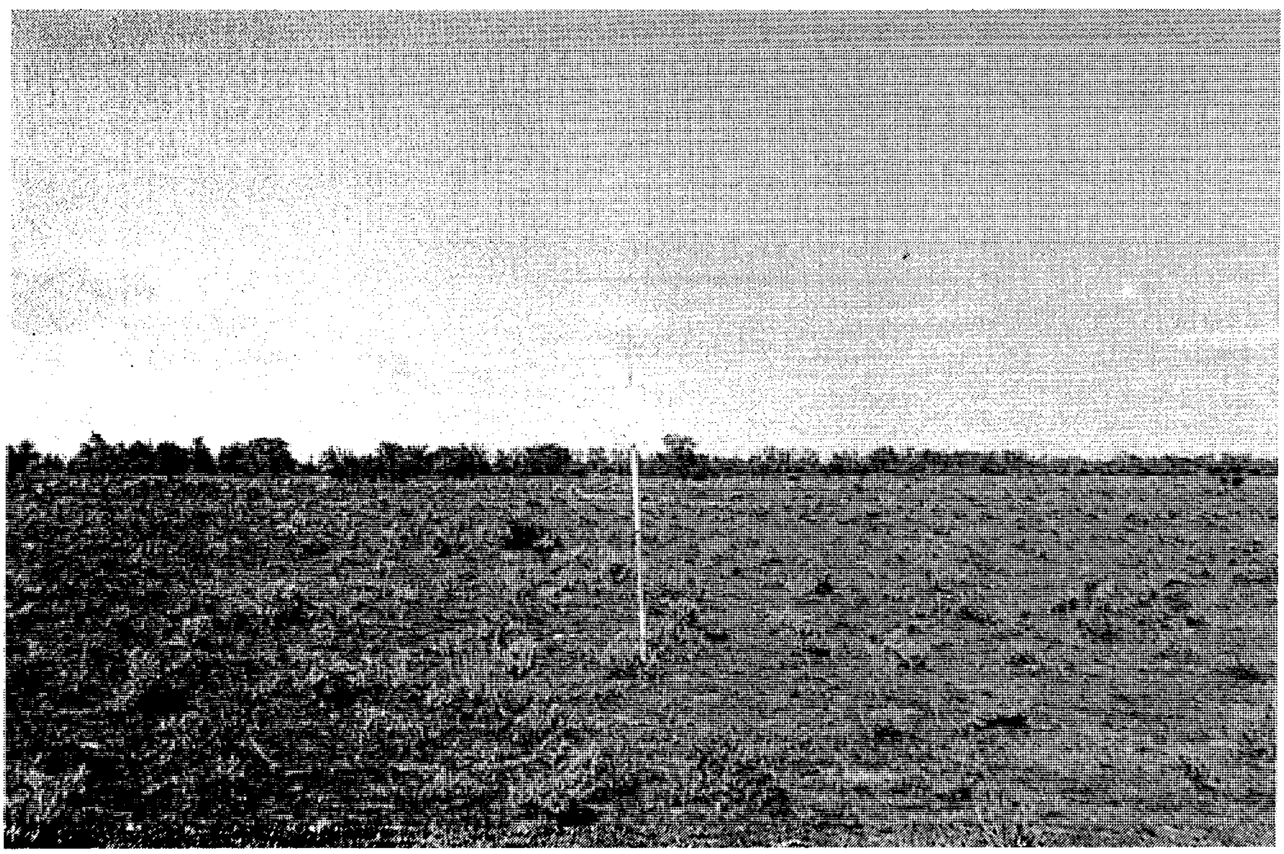
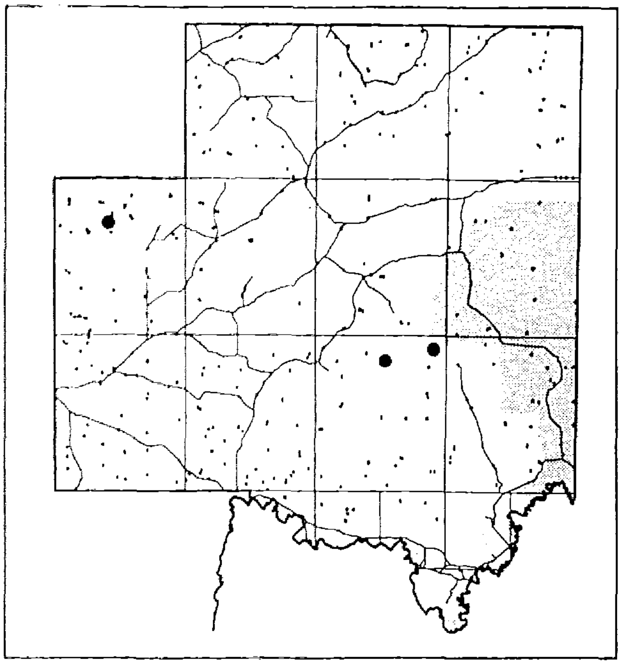


Figure 85
***Sclerolaena obliquicuspis* Low open shrubland at quadrat PA0102**

Floristic Group 12. *Sclerolaena diacantha* LOW VERY OPEN SHRUBLAND

3 members



Dominant Overstorey (or Characteristic) Species:

Sclerolaena diacantha (Grey Bindyi/Copperburr)

Sub-dominant Overstorey, Indicator[†] and Dominant Understorey Species:

Enchylaena tomentosa var. *tomentosa*
Senna artemisioides nothospp. *artemisioides*[†]
Goodenia fasicularis
Dodonaea viscosa spp. *angustissima*
Atriplex vesicaria spp.

Average Number of Plant Species (&range):

32.4 (25 - 56)

Vegetation Condition: Disturbed natural

Representative Quadrat(s): SE0202 (Figure 86)

Structural Data:

Overstorey Lifeform	variable
Overstorey Percent canopy (crown) Cover	variable
Average Overstorey Height (and range)	n/a
Average Overstorey Canopy Diameter (and range)	n/a
Average Overstorey Gap between canopies	n/a

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	various
Landform Elements	various
Surface Soil Texture	Sandy to sandy clay
Geological Surface Type	various
Surface Strew	various

Description:

A loose group, having only three sites, that therefore cannot be easily defined. Only two species [Ruby Saltbush (*E. tomentosa* var.) & Grey Copperburr (*S. diacantha*)] occur at all three sites and the overstorey is variable, with some sites having *Eucalyptus* spp..

Species	Cover/Abundance								Prop.	Chi	No.
	R	I	T	1	2	3	4	5	Occur.	Squ.	Gps
Enchylaena tomentosa var. *tomentosa*	0	2	0	1	0	0	0	0	1.00	0.20	34
Sclerolaena diacantha	0	0	0	3	0	0	0	0	1.00	1.85	26
Atriplex vesicaria ssp.	0	1	1	0	0	0	0	0	0.67	0.40	26
Dodonaea viscosa ssp. *angustissima*	0	2	0	0	0	0	0	0	0.67	1.18	20
Eucalyptus socialis	1	0	1	0	0	0	0	0	0.67	0.96	23
Goodenia fascicularis	0	1	0	1	0	0	0	0	0.67	1.40	22
Maireana georgei/turbinata	1	1	0	0	0	0	0	0	0.67	0.43	26
Maireana trichoptera	1	1	0	0	0	0	0	0	0.67	1.23	22
Myoporum platycarpum ssp.	2	0	0	0	0	0	0	0	0.67	0.24	26
Rhagodia ulicina	0	2	0	0	0	0	0	0	0.67	0.72	25
Senna artemisioides nothossp. *artemisioides*	0	1	1	0	0	0	0	0	0.67	9.52	8
Zygophyllum aurantiacum	1	1	0	0	0	0	0	0	0.67	1.33	19
Acacia colletioides	0	1	0	0	0	0	0	0	0.33	0.26	16
Acacia nyssophylla	0	1	0	0	0	0	0	0	0.33	0.30	18
Acacia oswaldii	1	0	0	0	0	0	0	0	0.33	1.10	15
Alectryon oleifolius ssp. *canescens*	0	1	0	0	0	0	0	0	0.33	0.00	30
Asphodelus fistulosus *	0	1	0	0	0	0	0	0	0.33	0.24	19
Atriplex stipitata	0	1	0	0	0	0	0	0	0.33	0.08	23
Cheilanthes lasiophylla	0	1	0	0	0	0	0	0	0.33	0.64	14
Convolvulus microsepalus/remotus	0	1	0	0	0	0	0	0	0.33	0.21	19
Danthonia sp.	0	0	1	0	0	0	0	0	0.33	0.00	28
Daucus glochidiatus	0	1	0	0	0	0	0	0	0.33	0.08	23
Daviesia benthamii ssp.	1	0	0	0	0	0	0	0	0.33	1.86	8
Dodonaea lobulata	0	1	0	0	0	0	0	0	0.33	1.09	10
Eremophila alternifolia	0	1	0	0	0	0	0	0	0.33	1.96	10
Eremophila glabra ssp.	0	1	0	0	0	0	0	0	0.33	0.29	16
Eremophila scoparia	0	1	0	0	0	0	0	0	0.33	0.55	15
Eucalyptus gracilis	0	0	1	0	0	0	0	0	0.33	0.18	22
Eucalyptus oleosa	0	0	1	0	0	0	0	0	0.33	0.25	16
Exocarpos aphyllus	1	0	0	0	0	0	0	0	0.33	0.08	24
Glycine clandestina var. *sericea*	0	1	0	0	0	0	0	0	0.33	2.21	7
Grevillea huegelii	1	0	0	0	0	0	0	0	0.33	0.38	13
Lysiana exocarpi ssp. *exocarpi*	0	1	0	0	0	0	0	0	0.33	0.46	15
Maireana brevifolia	1	0	0	0	0	0	0	0	0.33	0.17	23
Maireana pentatropis	0	1	0	0	0	0	0	0	0.33	0.17	20
Maireana pyramidata	0	1	0	0	0	0	0	0	0.33	0.04	31
Maireana radiata	1	0	0	0	0	0	0	0	0.33	2.55	8
Maireana sedifolia	0	1	0	0	0	0	0	0	0.33	0.04	30
Marrubium vulgare *	1	0	0	0	0	0	0	0	0.33	0.77	13
Oxalis perennans	0	1	0	0	0	0	0	0	0.33	0.05	27
Ptilotus obovatus var. *obovatus*	0	0	1	0	0	0	0	0	0.33	0.05	23
Rhagodia parabolica	0	1	0	0	0	0	0	0	0.33	0.13	23
Sclerolaena obliquicuspis	0	1	0	0	0	0	0	0	0.33	0.00	23
Senecio quadridentatus	0	1	0	0	0	0	0	0	0.33	0.67	10
Senna artemisioides nothossp. *coriacea*	0	1	0	0	0	0	0	0	0.33	0.14	20
Senna artemisioides ssp. *petiolaris*	0	0	1	0	0	0	0	0	0.33	0.17	18
Sida petrophila	0	1	0	0	0	0	0	0	0.33	0.35	16
Solanum petrophilum	0	1	0	0	0	0	0	0	0.33	0.80	14
Stipa scabra group	0	0	0	1	0	0	0	0	0.33	0.32	20
Zygophyllum apiculatum	0	1	0	0	0	0	0	0	0.33	0.26	17

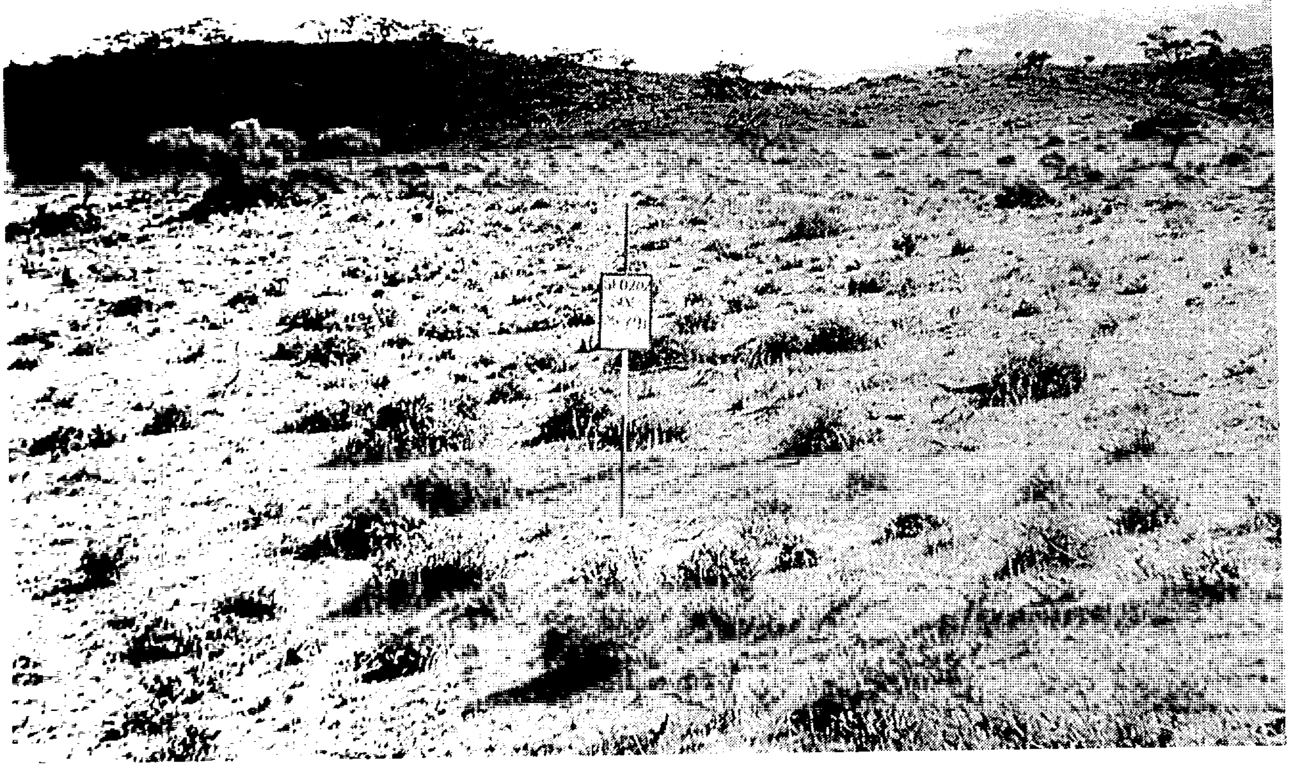
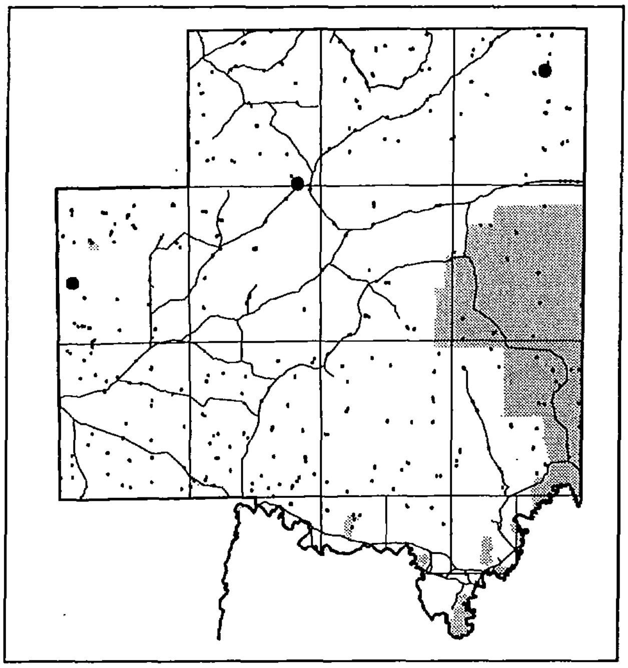


Figure 86
***Sclerolaena dicantha* Low very open shrubland at quadrat SE0202**

Floristic Group 10. *Atriplex angulata / Maireana brevifolia* LOW VERY OPEN SHRUBLAND

3 members



Dominant Overstorey (or Characteristic) Species:

Atriplex angulata† (Fan Saltbush)
Maireana brevifolia (Short-leaf Bluebush / Yanga Bush)

Sub-dominant Overstorey, Indicator† and Dominant Understorey Species:

Enchylaena tomentosa var. *tomentosa*
Senecio quadridentatus†
Sclerolaena divaricata
*Asphodelus fistulosus**
*Carrichtera annua**

Average Number of Plant Species (&range):

21.3 (8 - 30)

Vegetation Condition: Disturbed natural

Representative Quadrat(s): -

Structural Data:

Overstorey Lifeform	variable
Overstorey Percent canopy (crown) Cover	variable
Average Overstorey Height (and range)	n/a
Average Overstorey Canopy Diameter (and range)	n/a
Average Overstorey Gap between canopies	n/a

Environmental Parameters:
(*dominant)

Landform Patterns/Systems	various plains
Landform Elements	low lying elements
Surface Soil Texture	various
Geological Surface Type	Alluvium
Surface Strew	Nil to pebbles < 10%

Description:

A very loose group which may not reflect a true vegetation type. However, the sites did seem to occur in similar low-lying areas such as a pan, creekline or plain and contained several weed species. Only one species (*C. annua* - Wards Weed) was present at all three sites and seven species were shared at two. Very variable in structure - two sites had *Eucalyptus* overstorey.

Species	R	I	T	1	2	3	4	5	Prop. Occur.	Chi Squ.	No. Gps
	Cover/Abundance										
Carrichtera annua *	0	1	1	0	1	0	0	0	1.00	0.87	31
Asphodelus fistulosus *	0	1	1	0	0	0	0	0	0.67	1.87	19
Atriplex angulata	0	0	0	2	0	0	0	0	0.67	8.93	10
Enchylaena tomentosa var. *tomentosa*	0	0	0	0	2	0	0	0	0.67	0.00	34
Maireana brevifolia	0	1	0	0	1	0	0	0	0.67	1.53	23
Maireana pyramidata	0	1	1	0	0	0	0	0	0.67	0.08	41
Sclerolaena divaricata	0	2	0	0	0	0	0	0	0.67	4.02	12
Senecio quadridentatus	0	1	1	0	0	0	0	0	0.67	3.74	10
Acacia victoriae ssp. *victoriae*	0	0	0	0	1	0	0	0	0.33	0.63	12
Alectryon oleifolius ssp. *canescens*	1	0	0	0	0	0	0	0	0.33	0.00	30
Atriplex vesicaria ssp.	0	0	1	0	0	0	0	0	0.33	0.00	26
Convolvulus microsepalus/remotus	1	0	0	0	0	0	0	0	0.33	0.21	19
Einadia nutans ssp.	0	0	0	1	0	0	0	0	0.33	0.09	23
Eucalyptus camaldulensis var. *camaldulensis*	0	0	0	0	1	0	0	0	0.33	6.90	2
Eucalyptus gracilis	0	0	0	0	0	0	1	0	0.33	0.18	22
Eucalyptus leptophylla	0	0	0	0	1	0	0	0	0.33	4.25	4
Ixiolaena leptolepis/tomentosa	1	0	0	0	0	0	0	0	0.33	0.86	14
Lavatera plebeia	1	0	0	0	0	0	0	0	0.33	2.45	3
Lycium ferocissimum *	1	0	0	0	0	0	0	0	0.33	1.51	12
Maireana erioclada	0	1	0	0	0	0	0	0	0.33	0.55	18
Maireana pentatropis	0	0	1	0	0	0	0	0	0.33	0.17	20
Nicotiana glauca *	1	0	0	0	0	0	0	0	0.33	9.65	2
Osteocarpum sp.	0	1	0	0	0	0	0	0	0.33	2.37	9
Pittosporum phylliraeoides var. *microcarpa*	1	0	0	0	0	0	0	0	0.33	1.42	14
Rhagodia parabolica	0	0	0	0	1	0	0	0	0.33	0.13	23
Rhagodia spinescens	0	0	0	0	1	0	0	0	0.33	0.00	29
Salvia verbenaca form	1	0	0	0	0	0	0	0	0.33	0.32	18
Sclerolaena patenticuspis	0	0	1	0	0	0	0	0	0.33	0.20	21
Stipa acrociliata	0	0	0	0	1	0	0	0	0.33	1.43	9
Wahlenbergia communis	1	0	0	0	0	0	0	0	0.33	7.28	2
Zygophyllum apiculatum	0	0	1	0	0	0	0	0	0.33	0.26	17

Mallee and Chenopod/Blackoak Sub-Groups

From group species lists and statistics produced for the mallee and chenopod/blackoak *sub*-groups, the subdivisions produced recognizable floristic vegetation types. However, no significant patterns or trends could be visually detected in the physical parameters, probably because there were not enough quadrats sampled for each type. Therefore the sub-groups are not described individually but their floristic types warrant a mention. [Some of the sub-groups showed slight trends in their spatial (geographic) distribution and soil types which are noted.]

The first digit of the binary numbers used below refer to the mallee and chenopod/blackoak 'whole' groups as listed above. [The photographs of representative quadrats shown after each 'whole' group description above roughly reflect these sub-group variations.]

The mallee sub-groups, with possible trends, are:

1.1 *Eucalyptus gracilis* with chenopod shrubs
1.2 *E. gracilis* / *E. socialis* with mixed shrubs

2.1 *Eucalyptus oleosa* with *Zygophyllum aurantiacum*
2.2 *E. oleosa* / *E. gracilis* with *Z. aurantiacum* and shrubs - mostly southern occurrence,
2.3 *E. oleosa* with *Carrichtera annua*, *Z. aurantiacum* & chenopods - mostly western occurrence,

3.1 *E. oleosa* / *E. socialis* with *Z. aurantiacum* & shrubs
3.2 *E. socialis* / *E. gracilis* / *E. oleosa* with *Sclerolaena diacantha* - in northwestern corner,

4.1 *Euclyptus socialis* with chenopods
4.2 *E. socialis* / *Myoporum platycarpum* / *Senna artemisioides* ssp.

5.1 *Eucalyptus dumosa* with *Triodia irritans*
5.2 *E. dumosa* (2 sites only)
5.3 *E. socialis* with *Trioidia irritans*

The chenopod/blackoak sub-groups, with possible trends, are:

27.1 *Atriplex vesicaria* ssp. / *Sclerolaena obliquicuspis*
27.2 *A. vesicaria* ssp. with grasses - north-eastern and north-western tendencies,
27.3 *A. vesicaria* ssp. with *Casuarina pauper* - slight south-western trend,

28. no change (*Maireana astrotricha* / *A. vesicaria* ssp.)
29. no change (*Maireana pyramidata*)
30. no change (*M.pyramidata* / *A. vesicaria* ssp.)

31.1 *Carrichtera annua* with chenopods - near more populated areas i.e. near River Murray and west and north-western corner of area.
31.2 *Maireana sedifolia* / *C. annua*

32.1 *M. sedifolia*
32.2 *M. sedifolia* / *Stipa* sp.
32.3 *M. sedifolia* / *M.pyramidata* - slight northern tendency

33.1 *Casuarina pauper* / *M. sedifolia*
33.2 *C. pauper* - slight southern tendency but also in north.

34 no change (*C. pauper* with *Senna artemisioides* sspp.)

Ordination

The 34 vegetation groups' centroids ordination plot shows spatially the relationship of all groups to each other in terms of the plant species present (Figure 87). The only environmental trend evident on this plot is a slight tendency towards heavier, more clayey soils in the top right hand corner and more sandy soils in the bottom left corner, corresponding to the distribution of the chenopod and mallee vegetation types respectively, with the woodlands, grasslands/herblands and other shrublands in between.

Most of the soils throughout the survey area are loamy which would explain the lack of distinct trends related to soil type alone. Other physical or environmental trends such as landform variation, geographical location or rainfall gradient could not be detected, probably because there are only slight variations in these over the survey area. Other possible factors which may help explain the ordination plot would be soil pH, carbonate content and soil depth which were not measured on the survey.

As described in the methods chapter, ordination of all individual quadrats was divided into three plots: the major mallee groups, the central groups (i.e. from the centre of the dendrogram) and the major chenopod/Blackoak groups. The central group plot was too complex to intrepret due to the large number of groups and few quadrats in each. These small groups would need more samples before any ordination analysis could be interpreted.

The major mallee groups ordination plot (Figure 88) shows quite good clustering of the quadrats into the five groups. As indicated on the plot, there is a trend down the right hand side from *E. gracilis* to *E. oleosa* to *E. socialis* at the bottom, with mixtures of *E. gracilis*/*E. oleosa*/*E. socialis* in between. The left hand side is predominantly *E. dumosa* with *Triodia*, with *E. socialis* and *Triodia* in the bottom left corner. This trend reflects the mallee *sub*-groups, as described above, some of which are evident in the distributions of points (quadrats) within each group on the ordination plot.

The variety of surface soil types found in the mallee communities (but which were mainly within the sandy to loamy range) made distinct environmental trends difficult to identify. Nevertheless there seems to be a slight trend from sandier soils of dune systems in the left to more loamy/clayey soils of the plains systems at the right.

The major chenopod/Blackoak groups ordination plot is rather cluttered, having more quadrats, but nonetheless does show clustering into the eight groups (Figure 89). The left hand side is predominantly Pearl Bluebush (*M. sedifolia*) quadrats, with Ward's Weed dominated ones at the top left. The right hand side contains the Bladder Saltbush (*A. vesicaria*) quadrats with those that are co-dominated by Grey Bluebush (*Maireana astrotricha*) at the bottom right. The central top quadrats are Black Bluebush (*M. pyramidata*) dominated and communities mixed with Saltbush are to the right. The central quadrats are Blackoak dominated with a variety of the chenodpods as understorey (as shown by the proximity to all the other groups).

Most of the soils of the chenopod/Blackoak groups are various loams with some harder clays, thus trends across the ordination plot were not clearly evident. The only possible trend may be from shallow calcareous soils at the left (Pearl Bluebush) to deeper less calcareous soils at the right (Bladder Saltbush), as Jessup (1948) observed such trends in the west of the survey are

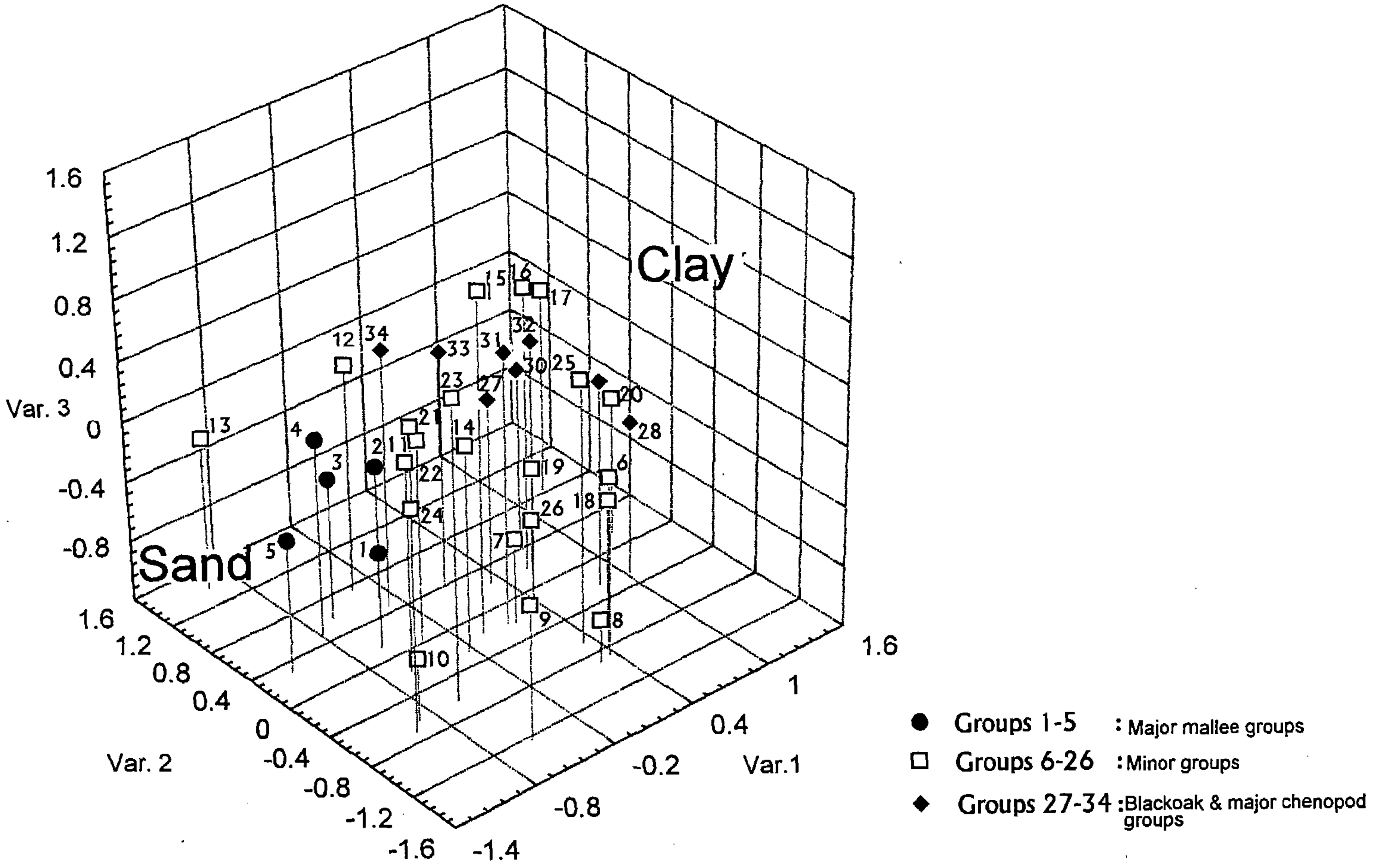


Figure 87
Scatterplot from multi-dimensional scaling of the 34 vegetation group centroids from the perennial plant analysis of the South Olary Plains survey.

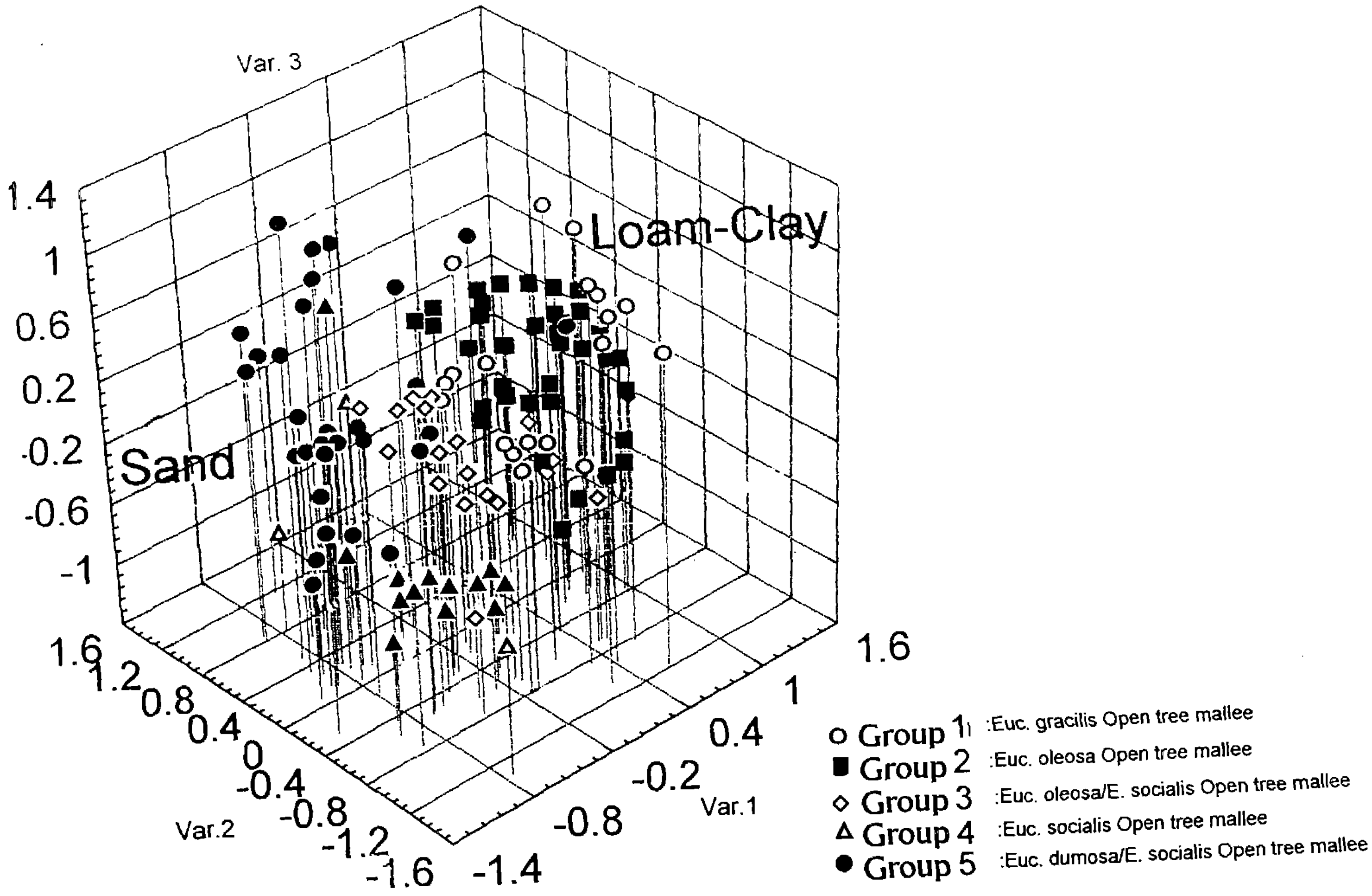


Figure 88
Scatterplot from multi-dimensional scaling of the major mallee vegetation groups from the perennial plant analysis of the South Olary Plains survey.

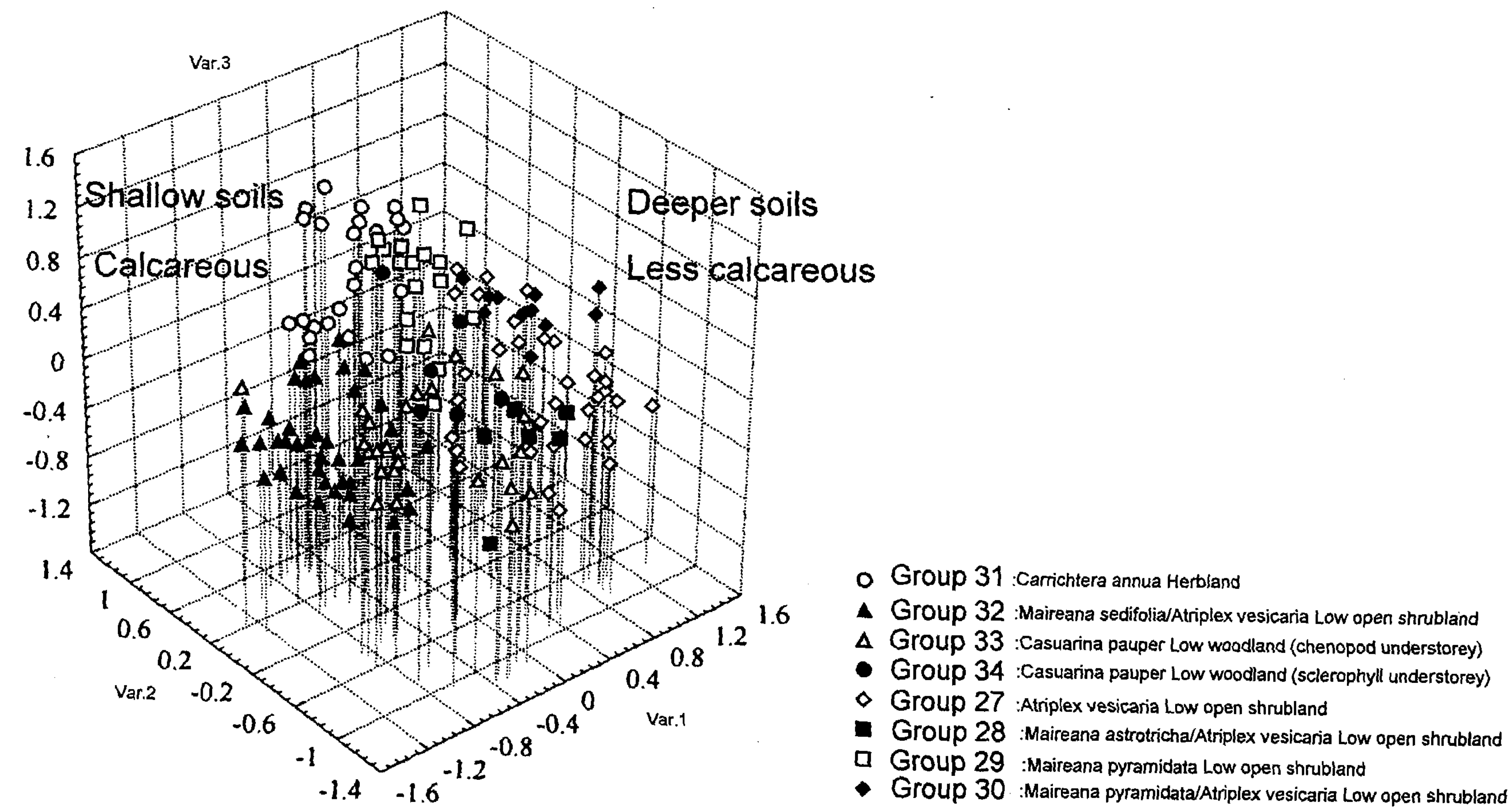


Figure 89
Scatterplot from multi-dimensional scaling of the major chenopod/blackoak vegetation groups in the South Olary Plains survey perennial plant analysis

SPECIES OF PARTICULAR INTEREST

Of the seventy-one species unique to the South Olary Plains survey, three (*Erodium cygnorum* ssp. *cygnorum*, *Frankenia parviflora* var. *fruticulosa* and *Heliotropium undulatum*) were found at locations well outside their previously known ranges and four have a significant conservation status (i.e. endangered or vulnerable)[*Acacia wattsiana*, *Maireana suaedifolia*, *Cymbopogon obtectus* and *Acacia rhigiophylla*]. Several others are classified as rare.

Of all the species found on the South Olary Plains survey, five are not recorded by Jessop (1993) as occurring in the Murray, Eastern or immediately adjacent regions (i.e. Northern Lofty and Flinders Ranges in the case of specimens found in the western part of the survey area). These species (*Erodium cygnorum* ssp. *cygnorum*, *Enneapogon intermedius*, *Frankenia pauciflora* var. *fruticulosa*, *Heliotropium undulatum* and *Swainsona oliveri*) were vouchered and identifications verified by the State Herbarium. Of the additional 334 species found by the other studies, ones found outside their known ranges are annotated in Appendix VI as being questionable identifications as they were collected on studies where specimens were not vouchered or verified by the State Herbarium.

Appendix VI also indicates the conservation status of species according to Briggs and Leigh (1995) and Lang and Kraehenbuhl (1994) on a national, state and regional basis. (Regional status only refers to Jessop's (1993) Murray region as the Eastern region has not yet been assessed). From the species found on the South Olary Plains survey, one is classified in Australia as vulnerable (*Codonocarpus pyramidalis*) and four as rare (*Acacia rhigiophylla*, *Acacia spilleriana*, *Acacia wattsiana* & *Maireana rohrlachii*). On a South Australian basis, two species are vulnerable (*Codonocarpus pyramidalis* & *Maireana suaedifolia*) and eight rare and for the Murray region, one is endangered, seven are vulnerable and 31 rare. *Acacia rhgiophylla*, *A. wattsiana* and *M. suaedifolia* were only found opportunisitically.

From the additional species found in the South Olary Plains area by the other studies, two are vulnerable in Australia (*Acacia carnei* & *Olearia pannosa* ssp. *pannosa*); in South Australia one is endangered (*Maireana decalvans*), three are vulnerable (*Acacia carnei*, *Olearia pannosa* ssp. *pannosa* and *Eremophila bignoniifolia*) and eleven rare, and for the Murray region one is endangered (*Santalum lanceolatum*), eight are vulnerable, one threatened and 28 rare.

South Australian distributions of species stated below are from Jessop (1993) and regions are abbreviated as follows (see Jessop for locations of regions):

EA	Eastern
EP	Eyre Peninsula
FR	Flinders Ranges
GT	Gairdner-Torrens
KI	Kangaroo Island
LE	Lake Eyre
MU	Murray
NL	Northern Lofty
NW	North-Western
NU	Nullarbor
SE	South-Eastern
SL	Southern Lofty
YP	Yorke Peninsula

The northern third of the South Olary Plains survey area lies in the EA region, and the southern two thirds in the MU region, with the western edge adjoining the NL and FR regions.

In the notes below, detailed references to distributions in South Australia are from Jessop and Toelken (1986). Known distributions in New South Wales are from Cunningham *et al.*, (1992), Hnatiuk (1990) and Fox's (1991) species list for the Ana Branch 1:250,000 mapsheet east of the S.A./N.S.W. border.

Species found beyond known ranges

The following species are *not* listed by Jessop (1993) as occurring in the MU or EA regions (or NL or FR regions if found in the far western portion of the survey area). All were vouchered and verified by the State Herbarium.

Heliotropium undulatum

A semi-erect annual with stems, leaves and sepals covered in simple hairs. Leaves are 2-7 cm long and 0.3-1 cm wide. Flowers are white with yellow inside, appearing all year round. Grows in red,sandy loams (Jessop and Toelken, 1986).

Two specimens of this species (both designated *H.* cf. *undulatum* by the State Herbarium) were found only on the South Olary Plains survey in the northern part of the area: one at WM0102 on Wadnaminga Station (found on sandy clay loam in a dry water course) and the other at DL0201 on Dlorah Downs (on silty clay loam in a drainage depression). This species is listed as only occurring in the Lake Eyre region and is not known from N.S.W., therefore, these records are at locations significantly further south than previously recorded.

Swainsona oliveri

A small, sparsely-downy, prostrate to erect annual forb with leaves 2-6.5 cm by 1-2 mm. Flowers are pea-like, blue, yellow or yellow and white with a pink tip and 4-5 mm long, appearing in late winter to spring. Fruit is a cylindrical pod, 15-25 mm by 2-4 mm. Grows on sandy plains (Cunningham *et al.*, 1992; Jessop & Toelken, 1986).

Although known from seven regions (NW, LE, NU, GT, FR & EP) the confirmation of this species from two sites in the central south-eastern part of the survey area [OK0201 on Old Koomooloo Station (on a silty clay loam plain) and CN0301 on Canegrass Station (on a clay loam plain)] is interesting as these locations are well outside the above ranges. It has also been recorded from Danggali Conservation Park by the University of South Australia (J. Gibbs, pers. comm.) and/or T.A.F.E. (1981) but this has not been confirmed as the records of these two sources have been combined and most specimens were not vouchered. Although not recorded by Fox (1991), this species is known to occur in northern far-western N.S.W., especially near Broken Hill.

Enneapogon intermedius - Tall Bottlewashers

An erect, loosely growing perennial grass, 30-70 cm high, hairy at the base. Leaves are 10-18 cm long, 2-4 mm wide and downy. Flowerhead is a compact spike, 3-13.5 x 1.5-2.5cm, generally appearing in autumn (Cunningham *et al.*, 1992; Jessop & Toelken, 1986).

This species was found in the northern parts of the survey area at three sites on Devonborough Downs Station, two on Mutooroo, one on Sturtvale, one on Benda and in Danggali Conservation Park by the University of South Australia (J. Gibbs, pers. comm.) but once again the latter record is unconfirmed. This species is, however, only recorded as occuring in the NW, LE, FR, and EP regions but does occur in north-western New South Wales [but not listed by Fox (1991)] so therefore is not totally unexpected but still notable.

Erodium cygnorum ssp. *cygnorum* Blue Storks-bill

A herbaceous plant growing to 50 cm high. Leaves have three principal lobes and are dissected to the midrib (in contrast to the more common subspecies *glandulosum*). Flowers are blue, 13 mm long and appear in winter and spring (Jessop & Toelken, 1986).

Found only on the current survey at one site (WK0301 on Mutooroo Station on a loamy plain), this subspecies is known from the NW, LE, NU, GT and EP regions but is not recorded as occurring in western N.S.W.. Thus this location is significantly further south than previously recorded.

Frankenia pauciflora var. *fruticulosa* Southern Sea Heath

A low, sprawling to erect shrub, *F. pauciflora* is a highly variable species. The variety *fruticulosa* has very prominant, broad, flat mid-veins in comparison to variety *gunnii* which is the one usually found in the Murray region. Jessop and Toelken (1986) should be consulted for accurate identification of these varieties.

Also found only on this survey at one site (BN0203 on Benda Station, on sandy loam in a dry water course), this variety has been recorded from the LE, EP, YP, SL and KI regions and is listed by Hnatiuk (1990) only as occurring in north far-western N.S.W.. So, being quite widespread, this record is therefore not totally unexpected.

Species of National Significance

National and New South Wales conservation status follows Briggs and Leigh (1995) and South Australian and regional status follows Lang and Kraehenbuehl (1994). Conservation status definitions and locations of other studies in the area are detailed in Appendix VI and South Australian regions are as described above.

Codonocarpus pyramidalis Slender Bell Fruit (Fig 90)

A small, neat, erect tree to about 7 m high with a loose crown of spaced, drooping branches. Linear leaves are pointed and 5-12 cm long. Flowers are small and insignificant, on a common stalk near the ends of branchlets, appearing in winter and spring. Fruit is bell-shaped to 1.5 cm long [longer than that of *C. cotinifolius* (Desert Poplar)] (Boomsma, 1981; Jessop and Toelken, 1986).

This species is classified as vulnerable both nationally, statewide and in the Murray region and is presumed extinct in New South Wales. It is vulnerable or threatened in five other regions of the state. On the South Olary Plains one individual was recorded at a site on Oulnina Park station (ESE of Yunta) on a rocky *Triodia* covered north facing hillslope with *Eucalyptus socialis*. It has also been recorded by Jessop (1948).

In the northern and central Flinders Ranges Davies (1995) found this species growing most frequently on the crests and slopes of low ridges and hills in loamy sand or sandy clay loam. It is usually associated with tall open to sparse shrublands dominated by *Acacia victoriae, A. aneura, A. rivalis, Callitris glaucophyla* and/or *Eucalytpus* species. Common understorey species include *Ptilotus obovatus, Cymbopogon ambiguus, Triodia irritans, Enneapogon* spp. and/or *Sclerolaena obliquicuspis*.

The greatest threat to populations of this species is from goat, stock and rabbit browsing (Davies, in prep.). It appears that in the past the species was common in localised habitats over a wide area but is now in a serious state of decline due to negligible regeneration. Fire may be required for seed regeneration.

Olearia pannosa ssp. *pannosa* Silver Daisy Bush (Fig. 91)

A spreading undershrub or shrub to 1.5 m high, producing root suckers. Leaves are 3-9 cm long, 1.5-5 cm wide (length usually greater than twice the width), prominantly reticulate-veined and shiny. Lower leaf surface is white to cream or a very pale rusty brown. Flower heads are hemispherical, white or pale mauve, 15-22 mm long and appear in spring. Occurs in mallee, woodland and forest communities (Jessop and Toelken, 1986).

This subspecies is classified as vulnerable in Australia, South Australia, the Murray region and a number of other regions. Although not found on the current survey, it has been recorded by the Native Vegetation Management Section in the hundred of Bright in the south-western corner of the current survey area and is known to occur on Mount Bryan in the Burra Hills, just west of the survey boundary (R. Davies, pers. comm.). Stephens (1992) included this subspecies in a summary list of the seventeen most threatened plant species in the Murray Mallee region. Lang and Davies (pers. comm.) rank it as the ninth most threatened plant species in the Murray-Darling Basin.

Acacia carnei Purple-wood Wattle / Needle Wattle / Dead Finish

A tall, rigid, straggly, spreading and prickly shrub or small tree to 4 m high with a dense crown and intricate branches. Phyllodes ('leaves') are 2-6.5 cm long, 1-2 mm diameter, rigid, four-angled with a vein at each angle and sharp-pointed. Flowers are yellow in heads 5-6 mm diameter, borne singly in the leaf axils. Seed pods are 2-5 cm long, 8-12 mm broad, hard and woody. Plants flower infrequently and irregularly throughout the year and fruits are rare. Seems to occur in colonies of 20-60 plants which are clonal (i.e. develop from suckers) and can easily be mistaken for a *Hakea*. (Cunningham *et al.*, 1992; Whibley & Symon, 1992).

This species is classified as vulnerable nationally and statewide but has not yet been assessed for the Eastern region. However, it is listed as endangered for the Flinders Ranges region. Stephens (1992) included *A. carnei* in the summary list of the seventeen most threatened plant species in the Murray Mallee region.

Although not found on the current survey, *A. carnei* has been recorded by Tiver (1994) and Barber and Linton (1989) just north of the survey boundary and is shown in Auld (1993) as occuring north-north-east of Yunta and in Davies (in prep.) as west and south west of Yunta so it could very well be found in the northern part of the South Olary Plains. It is also found around Broken Hill and in the north-western corner of New South Wales. South Australia Herbarium records indicate that this species is mainly restricted to the Eastern region in S.A. (Davies, pers. comm.).

Auld (1993) describes *A. carnei* as being largely confined to red sand dunes, alluvial accumulations or occasionally level sandy areas and generally occuring with *Alectryon oleifolius*, *Casuarina pauper* and *Maireana pyramidata*. It is also known to occur with *Atriplex vesicaria* and *Rhagodia spinescens* (Whibley and Symon, 1992) and *Eucalytpus socialis* and *Enchylaena tomentosa* (Davies, 1995).

The greatest threat to populations seems to be rabbit browsing (Davies, 1995).

Acacia rhigiophylla Dagger-leaf Wattle

A tangled, rigid, prickly, spreading, intricately-branched shrub 1.5-3 m high, usually wider than high. Phyllodes ('leaves') are deep green, flattened, 10-25 mm long, ~2 mm broad, spine-like, speading and sharply pointed with 2-3 prominent raised veins. Flowers are yellow and in globular or oblong heads 5-6 mm diameter which are usually borne sparsely in pairs in the leaf axils. Seed pods are linear, 5-8 cm long, 2-3 mm broad, much curved and loosely coiled. Plants flower in spring (Cunningham *et al.*, 1992; Whibley & Symon, 1992; Davies, 1992).

This species is classified as rare nationally and in South Australia and vulnerable in the Murray region. Lang and Davies (pers. comm.) rank it as the seventeenth most threatened plant species in the Murray-Darling Basin.

In South Australia *A. rhigiophylla* is described as having small and localised occurrences in north-eastern Eyre Peninsula (where it is classified as rare) and on the eastern foothills of the southern Mount Lofty Ranges near Monarto and Murray Bridge (Davies, 1992). In N.S.W. it only occurs in the central western slopes area (west of the Great Dividing Range). On the South Olary Plains survey this species was collected opportunistically on Franklyn Station (east of Terowie) on a degraded hilltop near the shearers quarters. This collection is a significant range extension for this species.

Whibley and Symon (1992) describe the species as occurring in open scrub associated with *Eucalytpus socialis* and *E. gracilis*. Davies (1992) reports it as being found near rocky outcrops on slopes and crests of low broad hills and ridges or on rises on undulating plains. The species occurs in a variety of plant communities dominated by *Eucalyptus leucoxylon*, *E. porosa*, *E. socialis*, *E. foecunda*, *E. dumosa*, *Callitris preissii* and/or *Melaleuca uncinata*.

A. rhigiophylla is a vigorous recoloniser after physical disturbance and fire but populations are potentially threatened by grazing, weed invasion and the absence of fire (Davies 1992).

Maireana rohrlachii - Rohrlach's Bluebush

An intricately branched shrub to 1 m high with slender, closely woolly branches. Leaves are 3-8 mm long, fleshy and hairless. Fruit is turbinate, 2mm high with a wing that is 12-16 mm in diameter and has a single radial slit. Occurs on heavy soils and fruits in summer and autumn (Jessop & Toelken, 1986).

This species is classified as rare in Australia, South Australia and the Murray and Flinders Ranges regions and vulnerable in the Northern and Southern Lofty regions. It was found at one site on the current survey (TW0103 east-southeast of Peterborough on the far western edge of the survey area, on a sandy loam plain). This location is very near the boundary of the Northern Lofty region where this species is classified as vulnerable. *M. rohrlachii* was also found by the Field Naturalists Society on the southern end of Calperum Station.

Acacia spilleriana - Round-leaf Mulga-bush

A bushy, compact, rounded, spreading, grey-green shrub 1-3 m tall. 'Leaves' are 2-3 cm long, 1-1.8 cm wide grey-green with a rounded apex. Flower heads are globular, yellow, 1 cm diameter occuring in small groups on a short stalk in spring. Fruit is 5.5 cm by 1.4-1.8 cm (Whibley & Symon, 1992).

This species, endemic to South Australia, is classified as rare in Australia but is of uncertain status in South Australia and the Murray region at present. It is restricted to a localized area around Burra in the northern Mt Lofty Ranges. On the current survey *A. spilleriana* was found at one site (SR0101 in the Scrubby Range, southeast of Burra, on medium clay on a hillslope) and also by the Native Vegetation Management Branch in the agricultural areas in the southwestern corner of the current survey area.

Species of South Australian Significance

Maireana decalvans Black Cottonbush

An erect or spreading, tufted to bushy subshrub, 30-50 cm high with slender striate branches, often with dense woolly tufts in the leaf axils. Leaves are fleshy, narrow-cylindrical and 5-8 cm long. Flowers are solitary and in the leaf axils. Fruit is flat with a horizontal wing, about 8 mm diameter with a single radial slit. Flowers and fruits appear in summer and autumn. Found in heavy seasonally waterlogged soil and/or in grassland, bladder saltbush and open woodland communities (Cunningham *et al.*, 1992; Jessop and Toelken, 1986).

This species is classified as endangered in South Australia and in the Northern and Southern Lofty regions and is not recorded anywhere else in the state. Although not found on the current survey, it was listed by Jessop (1948) and Barratt and Choate (1983). Jessop's record is to be expected being very near or just in the NL region but Barratt and Choate's is questionable being on Chowilla Station (near the N.S.W. border) and unvouchered. However, the species is known from western N.S.W., where it is not classified, but Cunningham *et al.* (1992) state it as being mainly confined to the eastern part of western N.S.W..

Codonocarpus pyramidalis - Vulnerable (see above)

Acacia carnei - Vulnerable (see above)

Maireana suaedifolia Lax Bluebush

A weak, open, spreading ,dark bluish-green shrub about 0.5 m high with axillary tufts of wool. Leaves are well spaced, fleshy and narrowed at the base, 5-25 mm long. Fruit is pink when fresh, flat with a thin horizontal wing, 8-12 mm diameter with a single radial slit. Flowers and fruits appear in summer. Plants are found on raised areas around salt lakes (Jessop and Toelken, 1986).

This species is classified as vulnerable in South Australia and the Murray region. Of all the studies conducted in the South Olary Plains area this species was only recorded as an opportunistic observation on the current survey on Calperum Station. Although not vouchered, it was observed by a reputable botanist.

Olearia pannosa ssp. *pannosa* - Vulnerable (see above)

Eremophila bignoniiflora Bignonia Emubush

A much branched, tall shrub or small tree 1.5-7 m high with a dense rounded crown. Branches and foliage are drooping, hairless and somewhat sticky. Leaves are pale green, 3-20 cm long and 2-14 mm wide. Flowers are cream to carmine with yellow-brown to carmine flecks on the inner surface, 20-30 mm long, broadly bell-shaped with five rounded lobes. Plants flower in winter and spring and occur on periodically flooded heavy clay soils of river and creek floodplains, in drainage lines and near lakes; in black box, river red gum and lignum communities (Cunningham *et al.*, 1992; Jessop & Toelken, 1986).

This species is classified as vulnerable in South Australia and the Murray region and is ranked as the twelfth most threatened plant species in the Murray-Darling Basin by Lang and Davies (pers. comm.). It is also known from the Lake Eyre region and northern western N.S.W.. In S.A. it is restricted to the channel country in the extreme north-east and along the Murray River. Although not found on the current survey it has been recorded on Danggali Conservation Park by the Unversity of S.A (pers.comm.) and/or T.A.F.E. (1981). As this record was not vouchered the identification is questionable as there are no large water bodies or floodplains in Danggali except dams.

Species Classified as Rare (in South Australia)

(Numbers following names relate to the sources of the records which are detailed in Appendix VI, as are other annotations.)

Acacia loderi (Nealie)	1,2,3,6,9,10,13
Acacia montana (Mallee Wattle)	12,13
Acacia rhigiophylla (Dagger leaf Wattle)	2 (see above)
Arabidella filifolia	1
?*Corynotheca licrota*	3
Cryptandra amara var. *longiflora* (Long-flower Cryptandra)	1,2,12,13
Danthonia semiannularis	11
Daviesia benthamii ssp. *humilis* (Mallee Bitter-pea)	1
Eragrostis lacunaria (Purple Lovegrass)	10
Eriostemon angustifolius ssp. *angustifolius*	1
Exocarpus strictus (Pale-fruit Ballart)	3,4,5,6,13
Haeckeria punctulata	1,6,10
Hakea tephrosperma (Hooked Needlewood)	3
Maireana pentagona @ (Hairy Bluebush)	5 (1983)
M. rohrlachii (Rohrlach's Bluebush)	1,13 (see above)
Osteocarpum acropterum var. *acropterum* (Small-wing bonefruit)	10
Podolepis jaceoides (Showy Copper-wire Daisy)	12
Santalum spicatum (Sandalwood)	3,6
Sphaerolobium minus (Leafless Globe-pea)	3,13

Species of Regional Significance (Murray region only)
(Eastern region not assessed yet)

Acacia wattsiana Dog Wattle

A dense, bushy, rounded, spreading shrub 1-2 m high. Phyllodes ('leaves') are 3-6 cm by 4-10 mm, straight or slightly curved, light-green and with the mid-vein slightly eccentric. The flower heads are yellow, globular and in groups of 5-8. Seed pods are linear, 6-12 cm by 6-7 mm. Plants flower in spring to early summer (Whibley & Symon, 1992).

This species is endemic to South Australia and classified as endangered in the Murray region. It also occurrs in the Flinders Ranges and Northern Lofty regions but has no significant status there. Whibley and Symon (1992) describe its occurrence as a rather restricted distribution in the NL region. On the South Olary Plains survey it was collected opportunistically from 'The Bluff', north-west of Robertstown, which is almost on the border with the NL region so this record is not surprising.

Santalum lanceolatum Plum Bush

A shrub or small tree up to 4 m high with pendulous branches. Leaves are variable, 3-8 cm long by 0.5-3.5 cm wide, waxy, dull and tapered to a point. Flowers are cream, scented and 0.5-0.6 long, appearing throughout the year but mainly in spring and summer. Fruit is ovoid, dark blue, plum-like and 1.2-1.5 cm long by 0.8-1 cm wide (Boomsma, 1981; Jessop & Toelken, 1986).

This species is endangered in the Murray region but occurs in eight other regions. The only South Olary Plains study that recorded it was Tiver (1994) but that record may have been just north of the current survey area.

Species classified as Vulnerable (in Murray region) and sources:
(see Appendix VI for source details)

Acacia montana (Mallee Wattle)	6, 12
Acacia rhigiophylla (Dagger leaf Wattle)	2 (see above)
Acacia rupicola (Rock Wattle)	3
Codonocarpus pyramidalis (Slender Bell Fruit)	1 (see above)
Crinum flaccidum (Darling Lily)	5, 10
Cymbopogon obtectus (Scented Grass)	1
Eremophila bignoniiflora (Rough Emubush)	3,4 (see above)
Gahnia trifida (Cutting Grass)	12
Glycine canescens (Silky Glycine)	1
Goodenia albiflora (White Goodenia)	1, 12
Hakea rugosa (Dwarf Hakea)	2
Maireana suaedifolia (Lax Bluebush)	2 (see above)
Olearia pannosa ssp. *pannosa* (Silver Daisy Bush)	12 (see above)
Olearia teretifolia (Cypress Daisy Bush)	5, 6, 13
Phyllanthus saxosus (Rock Spurge)	12

Species classified as Threatened (in Murray region) and sources:

Teucrium albicaule	13

Species classified as Rare (in Murray region):

31 species recorded on South Olary Plains survey.
28 additional species found in other studies.

Species of Local Significance

A few species found on the survey have their South Australian distributions centred on or localized in the South Olary Plains: *Acacia loderi* (Nealie) which only occurs on Oakbank, Oakvale and southern Mutooroo stations; *Acacia spilleriana* which is restricted to the northern Mount Lofty Ranges between Tarlee and Burra (not strictly on the South Olary Plains but just enters the south-western corner of the survey area).

A number of common plant species are shown in Figs 92-99.

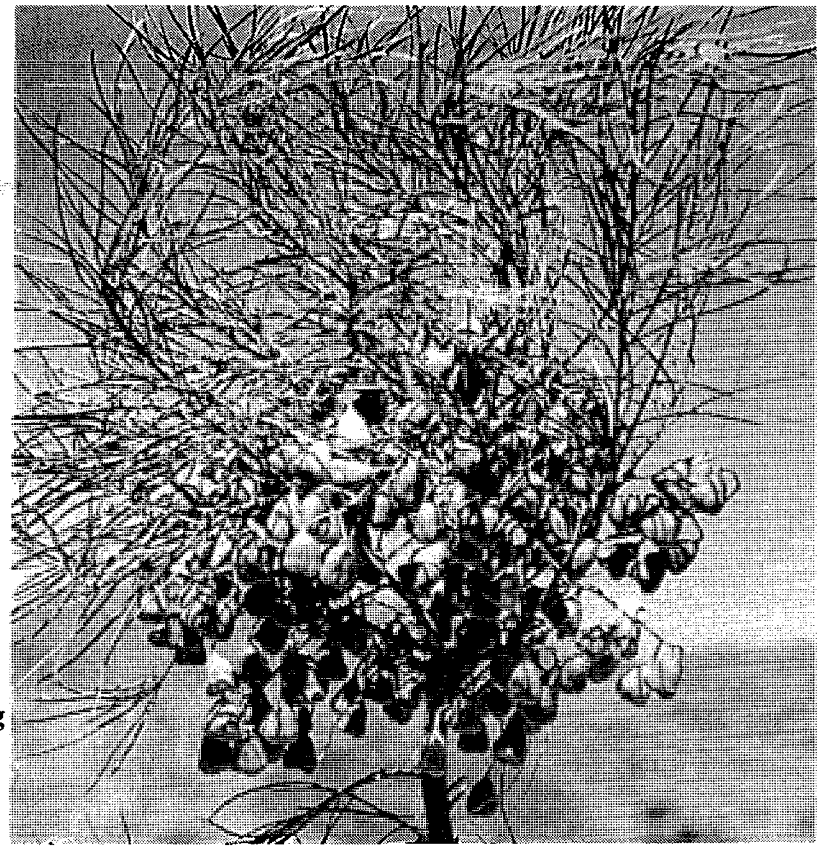


Figure 90
A single specimen of the Slender Bell Fruit, *Codonocarpus pyramidalis* was found during the survey on Oolnina Park Station
Photo: D. Kraehenbuel

Figure 91
The Silver Daisy Bush, Olearia pannosa ssp. pannosa is found in the south-west of the South Olary Plains survey area
Photo: D. Kraehenbuel

Figure 92
A flower of Black Bluebush, *Maireana pyramidata* a common species of the northern low open shrublands in the South Olary Plains survey area
Photo: D. Kraehenbuel

Figure 93
The Spiny Fanflower, *Scaevola spinescens* is found as an understorey in a variety of mallee types in the South Olary Plains survey area.
Photo: D. Kraehenbuel

Figure 94
The Rock Sida, *Sida petrophila* grows on the outlying hills of the Olary Spur in the north of the South Olary Plains survey area.
Photo: D. Kraehenbuel

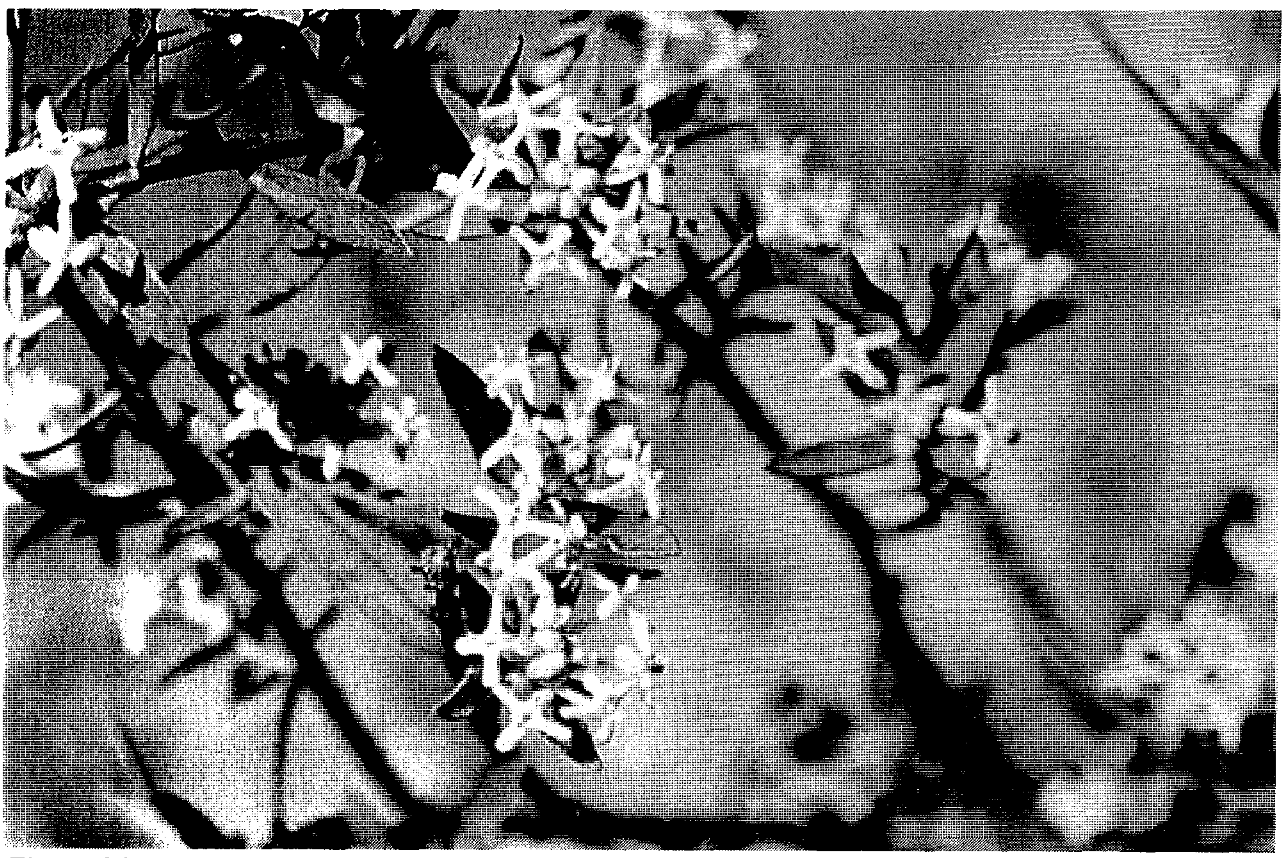


Figure 95
The Mallee Riceflower, *Pimelea microcephala* ssp. *microcephala* occurs in the southern mallee areas
Photo: D. Kraehenbuel

Figure 96
Silver Needlewood, *Hakea leucoptera* is a shrub to small tree of the northern South Olary Plains.
Photo: D. Krahenbuel

Figure 97
The Rough Blue-flower, *Halgania cyanea* adds a brilliant splash of colour to the mallee understorey in spring.
Photo: D. Kraehenbuel

DISCUSSION

Table 7 shows comparisons of the South Olary Plains mallee vegetation sub-groups with groups identified by other studies of the region and adjacent areas; namely Neagle (1995) (statewide); the Murray Mallee survey (Department of Environment and Natural Resources, unpublished data.) (which includes data from the Victorian mallee); Lock and Goodwins (1993) (Western Murray Flats); Tiver (1994) (top half and north of current survey area); Sparrow (1989) (all the southern mallee in S.A.); Noy-Meir (1971) (south-eastern Australia) and Morcombe and Westbrooke (1990) (Mallee Cliffs National Park, N.S.W.). Table 8 shows comparisons of the rest of the South Olary Plains vegetation types with the same studies, except Sparrow (1989).

Mallee vegetation groups (Table 7)

Most of the studies in Table 7 are of predominantly southern, more mesic (i.e. wetter), mallee communities, whereas the South Olary Plains area comprises northern arid mallee. Therefore, direct comparison of the groups is not easy, however, some trends are still evident.

The *E. gracilis* group (Group 1) was broadly recognised by Noy-Meir (1971) but sub-group 1.2 (*E. gracilis/E. socialis*) was almost exactly the same as defined by Sparrow (1991), who identified an *E. gracilis - E. socialis* (with *Zygophyllum aurantiacum*) group west of the River Murray near Morgan and Blanchetown.

The *E. gracilis/E. oleosa* association (sub-group 2.2) was consistently identified by all studies, being the most xeric (i.e. in drier habitats) and most common mallee type in South Australia (Sparrow, 1989). Sparrow (1989) found such a group occurring on sandy loams, as was the case on the South Olary Plains in the present study.

The separate South Olary Plains *E. oleosa* and *E. socialis* groups (Groups 3 and 4) were not identified by any of the other studies, maybe because of the more xeric nature of the current survey area and/or these groups may be included within the other mallee groups of those studies. [Although an *E. oleosa* group seems to be evident in the Burra Hills, west of the current survey area (R. Playfair, pers. comm., unpublished survey data)].

On the South Olary Plains survey, *E. gracilis* and *E. socialis* were distributed throughout the survey area but in more northern areas than the other Eucalypt species. This explains why separate *E. gracilis* and *E. socialis* (without *Triodia*) groups were not identified by the southern studies. [Neagle (1995) lists broader semi-arid mallee groupings and Tiver's (1994) area contained relatively little mallee, being predominantly further north].

The *E. socialis/E. dumosa* group (Group 5) has similarities with various groups across all the studies but comparisons are not direct. South of the River Murray (Murray Mallee area) the dominant Eucalypt species that occur with *Triodia irritans* are *E. socialis* and *E. leptophylla* (on dunes and swales) whereas on the South Olary Plains *Triodia* was commonly found with *E. dumosa* and/or *E. socialis*, predominantly on dune crests but sometimes in sandy swales in the south. The *E. dumosa* groups of the Murray Mallee (with *E. leptophylla*) and the Western Murray Flats (with *E. gracilis*) had only a little, or no, *Triodia* respectively and therefore have only slight similarities to the current survey's *E. dumosa/Triodia* sub-groups (5.1. & 5.2)

Therefore, the groups most similar to the current survey's *E. socialis* and *Triodia* sub-group (5.3) were the Murray Mallee groups 33, 36 and 40 which included *E. cyanophylla*, *E. leptophylla* and/or *E. incrassata* with *E. socialis*. On the South Olary Plains *E. leptophylla* and *E. incrassata* were generally only found in southern areas nearer the river, where they are at the northern extent of their distribution and did not form discrete communities as found south of the river.

In Mallee Cliffs National Park in N.S.W. (100km east of the Chowilla floodplains) the dominant vegetation types are *E. gracilis/E. dumosa/E. socialis* without *Triodia scariosa* on sandy-loam interdune plains and with *T. scariosa* on sandy low dune ridges (Morcombe and Westbrooke, 1990). Both of the associations correspond with the range of vegetation types in the South Olary Plains *E. dumosa/E. socialis* group (Group 5).

The *E. incrassata / E. dumosa* complex identified by Sparrow (1989) occurred on deeper sands on dunes and on duplex soils on sandplains, with the *E. incrassata* groups being more on the sand dunes and the *E. dumosa* group more diverse in location. On the South Olary Plains, *E. incrassata* was found predominantly on sandy dune crests and *E. dumosa* on sandy dunes, loamy sand swales and some plains, which seems to fit this pattern.

The *E. brachycalyx* group (Group 21), being associated with hills, was only identified by Sparrow (1989).

E. porosa has a scattered and irregular distribution across southern South Australia (Sparrow, 1989) and thus this species' assosiation was consistently detected by all the South Australian studies.

Table 7

Comparison of the South Olary Plains mallee vegetation floristic groups and sub-groups with those of other studies of the area and adjacent regions.

Neagle (1995) is a statewide classification, collated from all previous classification works in the state; the Murray Mallee survey area (Department of Environment & Natural Resources, in prep.) is south and south-east of the current survey (and includes data from the Victorian mallee) with results being derived from PANT analysis of cover/abundance data; the Western Murray Flats (Lock and Goodwins, 1993) is south-west of the survey area and also derived from PATN analysis of cover/abundance data; Sparrow (1989) is from multivariate analysis of sites throughout the southern mallee in S.A.; Noy-Meir (1971) is a survey of the semi-arid zone of south-eastern Australia, with multivariate analysis conducted on both presence/absence and dominance/cover data; and Tiver (1994) covers the top half and north of the survey area and is also from multivariate analysis (shown in brackets in Western Murray Flats column).

Groups are compared on the basis of the common species lists in the respective survey reports. Numbers are the vegetation group numbers from the respective surveys.

† = Conservation status classified as moderate by Neagle (1995).

South Olary Plains	**Neagle (1995)**	**Murray Mallee**	**Western Murray Flats** [+ Tiver, 1994]	**Sparrow (1991)**	**Noy-Meir** (presence/absence data)	**Noy-Meir** (dominance/cover data)
1.1 *Eucalyptus gracilis*	)				7. *E. gracilis*, *Sclerolaena obliquicuspis* (*Chenopodium desertorum*) open swale mallee	7. *E. gracilis* (*E. socialis*, *E. dumosa*, *E. oleosa*)
1.2 *E. gracilis*/ *E. socialis*	))			*E. gracilis*-*E. socialis*- *Z. aurantiacum*		
2.1 *Eucalyptus oleosa* with *Z. aurantiacum*	)) *E. oleosa* &/or					
2.2 *E. oleosa*/*E. gracilis*	) *E. gracilis* +/-) *E dumosa* (+/- *E. socialis*)	29. *E. gracilis*, *E. oleosa* Tall Sparse Shrubland	1. *E. gracilis*+/- *E. oleosa* Tall Open Shrubland	*E. oleosa*-*E. gracilis*- *Sclerolaena diacantha*	5. *E. oleosa*, *E. gracilis*, *Sclerolaena diacantha* dense semi-arid swale	4. *E. oleosa* (+ *E. dumosa*)
2.3 *E. oleosa* with *Carrichtera annua*	) Open Shrubland) OR					
3.1 *E. oleosa*/*E. socialis*	)*E. socialis* (or *E. oleosa*) +/-					
3.2 *E. socialis*/*E. gracilis*/ *E. oleosa*	)*E. gracilis* +/- *E dumosa*)Open Shrubland					
4.1 *Euclyptus socialis*	)					
4.2 *E. socialis*/*Myoporum platycarpum*/*Senna artemisioides* sspp.	)))) *E. socialis* (or *E. dumosa*))) +/- *E. gracilis*					
5.1 *Eucalyptus dumosa* with *Triodia irritans*	) Open Shrubland)	34. *E. dumosa* +/- E. *leptophylla* Tall Shrubland		*E. dumosa*-*T. irritans*-) *Beyeria lechenaultii*;		10. *E. dumosa* (*E. gracilis*, *E. socialis*)
5.2 *E. dumosa*	)) *E. dumosa*)) Open Shrubland † OR		3. *E. dumosa*+/- *E. gracilis* Tall Open Shrubland	)*E. dumosa*-*E. socialis*-)*E. rugosa*;		
5.3 *E. socialis* with *Triodia irritans*	)) *E. dumosa*, *E. socialis* †)) Open Shrubland OR	)33. *E. leptophylla*,) *E. socialis*) Tall Open Shrubland;	[A. *T. irritans*,] [*E. socialis*,] [*E. cyanophylla*]	))*E. socialis*-)*E. incrassata*-)*Melaleuca uncinata*;	3. *E. socialis*, *T. irritans* *Sclerolaena parviflora* semi-arid dune mallee	1. *E socialis*, *E. dumosa*

	) *E. dumosa* +/-)*E. socialis*) Tall Shrubland	)36. *E. cyanophylla*) +/- *E. socialis*) Tall Open Shrubland;		)*E. cyanophylla*-)*T. irritans*;)		18. *E. foecunda*, *T. irritans*
		)40. *E. incrassata*, *Leptospermum coriaceum* Tall Sparse Shrubland		)*E. incrassata*-)*T. irritans*	1. *E. incrassata*, *Callitris verrucosa* temperate mallee thicket	6. *E. incrassata* (+ *E. foecunda*)
13. *E. olesosa* Very Open Tree Mallee						
21.*E. brachycalyx* Open Tree Mallee	*E. brachycalyx* +/- *E. socialis* Open Scrub			*E. oleosa* - *E. brachycalx*		
23. *E. porosa* Open Tree Mallee	*E. porosa* Low Woodland	11. *E. porosa* Low Open Woodland	11. *E.porosa* +/- *Lomandra effusa* Tall Open Shrubland	*E. porosa* Group		

Mallee biogeography

The major north-south cline of mallee systems in South Australia reflects a gradient of annual rainfall and soil-water relations (Sparrow, 1989). The inter-relationship of the major mallee vegetation types is complex, being influenced by soil texture, pH, annual rainfall and limestone development.

Sparrow (1989) proposes a model that describes the relationship between depth of sand (or height of sand dune) and local annual rainfall as determining the optimal environmental conditions and hence dominance of Eucalypt species in sand dune alliances. That is, as one travels northwards in the mallee areas (of S.A.), certain Eucalypt species retreat to deeper sands as rainfall decreases, because in deeper sandy soils water can penetrate further down in the profile and less water is lost through evaporation than in more clayey shallow soils.

This is typified by *E. incrassata* which at the southern limit of its range occurs in swales but progresses to the dune crests at its most northerly extent (as found in the southern areas of the South Olary Plains). Sparrow (1989) states that this is clearly a response to soil-water relations, and graphically represents such trends for several Eucalypt species with each species having different individual water requirements and thus optimal conditions of rainfall and sand depth.

On the South Olary Plains, such a trend was noticed in *E. dumosa* distribution, particularly when conducting the vegetation mapping from aerial photography. Throughout most of the survey area, *E. dumosa* occurred with *Triodia scariosa* (and often with *E. socialis*) on sandy dune crests, whereas *E. oleosa, E. gracilis* and *E. socialis* occurred on swales and sandplains. However, towards the south of the area, *E. dumosa* and *Triodia* progressed down the dunes to the swales and *E. incrassata* dominated the dune crests.

In the survey area *E. gracilis* and *E. oleosa* tended to be less common in the sandy southern areas (the latter of which also fits Sparrow's model) but *E. socialis* occurred throughout the area. Sparrrow (1989) notes that the distribution of *E. socialis* is widespread (occurring in most of the mallee alliances) and is not well explained by the soil-water relations model. However, in that study *E. socialis* was recorded on sandier soils than *E. oleosa* and *E. gracilis* (as was found on the South Olary Plains survey) but at low rainfall it occured on various sands and loams (which accounts for the variations in *E. socialis* distribution recorded in the South Olary Plains).

Sparrow's (1989) model shows that *E. socialis* occurs on sandier soils than *E. dumosa*, which was not evident on the South Olary Plains. However this would be because under the drier conditions *E. dumosa* could only survive on the deeper dune crest sands, whereas *E. socialis* was adaptable to various soil types, particularly in the north, which is as Sparrow describes for this species at low rainfall.

Sparrow (1989) also noted that *E. socialis* tends to replace *E. oleosa* where there is sheet calcrete but occurs on more nodular carbonate than *E. dumosa.* Similarly Jessop (1948) recorded that *E. gracilis* becomes more prominant if limestone is nearer the surface.

Non-mallee vegetation groups (Table 8)

The South Olary Plains vegetaton groups 6 to 26 do not compare well with groups of the other studies, probably because they are minor groups and are perhaps more specific to this study area.

The most comparable groups across the studies are the grasslands, the *Sclerolaena diacantha* shrubland, the claypan and saline communities and the *Dodonaea viscosa* ssp. *angustissima* shrubland. Although the South Olary Plains survey did not identify separate *Alectryon oleifolius* and *Myoporum platycarpum* woodland groups, these species were most prevalent in the *Danthonia* sp. grassland group and thus correlated with such woodland groups of the other studies.

The Blackoak and chenopod groups (numbers 27 to 34), being larger, showed more similarities with groups from all the other studies. Most occurred quite consistently across all the studies, except the *Carrichtera annua* (with *Maireana sedifolia*) and *M. pyramidata*/*Atriplex vesicaria* low shrublands, both of which could have been included within other groups of the other studies. The Murray Mallee and Western Murray Flats surveys did not identify as many chenopod groups, being further south and in more mesic areas.

The chenopod groups all occurred on various sands and loams, as is generally the case (Cunningham *et al.*, 1981; Williams, 1979). [Although in smaller survey areas, such as in Mallee Cliffs National Park (Morcombe and Westbrooke, 1990), distinct soil trends related to vegetation groups seem to be more evident.

Unfortunately soil carbonate was not measured on the South Olary Plains survey as some trends should have been detectable. *Maireana sedifolia* is known to occur in areas with shalow calcareous soils (Jessop, 1948) particularly where there are limestone nodules at 60cm or less depth (Cunningham et al., 1981), whereas the similarly deep-rooted *Maireana pyramidata* (Williams, 1979) also occurs in shallow soils but where there is no, or only deep, lime (Jessop, 1948).

Atriplex vesicaria tends to grow on deeper soils (Jessop, 1948) but also commonly occurs on rocky hills and ridges (Cunningham *et al.*, 1981). *Maireana astrotricha* (Grey or Low Bluebush) is more common on hills and more frequent in northern areas where Pearl Bluebush is rarer or absent (Cunningham *et al.*, 1981). Although the

South Olary Plains floristic vegetation analysis did not show this, both these factors were apparent for *M. astrotricha* during the vegetation mapping.

The additional groups listed at the end of Table 8 were not identified in the South Olary Plains floristic analysis because they only occur as small isolated patches in the area, but they are still recognized vegetation types of the area:

Callitris preissii (Southern Cypress Pine) woodland - occurs in small patches in the south near the River Murray;
Callitris columellaris (White Cypress Pine) woodland (now *C. glaucophylla*) - identified in the vegetation mapping, in ranges in the northern areas, particularly around Oulnina Park station;
Eucalyptus camaldulensis (River Red Gum) woodland - mapped along major creek lines throughout the area;
Acacia aneura (Mulga) woodland - occurs amongst Blackoak woodlands in the northern areas (and was mapped with the Blackoak open woodland unit) but is more prevalent further north;
Alectryon oleifolius (Bullock Bush) woodland - small groves scattered throughout the area;
Acacia sp., *Acacia colletioides*, *Eremophila glabra* and *Senna artemisioides* ssp. shrublands - occur frequently as shrubby patches throughout the area (except *Eremophila*), mapped with the mixed shrubland unit;
Erodiophyllum elderi (Koonamore Daisy) ephemeral community - occurs in small patches in northern areas;
Acacia loderi (Nealie) - isolated populations in the central east of the area.

Table 8
Comparison of the South Olary Plains non-mallee vegetation floristic groups with those of other studies of the area and adjacent regions.

Neagle (1995) is a statewide classification, collated from all previous works in the state; the Murray Mallee survey area (Department of Environment & Natural Resources, in prep.) is south and south-east of the currrent survey (and includes data from the Victorian mallee) with results being derived from PATN analysis of cover/abundance data; the Western Murray Flats (Lock and Goodwins, 1993) is south-west of the survey area and also derived from PATN analysis of cover/abundance data; Noy-Meir (1971) is a survey of the semi-arid zone of south-eastern Australia, with multivariate analysis conducted on both presence/absence and dominance/cover data; Tiver (1994) covers the top half and north of the survey area and is also from multivariate analysis; and Morcombe and Westbrooke (1990) is a study of Mallee Cliffs National Park in N.S.W. (100 km east of the Chowilla floodplains) and is also a classification analysis oncover/abundance data [shown in brackets in the Tiver column].

Groups are compared on the basis of the common species lists in the respective survey reports. Numbers are the vegetation group numbers from the respective surveys. Additional groups listed at the end were not identified in the current floristic analysis but are known to occur as small isolated patches in the South Olary Plains.

Conservation status classified by Neagle (1995): † = moderate, †† = poor, (from a scale of excellent, reasonable, moderate, poor or nil conservation).

South Olary Plains	**Neagle (1995))**	**Murray Mallee**	**Western Murray Flats**	**Noy-Meir** (presence/absence data)	**Noy-Meir** (dominance/cover data)	**Tiver (1994)** [+ Morcombe and Westbrooke, 1990]
6. *Stipa scabra* group Open Grassland						
7. *Maireana trichoptera* Low Open Shrubland						
8. *Salvia verbenaca* Open Herbland						
9. *Enneapogon intermedius* Open Grassland						
10. *Atriplex angulata* / *Maireana brevifolia*			6. *E. tomentosa* +/- *M. brevifolia* Open Shrubland			
11. *Casuarina pauper* / *Eucalyptus dumosa* Low Open Woodland						
12. *Sclerolaena diacantha* Low Very Open Shrubland		7. *S. diacantha/uniflora*-*Stipa* sp.-*Enchylaena tomentosa* Low Open Shrubland		18. *S. dicantha*, *Casuarina pauper*, (*Einadia nutans*)		
14. *Eremophila sturtii* / *Acacia burkittii* Open Shrubland	*Acacia* spp. &/or *Eremophila* spp. &/or *Dodonaea* spp. &/or *Senna* spp. Tall Shrubland					

15. *Sida petrophila* / *Ptilotus obovatus* var.*ob.* Low Open Shrubland						H. *S. petroph.*, *P. obov.*, *S. ellipticum*, *E. tomentosa*
16. *Rhagodia ulicina* / *Maireana sedifolia* Low Open Shrubland						
17. *Lycium australe* Open Shrubland	*Sclerostegia tenuis* &/or *Halosarcia halocnemoides* Low Shrubland	52. *Halosarcia* spp. - *Disphyma crassifolium* ssp. *clavellatum* Low Shrubland; 53. *D. c.* ssp. *clavellatum.* - *Atriplex vesicaria* Low Shrubland (Vic. only)				
18. *Danthonia* sp. Open Grassland	*Alectryon oleifolius* Low Open Woodland †; *Myoporum platycarpum* Low Open Woodland)	8. *A. oleifolius* Tall Sparse Shrubland) 2. *Stipa* sp.) Open Grassland	5. *Geijera linearifolia* + *M. platycarpum* Woodland	17. *A. oleifolius*, *Duboisia hopwoodii* northern fringe dune mallee	8. *A. oleifolius*	
19. *Stipa* sp. Open Grassland	) *Stipa* spp., *Danthonia* spp.) Ephemeral Herbland; *S. nitida-Sclerolaena* spp. Ephemeral Community ††	))				
20. *Maireana aphylla* / *Nitraria billardierei* Low Open Shrubland	*Nitraria billardierei* Low Shrubland; *M. aphylla* Low Shrubland; *Eragrostis australasica* Tussock Grassland ††; *Muehlenbeckia cunninghamii* Low Shrubland; *Chenopodium nitrariacum* Low Shrubland ††;				12. *M. aphylla*, *N. billardierei*	
22. *Dodonaea viscosa* ssp. *angustissima* Open Shrubland	*Acacia* spp. &/or *Eremophila* spp &/or *Dodonaea* spp. &/or *Senna* spp. Tall Shrubland; *D. v.* ssp. *angustissima* Low Open Shrubland					[7. *Dodonaea viscosa* ssp. *angustissima* Shrubland]

24. *Rhagodia parabolica* / *Dodonaea lobulata* Open shrubland						
25. *Asphodelus fistulosus* Open Herbland						
26. *Sclerolaena obliquicuspis* Low Open Shrubland						
27. *Atriplex vesicaria* Low Open Shrubland	*Atriplex vesicaria* Low Shrubland			4. *A. vesicaria, Minuria cunninghamii, Malacocera tricornis* saltbush shrubland	3. *A. vesicaria* (*Disphyma crassifolium* ssp. *clavellatum*)	
28. *Maireana astrotricha* / *Atriplex vesicaria* Low Open Shrubland	*M. astrotricha* +/- *A. vesicaria* Low Shrubland					N. *A. vesicaria, M. astrotricha:* L. *M. astrotricha, Rhagodia spinescens*
29. *Maireana pyramidata* Low Open Shrubland	*Maireana pyramidata* Low Shrubland	10. *M. pyramidata* Sparse Shrubland		8. *M. pyramidata, M. tomentosa, M. georgei*, shrubland & shrub woodland	5. *M. pyramidata*	F. *M. pyramidata;* E. *M. pyramidata, S. obliquicuspis;* [9. *M. pyramidata* Low Open Shrubland]
30. *Maireana pyramidata* / *Atriplex vesicaria* Low Open Shrubland						
31. *Carrichtera annua* Herbland						
32. *Maireana sedifolia* Low Open Shrubland	*Maireana sedifolia* Low Shrubland	21. *M. sedifolia* Open Shrubland	8. *M. sedifolia* +/- *Lycium australe* Shrubland	14. *M. sclerolanoides, M. sedifolia, M. trichoptera* shrub and shrub woodland	11. *M. sedifolia, Myoporum platycarpum*	[8. *M sedifolia* Low Open Shrubland]))
33. *Casuarina pauper* Low Woodland (with *M. sedifolia*)	) *Casuarina pauper*) Low Woodland) OR	6. *C. pauper* Low Woodland		1. *C. pauper, Alectryon oleifolius, Atriplex stipitata*, typical semi-arid woodland	2. *C. pauper* (*A. oleifolius*)	)D. *M. sedifolia,*)*C. pauper,*)*S. obliquicuspis*
34. *Casuarina pauper* Low Woodland (+*Senna artemisioides* ssp.)	) *Casuarina pauper*) Low Open Woodland					[3. *C. pauper* Low Woodland/Low Open Woodland]

Additional groups known to occur in the South Olary Plains as minor isolated patches	*Callitris preissii* Low Woodland †	1. *C. preissii* Low Open Woodland	12. *C. preissii* Low Woodland	13. *C. preisii, Santalum murrayanum* southern mallee woodland		
	Callitris columellaris Low Woodland			6. *C. columellaris, Maireana enchylaenoides, Sclerolaena convexula,* eastern intermediate woodland	9. *C. columellaris,* (*E. intertexta*)	[4. *C. glaucophylla* (*columellaris*) Low Open Woodland]
	Eucalyptus camaldulensis Woodland †		16. *E. camaldulensis* Open Forest/Woodland			
	Acacia aneura Low Woodland OR *A. aneura* +/- *A. brachystachia* Tall Shrubland			16. *A. anuera, A. homalophylla Eremophila longifolia* northern woodland		[6. *A. aneura* Open Woodland]
	Alectyron oleifolius Low Woodland †					
	Acacia nyssophylla Low Open Shrubland †					
	Erodiophyllum elderi Ephemeral Community †					
				11. *Acacia colletioides, Eremophila glabra, Senna artemisioides* ssp. shrubby open swale mallee	17. *A. colletioides* (*Myoporum platycarpum, Geijera linearilob*a)	
					13. *Acacia loderi,* (*Alectryon oleifolius*)	
					19. *Senna artemisioides* sspp.	

Biogeographic considerations

The South Olary Plains represents a significant transition zone between three major biogeographic regions in South Australia: the southern Murray Mallee, the northern arid zone and the Mount Lofty and Flinders Ranges.

Vegetation in the southern half of the survey area comprises the northern-most (and most arid) extension of Murray Mallee communities that occur predominantly as fragmented patches of vegetation south of the River Murray. The five major mallee groups found on the current survey are such communities with the possible exception of Group 4 (*Eucalyptus socialis*) which is more widely distributed and extends into the arid zone, 'outliers' of Group 1 (*E. gracilis*) which occur in the north and Group 3 outliers (*E. oleosa/E. socialis*) occurring in the west.

The northern region of the survey area is at the southern edge of the extensive arid zone that covers a large proportion of South Australia. This northern part comprises predominantly low open chenopod shrublands (*Atriplex* spp. & *Maireana* spp.) and open Mulga (*Acacia aneura*) and Blackoak (*Casuarina pauper*) woodlands. Vegetation groups identified in the analysis exclusively with these northern arid zone affinities are the *Stipa scabra* group, the *Maireana astrotricha/Atriplex vesicaria* group and the *Enneapogon intermedius* group. A number of other groups had northern tendencies in their distributions; *Maireana pyramidata*, *Atriplex vesicaria* and *Stipa* sp./*M. pyramidata* groups (although all showed slight western tendencies as well).

The central region of the survey area encompasses the transition zone between the southern temperate mallee and northern arid chenopod/woodland communities. Dominated by Blackoak woodlands and Bluebush (*Maireana sedifolia*) shrublands, this semi-arid central area contains species and communities representative of both the northern and southern zones.

The western edge of the South Olary Plains survey area, extending into the foothills of the Burra Hills, contains a number of species and communities typical of the northern Mount Lofty Ranges such as *Eucalyptus porosa* and *E. brachycalyx* open woodlands. (These communities have subsequently been better sampled in the recent Burra Hills survey conducted by the Department of Housing and Urban Development). Sections of the south-western corner of the current survey area have been cleared for agriculture, being on the edge of the perpetual leasehold agricultural area. This western region of the survey area thus represents a transition zone between the ranges environment with agricultural land uses and the semi-arid pastoral plains.

Numerous species recorded on the South Olary Plains survey showed distinct northern, southern and/or western tendencies in their distributions which reflect their affinities with the arid, southern or western biogeographic zones respectively. They are, however, too numerous to list here. The north-south trend in species and communities generally reflects the climatic gradient of rainfall quantity and seasonality.

A number of outliers of the Olary Spur and southern Flinders Ranges environments occur in the northern part of the survey area [e.g.Pualco Range (between Spring Dam and Braemar Stations), Anabama Hill, Benda Range and Oulnina Hill and ranges]. These outliers can contain important relict populations and communities more typical of the larger ranges (e.g. *Codonocarpus pyramidalis*-Slender Bell Fruit). Unfortunately, as these outliers only occupy a very small percentage of the total survey area, only a few sites were located in them. These areas warrant further investigation which may reveal other interesting remnant populations.

Conservation considerations

As already discussed, the South Olary Plains contains numerous species which have significant conservation status on a national, state and/or regional basis.

Additionally, a number of communities identified are classified by Neagle (1995) as having important conservation status in South Australia. On a scale of excellent, reasonable, moderate, poor or nil conservation, those in the South Olary Plains classified as only moderately conserved are:

Eucalyptus dumosa Open Scrub with sparse sclerophyllous shrubs;
E. dumosa/ Eucalyptus socialis Open Scrub with sparse sclerophyllous shrubs;
Eucalyptus porosa Low Woodland with grassy understorey;
Eucalyptus camaldulensis Woodland with grassy understorey;
Alcetryon oleifolius Low Open Woodland and Low Woodland with semi-succulent shrubs;
Callitris preissii Low Woodland with grassy understorey;
Acacia nysophylla Low Open Shrubland (natural clearings);
Erodiophyllum elderi Ehemeral Community.

Those classified as being poorly conserved are:

Chenopodium nitrariaceum Low Shrubland (arid zone swamps and water courses);
Eragrostris australasica (Canegrass) Tussock Grassland;
Stipa nitida, Scleroleana spp. Ephemeral Communities.

The first two of these latter groups are given a priority of 12 in Neagle's (1995) index of conservation priorities for associations not conserved or poorly conserved in South Australia (total of 14 priorities). The third group is rated priority 14.

Lang and Davies (pers. comm.) have ranked ten plant associations of national significance that are poorly conserved (and under threat) in the South Australian part of the Murray-Darling Basin. *E. porosa* low grassy woodland is ranked equal second (behind four equal first rankings) as although it is relatively widespread it generally has a degraded understorey. *E. porosa* associations with different understories (e.g. non-grassy) are reasonably conserved in South Australia. The South Olary Plains *E. porosa* group can have a variety of understories.

Stephens (1992) has compiled a list of causes of decline and threats to the flora and fauna of the Murray Darling basin mallee. The most significant of these that are relevent to the South Olary Plains survy area are:

-habitat modification/competition with introduced weeds
-habitat degradation, such as overgrazing by domestic stock, feral animals and kangaroos
-habitat clearance
-altered fire regimes

Of concern on the South Olary Plains is the large number of introduced or weed species present (about 160 species - 18%) of which a number are quite common. The most common weeds, such as Ward's Weed (*Carrichtera annua*), Common Sow-thistle (*Sonchus oleraceus*), Smooth Mustard (*Sisymbrium erysimoides*), Common Stork's Bill (*Erodium cicutarium*), Smmoth Catsear (*Hypochaeris glabra*) and Flax-leaf Alyssum (*Alyssum linifolium*), were distributed throughout the survey area but predominantly in the western and northern areas. These areas, being nearer mains roads and the first in the area to be settled, would have suffered a much longer history of grazing (which was more intensive in the early years) and hence have endured greater weed invasion. A number of the creeklines and floodouts in the area are also heavily weed infested.

Of the major vegetation groups identified on the South Olary Plains survey, the five mallee groups are well conserved in Pooginook Conservation Park and Bookmark Biosphere Reserve (Danggali Conservation Park, Chowilla and Calperum leases) although *E. gracilis* communities only occur on Calperum. Western forms of these mallee groups (*E. gracilis*, *E. socialis* and *E. oleosa*) are conserved in Pandappa Conservation Park.

The *Casuarina pauper* (Blackoak) open woodland with shrubby understorey is quite well conserved in Bookmark but only comprises less than 5% of the park (Neagle, 1995). The Blackoak with Pearl Bluebush understorey community, however, is only represented in Bookmark in small patches, as it tends to be more extensive west of the park. A small amount occurs in White Dam Conservation Park (50% of the park) but as this park is very small and elongated and surrounded by grazed perpetual leasehold properties, it is not a very satisfactory refuge.

None of the major chenopod groups are conserved in conservation parks. The only exception is some Pearl Bluebush (*M. sedifolia*) shrublands which occupy 50% of White Dam Conservation Park, however survey sites in the park were classified as the *Carrichtera annua* herbland (with bluebush) group, thus indicating a high weed infestation. Additionally, as noted above, this park is very small.

It is also important to note that in the South Olary Plains the extensive Pearl Bluebush shrublands of the central, south-western and northern areas are not well conserved and the Black Bluebush (*M. pyramidata*) shrublands of the west and north, the Bladder Saltbush (*A. vesicaria*) shrublands of the central, west and north and far north-east and the Low Bluebush (*M. astrotricha*)/Bladder Saltbush shrublands of the north and east are not conserved at all in the region.

Many of the minor vegetation groups identified in the floristic analysis were not sampled well enough to be accurately defined and therefore cannot be included in this systematic conservation assessment. However, some of the larger, or more recognized, minor groups can be assessed.

Only four of these appear to be conserved to any extent in parks:

- the open shrublands of *Eremophila sturtii*, *Acacia burkittii* and *Dodonaea viscosa* ssp. *angustissima* (including *Senna artemisioides* sspp.) (i.e. two groups) (conserved in Bookmark C.P.);
- the western shrublands of *Dodonaea lobulata*, *Olearia decurrens* and *Rhagodia parabolica* [conserved in Pandappa Conservation Park, although only comprises 2% of the park, and is "*Cassinia laevis*, *O. decurrens* and *Dodonaea* spp. shrubland" (Neagle, 1995)];
- *Danthonia* sp. Open Grassland (in patches in Bookmark), [which includes scattered *Myoporum platycarpum* and *Alectryon oleifolius*].

Most of the larger recognized minor groups are not conserved in parks in the region:

- the native open grasslands in the north (*Stipa scabra* group, *Enneapogon intermedius*, northern *Danthonia* species, and known *Enneapogon avenaceus* populations);
- *Stipa* sp. open grasslands in the north, north-west and west of the area;
- the ridge communities (*Sida petrophila*, *Ptilotus obovatus*, *Solanum ellipticum*) of the west, north and north-west (although a very small community occurs in Pandappa C.P.);

- the saline and claypan communities (*Maireana aphylla*, *Nitraria billardierei*, *Lycium australe*, *Sclerostegia tenuis*, *Disphyma crassifolium* ssp *clavellatum*) scattered throughout the area;
- the western *Eucalyptus porosa* and *E. brachycalyx* woodlands [although *E. porosa* occurs in <1% of Pandappa and *E. brachycalyx* occurs with *E. oleosa* as one of the three dominant Eucalypt groups in that park (Neagle, 1995)].

VEGETATION MAPPING

by L. R. Foward[1]

A total of 20 primary vegetation mapping units were identified (13 major and 7 minor) and a large number of secondary and tertiary units (mosaics of primary units). Primary mapping units comprised 30% of the total survey area, with the remaining 70% being mapped as secondary and tertiary mosaics.

The vegetation map for the South Olary Plains study area is Map 1 in the back pocket of this report

When interpreting vegetation mapping units, it must be remembered that the units were delineated in a different way from the floristic groups i.e. by aerial photo interpretation of landforms, soils and upperstorey structure, and therefore there is no direct correlation between the two classifications but they do inter-relate to a degree. Therefore, by considering the predominant soils and landforms recorded for each floristic group and knowing the location of the sites of these groups within the mapping units, more detailed floristic composition of the mapping units could be derived.

Soil descriptions used refer only to the surface soil texture and vegetation structural formation classifications are from the table adapted from Specht (1972) in Appendix V.

The presence of large fire scars often made mapping unit determination difficult as young regrowth vegetation showed a different structure. In these cases the vegetation and mapping unit of surrounding areas were assumed if soil and landforms appeared the same.

As the South Olary Plains survey area is so large and varied, the structural and floristic description of most mapping units is written to encompass the range of that vegetation type across the whole area. Therefore the range of possibilities within each unit must be kept in mind when interpreting the vegetation map.

Major primary mapping units (containing >75% homogeneous vegetation type)

A. *Eucalyptus gracilis* / *E. oleosa* / *E. socialis* Open tree mallee

Identified on a variety of loamy soil types on swales and plains in plain or sandplain landform patterns, this unit comprises predominantly floristic groups one and two and probably some of group three. *Eucalyptus gracilis* (Yorrell) and/or *E. oleosa* (Red Mallee) dominate the upperstorey with *E. socialis* (or E. dumosa occurring on sandier soils. The canopy cover ranges from very open to mid-dense but open is the most common. The understorey comprises *Zygophyllum aurantiacum, Enchylaena tomentosa* var. *tomentosa* and a variety of other *Zygophyllum* species, *Grevillea huegellii, Olearia muelleri, Senna artemisioides* sspp. and chenopod shrubs.

In it's homogeneous form, this unit covers 1.2% of the survey area. It mostly occurs however as a mosaic with several other units: the other mallee units, blackoak woodlands, shrublands and grasslands and occurs predominantly throughout the southern half of the region but also in the west.

B. *Eucalyptus socialis* / *E. oleosa* Open tree mallee

This unit was identified by sandier soils on a variety of landform elements, but mostly dunes in dune systems, and comprises floristic groups three and four. *Eucalyptus socialis* (Beaked or Summer Red Mallee) dominates the overstorey but *E. oleosa* is also common, with *E. dumosa* occurring on deeper soils and some *E. gracilis* probably on less sandy soils. The soils are varied but sandier than in unit A and canopy cover is similarly variable. The understorey comprises a variety of shrubs including *Enchylaena tomentosa* var. *tomentosa, Zygophyllum* spp., *Olearia muelleri, Westringia rigida*, chenopod shrubs and some *Triodia irritans* on deeper sands.

Although covering only 0.01% of the survey area in its homogeneous form, this unit also occurs predominantly as mosaics with other mallee units, woodlands, shrublands and grasslands, throughout the south-eastern areas.

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Being similar to unit A in structure, these two units were difficult to separate in many places but were generally delineated on the basis of apparent soil sandiness, elevation and landform, i.e. unit A is more of a 'plains' mallee whereas unit B is a 'dune' mallee (without *Triodia*). [Due to their similarities and the difficulty in differentiating these two units, they were never mapped as a mosaic, but were generally separated as described above].

C. *Eucalyptus dumosa* / *Eucalyptus socialis* Open tree mallee

The presence of *Triodia irritans* (Spinifex) was the key factor in identifying this unit, as the hummock grassland understorey is clearly distinguishable as a very fine-grained dense shading on aerial photography. *E. dumosa* (White Mallee) and/or *E. socialis* (floristic group number five) dominate the upperstorey with *E. leptophylla* (Narrow-leaf Red Mallee) and *E. incrassata* (Ridge-fruit Mallee) also occurring in the south. Other understorey species include *Beyeria opaca, Eremophila glabra* and mixed shrubs, but less chenopods are present than in units A and B.

This unit occurs predominantly on sand or loamy-sand dunes, but where there are deeper sands in the far south of the area *Triodia* and *E. dumosa* dominate the swales and E. incrassata the dunes.

Covering 1.2% of the survey area this unit is distributed throughout the vast dunefields in the south-east of the area, commonly as a mosaic unit with the 'plain' and 'dune' mallees (units A and B) but with few other units due to the sandy soils.

D. *Eucalyptus socialis* / *E. gracilis* Open tree mallee

This arid mallee association occurs in the north and north-west of the survey (only 0.4% of the area) on the linear ranges of Benda Oulnina Park and northern Braemar stations and surrounding areas. This unit contains the northern sites of the mallee floristic groups one (*E. gracilis*) and four (*E. socialis*), occurring on various loams and skeletal soils.

The overstorey of *E. gracilis* and/or *E. socialis* may also include scattered Northern Cypress Pine (*Callitris glaucophylla*) and False Sandalwood (*Myoporum platycarpum*) with understorey species being predominantly low chenopods, grasses, *Triodia irritans*, *Dodonaea* spp., *Rhagodia spinescens* and/or ridge-top species such as *Sida petrophila, Ptilotus obovatus* var. *obovatus* and *Solanum* spp..

E. *Eucalyptus brachycalyx* (Gilga) Open tree mallee

Occurring only in the far west of the survey area, on the upper foothills of the Burra Hills, this *E. brachycalyx* dominated unit (including floristic group 21) also frequently contains *E. oleosa, E. gracilis* and sometimes *E. socialis.* Understorey species include *Zygophyllum* spp., chenopod shrubs, grasses and mixed shrubs.

Covering only 0.7% of the survey area, this unit is often mixed with grasslands and shrublands, and on the far western edge of the area is fragmented due to land clearance.

F. *Casuarina pauper* (Blackoak) Low woodland

The conspicuous presence of *Casuarina pauper* on aerial photographs characterise this and the next unit, both of which are dominated by Blackoak but which exhibit different structural characteristics, noticeable in the field and on aerial photographs. Although the floristic analysis separated two Blackoak groups (in terms of the species present) the mapping unit separation is on a structural basis. Therefore both these mapping units contain some of floristic groups 33 and 34. Although the soil sampling was limited on this survey, it is probable that the structural (and slight floristic) differences between these two units may be due in part to edaphic factors and subtle landform changes. Floristic groups 33 and 34 occur on plains on a range of sandy loam to clay loam soils

This low woodland unit is characterised by denser Blackoak woodlands which in the field are noticeably taller and more homogenous, with individual trees generally being a slender, upright shape. The understorey appears to be less diverse than the following unit and comprises *Enchylaena tomentosa* var. *tomentosa, Sclerolaena diacantha, Maireana sedifolia, Senna artemisioides* sspp. and various other shrubs (and is thus perhaps more similar to floristic group 33).

Covering 3.3.% of the survey area in its homogeneous form this unit is not as extensive as the following one. The Blackoak component of mosaic units is not identified as either of these two units but just as the presence of general Blackoak woodland with a range of understorey species, regardless of the specific structure. Blackoak mosaics occur extensively across the survey area.

G. *Casuarina pauper* Very low open woodland

This unit is characterised by more open Blackoak woodlands which in the field are not as tall as in the above unit, and individual trees have a more open broader canopy. Other tree species are common, particularly *Alectryon oleifolius, Myoporum platycarpum* and the occasional *Eucalyptus oleosa, E. gracilis* or *E. socialis.*

The understorey species are also more variable, including various chenopods, *Senna artemisioides* sspp., *Olearia* spp., *Eremophila* spp. and *Dodonaea* spp.. In the north of the survey area, Mulga (*Acacia aneura*) commonly occurs in this unit, sometimes in homogeneous groves, but is not extensive enough to be distinguished on aerial photography or recognised as a separate floristic group. This unit is perhaps most similar to floristic group 34 but is much more extensive than just that group implies, covering 6.2% of the survey area in its homogeneous form.

H. *Acacia* spp., *Dodonaea* spp., *Senna artemisioides* sspp., *Eremophila* spp. Mixed open shrubland

This variable shrubland unit contains a range of shrubs that are common understorey species throughout the South Olary Plains but which sometimes occur in single or mixed species stands. They do not often occur in large patches but usually as part of a mosaic with other units. Such shrublands could be detected on aerial photography as a very fine stipple and cover 0.4% of the survey area in their homogenoeus form.

Overstorey species in this unit include *Dodonaea viscosa* ssp. *angustissima* (Narrow-leafed Hop Bush) (floristic group number 22), *Senna artemisioides* sspp., *Eremophila sturtii* (Turpentine) / *Acacia burkittii* (floristic group 14), *Acacia colletioides, A. nyssophylla* and *A. victoriae* ssp. *victoriae. D. viscosa, S. artemisioides, E. sturtii* and *A. victoriae* often occur in disturbed areas such as around dams, homesteads or yards, with the latter particularly favouring watercourses and drainage lines.

The only extensive shrublands of these species occur in the west of the survey area, on the edge of the Burra Hills, where they tend to dominate the hilltops and contain other shrubs such as *Dodonaea lobulata, Cassinia* spp. and *Olearia* spp..

The understorey of this unit consists of low chenopod shrubs (*Enchylaena tomentosa*, *Scleoleana* spp.), grasses and herbs (many introduced).

I. *Maireana sedifolia* (Pearl Bluebush) Low open shrubland

Comprising floristic groups 31 and 32, the dominance of *Maireana sedifolia* renders this unit discernible on aerial photography by its blue tinge (not to be confused with the green haze of ephemeral growth). Additionally, knowledge of survey site information and the presence of *Casuarina pauper* nearby (as they often occur together) often assisted identifying this unit from other chenopod shrublands.

Shrub cover ranges from very open to mid-dense. Very open forms include other chenopod species such as *Sclerolaena obliquicuspis*, *Eriochiton sclerolaenoides* and *Enchylaena tomentosa* var.*tomentosa* and native grasses. Denser stands are often quite species poor with just a ground herbaceous cover, particularly of *Carrichtera annua* in the south-western areas where this introduced species is common.

This unit covers 6.1% of the study area in its homogeneous form and occurs extensively throughout the central, western and lower northern areas of the survey region, predominantly on plains with loamy soils ranging from sandy loam to clay loam, but also on rounded hills in the north (Barber and Linton, 1989). Further north, it seems to be replaced by *Atriplex vesicaria*/*Maireana astrotricha* (particularly on ridges) or *M. pyramidata* shrublands, but some of the latter may be degraded former Pearl Bluebush areas. Bluebush shrublands were often mapped as a mosaic unit with Blackoak woodland, *M. pyramidata* or *A. vesicaria* (particularly as it was still sometimes difficult to differentiate between the latter two species and bluebush, especially where there was significant ephemeral growth. Thus the mosaic units are common.

Some of the quadrats in floristic group 31 had virtually no bluebush, being mostly *Carrichtera annua*, but having a similar floristic component to group 32, they often looked the same on the aerial photographs. So, when interpreting the vegetation map, the range of possibilities within this unit must be considered.

J. *Maireana pyramidata* (Black Bluebush) Low open shrubland

This vegetation unit was more difficult to detect, not having the colour distinction of bluebush nor the stippling of tall shrublands. However, the distribution of floristic groups 29 and 30 indicate its abundance in the western and northern regions of the survey area, where it occurs on loamy to clay soils in plain and floodplain landform patterns, predominantly in low lying areas, on plains and footslopes, and low stony hills in the northern region. In the south it mainly occurs on the edge of the River Murray floodplain. This unit covers 3.3% of the total survey area in its homogeneous form.

Away from known site occurrences the presence of *Maireana pyramidata* shrubland was often surmised from the landforms present, field knowledge of the local area and proximity to disturbed areas. Denser shrublands did tend to look darker on the aerial photographs but were still easily confused with high ephemeral growth and grasslands.

Additional species present in this unit *include Atriplex vesicaria* ssp. (often up to a 50/50 mix*), Maireana georgei/turbinata, M. sedifolia, Enchylaena tomentosa* var. *tomentosa, Sclerolaena obliquicuspis, Stipa* spp., *Carrichtera annua* and other herbs.

In water courses, drainage lines and floodouts, this unit often includes *Nitraria billardierei, Maireana aphylla, Lycium* spp., *Acacia victoriae* ssp. *victoriae*, other shrubs and various herbs (usually weeds).

It is commonly thought that Black Bluebush shrublands indicate degraded former Pearl Bluebush areas, as the more palatable latter is known to be replaced by the less palatable Blackbush, where edaphic conditions are favourable (Barker, 1979; Williams, 1979). In many disturbed areas on the South Olary Plains this appeared to be the case, but the extensive Blackbush shrublands in the northern area could be natural Blackbush shrublands, but this would have to be investigated further. In 1945-47 Jessup (1948) mapped much of the western plains of the current survey area *as Myoporum platycarpum - Maireana sedifolia* association, noting that the shrub layer was "almost a monospecific cover of Bluebush". The current vegetation map shows the area to be mostly blackbush, suggesting that it has been degraded since Jessup's work. On the Burra Hill's survey, Playfair (pers. comm.) similarly found Jessop's Pearl Bluebush association to be virtually non-existent.

K. *Atriplex vesicaria* (Bladder Saltbush) / *Maireana astrotricha* (Grey Bluebush) Low open shrubland

The presence of *Atriplex* spp. was also generally mapped from site data, surrounding vegetation and local field knowledge. Only in some areas, probably where there was more *Maireana astrotricha*, did it show as a pale blue/green tinge on the aerial photographs. This unit covers 2.3% of the survey area in its homogrenous form.

Comprising floristic groups 27 and 28, these shrublands are distributed through the northern and north-western parts of the survey area on plains, hills and rocky ridges, with a variety of loamy and clay loam soils. On Braemar and Mutooroo stations they particularly occur in areas exhibiting gravel lenses or patterned ground (gilgais), especially with quartzite or ironstone gravels. *Maireana sedifolia* seems to occur on rises of deeper soils between such areas on Braemar but this was not investigated in the field. Further north, *A. vesicaria/M. astrotricha* seems to occur on higher, rockier ground than *M. sedifolia*. [Jessop (1948) observed that on rising ground where limestone was nearer the surface, bluebush replaces saltbush].

Associated species in this unit are *M. pyramidata*, *Sclerolaena obliquicuspis* and *M. sedifolia*. The unit was often difficult to distinguish from the other chenopod units and commonly occurs as mosaics with them. In some areas it occurs as very low very open shrublands, depending on the species composition, and thus is hard to distinguish from the grasslands/herbland unit. It also often occurs as an understorey to mallee and as small patches within mallee.

As this unit is difficult to distinguish on aerial photos, its distribution cannot be accurately assessed.

L. *Lycium* spp., *Sclerostegia* spp., *Disphyma* spp., *Nitraria* spp. Mixed low open shrubland

Exclusively found on claypans, scalds and depression areas, this unit is dominated by *Nitraria billardierei* and *Lycium australe* (Australian Boxthorn) (floristic group 20) and *Sclerostegia tenuis* (Slender Glasswort) and *Disphyma crassifolium* ssp. *clavellatum* (Round-leaf Pigface) (group 17) in more saline areas. Such claypan or saline communities are distributed throughout the central regions of the survey area, and often occur as small patches amongst chenopod shrublands, grasslands/herblands and Blackoak woodlands. They cover 0.4% of the survey area.

Additional species in this unit include *Maireana aphylla, Sclerolaena brachyptera, Maireana pyramidata, Eragrostis australasica* (Canegrass*), Muehlenbeckia florulenta* (Lignum) and other *Sclerolaena* species.

M. Open grassland / Open herbland / (Very) Low very open shrubland with emergent trees

This common but variable unit, scattered throughout the region on many landform types, includes very open to mid-dense grassland, herbland and very low chenopod shrublands, as these vegetation types cannot be visually distinguished when viewing aerial photographs. This unit covered 2.5% of the survey area in its homogeneous form but also frequently occurred as a mosaic.

Corresponding to a number of floristic groups, the grasslands are dominated by the native *Danthonia* (Wallaby Grass) and *Stipa* (Spear Grass) species and in localised areas *Enneapogon* intermedius, *E. avenaceus* (Tall and Common Bottle-washers respectively) and *Stipa scabra* group (all three in the north), *Stipa acrociliata* or *S. elegantissima*; the herblands are dominated by *Carrichtera annua* (Ward's Weed), *Asphodelus fistulosus* (Onion Weed), *Marrubium vulgare* (Horehound), *Salvia verbenaca*, *Erodium* spp., *Tetragonia* spp. and some introduced grass species; and the (very) low very open shrublands contain *Sclerolaena* spp. (Bindyii) (particularly *S. obliquicuspis* and *S. dicantha*), *Maireana tricoptera, Eriochiton sclerolaenoides, Atriplex* spp. and other isolated low chenopod shrubs.

A mixture of emergent trees and shrubs is also a significant part of this unit as they are not in sufficient density to be classified as very open woodlands or shrublands. Most commonly the trees are *Myoporum platycarpum* (False Sandalwood) and *Alectryon oleifolius* (Bullock Bush) but also include isolated Blackoak, mallees and Mulga, the latter particularly in the north. *Maireana pyramidata* frequently occurs in this unit, but other isolated shrubs and chenopods are also common. This unit commonly occurs as secondary and tertiary mosaic units with nearly all other units.

In the west and south of the survey area, this unit was used to classify cleared areas that are used for grazing but not cropping. The herblands generally occurred in more disturbed areas around dams, yards, buildings, watercourses and drainage lines.

In the south near the River Murray, patches of Southern Cypress pine (*Callitris preissii*) and River Box (*Eucalyptus largiflorens*) occur in this unit, but they are not extensive enough to map at this scale.

Minor primary units

N. *Eucalyptus camaldulensis* (River Red Gum) Low woodland

Throughout the South Olary Plains sandy ephemeral creeklines and major drainage lines are lined with River Red Gums. River Box (*E. largiflorens*) also often occurs, particularly in the south near the River Murray. This unit covered 0.3% of the survey area. A variety of understorey species are found, depending on the surrounding vegetation type, but generally include *Maireana pyramidata, Rhagodia spinescens, Acacia victoriae* ssp. *victoriae,* other shrubs, grasses and sometimes other Eucalypts.

O. *Eucalyptus porosa* (Mallee box) Open tree mallee

Covering only 0.08% of the survey area, this small unit is found only on some hills, ridges and hillslopes in the far west and north-west of the survey area. Corresponding to floristic group 23 it could not be identified on aerial photography unless there was an actual survey site known to be in this vegetation type, so the true extent of the unit cannot be assessed, but it was still considered worth mapping the known areas. Therefore, some areas have probably been mapped with the western *E. gracilis/E. oleosa/E. socialis* and *E. brachycalyx* mallee units.

The understorey is variable but generally contains Enchylaena tomentosa var. tomentosa, *Rhagodia parabolica,* various shrubs and ridge-top species such as *Cassinia laevis, Olearia decurrens* and *Solanum petrophilum.*

P. *Sida petrophila* (Rock sida) / *Ptilotus obovatus* var. *obovatus* (Silver Mulla Mulla) Low open shrubland

Throughout the South Olary Plains, this unit (floristic group 15) grows on rocky ridge tops. Co-existing species include *Enchylaena tomentosa* var. *tomentosa* (Ruby Saltbush), *Oxalis perennans, Prostanthera striatiflora, Chenopodium curvispicatum,* the native ferns *Cheilanthes lasiophylla* and *C. sieberi* ssp. *sieberi* in sheltered crevices, grasses, low chenopods and occasionally larger shrubs such as *Dodonaea* spp. and *Cassinia* spp..

Isolated trees sometimes occur on these ridges, such as *Eucalyptus porosa* in the north-west and Mulga (*Acacia aneura*) in the north where occasionally *E. gracilis* and E. *socialis* may also occur and *Callitris glaucophylla* on the slopes. In the north and north-west associated species also include *Triodia irritans, Maireana astrotricha* and *Atriplex vesicaria.*

Q. *Callitris glaucophylla* (Northern Cypress Pine) Low open forest

Although three *Callitris* species were found throughout the South Olary Plains area, only one grew as significant woodlands. *C. glaucophylla* low open forests occur in the northern most ranges of the survey area, on and around Oulnina Park Station, usually in gullies and on southern slopes. Other overstorey species include *E. gracilis, E. socialis, E. intertexta* (Barber and Linton, 1989) and *Alectryon oleifolius* with *Rhagodia parabolica, R. spinescens, Dodonaea* spp., *Cassinia laevis, Ptilotus obovatus* var. *obovatus* and *Maireana pyramidata* in the understorey.

This unit sometimes occurs as a mosaic with the northern arid mallee *E. socialis/E. gracilis.*

R. *Allocasuarina verticillata* (Drooping Sheoak) Low woodland

More of a northern Mount Lofty Ranges vegetation type rather than being typical of the South Olary Plains, this unit is found in the far south-western corner of the survey area, in the Burra Hills. Understorey species present at the only South Olary Plains site were *Lepidosperma laterale* (Variable Sword-sedge), *Acacia pycnantha* (Golden Wattle) and *Bursaria spinosa* (Sweet Bursaria).

This vegetation association is more extensive further west throughout the Burra Hills (R. Playfair, pers. comm.) and thus is not a true South Olary Plains vegetation type (hence the quadrat that was located there was excluded from the floristic analysis). Jessop (1948) described the understorey of this association as mostly being *Stipa* and *Danthonia* grasses and herbs. Playfair (pers. comm.) also found *Xanthorrhoea quadrangulata* and *Lomandra* spp..

S. Cleared / Agricultural (cropping) land

On the southern and western edges of the South Olary Plains survey area, native vegetation has been cleared for grazing and cropping. Areas that are cropped were mapped as cleared/agricultural, whereas areas not obviously cropped were mapped as grasslands/herblands.

T. Residential / Agricultural (vineyards/orchards)

Residential areas, vineyards and orchards along the River Murray were mapped as one unit as they are intermingled.

Secondary and Tertiary (mosaic) mapping units
(containing <75% homogeneous vegetation type)

The secondary and tertiary mapping units are mosaics of the above primary units i.e. secondary units comprise 25-75% each of two primary units and tertiary units 25-50% each of three primary units.

As detailed in the methods chapter, the mosaic units are not individually annotated on the map legend, but can be identified by the colour and symbol(s) of the mapped

polygon, which represent the component two (or three) primary units.
Most of the mosaic units do not need individual description, but some exhibited characteristic patterns or were difficult to distinguish and these together with the most common units are briefly described below.

E. gracilis/E. oleosa/E. socialis Open tree mallee and *E. dumosa/E. socialis* Open tree mallee mosaic

Comprising primary units A and C, this is a widespread mosaic, identified as mallee 'plain' vegetation (unit A) with scattered mallee-*Triodia irritans* dunes (unit C) or, at the other end of the scale, mallee-*Triodia irritans* dunes with interdunal mallee flats of much less sandy soils. The dunes are generally longitudinal, parallel and east-west aligned, and occur in a generally plains system. (In many places unit B would have occurred in small sandy patches and on some dune slopes).

E. socialis/E. oleosa Open tree mallee and *E. dumosa / E. socialis* Open tree mallee mosaic

Units B and C contribute to this extensive unit, recognised as mallee dune systems (unit B) with interspersed mallee-*Triodia* dunes (unit C). The difference between this and the above mosaic (of units A and C) is that the non-*Triodia* mallee (unit B) occurs on dunes or very sandy soils of relatively high relief, discernible by stereoscopic viewing of aerial photographs. The dunes in this system are more discontinuous and parabolic in shape, rather than linear, creating a true mosaic pattern, but the delineation between the *Triodia*-mallee and non-Triodia mallee is much less obvious, being more a gradual intergrade. Thus, it is a true dune system, with distinctly sandy soils.

This unit extends across the south and south-eastern region, encompassing 7.9% of the survey area.

As the two dominant mallee units ('plain' and 'dune' mallee, units A and B respectively) intergrade, so do the two mallee mosaic units (A+C and B+C), and thus they were difficult to separate at times.

E. gracilis/E. oleosa Open tree mallee *and Casuarina pauper* Open/very low open woodland mosaic

The mallee plains (unit A) and Blackoak low/very low open woodlands (units F and/or G) characterise this mosaic unit which extends in a broad band across the survey area joining the southern mallee communities and the northern woodlands. It occurs on transitional loam to clay loam soils generally in a plain landform pattern but with occasional low sandy rises.

E. socialis/E. oloesa Open tree mallee and Casuarina pauper Low/very low open woodland mosaic

Interspersed amongst the above mosaic are some mallee dune systems (unit B) with significant patches of Blackoak low/very low open woodland (units F and/or G). This unit is less common than the above 'plain' mosaic and has a mixture of soil types. The dunes are either parabolic or linear but generally without Triodia. [Where the more significant dunes have *Triodia irritans* they were mapped as a separate minor mosaic unit of Blackoak and *E. dumosa/E. socialis*].
Casuarina pauper Low Woodland and *Maireana sedifolia* Low open shrubland mosaic

M. sedifolia shrublands (unit I) occur among Blackoak woodlands (units F/G) and are often more extensive than just isolated patches of woodland understorey. This mosaic was extensively mapped across the whole central area of the South Olary Plains.

Other common secondary mapping units include various combinations of *Maireana sedifolia, M. pyramidata, Atriplex vesicaria/M. astrotricha* shrublands, other shrublands, grasslands, some Blackoak and mallee.

Common tertiary mapping units

The most common tertiary units mapped were those of mallee plain/*Triodia* dune/Blackoak woodland (units A, C and F/G) and mallee dune/*Triodia* dune/Blackoak woodland (units B, C and F/G). The former is more extensive and commonly contains patches of bluebush, mixed shrubs and grasslands.

Tertiary units of the various chenopod and other shrublands and grasslands are also quite common, with some woodlands and mallee.

Comparisons with other works

Table 9 shows comparisons of the current South Olary Plains vegetation mapping units with those of other studies of the area and adjacent regions. The units compare quite well with all the other studies although most were less detailed, except Jessop (1948).

The units mapped by Barratt and White (1993) generally corresponded to the South Olary Plains units, although they were often more detailed, being described from a local perspective within each land system.

Vegetation mapping of the Western Murray Flats (Lock and Goodwins, 1993) and the Murray Mallee (Kinnear, pers. comm.) was conducted at the floristic vegetation group scale which is more detailed than the current study. These groups are compared to the South Olary Plains floristic groups in Tables 7 and 8 in the Vegetation chapter.

The land system mapping of the Olary 1:250,000 mapsheet (Barber and Linton, 1989) (not tabulated) was not directly comparable with the present vegetation mapping as only Land Systems were mapped. In that study, the land units, which are at a similar scale to the present vegetation mapping are simply listed for each land system. Thus each land system contained several of the present vegetation mapping units.

Table 9

Comparison of the South Olary Plains vegetation mapping units with those of other studies of the area and adjacent regions.

Fox (1991) is a study of the natural vegetation of the Ana Branch-Mildura 1:250,000 mapsheet, in south-western N.S.W., that abuts onto the S.A. Chowilla 1:250,000 mapsheet; Barratt and White (1993) includes land system mapping of Bookmark Biosphere Reserve (Danggali, Calperum and Chowilla); Specht (1972) is a vegetation map of South Australia and Jessop (1948) is a vegetation map of the counties Eyre, Burra and Kimberley, in the west of the current survey area.

South Olary Plains (this survey)	**South-western N.S.W.** Fox (1991) [minor units in brackets not mapped]	**Bookmark Biosphere Reserve Land Systems** (Barratt and White (1993)	**South Australia** Specht (1972)	**Counties Eyre, Burra and Kimberley** (Jessop, 1948)
A. *E. gracilis*/*E. oleosa*/*E. socialis* Open Tree Mallee ('plain' mallee)	[*E. gracilis* Tall Shrubland ('swale mallee')]; [*E. oleosa* Tall Shrubland ('sandplain mallee')]			8. *E. oleosa* / *E. gracilis* association
B. *E. socialis*/*E. oleosa* Open Tree Mallee ('dune' mallee)				
C. *E. dumosa*/*E. socialis* Open Tree Mallee ('*Triodia* mallee')	3. *E. socialis* / *E. dumosa* Tall Shrubland ('dune mallee')			
D. *E. socialis*/*E. gracilis* Open Tree Mallee ('northern' mallee)			*E. socialis* / *E. gracilis* Open Scrub	
E. *E. brachycalyx* Open Tree Mallee				7. *E. oleosa* - *E. brachycalyx* association
F. *Casuarina pauper* (Blackoak) Low Woodland	4. *C. pauper*/*Alectryon oleifolius* Tall Shrubland	Hypurna	*Casuarina pauper* Low Woodland	11. *Casurarina pauper* association
G. *C. pauper* Very Low Open Woodland				
H. Mixed Open Shrubland (*Acacia* spp., *Dodonaea* spp., *Senna* spp., *Eremophila* spp.)	[*Acacia victoriae* Tall Shrubland]			9. *Eremophila*, *Dodonaea*, *Acacia* association
I. *Maireana sedifolia* Low Open Shrubland	9. *M. sedifolia* Low Shrubland	) Jack Halls	*A. vesicaria*/*M. sedifolia* Low Shrubland	10. *Myoporum platycarpum* - *M. sedifolia* assocation
J. *Maireana pyramidata* Low Open Shrubland	8. *M. pyramidata*/*Rhagodia spinescens* Low Shrubland; 10. *M. pyramidata*/*Atriplex vesicaria* Low Shrubland	))		
K. *Atriplex vesicaria* Low Open Shrubland	11. *A. vesicaria*/*Sclerostegia tenuis* Low Shrubland	) Littra	*A. vesicaria*/*M. sedifolia* Low Shrubland	10. *Myoporum platycarpum* - *M. sedifolia* assocation

South Olary Plains (this survey)	**South-western N.S.W.** Fox (1991) [minor units in brackets not mapped]	**Bookmark Biosphere Reserve Land Systems** (Barratt and White (1993)	**South Australia** Specht (1972)	**Counties Eyre, Burra and Kimberley** (Jessop, 1948)
L. Mixed Low Open Shrubland (*Lycium* spp., *Nitraria* spp., *Sclerostegia* spp., *Disphyma* spp.)	12. *Sclerostegia tenuis*/ *Atriplex* spp. Low Shrubland; 15. *D. clavellatum*/*S. tenuis* Open Herbland; [*Muehlenbeckia florulenta*] [*Eragrostis australasica*]	(scattered amongst many land systems)		
M.Open Grassland/Herbland / Low Very Open Shrubland	[Grassland - various species]	Sparks	(~*Myoporum platycarpum* Low Woodland)	
N. *Eucalyptus camaldulensis* Low Woodland	1. *E. camaldulensis* Open Forest	(~Chowilla)		1. *E. camaldulensis* association
O. *Eucalyptus porosa* Open Tree Mallee				
P. *Sida petrophila*/*Ptilotus obovatus* Low Open Shrubland				
Q. *Callitris glaucophylla* Low Open Forest	[*C. glaucophylla* Open Woodland]			
R. *Allocasuarina verticillata* Low Woodland				
S. Cleared / Agricultural (cropping)				
T. Residential / Agricultural (vineyards/orchards)				
Common mosaic units				
A + C (plain mallee + *Triodia* dune)				
B + C (dune mallee + *Triodia* dune)				
A + F/G (plain mallee + Blackoak)				
B + F/G (dune mallee + Blackoak)				
A,C +F/G (plain mallee, *Triodia* dune + Blackoak)				
B,C, + F/G/ (dune mallee, *Triodia* dune + Blackoak)	3 with 4 (dune mallee + Blackoak) 4 with 3 (Blackoak + dune mallee)			
F/G, C + J (Blackoak, *Triodia* dune + *M. pyramidata*)	4, 3 + 8 (Blackoak, mallee dune + *M. pyramidata*)			

MAMMALS

by L.R. Forward[1]

INTRODUCTION

No structured recording or trapping of mammals was undertaken in the South Olary Plains, until the 1970's when the Field Naturalists Society of South Australia Mammal Club made a number of field trips to various parks and stations in the area. It was not until 1986 that any systematic trapping and recording took place when the University of South Australia began yearly trips to Danggali Conservation Park. To date, no information has been published on the South Olary Plains mammals.

South Australian Museum records from the South Olary Plains date back to 1889, but most of these (80%) are from the last thirty years (prior to 1992) and those from 1889-1899 were mainly from the riverland area. [Note that the present survey area does not include the Murray River valley and floodplains].

Figure 98 shows the distribution of South Australian Museum mammal records from the South Olary Plains prior to the current survey. Records are concentrated around the edges of the area near towns, along main access routes and in conservation parks. Up to 1992, 30 extant species, 10 of which were introduced, were confirmed from the area, five locally extinct species were known from sub-fossil records and a number of others were thought to have occurred historically in the area.

TOTAL SPECIES

As numerous mammal species rapidly declined or disappeared soon after European settlement in Australia and there are very few or no confirmed location records for many species in some areas. However, the range of some of these species can be ascertained from the limited information in historical documents. As very little field work has been previously conducted in some areas, and particularly because most small mammals are nocturnal and can usually only be recorded by trapping, some species may still occur in the study area. The complete list of all mammal species from the South Olary Plains, shown in Appendix VIII therefore includes all those known as well as species which could have occurred there prior to European settlement.

A total of 66 species from 18 families is listed in Appendix VIII, of which 32 still live in the area (24 native and 8 introduced), 6 are thought to possibly/probably occur there (albeit in some cases as vagrants), 21 are thought to have been there historically and 6 are only known from sub-fossil records. Therefore, of the 50 native species known or thought to have been there since European occupation, 14 (28%) are now extinct in South Australia, four are endangered, two are vulnerable and five are rare (Appendix VIII).

The South Olary Plains survey recorded 29 confirmed extant species representing 11 families. Twenty-six species were recorded on quadrats and an additional three by opportunistic observations. One species was a new record for the area and sub-fossil material was recorded of another 13 species which are now locally extinct.

In total, 93% of known extant mammal species in the South Olary Plains area were recorded on the survey plus the one new record added. The known species that were not recorded were Yvonne's Ningaui (*Ningaui yvonnae*) and the Little Forest Eptesicus (*Eptesicus vulturnus*)).

The total number of mammal species and records recorded by quadrat and opportunistic methods on the survey are summarised in Table 10.

Table 10
Total number of mammal species recorded on the South Olary Plains survey.
Figures in brackets indicate species found *only* by opportunistic observations (which are included in the preceding figure).

	Indigenous	Introduced	Total
Number of species	21(3)	8	29(3)
Approx. no. of records of species	657(14)	296	953(14)

The frequency and abundance of all taxa recorded at survey quadrats (current survey and five University of South Australia Danggali Conservation Park quadrats) are

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listed in Table 11. The species that were included in the analysis are annotated. (Conversion of scientific to common names can be determined from Appendix XII.)

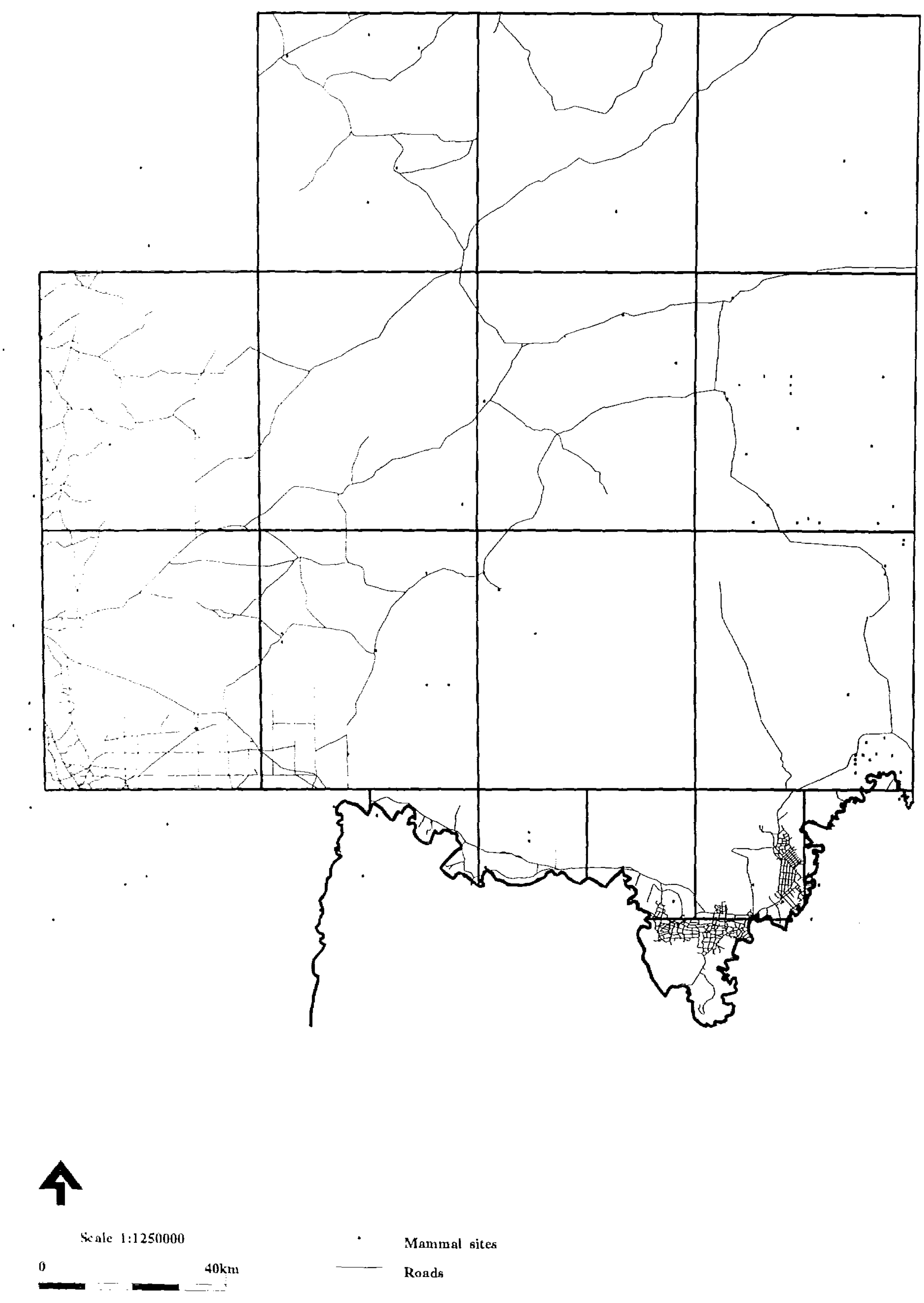


Figure 86

Distribution of South Australian Museum mammal records from the South Olary Plains prior to 1992.

The additional three extant species recorded only from opportunistic observations were the Hairy-nosed Wombat (*Lasiorhinus latifrons)*, Eastern Grey Kangaroo (*Macropus giganteus*) and the Western Broad-nosed Bat (*Scotorepens balstoni*). (Species recorded in the sub-fossil material are discussed later. As a number of species were predominantly recorded by opportunistic observations (e.g. bats) the frequency of all species recorded by this method is shown in Table 12 (remembering that frequency in this case is the number of locations at which the species was recorded, *not* the number of individuals observed).

Table 11
Mammal species frequencies and abundance recorded at quadrats on the South Olary Plains biological survey
The frequency is the number of quadrats at which the species was recorded. The total number of quadrats surveyed for fauna was 93.

Abundance figures represent the total number of individuals of the species recorded (at quadrats) on the survey (or signs of individuals e.g. tracks, scats). [Note that species abundance was not consistently (systematically) recorded at each quadrat. Therefore only species presence/absence (i.e. frequency) data can be accurately compared between species.]

Taxa shown in normal rather than italic typeface were considered unsuitable for analysis i.e. incomplete or dubious identification.

* Introduced species

\+ Species for which data *was* analysed in final analysis (i.e. small terrestrial mammals).

Species	Freq.	Abun.
* *Oryctolagus cuniculus*	50	127
Macropus fuliginosus	45	107
* *Capra hircus*	44	154
Macropus sp.	35	51
Macropus rufus	32	87
* *Ovis aries*	29	40
+ *Sminthopsis murina*	21	34
Tachyglossus aculeatus	21	26
* *Mus domesticus*	20	38
+ *Pseudomys bolami*	18	34
* *Vulpes vulpes*	17	25
+ *Sminthopsis crassicaudata*	16	39
Macropus robustus	10	34
* *Felis catus*	5	9
Chalinolobus gouldii	4	11
+ *Sminthopsis macroura*	4	6
Nyctophilus geoffroyi	3	7
Mormopterus planiceps ('little penis')	1	1
Mormopterus planiceps ('big penis')	2	2
Tadarida australis	2	5
* *Bos taurus*	2	3
Chalinolobus picatus	2	3
* *Lepus capensis*	2	3
Nyctophilus timoriensis	2	3
Eptesicus regulus	1	2
Eptesicus baverstocki	1	1
+ *Planigale tenuirostris*	1	1
* Rattus rattus (?)	1	1
Sminthopsis sp.	1	1

Total number of records of species: 393
Approx. number of individuals observed: 856

Table 12
Mammal species recorded by opportunistic observations on the South Olary Plains survey.
Frequency is the number of locations at which the species was recorded, *not* the number of individuals observed. (Sheep and cattle are not included).
* = introduced species

Species	Frequency
Macropus rufus	179
Macropus fuliginosus	128
* *Capra hircus*	52
* *Oryctolagus cuniculus*	34
* *Vulpes vulpes*	30
Nyctophilus geoffroyi	25
Macropus robustus	23
Chalinolobus gouldii	20
Eptesicus baverstocki	17
Mormopterus planiceps	7
Nyctophilus timoriensis	5
Tachyglossus aculeatus	5
* *Felis catus*	4
Tadarida australis	4
* *Mus domesticus*	2
Eptesicus regulus	1
Lasiorhinus latifrons	1
* *Lepus capensis*	1
Macropus giganteus	1
Total	**562**

From Table 11 it is evident that all species occurred at relatively low frequencies i.e. at less than 45 quadrats (48%), *except* rabbits which occurred at 50 quadrats (54%). The five most frequent species occurred in greater than 30% (29) of the quadrats, of which three are introduced species (rabbit, goat and sheep) and the others the Red and Western Grey Kangaroos. The rest of the species occurred at very low frequencies - 50% of them at less than 4% of the quadrats. Six introduced species were in the top 50% of species.

Goats and rabbits appeared to be the most abundant as these easily animals are easily observed. These figures cannot be compared accurately as abundance data was not collected in a systematic manner at each quadrat [and some of the abundance data is only signs (i.e. droppings, tracks and diggings)]. Red and Western Grey Kangaroos seemed to be the next most abundant animals.

The most abundant species recorded by opportunistic methods were the Red and Western Grey Kangaroos, followed by goats, rabbits and foxes. Most bats were trapped at opportunistic locations as the specified survey sites were not always suitable for bat trapping. Therefore the opportunistic frequencies of bat species give a more accurate picture of bat diversity and abundance. At some of these bat locations up to nine species were captured, including up to 300 individuals in one night, indicating a good bat diversity in the area.

PATN ANALYSIS

After a preliminary analysis conducted on the six small terrestrial mammals (five native, one introduced) it was observed that the ubiquitous House Mouse, found in numerous habitats, was confusing the clustering of the more habitat-specific small native mammals in the analysis. Thus, the final PATN analysis was conducted on presence/absence data of the five small native terrestrial mammals, from 47 quadrats (35 quadrats had no records of small mammals and 11 had only House Mice) (Fig. 99).

With so few species, multi-variate analysis is generally inappropriate and unnecessary as there are not enough data to enable detection of true patterns and any trends between quadrats and species can be visually assessed from a two-way table of species distribution by quadrat. The current survey's small mammal data was subjected to classification analysis to produce a two-way table and highlight some possible trends, but keeping in mind that true patterns could not be detected (and patterns that do appear may not have any real ecological meaning). Ordination of the analysis results was not warranted with such little data.

The dendrogram resulting from the *quadrat* analysis of mammal species is shown in Figure 110 (i.e. comparisons of the quadrats in terms of the mammal species present at each). Of the 47 quadrats, only 11 had records of more than one species of small mammal and of these only two had more than two species. Three of the mammal species had reasonable frequencies, one only occurred four times and another only once. Thus the quadrats on the dendrogram were clustered into four groups, on the basis of these four frequent species, with each group being dominated (almost solely) by one species: *Sminthopsis murina*, *S. crassicaudata*, *S. macroura* and *Pseudomys bolami*. By assessing the vegetation types of each quadrat, the first group contains mostly woodland communities, the next two mostly shrublands and the last woodlands and shrublands.

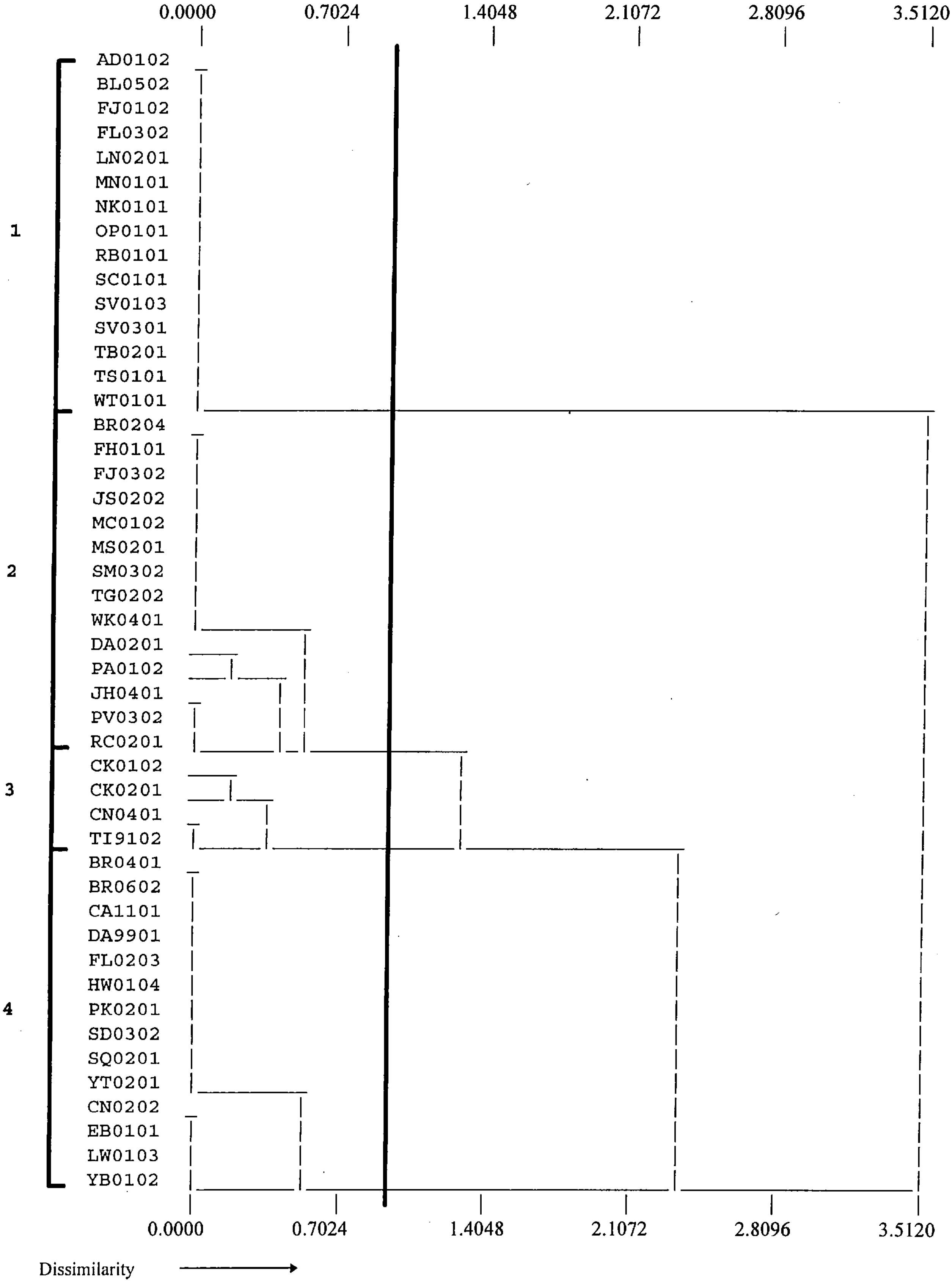


Figure 99
Dendrogram from classification analysis of native small terrestrial mammal data, showing quadrat groups.

The dendrogram of mammal *species* analysis (i.e. comparison of the distributions of each mammal species across all quadrats sampled) also best divided into four blocks of the same species (with *Planigale tenuirostris* grouped with *S. macroura*) (i.e. no true blocks of species could be detected at such low species densities).

The two-way table of species incidence by quadrat (Table 13) shows quite good patterning of the species distribution despite the low abundance data. However, it must be considered whether these can really be called patterns when there is generally only one species found at each quadrat. The validity of the patterns will become evident when the quadrat groups are discussed.

Table 13
Two-way table of native small terrestrial mammal species analysis showing groups of quadrats by blocks of mammal species.

```
GROUPS OF QUADRATS   ---->         1.              2.        3.        4.

                               ABFFLMNORSSSTTW.BFFJMMSTWDPJPR.CCCT.BBCDFHPSSYCELY
                               DLJLNNKPBCVVBST.RHJSCSMGKAAHVC.KKNI.RRAALWKDQTNBWB
BLOCKS OF                      000000000000000.00000000000000.0009.00190000000000
MAMMAL SPECIES                 151321111113211.21321232421432.1241.46192123222111
                               000000000000000.00000000000000.0000.00000000000000
                               222211111131111.41222122112121.2112.12113412112132
                                              .              .    .
1. Planigale tenuirostris                     .              .*   .
   Sminthopsis macroura                       .              .****.
                               ..................................................
2. Pseudomys bolami                           .         * ***.    .**************
                               ..................................................
3. Sminthopsis murina          ***************.         **   .    .          ****
                               ..................................................
4. Sminthopsis crassicaudata                  .**************.**  .
```

It must also be kept in mind that a quadrat with two species is no more similar to another quadrat with just one of the species than it is to another with just the other species (e.g. the last four quadrats on the two-way table, with both *P. bolami* and *S. macroura*, were included in Group 4 (*P. bolami* dominant) by the analysis, but they are no more similar to quadrats in that group (i.e. with just *P. bolami*) than to those quadrats with just *S. macroura* (Group 1). Their positioning in Group 4 is merely a factor of the way the analysis procedure executes the fusions and classification of the quadrats (i.e. in the order in which the quadrats are assessed and clustered). This shows that using multi-variate analyses with such small, low abundance data sets is inappropriate. With larger data sets such 'factors of the analysis procedure' are relatively insignificant compared with the overall patterns being detected.

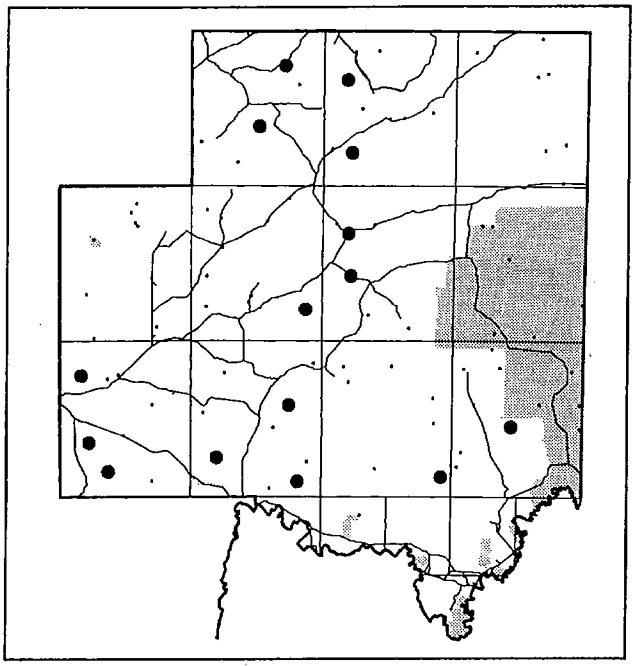
The four quadrat groups are individually described below, each with a map, the number of members (quadrats) and a mammal species list (from GLIST). The map shows the distribution of quadrats at which this suite of mammal species were observed, shown by large dots. The small dots indicate the location of all quadrats surveyed for fauna.

The species list shows the proportion of occurrence of each species within that group (i.e. the proportion of quadrats in that group at which the species occurred), the number of other groups in which that species occurred (i.e. out of a total of four groups) and the X^2 for each species [i.e. a measure of the uniqueness of that species to that group (see methods section)].

A description of the vegetation types indicated by the quadrats present in the group and the general soil types and landform systems present is summarised for each group. However, having such a small data set, an overall habitat type could not be confidently assigned to each group.

Group 1.

15 Members



Quadrat vegetation types

Generally Eucalypt or Blackoak (*Casuarina pauper*) woodlands (but mostly Eucalypts); a few shrublands and one grassland with emergent trees.

Soil types

Various, but generally less loamy than in Group 2 (i.e. more clay and sand components)

Landform systems

Mostly plains, but some dune and hill systems.

Mammal species present

Species	Proportion of Occurence	Number of Groups	Chi Squared	Standardised Residual
Sminthopsis murina Common Dunnart	1.000	3	1.1571	1.08

Comments

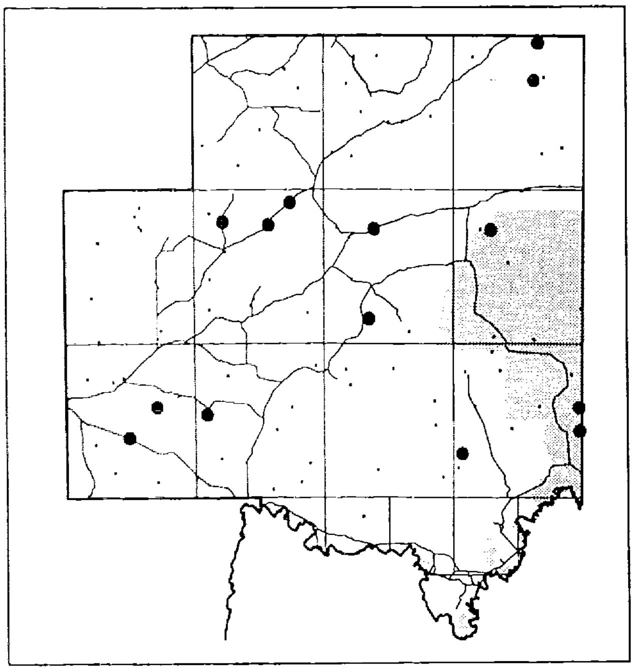
In comparison with Group 4 the quadrats in Group 1 seem to be more predominantly woodland communities and most often comprising mallee or tree Eucalypts.

Sminthopsis murina was the only native small terrestrial species found at these quadrats. Fox (1983) describes the Common Dunnart as inhabiting woodlands, open forests and heathlands, the first of which seems to be the case on the South Olary Plains.

This group is distributed throughout the South Olary Plains, except in the west-north-west (where the House Mouse was prevalent), the north-east (where few extensive woodlands occur) or in the east where *S. murina* co-occurred with *S. crassicaudata* and *Pseudomys bolami* and the quadrats were clustered into those species' quadrat groups. These latter quadrats however, were still all woodlands except one that had woodlands adjacent.

Group 2.

14 Members



Quadrat vegetation types

Mostly chenopod shrublands

Soil types

Various but generally more loamy than in Group 1.

Landform systems

Plains

Mammal species present

Species	Proportion of Occurence	Number of Groups	Chi Squared	Standardised Residual
Sminthopsis crassicaudata Fat-tailed Dunnart	1.000	2	1.0417	1.02
Pseudomys bolami Bolam's Mouse	0.2857	2	0.0040	-0.06
Sminthopsis murina Common Dunnart	0.1429	3	0.1285	-0.36

Comments

The quadrats in this group were all chenopod shrublands except three woodland sites (two Blackoak, one Eucalypt) which had chenopod understories.

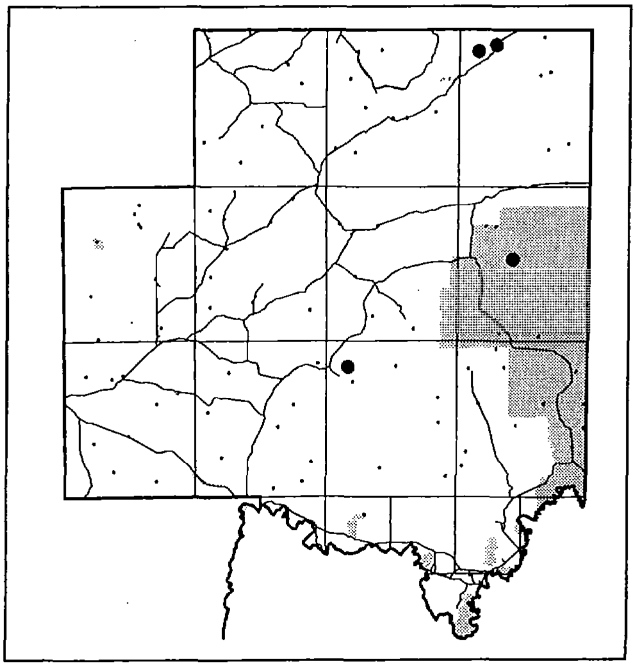
S. crassicaudata is the dominant species with *P. bolami* only occurring at four quadrats and *S. murina* at two. (The negative standardised residuals indicate that the presence of the latter two species in not significant).

The only other quadrats on the survey where *S. crassicaudata* occurred were in the northern chenopod shrublands where *S. macroura* was also captured.

This group is distributed throughout the north-western half of the survey area where extensive chenopod shrublands are predominant, except four quadrats in the south-east which were in patches of chenopods amongst woodlands. This distribution seems to fit that described by Morton (1983) for Fat-tailed Dunnarts: open woodlands, saltbush, bluebush, tussock grasslands, gibber and farmland; i.e. it is known to occur in a variety of habitats on clay, loam or sandy soils (Read, 1987; Morton *et al.*, 1983). However, in western N.S.W. Read (1987) found that these dunnarts preferred low shrublands in many areas.

Group 3.

4 Members



Quadrat vegetation types

Various chenopod shrublands and grasslands

Soil types

Various (loam, silty loam, clayloam, light clay)

Landform systems

Plains

Mammal species present

Species	Proportion of Occurence	Number of Groups	Chi Squared	Standardised Residual
Sminthopsis macroura Stripe-faced Dunnart	1.0000	1	2.2500	1.50
Sminthopsis crassicaudata Fat-tailed Dunnart	0.5000	2	0.0417	0.20
Planigale tenuirostris Long-nosed Planigale	0.2500	1	0.5625	0.75

Comments

Accurate description of this group is not possible , having only four quadrats. However, of these four quadrats, one was grassland with Black Bluebush, one saltbush, one Bluebush and the other *Lycium/Nitraria* shrubland, which suggest a low, sparse (chenopod) shrubland pattern.

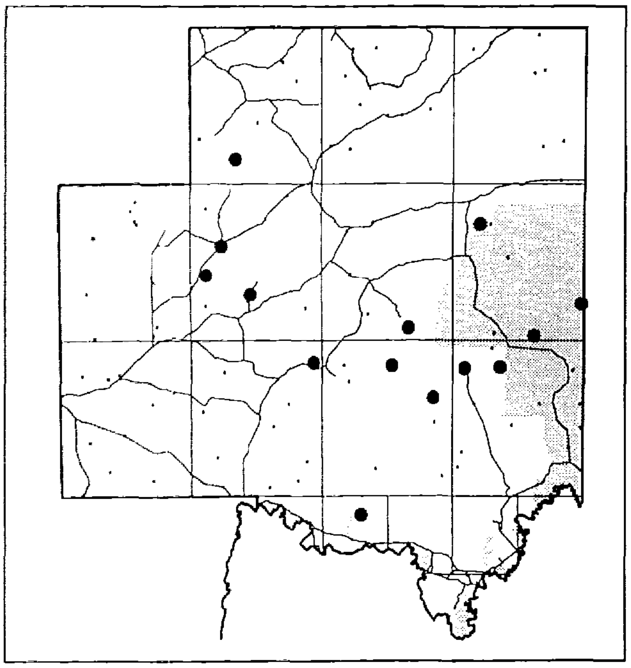
Sminthopsis macroura was the dominant species, with *S. crassicaudata* occurring at two quadrats and the only *Planigale tenuirostris* for the survey occurring at one of these. These four quadrats were the only records of *S. macroura* on the survey; two being in the open saltbush shublands/grasslands of the north-east and the other two in isolated shrublands and claypans further south.

The preferred habitat of *S. macroura* is uncertain but is thought to be saltbush, bluebush and grasslands (Morton, 1983), which is where they were found on the South Olary Plains. In another study though, *S. macroura* appeared to favour stony substrates in some areas but occurred on clay or loam in other areas (Morton *et al.,* 1983).

As discussed earlier, the occurrence of *P. tenuirostris* is significant geographically, being the most southerly record of this species in South Australia. Although commonly found on clay soils, the South Olary Plains site where it occurred was described as loam, but this species is known to occur in a variey of habitats and soils (Reid, 1987). *P. tenuirostris* is known to often occur with *S. crassicaudata* and *S. macroura* (Denny, 1992) as was the case at the South Olary Plains quadrat.

Group 4.

14 Members



Quadrat vegetation types

Mostly woodlands (predominantly Eucalypts) although a number were chenopod shrublands.

Soil types

Generally sandier.

Landform systems

Mixture of plain and dune systems and some hills

Mammal species present

Species	Proportion of Occurence	Number of Groups	Chi Squared	Standardised Residual
Pseudomys bolami Bolam's Mouse	1.000	2	1.4326	1.20
Sminthopsis murina Common Dunnart	0.2857	3	0.0143	-0.12

Comments

The quadrats in this group are a mixture, but predominantly woodlands of which most contain tree Eucalypts or mallee. The others were chenopod shrublands and one herbland.

Pseudomys bolami is the dominant species, with *S. murina* only occurring at four quadrats. The only other quadrats on the survey at which *P. bolami* was found were those four with *S. crassicaudata* in Group 2 of which, one was mallee, one Blackoak woodland and two chenopod shrublands.

Kitchener *et al.* (1984) described *P. bolami* as occurring on plains in Eucalypt low woodlands to open low woodlands with a sparse shrub layer, and in chenopod shrublands in swales, saline pans and spillway deposits. On the Chowilla floodplain survey, *P. bolami* individuals were captured in sandy Black Bluebush shrublands on the alluvial terraces (O'Malley and Sheldon, 1990).

Thus the distribution of this group (and that of *P. bolami*), throughout the mixed woodlands and shrublands of the central region of the South Olary Plains is as would be expected.

SPECIES OF PARTICULAR INTEREST

On the current survey one new species for the South Olary Plains was confirmed (Narrow-nosed Planigale); possible bones of another new to the area (unconfirmed Black Rat) were found in fox scats (by University of S.A. students) and sub-fossil remains of numerous historic or previously unknown species for the area were found (see below).

Of the species recorded on the survey one is classified as rare in Australia and South Australia (Little Pied Bat); one is vulnerable in South Australia and five are uncommon.

Table 13 shows the conservation status of all the confirmed and possible mammal species from the South Olary Plains on an Australian and South Australian basis. Although the status of mammal species have not yet been assessed on a regional basis, many native species would be classified as locally extinct, endangered, vulnerable or rare in the South Olary Plains.

Conservation status codes are as follows and are defined in Appendix XII:

X	Extinct
pX	Presumed extinct
E	Endangered
V	Vulnerable
pV	Potentially Vulnerable
R	Rare
I	Indeterminate
U	Uncommon
C/S	Common/Stable
O	Vagrant

Table 14
Conservation status of mammal species found, or thought to have occurred, in the South Olary Plains area on an Australian and South Australian basis.

	Australian Status							
S.A.	X	pX	E	V	pV	R	I	S
X	5	1	7	1	-	-	-	-
E	-	-	1	3	-	-	-	-
V	-	-	-	1	-	-	-	1
R	-	-	-	-	2	1	1	1
U	-	-	-	-	-	-	-	6
C	-	-	-	1	1	-	-	29
O	-	-	-	-	-	-	-	2

In the notes below, the Australian conservation status is from the Commonwealth *Endangered Species Protection Act 1992* [which is based on the 'Australian and New Zealand Environment Conservation Council (A.N.Z.E.C.C.) list of Threatened Vertebrate Fauna, April, 1991'] and updated from the action plans of Kennedy (1992) (marsupials), Lee (1995) (rodents) and Richards and Hall (1994) (bats). The South Australian status is from Kemper and Queale (1990). Australian current and historical distribution comments are from the action plans or Strahan (1983) and Watts and Aslin (1981) and South Australian distributions from Kemper and Queale (1990), Reardon and Flavel (1991) and S. A. Museum records. Ecological notes are from Reardon and Flavel (1991), Strahan (1983) and Watts and Aslin (1981) and reasons for decline from the action plans. Species only thought to possibly occur, or have occurred, in the South Olary Plains are from C. Kemper (pers.comm.). Only extant species (or those possibly or recently extant) in the survey area are discussed in detail.

Species of national and state significance

In the following lists 'H' indicates species for which there are no museum records from the South Olary Plains but the species are thought to have occurred there historically [deduced from Watts and Aslin, 1981 and Wakefield, 1966 (Blandowski expedition to north-western Victoria, 1856-57)]. 'F' indicates species previously not known to have occurred in the area but sub-fossil material has recently been found (i.e. species occurred there pre and possibly post European occupation).

<u>Extinct in Australia</u>
Crescent Nailtail Wallaby *Onychogalea lunata* H?, F
Eastern Hare-wallaby *Lagorchestes leporides* H
Pig-footed Bandicoot *Chaeropus ecaudatus* H (presumed extinct)
Lesser Stick-nest Rat *Leporillus apicalis* H, F
Long-tailed Hopping-mouse *Notomys longicaudatus* F
Gould's Mouse *Pseudomys gouldii* H, F

<u>Extinct in South Australia (and Australian classification as shown)</u>
Golden Bandicoot *Isoodon auratus* F (endangered)
Western-barred Bandicoot *Perameles bougainville* H, F (endangered)
Burrowing Bettong *Bettongia lesueur* H (endangered)
Numbat *Myrmecobius fasciatus* H (endangered)
Western Quoll *Dasyurus geoffroii* H? (endangered)
Bridled Nailtail Wallaby *Onychogalea fraenata* H? (endangered)
Red-tailed Phascogale *Phascogale calura* H?, F (endangered)
Greater Bilby *Macrotis lagotis* (vulnerable) H
Spotted-tailed Quoll *Dasyurus maculatus* H (including specimens) (potentially vulnerable)
Eastern Quoll *Dasyurus viverrinus* H? (potentially vulnerable)

<u>Endangered in South Australia (locally extinct and classified in Australia)</u>
Mulgara *Dasycercus cristicauda* F (endangered)
Brush-tailed Bettong *Bettongia penicillata* H (endangered)
Greater Stick-nest Rat *Leporillus conditor* H, F (vulnerable)
? Dusky Hopping Mouse *Notomys fuscus* F (vulnerable)

Vulnerable in Australia
Plains Mouse *Pseudomys australis* H, F (locally extinct)
Common Brushtail Possum *Trichosurus vulpecula* H, F (potentially vulnerable)
Sandhill Dunnart *Sminthopsis psammophila* F (vulnerable in S.A., locally extinct)

Rare in Australia and South Australia

Little Pied Bat *Chalinolobus picatus*

This small evening bat occurs in the arid mallee region near the S.A./N.S.W. border where it predominantly roosts in caves but is known to use trees and sheds.

Classified as rare in Australia and South Australia, it is distributed from south-west Queensland through central N.S.W. to north-eastern S.A.. The main reason for this species' decline is the destruction of roosting sites, particularly the loss of mature trees through clearance (Richards and Hall, 1994).

Although not recorded on the South Olary Plains survey, this species has been caught in Danggali Conservation Park at several locations by a number of observers since the seventies. The S.A. Museum has records from Mutooroo Station and it is known from Kinchega National Park in N.S.W., 100km east of Mutooroo (Ellis and Henle, 1988).

Rare in South Australia and potentially vulnerable in Australia

Yellow-footed Rock-wallaby *Petrogale xanthopus xanthopus*
This distinctly coloured rock-wallaby occurs only in three areas in South Australia: the Flinders Ranges (the most extensive populations), the Gawler Ranges and the Olary Hills (north of the Barrier Highway). The same subspecies also occurs in one area in western N.S.W. The range of this subspecies has declined by greater than 50% and continues to be threatened by competition with goats and rabbits and predation by foxes.

In the Olary Hills area rock-wallabies are known historically from south of the Barrier Highway. Skeletal remains have been found at Anabama Hill where there were reported sightings up to 1960. Further to the south-west there have been reported sightings up to 1980 at Pualco West. Both these locations are in the South Olary Plains survey area but extensive ground and aerial surveys in the 1980's revealed no extant populations south of the highway (Lim *et al.*, 1987).

On the South Olary Plains survey more Yellow-footed Rock-wallaby skeletal remains were collected from Anabama Hill and the species was also identified amongst the sub-fossil remains collected there.

Kultarr *Antechinomys laniger*

A small marsupial which is quite widespread but scattered across arid Australia, occurring in all mainland states except Victoria. This species is adapted to open areas, inhabiting desert plains, stony and sandy grasslands, low shrublands and *Acacia* shrublands.

The Kultarr is classified as potentially vulnerable in Australia due to its rare and scattered populations. It is rare in South Australia and known to have occurred on the peninsulas and in the western and eastern pastoral blocks but is now found mostly in the northern areas of the State. Occurrences were recorded on the Blandowski Expedition to the junction of the Murray and Darling Rivers in 1857 (Wakefield, 1966) and recently in Kinchega National Park in N.S.W. 100km east-north-east of the South Olary Plains (Ellis and Henle, 1988).

This species has not been recorded by any of the previous studies in the South Olary Plains and there are no museum specimens from the area, but it is known from Erudina Station 120km north of Yunta. Therefore, considering the habitat and known distribution, Kultarrs are thought to have probably occurred historically in the survey area and may possibly still be present in the northern parts. Sub-fossil material was found at Anabama Hill confirming that it occurred in this area in the past.

Vulnerable in South Australia

Eastern Grey Kangaroo *Macropus giganteus* (Fig. 100)
This large kangaroo is widely distributed throughout eastern Australia, coming only into South Australia in the south-east and east, although there have been occasional unconfirmed reports in the Murray Mallee and Eastern Pastoral districts. Classified as vulnerable in South Australia, only one museum specimen, collected in 1992 from near Overland Corner, is known from the South Olary Plains but a possible small family group has been sighted in the past on several occasions on northern Chowilla Station (P. Macrow, pers. comm.).

On the current survey a definite sighting was made on Lilydale Station of an adult female with a pouch young and a juvenile at foot. This is a very interesting find, like that from Overland Corner, as it confirms the species' existence in the area, a significant distance from known populations in N.S.W. and central eastern S.A..

It is difficult for an untrained observer to distinguish the two grey kangaroo species, the Western Grey Kangaroo (*M. fuliginosus*) is generally slightly smaller and more brown in colour, whereas *M. giganteus* is predominantly grey).

Rare in South Australia

Forrest's Mouse *Leggadina forresti*

A small, plump mouse that inhabits tussock grasslands, low shrublands and Mulga woodlands of the arid Australian inland. Although widely distributed it is considered rare in South Australia, occurring in the northern half of the state and historically being found as far south as 32°30". It could have occurred on the South Olary Plains and may possibly still be found in the northern parts.

Other notable species recorded

Narrow-nosed Planigale *Planigale tenuirostris*

This tiny carnivorous marsupial (average weight only six grams) is distributed throughout inland eastern Australia, occurring mostly in open grassy areas with cracking clay soils. Read (1987) found it to use a variety of habitats but Denny (1982) noted that it was usually located in areas away from water in more open, less dense vegetation (in contrast to that of *P. gilesi* - see over). In South Australia it occurs in the northern areas and is classified as uncommon.

One Narrow-nosed Planigale was recorded on the South Olary Plains survey at a grassy chenopod shrubland quadrat on Mutooroo Station. This together with records from Mt Remarkable National Park (Wauchope, 1984) are the most southerly records of this species is South Australia. It has also been recorded at Kinchega National Park in N.S.W. (100km east of Mutooroo).

Hairy-nosed Wombat *Lasiorhinus latifrons*

This almost uniquely South Australian species is distributed across the Nullarbor Plain, in the Gawler Ranges, upper western Eyre Peninsula and the Murraylands. A remnant population also exists on Yorke Peninsula. It is thought to have been distributed throughout much of these areas historically and small colonies have re-established where wombats were re-introduced to Wedge Island, Pooginook Conservation Park and Kia-ora Station in 1971 (St John and Saunders, 1989). The latter two locations are in the South Olary Plains survey area and the presence of active wombat warrens was confirmed during the survey. Disused warrens were also observed on Redcliffe Station. The Pooginook population is now known to be spreading south to the Murray River cliffs (B. St John, pers. comm.).

The Hairy-nosed Wombat is classified as uncommon in South Australia but presumed stable on a national basis.

Common Wallaroo (Euro) *Macropus robustus* (Fig. 101)

The Euro is very widely distributed across Australia and common in South Australia, inhabiting a variety of habitats but usually in areas with rocky hills or stony rises. On the South Olary Plains survey Euros were mostly observed near the Burra Hills and in the north and north-western region where there are isolated hills and small ranges, but one was seen near Redcliffe Station in the south.

National Parks employees in the Riverland have known a small group in Danggali Conservation Park for some years but recently there have been several groups sighted in the south and north of the park and on southern Calperum Station, which is unusual as the terrain is sandy dunes and plains. Anecdotal evidence suggests that before World War II euros were not seen south of Mutooroo Station but since then they have been appearing further south (M. Osbourne, pers. comm.).

Little Mastiff Bat *Mormopterus planiceps*

In South Australia this free-tailed bat is divided into two species (based on unpublished data) but it is not possible to distinguish between females using external characters: males have different sized penises. Thus they are commonly referred to as 'big penis' and 'little penis' Little Mastiff Bats.

The 'little penis' species is common in arid areas of South Australia, extending as far south as just below the River Murray. A number of specimens have been recorded from throughout the South Olary Plains.

The 'big penis' species is abundant from Fleurieu Peninsula to the Flinders Ranges and less common on Eyre Peninsula and in the South East. Up until 1991 no confirmed specimens were known from the South Olary Plains, except some caught on the Chowilla floodplain immediately south of the survey area (Brandle and Bird, 1990), but of course this only refers to males. There are numerous records of females from the area but these could be either species.

On the South Olary Plains survey a number of female and 'little penis' specimens were captured on Calperum, Chowilla, Pine Valley and Lilydale Stations and one 'big penis' specimen caught on Caroona Station. A few specimens of both species collected on the survey will provide valuable information for taxonomic clarification of these taxa.

Stick-nest Rats *Leporillus* species.

Stick-nest Rats are large native rodents, distinguished by their habit of building characteristic large stick nests. Once quite widespread across the central southern arid areas of Australia one species, the Lesser Stick-nest Rat (*Leporillus apicalis*) is now extinct and the other, the Greater Stick-nest Rat (*L. conditor*), is extinct on the mainland but survives on a few South Australian offshore islands. It is classified as endangered in S.A. and vulnerable on a national basis, having declined due to habitat destruction by introduced herbivores and predation by native and introduced predators (Lee, 1995).

Historic records of both *Leporillus* spp. are known from the Darling-Murray Plains in N.S.W., which is the most easterly extent of their presumed distribution. Remains of stick nests have been recorded from much of their historic distribution, including a few in the South Olary Plains area. Sub-fossil remains of both species are known from northern South Australia plus *L. apicalis* from one location on Eyre Peninsula and another at World's End (south-east of Burra, just inside the current survey area) (Copley, 1988; G. Medlin, pers. comm.).
Until recently no *Leporillus* spp. have been confirmed from the South Olary Plains area but they were presumed to have been there. However, in 1988 University of South Australia students (pers. comm.) found sub-fossil remains of *L. apicalis* in Danggali Conservation Park and on the South Olary Plains survey Stick Nest Rat droppings, nest material and bones of both *L. conditor* and *L. apicalis* were found in a cave at Anabama Hill. This confirms the historic presence of both species in the area and therefore more signs and remains of these rats may occur in other parts of the region as further sub-fossil work is carried out.

Common Dunnart *Sminthopsis murina*

This small native marsupial is commonly found in woodland, open forest and heathlands across southern Australia. In South Australia it is near the northern limit of it's range in the South Olary Plains.

On the South Olary Plains survey between 21 and 31 individuals were captured (some may have been recaptures). This more than doubles the S.A. Museum's records for this species from the region and helps clarify the northern extent of the Common Dunnart's distribution in South Australia.

Species probably/possibly extant in the area

The following species may occur in the South Olary Plains, given their past known or present distributions. Occurrences from Kinchega National Park (in N.S.W. 100km ENE of the current survey area) are from Ellis and Henle (1988) and records from north-western Victoria are from Robertson *et al.* (1989).

<u>Species with northern distributions</u>

Paucident Planigale *Planigale gilesi*

It is most likely to occur in the area as it is known from northern South Australia and three specimens were caught on the Chowilla floodplains just south of the survey area (Brandle and Bird, 1990). (These were the most southerly record of this species in S.A.). It is also known from Kinchega National Park and north-western Victoria. This species inhabits creek channels, floodouts and plains with cracking clay soils, particularly densely vegetated areas associated with water (Denny, 1982) and deeply cracking clay, although it can also be found in a variety of other habitats (Read, 1987).

Kultarr - (see notes above)

Forrest's Mouse - (see above)

<u>Species with southern distributions</u>

Black Rat *Rattus rattus*

The only museum records are from Nackara and Waikerie (just north-west and south of survey area respectively). Known from the Murray Mallee and Mt Lofty Ranges so could occur in the south and west of survey area as it is known to occupy sheds and small settlement in many areas. The record from Danggali Conservation Park was some bones found in fox scats but the identification is unconfirmed.

Chocolate Wattled Bat *Chalinolobus morio*

The only museum record is from Sutherlands (west of Morgan, just south of survey area). Occurs south and west of survey area so could be in the south-western corner. Also known from north-western Victoria.

<u>Vagrant species</u>

Yellow-bellied Sheathtail Bat *Soccolaimus flaviventris*

Only one record known locally, from Berri (south-west of Renmark) (Reardon and Flavel, 1991) but considered a widespread seasonal vagrant. Also recorded from Kinchega National Park.

Little Red Flying-fox *Pteropus scapulatus*

This species is not a usual inhabitant of S.A. but occasional vagrants do occur

Introduced species

As noted on the frequency tables, five introduced species were numerous and widespread throughout the South Olary Plains (goats, rabbits, House Mouse, foxes and cats).

Goats were certainly the most abundant introduced species, with many large herds (hundreds) being regularly sighted and extensive physical damage to shrubs evident in many places. The ubiquitous rabbit was next most abundant and also widespread, although only in low densities in some places such as the sandy areas of the south-east.

House Mice were also widespread, but less so in the central areas, where patches of native vegetation may be relatively undisturbed, and more isolated from townships and main access routes. Most native small terrestrial species were found away from the more inhabited north, south and western edges of the survey area. In many quadrats House Mice were the only small native terrestrial mammals recorded. Most of these locations were in the west and north-east of the survey area, nearer main roads, settlements and agricultural practices, suggesting that the House Mouse has displaced the small native mammals.

Foxes and cats were also quite widely observed on the South Olary Plains. Given that they are generally cryptic creatures and were not specifically covered on this survey quite a number were seen, posing the question as to how many others are also there and what impact must they be having on the remaining small native fauna (although rabbits and House Mice would be a significant component of their diets).

Sub-fossil material

In 1988 students from the University of South Australia collected sub-fossil material from an old owl roost near Morganvale Homestead on Danggali Conservation Park. Several extinct and historically known species were identified from this material but the information was not documented thoroughly at that time. These species are listed below and annotated as to whether they were thought to have been in the area historically (H) or not known to have occurred there (+). The conservation status of each is also shown with the first letter referring to the Australian status and the second to that in South Australia. (**X** = extinct, **E** = endangered, **V** = vulnerable, ? = uncertain identification):

Long-tailed Hopping-mouse **XX** +
Lesser Stick-nest Rat **XX** H
Gould's Mouse **XX** H
?Golden Bandicoot **EX** +
?Dusky Hopping-mouse **EE** +
Red-tailed Phascogale **EX** H?
Sandhill Dunnart **VV** +
Plains Rat **V-** H

Sub-fossil material collected on the South Olary Plains survey from Anabama Hill also contained many interesting speices (codes as above; plus **pV** = potentially vulnerably, **R** = rare, **U** = uncommon, **I** = indeterminate):

Crescent Nailtail Wallaby **XX** +
Long-tailed Hopping-mouse **XX** +
Lesser Stick-nest Rat **XX** H
Gould's Mouse **XX** H
Pig-footed Bandicoot **pXX** H
Western Barred Bandicoot **EX** H
?Dusky Hopping-mouse **EE** +
Mulgara **VE** +
Greater Stick-nest Rat **VE** H
Plains Rat **V-** H
Kultarr **pVR** H?
Yellow-footed Rock-wallaby **pVR** H (recent)
Desert Mouse **IR** H
Common Brushtail **pV-** H
Forrest's Mouse **-R** H
Common Dunnart **-U**
Long-haired Rat H?
Bolam's Mouse (extant)
Fat-tailed Dunnart (extant)
House Mouse (extant)
Short-beaked Echidna (extant)

A number of frog and gecko bones were also found in the Anabama Hill deposits.

Another sub-fossil deposit has been found at World's End in the south-western corner of the survey area, just in the foothills of the Burra Hills. This material was identified in 1984 but the information is un-published (G. Medlin, pers. comm.). No additional species to those found at the Danggali and Anabama sites were found, species identified included:

Long-haired Rat (the most southerly occurrence of this species)
Lesser Stick-nest Rat
Western Barred Bandicoot
Mulgara
Red-tailed Phascogale
Long-tailed Hopping-mouse
Plain's Rat
Desert Mouse
Gould's Mouse
Hopping-mouse (possibly Mitchell's)
Bolam's Mouse
Fat-tailed Dunnart
House Mouse
Common Dunnart
Common Brushtail Possum

These sub-fossil deposits add five new species to the total mammals known to have occurred in the South Olary Plains and four species confirmed to at least have been there pre European occupation (Red-tailed Phascogale, Kultarr, Long-haired Rat, Crescent Nailtail Wallaby). The five locally new species are particularly interesting as they were not previously known to have occurred in or near the South Olary Plains. Distributions in the following notes are from Kennedy (1992) and Lee (1995):

Mulgara *Dasycercus cristicauda*

Formerly widespread across arid parts of Northern Territory, Western Australia and northern and western South Australia but now known only from isolated pockets in those areas. However, sub-fossil remains have been found in the northern Flinders Ranges (Medlin, 1993), and now on the South Olary Plains (Anabama Hill and World's End), much further south than previously known.

Sandhill Dunnart *Sminthopsis psammophila*

Only known from Lake Amadeus, N.T. (but not since in 1895), the south-western corner of the Great Victoria

Desert and Queen Victoria Spring Nature Reserve (W.A.) and in South Australia in the Yellabinna sand dunes and at two locations on Eyre Peninsula (but not since 1969 for the latter) (Pearson and Robinson, 1990). The South Olary Plains location (Danggali) is a long way further east than previously expected for this species. It should be noted however that the bone material collected was only tentatively assigned to this species.

? Golden Bandicoot *Isoodon* cf. *auratus*

Formerly widespread in arid deserts and adjacent semi-arid areas of central to north-western Australia, but now extinct in these regions except a small area of north-west Kimberley and some offshore islands. Sub-fossils are known from the northern Flinders Ranges in South Australia (Medlin, 1993). The material from the South Olary Plains I (Danggali) is more like this species than any other possible bandicoot but with only fragmentary material this is not a definite identification (G. Medlin, pers. comm.). Fossil remains have also been found at Lake Victoria in south-western N.S.W. (Marshall, 1973).

Long-tailed Hopping-mouse *Notomys longicaudatus*

Thought to be once widespread throughout arid and semi-arid Australia, it is now extinct in Australia. The only previously confirmed specimens (all collected pre 1902) are from a few isolated locations in the Northern Territory, north of Perth and near Broken Hill (Watts and Aslin, 1981). Medlin (1993) has recorded sub-fossils in the northern Flinders Ranges. The location of this species at the three South Olary Plains sub-fossil sites is further south than previously known.

? Dusky Hopping-mouse *Notomys* cf. *fuscus*

Once distributed over much of central Australia, now restricted to north-eastern South Australia and south-western Queensland. Sub-fossils are known from the Flinders Ranges (Medlin, 1993), so the locations of Anabama Hill and Danggali are the furthest south-east known for this species. The identification made by G. Medlin is listed as, more like this species than *N. mitchelli* (G. Medlin, pers. comm.).

DISCUSSION

Comparisons of the PATN analyses cannot be made with any other local studies as none has been conducted in adjacent areas in N.S.W., the Murray Mallee biological survey mammal data were not analysed and the Victorian data has only been preliminarily analysed for the Sunset Country which is mostly sandy dune systems (Yen *et al.*, 1989). However, comparisons of species richness are possible with a few other regional studies.

The total number of native mammal species known to occur at some time in the South Olary Plains (48 species) is comparable with that in the north-eastern deserts of South Australia (46 species) (Kemper, 1990). Similarly, the 43 species known to have existed in the survey area since European occupation constitutes 70% of the known 60 species that occurred in the whole mallee region of south-eastern Australia in historical times (Bennett *et al.*, 1989). The South Olary Plains, like many other areas pre European occupation, had therefore quite a rich mammal fauna.

The number of extant species of the South Olary Plains area (31) is also similar to that currently known in the north-eastern deserts (36 species) (Kemper, 1990); north-western Victoria (40 species) (Robertson *et al.*, 1989) and species of the southern Australian mallee (37 species) (Bennett *et al.*, 1989), indicating that many areas have suffered similar substantial declines in species in recent times.

Mammal species richness recorded at quadrats on the South Olary Plains survey varied from zero to twelve species (see list in Appendix VIII), averaging 4.3 species. Species richness of small terrestrial mammal species was only an average of 0.6 pre quadrat. This is low compared with other studies conducted in semi-arid and arid pastoral areas of South Australia. The Yellabinna survey found small terrestrial mammal species richness averaging about two to three but this areas is more remote from towns and agricultural practises (Copley & Kemper, 1992). The Murray Mallee survey area, being agricultural with patchy remnants of native vegetation, had a much lower mammal species richness (unpublished data, Department of Environment and Natural Resources). However, species richness and abundance in mallee vegetation vegetation is known to be generally low (Bennett *et al.*, 1989) and may largely be attributed, in part, to the loss of species since European settlement (Menkhorst & Bennett, 1990).

Biogeographic considerations

As discussed in previous chapters, the South Olary Plains survey area lies adjacent to three South Australian regions: the Murray Mallee, the northern arid zone and the Mt Lofty-Flinders Ranges. On a national scale, the area represents an ecotone between the Bassian zoogeographic subregion, comprising temperate southern and eastern Australia, and the Eyrean subregion, encompassing the semi-arid and arid inland (Bennett *et al.*, 1989). More of the survey area lies in the Eyrean zone. Thus the South Olary Plains therefore contains mammal species with affinities to both these major biogeographic regions but predominantly Eyrean (Robertson *et al.*, 1989). Eyrean mammal species are known to predominate in mallee mammal fauna (Menkhorst & Bennett, 1990).

Some of the Eyrean species are:

- Long-nosed Planigale (*Planigale tenuirostris*)
- Paucident Planigale (*Planigale gilesi*)
- Mallee Ningaui (*Ningaui yvonneae*)
- Stripe-faced Dunnart (*Sminthopsis macroura*)
- Euro (*Macropus robustus*)

Red Kangaroo (*Macropus rufus*)
Little Pied Bat (*Chalinolobus picatus*)
Inland Eptesicus (*Vespadelus baverstocki*)
Greater Long-eared Bat (*Nyctophilus timoriensis*)
Western Broad-nosed Bat (*Scotorepens balstoni*)
Bolam's Mouse (*Pseudomys bolami*)

The few Bassian species are:
Common Dunnart (*Sminthopsis murina*)
Western Grey Kangaroo (*Macropus fuliginosus*)
Eastern Grey Kangaroo (*Macropus giganteus*)
King River Eptesicus (*Vespadelus regulus*)
Little Forrest Eptesicus (*Vespadelus vulturnus*)

Widespread species include:
Short-beaked Echidna (*Tachyglossus aculeatus*)
White-striped Mastiff Bat (*Tadarida australis*)
Gould's Wattled Bat (*Chalinolobus gouldii*)
Fat-tailed Dunnart (*Sminthopsis crassicaudata*)
Lesser Long-eared Bat (*Nyctophilus geoffroyi*)

Within the survey area, very few geographic trends of individual species distributions could be detected, probably due to the low overall abundances recorded and the presence of many known widespread species The few that showed slight trends were *Sminthopsis murina*, occurring mostly in the southern half of the area, and *S. macroura*, found only in the north, both of which were the anticipated distributions (from Strahan, 1983). Although *Planigale tenuirostris* was only found at one location, it was, as would be expected, in the far north of the area. Similarly, the single occurrences of *Macropus giganteus* and *Lasiorhinus latifrons* were, as expected, only in the eastern and southern areas respectively. Most other species were widely distributed e.g. Echidna, *S. crassicaudata*, *Macropus* species, rodents, introduced species and many bats.

Conservation considerations

At the time of European settlement, the mallee region of south-eastern Australia probably supported a rich and diverse mammal fauna, which was comparable to that of many other areas in Australia (Bennett *et al.*, 1989). However, with a large number of species locally extinct in many areas, this diversity is now low (Bennett *et al.*, 1989), and considering the relatively short time span over which this has occurred (i.e. less than 200 years), there is cause for concern that many remaining species and populations are at considerable risk. The prime causes of extinction and ongoing threat to remaining species are loss or degradation of habitat through clearing and overgrazing by domestic stock and rabbits; predation by introduced carnivores; competition for food and shelter with introduced species; indirect poisoning of animals and food prey through agricultural practises, and altered fire regimes that have reduced habitat heterogeneity or changed plant communities (Menkhorst & Bennett, 1990; Stephens, 1992). Once species and populations are under pressure, competition between native species for the limited habitat and food resources becomes another pressure. In the semi-arid and arid zones these effects and threats are then magnified in times of drought.

The high goat and rabbit numbers in the South Olary Plains and their suspected substantial combined grazing impact on native pastures is of great concern, as it is elsewhere in the state. Several institutions are conducting research into various rabbit control methods: the South Australian Animal and Plant Control Commission (field testing the Spanish Flea as an alternative myxomatosis vector suitable for arid areas); the Australian and New Zealand Rabbit Calicivirus Disease Program (field testing this alternative biological control agent); the Cooperative Research Centre for Biological Control of Vertebrate Pest Populations (researching immunocontraception control methods) and CSIRO Division of Wildlife and Ecology (integrated control - poisoning, warren ripping and fumigation).

Research into effective goat control is being undertaken by the South Australian Animal and Plant Control Commission and some soil boards are implementing regional control programs with Primary Industries S.A.. Regular extensive shooting is undertaken by the National Parks and Wildlife Service in large Conservation and National Parks, such as Danggali and Flinders Ranges.

A total grazing pressure study has recently commenced in the South Olary Plains area (by the Department of Environment and Natural Resources) to assess the grazing impacts that goats, rabbits, kangaroos and stock are having on the native pastures.

Kangaroo numbers, artificially increased by free water availability, are annually assessed throughout most of the pastoral areas, and controlled by the Department's Wildlife Management Sections' kangaroo surveys and shooting permits system.

Similarly, the effect of foxes and feral cats on the small native species populations is of great concern. The University of Adelaide has been conducting research into the effects of the domestic cat on small native mammal, bird and reptile species; the Western Australian Department of Conservation and Land Management and the Agriculture Protection Board are testing and implementing intensive fox baiting programs and CSIRO is investigating methods of biological control of foxes. Once again this is an enormous problem that will involve long-term programs.

On more localised scales, some projects are being undertaken to eradicate introduced pests (by extensive poisoning and shooting) to enable populations of threatened native species to stabilise and expand or be reintroduced into areas. In one such project being conducted by the Department of Environment and Natural Resources in the Olary Hills, significant increases in Yellow-footed Rock-wallaby numbers have already been noticed after less than two years of pest control, and under drought conditions (P. Alexander, pers. comm.). A similar project is being carried out in the Flinders Ranges National Park and another at Venus Bay Conservation Park on the west coast where two endangered species has been reintroduced and plans are underway for other releases.

As discussed earlier, the South Olary Plains contains some species that have significant conservation status on an Australian basis:

Little Pied Bat (rare)
Common Brushtail Possum (potentially vulnerable) - possibly in area

Others area rated on a South Australian basis:

Eastern Grey Kangaroo (vulnerable)
Yellow-footed Rock-wallaby (rare) - in adjacent areas
Kultarr (rare) - possible in area
Forrest's Mouse (rare) - possible in area

The South Olary Plains have a large number of nationally or locally extinct species (12) which are known to have occurred in the area but have disappeared since European occupation. Five other extinct species were possibly present historically and five were at least in existence prior to European occupation. Despite having already lost so many species, those that remain need protection, especially in light of the large numbers of thriving introduced species and ongoing agricultural and pastoral practices. Areas of suitable natural habitat must be maintained to support these remaining populations and possible reintroduced species. In the longer term it may be possible to re-introduce some species.

As has been discussed, the South Olary Plains contains mammal species of both Eyrean and Bassian origins, many of which are at the northern or southern limits respectively of their distributions. The survey area may be of particular importance to the survival of these populations if their status in the rest of their distributions is threatened, e.g. in the case of Bassian species, many or most of their preferred habitats have been cleared or severely damaged through agricultural practises and overgrazing, or in the case of Eyrean species, the added impacts of regular drought conditions and long term pastoralism may increase threats to these species.

Within the South Olary Plains region a significant area of Blackoak and mallee woodlands occurs in Bookmark Biosphere Reserve (Danggali, Chowilla and Calperum). Thus the mammal communities of these habitats are probably quite well conserved. Only small patches of chenopod shrublands occur in this park and White Dam Conservation Park (which is very small and isolated) so chenopod shrubland mammals are not well protected in the region.

All of the extant mammal species known from the South Olary Plains occur within Bookmark Reserve except the Hairy-nosed Wombat (which is conserved to an extent in some southern Murray Mallee Conservation Parks) and the Long-nosed Planigale which occurs mostly in the more northern chenopod shrublands. Although the Stripe-faced Dunnart has been caught in Danggali Conservation Park, it may not be very common there, also preferring the northern chenopod shrublands. Thus these more open area mammals of the northern South Olary Plains may not be sufficiently protected but the forth-coming North Olary Plains survey will enable better assessment of the status and conservation of these species and communities.

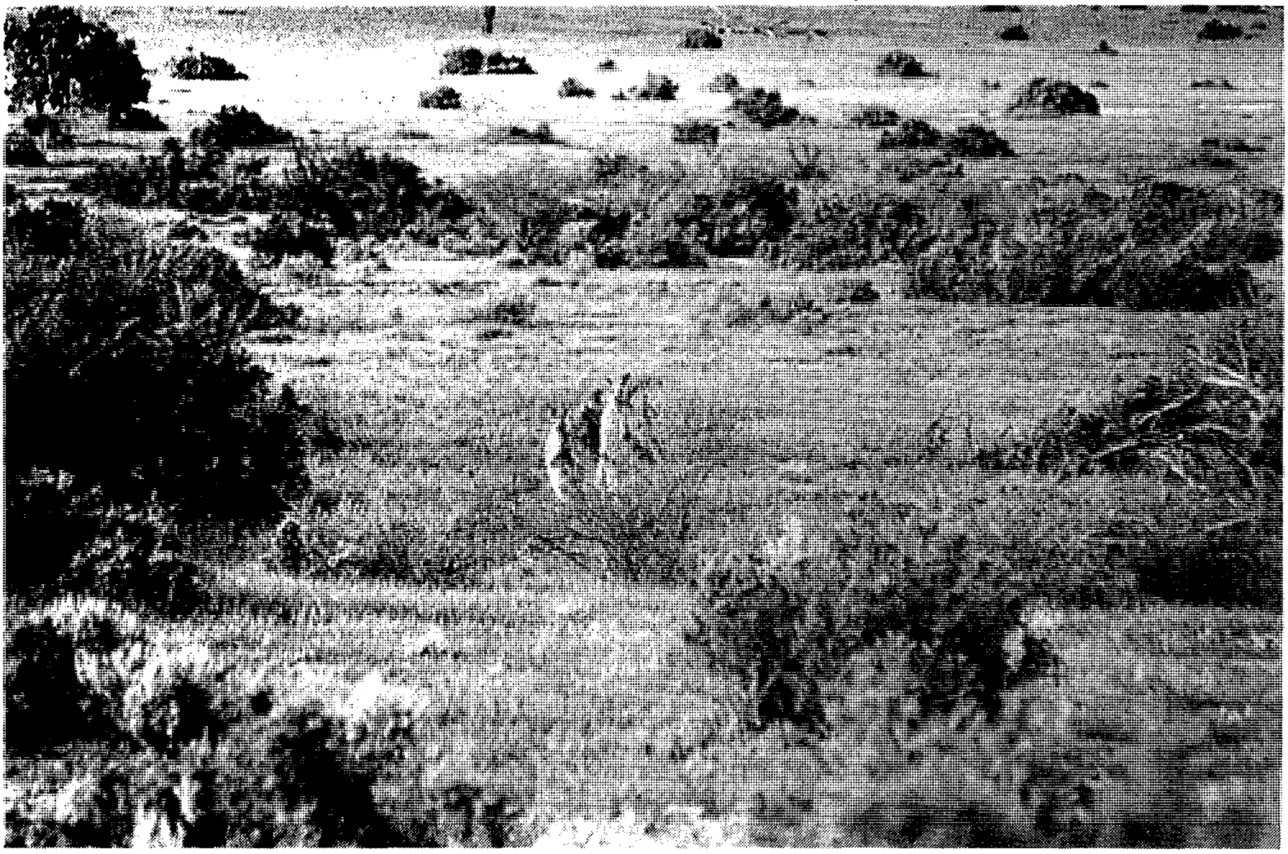


Figure 100
Eastern Grey Kangaroos, *Macropus giganteus* seen on Lilydale Station during the survey.
Photo: J. Arlidge

Figure 101
Euros, *Macropus robustus*, are generally found in rocky areas.
Photo: A. Robinson

Figure 102
The Stripe-faced Dunnart, *Sminthopsis macroura* was only found in the north of the South Olary Plains survey area.
Photo: A. Robinson

Figure 103
The King River Eptesicus, *Vespadelus regulus* is a tiny bat of the southern mallee
Photo: A. Robinson

BIRDS

by L. R. Forward[6] and J. R. W. Reid[7]

INTRODUCTION

Prior to this study the birds of the South Olary Plains had been poorly documented, with only one regional account having been published - that of Mack's (1970) compilation of his and colleagues' records over many years. Erhard Boehm published extensively on the birds of the Sutherlands - Mount Mary district just outside the study region (e.g. Boehm, 1934, 1957, 1959). McGilp (1934) published a short paper dealing with the study region which included one of the last records of the Spotted Bowerbird (*Chlamydera maculata*, from Chowilla on the Murray), now extinct in South Australia (Boehm, 1956). Like those of Boehm, his meticulous records of birds of the Lake Frome district (McGilp, 1923) do not pertain directly to the study region but provide valuable information on the status and habitat preferences of birds in an adjacent region. Schodde (1956) compiled a bird list for the Burra Creek in the extreme south-west, augmenting the earlier piecemeal observations of Pearse (1929, 1930, 1931, 1938 amongst others) from 'The Gums' Station, Florieton, along this creek. Darke (1929) published a list of birds seen while travelling along the northern margin and Morgan (1932) spent a week on Paratoo Station, on the north-western margin of the study region, compiling a comprehensive list.

We have not attempted an exhaustive review of the literature nor have we gathered all available sources of unpublished material, relying mainly on the depth of coverage contained in the Royal Australasian Ornithologists Union's (RAOU) 'Atlas of Australian Birds' scheme (Blakers *et al.*, 1984). In particular, distributional material published in the ornithological journals *Emu* and *South Australian Ornithologist* and in the South Australian Ornithological Association's Newsletter, as well as unpublished material held by that organisation, would need to be consulted for a thorough review of past distributions. Changes have taken place and will continue; for example Boehm (1983) documents the range expansion of the Ground Cuckoo-shrike into the Sutherlands district and then further south. Other species have declined in the region. Both Mack (1970) and Boehm (1934) relate the decline of the Southern Stone Curlew, an endangered species on the mainland of South Australia. Regional assessments of the conservation status of birds in the pastoral areas of the State have not been attempted yet, and exhaustive literature and other data reviews would be required to aid this process, as has been recommended by Reid and Fleming (1992) for arid Australia generally. For instance, across the border in New South Wales, Smith and Smith (1994) have documented an alarming decline of birds in that State's western regions.

Considerable attention is paid to species of conservation significance in following sections, and the twin major aim of this report is to analyse bird assemblage data gathered at sites at which comprehensive assessments of other environmental data were made. With the aid of multivariate pattern analyses, we aim to describe the composition of typical bird communities tied to particular vegetation types and discuss the patterns of their distribution across the landscape.

While Mack's (1970) report constitutes a valuable and interesting record, sightings of unusual species were not thoroughly documented or accompanied by supporting descriptions and field notes - for instance the record of the rare Square-tailed Kite has since been treated as unconfirmed by Debus (1991). Mack's observations would provide a better basis for comparison with the results of this survey if there had been available then a more comprehensive distributional framework, and if he had outlined patterns of distribution based on his extensive knowledge of the region. Mack was aware of wider distributional patterns and expressly listed a handful of species which he and colleagues did not record in the region and which may have been expected based on the general state-wide distribution descriptions of Condon (1969). However, we have a much more detailed understanding of avian distributions 25 years on, made possible by the easier access to remote places, better field guides and through the success of the Bird Atlas scheme (Blakers *et al.* 1984).

The Bird Atlas suffers a little from one of the same problems if unusual records are considered, despite the best efforts of Atlas organisers to ensure accuracy - in terms of the published observations and purchased database available to us, the observations are anonymous

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and unsubstantiable. Given these uncertainties we decided to present all observations we gathered and to simply indicate those species which we think require further confirmation of their presence in the region. The Atlas has provided us with a huge database and its authoritative text has set the stage for a thorough analysis of avian distribution patterns in the South Olary Plains.

The distributional ecology of the birds of the South Olary Plains provides an intriguing insight into factors that govern the distribution of southern Australian birds at two spatial scales. First, at the biogeographic scale, we witness the major avifaunal transition from typical mallee communities to the less speciose communities of the southern arid zone. Second, at the community level, the region affords the opportunity to describe and explain the marked differences between bird assemblages of structurally and floristically distinct vegetation types. There is also the role that the River Murray plays in controlling avian distribution within the region, despite the Murray Valley deliberately having been excluded from the study region. The presence of some species in the region is dependent on the proximity of the Murray and the Regent Parrot, a species of high conservation significance, is a good example. While its breeding range is largely confined to the river, outside of the breeding season, birds wander in search of food through the mallee belts to the north and south (Joseph, 1978; Garnett, 1992). This group of species illustrates how that most distinctive characteristic of birds, the power of flight, affords birds a greater mobility than most other organisms, and in turn how this may shape (and add complexity to) distribution patterns. Despite this, there are many species, and not only waterbirds, which are known from the Upper Murray (e.g. Mack, 1961), but for which we cannot trace records in the South Olary Plains.

Rich mallee bird communities are found only in the higher-rainfall southern, and particularly south-western, margins of the region (e.g. Mack, 1970). The transition to arid-zone communities occurs abruptly and is mimicked by the limits of agricultural development, with vegetation clearance and cropping being largely confined to the same margins. The interaction between topography and climate, and in particular their control of rainfall, are the dominant factors ultimately responsible for this biogeographic pattern (Gentilli, 1992). Mean annual rainfall declines quickly to the east of the escarpment of the North Mount Lofty Ranges in the extreme south-west of the South Olary Plains.

Schodde (1990) has reviewed the avifauna of the mallee biome at the continental level from a biogeographic and evolutionary perspective, identifying the characteristic suite of mallee bird species and providing evidence for their strong Bassian affinities. He contends that the mallee biome, as a significant structural vegetation formation with its obvious floristic links to southern wetter forests (eucalypts dominant), has provided an evolutionary pathway for the development of Eyrean species, today found in the acacia, chenopod and spinifex dominated landscapes of arid Australia. Schodde (1990) also asserts that the conservation prospects of the suite of mallee-dependent birds are more dire than for any other habitat-specific avian assemblage in Australia, due to the effects of wholesale clearance and habitat fragmentation.

The evolution, biogeography and natural history of arid Australian birds was reviewed by Schodde (1982). Dryland arid-zone bird communities are species-poor in comparison to their southern forest and mallee counterparts, notwithstanding the exceptions of those associated with structurally complex riverine woodlands (Reid *et al.* 1990). There are two steep gradients in avian species richness (frequency) in South Australia identified by Gentilli (1992) using a spatially coarse-grained approach. The first occurs across the boundary between the woodland and mallee formation of Eyre Peninsula and the arid Nullarbor Plain, the second across the boundary between mallee and more arid portions of the Olary Plains. Two other features of arid-zone birds set them apart from southern relatives: nomadism and terrestriality (in the sense of ground dwelling and feeding). A much higher proportion of arid-zone species exhibit these adaptations to a variable and open environment (Schodde 1982). Mack (1970) made two of these points in relation to the study region. He stated the bird communities of the southern mallee patches were much richer than those of the blackoak open woodlands and chenopod shrub-steppes (the three extensive avian habitats he recognised), but that these latter habitats, after good rains, could be rapidly colonised by vast numbers of mobile bird species, citing chats, budgerigars and woodswallows.

Nomenclature follows Parker and Horton (1990). Common names are used in the text, but scientific names, and some popular alternatives to both common and scientific names in current use, can be found in Appendix X.

TOTAL SPECIES

A complete list of all bird taxa recorded from the South Olary Plains in the current and previous studies is shown in Appendix IX. The total number of species is 257, representing 59 families and subfamilies, of which eight species are introduced to Australia.

Most species listed in Appendix IX were recorded by several sources except 24 indicated in Column 10 (mainly attributable to Boehm (1934, 1953, 1957, 1959, various others) and Mack (1970), and 11 that were only listed by the Royal Australasian Ornithologists Union (RAOU) Atlas database, most of which were waterbirds and vagrant or seasonal visitors. The RAOU database, compiled from extensive records collected by numerous private observers over a five year period from 1977 to 1981 (Blakers *et al.*, 1984) lists 222 species from the South Olary Plains and is the most comprehensive record of species for the entire region. The only species, other than the 24 in Column 10, not listed in the Atlas were the

Little Bittern (recorded on the current survey) and the Little Woodswallow (recorded by the University of South Australia (pers. comm.) at Danggali but which is a dubious identification - see species notes below). Mack (1970) recorded 190 species from his region which extended further to the north than the South Olary Plains.

Opportunistic observations made on the South Olary Plains survey recorded the next highest number of species for the area (150 species, representing 48 families). Compared to the site based records from this survey, 42 extra species (12 families) were only recorded by opportunistic observations, indicating the value of including this recording method in a survey.

On the South Olary Plains survey 162 species representing 51 families were identified. More species were detected by opportunistic observations (away from sites) than by systematic sampling at sites - 120 species (39 families) on the 93 quadrats versus 150 species (48 families) opportunistically. The value of recording opportunistic data can be seen with the addition of 42 species and 12 families. Four of the 162 species are introduced. Table 15 summarises the total numbers of species and individuals recorded. These totals include the data from five sites in Danggali Conservation Park surveyed by the University of South Australia and which were used in the present analysis.

Table 15
Total numbers of bird families, species, records of species and individual birds recorded on the South Olary Plains Survey.
Figures in brackets indicate the number of records of families/species found *only* opportunistically (which is included in the number preceding).

* Includes families and subfamilies.
† Includes species and subspecies.

	Indigenous	Introduced	Total
Number of families*	49 (11)	2 (1)	51 (12)
Number of species†	169 (46)	4 (3)	173 (49)
No. of records of species†	3336 (1474)	39 (29)	3375 (1503)
Approx. no. of birds recorded	8419 (3685)	~86 (72)	~8505 (3757)

On the South Olary Plains survey 65% of the known bird species of the area were recorded and one confirmed species added (Little Bittern). A species-area curve calculated for the bird data from the South Olary Plains survey showed that sampling was adequate to detect most of the bird species. Although 35% of the known avifauna was not recorded, a survey conducted over one short period cannot be expected to detect the large number of waterbirds and occasional or vagrant visitors that accumulate with long-term observations.

The frequency and abundance of all taxa recorded at survey quadrats (current survey plus five Danggali quadrats) are listed in Table 5B. Genus-only designations are shown in normal rather than italic typeface and species masked out of the analysis are indicated. Thus the rest of the list shows all the species included in the analysis, with the exception of those with a frequency of one (i.e. only occurred at one quadrat) which were also masked out. A conversion list of scientific names to common names is in Appendix X. The additional species recorded from opportunistic observations are listed in Table 16.

Table 16
Bird species frequencies and abundance recorded on the South Olary Plains biological survey

The frequency is the number of quadrats at which the species was recorded. The total number of quadrats surveyed for fauna was 93.

Abundance figures represent the total number of individuals of the species recorded (at quadrats) on the survey. [Note that species abundance was not consistently (systematically) recorded at each quadrat. Therefore only species presence/absence (i.e. frequency) data can be accurately compared between species.]

Taxa shown in normal rather than italic typeface were considered unsuitable for analysis i.e. incomplete identification.

* Introduced species

\+ Species excluded from the analysis (i.e. highly mobile, cryptic, seasonal etc - see methods chapter)

G Subspecies that were changed back to species for the analysis.

Species	Freq.	Abun.
+ *Eolophus roseicapillus*	63	212
Acanthagenys rufogularis rufogularis	57	217
+ *Corvus coronoides coronoides*	57	139
+ *Gymnorhina tibicen*	57	134
+ *Melopsittacus undulatus*	53	175
Cracticus torquatus torquatus	53	134
Aphelocephala leucopsis	46	158
Oreoica gutturalis	45	150
Acanthiza uropygialis	44	134
Colluricincla harmonica	42	113
Psephotus varius	41	119
Pomatostomus superciliosus	41	105
+ *Dromaius novaehollandiae*	41	67
Pardalotus striatus	38	109
Artamus superciliosus	38	100
Falco cenchroides cenchroides	36	57
Smicrornis brevirostris	32	108
Malurus leucopterus	30	123
Meliphaga ornata	28	142
Anthus novaeseelandiae	28	93
Pyrrholaemus brunneus	27	71
Microeca leucophaea	27	69
Barnardius zonarius barnardi G	26	45
Artamus personatus	26	37
Petroica goodenovii	24	94
Epthianura albifrons albifrons	23	85
Coracina novaehollandiae novaeholl.	23	41
Ocyphaps lophotes	23	39
Rhipidura leucophrys leucophrys	22	72
Pomatostomus ruficeps	22	70
Meliphaga virescens	21	53
Pachycephala rufiventris rufiventris	21	38
Chrysococcyx basalis	21	35
Barnardius zonarius	20	57
Climacteris picumnus picumnus	19	80
Malurus lamberti assimilis	19	48
+ *Merops ornatus*	19	39
Cinclosoma castanotum	19	37
Melanodryas cucullata	19	36
Phaps chalcoptera	19	27
Lalage sueurii	18	42
Nymphicus hollandicus	18	28
Malurus splendens	17	38
Hirundo nigricans nigricans	17	32
Northiella haematogaster	17	29
Strepera versicolor	16	36
+ *Corvus mellori*	16	34
Artamus cinereus cinereus	16	23
+ *Aquila audax audax*	16	20
Acanthiza chrysorrhoa	15	25
Phylidonyris albifrons	14	58
Cincloramphus cruralis	14	37
Manorina flavigula flavigula	13	36
Climacteris affinis	13	29
+ *Corvus bennetti*	13	20
Corcorax melanorhamphos	12	32
Pardalotus xanthopygus	12	29
Melithreptus brevirostris	12	18
Calamanthus campestris	11	36
Pachycephala inornata	11	21
Acanthiza apicalis	11	18
Aegotheles cristatus	11	13
Meliphaga leucotis	10	25
+ Corvus sp.	10	24
+ *Falco berigora*	10	10
Daphoenositta chrysoptera	9	11
Anthochaera carunculata carunculata	8	15
* *Sturnus vulgaris vulgaris*	8	11
Cacatua leadbeateri	8	8
Leipoa ocellata	7	12
Chrysococcyx osculans	7	10
Artamus sp.	7	8

Poephila guttata	5	5	*Pteropodocys maxima*	2	2
Meliphaga plumula	4	10	+ *Stiltia isabella*	2	2
+ *Hirundo neoxena*	4	8	*Amytornis striatus*	1	6
Neophema chrysostoma	4	5	*Rhipidura fuliginosa*	1	4
Accipiter cirrhocephalus cirrhocephalus	4	4	+ *Turnix velox*	1	3
Accipiter fasciatus fasciatus	4	4	+ *Cheramoeca leucosternum*	1	2
+ *Cuculus pallidus*	4	4	Halcyon sp.	1	2
Meliphaga penicillata	3	12	+ *Anas gracilis gracilis*	1	1
Myiagra inquieta inquieta	3	9	*Cacomantis flabelliformis flabelliformis*	1	1
+ *Grallina cyanoleuca*	3	7	+ *Chenonetta jubata*	1	1
Hoplopterus tricolor	3	6	Cinclosoma sp.	1	1
+ *Cacatua sanguinea*	3	4	+ *Circus assimilis*	1	1
Hylacola cauta	3	4	Climacteris sp.	1	1
Psephotus haematonotus	3	4	+ *Falco peregrinus*	1	1
+ *Certhionyx variegatus*	3	3	+ *Falco subniger*	1	1
Coturnix novaezelandiae	3	3	+ *Gallinula ventralis*	1	1
Epthianura tricolor	3	3	*Geopelia placida placida*	1	1
+ *Hieraaetus morphnoides morphnoides*	3	3	Melithreptus sp.	1	1
+ *Ninox novaeseelandiae*	3	3	*Neophema splendida*	1	1
Meliphaga penicillata leilavalensis G	2	22	*Sugomel niger*	1	1
Glossopsitta porphyrocephala	2	5	Turnix sp.	1	1
Geopelia cuneata	2	4	*Zosterops lateralis*	1	1
* *Alauda arvensis*	2	3			
Artamus cyanopterus	2	3	**Total number of records of species:**	1872	
+ *Podargus strigoides*	2	3	**Total number of individual bird observations:**		4748

Table 17
Additional bird species recorded by opportunistic observations on the South Olary Plains survey

Species	Abundance	Species	Abundance
Gymnorhina tibicen leuconota	47	*Acanthiza iredalei*	1
Elseyornis melanops	10	*Acanthiza pusilla*	1
Passer domesticus domesticus	10	*Acrocephalus stentoreus*	1
Ardea novaehollandiae novaehollandiae	9	*Anas rhynchotis rhynchotis*	1
Tachybaptus novaehollandiae	9	*Anhinga melanogaster*	1
Malacorhynchus membranaceus	8	*Ardeotis australis*	1
Anas superciliosa superciliosa	6	*Childonias hybridus*	1
Ardea pacifica	5	*Cladorhynchus leucocephalus*	1
Malurus lamberti	5	*Elanus caeruleus notatus*	1
Amytornis striatus	4	*Falco hypoleucos*	1
Falco longipennis	4	*Falco peregrinus*	1
Holopterus miles novaehollandiae	4	*Gallinula tenebrosa*	1
Meliphaga penicillata	4	*Holopterus miles*	1
Poliocephalus poliocephalus	4	*Ixobrychus minutus*	1
Erythogonys cinctus	3	*Manorina melanocephala*	1
Fulica atra	3	*Manorina melanotis*	1
Aythya australis	2	*Melithreptus lunatus lunatus*	1
Elanus caeruleus	2	*Neophema elegans*	1
Haliastur sphenurus	2	*Pachycephala rufogularis*	1
Hirundo ariel	2	*Polytelis anthopeplus anthopeplus*	1
Megalurus gramineus	2	*Porzana fluminea*	1
Peltohyas australis	2	*Trichoglossus haematodus*	1
Phalacrocorax melanoleucos emlanoleucos	2	*Turdus merula merula*	1
Phalacrocorax sulcirostris	2	*Tyto alba*	1
Platalea flavipes	2		

From Table 16 it is evident that the top six species (Galah, Spiny-cheeked Honeyeater, Australian Raven, Australian Magpie, Budgerigah and Grey Butcherbird) were very common, occurring at greater than 50% of the quadrats (i.e. at 46 quadrats or more). Blakers *et al.* (1984) list the Australian Magpie as the most common bird species in Australia and the Galah as sixth. On a state basis, the Australian Magpie and the Galah ares the most common birds in South Australia, N.S.W. and north-western Victoria (Blakers *et al.*, 1984; Emison and Bren, 1989).

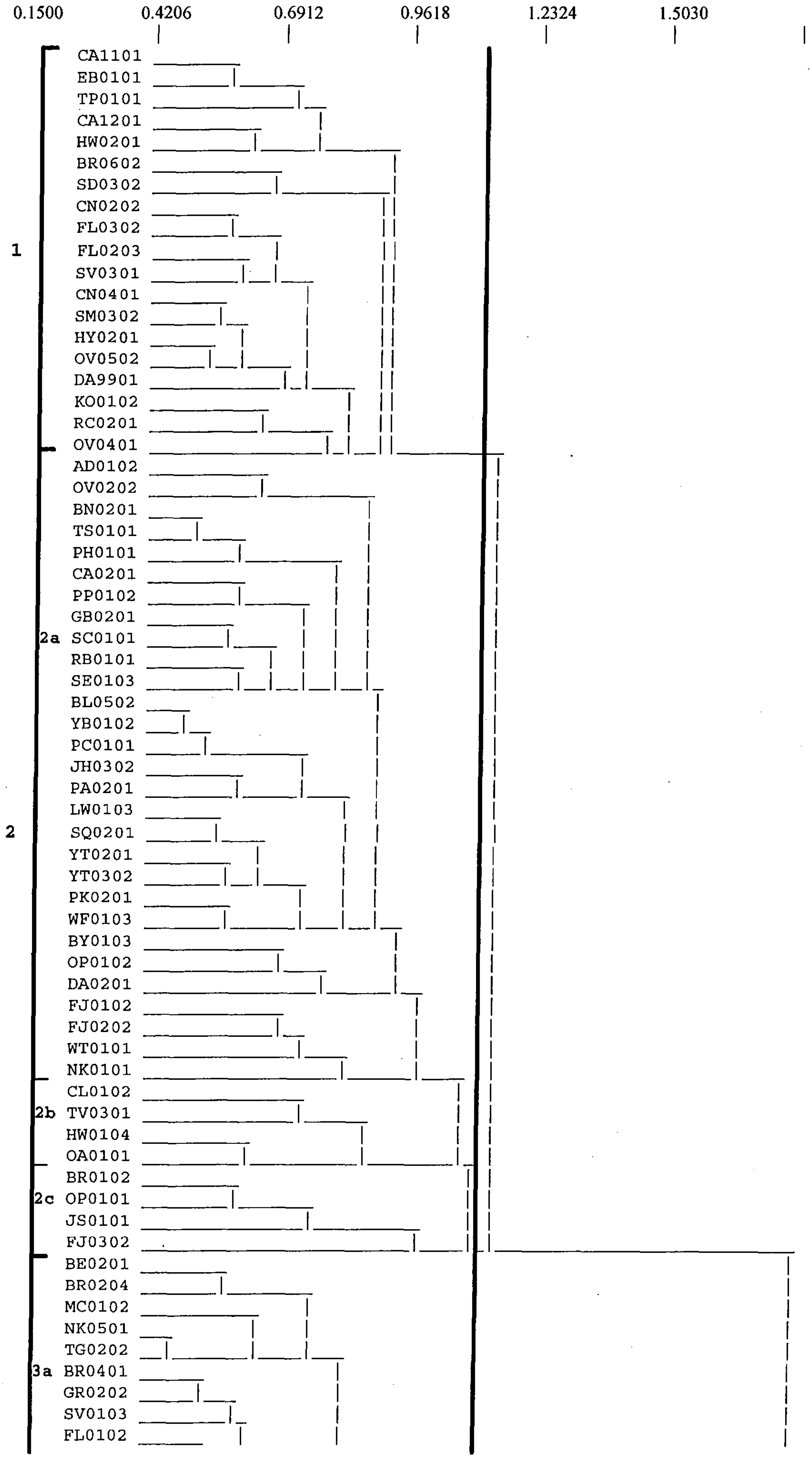
The South Olary Plains six most frequent species accounted for 21% of the total number of individuals of birds observed. Over fifty percent of the species (65) were recorded at less than nine quadrats (~9%). A long tail of infrequently recorded species is typical of any comprehensive biological survey.

PATN ANALYSIS

Classification

The final PATN classification analysis was conducted on presence/absence data of 82 species from 92 quadrats, after masking out all large raptors, cockatoos, corvids, waterbirds, night birds, very mobile, high flying, nomadic or irregular species, and all single occurrences of species. After a preliminary analysis one inadequately sampled quadrat (TP0102) which appeared on the initial dendrogram as a single-quadrat group was also masked out.

The dendrogram resulting from the *quadrat* analysis of bird species is shown in Figure 104. The primary division of the dendrogram is into two groups, reflecting the distinction between woodland/open woodland communities and low shrubland communities (generally chenopods - e.g. Bluebush, Saltbush).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0.4206
0.6912
0.9618
1.2324
1.5030
CA1101
EB0101
TP0101
CA1201
HW0201
BR0602
SD0302
CN0202
FL0302
1
FL0203
SV0301
CN0401
SM0302
HY0201
OV0502
DA9901
KO0102
RC0201
OV0401
AD0102
OV0202
BN0201
TS0101
PH0101
CA0201
PP0102
GB0201
2a
SC0101
RB0101
SE0103
BL0502
YB0102
PC0101
JH0302
PA0201
LW0103
2
SQ0201
YT0201
YT0302
PK0201
WF0103
BY0103
OP0102
DA0201
FJ0102
FJ0202
WT0101
NK0101
CL0102
2b
TV0301
HW0104
OA0101
BR0102
2c
OP0101
JS0101
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BR0204
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TG0202
3a
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GR0202
SV0103
FL0102

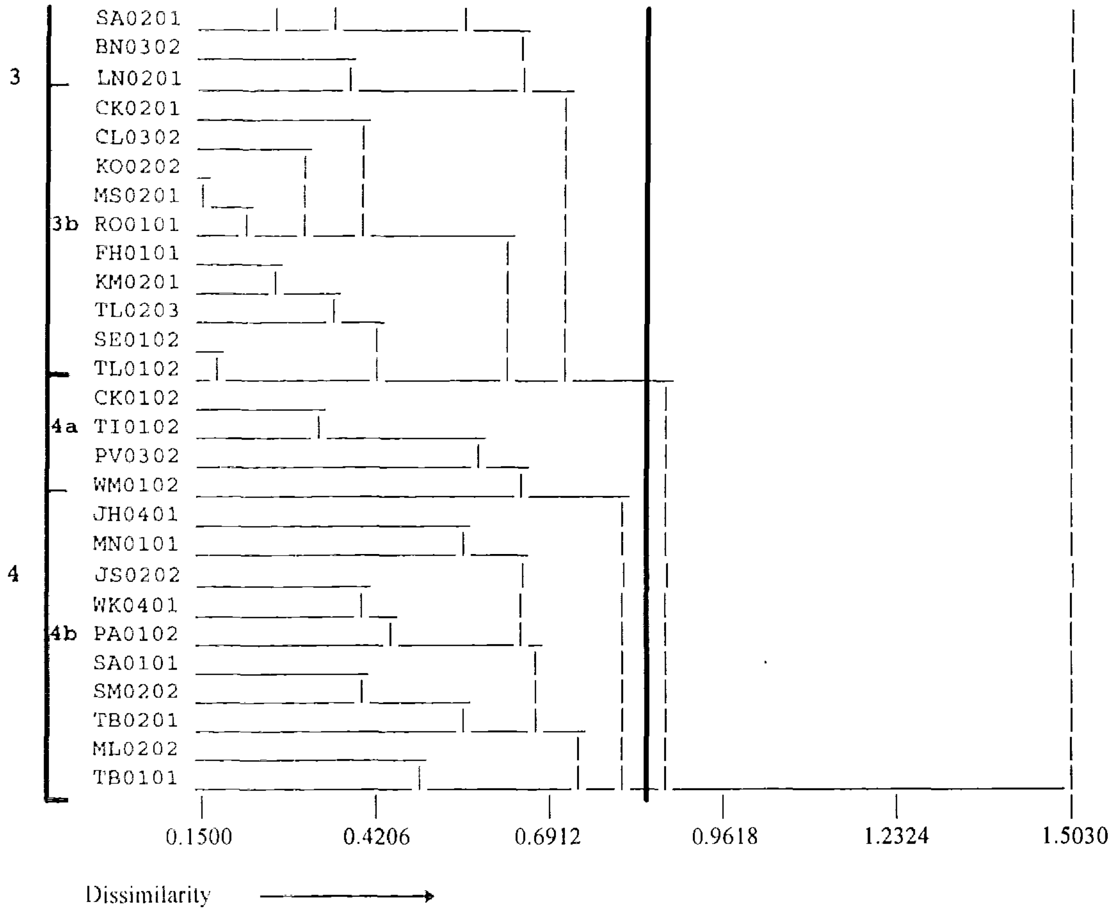


Figure 104
Dendrogram from classification analysis of bird data, showing quadrat groups

Further division of the dendrogram produces four quadrat groups (as shown on Fig. 104):

Group 1 Blackoak (*Casuarina pauper*) woodland
Group 2 mallee
Group 3 chenopod shrubland
Group 4 chenopod shrubland with emergent trees.

These broad classifications of the known vegetation types match the known preferred habitats of the bird species found there, as listed in the quadrat group descriptions later (derived from the GLIST output). The clumping of quadrats into four main groups as recognised here results from the distribution of bird species as recorded on the survey. As later analyses show, birds which were frequently recorded from similar habitats (occupying many quadrats) tended to cluster separately from other species which were infrequently recorded that still exhibited a similar habitat preference. Likewise, species which were common and fairly generally distributed across a range of quadrats, while still exhibiting (in most cases) a clear habitat preference, caused some blurring of the habitat-bird community relationships. This is hardly surprising however, given the mobility of birds and the way in which habitats of one vegetation type were frequently adjacent to or contained within others.

If the dendrogram is divided further, two small sub-groups (2b and 2c) are separated from the bottom of Group 2 (2c with non-mallee Eucalypt trees) and one (4a) from the top of Group 4. Slight differences in the bird species composition of these sub-groups is evident, as shown on the two-way table (Table 17). Floristically, the sub-groups are just variants of the group's vegetation type, however, these slight floristic variations also explain some of the variability in the bird species composition (see group descriptions later). Group 3 also divides further into two sub-groups (3a and 3b) which is a distinction between chenopod shrublands with and without emergent trees respectively and is reflected in the bird species recorded (see two-way table and group discussions later).

The bird *species* analysis (i.e. comparison of the distributions of each bird species across all quadrats sampled) produced a more untidy dendrogram (not shown here) which is usually the case for species analysis. However, this dendrogram also showed a highly distinctive primary division between the characteristic birds of woodlands and those of low shrublands. The next best grouping from this dendrogram was into ten bird groups (to be called *blocks*) - three of which generally reflected the above four quadrat groups, two minor groups and five very low frequency groups - determined by assessing the two-way table of species incidence by quadrat (Table 17). (Closer inspection of this table also revealed sub-groups in blocks one, two and ten.):

Block 1 Frequent woodland generalists
a. frequent woodland generalists (mallee and Blackoak)
b. Blackoak-preferring generalists

Block 2 Mallee-dwelling species
a. sedentary mallee species
b. as above but also frequent in mixed woodlands

Block 3 Less frequent generalists - preferring mallee
Block 4 Less frequent generalists - preferring Blackoak

Block 5)
Block 6) Rarer mallee-dwelling species
Block 7)

Block 8 Rarer chenopod shrubland dwelling species

Block 9 Rarer open-habitat species

Block 10 Chenopod shrubland and open-habitat specialists
a. 'pure' chenopod shrublands - no trees
b. open chenopod-dominant environment and/or open woodlands

Interpretation of the bird species analysis is discussed by referring to the two-way table (Table 18). The primary division already mentioned from the quadrat and species analyses (i.e. woodland versus shrubland) can be seen on the two-way table as the trend of points in the top left half versus the bottom right corner of the table, with the rarer species in between.

Table 18
Two-way table of bird species analysis showing Groups of quadrats by Blocks of bird species.

```
GROUPS OF QUADRATS                       1.                           2.                              3.               4.
                                                                   2a            |2b |2c        3a    |     3b     4a |4b
                                CETCHBSCFFSCSHODKRO.AOBTPCPGSRSBYPJPLSYYPWBODFFWNCTHOBOJF.BBMNTBGSFSBLCCKMRFKTST.CTPWJMJWPSSTMT
                                ABPAWRDNLLVNMYVAOCV.DVNSHAPBCBELBCHAWQTTKFYPAJJTKLVWARPSJ.ERCKGRRVLANNKLOSOHMLEL.KIVMHNSKAAMBLB
                                1001000000000009000.0000000000000000000000000000000000000.0000000000000000000000.00000000000000
BLOCKS OF                       1112263232343259124.1221121211151132122321112121113111113.2215242112322322112211.11314124112221
BIRD SPECIES                    0000000000000000000.0000000000000000000000000000000000000.0000000000000000000000.00000000000000
                                1111122223112121211.2211112111322121311213321221121412112.1421212321211221111322.22221121212121

    Acanthagenys rufogularis    ****  ***** *******. ******  **** ******  * ***  * ***** .  ******** *          .    ***  ***  
    Cracticus torquatus         ***  ********** *  .   *  ********* **** *     * ********.      ****   *        . *   *********
    Acanthiza uropygialis       *******************.**   * ** *** ******  *   *    *     .     * **             .  *  ** * *   
    Pomatostomus superciliosus  ****  *************. *   ** ********   *        ***** *  .   *    **            . *        **  
1a  Psephotus varius            **** ** ** ******* .  * * *****   * **** ** **  *     *  .  **   **             .     *    **  
    Oreoica gutturalis          ** * **************. *         ********* ** ***** ***    .     *****            .    *     *  *
    Artamus superciliosus       ** *   ****     ***.**  ***** **  * **       **     *  * .      ******        **.  * * *   *   
    Artamus personatus                   **     ** .**     ****       **           **    .       ***** *    ****.  *       *   
    Chrysococcyx basalis        *        **   * ** .              *****     **      *    .     ****  *   *      .          *   
1.  Lalage sueurii                 *     *       * .       ** *     ** *    * *          .      ***  *          .    * *   *   
    Rhipidura leucophrys           *  *  *        *. *     ***      ***     * * *   *    .        *  *          .      * * **  
    Acanthiza apicalis           **    *  * *    * .                      *    *   *     .        *             .     *        
    Climacteris affinis         ** * * ** * *   ** .                *                    .        *             .          *   
    Malurus splendens            * *   ** ***** ** . *     *      **      *              .        *             .  **      * **
1b  Petroica goodenovii         *********** *****  .          *    *        *            .        *    *        .*         *   
    Pachycephala rufiventris    *  ******** ***   *. *        *    *      ***        **  .                      .              
    Cacatua leadbeateri            *   *  *   *    .                *  *                *.       *              .              
    Pachycephala inornata       *  *     **   **   . *            * *    *          *    .                      .              
    Phylidonyris albifrons               ** *  *   .     *      *    ***         ****    .    *                 .              
                                ...............................................................................................
    Aegotheles cristatus        *  *  *     *      .      * *  *  ***                 *  .                      .              
    Meliphaga leucotis          ****               .      * *  *** *                     .                      .              
    Cinclosoma castanotum          * *  ***     *  .      **   *** **    *  *  * ***    .                      .              
    Melithreptus brevirostris          **          .      ***   ***** **                 .                      .              
2a  Strepera versicolor                  **   *    . *    **** ** * * ** *        *      .                      .              
    Leipoa ocellata                *               .           ** *   *            **    .                      .              
    Pardalotus xanthopygus         *               .       *** *****  *            **    .                      .              
    Anthochaera carunculata       *                .      *  * ***    *                  .                      .              
    Plectorhyncha lanceolata     *     *           .           ***  *                    .                      .              
2.  Drymodes brunneopygia          *               . *               *          *  *     .                      .              
    Barnardius zonarius          ***   ****      * .************** ******** *******     *.   **  **             .        *     
    Colluricincla harmonica     ** *   **** ****   . ************************   * * * *  .        **            .             *
    Pardalotus striatus         *  **  **   * **   .****************  **  *** *      ****.                    **.   *          
    Smicrornis brevirostris      * **   *      *   .*** ******************* *      * **  .                      .        *     
    Coracina novaehollandiae    ** ** * *       ** .**      *** ****            *    *** .           *          .        *     
2b  Phaps chalcoptera           **     *  *      * .    ***  * ** **      *  *    *     *.       *              .  *           
    Climacteris picumnus        *****            * .*   ***** ** *  *     *   * *        .                      .              
    Meliphaga ornata            *****              . *   *********  *** ***  **** ***    .                      .              
    Microeca leucophaea          ***   *  *        . *  ******** ******   *  ****  **    .                      .              
    Melanodryas cucullata         **** *        ** .     **** *     *       *** *   *    .           *          .              
    Malurus lamberti            * ***    *         .     ** *  *  *   *          ** * ** .         *            .*          *  
    Hirundo nigricans                              .**  *** * *   * *        ***      * *.                   *  .         **   
```

```
     Corcorax melanorhamphos        **         *     .  ***  ****     *               *    .                       .
     Daphoenositta chrysoptera      *  **     *        .  *   ** **                          .                       .
                                    ................................................................................................
     Acanthiza chrysorrhoa          ***** *          * .         **           *            *  .                  * * .      * *
     Manorina flavigula                *        *      .  ***   * *                       *** .    *                 .     * *
3.   Nymphicus hollandicus                           * .*   ***  **                *        * .  *        *    *** **.           * *
     Sturnus vulgaris                                  .     *  ***                           .           *    *     .       **
     Halcyon pyrrhopygia                               .         **     *                     .                      .   *        *
     Cinclorhamphus mathewsi                           .     * *                              .             *        .    *     *
                                    ................................................................................................
     Chrysococcyx osculans          **        *        .                                      .       *              .    *     * *
     Cracticus nigrogularis         ** *               .                                      .       *              .  *
4.   Poephila guttata               * *                .                         *            .  *                   .             *
     Psephotus haematonotus                            .        *                             .       *              .           *
     Struthidea cinerea                  **            .                                      .       *              .      * **
                                    ................................................................................................
     Accipiter cirrhocephalus                          .     **   *                           .                  *   .
5.   Glossopsitta porphyrocephala                      .      *   *                           .                      .
     Artamus cyanopterus                               . *    *                               .                      .
     Accipiter fasciatus                               .     *     *                       ** .                      .
                                    ................................................................................................
6.   Geopelia cuneata                                  .              *            *          .                      .
                                    ................................................................................................
     Hylacola cauta                    *               .               *       *              .                      .
7.   Meliphaga plumula                *                .               **           *         .                      .
     Myiagra inquieta                                  .       *                 *   *        .                      .
                                    ................................................................................................
8.   Alauda arvensis                                   .                                      .           *      *   .
     Neophema chrysostoma                              .          *                           .           * * *     .
                                    ................................................................................................
     Coturnix novaezelandiae                           .                                      .             * **     .
     Epthianura aurifrons                              .                                      .            **        .***
9.   Psophodes cristatus                               .                                      .                      .** *  **
     Hoplopterus tricolor                              .                                      .*       *            .    *
     Pteropodocys maxima                               .                                      .    **               .
                                    ................................................................................................
     Anthus novaeseelandiae                            .                         *    *       .** *******************. ***  **
     Malurus leucopterus             *                 .                                    * .**********  ******** *.*** *****   *
10a  Epthianura albifrons                    *      * *.               *                      .* *** ****  ********  .    *   *
     Falco cenchroides                             *   .     **  *                    *   * **.****** ***** **** ****.**    ***** **
     Cinclorhamphus cruralis                           .                                      .* ***    * *********.
 —   Calamanthus campestris            *          *    .                                      .           ***** * * .  *    *
10.  Aphelocephala leucopsis        ***    * * ********.**     *  *   *          *            . ********* *     *****. **********  *
     Ocyphaps lophotes               *    *         * *.**      *                           * .    ***** *      * **.**** *  *
     Artamus cinereus                *   **            .                           *          .** ****** * *        .            **
10b  Northiella haematogaster             *      *   * .                               *    * .  ***** ***           .      * * *  *
     Pyrrholaemus brunneus            *     * ***      .     *                        * **    .  * * * ** ****    *.*** **    * **
     Meliphaga virescens            ****        *     *.        *                *    **      .  *** ***      *  *  .         ***
     Pomatostomus ruficeps           *            *    .            *   ** *    *      *  * .    * * *             .  * ******** *
```

In the following discussion *quadrat* groups (1-4) will be referred to as *groups* and bird *species* groups (1-10) will be referred to as *blocks*. On the two-way table (Table 18) the quadrat groups are shown across the top and the bird species blocks down the left-hand side. The order of quadrats/species and groups/blocks are the same as on the respective dendrograms. In this discussion references to specific vegetation sub-types (e.g. dense or open Blackoak), other than the quadrat sub-groups mentioned above, are implied from the bird species present not from the finer details of the quadrat vegetation descriptions - these often didn't seem to reflect the implied sub-types (possibly due to observer variation in the structural vegetation data collected).

Bird species groups

Block 1 contains the frequent woodland generalist species (i.e. occurring in Blackoak and/or mallee). Block 1a species, especially the top six species, which are largely sedentary (S), are particularly widespread and are only really absent from the treeless chenopod quadrats (second half of Group 3):

Spiny-cheeked Honeyeater (*Acanthagenys rufogularis*) - mobile (but usually present within region)
Grey Butcherbird (*Cracticus torquatus*) S
Chestnut-rumped Thornbill (*Acanthiza uropygialis*) S
White-browed Babbler (*Pomatostomus superciliosus*) S
Mulga Parrot (*Psephotus varius*) ?S
Crested Bellbird (*Oreoica gutturalis*) S

The next five species follow a similar pattern but are less frequent in occurrence. Unlike the previous six species the first four are highly mobile (M - migratory or nomadic, often vacating the entire region):

White-browed Woodswallow (*Artamus superciliosus*) M
Masked Woodswallow (*A. personatus*) M
Horsefield's Bronze Cuckoo (*Chrysococcyx basalis*) M
White-winged triller (*Lalage sueurii*) M
Willie Wagtail (*Rhipidura leucophrys*) - less mobile, at least partly sedentary (?S).

These Block 1a species don't make much distinction between Blackoak and mallee - as long as there are some large trees and non-chenopod shrubs (e.g. *Eremophila*, Native Cherry (*Exocarpus*), *Senna/Cassia*). They are less common in pure (dense) mallee, preferring it to be broken up with more open and shrubbier patches.

Block 1b contains the Blackoak-preferring generalists, which avoid most of the pure uniform mallee and chenopod quadrats (Group 2, 3 and 4 - particularly the treeless chenopod quadrats). The first five species are basically sedentary (S) bush birds which reliably occur in good Blackoak stands (and in Mulga):

Inland Thornbill (*Acanthiza apicalis*) S
White-browed Treecreeper (*Climacteris affinis*) S
Splendid Fairy-wren (*Malurus splendens*) S
Red-capped Robin (*Petroica goodenovii*) S
Rufous Whistler (*Pachycephala rufiventris*) S

The next three species in Block 1b are less frequent, and not so dependent on Blackoak (or Mulga). They also avoid dense mallee and pure chenopod shrublands, preferring open woodland with large shrubs e.g. False Sandalwood open woodland with flowering Eremophilas. These three species are patchily distributed (P):
Pink Cockatoo (*Cacatua leadbeateri*) P,S - large, sedentary but locally mobile
Gilbert's Whistler (*Pachycephala inornata*) P,S - rare, areas with sparse trees and shrubby patches
White-fronted Honeyeater (*Phylidonyris albifrons*) P,M - highly mobile, nectar-seeking

Block 2 comprises the typical suite of species inhabiting mallee, along with a few woodland generalists. They avoid the chenopod low shrublands if the emergent trees are not at sufficient density and this separates them from Block 1a species that occur in chenopod shrublands with emergent trees. Block 2 has some confounding influences that derive from the presence of mallee habitats in predominantly Blackoak quadrats (either mallee was adjacent to some of the quadrats in Group 1 or there were very small mallee pockets occurring within the quadrat, especially so with the first five quadrats). This is reflected in the distribution of some of the mallee-dependent bird species found throughout Group 1 (Blackoak) as well as in Group 2 (mallee) quadrats.

Most of the species in Block 2a are sedentary (S), typical mallee (Ma) species, completely avoiding the chenopod quadrats of Groups 3 and 4 and tending to avoid the northern Blackoak-dominated quadrats in Group 1 (but which do occur in some of the mixed quadrats of Group 1, especially in the south of the region). Only the Pardalote and Wattlebird are strongly mobile (M), while some are better regarded as southern eucalypt (E) generalists (i.e. woodland and mallee) rather than mallee specialists:

Australian Owlet-nightjar (*Aegotheles cristatus*) S,E
White-eared Honeyeater (*Meliphaga leucotis*) S,Ma
Chestnut Quail-thrush (*Cinclosoma castanotum*) S,Ma
Brown-headed Honeyeater (*Melithreptis brevirostris*) S,E
Grey Currawong (*Strepera versicolor*) S,E
Malleefowl (*Leipoa ocellata*) S,Ma
Yellow-rumped Pardalote (*Pardalotus xanthopygus*) M,Ma
Red Wattlebird (*Anthochaera carunculata*) M,E
Striped Honeyeater (*Plectorhyncha lanceolata*) ?S
Southern Scrub-robin (*Drymodes brunneopygia*) S,Ma

Block 2b species also tend to be sedentary, preferring mallee or eucalypt trees generally (non-mallee eucalypts in Group 2c), but tend to be more frequently recorded than Block 2a species and more common in the *mixed* mallee and Blackoak quadrats of Groups 1 and 2. Apart from the first two generalists (which still exhibit a slight mallee preference), these species seem to avoid the 'purer' and more northerly Blackoak quadrats in Group 1 (second half):

Ringneck (*Barnardius zonarius*) S
Grey Shrike-thrush (*Colluricincla harmonica*) S
Striated Pardalote (*Pardalotus striatus*) S,E
Weebill (*Smicrornis brevirostris*) S,Ma
Black-faced Cuckoo-shrike (*Coracina novaehollandiae*) M,E
Common Bronzewing (*Phaps chalcoptera*) S
Brown Treecreeper (*Climacteris picumnis*) S,E
Yellow-plumed Honeyeater (*Meliphaga ornata*) S,Ma
Jacky Winter (*Microeca leucophaea*) S,Ma
Hooded Robin (*Melanodryas cucullata*) S
Variegated Fairy-wren (*Malurus lamberti*) S
Tree Martin (*Hirundo nigrogularis*) M,E
White-winged Chough (*Corcorax melanorhamphos*) S,E
Varied Sitella (*Daphoenositta chrysoptera*). S

Block 2 species would be expected to occur wherever there are good-sized relatively undisturbed patches of mallee bearing a moderate degree of structural diversity.

Blocks 3 and 4 mirror the trend expressed in the woodland generalists Blocks of 1a and 2b, in that there is a slight tendency towards Blackoak-preferring species (in Blocks 4 and 1a) versus the slight mallee preference of species in Blocks 3 & 2b. However, Blocks 3 & 4 are the rarer or infrequent generalists that prefer much more open woodlands - Block 3 species avoid the denser mallee habitats (second half of Group 2) and Block 4 species avoid the apparently denser Blackoak woodlands (second half of Group 1). Both Blocks seem to also occur in some chenopod sites (Groups 3 & 4). An unusual mixture of sedentary (S), 'patchily'-distributed (P), highly mobile (M) and 'edge of customary range' (Ed) species are grouped together in these two blocks. Block 3:

Yellow-rumped Thornbill (*Acanthizia chrysorrhoa*) S
Yellow-throated Miner (*Manorina flavigula*) S
Cockatiel (*Nymphicus hollandicus*) M
Common Starling (*Sturnus vulgaris*) M,Ed
Red-backed Kingfisher (*Halcyon pyrrhopygia*) M
Rufous Songlark (*Cinclorhamphus mathewsi*) M

Block 4:

Black-eared Cuckoo (*Chrysococcyx osculans*) M
Pied Butcherbird (*Cracticus nigrogularis*) S - unusual sighting in this habitat as tends to occur more in River Red Gums
Zebra Finch (*Poephila guttata*)
Red-rumped Parrot (*Psephotus haematonotus*) E
Apostlebird (*Struthidea cinerea*) P.

Blocks 5,6 and 7 are generally rare mallee birds because they are either on the edge of their range (Ed), naturally patchy in their distribution (P) or are raptors which are naturally rare (R). Not all are typically mallee species (N). Block 5:

Collared Sparrowhawk (*Accipiter cirrhocephalus*) R
Purple-crowned Lorikeet (*Glossopsitta porphyrocephala*) Ed
Dusky Woodswallow (*Artamus cyanopterus*) Ed
Brown Goshawk (*Accipiter fasciatus*) R

Block 6:

Diamond dove (*Geopelia cuneata*) N - unusual that it appears in a bunch of mallee Blocks

Block 7 - curiously, the first two species exhibit a strong preference for regenerating mallee, e.g. Boehm (1957):

Shy Hylacola (*Hylacola cauta*) Ed
Grey-fronted Honeyeater (*Meliphaga plumula*) P
Restless Flycatcher (*Myiagra inqiueta*) Ed

Block 8 contains the rarer low open shrubland bird species, which although not necessarily chenopod specialists, they like open grassy habitats in which to feed:

Skylark (*Alauda arvensis*) E (agricultural lands)
Blue-winged Parrot (*Neophema chrysostoma*) P,M (migratory)

Block 9 species are similarly infrequent birds of open, grassy or shrubby, not necessarily chenopod-dominated, habitats. Three (possibly four) are highly mobile (M) and one is patchily distributed (P):

Stubble Quail (*Coturnix novaezelandiae*) M
Orange Chat (*Epthianura aurifrons*) M,C - favours chenopods strongly
Banded Lapwing (*Hoplopterus tricolor*) M
Ground Cuckoo-shrike (*Pteropodocys maxima*) ?M
Chirruping Wedgebill (*Psophodes cristatus*) S,P

Block 10 comprises the chenopod and other open environment specialists. Some have a particular liking for low chenopod shrublands (C) and others prefer or require emergent trees (or tall shrubs) (T). Most of the species are sedentary (S).

Block 10a species prefer chenopod habitats without or only a sparse tree layer (Group 3b quadrats):

Richard's Pipit (*Anthus novaeseelandiae*) S
White-winged Fairy-wren (*Malurus leucopterus*) S,C
White-fronted Chat (*Epthianura albifrons*) M,C
Nankeen Kestrel (*Falco cenchroides*) M
Brown Songlark (*Cinclorhamphus cruralis*) M
Western Field-wren (*Calamanthus campestris*) S,C - particularly in areas with no trees.

Block 10b are not so dependent on chenopods and may occur in open woodlands without chenopods. Thus the species of this group occur more frequently at some of the Group 1 and 2 quadrats, while still showing a distinct preference for the open and chenopod-dominated environments (Groups 3 & 4):

Southern Whiteface (*Aphelocephala leucopsis*) S
Crested Pigeon (*Ocyphaps lophotes*) T
Black-faced Wooodswallow (*Artamus cinereus*) ?S
Bluebonnet (*Northiella haematogaster*) S,T
Redthroat (*Pyrrolaemus brunneus*) S
Singing Honeyeater (*Meliphaga virescens*) S
Chestnut-crowned Babbler (*Pomatostomus ruficeps*) S,T

Apart from the Redthroat (and Whiteface?), these species tend to be less frequent in straight chenopod low shrublands without emergent trees or without patches of taller shrubs (i.e. Group 3b).

Bird quadrat groups

The four quadrat groups are individually described below, each with a map, the number of members (quadrats) and a bird species list (from GLIST). The map shows the distribution of quadrats at which this suite of bird species were observed, shown by large dots. The small dots indicate the location of all quadrats surveyed for fauna.

The species list shows the proportion of occurrence of each species within that group (i.e. the proportion of quadrats in that group at which the species occurred), the number of other groups in which that species occurs (i.e. out of a total of four groups) and the X^2 for each species (i.e. a measure of the uniqueness of that species to that group - note that a negative standard residual means that it is the low abundance or near absence of the species from that group that is significant). The list is in order of descending proportion of occurrence and only shows species with a proportion of occurrence greater then 0.05.

By assessing the known vegetation types at each quadrat within a group, and having a knowledge of the habitat preferences of the bird species found there, each of the four groups was assigned a broad vegetation type. A description of the vegetation types indicated by the quadrats present in the group is summarised for each group. In general however, it is more biologically realistic to view the broad habitats as typified in terms of the avifauna present, rather than the vegetation classification at each quadrat, because being mobile, birds use areas much larger than the vegetation quadrat (which may be surrounded by another vegetation type or have significant patches nearby or within) thus leading to a mixture of bird species present. Hence the individual quadrat vegetation types don't always match the general group name.

Similarly, as birds are mobile and the quadrat groups are less rigid than in the vegetation species analysis grouping, it is not appropriate to identify *indicator* species as defined previously, but *characteristic* species can be noted. In the case of bird species, the proportion of occurrence and X^2 for each species can only be used as a guide to identify important species - a detailed knowledge of bird-habitat relationships is necessary to correctly interpret each group's bird assemblage.

For each group, the species are discussed in four categories and denoted as such on the proportion of occurrence list:

c Frequent, characteristic (core) species - frequent and characteristic species of the vegetation type, generally with a proportion of occurrence greater than 0.25 and $X^2 > 0.2$.

f Frequent species - species frequently found in that vegetation type but which are not specifically characteristic of it (i.e. are found more generally across other habitats as well). Generally proportion of occurrence is greater than 0.3 and $X^2 < 0.2$.

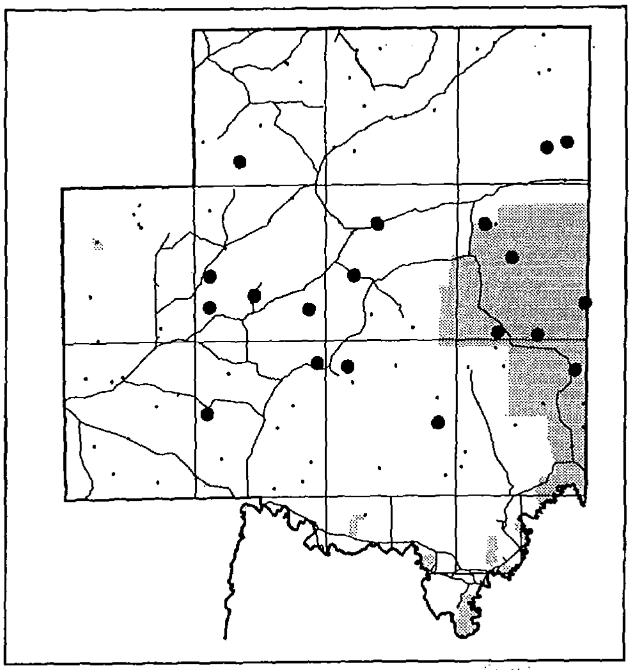
r Rarer, significant species - rarer but significant species that are considered characteristic of the vegetation type, based on knowledge of their habitat preferences; they tend to have a lower proportion of occurrence and X^2 values. (Although known to be characteristic species these showed a low X^2 in the current data - maybe due to inadequate sampling, seasonal or weather conditions or just because they are rarer birds.)

o Other notable species - fairly common but less frequent species (proportion of occurrence greater than 0.15) in the vegetation type but that are mobile, seasonal or characteristic of variants of the vegetation type (and thus only have a low X^2 for the whole group).

In the discussion of species for each group the following abbreviations are used to denote the habits and preferences of species:
M - mobile
B - Blackoak (preference for Blackoak over mallee)
Ma - mallee
W - widespread
C - low open shrublands (usually chenopods)
S - sedentary
Ed - on or approaching edge of species' range
G - ground-feeding
T - emergent trees

Group 1. Birds of Blackoak woodlands

19 Members



Quadrat vegetation types

Blackoak (*Casuarina pauper*) low open woodland to low open forest, often with Bullock Bush (*Alectryon oleifolius*), Sugarwood (*Myoporum platycarpum*) &/or *Acacia* spp., with chenopod or other (*Eremophila* spp., *Senna* spp., *Olearia* spp.) shrub understorey. Sometimes with small patches of mallee within or nearby.

Bird species present

	Species	Prop. Occur.	No. Grps	Chi Squ.	Std Res.
c	*Acanthiza uropygialis*	1.0000	4	0.5364	0.73
c	*Oreoica gutturalis*	0.8947	4	0.3859	0.62
c	*Pomatostomus superciliosus*	0.8947	4	0.4924	0.70
f	*Acanthagenys rufogularis*	0.8421	4	0.1020	0.32
c	*Petroica goodenovii*	0.8421	4	1.0567	1.03
c	*Psephotus varius*	0.7895	4	0.3301	0.57
f	*Cracticus torquatus*	0.7368	4	0.0413	0.20
f	*Aphelocephala leucopsis*	0.6842	4	0.0193	0.14
c	*Pachycephala rufiventris*	0.6842	2	0.9364	0.97
f	*Colluricincla harmonica*	0.5789	4	0.1115	0.33
c	*Malurus splendens*	0.5789	4	0.3219	0.57
c	*Climacteris affinis*	0.5263	4	0.7681	0.88
o	*Artamus superciliosus*	0.5263	4	0.0384	0.20
f	*Barnardius zonarius*	0.4211	4	0.0067	0.08
	Pardalotus striatus	0.4211	4	0.0262	0.16
o	*Coracina novaehollandiae*	0.4211	4	0.1777	0.42
c	*Melanodryas cucullata*	0.3684	3	0.2044	0.45
o	*Acanthiza chrysorrhoa*	0.3684	4	0.2051	0.45
c	*Pachycephala inornata*	0.3158	2	0.3658	0.60
c	*Acanthiza apicalis*	0.3158	4	0.2733	0.52
o	*Meliphaga virescens*	0.3158	4	0.0171	0.13
	Climacteris picumnus	0.3158	2	0.1331	0.36
o	*Chrysococcyx basalis*	0.3158	4	0.0428	0.21
r	*Cinclosoma castanotum*	0.3158	2	0.1331	0.36
r	*Pyrrholaemus brunneus*	0.2632	4	0.0212	-0.15
	Malurus lamberti assimilis	0.2632	4	0.0308	0.18
	Phaps chalcoptera	0.2632	4	0.0431	0.21
	Microeca leucophaea	0.2632	2	0.0111	0.11
	Meliphaga ornata	0.2632	2	0.0080	0.09
	Smicrornis brevirostris	0.2632	3	0.0001	0.01
	Rhipidura leucophrys	0.2105	4	0.0005	-0.02

	Species	Prop. Occur.	No. Grps	Chi Squ.	Std Res.
o	*Ocyphaps lophotes*	0.2105	4	0.0214	-0.15
o	*Artamus personatus*	0.2105	4	0.0129	-0.11
	Phylidonyris albifrons	0.2105	3	0.0589	0.24
	Meliphaga leucotis	0.2105	2	0.1477	0.38
	Daphoenositta chrysoptera	0.2105	2	0.1783	0.42
r	*Cacatua leadbeateri*	0.2105	3	0.1891	0.43
	Aegotheles cristatus	0.2105	2	0.1224	0.35
	Cracticus nigrogularis	0.1579	3	0.1158	0.34
o	*Artamus cinereus*	0.1579	4	0.0073	-0.09
o	*Northiella haematogaster*	0.1579	4	0.0153	-0.12
	Corcorax melanorhamphos	0.1579	2	0.0331	0.18
	Epthianura albifrons	0.1579	4	0.0425	-0.21
	Strepera versicolor	0.1579	2	0.0073	0.09
r	*Chrysococcyx osculans*	0.1579	3	0.0274	0.17
o	*Lalage sueurii*	0.1579	4	0.0062	-0.08
	Poephila guttata	0.1053	4	0.0297	0.17
r	*Struthidea cinerea*	0.1053	3	0.0022	0.05
	Melithreptus brevirostris	0.1053	2	0.0014	0.04
	Plectorhyncha lanceolata	0.1053	2	0.0506	0.22
	Manorina flavigula	0.1053	4	0.0039	-0.06
	Pomatostomus ruficeps	0.1053	4	0.1144	-0.34
	Calamanthus campestris	0.1053	3	0.0093	-0.10
	Anthochaera carunculata	0.0526	2	0.0000	0.00
	Leipoa ocellata	0.0526	2	0.0000	0.00
	Pardalotus xanthopygus	0.0526	2	0.0139	-0.12
	Malurus leucopterus	0.0526	4	0.2983	-0.55
	Drymodes brunneopygia	0.0526	2	0.0039	0.06
	Meliphaga plumula	0.0526	2	0.0110	0.11
	Nymphicus hollandicus	0.0526	4	0.0924	-0.30
	Hylacola cauta	0.0526	2	0.0253	0.16
	Falco cenchroides	0.0526	4	0.3382	-0.58

Notable bird species

Frequent, characteristic species (c)

Chestnut-rumped Thornbill (*A. uropygialis*)
Crested Bellbird (*O. gutturalis*)
White-browed Babbler (*P. superciliosus*)
Red-capped Robin (*P. goodenovii*)
Mulga Parrot (*P. varius*)
Rufous Whistler (*P. rufiventris*)
Splendid Fairy-wren (*M. splendens*)
White-browed Treecreeper (*C. affinis*)
Hooded Robin (*M. cucullata*)
Gilbert's Whistler (*P. inornata*)
Inland Brown Thornbill (*A. apicalis*)

Frequent species (f)

Spiny-cheeked Honeyeater (*A. rufogularis*)
Grey Butcherbird (*C. torquatus*)
Southern Whiteface (*A. leucopsis*)
Grey Shrike-thrush (*C. harmonica*)
Ringneck Parrot (*B. zonarius*)

Rarer, significant species (r)

Chestnut Quail-thrush (*C. castanotum*)
Redthroat (*P. brunneus*)
Pink Cockatoo (*C. leadbeateri*)
Black-eared Cuckoo (*C. osculans*)
Apostlebird (*S. cinerea*)

Other notable species (o)

These species are more frequently found in more open Blackoak woodlands

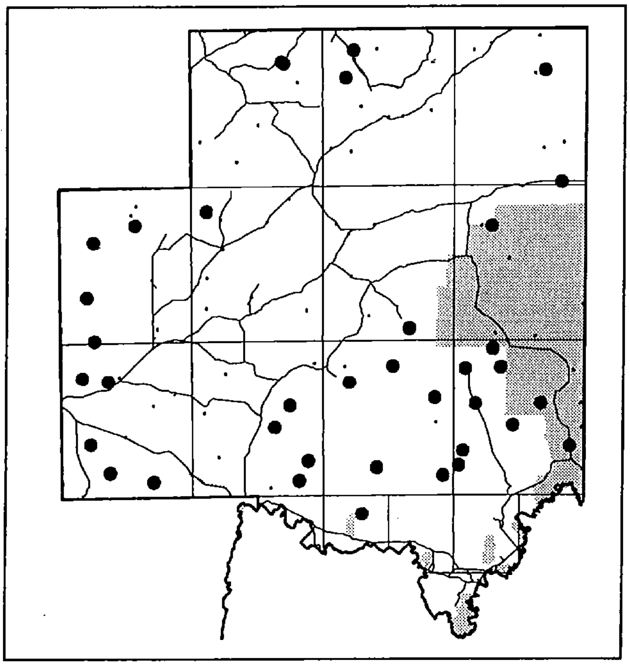
White-browed Woodswallow (*A. superciliosus*) M
Black-faced Cuckoo-shrike (*C. novaehollandiae*) M
Yellow-rumped Thornbill (*A. chrysorrhoa*)
Singing Honeyeater (*M. virescens*)
Horsefield's Bronze Cuckoo (*C. basilis*) M
Crested Pigion (*O .lophotes*)
Masked Woodswallow(*A. personatus*) M
Black-faced Woodswallow (*A. cinereus*)
Bluebonnet (*N. haematogaster*)
White-winged Triller (*L. sueurii*) M

Comments

The distribution of this group in the central part of the survey area follows that of the extensive Blackoak woodlands.

Group 2. Birds of mallee woodlands

37 Members



Quadrat vegetation types

Variety of tree or shrub very open mallee to mallee (*E. gracilis, E. socialis, E. oleosa, E. dumosa*) with chenopod or mixed shrub understorey. Includes some Eucalypt (tree) low woodlands (*E. brachycalyx* - Gilja, *E. porosa* - Mallee Box, *E. camaldulensis* - River Red Gum) and one *Callitris glaucophylla* (White Cypress Pine) woodland.

Bird species present

	Species	Prop. Occur.	No. Grps	Chi Squ.	Std Res.
c	*Barnardius zonarius*	0.8108	4	0.5203	0.72
c	*Colluricincla harmonica*	0.7568	4	0.3902	0.62
c	*Smicrornis brevirostris*	0.7027	3	0.7580	0.87
f	*Cracticus torquatus*	0.6486	4	0.0077	0.09
c	*Meliphaga ornata*	0.6216	2	0.7248	0.85
c	*Microeca leucophaea*	0.5946	2	0.6739	0.82
f	*Oreoica gutturalis*	0.5405	4	0.0108	0.10
f	*Psephotus varius*	0.4865	4	0.0112	0.11
f	*Pomatostomus superciliosus*	0.4865	4	0.0066	0.08
f	*Acanthiza uropygialis*	0.4595	4	0.0017	-0.04
f	*Artamus superciliosus*	0.4324	4	0.0023	0.05
c	*Hirundo nigricans*	0.3784	3	0.3955	0.63
c	*Strepera versicolor*	0.3514	2	0.3943	0.63
c	*Climacteris picumnus*	0.3514	2	0.2043	0.45
f	*Coracina novaehollandiae*	0.3514	4	0.0749	0.27
c	*Cinclosoma castanotum*	0.3514	2	0.2043	0.45
f	*Phaps chalcoptera*	0.3243	4	0.1247	0.35
f	*Rhipidura leucophrys*	0.2973	4	0.0263	0.16
f	*Malurus lamberti*	0.2973	4	0.0647	0.25
f	*Melanodryas cucullata*	0.2973	3	0.0803	0.28
c	*Pardalotus xanthopygus*	0.2973	2	0.5032	0.71
c	*Melithreptus brevirostris*	0.2703	2	0.3314	0.58
f	*Artamus personatus*	0.2703	4	0.0000	0.00
r	*Corcorax melanorhamphos*	0.2432	2	0.2037	0.45
o	*Phylidonyris albifrons*	0.2432	3	0.1124	0.34
o	*Manorina flavigula*	0.2162	4	0.0618	0.25
o	*Lalage sueurii*	0.2162	4	0.0029	0.05
o	*Nymphicus hollandicus*	0.2162	4	0.0062	0.08
o	*Pachycephala rufiventris*	0.2162	2	0.0004	-0.02

	Species	Prop. Occur.	No. Grps	Chi Squ.	Std Res.
c	*Pardalotus striatus*	0.7297	4	0.4908	0.70
f	*Acanthagenys rufogularis*	0.7027	4	0.0192	0.14
o	*Chrysococcyx basalis*	0.2162	4	0.0000	-0.01
	Falco cenchroides	0.1892	4	0.1406	-0.37
	Pomatostomus ruficeps	0.1892	4	0.0329	-0.18
r	*Aegotheles cristatus*	0.1892	2	0.0798	0.28
r	*Meliphaga leucotis*	0.1622	2	0.0511	0.23
r	*Leipoa ocellata*	0.1622	2	0.2192	0.47
r	*Anthochaera carunculata*	0.1622	2	0.2192	0.47
	Aphelocephala leucopsis	0.1622	4	0.2996	-0.55
	Pachycephala inornata	0.1351	2	0.0044	0.07
	Daphoenositta chrysoptera	0.1351	2	0.0275	0.17
	Malurus splendens	0.1351	4	0.0743	-0.27
	Sturnus vulgaris	0.1081	3	0.0060	0.08
r	*Accipiter fasciatus*	0.1081	1	0.2432	0.49
	Ocyphaps lophotes	0.1081	4	0.1133	-0.34
r	*Plectorhyncha lanceolata*	0.1081	2	0.0562	0.24
	Meliphaga virescens	0.1081	4	0.0809	-0.28
	Pyrrholaemus brunneus	0.1081	4	0.1666	-0.41
r	*Drymodes brunneopygia*	0.1081	2	0.1148	0.34
	Acanthiza chrysorrhoa	0.1081	4	0.0272	-0.16
	Petroica goodenovii	0.0811	4	0.1498	-0.39
	Acanthiza apicalis	0.0811	4	0.0175	-0.13
	Meliphaga plumula	0.0811	2	0.0679	0.26
r	*Myiagra inquieta*	0.0811	1	0.1824	0.43
r	*Accipiter cirrhocephalus*	0.0811	2	0.0773	0.28
	Cacatua leadbeateri	0.0811	3	0.0001	-0.01
	Halcyon pyrrhopygia	0.0811	2	0.0112	0.11
r	*Glossopsitta porphyrocephala*	0.0540	1	0.1216	0.35

r	*Hylacola cauta*	0.0540	2	0.0281	0.17		*Anthus novaeseelandiae*	0.0540	3	0.2419	-0.49
	Cinclorhamphus mathewsi	0.0540	3	0.0007	-0.03	r	*Artamus cyanopterus*	0.0540	1	0.1216	0.35
	Northiella haematogaster	0.0540	4	0.1208	-0.35		*Geopelia cuneata*	0.0540	1	0.1216	0.35

Notable bird species

Frequent, characteristic species (c)

Ringneck Parrot (*B. zonarius*) A
Grey Shrike-thrush (*C. harmonica*)
Striated Pardalote (*P. striatus*)
Weebill (*S. brevirostris*)
Yellow-plumed Honeyeater (*M. ornata*) A
Brown Flycatcher (*M. leucophaea*)
Tree Martin (*H. nigricans*)
Grey Currawong (*S. versicolor*)
Brown Treecreeper (*C. picumnus*)
Chestnut Quail-thrush (*C. castonotum*) A
Yellow-rumped Pardalote (*P. xanthopygus*) A
Brown Honeyeater (*M. brevirostris*)

Frequent species (f)

All of these species are widely distributed across the drier parts of southern and central Australia.

Spiny-cheeked Honeyeater (*A. rufogularis*)
Grey Butcherbird (*C. torquatus*)
Crested Bellbird (*O. gutturalis*)
Mulga Parrot (*P. varius*)
White-browed Babbler (*P. superciliosus*)
Chestnut-rumped Thornbill (*A. uropygialis*)
White-browed Woodswallow (*A. superciliosus*)
Black-faced Cuckoo-shrike (*C. novaehollandiae*)
Common Bronzewing (*P. chalcoptera*)
Willie Wagtail (*R. leucophrys*)
Variegated Fairy-wren (*M. lamberti assimilis*)
Hooded Robin (*M. cucullata*)
MaskedWoodswallow (*A. personatus*)

Rarer, significant species (r)

Many of these species are mallee specialists (A) found more commonly further south, in the true mallee belt south of the River Murray. Most of the others are the mallee woodland temperate eucalypt species which are widespread across southern Australian open forest, woodlands and mallee environments. Many are also approaching the edges of their ranges (E) and therefore were recorded infrequently on the current survey - mainly in the higher rainfall areas along the southern and western margins.

White-winged Chough (*C. melanorhamphos*)
Owlet Nightjar (*A. cristatus*) W
White-eared Honeyeater (*M. leucotis*)
Malleefowl (*L. ocellata*) A
Red Wattlebird (*A. carunculata*)
Brown Goshawk (*A. fasciatus*)
Striped Honeyeater (*P. lanceolata*)
Southern Scrub-robin (*D. brunneopygia*) A
Restless Flycatcher (*M. inquieta*)
Collared Sparrowhawk (*A. cirrhocephalus*) W (but favours mallee within the study area)
Purple-crowned Lorikeet (*G. porphyrocephala*)
Shy Heathwren (*H. cauta*) A
Dusky Woodwallow (*A. cyanopterus*)

The opportunistic records of Red-lored Whistler (*Pachycephala rufogularis*), Black-eared Miner (*Manorina melanotis*) and Striated Grasswren (*Amytornis striatus*), which were recorded in mallee communities, also fit into this category.

Other notable species (o)

These mainly widespread and mobile species are fairly frequently recorded in mallee.
White-fronted Honeyeater (*P. albifrons*)
Yellow-throated Miner (*M. flavigula*) (sedentary, uncommonly low frequency across whole survey)
White-winged Triller (*L. sueurii*)
Cockateil (*N. hollandicus*)
Rufous Whistler (*P. rufiventris*)
Horsefield's Bronze Cuckoo (*C. basilis*)

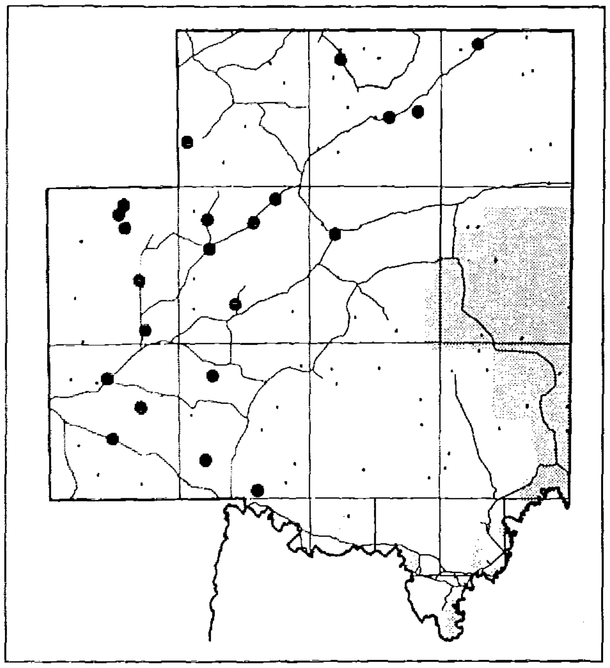
Comments

As mentioned earlier, sub-groups 2a and 2b are floristically not very different but 2c does have more Eucalypt trees present, thus accounting for some of the tree-preferring species present in this group description

The distribution of this group is concentrated in the extensive mallee dunefields of the south-east of the survey area, with some also occurring in the mallee on the western and northern edges.

Group 3. Birds of chenopod shrublands (generally treeless)

22 Members



Quadrat vegetation types

Variety of low (< 1m) chenopod very open shrubland to shrubland (Pearl Bluebush - *M.sedifolia*, Black Blackbush - *M. pyramidata*, Bladder Saltbush - *A. vesicaria*). Generally treeless but some with very occasional trees (False Sandalwood, Blackoak) or grasses in between shrubs.

Bird species present

	Species	Prop. Occur.	No. Grps	Chi Squ.	Std Res.
c	*Anthus novaeseelandiae*	0.9545	3	1.1009	1.05
c	*Falco cenchroides*	0.8636	4	0.4162	0.65
c	*Malurus leucopterus*	0.8636	4	0.5501	0.74
c	*Epthianura albifrons*	0.7273	4	0.8145	0.90
f	*Aphelocephala leucopsis*	0.6818	4	0.0185	0.14
c	*Cinclorhamphus cruralis*	0.6364	1	1.4319	1.20
f	*Pyrrholaemus brunneus*	0.4545	4	0.0317	0.18
c	*Artamus cinereus*	0.4545	4	0.3428	0.59
f	*Artamus personatus*	0.4545	4	0.1269	0.36
f	*Acanthagenys rufogularis*	0.4091	4	0.0584	-0.24
f	*Ocyphaps lophotes*	0.4091	4	0.0498	0.22
f	*Artamus superciliosus*	0.3636	4	0.0037	-0.06
f	*Meliphaga virescens*	0.3636	4	0.0511	0.23
f	*Northiella haematogaster*	0.3636	4	0.1021	0.32
f	*Nymphicus hollandicus*	0.3182	4	0.1009	0.32
c	*Calamanthus campestris*	0.3182	3	0.2203	0.47
o	*Chrysococcyx basalis*	0.2727	4	0.0131	0.11
o	*Oreoica gutturalis*	0.2273	4	0.1247	-0.35
o	*Cracticus torquatus*	0.2273	4	0.2160	-0.46

	Species	Prop. Occur.	No. Grps	Chi Squ.	Std Res.
o	*Barnardius zonarius*	0.1818	4	0.0967	-0.31
o	*Psephotus varius*	0.1818	4	0.1335	-0.37
o	*Lalage sueurii*	0.1818	4	0.0006	-0.02
	Pomatostomus superciliosus	0.1364	4	0.2031	-0.45
r	*Neophema chrysostoma*	0.1364	2	0.2234	0.47
	Acanthiza uropygialis	0.1364	4	0.2536	-0.50
r	*Coturnix novaezelandiae*	0.1364	1	0.3069	0.55
o	*Pomatostomus ruficeps*	0.1364	4	0.0785	-0.28
	Pardalotus striatus	0.0909	4	0.1716	-0.41
	Rhipidura leucophrys	0.0909	4	0.0767	-0.28
o	*Hoplopterus tricolor*	0.0909	2	0.0624	0.25
	Alauda arvensis	0.0909	1	0.2045	0.45
o	*Epthianura aurifrons*	0.0909	2	0.0028	0.05
	Sturnus vulgaris vulgaris	0.0909	3	0.0003	0.02
	Acanthiza chrysorrhoa	0.0909	4	0.0423	-0.21
	Pteropodocys maxima	0.0909	1	0.2045	0.45
	Petroica goodenovii	0.0909	4	0.1360	-0.37
	Colluricincla harmonica	0.0909	4	0.2148	-0.46

Notable bird species

Frequent, characteristic species (c)

All these species are ground-feeding specialists (G), specific to low shrublands (C). Most feed, rest and breed at ground or low shrub level. Some species (L) indicate thar there was green, almost lush, conditions at the time of the survey attracting these species (current survey was after significant rains).

Richard's Pipit (*A. novaeseelandiae*) G
Australian Kestrel (*F. cenchroides*) (raptorial but prey are ground dwellers) T M
White-winged Fairy-wren (*M. leucopterus*) G C
White-fronted Chat (*E. albifrons*)L G M
Brown Songlark (*C. cruralis*)L G M
Black-faced Woodswallow (*A. cinereus*) T
Western Fieldwren (*C. campestris*) G C

Frequent species (f)

Southern Whiteface (*A. leucopsis*) G
Redthroat (*P. brunneus*) G C
Masked Woodswallow (*A. personatus*) T M
Spiny-cheeked Honeyeater (*A. rufogularis*) T M
Crested Pigeon (*O. lophotes*) T
White-browed Woodswallow (*A. superciliosus*) T M
Singing Honeyeater (*M. virescens*) C
Bluebonnet (*N. haematogaster*) T
Cockatiel (*N. hollandicus*) T M

Rarer, significant species (r)

Blue-winged Parrot (*N. chrysostoma*) G M
Stubble Quail (*C. novaezelandiae*) G L M

Other notable species (o)

Horsefield's Bronze Cuckoo (*C. basilis*) T M
Crested Bellbird (*O. gutturalis*) T
Grey Butcherbird (*C. torquatus*) T
Ringneck Parrot (*B. zonarius*) T
Mulga Parrot (*P. varius*) T
White-winged Triller (*L. sueurii*) T M
Chestnut-crowned Babbler (*P. ruficeps*) T
Banded Plover (*Holopterus tricolor*) G L
Orange Chat (*Ephthianura aurifrons*) G C L

Comments

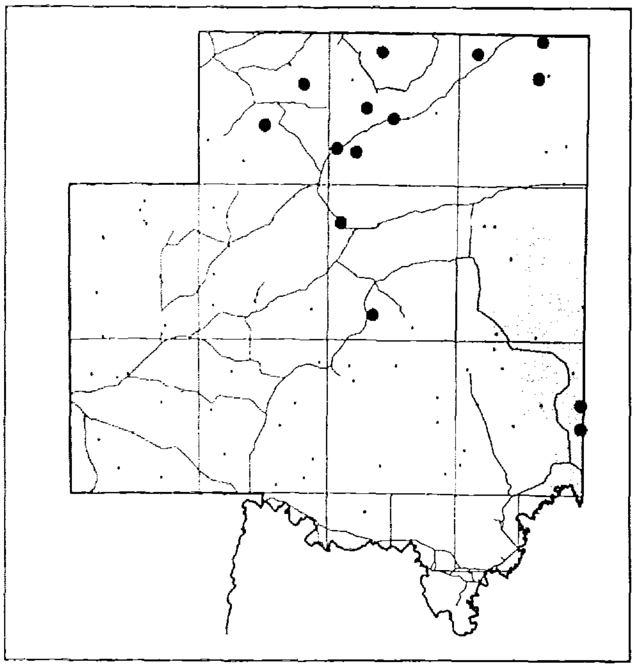
In terms of the vegetation and bird species, it is very difficult to differentiate this group from Group 4. Sub-group 3b contains all treeless quadrats and therefore separates well from Group 4 but it is unclear as to why Sub-group 3a is included in Group 3 (although nearly half of the quadrats are also treeless but the others have various emergents).

However, the nine species with the highest X^2 values in the above list (the seven frequent/characteristic ones and the two rarer ones) are ground-dwelling specialists [with the exception of the kestrel (but its prey are ground-dwellers i.e. mice, lizards & insects) and the Black-faced Woodswallow which both require the occasional perch for nesting]. The habitat preferences of these top species indicate that the vegetation structure is predominantly low shrublands with the very occasional, if any, emergent tree (as suggested by the preferences of a few species). Thus this seems to match the treeless vegetation descriptions of the Sub-group 3b and half of 3a.

The distribution of this group is mainly in the western and northern halves of the survey area where the extensive treeless chenopod shrublands occur (mostly Pearl Bluebush in the central area, Black Bluebush in the western and northern areas and Saltbush species in the north).

Group 4. **Birds of chenopod shrublands (generally with emergent trees)**

14 Members



Quadrat vegetation types

Variety of chenopod low open shrubland to shrubland (as in Group 3) but many with emergent trees (False Sandalwood, Blackoak, mallee, Bullock Bush), larger shrubs, grasslands &/or claypan shrub species.

Bird species present

	Species	Prop. Occur.	No. Grps	Chi Squ.	Std Res.
f	*Aphelocephala leucopsis*	0.7857	4	0.0742	0.27
f	*Cracticus torquatus*	0.7143	4	0.0302	0.17
c	*Pomatostomus ruficeps*	0.7143	4	0.6398	0.80
f	*Malurus leucopterus*	0.6429	4	0.1531	0.39
f	*Falco cenchroides*	0.6429	4	0.0969	0.31
f	*Pyrrholaemus brunneus*	0.5714	4	0.1412	0.38
o	*Ocyphaps lophotes*	0.4286	4	0.0673	0.26
o	*Acanthagenys rufogularis*	0.4286	4	0.0468	-0.22
o	*Anthus novaeseelandiae*	0.3571	3	0.0007	0.03
o	*Acanthiza uropygialis*	0.3571	4	0.0352	-0.19
c	*Psophodes cristatus*	0.3571	1	0.8035	0.90
o	*Malurus splendens*	0.3571	4	0.0218	0.15
o	*Northiella haematogaster*	0.2857	4	0.0230	0.15
o	*Rhipidura leucophrys*	0.2857	4	0.0189	0.14
	Artamus superciliosus	0.2857	4	0.0336	-0.18
	Pomatostomus superciliosus	0.2143	4	0.1104	-0.33
	Psephotus varius	0.2143	4	0.0993	-0.32
r	*Struthidea cinerea*	0.2143	3	0.1659	0.41
r	*Chrysococcyx osculans*	0.2143	3	0.1156	0.34
	Meliphaga virescens	0.2143	4	0.0052	-0.07
	Oreoica gutturalis	0.2143	4	0.1385	-0.37
c	*Epthianura aurifrons*	0.2143	2	0.2496	0.50
	Lalage sueurii	0.2143	4	0.0025	0.05
o	*Cinclorhamphus mathewsi*	0.1429	3	0.1118	0.33
	Manorina flavigula	0.1429	4	0.0019	0.04
	Sturnus vulgaris	0.1429	3	0.0386	0.20
	Hirundo nigricans	0.1429	3	0.0000	0.00
	Malurus lamberti assimilis	0.1429	4	0.0105	-0.10

	Species	Prop. Occur.	No. Grps	Chi Squ.	Std Res.
	Artamus personatus	0.1429	4	0.0595	-0.24
o	*Halcyon pyrrhopygia*	0.1429	2	0.1349	0.37
	Artamus cinereus	0.1429	4	0.0142	-0.12
	Acanthiza chrysorrhoa	0.1429	4	0.0068	-0.08
	Petroica goodenovii	0.1429	4	0.0740	-0.27
	Nymphicus hollandicus	0.1429	4	0.0086	-0.09
r	*Calamanthus campestris*	0.1429	3	0.0000	0.00
r	*Epthianura albifrons*	0.1429	4	0.0554	-0.24
	Psephotus haematonotus	0.0714	3	0.0349	0.19
	Hoplopterus tricolor	0.0714	2	0.0234	0.15
	Pardalotus striatus	0.0714	4	0.2010	-0.45
	Smicrornis brevirostris	0.0714	3	0.1361	-0.37
	Barnardius zonarius	0.0714	4	0.2422	-0.49
	Chrysococcyx basalis	0.0714	4	0.0995	-0.32
	Climacteris affinis	0.0714	4	0.0551	-0.23
	Phaps chalcoptera	0.0714	4	0.0622	-0.25
	Poephila guttata	0.0714	4	0.0013	0.04
	Coracina novaehollandiae	0.0714	4	0.1024	-0.32
	Cracticus nigrogularis	0.0714	3	0.0001	0.01
	Colluricincla harmonica	0.0714	4	0.2453	-0.50
	Acanthiza apicalis	0.0714	4	0.0253	-0.16

Ordination

A three-dimension ordination plot of the bird species quadrat analysis is shown in Figure 105. This represents the multi-dimensional relationships of the fauna quadrats (i.e. how the quadrats relate to each other in terms of the bird species present) reduced to three dimensions to enable easier assessment. In other words, the closeness of any one point (quadrat) on the plot to another indicates their similarity to each other in terms of the bird species found there.

From Figure 106 the quadrats of Groups 1 - 3 (i.e. Blackoak woodland, mallee and chenopod shrubland habitats respectively) are well clustered. The quadrats of group four (chenopod shrubland habitats with emergent trees) are more scattered indicating their intermediate nature between shrubland and woodlands and thus the mixture of bird species found there.

A two-dimension ordination plot showed a distinct linear gradation from Group 2 to 1 to 4 to 3 (i.e. mallee habitat to Blackoak woodland to 'chenopod shrubland with trees' to chenopod habitats). This seems to logically indicate a vegetation structural and floristic gradient which is reflected in the differences in bird species assemblages observed. However, by inspecting the three dimensional plot the true relationship between the groups from either end of the two-dimension (i.e. mallee and chenopod habitats) can be seen.

The three-dimension plot shows that the mallee and chenopod habitat groups are more closely related than initially thought (in terms of bird species present). This closeness can be explained by the occurrence of intermediary quadrats having a mixture of bird species; such as in chenopod shrubland which has mallee adjacent, or in very open mallee with chenopod understorey, which thus have bird species typical of both mallee and chenopod habitats. The adjacency of the Blackoak and chenopod groups on the plot would also indicate the presence of similar intermediate quadrats in terms of vegetation and bird species present.

Also more apparent on the three-dimensional plot is the scattered nature of group four ('chenopod shrublands with emergent trees' habitats) which explains the difficulties encountered in distinguishing and describing this group earlier. The distribution of these quadrats reflects affinities with all the other groups indicating the varied nature of the member quadrats (i.e. some with emergent mallees, others with Blackoak and others almost pure shrubland - hence the mixture of birds recorded in this group).

Thus, in terms of the bird species present, the quadrats of each group clumped together quite well and showed transitions between the groups that could be explained in terms of the vegetation present. No other quantifiable environmental factors (other than vegetation type) seemed to be influencing the ordination plot. A north-south gradient reflecting increasing rainfall was not apparent (as it is in many other regional surveys), perhaps because the gradient is so slight in this area (see climate section in Background chapter).

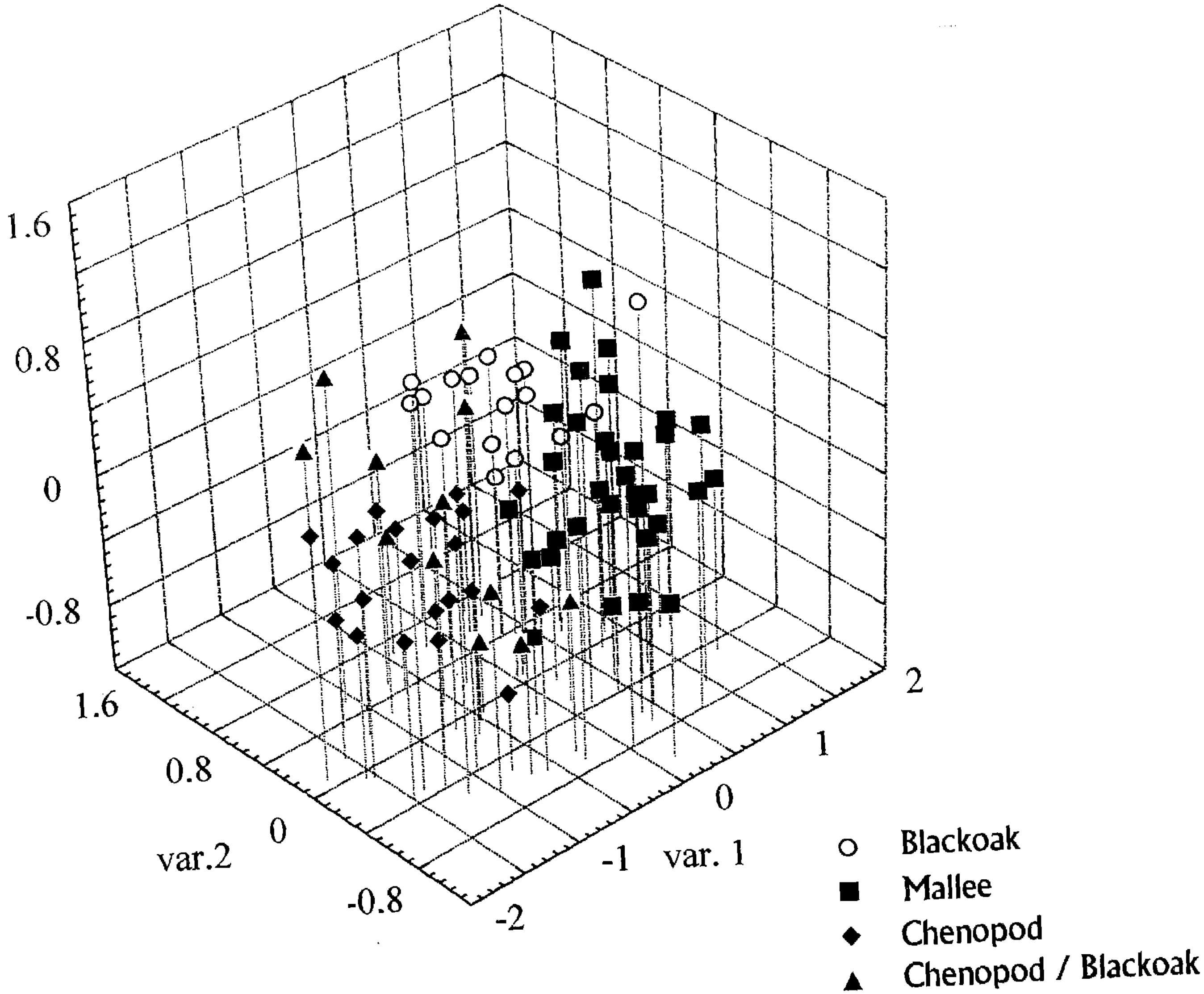


Fig. 105
Scatterplot from multi-dimensional scaling of the four major communities from the bird analysis of the South Olary Plains survey.

SPECIES OF PARTICULAR INTEREST

Numerous species found on the South Olary Plains survey are significant because of their conservation status. The conservation status of all species recorded from the region, compiled from all major sources for the survey area, is annotated in Appendix IX (where the status categories are defined).

Of the species found on the current survey, one is classified as vulnerable in Australia and South Australia (Malleefowl), seven are vulnerable in South Australia and three rare. From the additional species recorded opportunistically one is endangered in Australia and South Australia (Black-eared Miner), two are vulnerable in Australia and S.A. (Regent Parrot & Red-lored Whistler), four are vulnerable in S.A., three rare and one indeterminate. The area was formerly occupied by at least one species that is now extinct in South Australia, the Spotted Bowerbird (Boehm, 1956b).

From the studies previously conducted in the area, two species are classified as rare in Australia, in South Australia one is classified as endangered (Southern Stone Curlew or Bush Thick-knee), three are vulnerable and six rare.

Thus the South Olary Plains contain a considerable number of significant species from a conservation perspective: on an Australian basis there is one endangered, three vulnerable, two rare and two indeterminate species and on a South Australian basis there are two endangered, 15 vulnerable, 12 rare and one indeterminate species occurring in the area.

In the notes below, the Australian conservation status is from the Commonwealth Endangered Species Protection Act 1992 [which is based on the 'Australian and New Zealand Environment Conservation Council (A.N.Z.E.C.C.) list of Threatened Vertebrate Fauna, April, 1991'] with amendments made by Garnett (1992) in The Action Plan for Australian Birds. The South Australian status is from the National Parks and Wildlife Act 1972 schedule and Parker and Horton (1990) with updates by Threatened Species Strategy Steering Committee (1993) and Carpenter and Reid (1994). General species descriptions and notes on distribution, habitat, cause of decline and threats are from Pizzey (1980), Slater (1978), Carpenter and Reid (1988), Blakers *et al.* (1984), Garnett (1992) and Stephens (1992). References to distributions in the Murray Mallee (south of the River Murray) and Western Murray Flats (west of the river) are from those surveys results (surveyed in 1991), which are still in preparation by the Department of Environment and Natural Resources. Distributions from the mallee of north-western Victoria. are from Robertson *et al.* (1989). The latter two sources are only used to augment distributions of rarely recorded species.

Species recorded beyond known ranges

Little Bittern *Ixobrychus minutus*

This tiny, often migratory bittern lives in four continents of the world. In Australia it inhabits dense vegetation of swamps, lakes and rivers in the eastern and southern regions, breeding in spring and summer and migrating northwards in winter.

In South Australia there are only sporadic records of Little Bittern from the South East, River Murray and Eyre Peninsula, hence it is classified as vulnerable in this state. Thus, the unusual sighting of one on the South Olary Plains at Pine Valley Station was very interesting, presumably a migrating individual, and is the first confirmed record from the region.

Little Woodswallow *Artamus minor*

A nomadic (and partly migratory) species which inhabits *Acacia* scrub and Spinifex where there are gorges in rocky country but also known to live in tussock grasslands. Distributed across northern and central Australia, south to 30^{o} latitude, and into the northern Flinders and Gawler Ranges in South Australia.

Classified as rare in South Australia, the RAOU altas only shows records of this species north of the South Olary Plains and Parker and Horton (1990) list it as occurring in the Flinders Ranges and Northern Arid regions and unconfirmed in the Western Pastoral and Murray Mallee regions. The University of South Australia (1994) supposedly recorded it on Danggali Conservation Park but in light of the documented distributions described above this is unlikely, however possible, as it was recorded (Condon, 1969) at Lake Meretti on the River Murray on Calperum Station.

Species of National Significance

Malleefowl *Leipoa ocellata*

A large, quiet-moving, sedentary and territorial species which lives in mallee and eucalypt woodland growing on poor sandy soil but is also known to occur in Mulga (*Acacia aneura*) and other scrubby associations. Builds a conspicuous large nesting mound on the ground requiring much leaf litter for incubation of its eggs.

This species was previously widely distributed throughout mallee regions across southern Australia but is now severely restricted in range and extinct in some areas. Reasons for this decline include habitat degradation due to clearance and overgrazing, altered fire regimes, competition with introduced and native species, predation and the fragmented small populations being more susceptible to these and genetic problems due to inbreeding.

The Malleefowl was classified as endangered in Australia but has recently been changed to vulnerable (Garnett, 1992) although it is included in the top ten most threatened bird species according to Stephens (1992). It is vulnerable in South Australia, Victoria and Western Australia and endangered in N.S.W.

On the South Olary Plains survey numerous sightings of birds, mound and tracks were recorded across the south-eastern third of the area where it has been recorded by most other sources as well (as listed in Appendix IX). Because mallee habitat in the area has been less fragmented through clearance than districts further south, the South Olary Plains constitutes significant habitat for the species.

Black-eared Miner *Manorina melanotis*

A sedentary inhabitant of long unburnt (>60 years), uncleared scrubby mallee of *Eucalyptus gracilis*, *E. incrassata* and *E. oleosa* with a shrubby and/or Spinifex (*Triodia* spp.) understorey. The taxonomic status is uncertain due to the difficulty of distinguishing it from the Yellow-throated Miner (*M. flavigula*) with which it has extensively hybridised. Thus the total number of non-hybrid individuals is uncertain but the species is definitely endangered in Australia, occurring only in localised patches in far eastern South Australia, north-western Victoria and south-western N.S.W. (classified as endangered in all of these areas) and categorised as Critical under IUCN criteria. It is also listed as a priority threatened bird species by Stephens (1992).

Clearance, overgrazing and burning of mallee has significantly reduced the natural habitat separation of this species from the Yellow-throated Miner (which prefers more open woodlands) thus facilitating increased hybridisation and competition. Other reasons for the species' decline include competition with other species and the instability of the critically small remaining populations.

On the South Olary Plains survey one hybrid Black-eared Miner was recorded by opportunistic observation on Calperum Station. The species has also been observed on Cooltong Conservation Park by several reputable ornithologists (park records) and is listed in the RAOU Atlas as occurring north-west of Renmark on Calperum Station. Joseph (1986) documents one confirmed specimen being found about 10 kilometres west of Renmark and another about 30 km north of Pooginook Conservation Park. He personally recorded intermediates with *M. flavigula* at three locations on Calperum Station north-west of Lake Merreti and reports sightings of *flavigula*-like intermediates on Pooginook Conservation Park by P. Bird (pers. comm. in Joseph, 1986). The S.A. Museum has an additional two records of hybrids from Calperum Station. The RAOU Atlas shows several recent and historic records in the Murray Mallee. Only eight non-hybrids are known definitely to exist - in the north-west of Victoria.

Red-lored Whistler *Pacycephala rufogularis* (Fig. 106)

A mobile inhabitant of low mallee open woodland (*E. socialis, E. dumosa & E. incrassata*) which has an understorey of Spinifex, Native Pine (*Callitris* spp.) or Broombush (*Melaleuca uncinata*) shrubland. Originally distributed throughout western N.S.W., Victoria and eastern South Australia it has been severely restricted to mallee pockets in far eastern S.A., south-western N.S.W. and north-western Victoria and is still declining. Recently the species was found to occur in northern Eyre Peninsula, constituting a major range extension (Mathew *et al.* 1995). However, its status there is unclear - because of the species' mobility it is possible that the records represent wandering individuals or a temporary population only, but Mathew *et al.* suspect an established population exists there.

This species is classified as vulnerable in Australia, South Australia and Victoria and endangered in N.S.W. and also listed by Stephens (1992) as a priority threatened bird species. Reasons for decline include clearance due to agriculture and overgrazing, altered fire regimes, and instability of the small populations.

Red-lored Whistlers were recorded on the current survey by opportunistic observation on Calperum Station and by University of S.A. (1994) on Danggali Conservation Park. Eckert (1972, in Pedler, 1982b) recorded it breeding on Gluepot Station and Rix (pers. comm. in Pedler, 1982b) observed one specimen in 1977 in the north-west of Calperum Station where Pedler (1982) later had a more recent sighting. The RAOU Atlas shows records at a number of locations in the Murray Mallee and there are scattered records in patches of north-western Victoria

Regent Parrot (eastern subspecies) *Polytelis anthopeplus anthopeplus*

Distributed throughout the eastern mallee region of Australia this species has declined due to the disruption of breeding sites in River Red Gums (*E. camaldulensis*) along the Murray and Wimmera Rivers and fragmentation of adjacent feeding areas of mallee, Black Box (*E. largiflorens*) and Blackoak (*C. pauper*). The requirement for two distinct habitats, breeding and feeding, is an interesting aspect of the species' ecology, and makes its formal conservation more difficult. Outside of the breeding season, flocks wander considerable distances into adjacent mallee regions (Joseph, 1978; Beardsell, 1985), including the South Olary Plains. Reasons for decline are habitat clearance, overgrazing, competition for nest sites with introduced Honey Bees, loss of nest sites associated with the death of Red Gums through clearance and waterlogging, possible trapping for the bird trade and poisoning and shooting by orchardists.

This eastern subspecies is classified as vulnerable in Australia, South Australia and Victoria and endangered in

N.S.W. and also included on Stephen's (1992) list of the ten most endangered birds. On the current survey it was recorded opportunistically halfway between Westons Flat and Taylorville just north of the River Murray and has also been observed in Danggali Conservation Park (two sources), Cooltong Conservation Park and Calperum Station (~80 birds). The RAOU Atlas shows records in northern Calperum, south-western Danggali, south-eastern Chowilla Station and on Taylorville Station, and Mack (1970) and Joseph (1978) list additional northern records from Morganvale, Canopus, Canegrass and Gluepot Stations. Mack (1970) stated it was rare in the region. Burbidge (1985) found nesting sites at several locations along the River Murray near Morgan, Waikerie, Barmera, Renmark and Chowilla.

Freckled Duck *Stictonetta naevosa*

A nomadic species that has been recorded at some time in all regions of Australia except Cape York, it generally inhabits open lakes and wetlands surrounded by thick vegetation, especially lignum swamps, in eastern and south-western Australia. Parker *et al.* (1985) consider that the Channel Country in eastern arid Australia may actually be the species' stronghold rather than the Murray-Darling Basin.

Although listed as rare in Australia, A.C.T., N.S.W., Victoria and Queensland it is considered vulnerable in Western and South Australia. Causes which contribute to its decline are predation, hunting, modification of hydrological conditions of wetlands, salinisation, pollution and drainage of wetlands and clearance of lignum.

Although not recorded on the current survey, Freckled Ducks have been observed on Cooltong Conservation Park (park records) and more frequently along the River Murray (Parker *et al.*, 1985). In times of high rainfall they occur further inland on swamps and lagoons, as at Florieton in the region's extreme south-west (Pearse, 1929, 1937).

Scarlet-chested Parrot *Neophema splendida*

A nomadic species of arid and semi-arid areas across Australia that occasionally visits and breeds in agricultural regions. Requires a mallee or Acacia habitat with a prominent shrub and undershrub layer, especially Spinifex. Numbers can vary from abundant at times (rarely) to rare at others (Garnett, 1992).

Classified as rare in Australia and South Australia, uncertain in Western Australia and as occasional visitors to Victoria, N.S.W. and the Northern Territory. Threatening factors include overgrazing and clearance of native vegetation, altered fire regimes (species known to occur in burnt and unburnt areas) and predation.

Although not found on the current survey, this species has been recorded on Danggali Conservation Park (three sources - see Appendix VIII), Cooltong Conservation Park and various places between (Joseph, 1976).

Striated Grasswren and Slender-billed Thornbill - both classified as indeterminate (see below).

Species of South Australian Significance

Spotted Bowerbird *Chlamydera maculata*

Inhabiting inland scrubs and open woodlands, this species is still widespread in semi-arid eastern Australia. However, it is extinct in South Australia, the last dated record being from near Swan Reach in 1929 (Blakers *et al.*, 1984). McGilp (1934) documented a later record from near Chowilla Homestead and Boehm (1956b) reviewed the little known about its former occurrence in the State, adding further historical records from the Upper Murray. Considering these locations and the current known distribution, Spotted Bowerbirds probably occurred on the South Olary Plains in the past. The species is considered stable in Australia. Boehm (1956b), in concluding his account of the species' demise, stated '... one must deplore the general apathy which ornithologists and protectionists of earlier generations appear to have displayed in regard to the study and conservation of this extremely interesting species in South Australia.'

Black-eared Miner - see above.

Bush Thick-knee (Southern Stone Curlew) *Burhinus magnirostris* (*B. grallarius*)

A largely sedentary species which occupies a range of woodland habitats with short or scattered grass. Once widely ranging across many parts of Australia it has severely declined in recent years due to the effects of habitat clearance, overgrazing and predation. Although most populations in Australia are considered secure the species is vulnerable in Victoria and endangered in South Australia. It is virtually extinct in many formerly inhabited areas in S.A. and now only occurs in isolated pockets in the South East, Cooper Creek, Kangaroo Island, on islands off Eyre Peninsula and in the Upper Murray districts (Tay, 1992). In the latter area it mainly occurs along the river valley.

Although not recorded on the South Olary Plains survey, Bush Thick-knees are known to occur along the River Murray and were reported by locals to be in the hundreds of Bower and Bundey, east of Robertstown (Native Vegetation Management Section records). Historical records from the region can be found in Pearse (1929, 1938), Boehm (1934) and Mack (1970) - the first two authors blamed the fox for its virtual disappearance from the region.

Malleefowl - see above.

Little Bittern - see above.

Striated Grasswren (sandplain subspecies) *Amytornis striatus striatus*

A mostly ground-dwelling, sedentary species distributed across semi-arid mainland Australia, inhabiting sandplains dominated by mature hummock grass (Spinifex or *Plectrachne*) and usually with an overstorey of mallee in southern regions. This subspecies' range has contracted significantly due to the effects of clearance, overgrazing, altered fire regimes and predation by foxes and cats. Although its Australian conservation status is still insufficiently unknown, as the species is elusive and variable in abundance, it is classified as rare in N.S.W. and vulnerable in Victoria and South Australia where its stronghold is in the Murray Mallee. This subspecies is included in Stephen's (1992) list of most threatened bird species.

Striated Grasswrens were observed opportunistically in northern and southern Calperum Station and have been recorded by all the other sources of bird studies in the survey area. Eckert (1972) regarded them as plentiful on Gluepot Station in 1970, while Mack (1970) stated they were restricted (patchily) to southern mallee areas in the study region. Northernmost records appear to be Gluepot, Calperum and Danggali.

Slender-billed (Samphire) Thornbill (western subspecies) *Acanthiza iredalei iredalei*

A sedentary inhabitant of arid and semi-arid Saltbush, Bluebush or Samphire shrublands, this subspecies occurs sparingly across the southern arid zone in South Australia, from the study region, around the head of Spencers Gulf, in the Gawler Ranges, across the Nullarbor and into central and south-western Western Australia (Mathew, 1994). Although there is dispute about the validity of the described subspecies, all three occur in S.A. where they are considered vulnerable. The species is classified as indeterminate in W.A. and on a national basis (Garnett, 1992). This subspecies has disappeared from much of its former range and remaining populations are fragmented due to the destruction of shrublands brought about by rabbit and stock grazing (Reid and Fleming, 1992).

On the South Olary Plains survey the species was observed opportunistically on Redcliffe Station (north of Morgan), which geographically makes it most likely to be referable to the subspecies *iredalei*. Historically a specimen was collected near Nackara on the north-western margin of the study region (Darke, 1929), while Mathew (1994) stated there were three Field Atlas records submitted from an area south-east of Peterborough. Apparently they were not accepted for publication in the final Atlas (see Blakers *et al.*, 1984). During the current survey another ornithologist considered she may have seen this species in Bluebush shrubland not far from Redcliffe (B. Cohen, pers. comm.), and so it is likely that a small population persists in the south-west of the South Olary Plains over a reasonable area.

Major Mitchell (Pink Cockatoo) *Cacatua leadbeateri*

A mostly sedentary species which occurs patchily through the dry woodlands of inland Australia, wherever there is fresh surface water and large hollow trees for nesting (Blakers *et al.*, 1984). It has declined throughout its range due to clearance, trapping and nest robbing and has been lost from some areas. Fragmentation of its habitat on the margin of the agricultural belt in Western Australia has threatened its long-term survival there (Rowley and Chapman, 1991). Preferred habitats in South Australia include tall open mallee (*E. socialis*, *E. gracilis*), Red Gum, Black Box, Blackoak, Native Pine and False Sandalwood (*Myoporum platycarpum*) woodlands.

Classified as secure throughout Australia but rare in N.S.W. and Victoria and vulnerable in South Australia, the Pink Cockatoo was recorded by all sources throughout much of the South Olary Plains. Mack (1970) considered the population to have stabilised within the region following a considerable decline due to trapping for the avicultural trade.

Blue-winged Parrot *Neophema chrysostoma*

A mobile species inhabiting south-eastern Australia where it breeds in summer in the Murray-Darling, South East and Tasmanian regions and migrates north-westwards towards the south-eastern coast and north-eastern corner of South Australia in winter. Here it inhabits eucalypt woodland, saltbush shrublands, open grasslands and lignum swamps.

This species is classified as secure in N.S.W., Victoria and Tasmania but vulnerable in South Australia. It was observed at several sites on the current survey and has been recorded by a number of other sources throughout the area.

White-winged Chough *Corcorax melanorhamphos*

A sedentary and colonial species inhabiting taller mallee and eucalypt woodland throughout south-eastern Australia where it is at risk due to habitat clearance. This species has declined in the Upper Murray district through general clearance, removal of large trees by woodcutting and destruction of nests and is potentially at risk from vertebrate pest poisoning programs as it feeds on invertebrates in the leaf litter.

This species is considered vulnerable in South Australia and was recorded at numerous sites throughout the South Olary Plains by all sources.

Chestnut Quail-thrush *Cinclosoma castanotum*

A sedentary, ground-frequenting species that is almost continuously distributed across southern Australia in mallee habitats. It inhabits open mallee (*E. socialis*, *E. oleosa*, *E. gracilis*) with an open understorey and well-developed litter layer and is threatened by habitat loss due to clearing and thinning of the mallee, overgrazing, altered fire regimes and predation.

Classed as secure in Australia, rare in N.S.W. and vulnerable in South Australia it was recorded by all sources throughout the South Olary Plains. Boehm (1957) considered it to be declining in the Mount Mary district, while Mack (1970) described it as uncommon, preferring ungrazed mallee in the south of the region.

Striped Honeyeater *Plectorhyncha lanceolata*

A mobile species that inhabits dry mallee and eucalypt woodland throughout eastern Australia. In South Australia its stronghold is along the River Murray where it occurs in Red Gum and Black Box woodlands, in adjacent mallee and northwards in Blackoak and Sugarwood (*Myoporum platycarpum*) woodlands.

Classified as vulnerable in South Australia, it was recorded by all the sources throughout the South Olary Plains.

Australian Bustard *Ardeotis australis*

A nomadic species occupying open country that is timbered or treeless, saltbush plains, low heath, grasslands or crop stubble. Distributed across most of Australia, except the far south-east and Tasmania, it is threatened by habitat disturbance due to clearance and overgrazing, hunting, human disturbance during breeding, inadvertent poisoning and predation of chicks and eggs.

Although classified as secure in Australia, it is extinct in the A.C.T., endangered in Victoria and vulnerable in N.S.W. and South Australia. In S.A. it is declining and is locally extinct in some areas. On the South Olary Plains survey locals reported recent sightings around Pine Valley Station. It has also been recorded on Cooltong Conservation Park and in the hundred of Bundey (north-west of Robertstown) by Native Vegetation Management Section staff. Its decline in the region has been charted by Pearse (1936), Boehm (1947) and Mack (1970). The RAOU bird atlas shows a few records along the River Murray and one ENE of Morgan.

Painted Button-quail *Turnix varia*

A sparsely distributed and mobile species that inhabits a range of eucalypt forest, woodland and heath where there is some shrub cover and a layer of leaf and twig litter. Distributed in isolated populations across eastern Australia it has declined due to clearance and grazing of habitat.

Considered secure in Australia, this species is classified as rare in the A.C.T. and vulnerable in Tasmania and South Australia. Although not recorded on the current survey, the RAOU Atlas shows it at one location near Robertstown (in the south-western corner of the current survey area) and on Danggali Conservation Park where Pedler (1982a) observed two individuals south-west of Canopus homestead.

Diamond Firetail *Emblema guttata*

A sedentary ground feeder which inhabits taller mallee and open eucalypt woodland and forests along rivers and in farmland throughout eastern Australia. Its range has declined due to human settlement, clearance and overgrazing of habitat and predation.

This species is considered secure in Australia but vulnerable in South Australia where it was once common but now persists only in scattered populations. The species was listed in the South Olary Plains at a few locations around Robertstown in the RAOU Atlas, which shows it was more frequently recorded further west and south of the survey area. The study region is largely outside the species' documented range (e.g. Boehm, 1957) due to its preference for higher rainfall regions. It was recorded at one location in the southern Murray Mallee on that survey.

Species classified as rare in South Australia

(Numbers following names refer to the sources of records as detailed in Appendix IX).

Apostlebird *Struthidea cinerea* 1,2,3,4,5,6,7,9,10
Australasian Shoveller *Anas rhynchotis* 2,4,5,6,10
Blue-faced Honeyeater *Entomyzon cyanotis* 5,6
Darter *Anhinga melanogaster* 2,5,6
Fuscous Honeyeater *Meliphaga (Lichenostomus) fusca* 5,6,10
Gilbert's Whistler *Pachycephala inornata* 1,2,3,5,6,10
Glossy Ibis *Plegadis falcinellus* 5,10
Little Woodswallow *Artamus minor* (see above) 3
Peregrine Falcon *Falco peregrinus* 2,3,4,5,6,7,9,10
Pied Honeyeater *Certhionyx variegatus* 1,2,3,5,6,7,9,10
Scarlet-chested Parrot *Neophema splendida* (see above) 3,5,6,9,10

Species classified as indeterminate in South Australia

Elegant Parrot *Neophema elegans* 2,5,6,10

Single-species studies, focussing on birds of conservation significance, have been published in recent years. Of relevance here, records of Painted Button-quail and Red-lored Whistler in mallee scrub north of the Murray have been documented and reviewed by Pedler (1982a, b). The likely veracity of records of two of three rare raptors listed by Mack (1970) has been assessed: Parker (1977) accepted the Masked Owl (*Tyto novaehollandiae*) from Manunda, Debus (1991) rejected the record of Square-tailed Kite (*Lophoictinia isura*), while we consider the Grey Falcon (*Falco hypoleucos*) records attributable to the reliable observer, Garnham Skipper, to be plausible. This last species is also known from Florieton in the extreme south-west of the study region (Pearse 1929) and its decline in semi-arid regions of southern Australia has been documented by Olsen and Olsen (1986). Plumed Whistling-Duck (*Dendrocygna eytoni*) and Freckled Duck were recorded from Florieton by Pearse (1929). Mack (1970) was given old reports of Plains-wanderer (*Pedionomus torquatus*) in the region and Boehm (1934) captured one near Sutherlands. The Fuscous Honeyeater was reported from Manunda (Mack, 1970) as well as from Sutherlands (Boehm, 1957). There is a Bird Atlas record of Diamond Firetail (Appendix VIII) (what is its precise location?), but additionally the species was recorded just outside the study region by Boehm (1957) at Sutherlands.

Joseph (1986) reviewed the status and distribution of the endangered Black-eared Miner in the South Australian mallee, while Mathew (1994) undertook a similar review of the Slender-billed Thornbill. Franklin and Menkhorst (1988) documented the decline of the Regent Honeyeater in South Australia. Hybrids only of the first species in the study region were located by Joseph, while records of the other two, close to but just outside the region, were documented (Darke, 1929 - thornbill at Nackara and honeyeater at Oodlawirra; Boehm, 1957 - honeyeater at Sutherlands). Similarly records of Latham's Snipe (*Gallinago hardwickii* - Sutton, 1934) and Red-winged Parrot (*Aprosmictus erythropterus* - Mack, 1970), and Painted Honeyeater (*Grantiella picta* - Woodcock, 1985) derive from localities immediately adjacent to the northern and western boundaries respectively. One record apiece of Little Lorikeet (*Glossopsitta pusilla*) and Swift Parrot (*Lathamus discolor*) was documented by Boehm (1959) from Sutherlands immediately beyond the south-western margins of the study region. Boehm (1974b) also recorded a vagrant Shining Bronze-Cuckoo (*Chrysococcyx lucidus*) at Sutherlands.

Although the record of Square-tailed Kite was rejected, there are substantiated (and breeding) records in the close vicinity along the Murray (Fraser, 1983, 1993). Because of its migratory behaviour, the species almost certainly passes through the study region (Debus 1991), there being many records to the north. Similarly, although Mack (1970) specifically stated he could find no records of Letter-winged Kites (*Elanus scriptus*), the dispersive nature of the species during eruptions from the Channel Country would indicate its passage through and temporary residence in the region. Records of White-bellied Cuckoo-shrike (*Coracina papuensis*) and Little Friarbird (*Philemon citreogularis*) from Oulnina Park and Manunda respectively (Mack, 1970) probably relate to vagrants straying from their regular haunts on the Upper Murray (Jaensch, 1980, 1982; Condon, 1969). In like vein, although there are no reports to date, mobile species such as the Brown Quail (*Coturnix ypsilophorus* - Reid, 1986) and Olive-backed Oriole (*Oriolus sagittatus* - Condon, 1969) known from the Upper Murray, could be expected to stray into the region, as again there are records further north in the State.

Figures 109-111 show other birds typical of the South Olary Plains survey area.

DISCUSSION

Comparison of the South Olary Plains PATN analysis with that of the Murray Mallee survey (conducted by this department in 1991) is not possible in detail as the latter's results have not yet been finalised. However, from preliminary results, the Murray Mallee bird species data divided into four mallee groups and two heathland/woodland groups reflecting a north (xeric - dry) to south (mesic -wetter) gradient. The area was mostly mallee and sample sizes were large within that habitat type. Hence several groups of mallee birds could be identified. Two of the mallee groups were more southern and had no similarities with the South Olary Plains mallee bird species group. Another group (*Eucalyptus leptophylla/E. incrassata/E. gracilis/E. oleosa* habitat) had only two bird species in common with the South Olary Plains group: Mallee Ringneck and Brown Treecreeper. However, the last group (*E. gracilis/Acacia nyssophylla* habitat), which was the most northern, had many similarities in significant and frequent species to the South Olary Plains mallee group: Grey Shrike-thrush, Grey Butcherbird, Jacky Winter, Crested Bellbird, Mulga Parrot, Chestnut-rumped Thornbill, Brown Treecreeper, Chestnut Quail-thrush, Willie Wagtail, White-winged Chough and Yellow-throated Miner. Many of the other significant species of the current survey's mallee group are Eyrean in their affinities, reflecting the more arid environment of the South Olary Plains (see below).

Comparison with work conducted in north-western Victoria (Emison and Bren, 1989) also shows a number of similarities with identified bird communities of the South Olary Plains. In the Victorian mallee bird species group, three significant species were identified that occurred in the South Olary Plains mallee group: Malleefowl, Chestnut Quail-thrush and Yellow-rumped Pardalote. Another Victorian group of heath and mallee also had several South Olary Plains mallee group species: Southern Scrub-robin, Shy Hylacola, Red Wattlebird, White-eared Honeyeater, White-fronted Honeyeater and Red-lored Whistler (only found opportunistically, but within mallee, on the current survey).

The Victorian woodland group had only Apostlebird and White-browed Treecreeper in common with the South Olary Plains survey woodland group, but a combined mallee and woodland group had many similarities with both the South Olary Plains separate mallee and woodland groups: mallee - Mallee Ringneck, Mulga

Parrot, Common Bronzewing, Chestnut-rumped Thornbill, Southern Whiteface and Striped Honeyeater; woodland - Pink Cockatoo, Mallee Ringneck, Mulga Parrot, Red-capped Robin, Hooded Robin, Splendid Fairy-wren, Chestnut-rumped Thornbill and Southern Whiteface, noting that four of these 10 species were common to (i.e. frequently occurred in) both habitats in the South Olary Plains. We interpret this to show the degree of overlap in the bird communities associated with these two distinctive habitats in this region, as well as reflecting the mosaic nature of the distribution of habitats.

Thus the South Olary Plains bird quadrat groups represent suites of species that occur over much larger areas in the mallee biome of south-eastern Australia. However, the current survey area represents either the northern, more arid variants of these groups or new combinations of some southern birds with Eyrean species.

Wetlands

Wetland habitats and waterbirds are obviously not a distinctive feature of the South Olary Plains given its (semi-)arid climate and the absence of major rivers. However, as documented by Boehm (1953) for the Mount Mary district, runoff occurs after large rainfall events and then extensive if shallow wetlands may form and support rich and abundant waterbird populations (and see Pearse, 1929). In particular, the creeks that flood out into the study region from the ranges and hills to the west and north of the South Olary Plains are significant. Their termini constitute the most important ephemeral wetlands in the region, but they have been poorly studied, if at all, and so await further documentation. For example, Parker *et al.* (1979, 1985) have identified a lagoon near Robertstown in the region's extreme south-west as supporting significant waterbird species at times. Given the destruction and degradation of many of the State's wetlands in the south, these ephemeral wetlands probably warrant further investigation, and the occasional records of significant birds like Freckled Duck, Plumed Tree-Duck, Musk Duck, Blue-billed Duck, Spotless Crake and Baillon's Crake attest to their regional importance.

The building of dams for watering stock has provided additional and permanent waterbodies throughout the region. Waterbirds, in limited numbers governed by the size of the dams, make use of this artificial habitat, and so the dynamics of waterbird composition and distribution have no doubt changed as a result.

Historical changes in the distribution of dryland birds

The provisioning of permanent waterpoints throughout the region has undoubtedly affected populations of many dryland birds, in addition to its more obvious effect on waterbirds. In fact, both Reid and Fleming (1992) and Smith and Smith (1994) have raised this issue with respect to the changing status of birds in the Australian arid zone. These authors have documented many cases of birds which historically have expanded or contracted their distributions on a continental scale. Some of these changes may be attributable, in part, to the addition of permanent drinking supplies in a previously waterless environment. The historical status of the Apostlebird in the region is a mystery (Mack, 1967). It was not reported in the Upper Murrray and Olary Plains regions until 1933 (McGilp, 1934) and appears to need to drink daily (Mack, 1967). Although pastoralists assured Mack that the birds had been in the region of Mutooroo and Lilydale Stations for a long time, it is likely that the species could only have colonised the South Olary Plains once permanent waters were established.

Boehm (1952) discussed changes in distribution of birds in the agricultural zone due to vegetation clearance and other factors. The southerly expansion of the ranges of Crested Pigeon, Galah, Little Corella and Ground Cuckoo-shrike through the South Olary Plains has been documented by him (Boehm, 1934, 1952, 1983) and others (Pearse, 1929; Mack, 1970). Boehm (1952) also documented the decline of species such as Chestnut Quail-thrush and Shy Heathwren through loss of habitat for agriculture, while observing that some species, such as the latter and Grey-fronted Honeyeater, were frequently found in patches of chained mallee that had resprouted and were in early stages of regeneration. The decline of species such as the Plains-wanderer, Bush Thick-knee, Australian Bustard and Sulphur-crested Cockatoo, were noted by the above observers. Some further changes are of pressing conservation concern and are discussed later.

Biogeographic considerations

The South Olary Plains is a significant transition zone between three South Australian regions: the Murray Mallee, the northern arid zone and the northern Mt Lofty and southern Flinders Ranges. On a national scale, the area is an ecotone between the Bassian (scleromorphic eucalypt forests of southern Australia) and Eyrean (Acacia and dunefield ecosystems of arid Australia) zoogeographical zones, as described by Schodde (1982). Overall though, the survey area has more in common with the Eyrean zone. Thus the South Olary Plains contains significant bird species having affinities with both Bassian and Eyrean biotas, but more of the latter.

The southern Australian mallee zone, of which the lower half of the South Olary Plains is comprised, is described by Schodde (1990) as overlying the interface between the Bassian and Eyrean biotas, which is reflected in the composition of the bird fauna.

Of the four most dominant families in the Mediterranean-type Mallee (Schodde, 1990) the South Olary Plains contains 75% of the species: 16 of 21 species of honeyeaters (Meliphagidae); 10 of 13 acanthizid warblers (Acanthizidae-Pardalotidae); six of nine whistlers (Pachycephalidae) and 11 out of 14 parrots (Psittacidae).

Schodde (1990) lists 150 indigenous dryland birds of the Mediterranean Mallee, of which 126 (84%) occur on the South Olary Plains. Of these indigenous mallee species in the current survey area, 42 are of Eyrean origin and 34 Bassian. Thirteen out of Schodde's (1990) 15 designated mallee-dependent species, and 15 out of the 21 species and subspeices endemic to Mediterranean Mallee, occur in the South Olary Plains. Thus although only the lower half of the survey area is in the northern-most limits of the mallee zone, the significant mallee bird species are well represented.

The mallee-dependent species from the South Olary Plains are listed as follows and those that are endemic to the Mediterranean Mallee biome are annotated with 'E':

Malleefowl E
Regent Parrot E
Scarlet-chested Parrot E
Southern Scrub-robin E
Gilbert's Whistler E
Red-lored Whistler E
Chestnut Quail-thrush
Striated Grasswren
Shy Hylacola E
Purple-gaped Honeyeater E
Yellow-plumed Honeyeater E
Grey-fronted Honeyeater E
Black-eared Miner E.

The subspecies which are endemic to the Mediterranean Mallee biome are:

Barnardius zonarius barnardi Mallee Ringneck
Cinclosoma castanotum castanotum Chestnut Quail-thrush
Amytornis striatus striatus Striated Grasswren
Melithreptus brevirostris leucogenys Brown-headed Honeyeater
Pardalotus punctatus xanthopygus (*P. xanthopygus*) Yellow-rumped Pardalote

The Australian Eyrean avifauna comprises a mere 15% of the whole continent's birds in a region which covers almost 70% of the country. This is poor compared to those of wetter parts of Australia and desert regions on other continents (Schodde, 1982). Eighty-eight bird species are autochthonous to (originated in) the arid zone. Of these species, 56 occur in the South Olary Plains indicating the area's strong Eyrean affinities.

A few Bassian species, not listed by Schodde (1990) as being indigenous to the Mediterranean Mallee biome, have been recorded in the South Olary Plains. In the main they are vagrants and their occurrences have been largely confined to the wetter districts of the south-western margin. Examples include the Swift Parrot, Little Lorikeet, Shining Bronze-Cuckoo, Regent Honeyeater, Fuscous Honeyeater and Little Wattlebird, and they are all migratory or dispersive species, characteristic of temperate Australian heaths, woodlands and forests. More common species in the region are the Stubble Quail and White-fronted Chat (both Bassian) and Brown Songlark (of uncertain biogeographic origins), and it is unclear whether they were deliberately excluded by Schodde (1990) on the grounds that they do not regularly inhabit mallee vegetation or were simply oversights. Certainly, mallee does not constitute their preferred habitats, but all three regularly occur within the mallee biome and inhabit grassy open mallee communities.

Likewise, a few species of uncertain biogeographic affinities and which are considered typical elements of neither mallee nor arid Australian regions (Schodde, 1982, 1990) have been recorded in the region as vagrants, notably the Masked Owl and White-bellied Cuckoo-shrike. These few exceptions, mainly vagrants, simply support the generalisations made above. The avifauna of the South Olary Plains is a blend of typical mallee and southern arid-zone birds and as such has strong Bassian and Eyrean affinities. Because of its geographic location, the avifauna does not include some sedentary taxa of southern and wetter mallee-heath habitats (e.g. the Western Whipbird *Psophodes nigrogularis*), nor does it contain any birds restricted to wet forest, woodland and heath of southern and eastern Australia, other than on a vagrant basis. Similarly, a number of Eyrean species from central and northern arid regions of Australia are missing due to the absence of extensive mulga shrublands (e.g. Slaty-backed Thornbill *Acanthiza robustirostris*), stony (gibber) desert (Chestnut-breasted Whiteface *Aphelocephala pectoralis*), sandy deserts (Banded Whiteface *A. nigricincta*) and spinifex-clad ranges (Painted Firetail *Emblema pictum*).

There are two finer-scaled biogeographic gradients or corridors evident in the study region as revealed by avian distribution patterns. First, there is the steep rainfall and habitat gradient encountered between the eastern scarp of the North Mount Lofty ranges and the South Olary Plains proper (and a similar but less dramatic gradient occurs in association with the Olary Spur to the north and north-west of the study region). Because of its higher rainfall much of the native vegetation in the extreme south-west of the region has been cleared, but remnants still support a few species more typical of higher rainfall districts in the State (e.g. Adelaide Rosella, Scarlet Robin, Diamond Firetail, New Holland Honeyeater). It is not surprising that most of the vagrant Bassian wet-country species have been recorded from these parts (examples given in previous paragraph). Hence the bird communities of the patches of mallee remaining in the west (e.g. Pandappa Conservation Park) are distinct from those associated with the drier northern mallee formations and extensive mallee-spinifex communities further east (Danggali).

Second, there is the succession of habitats encountered from the Murray Valley in the south to the arid formations in the north of the South Olary Plains. With the recent inclusion of the Chowilla and Calperum leases adjoining Danggali Conservation Park to form the extensive Bookmark Biosphere Reserve, the opportunity exists to develop a highly significant reserve that conserves and presents this remarkable sequence of habitats. Incorporating some of the best wetlands in the State, the best remaining examples of River Red Gum riverine forest, through the Black Box woodlands and associated shrublands, to the drier habitats described in this report, the reserve supports many distinctive bird communities and a highly species-rich avifauna. As outlined earlier, the presence of the River Murray, immediately to the south of the South Olary Plains study region, has a strong influence on the bird communities and distribution patterns described here. Conservation management must endeavour to take these links and networks into account.

Conservation Considerations

As discussed earlier, the South Olary Plains contains numerous bird species that have significant conservation status on an Australian basis:

Endangered
- Black-eared Miner
- Regent Honeyeater

Vulnerable
- Malleefowl
- Red-lored Whistler
- Regent Parrot
- Plains-wanderer
- Swift Parrot

Rare
- Freckled Duck
- Grey Falcon
- Scarlet-chested Parrot
- Masked Owl (nominate subspecies)
- Painted Honeyeater

Several species are also rated in South Australia:

Endangered
- Black-eared Miner

Vulnerable
- Malleefowl
- Bush Thick-knee
- Little Bittern
- Striated Grasswren (sandplain subspecies)
- Slender-billed Thornbill (western subspecies)
- Major Mitchell (Pink Cockatoo)
- Blue-winged Parrrot
- White-winged Chough
- Chestnut Quail-thrush
- Striped Honeyeater
- Australian Bustard
- Painted Button-quail
- Diamond Firetail

In addition, eleven species are classified as rare in South Australia.

The presence of these numerous rated species and the biogeographical location of the South Olary Plains (as a transition zone between several major regions in South Australia and Australia) highlights the area to be of conservation importance for bird species for the following reasons:

A variety of species is present with origins from both the Bassian and Eyrean biogeographic zones. This may be important for the conservation of some species depending on their status in the centre of those zones.

Being at the northern limit of the mallee zone and the southern limit of the arid open woodlands and shrublands of South Australia, many species are at the edge of their normal ranges which may be significant if the rest of the range has been severely affected in some way.

Being just north and east of the highly developed and cleared agricultural areas, and having little clearance or extensive disturbance itself, the area is a valuable habitat and refuge for species that have been severely affected in the agricultural areas.

Under scenarios of climate change the presence of contiguous and extensive sequences of different vegetation formations across this uncleared biogeographic ecotone may allow adaptive changes to take place more readily.

Many species have significantly declined over their range particularly in agricultural areas due to the effects of land clearance, overgrazing and altered or inappropriate fire regimes. These impacts lead to fragmentation of remaining populations and competition with other species for the limited habitat, particularly for nest sites and appropriate food sources. Some species specifically require a dense shrub stratum in which to live (e.g. Red-lored Whistler) and others need deep leaf litter in which to feed or build nests with (e.g. Malleefowl, White-winged Chough). Both these shrub and ground (litter) strata of the vegetation are lost in areas that are overgrazed or inappropriately burned and may never recover properly even when the impact is minimised or removed. Loss of nest sites for species that require large trees with hollows is also a serious problem. In this context the extensive, uncleared tracts of mallee vegetation in the South Olary Plains, particularly in the southern portion, provide opportunities for long-term conservation that have largely been lost over most of the Murray Mallee region to the south.

Species significantly affected by habitat fragmentation due to clearance are:
- Malleefowl
- Black-eared Miner
- Red-lored Whistler
- Regent Parrot
- Swift parrot
- Scarlet-chested Parrot

- Plains-wanderer
- Bush Thick-knee
- Striated Grasswren
- Slender-billed Thornbill
- Pink Cockatoo
- Blue-winged Parrot
- White-winged Chough
- Chestnut Quail-thrush
- Regent Honeyeater
- Striped Honeyeater
- Painted Honeyeater
- Australian Bustard
- Painted Button-quail
- Diamond Firetail.

The first three species listed are further at risk due to the instability of their critically small populations.

Some of these species are also at severe risk from predation by introduced predators such as foxes and cats, often because of their ground-feeding or ground-dwelling habits:

- Malleefowl
- Regent Parrot
- Freckled Duck
- Scarlet-chested Parrot
- Plains-wanderer
- Bush Thick-knee
- Striated Grasswren
- Chestnut Quail-thrush
- Australian Bustard
- Painted Button-quail
- Diamond Firetail

Other species are also at risk from hunting (as perceived pests or for illegal trade) and poisoning (i.e. directly or indirectly killed as a result of poisoned food sources):

- Regent Parrot
- Freckled Duck
- Pink Cockatoo
- Plains-wanderer
- White-winged Chough
- Australian Bustard

Although the South Olary Plains has not been significantly cleared for agriculture, it is extensively grazed by sheep and some cattle. With moderate grazing levels and proper management, impact on the natural vegetation can be minimised but if allowed to be too concentrated in any one area over long periods of time important avian food sources, nesting material and roosting sites (particularly those in the lower vegetation strata) are depleted or permanently removed. Both Reid and Fleming (1992) and Smith and Smith (1994) have highlighted the bird conservation problems posed by overgrazing in arid Australia generally and in western New South Wales. Smith and Smith identified habitat fragmentation (through clearance for agriculture) and overgrazing of pastoral lands as the twin biggest causes of decline of birds in western New South Wales, adjacent to the South Olary Plains. Although the grazing lands of the Olary Plains may not have suffered as severely as their counterparts in New South Wales due to structural and historical differences in the patterns of pastoral occupation, overgrazing remains a problem in some portions of the study region. With the fragmented and degraded landscapes that exist in many areas, particularly further south and west, species dependent on resources in the ground and shrub strata may not find suitable habitats in which to survive without improved pastoral management and the dedication of new reserves in preferred grazing landscapes (see below).

Large areas of mallee and Blackoak woodland communities in the South Olary Plains are adequately conserved in Bookmark Biosphere Reserve (Danggali, Chowilla and Calperum leases) with smaller areas reserved in Pooginook and Pandappa Conservation Parks (the latter representing a different mallee community of western hills). Thus the bird communities of these habitats are quite well protected at this stage. White Dam Conservation Park, being only a small linear section of an old stock route, is not sufficiently large to provide sole refuge for any particular species but may serve as an important corridor.

Some examples of chenopod shrubland with emergent trees are represented in Danggali Conservation Park and Chowilla Regional Reserve but most are distributed further north. Similarly the pure chenopod shrublands, as an extensive formation, do not occur in the reserves, but are more expansive in the west and particularly the north of the area. Scattered small areas of Bluebush shrubland occur on Chowilla Regional Reserve and Danggali and White Dam Conservation Parks but they are not extensive.

The central to western chenopod shrublands of the South Olary Plains are mostly Pearl Bluebush and the far western shrublands mostly Black Bluebush with some Pearl Bluebush. The latter shrublands would have probably been extensively grazed historically as these areas were among the first settled in the area. These and the northern chenopod shrublands (Black Bluebush and Saltbush species) are currently not reserved to any extent, occurring in areas mostly under pastoral leasehold. These communities (particularly Black Bluebush and Saltbush species) extend further north so will also be assessed in the forthcoming North Olary Plains survey. The recent records of Slender-billed Thornbill from the south-west of the region are considered highly significant. Reid and Fleming (1992) identified chenopod shrublands to be a significant and severely threatened habitat in the arid zone, due to their inadequate representation in ungrazed conservation reserves and because of their palatability to domestic livestock and rabbits. The Western Fieldwren and Redthroat (other distinctive members of this habitat) have also declined in chenopod shrublands over parts of their former Australian ranges (Reid and Fleming, 1992), and so examples of the Pearl Bluebush shrublands in the south-west of the survey area should be managed for more adequate protection.

Figure 106
The Red-lored Whistler, Pachycephala rufogularis is a bird classified as vulnerable in Australia which is found at several sites in the southern mallee.
Photo: L. Pedler

Figure 107
The Ground Cuckoo-shrike, *Pteropodocys maxima* is an uncommon bird in open woodland and shrubland habitats.
Photo: L. Pedler

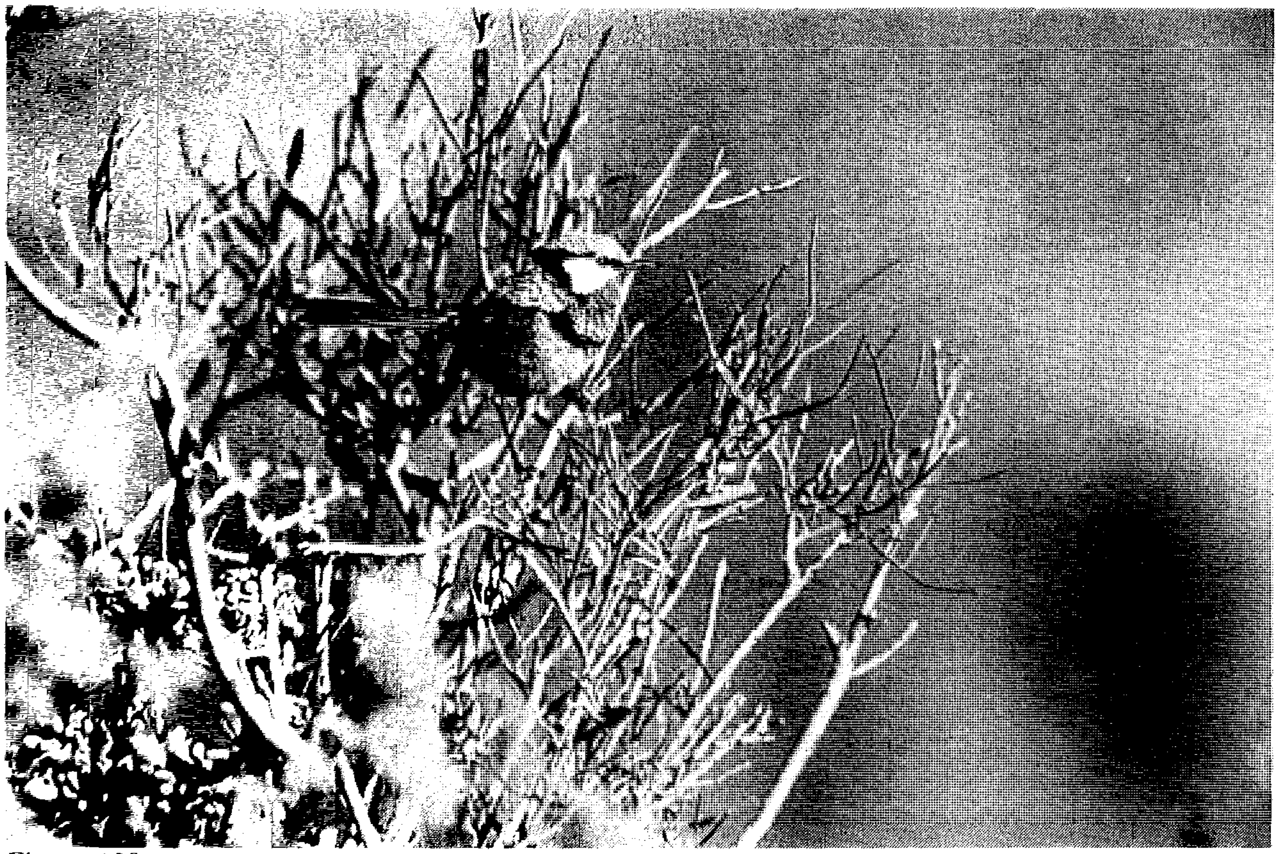


Figure 108
The Black-backed Wren, *Malurus splendens melanotus*, occurs in small family groups in chenopod shrubland habitat.
Photo: L. Pedler

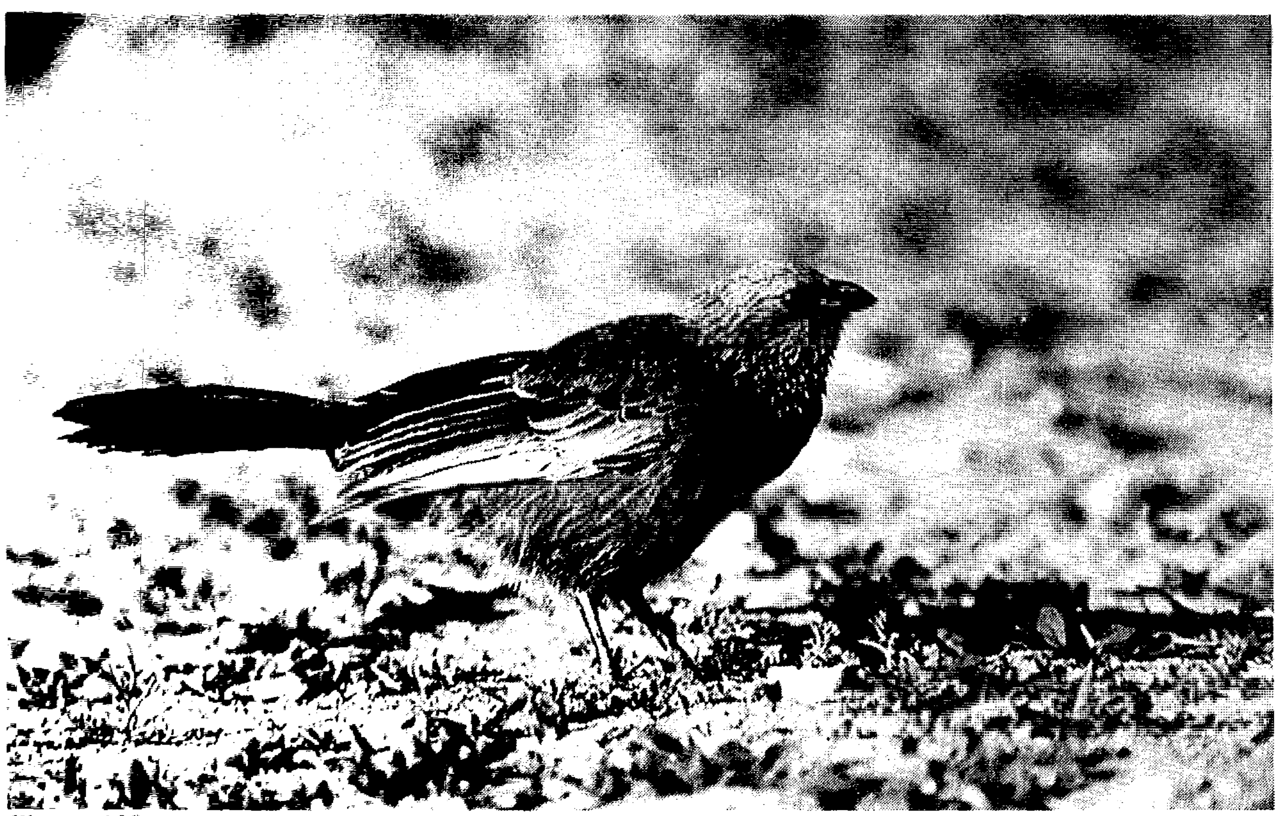


Figure 109
Noisy groups of Apostlebirds, *Struthidea cinerea*, forage on the ground among the mallee trees.
Photo: L. Pedler

REPTILES AND AMPHIBIANS

by L. R. Forward[8] and M. N. Hutchinson[9]

INTRODUCTION

Prior to the South Olary Plains survey, the only systematic searching or trapping of reptiles and amphibians conducted in the area was Morley and Morley's (1984) work in south-eastern Danggali Conservation Park (1976-77), field trips by the Field Naturalists Society of S.A. Herpetology Club to Danggali (1987) and Pooginook Conservation Park (1991) and the University of South Australia's annual trips to Danggali since 1986.

There are few studies of adjacent areas the main ones being, the Murray Mallee survey conducted in 1991 by the Department of Environment and Natural Resources (results not yet published) and a survey of north-western Victoria (Bennett *et al.*, 1989).

Figure 110 shows the distribution of South Australian Museum reptile records from the South Olary Plains prior to 1992. In addition to specimens collected by the above studies, these records are mostly random collections, concentrated around the edges of the area near towns, along main access routes and in the conservation parks. Up to 1992, 81 species were confirmed from the area (72 reptiles and 9 amphibians). To date, the only information published on the area's reptile fauna is that from Danggali (Morley and Morley, 1984).

TOTAL SPECIES

A complete list of all reptile and amphibian taxa recorded from the South Olary is shown in Appendix XI. The total number of species recorded is 88 (78 reptiles and 10 amphibians) representing 14 families and sub-families.

The South Olary Plains survey recorded 70 species (64 reptiles and 6 amphibians) with 64 species being recorded on quadrats and an additional 6 by opportunistic observations. This survey added five new species for the area. In addition, a species thought to be extinct was found just outside the survey area.

In total, 77% of known reptile and amphibian species in the South Olary Plains area were recorded on the survey plus the five confirmed new species for the area added.

Records collected by opportunistic observations (i.e. not on specified survey quadrats) numbered 56 species (including six species *not* recorded on any quadrats) indicating that this method is a valuable addition to site-based records.

The total number of reptile and amphibian species, records and individuals recorded by quadrat and opportunistic methods on the survey are summarised in Table 19.

Table 19
Total numbers of reptile and amphibian species recorded on the South Olary Plains survey.

R = reptiles, A = amphibians

		Quadrats	Opportun.	Total
Number of species	R	61	52	64
	A	3	4	6
				70
No. of records of species	R	562	345	907
	A	21	7	28
				935
Approx. no. indiv. recorded	R	1271	~860	~2131
	A	42	14	56
				2187

The frequency and abundance of all taxa recorded at survey quadrats are listed in Table 20. Genus-only designations are shown in normal rather than italic typeface and species masked out of the analysis are indicated, as are species that were grouped for the analysis. The rest of the list shows all species included in the analysis, except those with a frequency of one (which were also masked out). A conversion list of scientific names to common names is in Appendix XI.

The additional species recorded from opportunistic observations are listed in Table 20.

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[9] M. N. Hutchinson S. A. Museum, North Terrace, Adelaide, S. A. 5000

Table 20
Reptile and amphibian species frequencies and abundance recorded at quadrats on the South Olary Plains biological survey

The frequency is the number of quadrats at which the species was recorded. The total number of quadrats surveyed for fauna was 93.

Abundance figures represent the total number of individuals of the species recorded (at quadrats) on the survey. [Note that species abundance was not consistently (systematically) recorded at each quadrat. Therefore only species presence/absence (i.e. frequency) data can be accurately compared between species.]

Taxa shown in normal rather than italic typeface were considered unsuitable for analysis i.e. incomplete identification.

+ Species excluded from the analysis (i.e snakes, varanids, legless lizards and amphibians - see methods chapter)

G Species that were grouped for the analysis.

Species	Freq.	Abun.
Tiliqua rugosa	38	64
Ctenotus schomburgkii	33	93
Menetia greyii	27	83
Heteronotia binoei	26	42
Gehyra variegata G	25	60
Cryptoblepharus carnabyi G	23	33
Egernia striolata	22	55
Ctenotus regius	22	41
Morethia adelaidensis	21	54
Lerista muelleri	21	50
Diplodactylus vittatus	20	28
Morethia boulengeri	19	47
Ctenotus uber	16	26
Lerista punctatovittata	16	22
Ctenophorus fordi	14	183
Pogona vitticeps	14	14
Ctenophorus pictus	12	22
Cryptoblepharus plagiocephalus G	12	14
+ *Neobatrachus pictus*	11	26
Diplodactylus damaeus	11	23
Rhynchoedura ornata	10	15
Amphibolurus nobbi	10	13
Diplodactylus byrnei	9	22
Morethia obscura	9	21
Tympanocryptis tetraporophora	9	13
+ *Varanus gouldii*	8	10
Gehyra '2N=44' G	8	9
Strophurus williamsi	7	13
Tiliqua occipitalis	6	10
Ctenophorus decresii	6	9
+ *Neobatrachus sudelli*	6	6
Ctenotus robustus	5	9
Strophurus elderi	5	8
Ctenotus strauchii	5	7
Lerista dorsalis	5	6
+ *Pseudonaja nuchalis*	5	6
+ *Pseudechis australis*	5	5
+ *Neobatrachus centralis*	4	10
+ *Lialis burtonis*	4	6
+ *Delma australis*	4	5
+ *Delma butleri*	3	5
Diplodactylus tessellatus	3	5
+ *Ramphotyphlops australis*	3	5
+ *Ramphotyphlops bituberculatus*	3	4
+ *Suta nigriceps*	3	4
Tympanocryptis lineata	3	4
+ *Pseudonaja textilis*	3	3
Ctenotus atlas	2	3
Hemiergis millewae	2	3
Cryptoblepharus sp. G	2	2
Eremiascincus richardsonii	2	2
Nephrurus levis	2	2
Nephurus milii	2	2
+ *Pseudonaja modesta*	2	2
+ Pseudonaja sp.	2	2
+ *Suta spectabilis*	2	2
+ *Delma molleri*	1	2
Egernia inornata	1	2
Oedura marmorata	1	2
+ *Simoselaps australis*	1	2
+ *Aprasia inaurita*	1	1
Ctenotus brachyonyx	1	1
+ *Demansia psammophis*	1	1
Egernia sp.	1	1
Egernia stokesii	1	1
Lerista labialis	1	1
Tiliqua scincoides	1	1
Total number of records of species:	583	
Total number of individuals observed:		1313

Table 21
Additional reptile and amphibian species recorded by opportunistic observations on the South Olary Plains survey.

Species	Abundance
Limnodynastes tasmaniensis	5
Suta suta	3
Aprasia pseudopulchella	1
Limnodynastes dumerili	1
Litoria raniformis	1
Tiliqua adelaidensis	1

From Table 20 it is evident that no species occurred at more than 41% (i.e. 38) of the quadrats. The Sleepy Lizard (*T. rugosa*) and Sandplain Ctenotus (*C. schomburgkii*) was recorded at greater than 35% of the quadrats with the Dwarf Skink (*M. greyii*), Bynoe's Gecko (*H. binoei*) and Tree Dtella (*G. variegata*) recorded at 26-29%. In terms of numbers of individuals the Mallee Dragon (*Ctenophorus fordi*) was the most common reptile, followed by the Sandplain Ctenotus and Dwarf Skink (however, abundance was not consistently recorded for all species). Fifty percent of the species (32) were recorded at less than six quadrats (~6.5%).

PATN ANALYSIS

Classification

The final PATN classification analysis was conducted on presence/absence data of 37 species from 89 quadrats (after masking out all snakes, varanids, legless lizards, amphibians, single occurrences of species and quadrats with only one species). Note that many specimens of *Cryptoblepharus* proved difficult to key out and so the two species were included in the analysis as a species composite, *Cryptoblepharus carnabyi/plagiocephalus*.

The dendrogram resulting from the *quadrat* analysis of reptile species is shown in Figure 111. A primary division of the dendrogram into two groups reflects the distinction between quadrats with woodlands (Blackoak and mallee) (top half of dendrogram) and those with shrublands, grasslands or very open woodlands (bottom half). Further division of the dendrogram, as shown, results in five quadrat groups:

- Group 1 — Open or very open Blackoak, mallee or mixed woodlands with chenopod and/or grassland understorey;
- Group 2 — Chenopod shrublands generally without significant emergent trees;
- Group 3 — Claypan/saline shrublands;
- Group 4 — Mallee with shrubby or spinifex (*Triodia*) understorey;
- Group 5 — Denser Blackoak and/or mallee woodland.

These broad classifications match the known preferred habitats of the reptile species found at the quadrats in these groups, as listed in the quadrat group descriptions later (derived from the GLIST output).

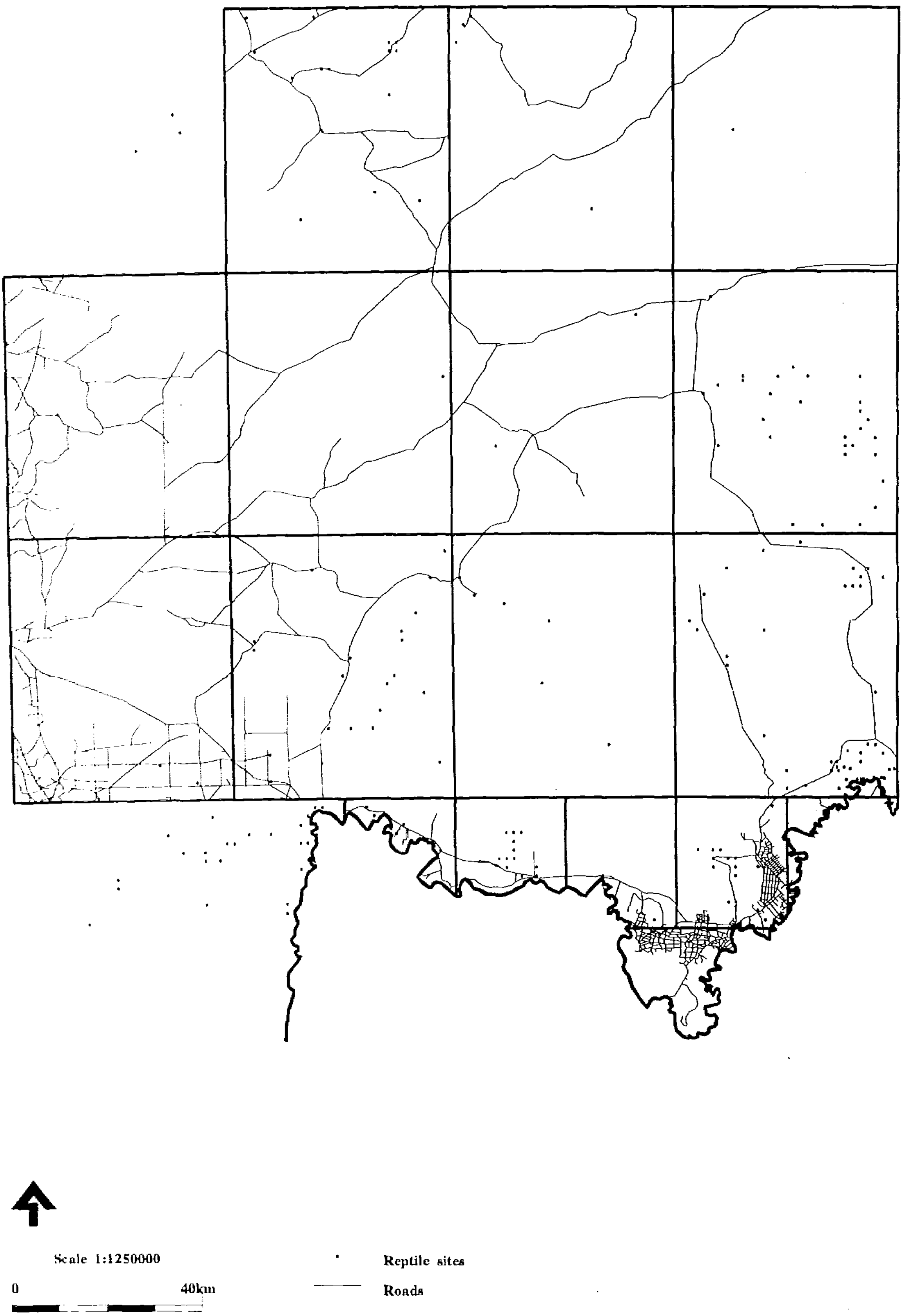
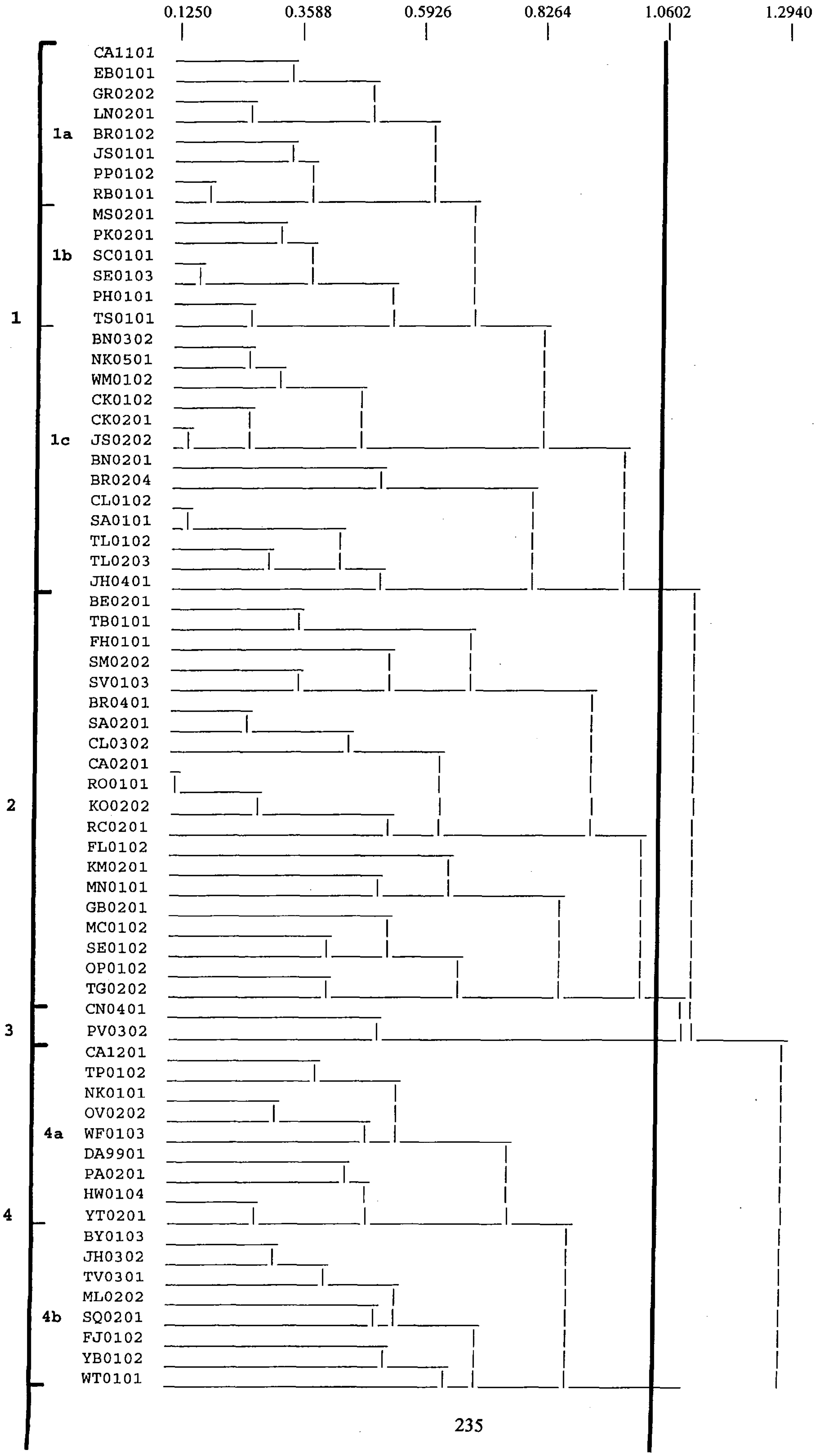


Figure 110

Distribution of South Australian Museum reptile records from the South Olary Plains prior to 1992.


0.1250
0.3588
0.5926
0.8264
1.0602
1.2940
1
1a
1b
1c
2
3
4
4a
4b
CA1101
EB0101
GR0202
LN0201
BR0102
JS0101
PP0102
RB0101
MS0201
PK0201
SC0101
SE0103
PH0101
TS0101
BN0302
NK0501
WM0102
CK0102
CK0201
JS0202
BN0201
BR0204
CL0102
SA0101
TL0102
TL0203
JH0401
BE0201
TB0101
FH0101
SM0202
SV0103
BR0401
SA0201
CL0302
CA0201
RO0101
KO0202
RC0201
FL0102
KM0201
MN0101
GB0201
MC0102
SE0102
OP0102
TG0202
CN0401
PV0302
CA1201
TP0102
NK0101
OV0202
WF0103
DA9901
PA0201
HW0104
YT0201
BY0103
JH0302
TV0301
ML0202
SQ0201
FJ0102
YB0102
WT0101

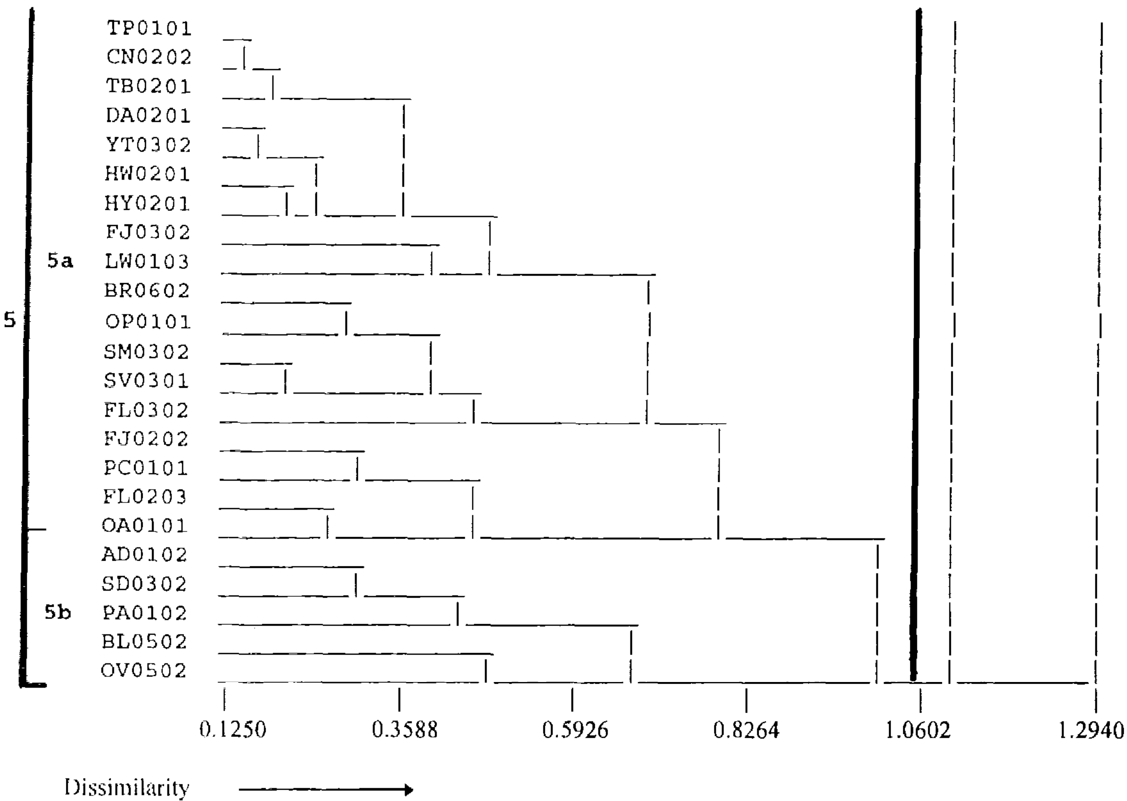


Figure 111
Dendrogram from classification analysis of reptile data, showing quadrat groups

If the dendrogram is divided further, sub-groups appear which generally reflect minor variations in the vegetation type and thus slight changes in reptile species present. These sub-groups are indicated on Figure 6C and discussed in the quadrat group descriptions later. Briefly, Sub-group 1a contains quadrats with larger trees, 1b are mallees and 1c more open woodlands. Sub-group 4a has Spinifex (*Triodia*) whereas 4b doesn't and 5a is more open woodland than 5b.

The dendrogram of the reptile *species* analysis (i.e. comparison of the distributions of each reptile species across all quadrats sampled) was also best divided into five groups but which were slightly different (dendrogram not shown here but groupings are denoted on Table 6D). The primary division of the species dendrogram was into mallee-dwelling reptile species (only seven species) and the rest woodland and shrubland generalist species. Further subdivisions resulted in a total of five groups (to be called blocks):

Block 1	Mallee-dwelling species,
Block 2	Woodland generalists,
Block 3	Rocky habitat species,
Block 4	Miscellaneous rarer species,
Block 5	Chenopod-preferring species (i.e. Blueblush, Blackbush, Saltbush).

Similarly, sub-blocks were recognisable within these species blocks and are discussed below.

The two-way table of species incidence by quadrat (Table 22) combines the results of the quadrat and species analyses into a more easily interpreted form. In these discussions *quadrat* groups are referred to as *groups* (across the top of the two-way table) and reptile *species* groups are referred to as *blocks* (down the left-hand side of the table).

Table 22

Two-way table of reptile species analysis showing Groups of quadrats by Blocks of reptile species.

```
GROUPS OF QUADRATS                                   1.                       2.         3.        4.                   5.

                                            1a  | 1b   |     1c                                   4a  | 4b             5a        | 5b
                                         CEGLBJPRMPSSPTBNWCCJBBCSTTJ.BTFSSBSCCRKRFKMGMSOT.CP.CTNOWDPHYBJTMSFYW.TCTDYHHFLBOSSFFPFOASPBO
                                         ABRNRSPBSKCEHSNKMKKSNRLALLH.EBHMVRALAOOCLMNBCEPG.NV.APKVFAAWTYHVLQJBT.PNBATWYJWRPMVLJCLADDALV
                                         100000000000000000000000000.00000000000000000000.00.10000900000000000.00000000000000000000000
BLOCKS OF                                112211112211113511222211124.21121423212212121112.43.21121921213322111.12223223161333212113155
REPTILE SPECIES                          000000000000000000000000000.00000000000000000000.00.00000000000000000.00000000000000000000000
                                         1121212111131121222121421231.11123112112121112222.12.12123114132121221.12112112321212213122222

       Amphibolurus nobbi                 *                  *      .                    .  .*     *  *    ** .              **      *
       Diplodactylus damaeus                                        .                    .  .   * ****    **  .   * *        *  *
   1a  Ctenophorus fordi                  *       *                 .                    .  .********* *   ** .
1.     Strophurus elderi                  *       *                 .                    .  .     ***         .
       Strophurus williamsi              **                         .                  * .  .  *    **        .          *
       Ctenotus atlas                                               .                    .  .*      *         .
   1b  Nephrurus levis                                              .                    .  .       **        .
.............................................................................................................................................
       Cryptoblepharus carnabyi/plagio.  ****  **  ***              .    *      *  *     .  .* **             .******* ******       **
       Egernia striolata                  *                         .     *     *        .  .  **  *          .****************
   2a  Morethia boulengeri                *  ****            *      .                    .  .*             *  .  *      *********  *
       Ctenotus regius                    *                        *. * *                .  .     ******      .*******    *   ***   *
       Ctenotus schomburgkii             *   *                     *. * **               .  .* *** * *******  .* *******  ** ****
       Diplodactylus vittatus                      *          *   * .           * *******.  .              *  . **  *   ****
   2b  Gehyra variegata                  **  ****      **   * ***** .   **            *  .  .*         **     .********* **      * *
2.     Heteronotia binoei                ***** **      **    *******.  *           *     .  .      *          .***  **       *   *
       Lerista muelleri                                ***  **  *   .    *              *.  .                 .  *  **    *****  *****
       Ctenophorus pictus                **          *              .        *  *        .  .***        *     .             ** *
   2c  Lerista punctatovittata            *                      *  .                 *  .  .     *   ***** **.      *           *** *
       Rhynchoedura ornata                                          .  ***               .  .             *   .    ***    **         *
       Lerista dorsalis                        *     **             .                    .  .              * *.
       Morethia obscura                        **  * *              .            *  *    .  .      *          .      *             *
   2d  Menetia greyii                     ** ****************       . *             ***  .  .  * **           .          **
       Tiliqua rugosa                    ***** ******** * ***  *****.       *****     ***.  .*   *            .***    *      *     *
       Pogona vitticeps                  **    * ****               .       *  *  *      .* .                 .           * *      *
.............................................................................................................................................
       Ctenophorus decresii                  * *               * ** .                    .  .                 .          *
3.     Ctenotus robustus                     *                 **   .                *   .  .                 .           *
       Hemiergis millewae                    *                      .                    .  .                 .          *
       Tympanocryptis lineata                                  ***  .                    .  .                 .
```

```
                                   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
    Diplodactylus tessellatus                                 .                   .**.                 .        *
4.  Eremiascincus richardsonii                    *           .                   .  .                 .       *
    Nephurus milii                                     **     .                   .  .                 .
                                   . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . . .
    Ctenotus strauchii                                **       .**          *      .  .                 .
    Tympanocryptis tetraporophora                 *  ***       . *   ***        *  .  .                 .
5.  Ctenotus uber                    *   *               *** *.    ********       . *.            *    .
    Diplodactylus byrnei                                      . *  * **    ***  * .  .                 .                  *
    Morethia adelaidensis            *     *          *    *  .******* ***     ***.  .            *    .  *
    Tiliqua occipitalis                                    *  .          **    ** .  .       *         .
```

Reptile Species Groups

Block 1 comprises the specifically mallee-preferring species (labelled 'M' below) including some Spinifex (*Triodia*) specialists (T) and sandy habitat dwellers (S). The fifth species (*S. williamsi*) is specifically arboreal (A) and likes any tall straight trees, not necessarily mallee. Thus, from the two-way table, these species occur predominantly in Group 4 (mallee) and at the mixed mallee quadrats of Groups 1 and 5. They seem to avoid the larger Eucalypt quadrats of the second part of Group 1a and the open woodlands of Group 5b. The two species of Block 1b (*C. atlas & N. levis*) are exclusively mallee-*Triodia* inhabitants and with *S. elderi* and *S. williamsi* seem to avoid the non-Triodia quadrats of Group 4b.

Nobbi (*A. nobbi*) M
Beaded Gecko (*D. damaeus*) M S
Mallee Dragon (*C. fordi*) M T
Jewelled Gecko (*S. elderi*) M T
Eastern Spiny-tailed Gecko (*S. williamsi*) A
Southern Spinifex Ctenotus (*C. atlas*) M T
Smooth Knob-tailed Gecko (*N. levis*) M S

Block 2 comprises the woodland generalist species and can loosely be divided into four sub-groups.

Block 2a species seem to prefer the denser woodlands (mallee and Blackoak) of Group 5 (particularly 5a). Their lower presence in Groups 1 and 4 (open woodland and mallee) is probably at the denser wooded quadrats only and the few occurrences in Group 2 (chenopod shrublands) would be at quadrats with emergent trees. Within Group 1 these species seem to prefer the larger treed quadrats of Group 1a but are virtually absent in the very open grassy and shrubby woodlands of Group 1c (and also Group 5b). Two of the species are strictly arboreal (A) (i.e. prefer vertical, large trees) and the other three are known to be generalists (G) with one preferring larger trees [(A)] and two liking chenopod shrubs as well (C):

Speckled/Desert Wall Skink (*C. carnabyi/plagiocephalus*) A
Eastern Tree Skink (*E. striolata*) A
Common Snake-eye (*M. boulengeri*) G (A)
Eastern Desert Ctenotus (*C. regius*) G (C)
Sandplain Ctenotus (*C. schomgurgkii*) G

Block 2b comprises the true woodland generalists as can be seen by the almost even spread of occurrences across the two-way table. However they possibly avoid pure mallee, as indicated by their low presence or absence in Group 4 and Group 1b but tend towards larger trees such as Blackoak (B) and tree Eucalypts (E) scattered elsewhere. They show a slight avoidance of the treeless chenopod shrublands. Three of the species particularly do *not* occur in sandy mallee areas (NS) [hence avoidance of pure mallee which is usually on sandy soil and tendency for larger trees usually on heavier soils]:
Eastern Stone Gecko (*D. vittatus*) G (B,M)
Tree Dtella (*G. variegata*) A (B,E) NS
Bynoe's Gecko (*H. binoei*) G
Dwarf Three-toed Slider (*L. muelleri*) G NS

The generalists of Block 2c, like 2a, seem to slightly prefer denser woodlands (of Group 4 and 5) but avoid the larger tree Eucalypt quadrats of the second half of Group 1a. The first species (*C. pictus*) most often occurs in mallee that has recently been burnt. The second two are true generalists, known to be widespread throughout many habitats types.

Painted Dragon (*C. pictus*) G M
Spotted Slider (*L. punctatovittata*) G
Beaked Gecko (*R. ornata)* G

Block 2d also comprises true generalists but which appear to favour the more open areas in Groups 1 and 2.

Southern Four-toed Slider (*L. dorsalis*) G
Mallee Snake-eye (*M. obscura*) G S M
Dwarf Skink (*M. greyii*) G
Sleepy Lizard (*T. rugosa*) G
Central Beared Dragon (*P. vitticeps*) G

Blocks 3 and 4 contain the rarer species. Block 3 comprises three rocky hill dwelling species (RH). The fourth is more of a generalist that can occur in rocky habitats (R) also but is possibly grouped here because of its very low frequency.

Tawny Dragon (*C. decresii*) RH
Eastern Striped Skink (*C. robustus*) RH
Rusty Earless Skink (*H. millewae*) RH T M
Five-lined Earless Dragon (*T. lineata*) G (R)

Block 4 contains an unusual mixture of rare species with a variety of preferences although they tend to prefer heavier soils (H). They have probably been grouped together because of their rarity, which is the tendency of PATN analysis when handling low frequency species. The first species corresponds nicely with both quadrats in claypan Group 3.

Tessellated Gecko (*D. tessellatus*) - H C
Broad-banded Sandswimmer (*E. richardsonii*) G NS
Barking (Thick-tailed) Gecko (*N. milii*) G (R,H)

Block 5 contains nearly all heavy soil preferring species (H) and some chenopod specialists (C) that inhabit open areas, so thus they occur predominantly in Group 2 and almost exclusively in that and Group 1. The last species is unusually grouped here but once again perhaps because it is rarer.

Short-legged Ctenotus (*C. strauchii*) H
Eyrean Earless Dragon (*T. tetraporophora*) H C
Spotted Ctenotus (*C. uber*) H (R)
Pink-blotched Gecko (*D. byrnei*) H C
Adelaide Snake-eye (*M. adelaidensis*) C (H)
Western Bluetongue (*T. occipitalis*) G

Quadrat Groups

The five *quadrat* groups are individually described below, each with a map, the number of members (quadrats) and a reptile species list (from GLIST). The map shows the distribution of quadrats at which the suite of reptile species were observed, shown by large dots. The small dots indicate the location of all quadrats surveyed for fauna.

The species list shows the proportion of occurrence of each species within that group (i.e. the proportion of quadrats in that group at which the species occurred), the number of other groups in which that species occurs (i.e. out of a total of five groups) and the X^2 for each species [i.e. a measure of the uniqueness of that species to that group (see methods section) (note that a negative standardised residual means that it is the low abundance or near absence of the species from that group that is significant)]. The list is in order of descending proportion of occurrence, showing only species with a proportion of occurrence greater than 0.05.

By assessing the known vegetation types at each quadrat within a group, and having a knowledge of the habitat preferences of the reptile species found there, each of the five groups could be assigned a broad vegetation type. A description of the vegetation types indicated by the quadrats present in the group and the general soil types and landform systems present are summarised for each group.

In the reptile data analyses the quadrat groups were less rigid than in the vegetation or bird analysis grouping so it was not appropriate to identify indicator species but characteristic or frequent species could be noted. In the case of reptile species, the proportion of occurrence and X^2 for each species can only be used as a rough guide to identify important species - a detailed knowledge of reptile-habitat relationships is necessary to correctly interpret the group species lists.

For each group, the species are discussed in four categories and denoted as such on the proportion of occurrence list:

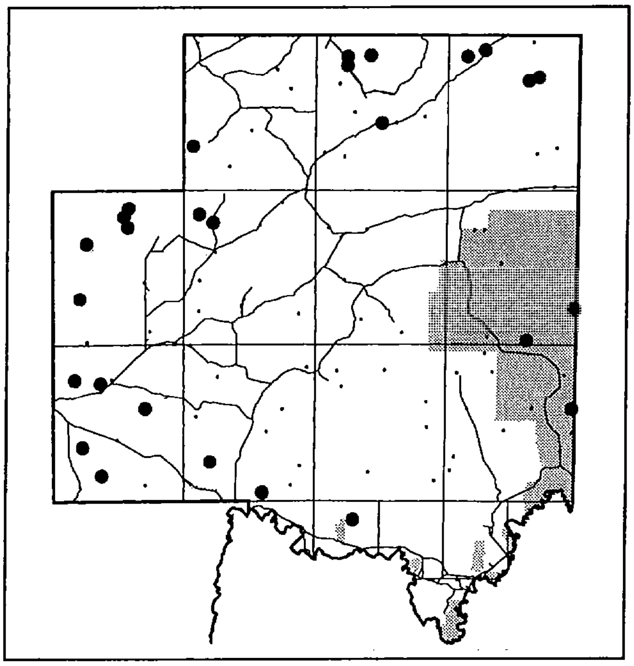
- c — Frequent, characteristic species - frequent and characteristic species of the vegetation type, generally with a proportion of occurrence greater than 0.25 and $X^2 > 0.2$.
- f — Frequent species - species frequently found in that vegetation type but which are not specifically characteristic of it (i.e. are more generalist across other habitats as well). Generally proportion of occurrence is greater than 0.3 and $X^2 < 0.2$.
- r — Rarer, significant species - rarer but significant species that are characteristic of the vegetation type, from a knowledge of general reptile habitat preferences. Tend to have lower proportion of occurrence and X^2. (Although known to be characteristic species these showed a low X^2 in the current data - maybe due to inadequate sampling, seasonal or weather conditions or just the fact that they are generally rarer reptiles.)
- o — Other notable species - fairly common but less frequent species (generally proportion of occurrence >0.15) in the vegetation type but that characteristic of variants of the vegetation type (and thus only have a low X^2 for the whole group).

In the discussion of species for each group the following abbreviations are used to denote the habitats and preferences of species (or slight preferences if in parentheses):

A = arboreal
B = Blackoak
C = chenopod shrubs
F = fallen trees
G = generalist
H = heavy soils
L = leaf litter
M = mallee
NS = non-sandy
R = rocky
RH = rocky hills
S = sandy soils
T = spinifex (*Triodia*)

Group 1. Reptiles of open mixed woodlands

27 Members



Quadrat vegetation types

Blackoak (*Casuarina pauper*) and/or Eucalypt (tree) low woodland to low very open woodland and/or open to very open mallee, with shrubby understorey. Often just chenopod shrubland and/or grassland with very few trees or none but some nearby.

Soil types

Various but tending towards clayier and/or siltier.

Reptile species present

	Species	Prop. Occur.	No. Grps	Chi Squ.	Std Res.
f	*Tiliqua rugosa*	0.8148	4	0.7725	0.88
f	*Menetia greyii*	0.6667	4	0.8591	0.93
f	*Heteronotia binoei*	0.5926	4	0.6891	0.83
f	*Gehyra variegata*	0.5185	4	0.1982	0.45
f	*Cryptobleph. carnabyi/plagio.*	0.3333	4	0.0192	0.14
	Pogona vitticeps	0.2593	4	0.0127	0.11
o	*Ctenotus uber*	0.2222	4	0.0008	-0.03
o	*Lerista muelleri*	0.2222	3	0.0113	0.11
o	*Morethia boulengeri*	0.2222	3	0.0210	0.14
o	*Ctenophorus decresii*	0.1852	2	0.4253	0.65
o	*Tympanocryptis tetraporoph.*	0.1481	2	0.0589	0.24
o	*Morethia adelaidensis*	0.1481	4	0.0057	-0.08
o	*Morethia obscura*	0.1481	4	0.0610	0.25
	Lerista dorsalis	0.1111	2	0.0934	0.31
	Ctenotus schomburgkii	0.1111	4	0.1321	-0.36
	Tympanocryptis lineata	0.1111	1	0.3555	0.60
	Ctenophorus pictus	0.1111	4	0.0002	-0.01
	Ctenotus robustus	0.1111	3	0.1204	0.35
	Diplodactylus vittatus	0.1111	4	0.0232	-0.15
	Ctenophorus fordi	0.0741	2	0.0430	-0.21
	Strophurus williamsi	0.0741	4	0.0004	0.02
	Strophurus elderi	0.0741	2	0.0115	0.11
	Lerista punctatovittata	0.0741	4	0.0481	-0.22
	Ctenotus strauchii	0.0741	2	0.0191	0.14
	Nephurus milii	0.0741	1	0.2370	0.49
	Ctenotus regius	0.0741	4	0.0878	-0.30
	Amphibolurus nobbi	0.0741	3	0.0066	-0.08

Notable reptile species

As this is a very general group of a variety of vegetation types there are no true characteristic species (i.e. all the chi-squared values are low). However, some frequent and other notable species do indicate the range of vegetaion types present in this group.

Frequent species
Sleepy Lizard (*T. rugosa*) G
Dwarf Skink (*M. greyii*) G F
Bynoe's Gecko (*H. binoei*) G F
Tree Dtella (*G. variegata*) A
Speckled/Desert Wall Skink (*C. carnabyi/plagiocephalus*) A

Other notable species
Spotted Ctenotus (*C. uber*) H (R)
Dwarf Three-toed Slider (*L. muelleri*) G NS
Common Snake-eye (*M. boulengeri*) G NS F
Tawny Dragon (*C. decresii*) RH
Eyrean Earless Dragon (*T. tetraporophora*) H C
Adelaide Snake-eye (*M. adelaidensis*) C (H)
Mallee Snake-eye (*M. obscura*) G S M

Comments

The quadrats in this group occur mostly in the western and northern parts of the survey area which contain the more open woodlands and shrublands.

The high number of generalist reptile species indicates that the woodlands in this group are very variable; some have significant numbers of trees as indicated by the arboreal and fallen timber-dwelling reptile species; some are rocky sites and some have harder soils and are predominantly chenopod shrubland as indicated by the chenopod-preferring species. Many of the species prefer hard or non-sandy soils.

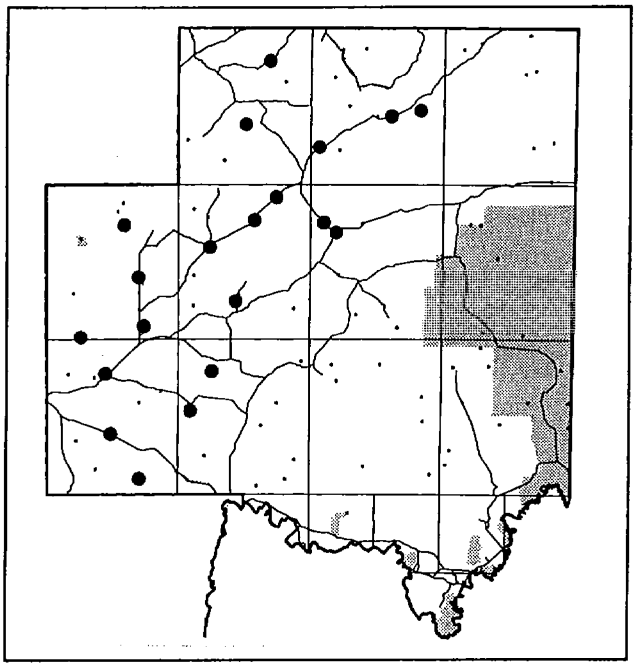
From the dendrogram and two-way tablethis group can be divided into three to four sub-groups. The first contains quadrats with larger trees, either Blackoak, Sugarwood or tree Eucalypts (*E. porosa, E. camaldulensis, E. brachycalyx*). This sub-group is noticeable on the two-way table and discussed with the species blocks.

The second sub-group consists of mallee quadrats which are probably in this group as the trees are larger and/or the soils are not so sandy. This was also discussed in the context of the species blocks. The fact that no mallee-specific reptiles occuurred in any numbers in this group would indicate that this mallee is perhaps not pure or occurred only in small patches amongst other woodland species.

Sub-group three is actually two sub-groups (three and four) but between which no difference could be seen on the basis of vegetation types. The quadrats in this sub-group all seem to be more open chenopod shrublands and grasslands with emergent trees, which is reflected in the wide range of reptile species found there.

Group 2. Reptiles of chenopod shrublands

20 Members



Quadrat vegetation types

Low open to very open cheopod shrublands (i.e. Bluebush - *Maireana sedifolia*; Black Bluebush - *M. pyramidata*; Bladder saltbush - *Atriplex vesicaria*; and other minor chenopods). Generally without trees but some with the occasional Blackoak, mallee, Sugarwood (*Myoporum platycarpum*) or Bullock Bush (*Alectryon oleifolius*)

Soil types

Various but generally more clayey and silty.

Reptile species present

	Species	Prop. Occur.	No. Grps	Chi Squ.	Std Res.
c	*Morethia adelaidensis*	0.6500	4	1.2263	1.11
c	*Diplodactylus byrnei*	0.4000	2	1.0926	1.05
f	*Tiliqua rugosa*	0.4000	4	0.0208	0.14
f	*Diplodactylus vittatus*	0.4000	4	0.2899	0.54
f	*Ctenotus uber*	0.4000	4	0.1136	0.34
c	*Tympanocryptis tetraporoph.*	0.2500	2	0.3646	0.60
	Tiliqua occipitalis	0.2000	3	0.3352	0.58
	Menetia greyii	0.2000	4	0.0030	-0.05
	Pogona vitticeps	0.1500	4	0.0161	-0.13
o	*Ctenotus strauchii*	0.1500	2	0.2469	0.50
o	*Ctenotus schomburgkii*	0.1500	4	0.0865	-0.29
o	*Gehyra variegata*	0.1500	4	0.0618	-0.25
	Rhynchoedura ornata	0.1500	3	0.0334	0.18
o	*Cryptobleph. carnabyi/plagio.*	0.1500	4	0.0481	-0.22
	Ctenophorus pictus	0.1000	4	0.0020	-0.05
	Heteronotia binoei	0.1000	4	0.0585	-0.24
	Morethia obscura	0.1000	4	0.0057	0.08
o	*Egernia striolata*	0.1000	4	0.0514	-0.23
	Ctenotus regius	0.1000	4	0.0574	-0.24
	Lerista muelleri	0.1000	3	0.0338	-0.18
	Strophurus williamsi	0.0500	4	0.0051	-0.07
	Ctenotus robustus	0.0500	3	0.0020	0.04
	Lerista punctatovittata	0.0500	4	0.0778	-0.28

Notable reptile species

Frequent characteristic species

Adelaide Snake-eye (*M. adelaidensis*) C (H)
Pink-blotched Gecko (*D. byrnei*) C
Eyrean Earless Dragon (*T. tetraporophora*) H C

Frequent species

Sleepy Lizard (*T. rugosa*) G
Eastern Stone Gecko (*D. vittatus*) G (A)
Spotted Ctenotus (*C. uber*) H

Other notable species

Short-legged Ctenotus (*C. strauchii*) H
Sandplain Ctenotus (*C. schomburkii*) G (C)
Tree Dtella (*G. variegata*) A
Speckled/Desert Wall Skink (*C. carnabyi/plagiocephalus*) A
Tree Skink (*E. striolata*) A

The presence of three arboreal species indicates the occasional tree present in the chenopod shrublands.

Comments

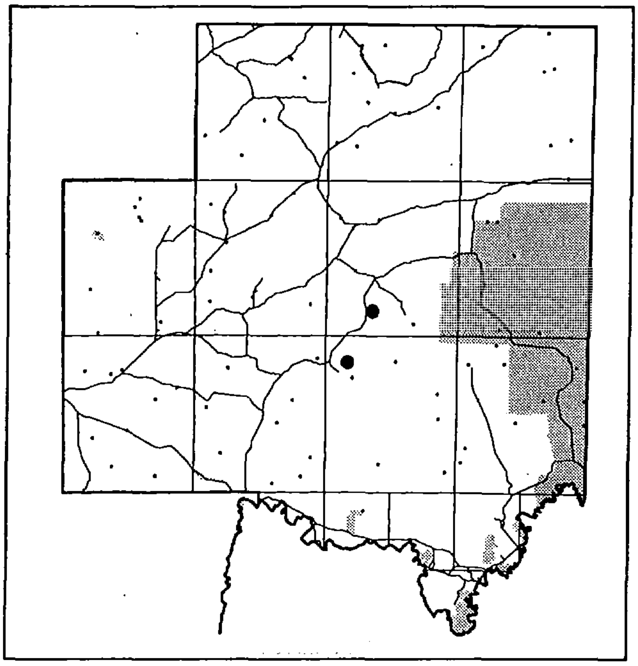
Quadrats in this group occurred in the northern, western and central parts of the survey area where the chenopod shrublands ocurr (extensive in the north and west and amongst woodlands and mallee in the central).

Reptile species present certainly indicate a dominance of chenopod shrubs and harder soils in this group with the lower frequency arboreal species indicating the occasional tree.

Sub-groups could not be clarified in terms of the vegetation present but the whole group seems to be fairly consistently chenopod shrublands with the exception of a few quadrats of Eucalypts, Native Pine (*Callitris*) and and Sugarwood which had significant chenopod understoreys.

Group 3. Reptiles of claypan environments

2 Members



Quadrat vegetation types

Low open shrubland of Boxthorn (*Lycium australe*), Nitre-bush (*Nitraria billardierei*) and/or Cotton-bush (*Marieana aphylla*). Generally on claypans or areas of clay soils.

Soil types

Clays

Reptile species present

Species	Prop. Occur.	No. Grps	Chi Squ.	Std Res.
c *Diplodactylus tessellatus*	1.0000	2	3.0004	1.73
c *Ctenotus uber*	0.5000	4	0.2946	0.54
c *Pogona vitticeps*	0.5000	4	0.4102	0.64

Notable reptile species

<u>Frequent, significant species</u>

Tessellated Gecko (*D. tessellatus*) H C
Spotted Ctenotus (*C. uber*) H (R)

<u>Frequent speces</u>

Central Bearded Dragon (*P. vitticeps*) G

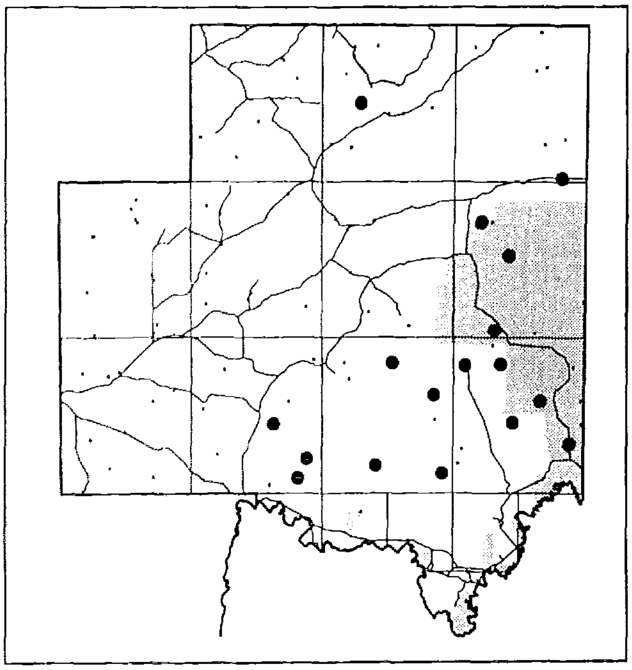
Comments

Both the quadrats in this group occurred on claypans in the centre of the survey area. However, having only two quadrats with three species the group cannot be properly defined.

At least two of the species seem to be quite specific to the habitat type. The third (*P. vitticeps*), although showing a high chi-squared value, is a generalist species. More samples on claypan environments would be needed to describe this group properly.

Group 4. Reptiles of mallee communities

17 Members



Quadrat vegetation types

Variety of tree and shrub very open mallee to mallee, with chenopod or mixed shrub and/or Spinifex (*Triodia*) understorey. Mostly *Eucalyptus socialis, E. gracilis, E. oleosa* and *E. dumosa.*

Soil types

Generally sandy

Reptile species present

	Species	Prop. Occur.	No. Grps	Chi Squ.	Std Res.
f	*Ctenotus schomburgkii*	0.7059	4	0.4845	0.70
c	*Ctenophorus fordi*	0.7059	2	1.9385	1.39
f	*Lerista punctatovittata*	0.4706	4	0.5848	0.76
c	*Diplodactylus damaeus*	0.4118	2	0.7412	0.86
f	*Ctenotus regius*	0.3529	4	0.0977	0.31
c	*Amphibolurus nobbi*	0.2941	3	0.3789	0.62
o	*Ctenophorus pictus*	0.2353	4	0.1247	0.35
o	*Gehyra variegata*	0.1765	4	0.0395	-0.20
r	*Strophurus elderi*	0.1765	2	0.3187	0.56
o	*Cryptobleph. carnabyi/plagio.*	0.1765	4	0.0281	-0.17
o	*Menetia greyii*	0.1765	4	0.0109	-0.10
o	*Egernia striolata*	0.1765	4	0.0032	-0.06
o	*Strophurus williamsi*	0.1765	4	0.1685	0.41
r	*Ctenotus atlas*	0.1176	1	0.3763	0.61
	Tiliqua rugosa	0.1176	4	0.1269	-0.36
o	*Morethia boulengeri*	0.1176	3	0.0129	-0.11
	Lerista dorsalis	0.1176	2	0.1129	0.34
r	*Nephrurus levis*	0.1176	1	0.3763	0.61
	Morethia obscura	0.0588	4	0.0051	-0.07
	Tiliqua occipitalis	0.0588	3	0.0000	0.00
	Ctenotus uber	0.0588	4	0.1332	-0.36
	Heteronotia binoei	0.0588	4	0.1099	-0.33
	Rhynchoedura ornata	0.0588	3	0.0131	-0.11
	Morethia adelaidensis	0.0588	4	0.0817	-0.29
	Diplodactylus vittatus	0.0588	4	0.0770	-0.28

Notable reptile species

Frequent, characteristic species

Mallee Dragon (*C. fordi*) M T
Beaded Gecko (*C. damaeus*) M S
Nobbi (*A. nobbi*) M (T)

Frequent species

Sandplain Ctenotus (*C. schomburgkii*) G (C)
Spotted Slider (*L. punctatovittata*) G (LF)
Eastern Desert Ctenotus (*C. regius*) G (C)

Rarer, significant species

Jewelled Gecko (*S. elderi*) T M
Southern Spinifex Ctenotus (*C. atlas*) T M
Smooth Knob-tailed Gecko (*N. levis*) M S

Other notable species

Tree Dtella (*G. variegata*) A (NS)
Speckled/Desert Wall Skink (*C. carnabyi/plagiocephalus*) A
Dwarf Skink (*M. greyii*) G L F
Tree Skink (*E. striolata*) A
Eastern Spiny-tailed Gecko (*S. williamsi*) A F
Common Snake-eye (*M. boulengeri*) G (A) F

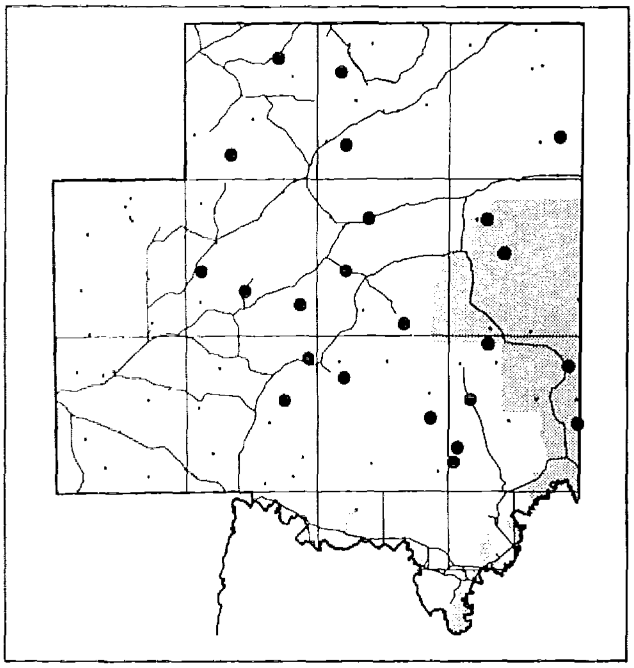
Comments

Quadrats in this group occur mostly in the south-east of the survey area where there is extensive mallee. Reptile species present strongly indicate sandy mallee, often with Spinifex (*Triodia*) and fallen timber and leaf litter.

Two sub-groups are present as indicated on the dendrogram and two-way table. Sub-group 4a generally has *Triodia* present whereas sub-group 4b doesn't. This is noticeable on the two-way table with the *Triodia*-specialists of Block 1 avoiding sub-group 4b.

Group 5. Reptiles of mixed woodlands

23 Members



Quadrat vegetation types

Blackoak low open woodlands to low open forest and/or open to closed mallee (generally denser than in Group 1), over mixed shrub or chenopod and/or grass understorey.

Soil types

various

Reptile species present

	Species	Prop. Occur.	No. Grps	Chi Squ.	Std Res.
c	*Egernia striolata*	0.6957	4	1.2083	1.10
c	*Cryptobleph. carnabyi/plagio.*	0.6522	4	0.5791	0.76
f	*Ctenotus schomburgkii*	0.6087	4	0.2735	0.52
f	*Lerista muelleri*	0.5652	3	0.8470	0.92
c	*Gehyra variegata*	0.5652	4	0.2843	0.53
f	*Ctenotus regius*	0.5217	4	0.4640	0.68
c	*Morethia boulengeri*	0.4783	3	0.6052	0.78
f	*Diplodactylus vittatus*	0.3043	4	0.0959	0.31
f	*Heteronotia binoei*	0.3043	4	0.0411	0.20
	Tiliqua rugosa	0.2609	4	0.0105	-0.10
	Rhynchoedura ornata	0.2609	3	0.2967	0.54
	Lerista punctatovittata	0.2174	4	0.0186	0.14
o	*Diplodactylus damaeus*	0.1739	2	0.0275	0.17
	Pogona vitticeps	0.1304	4	0.0289	-0.17
o	*Ctenophorus pictus*	0.1304	4	0.0020	0.04
o	*Amphibolurus nobbi*	0.1304	3	0.0094	0.10
	Menetia greyii	0.0870	4	0.0856	-0.29
	Morethia obscura	0.0870	4	0.0009	0.03

Notable reptile species

Frequent, characteristic species

Tree Skink (*E. striolata*) A
Speckled/Desert Wall Skink (*C. carnabyi/plagiocephalus*) A
Tree Dtella (*G. variegata*) A
Common snake-eye (*M. boulengeri*) G (A F)

Frequent species

Sandplain Ctenotus (*C. schomburgkii*) G (C)
Dwarf Three-toed Slider (*L. muelleri*) G NS (L F)
Eastern Desert Ctenotus (*C. regius*) G (C)
Eastern Stone Gecko (*C. vittatus*) G B M NS
Bynoe's Gecko (*H. binoei*) G (F)

Other notable species

Beaded Gecko (*D. damaeus*) M S
Painted Dragon (*C. pictus*) G M
Nobbi (*C. nobbi*) M F

Comments

This group generally occurs throughout the central and southern part of the survey area where there are more extensive, denser woodlands.

Reptile species in this group strongly indicate the presence of substantial tall trees and fallen timber with a variety of understorey. Two-subgroups are evident, with group 5b being more open grassy or shrubby.woodlands.

Ordination

A three-dimension ordination plot of the reptile species quadrat analysis is shown in Figure 112. This represents the multi-dimensional relationships of the fauna quadrats (i.e. how the quadrats relate to each other in terms of the reptile species present) reduced down to three dimensions to enable easier assessment. In other words, the closeness of any one point (quadrat) on the plot to another indicates their similarity to each other in terms of the reptile species found there.

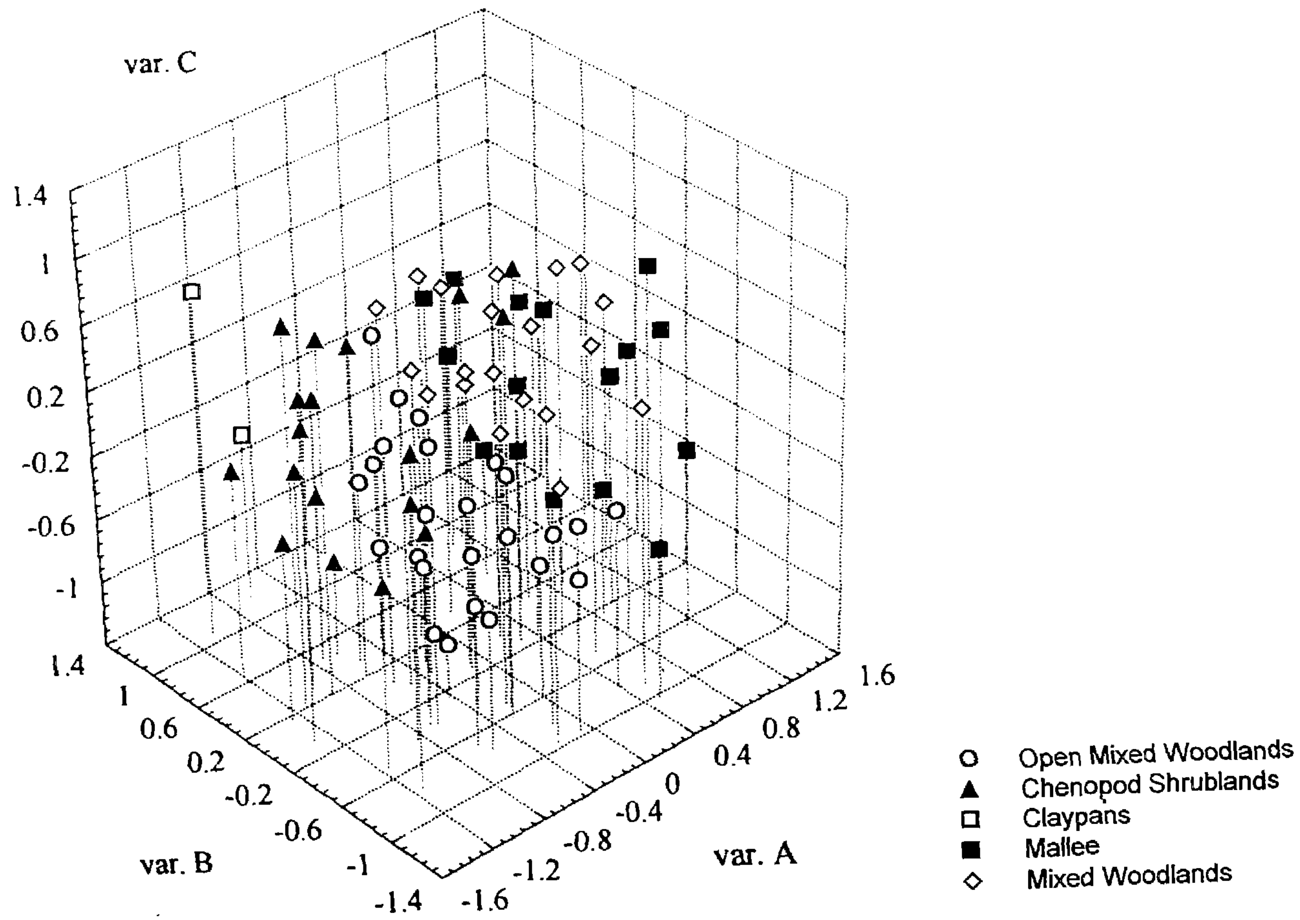


Figure 112
Scatterplot from multi-dimensional scaling of the four major communities from the reptile analysis of the South Olary Plains survey.

From Figure 112, the quadrats of groups one, two, four and five (i.e. open woodlands, chenopod shrublands, mallee and denser woodland habitats respectively) are quite well clustered. The two quadrats of group three (claypan environments) appear scattered but with only two points, the degree of clustering cannot be assessed.

By assessing the soil types at each quadrat, there seems to be a general trend from sandier soils on the right side (predominantly mallee quadrats - Group 4) to more clayey soils on the left side (predominantly chenopod shrublands - Group 2).

The closeness and overlapping of all groups on the ordination plot indicates the variety of vegetation types and soils within each group and the gradation of types between groups, reflected in the variety of reptile fauna found. This is not surprising as some quadrats were pure mallee (right side of plot); many were Blackoak woodlands (open and denser) (centre of plot) mixed with varying proportions of mallee and chenopod shrublands (to right and left respectively); and others chenopod shrublands with emergent trees (left) or pure chenopods (far left). Within these vegetation trends are changing soil types that are also pertinent to the reptile fauna, thus causing a more complex ordination plot than for bird species.

The two Group 3 quadrats appear amongst the Group 2 quadrats on the plot, having mostly chenopod plant species present, hard clay soils and thus reptile species specific to those habitats.

A possible geographic trend is also visible on the ordination plot, from the left (mostly south and south-eastern quadrats of the survey area) to the right (north-western and central quadrats), probably reflecting the soils trend from sandy to more clayey. A trend between dry and moist environments is not apparent on the plot probably because the rainfall gradient across the area is so slight.

SPECIES OF PARTICULAR INTEREST

As already mentioned, records of five new species for the South Olary Plains have been confirmed and one 're-discovered' species found. Seven of the total species recorded are of significant or notable conservation status on a national or state basis, as shown (and defined) in Appendix XI.

Of the species found on the current survey, one is classified as endangered in Australia and South Australia, one is vulnerable in Australia and rare in S. A., one is vulnerable and another rare in S.A.. From the studies previously conducted in the area one additional species is classified as vulnerable in Australia and rare in S.A., one is rare in S.A. and another indeterminate on a national basis but rare in S.A..

In the notes below, the Australian conservation status is from the Commonwealth *Endangered Species Protection Act 1992* [based on the 'Australian and New Zealand Environment Conservation Council (A.N.Z.E.C.C.) list of Threatened Vertebrate Fauna, April, 1991'] with amendments made by Cogger *et al.* (1993) in *The Action Plan for Australian Reptiles.* The South Australian status is from Threatened Species Strategy Steering Committee (1993) and M. Hutchinson (pers. comm.). Australian distribution comments are from Wilson *et al.* (1988) and Cogger (1983) and South Australian distributions from Edwards and Tyler (1990) and M. Hutchinson (pers. comm.). Ecological notes are from Wilson *et al.* (1988) and Cogger (1983) and reasons for decline from M. Hutchinson and Stephens (1992).

The re-discovery of the Pygmy (Adelaide) Bluetongue *Tiliqua adelaidensis* (Fig 113)

Before the South Olary Plains survey this scincid lizard was regarded as highly endangered if not extinct, having not been seen for 33 years. It was thought to be the only Australian reptile species to become extinct since European settlement. However, on 14th October 1992 the species was rediscovered east of Burra.

Only 20 specimens had been previously collected over 130 years, with only two reports from this century. Two specimens were found in the Burra area in the 1940's and most recently two were collected from Marion in Adelaide in 1959. Unfortunately there was very little location and habitat data with these specimens so not much was known about the ecology of this elusive species. It was only known to occur from the Adelaide Plains to Burra in the northern Mount Lofty Ranges (Armstrong *et al.*, 1993).

On the South Olary Plains survey two biologists found an undigested Pygmy Bluetongue in the stomach of a recently road-killed Eastern Brown Snake three kilometres east of Burra - just three kilometres west (and outside) of the current survey boundary. Six days later another specimen was found eight kilometres to the northeast (just 1 km out of the survey area) apparently freshly killed by a bird of prey. A few weeks later two more specimens were found near the location of the first, both also prey victims.

After intensive searching of the area by South Australian Museum staff over the following weeks the first live specimen was eventually caught in a pit trap in November. Extensive field surveys have since revealed eight populations in a 70km strip between Burra and Peterborough (M. Hutchinson, pers. comm.).

The Pygmy Bluetongue is much smaller than other bluetongue lizards, not exceeding 20cm. It has a short tail and a disproportionately large head for the small tapering body (Armstrong & Reid, 1992). The tongue is pink and the body grey-brown to orange-brown with smooth, flat and overlapping scales. The body patterning is of dark scattered longitudinal series of irregular small blotches, unlike any other bluetongue lizard.

This species is very cryptic, tending to hide in spider holes and rapidly disappearing if disturbed - hence the difficulty in locating populations. It inhabits remnant patches of native tussock grassland (spear grass - *Stipa*, wallaby grass - *Danthonia*, iron grass - *Lomandra*) and open woodland in the Mid-North area (Cogger *et al.*, 1993).

The reasons for this species' decline include habitat modification for agriculture (particularly ploughing and pasture improvement) and urban and industrial development (Cogger *et al.*, 1993). On-going research is continuing to better establish the status of the Pygmy Bluetongue and to conserve remaining populations. It is currently classified as endangered on an Australian and South Australian basis.

New confirmed species for the area

Adelaide Snake-lizard *Delma molleri*
A large and moderately robust legless lizard which inhabits sub-humid to semi-arid chenopod shrublands, often associated with woodlands, on sandy to stony soils. It shelters beneath dead vegetation, rocks, logs and surface debris. Distribution is restricted to the Mount Lofty and southern Flinders Ranges and Yorke Peninsula.

From South Australian Museum records prior to the South Olary Plains survey, four specimens were known of this species from around Burra just west of the survey boundary and a few have been recorded recently from the same area. On the current survey two specimens were collected from a quadrat 36km east of Burra which is the most easterly of this species (approximately 30km east of former locations). No other studies have reported this species from the South Olary Plains.

Short-legged Ctenotus *Ctenotus strauchii*
A widely distributed skink that occurs through the interior of New South Wales and southern Queensland, extending into adjacent regions of South Australia and Northern Territory. It favours stony clay soils with sparse ground cover, usually in association with woodlands, mallee, shrublands or grasslands but seems to avoid Spinifex (*Triodia*). Usually found in leaf litter or amongst fallen timber and other ground debris.

This variable species has two subspecies - one (*C. s. strauchii*) which occurs in eastern and mid-western Queensland to northern interior N.S.W. and the other (*C. s. varius*) which occurs through south-western Qld, south-eastern N.T., north-eastern S.A. and far north-western N.S.W.. *C. s. strauchii* also extends into S.A., with one S.A. museum specimen coming from near Blanchetown and records being known from the Olary Spur. *C. s. varius* specimens are from much further north.

The seven specimens collected on the South Olary Plains survey are all *C. s. strauchii* - one being found in the west of the survey area and the other six in the north and north-east. Thus these are the first South Australian records of this species from the South Olary Plains, linking the N.S.W. and Olary Spur records with the isolated Blanchetown one.

Gidgee (Spiny-tailed) Skink *Egernia stokesii*
A widespread species that occurs across arid interior Australia. Found among rock outcrops, stony hills and mountain ranges where it shelters in deep crevices or under large boulders.

In South Australia the closest museum records of this species to the South Olary Plains are from the southern Flinders Ranges near Quorn and one from the hills above Port Germain (north of Port Pirie). (Although Edwards and Tyler (1990) record this species as occurring in the eastern pastoral region, there are no museum specimens to substantiate it).

On the South Olary Plains survey four specimens were recorded from on and near Tilkilki Station in the north-western part of the survey area, all on rocky hills. Thus these are the most southern and south-eastern records of the species in South Australia. However, as this is a rocky hill dweller it is not likely to be found on the true South Olary Plains but may occur on some of the Olary Spur outliers and rocky outcrops in the north and north-east of the area.

Neobatrachus pictus
This stout, burrowing frog occurs in south-eastern South Australia and adjoining areas in Victoria and New South Wales. It is usually found only after summer rains when it breeds in grassy marshes, lagoons and temporary roadside pools.

In South Australia it is known from the South East, Murray Mallee, Mount Lofty and Eyre and Yorke Peninsula regions although, as the species' occurrence is seasonal and sporadic, it could easily occur elsewhere. On the South Olary Plains survey numerous specimens were recorded from eleven quadrats across the survey area, from southern Calperum Station to as far north as Oakvale and Oulnina Park Stations. These individuals would have emerged in response to the significant widespread rains which fell just before and during the survey, and thus have significantly extended northwards the previously known distribution.

Eastern Bluetongue *Tiliqua scincoides*
A very large, robust skink which is distributed throughout eastern and northern Australia, extending into south-eastern South Australia. It occurs in virtually all habitats in this area, except at high altitudes and in humid environments, and shelters in hollow logs and under ground debris.

In South Australia this species is known from all major regions but no specimens have been confirmed from the South Olary Plains area. The closest records are from locations further west and south-west of the survey area. Thus the specimen captured on the current survey on Tilkilki Station is a first for the South Olary Plains. However, the species is not likely to be found on the true plains further east as it is more of a wetter hills dweller in this part of its range. *Tiliqua occipitalis* is more likely to be found on the warmer, dry plains.

Species of National Significance

Carpet (Diamond) Python *Morelia spilota*
A widespread python which occurs throughout continental Australia, except in southern Victoria and the arid centre and west. It exists in a variety of habitats from rainforest to centralian deserts but mostly occurs in rocky areas or along watercourses where crevices and tree hollows provide refuge (Hutchinson, 1992).

Three subspecies are identified in Australia with *M. s. variegata* occurring in eastern and northern South Australia. while the south-western W.A. subspecies, *M. s. imbricata*, which is classified as vulnerable on a national basis, extends into South Australia along the Great Australian Bight.

In South Australia the species is classified as rare as the populations have substantially reduced since European settlement, primarily due to vegetation clearance and intensive agriculture. The species is known to occur in all regions except the South East and coastal areas. Although not found on the South Olary Plains survey the S.A. Museum has specimens from north of Morgan, Robertstown and along the River Murray.

Flinders Worm Lizard *Aprasia pseudopulchella*
An endemic South Australian legless lizard this species inhabits stony areas, particularly near creeks and rivers, in the Flinders and central and northern Mount Lofty Ranges (Cogger, 1993). It is regarded as rare on a state basis and vulnerable nationally. Although still occurring over a significant area in South Australia, populations are thought to have been substantially reduced since European settlement due to habitat clearance, overgrazing by stock, cropping, pasture improvement and urbanisation (Cogger, 1992).

On the South Olary Plains survey this species was found at the same location as the Pygmy Bluetongue, just east of the survey boundary, which is actually in the Northern Mount Lofty Ranges where it has been previously recorded. The S.A. Museum does not have records of the species from the South Olary Plains and it is not likely to occur on the true plains but could occur in the hills in the northeast of the area.

Species of State Significance

Pygmy Bluetongue (see above)

Flinders Worm Lizard (see above)

Carpet Python (see above)

Golden Bell Frog *Litoria raniformis*
Distributed through southern N.S.W., Victoria, Tasmania and south-eastern South Australia this frog inhabits vegetation within or at the edge of permanent water bodies, including dams. In South Australia it occurs in the southern Mt Lofty Ranges, the Murray Mallee and the South East.

Classified as vulnerable in South Australia the Golden Bell Frog has dramatically declined over much of its former range. Since European settlement, populations have been substantially reduced, the cause for which is unsure but suspected to include predation and the effects of insecticides, herbicides and salinisation.

On the South Olary Plains this species was captured at night while spotlighting near the River Murray but it is commonly known along the River Murray valley.

Marbled Velvet Gecko *Oedura marmorata* (Fig. 115)
A large, variable velvet gecko that is widely distributed throughout eastern, central and northern Australia (excluding the east coast and northern Queensland), this species is largely arboreal, sheltering in crevices or under loose bark of standing or fallen trees.

In South Australia this species is classified as rare as its distribution and abundance is uncertain, possibly having a small range and sparse abundance. It is known from the Eastern Pastoral district and the Flinders Ranges.

On the South Olary Plains survey this species was captured at one quadrat on Danggali Conservation Park. The University of South Australia has also recorded it on Danggali at several sites.

Common Bandy-bandy *Vermicella annulata*
This robust banded snake occupies nearly all habitat types across northern Western Australia and the central and eastern states (except extreme south-eastern Australia).

In South Australia this species is classified as rare as its distribution and abundance is uncertain but probably sparse. It only occurs in the Murray Mallee and the Flinders Ranges, and is rated on a national basis as indeterminate at this stage.

Although not found on the South Olary Plains survey it has been recorded on Danggali Conservation Park by Morley and Morley (1984) and the S.A. Museum has records from Danggali and near Renmark.

Bardick *Echiopsis curta*
A medium-sized elapid snake which is widely distributed from south-western Western Australia through southern

South Australia to western Victoria and south-western N.S.W.. It inhabits heathlands, woodlands and mallee-Spinifex associations on sandy to loamy soils.

In South Australia the Bardick is classified as rare as its distribution and abundance is uncertain but thought to be sparse due to the decline of habitat quality. It is known to occur on Eyre Peninsula, in the western pastoral district, the Murray Mallee and possibly in the South East. Although not recorded on the South Olary Plains survey the S.A. Museum has one record from Danggali Conservation Park collected by Morley and Morley (1984).

Other notable species

Southern Rock Dtella *Gehyra* '2N=44'
This unnamed rock-dwelling Dtella has been separated from the Tree Dtella (*G. variegata*) taxon (King, 1979), but has not yet received a formal taxonomic description. As the common name implies it is usually found around rocks or loose tin and rubbish typically in rocky Eucalypt woodland, as opposed to *G. variegata* which is specifically a tree-dweller in the south of its range (i.e. in the South Olary Plains).

On the South Olary Plains survey this species was found at eight quadrats and opportunistically throughout the north-western half of the survey area. It has also been recorded by the Field Naturalist's Society of S.A. Herpetology Club in Pooginook Conservation Park.

Eastern Four-toed Slider *Lerista dorsalis*
A relatively widespread elongate skink that occurs in a variety of shrubland and woodland habitats from Norseman in Western Australia east to the lower River Murray.

On the South Olary Plains survey numerous specimens were recorded from the western and southern parts of the area and as far east as the eastern edge of Calperum Station. The nearest S.A. Museum records are from Burra and Blanchetown to the south-west so these survey records have helped clarify the eastern edge of this species' range.

Photos of a range of reptiles and amphibians typical of the South Olary Plains survey area are shown in Figs 116-125.

DISCUSSION

Comparison of the South Olary Plains survey PATN analysis results with that of the Murray Mallee survey (conducted by this department in 1991) is not possible in detail as the latter's results have not yet been finalised. However, from preliminary analyses, it seems that the more northern Murray Mallee survey group is very similar to the current mallee species group and the more arid woodland group from the Murray Mallee is similar to the two South Olary Plains woodland groups. Overall however the Murray Mallee reptile groups contained species typical of slightly wetter habitats as would be expected.

These reflect a north-south (xeric/dry - mesic/wetter) gradient and an east-west gradient (related to soil changes). Only the northern groups had any similarities to those of the South Olary Plains:

The total number of reptile species known from the South Olary Plains (78 species) is comparable to the 77 species found in north-western Victoria (Robertson *et al.*, 1989) and that of the north-eastern deserts of South Australia (77 species) (Tyler *et al.*, 1990), but substantially more than the 50 or so species recorded on the Murray Mallee (S.A.) survey (unpublished data). However, in this latter area the remaining natural vegetation is much more degraded and large areas are cleared for agriculture. Menkhorst and Bennett (1990) report 95 species are known from the southern Australian mallee, but this includes areas in Western Australia which have a very high reptile diversity and consequently high level of endemism relative to the eastern mallee (ie E of Eyre Peninsula). Reptiles are a particularly prominent component of mallee fauna (Menkhorst and Bennett, 1990).

Conversely, the abundance of amphibians is low in mallee environments (Menkhorst and Bennett, 1990) and in this study they (10 species) occurred at similar levels to other studies; north-western Victoria - 10 species (Robertson *et al.*, 1989), southern Australian mallee - 11 species (Menkhorst and Bennett, 1989) and the Murray Mallee (S.A.) - 4 species (unpublished data).

Reptile species richness at quadrats on the South Olary Plains survey varied from one to 16, averaging 6.0 per quadrat. The only other study with which this can be compared is that of the Yellabinna survey (Armstrong, 1992) where an average of 6.9 species per quadrat was found in a very large and relatively undisturbed area of natural vegetation.

Biogeographic considerations

As discussed in previous chapters, the South Olary Plains is a transition zone between three South Australian regions: the Murray Mallee, the northern arid zone and the Mt Lofty-Flinders Ranges. On a national scale, the area represents an ecotone between the Bassian zoogeographic subregion, comprising temperate southern and eastern Australia, and the Eyrean subregion, encompassing the semi-arid and arid inland (Bennett *et al.*, 1989). However, more of the survey area lies in the Eyrean zone. Thus the South Olary Plains contains reptile species with affinities to both these major regions but predominantly Eyrean. In general, the mallee reptile fauna as a whole is more Eyrean than Bassian (Menkhorst & Bennett, 1990).

This area generally includes several genera which have speciated extensively in arid environments (e.g. *Ctenotus*, *Lerista*, *Ctenophorus*, *Diplodactylus*) (Menkhorst and Bennett, 1989).

The few typical Bassian species that occur on the South Olary Plains include the Four-toed Slider (*L. dorsalis*) and the Marbled Gecko (*P. marmoratus*).

Most of the reptile species found on the South Olary Plains survey were generally widespread e.g. Painted Dragon (*Ctenophorus pictus*), Bynoe's Gecko (*H. binoei*), Dwarf Skink (*M. greyi*), Common Snake-eye (*M. boulengeri*) and Sleepy Lizard (*T. rugosa*). A few species showed far western and/or southern distributions, being more mesic habitat dwellers: Southern Four-toed Slider (*L. dorsalis*), Mallee Snake-eye (*M. obscura*) and the frog *Neobatrachus pictus*. Several species occurred predominantly in the north-west of the area, as they prefer rocky outcrops and are more frequently found in the Mt Lofty and Flinders Ranges and Olary Spur: Tawny Dragon (*C. decresii*), Gidgee Skink (*E. stokesii*), Adelaide Snake-lizard (*D. molleri*) and Eastern Bluetongue (*T. scincoides*). [The last three of these are atypical of the South Olary Plains.]

There is known to be a low level of habitat specialisation amongst mallee reptilian fauna with most species utilising several habitat types (Menkhorst and Bennett, 1989). Seven reptile species have been described as endemic to mallee by Cogger (1989). Of these, three species occurred on the South Olary Plains: Barred Snake-lizard (*D. australis*), Mallee Dragon (*C. fordi*) and Sandplain Ctenotus (*C. schomburgii*). The first two showed a significant association with the mallee areas but the latter seemed to be more of a generalist, occurring in Blackoak woodlands and chenopod shrublands as well. However, Menkhorst and Bennett (1990) comment that only one or two reptile species are thought by some experts to be considered true mallee specialists.

On the South Olary Plains, other species also showed a preference for mallee habitats, particularly that with a Triodia understorey. These included the Beaded Gecko (*D. dameus*), Jewelled Gecko (*S. elderi*), Nobbi (*A. nobbi),* Mallee Dragon*(C. fordi*), Southern Spinifex Ctenotus (*C. atlas*), Eastern Ctenotus (*C. brachyonyx*), Rusty Earless Skink (*H. millewae*) and Spinifex Slake-lizard (*D. butleri*).

Those that generally showed a preference for woodland habitats were particularly the arboreal species: Tree Skink (*E. striolata*), Tree Dtella (*G. variegata*) and the wall skinks (*C. carnabyi/plagiocephalus*).

The most chenopod-preferring species appeared to be the Adelaide Snake-eye (*M. adelaidensis*), the Pink-blotched Gecko (*D. byrnei*) and the Eyrean Earless Dragon (*T. tetraporophora*).

Conservation considerations

Despite the enormous effect European settlement has had on the mammal species of Australia, reptiles and amphibians have not quite suffered to the same extent such that no species are extinct yet, but many are still threatened, endangered or locally extinct.

Cogger (1989) states that the effects of mallee clearing has resulted in the permanent loss of 70-95% of the original mallee herpetofauna. Ehmann and Cogger (1985) also note that in the Murray Mallee region of South Australia and N.S.W. the clearing of mallee lands since the mid 1960s has resulted in the permanent removal of 26 species from those areas. These figures are particularly pertinent for the agricultural region where habitat clearance is the key threatening process. In pastoral areas though, the effects of grazing (and altered fire regimes to a lesser degree) would have direct impact on reptiles. Cogger (1989) has recorded species diversity to be directly proportional to the structural complexity of the understorey vegetation. This vital stratum for reptiles has been substantially altered by overgrazing and changed fire regimes.

Other possible threats to reptile populations are predation by introduced carnivores, indirect poisoning from chemicals and perhaps more subtle effects such as soil-compaction (Stephens, 1992; Cogger, 1989). Much more research is needed to accurately assess the status of many species and populations and ascertain key threats.

Within the South Olary Plains a significant area of Blackoak and mallee woodlands are contained in Bookmark Biosphere Reserve (Danggali, Chowilla, Calperum). A number of quadrats from each of the three woodland and mallee habitat reptile groups occurred in Bookmark so these reptile communities are quite well protected. However, only isolated patches of chenopod shrublands occur in Bookmark and none of the survey quadrats exhibiting reptile species of chenopod habitats (Group 2) were found there. Reptile species of chenopod shrublands, claypans and open communities may not be sufficiently conserved in the South Olary Plains, but this will be better assessed in the forth-coming North Olary Plains biological survey where a much greater number of these habitats will be sampled.

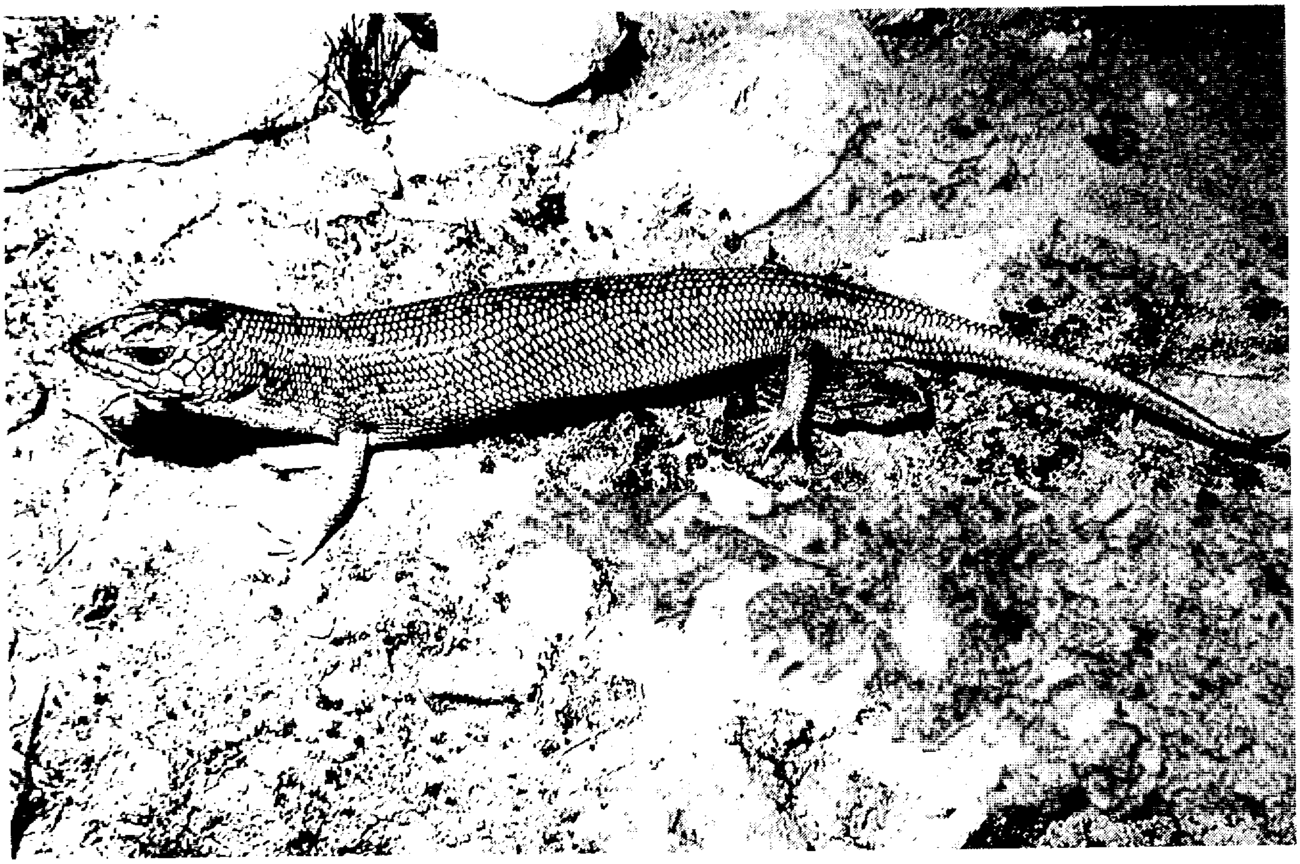


Figure 113
The Pigmy Bluetongue, *Tiliqua adelaidensis* thought to be extinct, was re-discovered during the South Olary Plains biological survey.
Photo: M. Hutchinson

Figure 114
The spectacular Marbled Velvet Gecko, *Oedura marmorata* has been found at several sites in Danggali Conservation Park.
Photo: M. Hutchinson

Figure 115
The Jewelled Gecko, *Strophurus elderi* lives exclusively in spinifex tussocks.
Photo: P. Canty

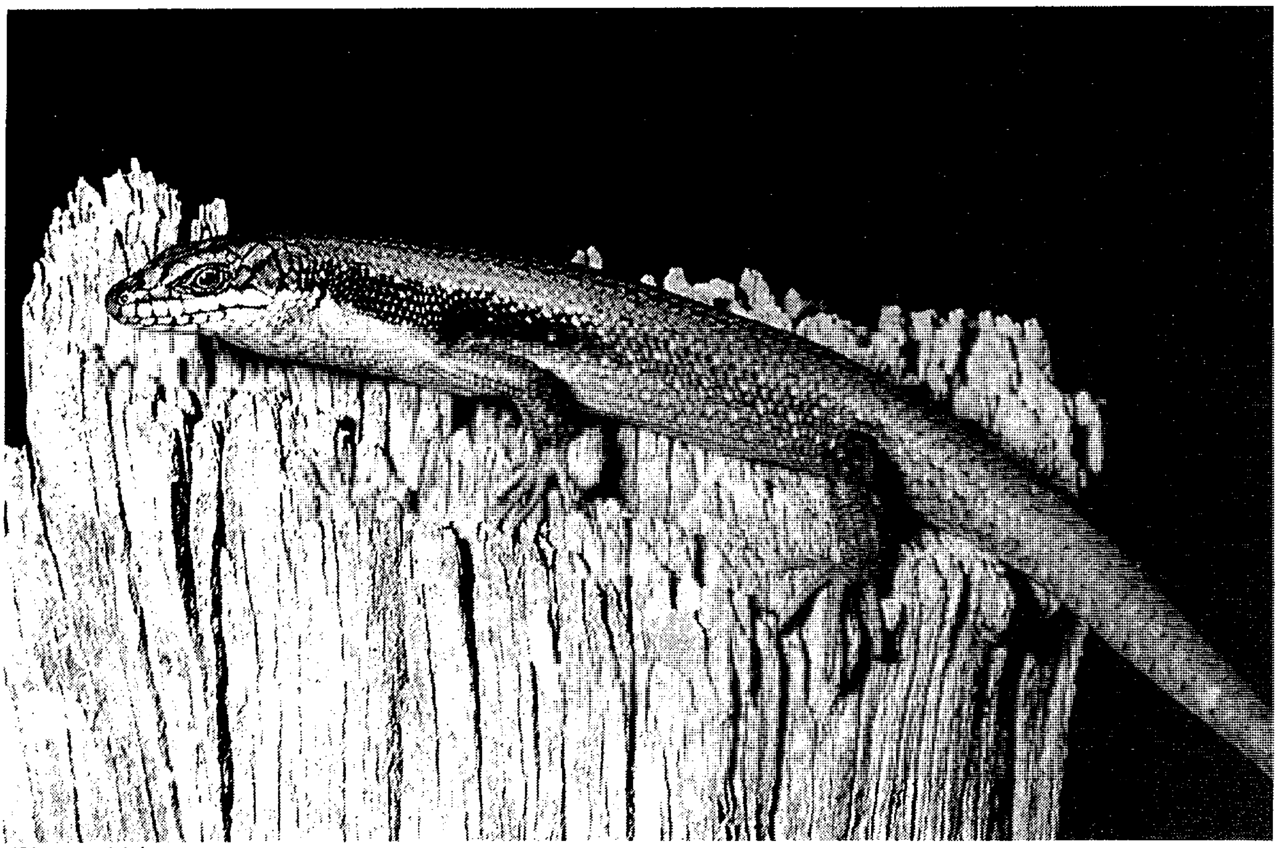


Figure 116
The Tree Skink, *Egernia striolata* prefers large mallee with hollow limbs in which it can live.
Photo: T. Morley

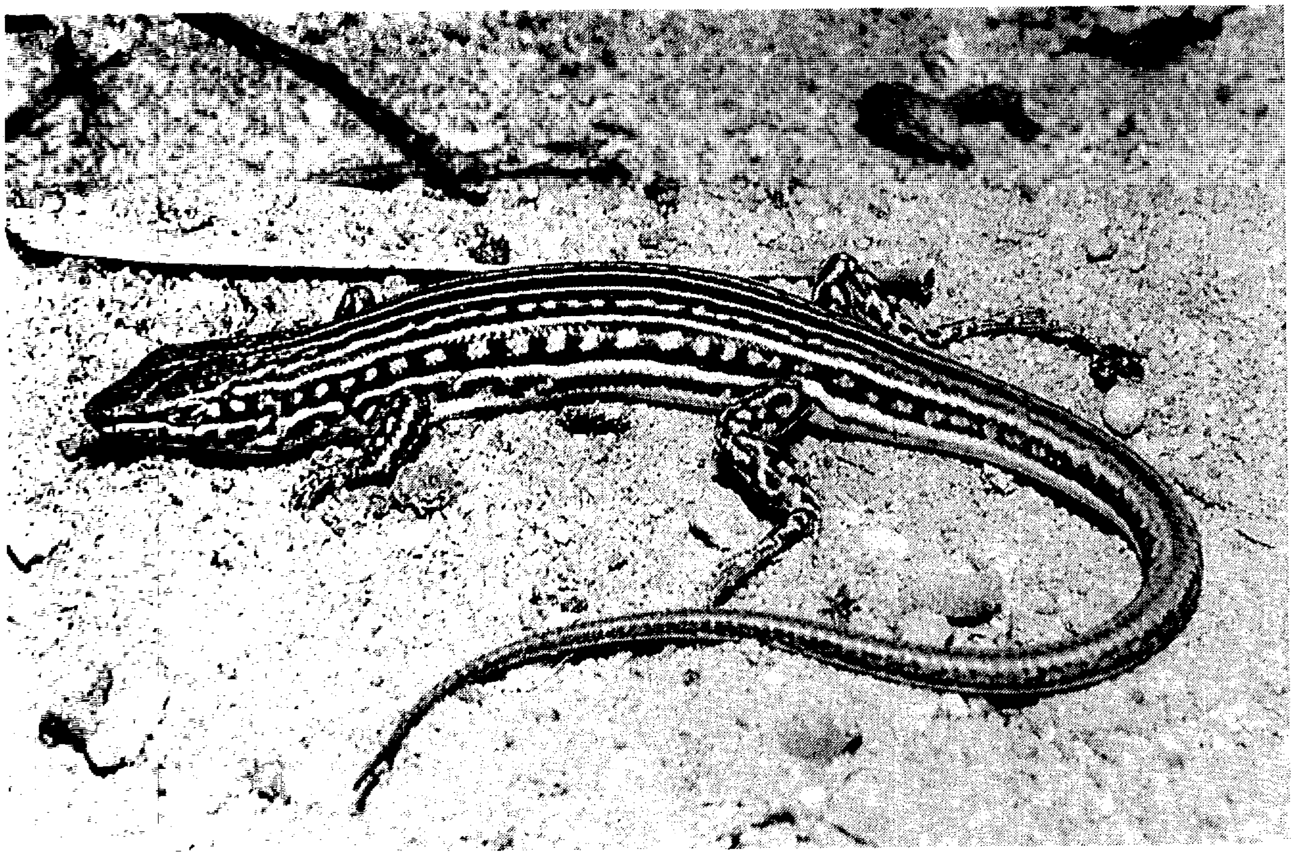


Figure 117
The Sandplain Ctenotus, *Ctenotus schomburgki* is widespread through the chenopod shrublands of the South Olary Plains survey area.
Photo: P. Canty

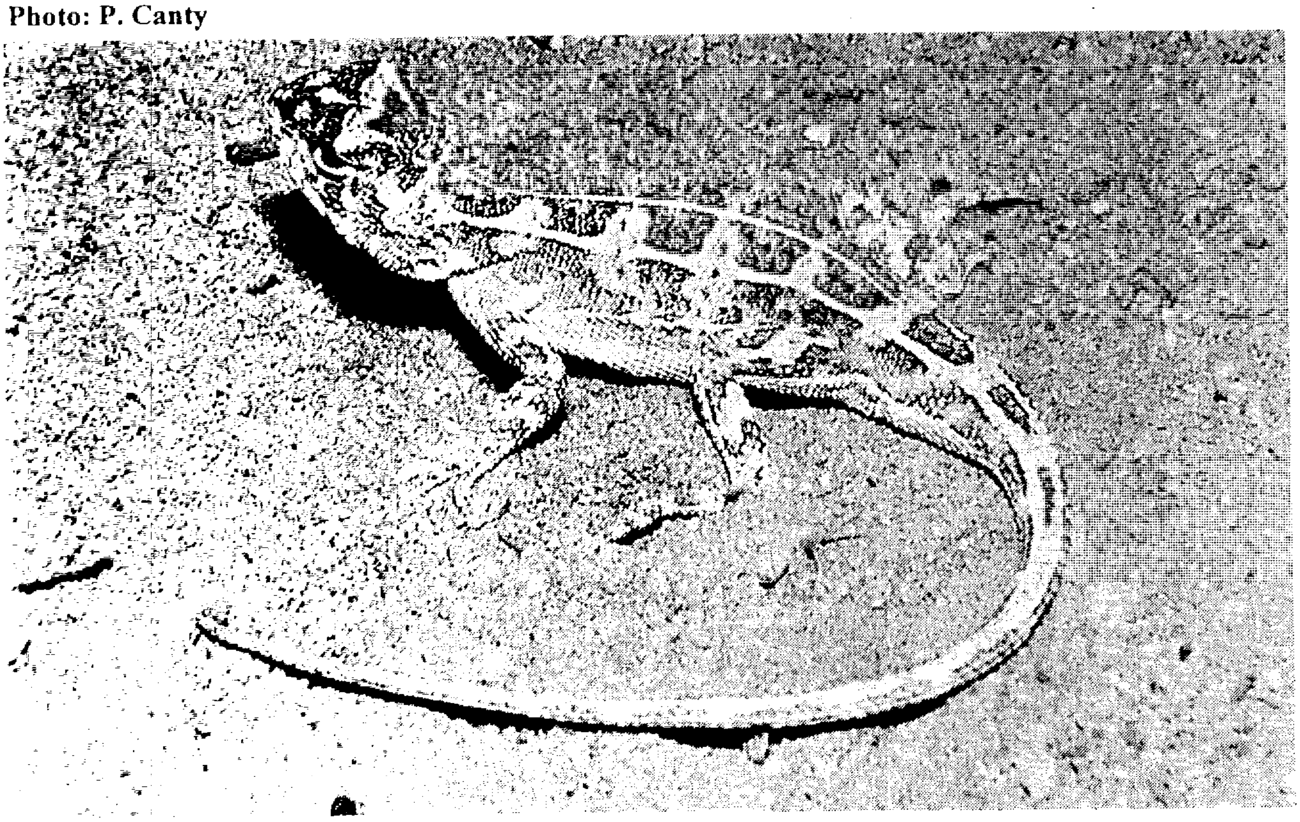


Figure 118
The Five-lined Earless Dragon, *Tympanocryptis lineata* relies on perfect camouflage against the stony surfaces it lives on
Photo: P. Canty

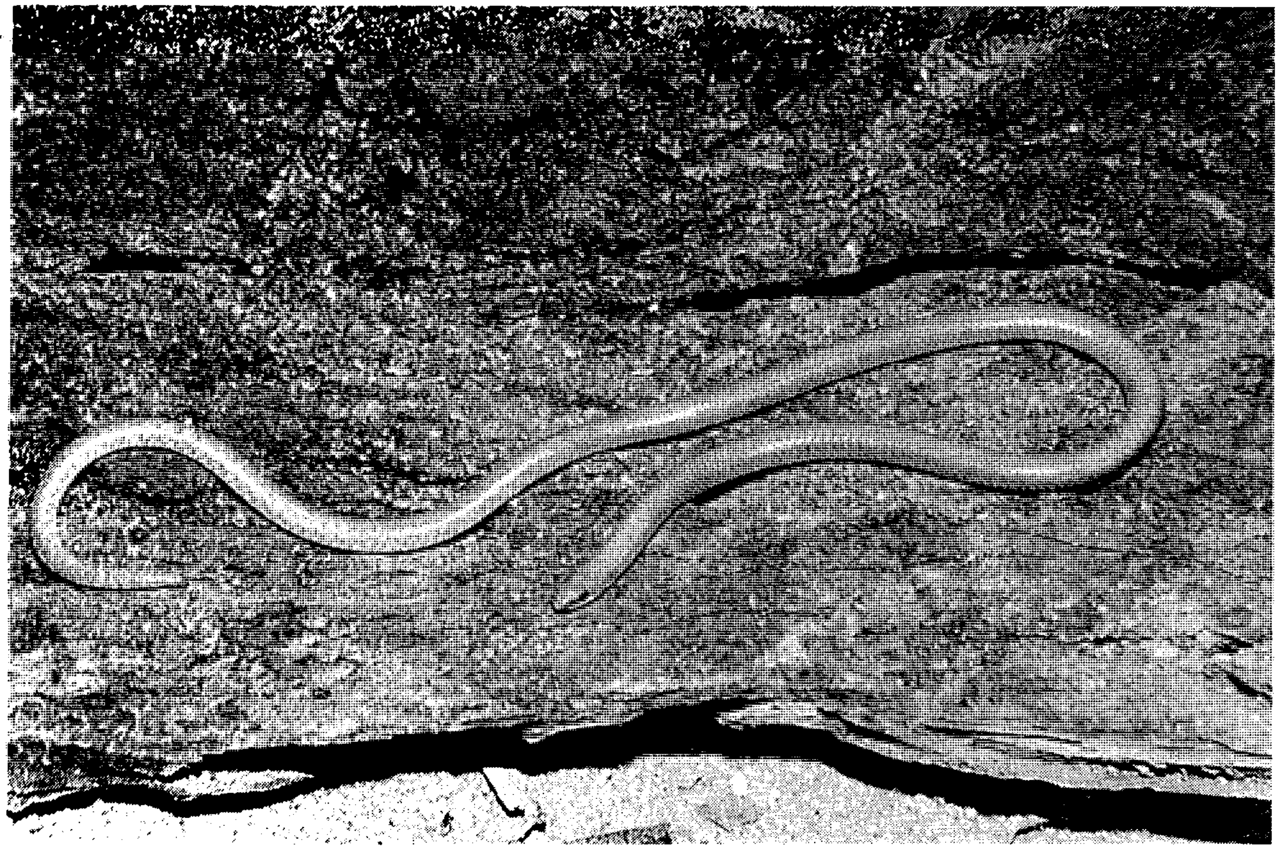


Figure 119
The Red-tailed Worm-lizard, *Aprasia inaurita* a burrowing species of the southern mallee
Photo: P. Canty

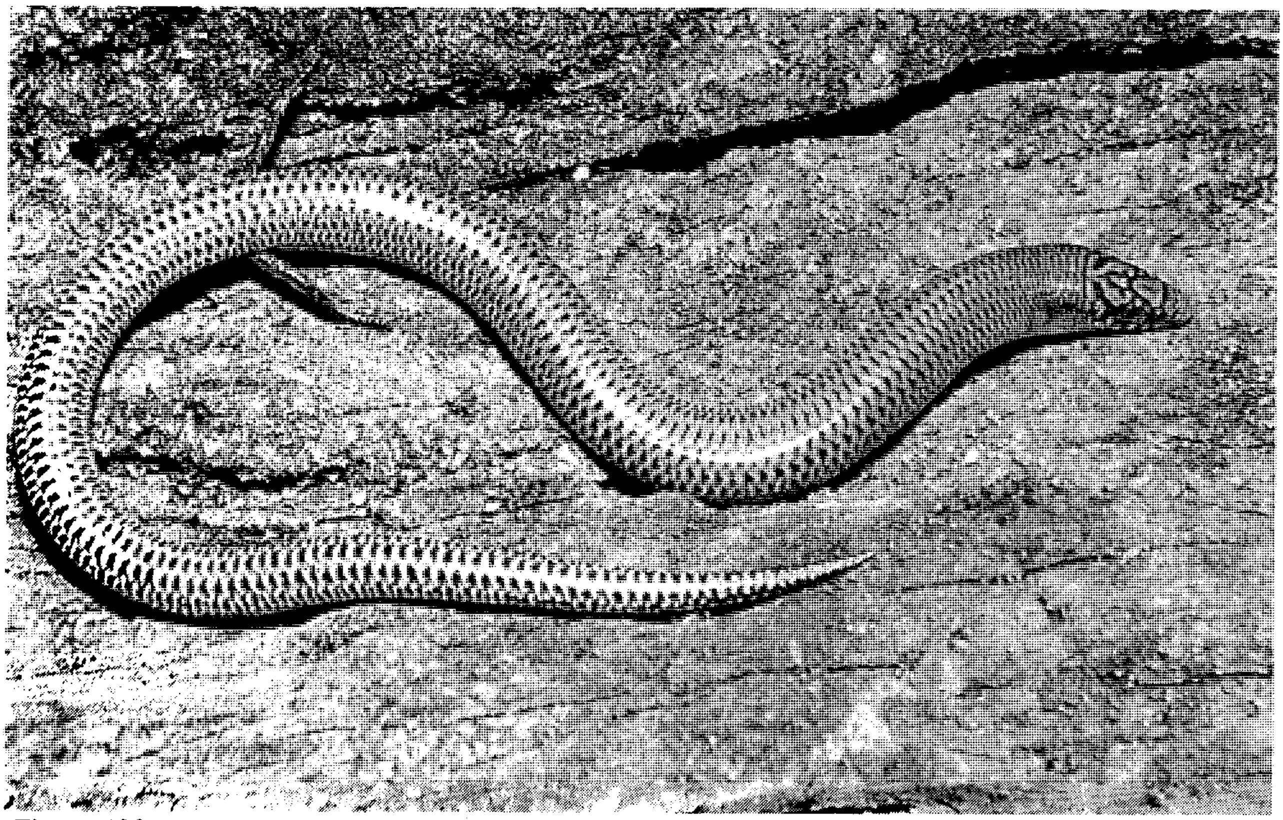


Figure 120
The Spotted Slider, *Lerista punctatovittata* is found in a variety of habitats where it burrows through the litter and soil.
Photo: P. Canty

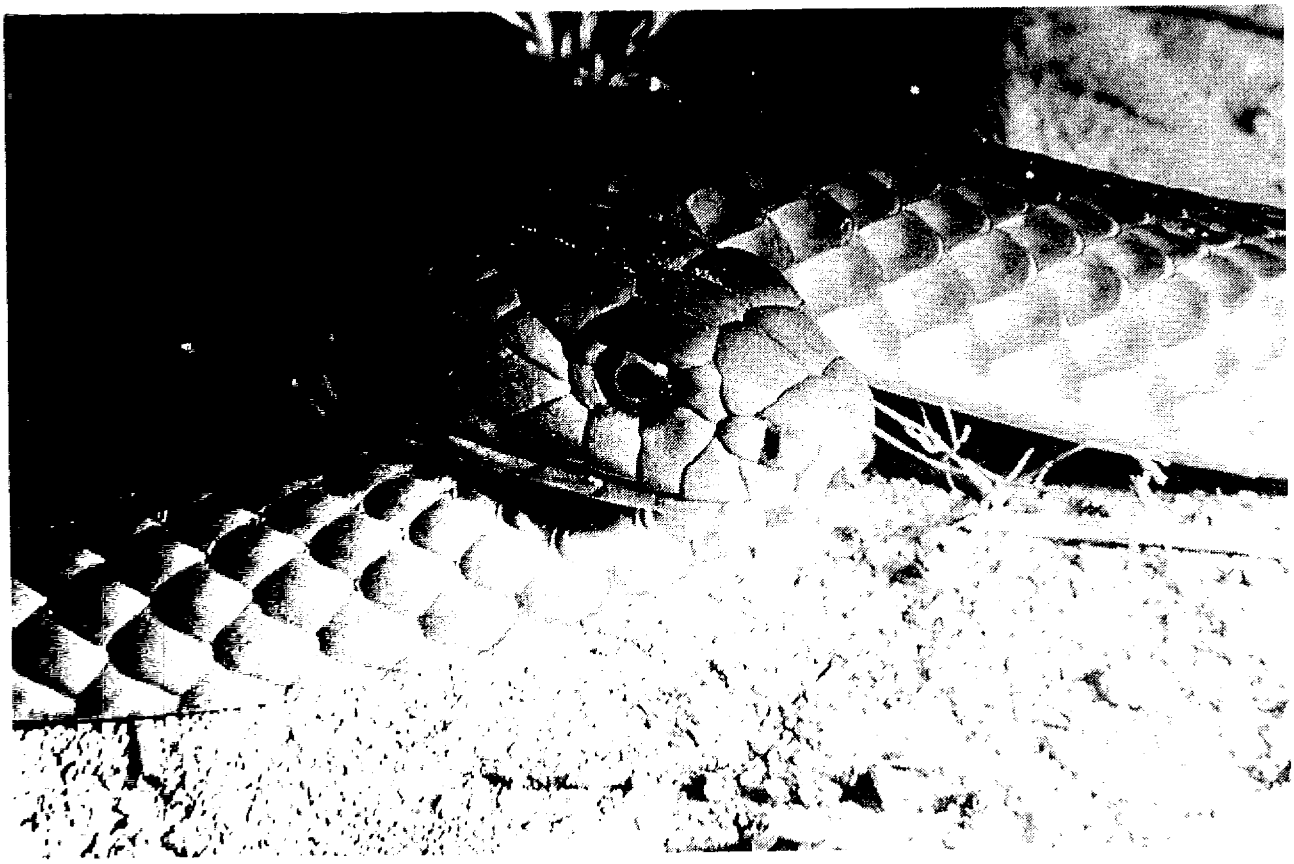


Figure 121
The Mulga or King Brown Snake, *Pseudechis australis* is common over much of Australia
Photo: T. Morley

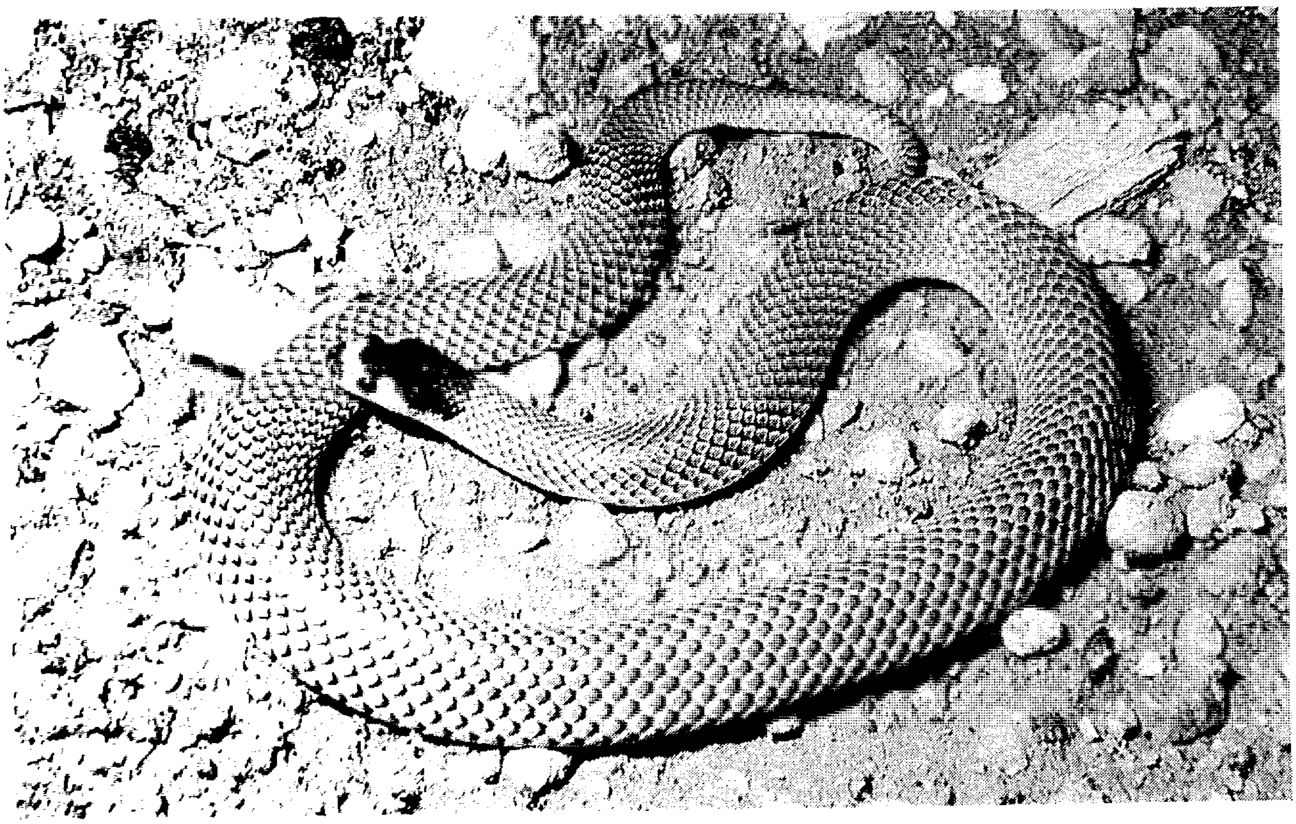


Figure 122
The Mallee Black-headed Snake, *Suta spectabilis* lives under logs or in leaf litter
Photo: M. Hutchinson

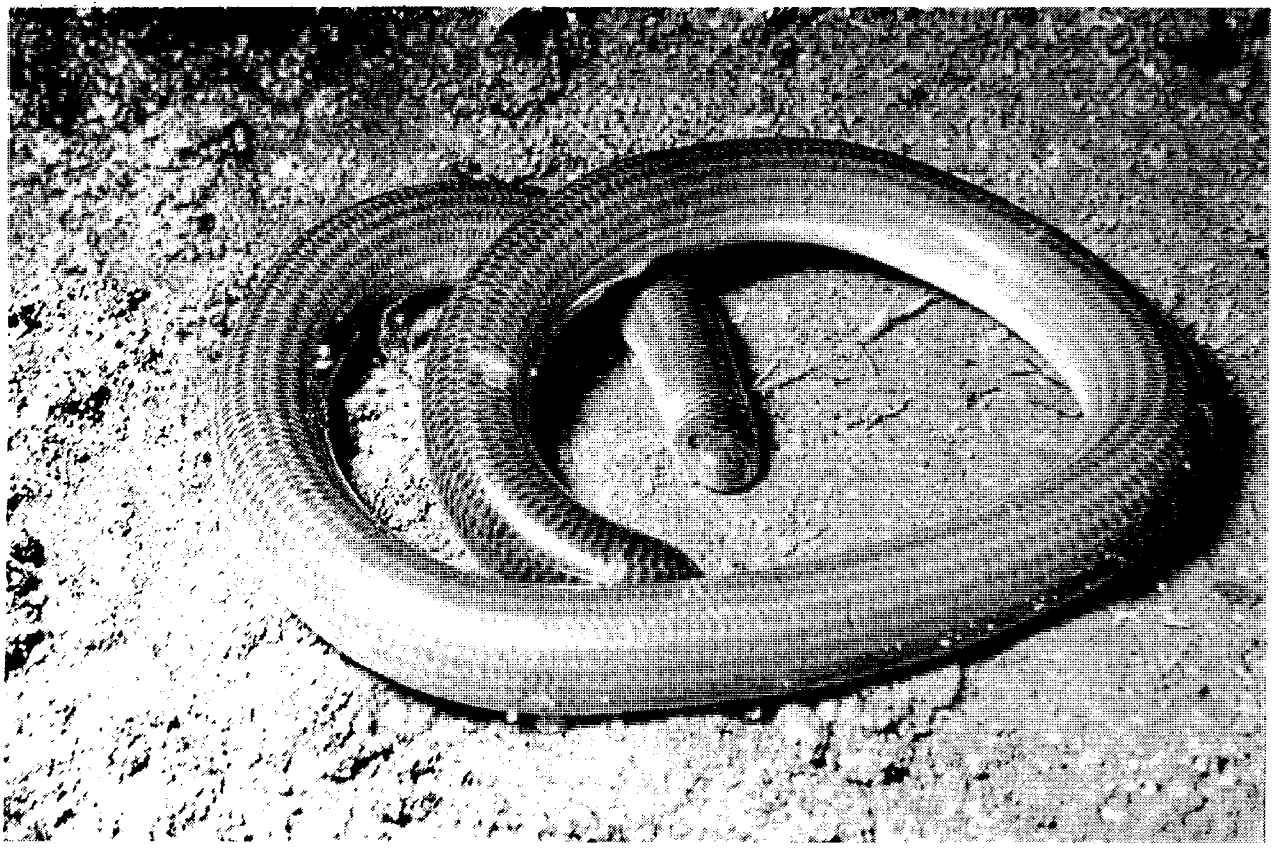


Figure 123
The Southern Blind Snake, *Ramphotyphlops australis* lives most of its life in the soil, only coming to the surface on rainy or humid nights.
Photo: T. Morley

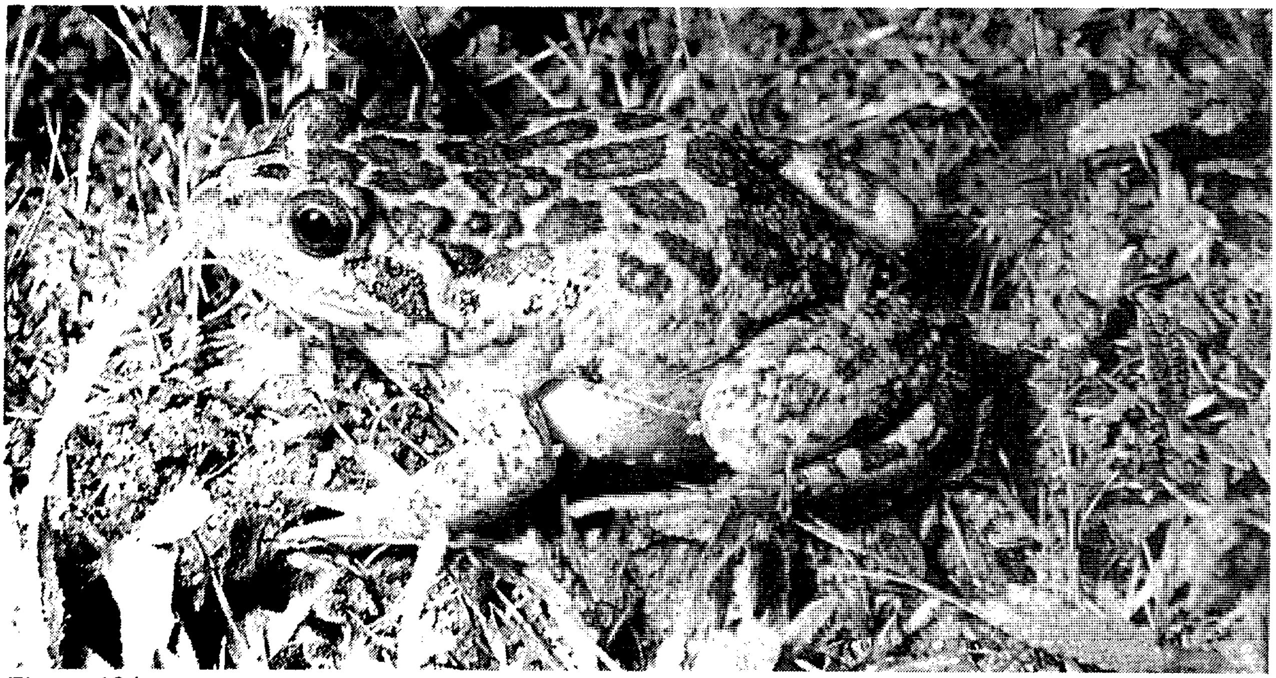


Figure 124
The Marbled Frog, *Limnodynastes tasmaniensis* is often found in dams well away from major drainage channels
Photo: T. Morley

Fire Ecology

by J. Morelli[1] and L.R. Forward[1]

INTRODUCTION

Mallee ecosystems are both fire-dependant and fire-promoting (Noble, 1989) containing plant species that have developed mechanisms or traits to cope with fire. Based on this, it would be reasonable to suggest that fire has the potential to be used as a management tool in the mallee regions of South Australia. Fire, however, is also regarded to be a 'natural' problem keeping in mind that unplanned frequent fires can have an adverse affect on vegetation communities.

To decide whether or not mallee plant species are able to cope with wildfires or prescribed burns it is essential that their fire response is adequately understood. To assess the fire responses of plant species, data needs to be gathered on the species' regenerative mechanisms, the time taken to reach reproductive maturity and to replenish seedbanks, rate of seedling establishment and species longevity. To date, these data are being collected and stored in national and state registers that serve as inventories or databases holding fire response information for individual plant species. This has also lead to the development of a prototype flora monitoring system by Gill and Nicholls (1989) which aims to observe the regeneration of plant species following a fire event.

AIMS AND OBJECTIVES

This section of the South Olary Plains biological survey aims to establish a preliminary review on mallee fire ecology, focussing on fire histories and the response of mallee plant species to fire within the South Olary Plains Environmental Region and to utilise the information to establish a similar monitoring system to that of Gill and Nicholls (1989). As explained in the Introduction chapter, the three-state *Mallee Fire Ecology* project involved the Victorian Department of Conservation and Environment, the New South Wales National Parks and Wildlife Service and CSIRO, Divisions of Plant Industry and Wildlife and Ecology (see Noble, 1992).

The objectives of the South Australian Mallee Fire Ecology project were:

1. To collate fire history information and map fires for the South Olary Plains, focussing on Danggali Conservation Park, Chowilla Regional Reserve and Game Reserve, Calperum Pastoral Lease and adjacent areas.
2. To collect data on fire response mechanisms and life histories of plant species which will contribute to national and state plant fire response registers.
3. To investigate, and recommend on, the establishment of a practical monitoring system for plant species prone to fire in the South Olary Plains.

BACKGROUND

The Study Area

The scope of this project was limited to fire-prone mallee/*Triodia* and mallee/shrubland communities and their component species. More specifically, this included the sandy dunefields of Danggali Conservation Park, Chowilla Regional Reserve and Game Reserve, and Calperum Pastoral Lease (together now known as Bookmark Biosphere Reserve). This area has a long history of sheep grazing (see Background chapter) and being a Biosphere Reserve, provides an ideal opportunity to establish long-term monitoring programs to measure factors relating to fire management and other habitat management issues.

National Plant Fire Response Register

A national register for the fire responses of plant species has been established by Gill and Bradstock (1992) and currently holds fire response information for approximately 3000 vascular plant species. The register has been set up as a national scheme, therefore, the work is part of a cooperative research effort conducted by all States. The South Australian Department of Environment and Natural Resources has a separate Fire/Plant Response Register previously referred to as the 'Plant Regenerative Mechanism and Life-cycle' Register, housed within the Wildlife Management Section of the Department of Environment and Natural Resources (see Choate and Casperson, 1993). This system is comparable to the

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national register so data can be combined or exchanged. To date, the South Australia database holds approximately 1700 records on a variety of heath, coastal and woodland plant species and is rapidly expanding. As an extension to this register, a database specifically for the mallee species of the South Olary Plains has been established and currently holds 502 entries.

The national and state registers categorise the responses of species to fires, but do not provide the basis for the prediction of population behaviour in relation to fire regimes in a detailed quantitative manner (Gill and Bradstock, 1992). Nonetheless, fire-sensitive species and those that are more tolerant to fire events can be indicated from the register information. The main purpose of the register is to identify the regenerative mechanisms adopted by species in order to persist after a fire. Basically, plants return after fire by seed or vegetative regrowth via basal buds, root suckers, rhizomes, epicormic shoots and/or aerial apical buds. The time taken for a species to recover sufficiently after a fire before it can tolerate a further fire can also be determined from the Register data, by identifying the time to first flowering. Some modelling of community response to fire is also undertaken using data from the Register (Forward, in prep). Currently, information collected for the national register is being assessed and used to develop practical monitoring systems for plant species prone to fire in conservation areas (Gill, 1992).

Monitoring Systems

Monitoring of fire effects is important for identifying any undesirable impacts that planned and unplanned fires may be having on natural ecosystems (Wouters, 1992). Even though monitoring has a crucial role in habitat management, it has been omitted in most conservation reserves partly because no practical system had been invented. This monitoring problem has been overcome by Gill and Nicholls (1989) who have designed a prototype monitoring system based on the idea of minimal data sets. This type of system has been established in the Nadgee Nature Reserve in south eastern New South Wales, the Big Desert and Sunset Country in the Victorian Mallee region, as well as in National Parks in Western Australia.

The most common question associated with monitoring is "what to monitor"? Monitoring systems in the past have tried to measure too many variables, but as Gill (1992) stated "the key to the design of effective, practical monitoring systems is knowing what is the minimal amount of observation necessary to obtain most of the needed information." For example, the monitoring systems are designed to monitor a minimal number of species (by selecting vulnerable species and those with no fire response information), at a minimal number of sites (chosen to include all species at least once or as many times as may be required), for a minimal number of years after fire using the minimal number of observation times per year to note the first time a species flowers (Gill and Nicholls, 1989). Within the South Australian Register, the time taken to reach reproductive maturity has been identified for each species so that it is no longer necessary to monitor, and the time is used to determine when seed replenishment is adequate for the species to persist at the site. Gradually, as knowledge of the responses of species in the 'unknown' category is gained the monitoring task is reduced.

METHODS

The workplan of this study closely follows that used in Victoria (Heislers and Yorston, 1992) and consists of the following three phases:

<u>Fire History</u>

Historical information on past burning practices was gathered and maps depicting fires from the 1970's to recent years for the study area were produced. The fire history of the study area was largely unknown with the exception of Danggali Conservation Park which had an existing fire history map. Consequently, much of the fire research was concentrated on Calperum, Chowilla and adjoining properties (Gluepot, Taylorville, Pine Valley, Quondong, Parcoola, Hawks Nest and Teonga). Fire history maps were compiled using South Australian National Parks and Wildlife Service fire records, newspaper articles, aerial photographs, aerial photo-mosiacs and satellite imagery which provided an adequate indication of the number, location and extent of fires in the region. Together, the aerial photographs and satellite imagery covered the years 1975 to 1994, but were not available for every year which caused difficulties in assessing exact fire ages. An account of the region's fire history of the 1930's to 1970's was gathered from consulting with park rangers and former pastoral managers. This aided in collating historical documents on past fire regimes (i.e. frequency, intensity and season of burn).

<u>Plant Species Response to Fire</u>

Existing plant species response data and life history information was collated and assessed. Conservation and Park Management students of the University of South Australia have collected data at five burned study sites within Danggali Conservation Park from 1986 to 1994 (SACAE, 1986; University of S.A., 1988-92; Morelli, 1990; Donovan, 1990). This data was primarily used to initiate the establishment of a plant regenerative mechanism and life-cycle register specifically for the South Olary Plains which was combined with current data in the South Australian plant fire response register. This helped determine the amount of plant response information available for a variety of mallee community species and identified those that lacked fire response information.

A winter survey was carried out in Danggali and Calperum at sites of known fire history to obtain additional information on plant species response to fire. Data was collected using standard data sheets and included recording height class, height class abundance, regenerative mechanism, seedling recruitment, presence/absence of buds, flowers or fruits and abundance of buds, flowers and fruits for each species examined (Choate and Casperson, 1993).

Monitoring

This phase involved investigating the establishment of a monitoring system for the South Olary Plains study area based on the minimal data set method described in Gill and Nicholls (1989). Unlike other States, where a minimal data set analysis has been carried out to determine a suite of monitoring sites, time and money constraints prevented the same being done for the current South Australian project. In spite of this, using site-specific vegetation data from the South Olary Plains biological survey an initial set of monitoring sites have been hand-picked for Danggali, Chowilla and Calperum. This entailed identifying the number and location of appropriate monitoring sites and target species to be monitored. Monitoring sites were selected and evaluated in terms of their representation of dominant plant species, vegetation communities, fire histories, existing permanent study sites and accessibility. Species chosen to be monitored include the native perennial species described by the South Olary Plains Survey. Priority was given to those perennial species that have no data or inadequate fire response information, and to those that are most vulnerable to local extinction. A set of characteristics for selecting plants vulnerable to fire disturbances include, obligate seed regenerators, short-term seed viability, and late flowering and seed maturing (Wouters, 1992). Generally, these characteristics cause the species to be fire-sensitive and intolerant of high fire frequencies. Plant species with some or all of these characteristics also make good indicators of community health or condition (Wouters, 1992). Plant species whose conservation status is listed as either rare, vulnerable or endangered in South Australia were also important to monitor.

RESULTS AND DISCUSSION

Fire History

The fire history has been mapped for the south-eastern South Olary Plains region which covers the Canopus, Lilydale, Chowilla, Parcoola, Renmark and Moorook 1:100 000 mapsheets (Map 2 in pocket of this report). The map was digitised by the Geographical Analysis and Research Unit of the Department of Housing and Urban Development using ESRI Arc/Info. The fire history of Calperum, Chowilla and neighbouring pastoral properties was less comprehensively documented than that of Danggali as most of the fire dates are only estimates. The earliest fires mapped date back to 1973, with the latest being 1988. Fires earlier than the 1970's have been recorded but not mapped due to time constraints and the unavailability of aerial photographs for that time period.

Danggali Conservation Park

The fire history of Danggali Conservation Park has only been accurately documented since its Government acquisition in 1976 (SACAE, 1986). Therefore much of the early fire records have been obtained from landholders. Local people recall large intense fires in 1917 and during the 1930's, 1940's and 1950's. According to local lore, the fire which occurred in the 1930's burned an area of approximately 260 square kilometres in the southern region (SACAE, 1986). The fires of December 1950 started at a woodcutters camp in tall spear grass and spread through Danggali and neighbouring properties (R. Taylor, pers. comm.). These fires lasted for two weeks (Neville Taylor, pers. comm.) and burned vast areas of the South Olary Plains, from Morgan to over the New South Wales border. Without aerial photographs these fires could not be mapped with certainty.

The earliest fire mapped for Danggali was the 1974 fire located northwest of Hypurna. Since then, fifteen fires varying in age, intensity and size have been recorded and digitised. There have been no recent fires since 1988. The most notable large-scale fires recorded for Danggali occurred during the 1984/85 fire season. The Oakvale rainfall records show that in 1983 heavy rains fell over most of the pastoral country, thus promoting abundant growth of spear grass and other ephemeral herbs and grasses. This was followed by dry conditions during the summer of 1984/85 which cured the vegetation providing a continuous high fuel load. In the period of November to January, five fires were started by lighting resulting in the majority of the north-western section of the park being burned. In the same season, a further four fires started in the southern part of the park. These fires were significantly smaller in size and less intense. In total, the 1984/85 fires burned 56 000 hectares of native vegetation (*The Australian*, Jan. 1985) which represents 22% of the total area of the park. In December 1985, another wildfire fanned by westerly winds burned 20 000 hectares of mallee and was contained by a backburn along the park's eastern boundary.

It is estimated that in the last twenty years or so, fires have occurred somewhere in Danggali at an average of one every 2.5 years and have been reasonably small in size with the exception of the 1984/85 fire. Although Danggali appears to have a relatively high fire frequency, there are areas in the southern parts of the park that have not been burned for almost forty to fifty years. A long absence of fire is indicated by the presence of single-stemmed mallees in this area of the park. The 1984/85 fires demonstrate that the park is able to sustain large wildfires when certain conditions prevail. Nevertheless, it seems that under normal conditions high proportions of the park are not usually burnt in any single wildfire nor is there a high chance of an area being burned more than once in a short interval of years.

Calperum Pastoral Lease

The earliest fires recollected by pastoral managers in Calperum occurred in the 1930's and 1950's which burned parts of the station. The majority of fires have occurred during the 1970's and 1980's, the most recent being in 1990 near Paringa, which was started by a camp fire (D. McNaughton, pers. comm.). During the 70's and 80's, fires were deliberately hand lit by pastoral managers in the winter months creating mostly small, low intensity burns. Fires were usually lit from vehicle tracks and left to burn virtually unhindered throughout the day (D. McNaughton, pers. comm.). The fires would gradually extinguish at night, however, on a few occasions, some did not burn out and continued to spread inducing wildfire situations. From discussions with pastoralists it was evident that mallee/*Triodia* communities are regarded as 'poor' or 'non-productive' vegetation due to its inadaquency to produce sufficient feed for sheep. For this reason, these communities were burned to promote the growth of ephemeral grasses for sheep grazing. Fires were also ignited to mark junctions of tracks which served as distinguishable landmarks for easy relocation (D. McNaughton, pers. comm.).

The largest wildfire in Calperum originally started in Hawks Nest Station sometime between 1976 and 1978. The fire burned extensive areas of dunefields dominated by mallee/*Triodia* vegetation communities. The area of this fire is distinguishable today by numerous stands of Desert Poplar, *Codonocarpus cotinifolius*, growing on dune crests and that have reached heights of ten to twelve metres. Desert Poplar is an indicator species which recolonises immediately after a fire event through seed stored in the soil. Although this species is thought to have relatively short life spans of approximately ten to fifteen years (see Donovan, 1990) signs of persistence is still evident at this burned patch. This was also apparent at a Danggali survey site where the species was found to be regenerating 6.5 years after a fire (University of South Australia, 1992). The growth of Desert Poplar is dependant upon climatic events rather than seasonal changes, so age is difficult to determine (Pate *et al.*, 1985, in University of South Australia, 1992).

In overview, the frequency of fires in Calperum is similar to that of Danggali. Although, most fires in Calperum have been deliberately lit, whereas in Danggali fires have occurred under natural conditions. Fires have mainly occurred in the southern parts of Calperum whereas in the north and north-western portions, including Yubalia, fires are almost absent. It is unsure why fires have been more frequent in the south, but there are two possible reasons. Firstly, the region may not be particularly prone to lightning strikes and secondly, the northern area was not maintained as regularly by pastoral managers, so less fires were hand lit (David McNaughton, pers. comm.).

Chowilla Regional Reserve and Game Reserve

There is no historical evidence to suggest that wildfires were a common occurrence in Chowilla or that landholders burned the region at the same frequency as the managers who maintained Calperum. According to former pastoral managers the region has not experienced a fire in the last twenty years. However, fires were not totally absent from Chowilla as there have been occasional early fires. For instance, the majority of the area was burned during the 1950 wildfire, some of which was subsequently burned in the 1960's. Pastoral managers acknowledged that during the mid 1960's there were two fires which both occurred in the southern parts of Chowilla. In 1964 an area of scrub was chained and burned by hand to remove large mallees (A. Grove-Jones, pers. comm.). This fire can be identified by the large uprooted mallee stumps and age of mallee regrowth. A portion of the 1964 fire area was re-burnt in 1974 and this fire spread into Calperum. In the same year, lightning caused a fire to burn an area west of Paradise Station (now part of eastern Chowilla) (A. Grove-Jones pers. comm.). Since this particular fire, there have been no following fires.

In comparison to Danggali and Calperum, the frequency of fires in Chowilla is significantly less. For example, fires have occurred on average every fifteen years. The irregular nature of Chowilla's fire events suggest that wildfires are not generally a major concern, but high river levels and sporadic rainfall events can result in vegetation flushes and local high fuel loads which initiate wildfire conditions. Furthermore, dry electrical storms are frequent events in the December to March period and can provide a sources of fire ignition (Department of Environment and Natural Resources, 1993).

Other Pastoral Properties (see Figure 29 for locations)

Taylorville Station, adjacent to Calperum, has had a long history of burning, rendering it the most frequently burned in the area. A large area of leases 2111 and 2511 and the northern section of lease 2513 was burned in the 1950 fire that spread through most parts of the south-eastern South Olary Plains (R. and N. Taylor, pers. comm.). Throughout the 1960's, pastoral managers recall regularly lighting a series of small fires. The pastoralists burned less country during the 1970's in response to current regulations that prohibit lighting fires. Unlike in Calperum, the pastoralists preferred to light fires in the months of February and March. Dense mallee and porcupine country was burned to increase grass growth for sheep. The entire area of lease 2514, except for a portion of country in the south east corner, has had fires between the years 1973 and 1988. Some of this area has been burned up to three times since 1939 (R. Taylor, pers. comm.). In leases 2514, 2518 and 2513 the majority of fires have occurred between 1975 and 1981. A gap in years in the aerial photographs and satellite imagery has prevented the exact age of these fires to be identified. The most recent fire occurred in 1991 and was caused by a lightning strike. This fire burned quite a large area of dense mallee/*Triodia* country within lease 2514 (R. Taylor, pers. comm.).

Less detailed fire records are available for other pastoral properties such as Parcoola, Quondong, Teonga, Gluepot and Pine Valley. Most of these properties were partially or totally burned during the 1950 fire season (R. Taylor, pers. comm.). As shown on the fire map (Map 1), the most significant fires occurred on Pine Valley Station. In November 1977, a lightning strike caused a fire to ignite within Quondong Station which spread into Pine Valley. The South Australian National Parks and Wildlife Service fire records state that the fire burned 50 000 hectares of mallee/*Triodia* country but was suppressed before reaching the Danggali Conservation Park boundary. Apparently, the pastoral manager recalls that this area was previously burned in 1968. The latest fire occurred in 1985, starting just within Danggali's western boundary and spreading into Pine Valley.

Plant Species Response to Fire

The 72 South Olary Plains survey sites within Danggali, Chowilla and Calperum revealed a total of 141 perennial native plant species. These species have been classified into thirty-four vegetation communities (see Vegetation chapter). A summary of the data entered into the South Olary Plains plant species fire response register is shown in Table **23**. On examination of the data, fire response information of 66 plant species have so far been characterised. The time taken for a species to reach first flowering has been identified for 45 species and the regenerative mechanisms of 48 species have been identified. The 24 species highlighted in Table **22** have complete fire response records, that is, both age to first flowering and recovery strategies have been recognised. These particular species are not required to be further monitored and thus have not been incorporated into the monitoring system for the study area.

From the total 66 species listed in Table **23**, 7 species vegetatively resprout after fire, 30 species are obligate seed regenerators, 17 species adopt both strategies, while the remaining 12 species have unknown responses. Typical regenerative strategies of *Eucalyptus* spp. and *Callitris verrucosa* are shown in Figures 123 and 124 For monitoring, only species with inadequate fire response and/or life history information and those with non-vegetative recovery mechanisms were considered. Plant species of special interest considered for monitoring include Nealie, *Acacia loderi* which is classified rare in South Australia. Altogether, from the total 141 species there remains 117 species yet to be further investigated. These monitoring species represent most of the dominant flora surveyed within the South Olary Plains.

Table 23
Fire/Plant Response Register of South Australia (1995) data on species fire response information for the south-eastern South Olary Plains
N = number of plant fire response register records (although not all include regenerative mechanisms)
Species highlighted have complete fire response records (i.e. regenerative mechanisms and age to first flowering)

Species	N	Age to first flowering (yrs)	Regenerative mechanisms					
			1	2	5	6	8	Unk.
Acacia burkittii	24	2.4		*	*			
Acacia colletioides	10	2.4		*	*			
Acacia ligulata	7	-		*				
Alectryon oleifolius ssp. canescens	3	-		*	*			
Atriplex acutibractea	1	3.4						*
Atriplex stipitata	7	3.4		*				
Baeckea crassifolia	4	2.4					*	
Beyeria opaca	18	2.4		*				
Beyeria lechenaultii	1	2					*	
Brachycome ciliaris var. lanuginosa	1	3.4						*
Callitris verrucosa	2	-					*	
Cassinia laevis	1	3.4						*
Chenopodium desertorum	5	2.4						*
Chenopodium nitrariaceum	1	4.3						*
Codonocarpus cotinifolius	8	3.4		*				
Daviesia genistifolia	1	-		*				
Daviesia benthamii ssp. humilis	1	-					*	
Dianella revoluta	1	6			*			
Dissocarpus paradoxus	3	-		*				
Dodonaea viscosa ssp. angustissima	12	5.4		*	*			

Duboisia hopwoodii	22	2.4		*				
Einadia nutans	1	3.3						*
Enchylaena tomentosa var. tomentosa	9	2.4		*				
Eremophila glabra	22	2.4		*	*			
Eremophila scoparia	15	3.3		*	*			
Eremophila sturtii	10	-			*			
Eucalyptus dumosa	15	6.4		*	*			
Eucalyptus gracilis	11	3.3		*	*			
Eucalyptus incrassata	7	2.5		*	*			
Eucalyptus leptophylla	2	-			*			
Eucalyptus oleosa	4	6.4		*	*			
Eucalyptus porosa	1	4.3			*			
Eucalyptus socialis	19	2.8		*	*			
Eutaxia microphylla	6	-		*				
Goodenia willisiana	1	2.8					*	
Grevillea huegelii	6	-		*	*			
Hakea leucoptera	4	-		*				
Halgania cyanea	10	2.4		*				
Lepidosperma viscidum	1	-	*	*	*			
Logania nuda	2	4.3						*
Lomandra effusa	2	-			*			
Maireana georgei	6	4.3		*				
Maireana trichoptera	1	2.4		*				
Maireana triptera	7	3.4		*				
Melaleuca uncinata	1	-	*	*	*			
Myoporum platycarpum	9	-		*	*	*		
Olearia decurrens	2	-		*				
Olearia pimeleoides ssp. pimeleoides	9	6.4		*				
Olearia subspicata	5	6.4						*
Pittosporum phylliraeoides	1	-					*	
Ptilotus exaltatus var. exaltatus	7	-		*				
Rhagodia spinescens	6	2.4		*				
Salvia verbenaca	1	3.4						*
Scaevola spinescens	2	-			*			
Sclerolaena diacantha	7	-		*				
Sclerolaena obliquicuspis	5	2.4		*				
Sclerolaena parviflora	4	3.4						*
Sclerolaena uniflora	2	2.4						*
Senna artemisioides ssp. coriacea	12	3.4						*
Senna artemisioides ssp. petiolaris	15	2.7		*	*			
Solanum coactiliferum	8	2.4		*				
Triodia irritans	16	2.7		*	*			
Westringia rigida	6	2.4			*			
Zygophyllum apiculatum	6	3.4		*				
Zygophyllum billardierei	1	1		*				
Zygophyllum eremaeum	2	-		*				

[†]Regenerative mechanisms codes (adapted from Gill (1992):

100% scorch 'kills' plants and:

1 = seed storage on plant pre-fire (eg. woody seed capsule);
2 = viable seed stored in soil pre-fire;
3 = no seed storage in burnt area (eg. wind, water or bird-dispersed);
8 = seed status unknown.

Plants survive 100% scorch by:

4 = root suckering;
5 = basal resprout;
6 = epicormic shoot response;
7 = outgrowth of large apical bud;
9 = vegetative response unknown.

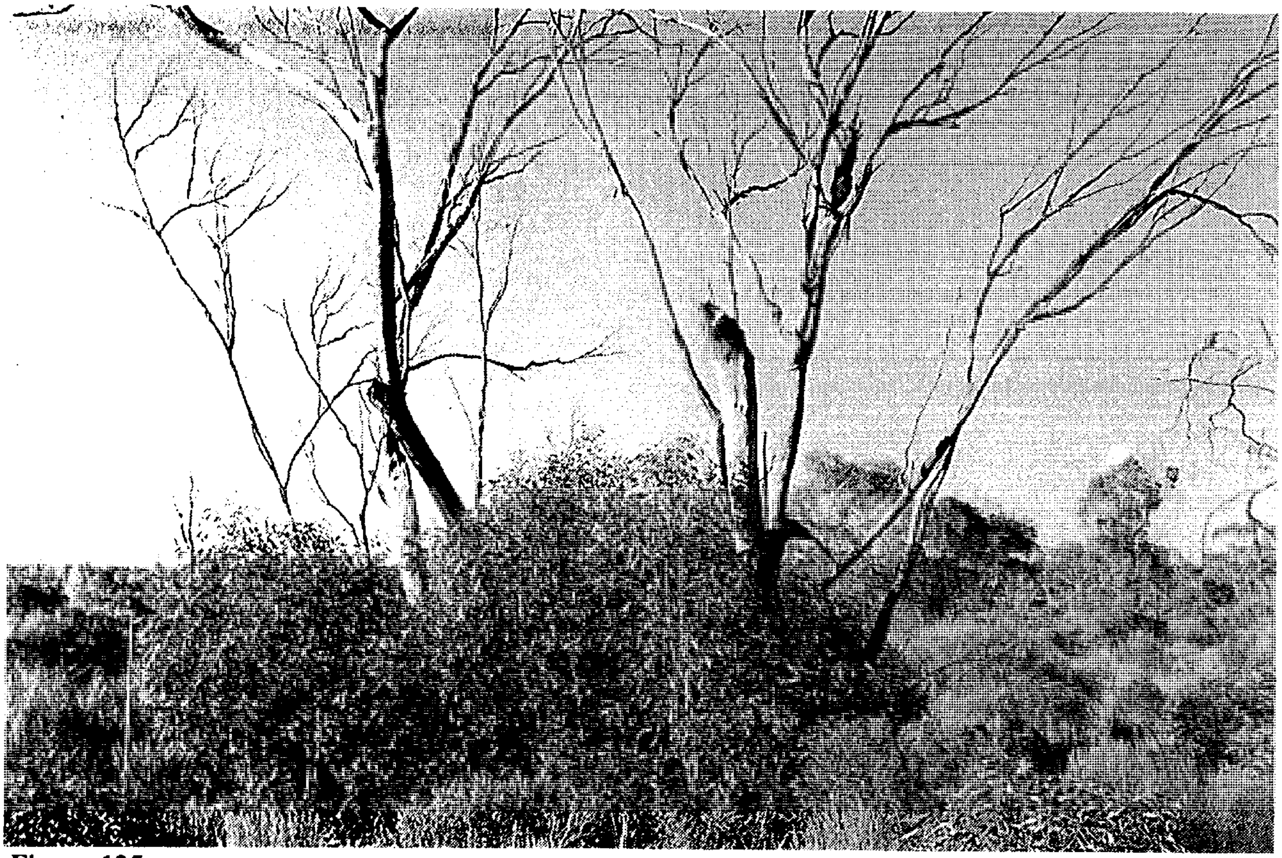

Figure 125
Basal resprout of *Eucalyptus* sp. six years after the 1988 fire on Danggali Conservation Park

Figure 126
Seedling recruitment of *Callitris verrucosa* 16 years after the 1979 fire on Danggali Conservation Park

The Monitoring System

The monitoring system for the South Olary Plains was established as a long term strategy for obtaining plant fire response information with minimal survey effort. The system is based on the plant species, vegetation communities and study sites derived from the South Olary Plains survey. The main purpose of monitoring is to reveal the regenerative status of all plant species present so that planned fires may be initiated, or unplanned fires suppressed, according to current species condition. Furthermore, monitoring will aid park managers to detect any unexpected changes that may occur in plant populations.

Selection of Monitoring Sites

By choosing a minimum number of sites, from the 72 available, a total of 29 sites were needed to record the 117 'monitoring species' at least once (Table **24**). Although a species may occur at many sites, choosing to assess a species at only one site reduces the monitoring task (Gill and Nicholls, 1989). From the 29 sites selected, 9 were permanently marked and had photo-points established on the South Olary Plains fauna survey. The other 20 sites, sampled only on the vegetation survey, were not permanently marked but are relocatable using AMGs and mud maps. The monitoring sites are located in 13 different vegetation communities reflecting the range of vegetation communities and floristics present. The sites selected and species to be monitored at each are shown in Appendix **XIII**. The live fuel types of the monitoring sites vary from highly flammable litter-grass-shrub types to scarcely flammable semi-succulent shrub types

Table 24
South Olary Plains survey sites selected for plant species fire response monitoring
'†' denotes sites permanently marked

Location	Site Numbers
Danggali Conservation Park	DA9901†, DA0101, DA0201†, DA0301, DA0302, DA0602, HY0301
Calperum Pastoral Lease	FJ0101, FJ0102†, FJ0302†, FJ0303, FJ0401,FJ0402, FC0102, FC0201, WT0101†, WT0102, YT0101, YT0201†, YT0302†, YB0101, TM0101,TM0301, HW0103, HW0202
Chowilla Regional Reserve	HY0601, JH0302†, PA0102†, PA0202

Monitoring sites dominated by plants not prone to promote or carry fire, such as *Callitris* sp., *Casuarina* sp., and chenopods, have been included because there is a chance that the vegetation could provide sufficient fuel to enable fires to spread after exceptionally good seasons and subsequent hot and windy conditions. In reference to the region's fire history, it is likely that all the monitoring sites were burned during the 1950 fires that scorched immense proportions of pastoral country. With the exception of site DA9901, which was burned during the 1984/85 fires, all other sites have not received a recent burn.

In addition to the initial set of monitoring sites, the 27 permanent study sites established and re-assessed in Danggali Conservation Park by the University of South Australia could also serve as monitoring sites if subjected to a fire.

The Monitoring Procedure

Monitoring begins at a site soon after it is has been burned. The aim of each visit to the selected monitoring sites following a fire is to record the immediate fire response for each plant species and identify when a species begins to produce flowers or fruits. This information can be obtained through routine plot inspections by trained staff or other interest groups. The use of the standard plant species fire response data sheet (Choate, 1993) is recommended to record information in a clear and efficient manner. At permanent sites, photographs should be taken recording the condition of the vegetation at different stages of recovery. As monitoring proceeds, further species can be dropped from the program on the basis that enough information has been gathered on their regenerative mechanisms and their regenerative status has become adequate to ensure their persistence in the event of another fire.

Collecting Regenerative Mechanisms Data

Generally, the regenerative mechanisms of species can be identified within the first two to three years post fire. After this time, it is usually difficult to distinguish a plant's recovery method. Each species is recorded onto data sheets by relative abundance and height class. Recording species by height class assists in determining previous recruitment events over time and whether type of response to fire depends on age as reflected in height. Data recording follows that of Choate and Casperson (1993).

Collecting Phenology Data

The critical observation for fire-sensitive species is when they begin to flower. An analysis of flowering calenders in the literature revealed that, for all species present, five to nine visits per year could be necessary to observe every species flowering (Gill, 1992). On each visit the range of species flowering, fruiting or budding is to be recorded onto the data sheets. Flower, fruit and bud abundance is to be noted by taking an average across the population.

Species may be regarded as safe from local extinction, given a repeated fire, when its seed supply is adequate (Gill, 1992). The time taken for a species to replenish seed stores is relatively unknown, but many years may be necessary before seed production is sufficient to restore the population after fire. On the basis of available information, two rules-of-thumb have been suggested which are to be used as guides for determining when suitable seed supplies are produced (Gill, 1992): identify when 50% of the plants of that species have become reproductive; or double the observed number of years from the time of the fire to the start of flowering (Gill and Nicholls, 1989). The aim of management would be to keep fire out of the community until this doubling time had been reached by all plants, particularly those in 'sensitive' and 'unknown' categories. Obviously, observation of the plants would not be necessary during the time from first flowering to double this time.

Tagging plants for monitoring

Tagging individual plants after a fire has proven to be particularly useful for monitoring fire responses (see Morelli, 1990). This method ensures that the same plants are observed on each visit, and provides an ideal opportunity to closely monitor when in a plant's life cycle does it become mature, senescent and absent from the area. Tagging plants also provides information on the regularity of reproductive out put. This would entail examining the amount of flower and seed produced seasonally.

In the absence of some sort of monitoring program the chances of adequately understanding the fire responses of plant species is very limited. Essentially monitoring is an ongoing process which relies on repeated measurements in order to gain accurate results. Once a monitoring system is implemented, the process of review and evaluation will be necessary if monitoring is to remain practical and continue to be relevant to the manager (Wouters, 1992). Further evaluation may be assisted by comparing results from monitoring in similar areas elsewhere in other States.

CONCLUSION

This report serves as a pilot study and describes the current status of the mallee fire ecology project undertaken in South Australia for the South Olary Plains. To date, a plant fire response register has been established for the South Olary Plains containing information on a variety of mallee plant species. There still remains numerous plant species that lack fire response data and so it is encouraged that any extra information collected is to be added to the register. This will undoubtedly aid in improving the current plant fire responses information base. The monitoring system outlined in this report was established in accordance with the minimal data set scheme devised by the CSIRO. Even though this system seems to be the most appropriate, it is certainly not static. It is envisioned that monitoring will become more refined and developed as the program is implemented and results are reviewed. Ultimately, when time allows and funding becomes available, a minimal data set analysis of the perennial vegetation data from the survey can be conducted by the CSIRO to provide a further set of monitoring sites. The usefulness of minimal data sets also depends very much on the questions you wish to answer.

As data from state and national plant fire response registers, monitoring programs and research become available, present fire management strategies will be revised and procedures modified. There is much still to be learnt before the exact role of fire can be specified with any degree of confidence and certainty however and where fire management ultimately falls in the overall management of this region will depend on management objectives and priorities.

Conclusions & Conservation Recommendations

by L.R. Forward[1]

THE SOUTH OLARY PLAINS ENVIRONMENT

The three million hectare area that constitutes the South Olary Plains encompasses a range of environments: the sand dune systems of the south-east, extending south to the River Murray valley; the western flats that rise into the Burra Hills and the northern Mount Lofty Ranges; and the arid plains in the north dotted with unique outliers of the southern Flinders Ranges, divided by ephemeral watercourses leading to the floodouts and claypans of the central plain area.

The South Olary Plains area constitutes a transition zone between three major biogeographic regions in South Australia: the southern Murray Mallee, the northern arid zone and the Mount Lofty and Flinders Ranges. Flora and fauna species found in the area generally have affinities with one or more of these regions. Thus there is a high species diversity on the South Olary Plains with species from all three regions being found, many of which are at the limits of their natural distribution.

The South Olary Plains also straddles the boundary between two major Australian zoogeographic regions: the Bassian region of temperate southern and eastern Australia and the Eyrean region of the semi-arid and arid inland, although most of the survey area is in the Eyrean zone. Thus the vertebrate fauna of the survey area comprises species with generally Bassian or Eyrean affinities, but mostly the latter. Hence, many species that are associated with these regions are occurring at the edge of their Australian range in the South Olary Plains area.

BIOLOGICAL COMMUNITIES

Thirty-four different vegetation associations were identified in the South Olary Plains, with thirteen major associations extending over large parts of the area: the mallee communities of the south-eastern dune systems (*Eucalyptus dumosa, E. oleosa, E. socialis, E. gracilis*); the Blackoak (*Casuarina pauper*) woodlands, mixed woodlands and Pearl Bluebush (*Maireana sedifolia*) shrublands of the centre; the Black Bluebush (*M. pyramidata*) and Bladder Saltbush (*Atriplex vesicaria*)/Grey Bluebush (*M. astrotricha*) low shrublands and grasslands in the arid north, with River Red Gum lined watercourses and arid mallee (*E. socialis, E. gracilis*) on the hills; and mixed chenopod shrublands in the west with Eucalypt woodlands (*E. brachycalyx, E. porosa, E. oleosa/gracilis/socialis*) on the Burra Hills.

Vegetation mapping of the area, determined structurally from aerial photography, identified thirteen major and seven minor vegetation alliances. Most correlated with groupings of the major floristic associations identified in the vegetation analysis, but a few minor types not detected by the analysis were visible on aerial photography and thus mapped.

Bird species of the area tend to occur in one of four habitat-specific groups: those of Blackoak woodlands, mallee communities and chenopod shrublands with and without emergent trees.

Reptile species similarly exhibit habitat-linked groups: those of mixed woodlands, mixed open woodlands, mallee communities, chenopod shrublands and claypan environments.

Native mammal species diversity is too low to detect clear patterns but amongst the small terrestrial species four groups dominated by each of the four most common species (Common Dunnart, Fat-tailed Dunnart, Bolam's Mouse, Striped-faced Dunnart) seem to be specific to either woodland, chenopod shrubland or grassland habitats.

SPECIES RICHNESS

Information brought together for this report shows that the South Olary Plains supports 876 plant species, 31 mammal species, 257 bird species, 78 reptile species and 10 amphibian species. The field survey in 1991 and 1992, with over 18 000 observations of flora and fauna (Table 25), recorded a high proportion of this total species richness for the area with 540 plants, 29 mammals, 162 birds, 64 reptiles and 6 amphibians. Using the data from the biological survey sites (Table 26) can therefore

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provide a reliable indication of potential areas with high species richness within the range of environments sampled and so provide pointers to areas of particular conservation significance. It must be emphasised however in a landscape such as the South Olary Plains with it's almost unbroken cover of natural vegetation, that nature conservation management is a responsibility of all land managers as the plants and animals do not always stay within any areas which might be designated as having high conservation significance.

Table 25
Numbers of plant and vertebrate fauna species observations recorded during the South Olary Plains survey.

	Quadrats	Opportunistic	Total
Plants	12 648	222	12 870
Birds	1 872	1 503	3375
Reptiles	562	345	907
Mammals	393	562	955
Amphibians	21	7	28
Total	15 496	2 639	18 135

Table 25 shows the total numbers of flora and fauna species recorded at each fauna survey quadrat used in the South Olary Plains survey analysis, to point to areas of high species richness and hence possible high priority areas for nature conservation.

Table 26
Numbers of vascular plant and vertebrate fauna species found at each fauna survey quadrat on the South Olary Plains.

Numbers and quadrats in bold indicate the two highest diversities (number of species) for each biota type. Underlined figures are the third and fourth highest diversities.

[Note - quadrats and associated numbers in brackets indicate a higher sampling effort (by the University of S.A. on Danggali Conservation Park) and thus figures cannot be accurately compared to the rest of the table.]

Quadrat	Plants	Birds	Mammals	Reptiles	Amphibians	Total
[CA1101	**66**	38	**12**	9	0	**125]**
[CA1201	37	**50**	**10**	**13**	0	**110]**
DA0201	55	28	7	7	1	98
OV0202	53	29	3	5	2	92
SM0202	43	30	7	7	1	88
[EB0101	22	35	**10**	**16**	1	84]
CA0201	46	27	6	4	0	83
FL0203	42	30	6	4	0	82
SV0103	37	29	5	8	2	81
OV0401	**58**	18	0	1	2	79
PP0102	27	34	5	12	0	78
PA0201	31	30	5	12	0	78
BR0102	50	11	5	10	0	76
TB0201	39	17	9	11	0	76
JH0302	35	29	5	6	0	75
SA0201	42	24	5	4	0	75
SM0302	32	24	5	**13**	1	75
TP0101	34	26	6	8	0	74
SV0301	29	31	3	8	0	71
OV0502	38	24	0	6	2	70
NK0101	33	23	5	8	0	69
WM0102	55	10	2	2	0	69
CN0202	31	25	5	8	0	69
HY0201	36	15	6	12	0	69
LW0103	21	36	4	5	0	66
SA0101	41	15	5	5	0	66

Quadrat	Plants	Birds	Mammals	Reptiles	Amphibians	Total
SC0101	14	**39**	6	6	0	65
OP0101	31	18	6	9	1	65
RC0201	24	25	6	9	1	65
SE0103	18	37	4	5	0	64
FL0302	28	23	3	9	1	64
TV0301	35	18	5	5	0	63
RB0101	16	31	4	9	0	60
SD0302	34	20	3	3	0	60
JS0202	30	21	1	7	0	59
BY0103	30	21	2	5	0	58
SQ0201	32	20	1	5	0	58
FJ0302	35	11	6	5	1	58
OA0101	28	24	0	5	0	57
YT0201	19	27	4	7	0	57
TL0203	31	15	4	7	0	57
YB0102	22	24	7	3	0	56
CL0102	32	15	2	7	0	56
PA0102	22	19	8	7	0	56
CK0201	35	13	2	5	1	56
FL0102	22	29	3	2	0	56
TB0101	26	18	3	8	0	55
BL0502	21	27	3	3	0	54
JS0101	30	21	0	3	0	54
BR0602	25	15	8	6	0	54
WK0401	36	14	2	1	0	53
JH0401	22	15	8	8	0	53
DA9901	19	19	3	10	1	52
CK0102	35	11	3	3	0	52
TL0102	18	19	3	11	1	52
MC0102	21	17	7	7	0	52
BN0201	34	11	2	4	0	51
PC0101	23	20	2	6	0	51
AD0102	28	15	3	5	0	51
YT0302	22	20	2	7	0	51
LN0201	19	25	3	3	0	50
FJ0202	14	22	4	9	0	49
GB0201	11	31	4	3	0	49
BR0401	22	18	5	4	0	49
FH0101	31	9	6	3	0	49
BN0302	33	8	2	5	0	48
MS0201	17	16	9	5	1	48
BE0201	31	12	3	2	0	48
ML0202	31	9	3	5	0	48
CN0401	32	8	5	2	0	47
GR0202	17	20	3	6	1	47
CL0302	16	22	4	5	0	47
PH0101	20	18	1	7	0	46
KO0102	14	24	6	1	0	45
TG0202	12	22	5	4	0	43
MN0101	19	14	5	4	0	42
TI0102	20	18	2	1	1	42
RO0101	23	14	1	4	0	42
KO0202	23	11	3	5	0	42
NK0501	12	16	7	6	0	41
KM0201	18	18	1	4	0	41
FJ0102	14	15	4	7	0	40

Quadrat	Plants	Birds	Mammals	Reptiles	Amphibians	Total
HW0104	11	16	2	11	0	40
WF0103	20	12	3	5	0	40
OP0102	26	6	3	3	0	38
BR0204	22	7	4	5	0	38
TP0102	21	10	5	2	0	38
HW0201	9	13	5	11	0	38
PV0302	14	17	4	2	0	37
SE0102	10	14	2	9	0	35
TS0101	19	10	1	3	0	33
WT0101	13	10	5	3	0	31
PK0201	12	6	6	7	0	31
TOTAL	2546	1855	391	551	22	5365

The two quadrats with the highest total species diversity (CA1101, CA1201) were surveyed by the University of South Australia students on Danggali Conservation Park and were sampled for a longer period and with more observers than at quadrats sampled on the actual South Olary Plains survey. Thus these high species numbers may be due to increased sampling effort. However, the third most diverse quadrat, sampled on the current survey, was also on Danggali, suggesting that the park does contain a higher diversity of flora and fauna.

A third University of S.A. quadrat recorded the sixth highest diversity. To more accurately ascertain the species diversity across the South Olary Plains, these three intensively sampled Danggali quadrats will be disregarded. Thus the quadrats with the highest species diversities (in descending order) were:

Total species - DA0201 (Danggali), OV0202 (on Oakvale Station), SM0202 (on Lilydale Station);
Plants - DA0201, OV0401 (Oakvale), WM0102 (Wadnaminga) [although these figures may be influenced by numbers of annual species which were more prevalent in the last week of the survey, when these three quadrats were sampled];
Birds - SC0101 (south-western agricultural area), SE0102 (north-western perpetual leasehold), LW0103 (Lord's Well/Pine Valley);
Mammals - TB0201 (Lilydale), MS0201 (south-western perpetual leasehold), BR0602 (Braemar), PA0102 & JH0401 (Chowilla). However, the first three all had high numbers of introduced species. The quadrats with the most small, native terrestrial species were CK0102 (Mutooroo) and DA0201 (Danggali).
Reptiles - SM0302 (Lilydale), PP0102 (Pandappa C.P.), PA0201 (Chowilla), HY0201 (Danggali).

If assessing the actual numbers of individual animals recorded, a few more sites are notable [bearing in mind that variability in actual numbers of individuals captured would be influenced more by differences in observer effort than simply number of species would]. Thus quadrats with high numbers of individual animals recorded (in descending order) were:

Total individual animals - NK0101 (Nikalapko Station), FL0203 (Ford's Lagoon/Sturtvale Station), SA0201 (Lilydale Station);
Individual birds - NK0101 (Nikalapko), FL0203 (Ford's Lagoon/Sturtvale), SA0201 (Lilydale);
Individual reptiles - JS0202 (Mutooroo Station), DA9901 (Danggali), PA0201 (Chowilla);
Individual mammals - BR0602 (Braemar), TL0203 (Tilkilki), SV0301 (Sturtvale).

SIGNIFICANT SPECIES

A number of particularly interesting flora and fauna species were found on the South Olary Plains survey and numerous species of national and state conservation significance are known to occur in the area.

Species recorded beyond previously known distributions

PLANTS
Heliotropium undulatum
Swainsona oliveri
Enneapogon intermedius Tall Bottlewashers
Erodium cygnorum ssp. *cygnorum* Blue Storks-bill
Frankenia pauciflora var *fructiculosa* Southern Sea Heath

MAMMALS
Planigale tenuirostris Narrow-nosed Planigale
Macropus giganteus Eastern Grey Kangaroo

BIRDS
Little Bittern *Ixobrychus minutus*
Little Woodswallow *Artamus minor*

REPTILES & AMPHIBIANS
Delma molleri Adelaide Snake-lizard
Ctenotus strauchii Short-legged Ctenotus
Egernia stokesii Gidgee (Spiny-tailed) Skink
Tiliqua scincoides Eastern Bluetongue
Neobatrachus pictus

Endangered species

[A = status in Australia; S = South Australia; R = regional (plants only)]

PLANTS
Maireana decalvens Black Cottonbush (S,R)

BIRDS
Black-eared Miner *Manorina melanotus* (A,S)
Bush Thick-knee *Burhinus magnirostris* (S)

REPTILES
Pygmy (Adelaide) Bluetongue *Tiliqua adelaidensis* (A,S) (previously presumed extinct; found just outside western border of survey area)

Vulnerable species

PLANTS
Codonocarpus pyramidalis Slender Bell Fruit (A,S,R)
Olearia pannosa ssp. *pannosa* Silver Daisy Bush (A,S,R)
Acacia carnei Needle Wattle (A,S)
Maireana suaedifolia Lax Bluebush (S,R)
Eremophila bignoniiflora Bignonia Emubush (S,R)

MAMMALS
Macropus giganteus Eastern Grey Kangaroo (S)

BIRDS
Mallee Fowl *Leipoa ocellata* (A,S)
Red-lored Whistler *Pachycephalus rufogularis* (A,S)
Regent Parrot *Polytelis anthopeplus anthopeplus*(A,S)
Freckled Duck *Stictonetta naevosa* (S)
Little Bittern *Ixobrychus minutus* (S)
Striated Grasswren *Amytornis striatus striatus* (S)
Slender-billed Thornbill *Acanthiza iredalei iredalei* (S)
Major Mitchell (Pink Cockatoo) *Cacatua leadbeateri* (S)
Blue-winged Parrot *Neophema chrysostoma* (S)
White-winged Chough *Corcorax melanoramphos* (S)
Chestnut Quail-thrush *Cinclosoma castanotum* (S)
Striped Honey-eater *Plectorhyncha lanceolata* (S)
Australian Bustard *Ardeotis australis* (S)
Painted Button-quail *Turnix varia* (S)
Diamond Firetail *Emblema guttata* (S)

REPTILES & AMPHIBIANS
Morelia spilota imbricata Carpet (Diamond) Python (possibly) (A)
Aprasia pseudopulchella Flinders Worm Lizard (A)
Litoria raniformis Golden Bell Frog (S)

Rare species

21 plants
13 birds
4 reptiles
1 (possibly 3) mammals

An additional 93 plant species are classified as endangered, vulnerable, threatened or rare for the region.

Species known to have occurred historically in the area but which are now extinct in Australia and/or South Australia

9 mammal species
1 bird species

Five (possibly seven) mammal species that were known to have occured historically in the survey area are now locally exinct.

Sub-fossil material

Bones collected from three sub-fossil deposits on the South Olary Plains revealed a large variety of mammal species that occurred historically in the area. Most were already thought to have been there but five were new historic occurrences for the area and four were newly confirmed to have been there at least pre European occupation.

Introduced species

A large number of introduced species of flora and fauna occur on the South Olary Plains:

160 plant species (many common)
6 bird species (2 common)
9 mammal species (5 common)

Most of these species occur throughout the region, particularly in the northern and western areas which are the nearest to main roads and towns and were subjected to agricultural and pastoral activities earlier than the rest of the region. Thus these areas appear to be the most degraded.

The worst effect of introduced species is that from rabbits, foxes, cats and goats (i.e. overgrazing and predation) and methods of control are being implemented Australia-wide for these species.

Despite these high numbers of introduced species, they were not as high as recorded further south on the Murray Mallee survey (except goats) where House Mice were particularly numerous (D. Armstrong, pers. comm.).

CAUSES OF ENVIRONMENTAL DECLINE AND ONGOING THREATS

The decline in numbers of the now endangered, vulnerable or rare flora and fauna species and communities in the South Olary Plains can be attributed to a number of factors. Stephens (1992) has compiled a list of causes of decline and ongoing threats to the environment for the Murray Darling Basin mallee, most of which are relevant to the South Olary Plains. Those that are most are:

- habitat degradation through overgrazing by stock, feral animals or kangaroos
- clearance of native vegetation
- introduced predators
- competition with introduced species
- altered fire regimes

Those that have had/have less impact in the South Olary Plains but which are still relevant are (i.e. generally in the southern and eastern agricultural areas, along the River Murray or relevant only to small populations):

- loss of genetic distinctiveness (e.g. through hybridisation)
- trapping for commercial activity
- hunting
- cropping or pasture improvement
- insecticides/herbicides
- modification of hydrological conditions (e.g. river, wetlands)
- salinisation
- pollution and blue-green algae
- urban development and earthworks (roads, firebreaks, quarries)
- natural population cycles (linked to climatic cycles)
- competition with other native species
- native predators
- small size of remnant populations rendering them more vulnerable to the above threats and natural 'catastrophes' (e.g. drought, flood etc)

FIRE ECOLOGY

Fire management is clearly a significant issue particularly in the southern half of the study area. With the vegetation mapping and the individual plant species fire response data and ongoing monitoring initiated as part of this project, there is now a basis to add a conservation of plant communities and species to any ongoing fire management

SIGNIFICANT AREAS OF THE SOUTH OLARY PLAINS

In terms of endangered/vulnerable species

Several areas where a number (i.e. two or more) of endangered and vulnerable species have been recorded are considered to be of conservation significance. These are listed as follows, with the reasons for their significance.

Bookmark Biosphere Reserve (Danggali, Calperum & Chowilla) - contains numerous endangered and vulnerable species (although may be because more survey work has been conducted in Danggali over many years by various researchers) e.g. Black Cottonbush (*M. decalvens*), Lax Bluebush (*M. suaedifolia*), Black-eared Miner, Red-lored Whistler, Regent Parrot, Scarlet-chested Parrot, Painted Button-quail, Marbled Velvet Gecko (rare in state and region), Bardick, Common Bandy Bandy, Little Pied Bat.

Cooltong Conservation Park - Black-eared Miner, Scarlet-chested Parrot, Regent Parrot, Freckled Duck, Australian Bustard.

South-western corner of South Olary Plains - (around Robertstown and hundreds of Bundey, Bright and Bower) - Silver Daisy Bush (*O. pannosa* ssp. *pannosa*), Bush Thick-knee, Australian Bustard, Diamond Firetail, Painted Button-quail.

The River Murray Valley - (although not surveyed, species known to occur there) - Regent Parrot, Golden Bell Frog, Carpet Python.

Taylorville/Gluepot Stations - Black-eared Miner, Regent Parrot.

Pine Valley Station - Little Bittern, Australian Bustard.

Central Mutooroo Station - Narrow-nosed Planigale (regionally rare) and two other small native mammal species all at one site.

Oulnina Park Station (Fig. 127)- Slender Bell Fruit (*C. pyramidalis*) and the possibility of other rare species in this unique area.

Burra Hills - (although only the eastern flanks surveyed) - Adelaide Blue-tongue Lizard, Flinders Worm-lizard.

Redcliffe Station - Slender-billed Thornbill.

Franklyn Station - Dagger-leaf Wattle *(Acacia rhigiophylla)*

Additionally, the following vulnerable bird species occurred in most of the above areas and throughout the survey area: Striated Grasswren (sandplain subspecies), Major Mitchell, Blue-winged Parrot, White-winged Chough, Chestnut Quail-thrush and Striped Honeyeater.

In terms of species richness

The area with the highest species richness and number of individual animals seems to be southern Danggali Conservation Park, although sampling effort has been greater there. Other areas with high diversities are:

northern Danggali Conservation Park and Oakvale Station,
Lilydale Station,
Braemar Station,
Chowilla Regional Reserve,
Sturtvale/Ford's Lagoon Station,
Mutooroo Station.

In terms of communities not or poorly conserved in South Australia or the South Olary Plains

Three communities classified by Neagle (1995) as being poorly conserved in South Australia occur in the South Olary Plains. They are *Chenopodium nitrariaceum* Low Shrubland (arid zone swamps and water courses), *Eragrostis australasica* (Canegrass) Tussock Grassland and *Stipa nitida, Sclerolaena* spp. Ephemeral Communities. The first two occur in the claypan (Fig. 128) and saline environments of the central and north-eastern areas of the survey region (although mostly occur as components of other communities) and the third occurs throughout the region.

Neagle has listed a number of other communities classified as only moderately conserved in South Australia which occur throughout the South Olary Plains.

Considering the conservation status of each of the flora and fauna species groups identified on the current survey, the following areas are deemed important in that they contain communities (as listed) which are *not* currently conserved in the South Olary Plains:

<u>Central area</u>
- Blackoak woodlands over Pearl Bluebush
- Very open low Blackoak woodlands with mixed understorey
- Pearl Bluebush shrublands
- saline and claypan communities [which include the *C. nitrariaceum* and Canegrass communities rated by Neagle (1995)]
- (plus minor Black Bluebush, Saltbush and Grey Bluebush shrublands)

<u>South-south-west area</u> (north of Morgan)
- Pearl Bluebush shrublands
- Blackoak woodlands over bluebush
- (minor claypan and saline communities)

<u>Western area</u>
- Black Bluebush shrublands
- *Eucalyptus porosa* woodlands
- ridge communities (*Sida* spp., *Ptilotus* spp. etc)
- (minor Saltbush shrublands)

<u>Northern area</u>
- Very low open Blackoak woodland with Mulga, Bullock Bush and mixed understorey
- Pearl Bluebush and Saltbush shrublands
- (minor Blackoak woodland over bluebush)
- native grasslands - *Stipa scabra, S. acrociliata, Enneapogon intermedius, E. avenaceus, Eragrostis dielsii*
- ridge communities (*Sida* spp., *Ptilotus* spp. etc)
- claypan communities [including those rated by Neagle (1995)]
- *Eucalyptus camaldulensis* ephemeral creeklines
- northern mallee (*E. gracilis/E.socialis*)
- *Callitris glaucophylla* (Native Pine) woodland

<u>North-eastern corner</u> (Mutooroo and Devonborough Downs Stations)
- Saltbush and Grey Bluebush shrublands
- *Stipa scabra* and *Enneapogon intermedius* grasslands (plus *E. avenaceus, Eragrostis dielsii*)

<u>Throughout the whole area</u>
- *Stipa* sp. grasslands and *Sclerolaena* sp. herblands [as also rated by Neagle (1995)]
- Bird, mammal and reptile communities of chenopod shrublands, very open woodlands, grasslands and claypan shrublands.

CONSERVATION STATUS IN THE SOUTH OLARY PLAINS

Adequate conservation

Danggali Conservation Park and Chowilla Regional Reserve adequately conserve areas of rich species diversity and animal numbers in the South Olary Plains.

Endangered and vulnerable species considered to be adequately conserved in the survey region are:

PLANTS
Black Cottonbush (*Maireana decalvans*)
Lax Bluebush (*Maireana suaedifolia*)
Bignonia Emubush (*Eremophila bignoniiflora*)

MAMMALS
Eastern Grey Kangaroo

BIRDS
Mallee Fowl
Red-lored Whistler
Regent Parrot
Striated Grasswren
Major Mitchell
Blue-winged Parrot
White-winged Chough
Chestnut Quail-thrush
Striped Honeyeater
Freckled Duck

REPTILES & AMPHIBIANS
Carpet Python
Golden Bell Frog

Vegetation communities identified on the current survey that are considered to be adequately conserved in the area are:

Eucalyptus gracilis Open tree mallee
E. oleosa Open tree mallee
E. oleosa/E. socialis Open tree mallee
E. socialis Open tree mallee
E. dumosa/E. socialis Open tree mallee
E. brachycalyx Open tree mallee
Casuarina pauper Low woodland with shrubby non - chenopod understorey
Mixed Shrublands (*Acacia* spp., *Dodonaea* spp., *Eremophila* spp., *Senna* spp.)
Danthonia sp. Grasslands

Faunal communities that are considered to be adequately conserved in the area are:

Birds of mallee and *Casuarina pauper* woodlands
Reptiles of mallee, mixed woodlands and open mixed woodlands
Mammals of woodlands and mallee

Inadequate conservation

Areas of high species diversity and animal numbers in the South Olary Plains that are not adequately conserved are on Oakvale Station (although this abuts Danggali Conservation Park); Lilydale Station; Braemar Station; Sturtvale/Ford's Lagoon Station and Mutooroo Station.

Endangered and vulnerable species that are not adequately conserved in the South Olary Plains are:

PLANTS
Slender Bell Fruit (*Codonocarpus pyramidalis*)
Silver Daisy Bush (*Olearia pannosa* spp. *pannosa*)
Dagger-leaf Wattle (*Acacia rhigiophylla*)
Needle Wattle (*Acacia carnei*)

MAMMALS
Narrow-nosed Planigale (regionally rare)

BIRDS
Black-eared Miner
Bush Thick-knee
Australian Bustard
Slender-billed Thornbill
Painted Button-quail
Diamond Firetail

REPTILES
Pygmy Bluetongue
Flinders Worm-lizard

Major vegetation communities identified on the current survey that are not conserved in the South Olary Plains are:

Eucalyptus gracilis/E. socialis Open tree mallee (northern, arid areas)
Casuarina pauper Low woodland (with *Maireana sedifolia* understorey)
C. pauper Very low open woodland (with mixed understorey)
Maireana sedifolia Low shrubland
M. pyramidata Low shrubland
Atriplex vesicaria sspp. Low Shrubland
A. vesicaria/Maireana astrotricha Low shrubland
saline and claypan communities
ridge communities (*Sida* spp., *Ptilotus* spp., *Solanum* spp.)
native grasslands (*Stipa* spp., *Enneapogon* spp. and northern *Danthonia* spp.)

Minor vegetation communities that are not conserved are:

Eucalyptus porosa Low woodland
Eucalyptus camaldulensis Low woodland (arid areas)
Callitris glaucophylla Low woodland
Sclerolaena spp. Low shrubland

Fauna communities that are not conserved in the South Olary Plains are:

Birds of chenopod shrublands (with and without emergent trees)
Reptiles of chenopod shrublands, claypans, open grasslands and very open environments
Mammals of chenopod shrublands and the northern areas

SIGNIFICANT AREAS FOR CONSERVATION

The south-eastern and southern areas of the South Olary Plains are well conserved in Bookmark Biosphere Reserve, Pooginook Conservation Park and the Murray River National Park, preserving areas of high species diversity and high animals numbers, numerous endangered and vulnerable species and several major South Olary Plains flora and fauna communities.

The following regions do not currently contain any formal conservation reserves, but are considered significant in terms of either having high species diversity, and/or containing endangered or vulnerable species, and/or containing vegetation communities that are not conserved in the South Olary Plains:

<u>Central South Olary Plains</u>

- high species diversity (Lilydale, Braemar, Lord's Well/Pine Valley, Sturtvale/Ford's Lagoon Stations)
- Little Bittern (although migratory), Australian Bustard (Pine Valley)
- *Casuarina pauper* Low woodland (with *Maireana sedifolia* understorey)
- *C. pauper* Very low open woodland (with mixed understorey)
- *Maireana sedifolia* Low shrubland
- saline and claypan communities (including *Muehlenbeckia florulenta* and *Eragrostis australasica*]
- *Atriplex vesicaria/Maireana astrotricha* Low shrublands (Braemar Station)
- *Scleroalena* spp. Low shrubland

- native grasslands
- mammal, reptile and bird communities of chenopod shrublands, very low open woodlands, claypans and grasslands.

South-south-west South Olary Plains

- *Maireana sedifolia* Low shrubland
- *C. pauper* Low woodland (with *M. sedifolia* understorey)
- minor claypan and saline communities
- mammal, reptile and bird communities of chenopod shrublands

South-western South Olary Plains

- five endangered or vulnerable species (Olearia pannosa, Diamond Firetail, Painted Button-quail, Australian Bustard and Bush Thicknee) found nowhere else in the survey area (although this corner is just outside the true South Olary Plains, and these classified species occur in the areas further west and south)

Western South Olary Plains

- two endangered/vulnerable species (reptiles) in the Burra Hills (but these were found just outside the true South Olary Plains and occur at other locations in the hills)
- *Maireàna pyramidata* Low shrublands
- minor *Atriplex vesicaria* sspp. Low shrublands
- *Eucalyptus porosa* Low woodlands
- ridge communities (*Sida* spp., *Ptilotus* spp., *Solanum* spp.)
- native grasslands
- *Sclerolaena* spp. Low open shrubland
- mammal, reptile and bird communities of chenopod shrublands

Northern South Olary Plains

- uniqueness of Oulnina Park Station (*Codonocarpus pyramidalis*, *Callitris glaucophylla* woodland) being an outlier of the southern Flinders Ranges
- *C. pauper* Very low open woodland (with Mulga, Bullock Bush and mixed understorey)
- *M. pyramidata* Low shrubland
- *A. vesicaria* Low shrubland
- native grasslands (*Stipa scabra*, *S. acrociliata*, *Enneapogon intermedius*, *E. avenaceus*. *Eragrostis* spp.)
- *Sclerolaena* spp. Low open shrubland
- ridge communities (*Sida* spp., *Ptilotus* spp., *Solanum* spp.)
- claypan communities (including *Muehlenbeckia florulenta* and *Eragrostis australasica*]
- *Eucalyptus camaldulensis* Low woodland
- *E. gracilis/E. socialis* Open tree mallee (northern, arid)
- mammal, bird and reptile communities of all these environments

[However, all these communities will be better assessed after the North Olary Plains survey].

North-eastern South Olary Plains

- relatively high species diversity (Mutooroo Station)
- *A. vesicaria/Maireana astrotricha* Low shrubland (Mutooroo Station)
- Narrow-nosed Planigale and three species of small native mammals co-occurring (Mutooroo)
- native grasslands (*Stipa scabra*, *Enneapogon intermedius*, *E. avenaceus*, *Eragrostis* spp.)
- mammal, reptile and bird communities of these environments

These communities will also be better assessed after the North Olary Plains survey].

RECOMMENDATIONS

In general, the areas of high species richness in the south-eastern part of the South Olary Plains study area are already included within the South Australian Government conservation reserve system. The remainder of the area is largely held under pastoral leasehold tenure. Until a comparable biological survey is completed for the North Olary Plains (under way, 1995) it is not possible to confidently identify areas of conservation significance in the northern part of the present study area. The areas and species identified earlier in this chapter however will begin to provide a conservation management focus for particular pastoral lessees in their property management planning.

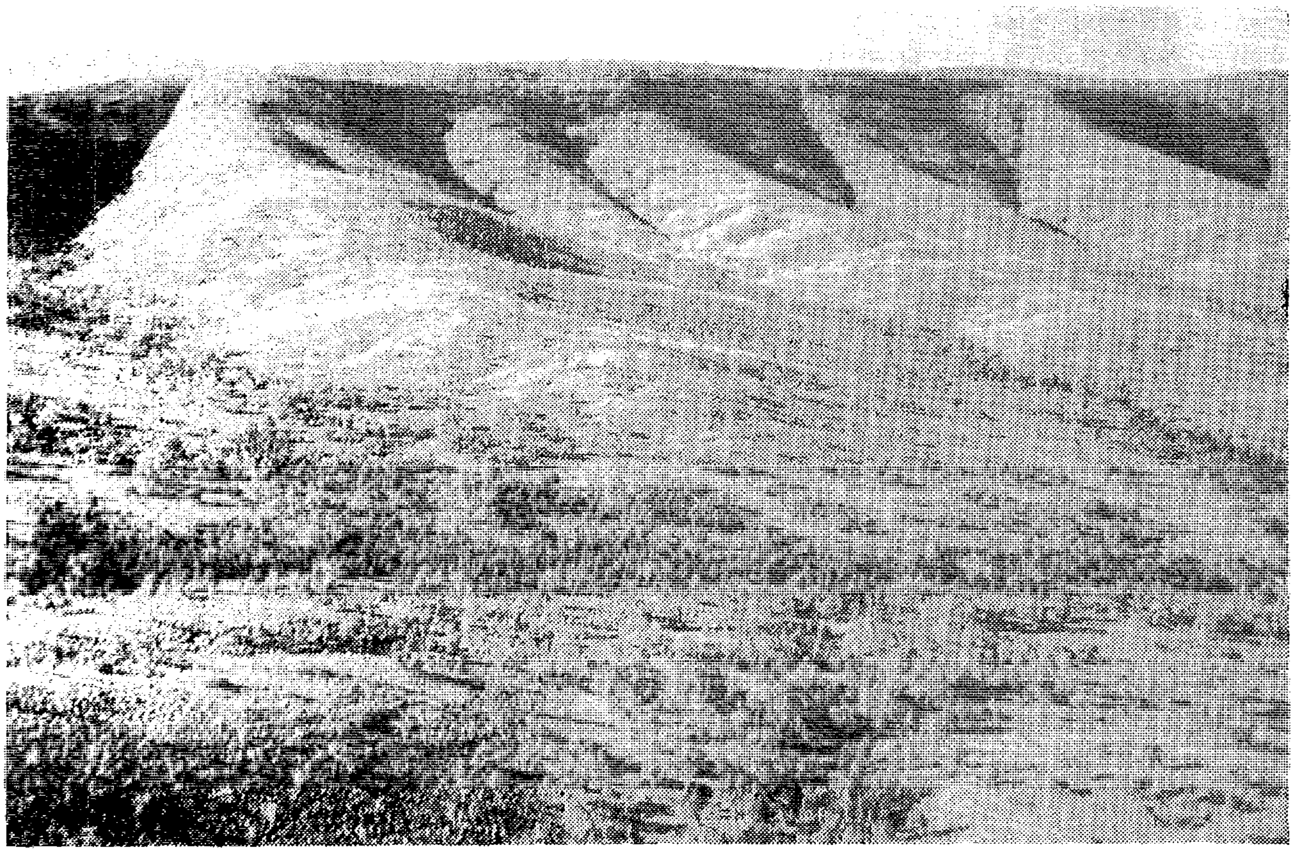

Figure 127
An aerial photo of spinifex covered hills and native pine woodlands on Oulnina Park Station
Photo: P. Canty

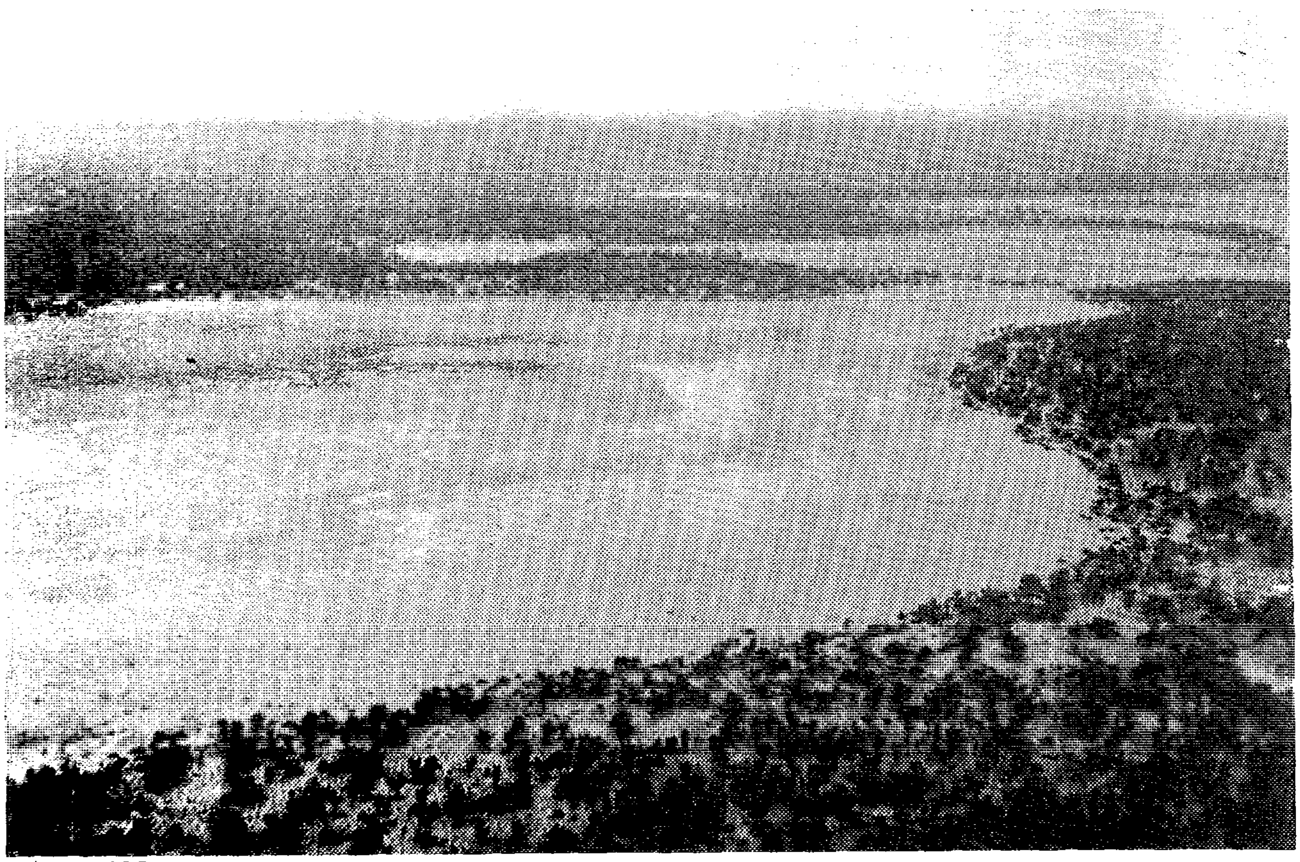

Figure 128
Claypans on Pine Valley Station
Photo: P. Canty

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Appendix I

VEGETATION CLASSIFICATIONS USED ON THE SOUTH OLARY PLAINS SURVEY

Structural Classification [adapted from Muir (1977)]

Life form/height class		Canopy cover			
		Dense d 70-100%	**Mid Dense c** 30 - 70%	**Sparse i** 10 - 30%	**Very Sparse r** 1 - 10%
T	Trees > 30m	Dense tall forest	Tall forest	Tall woodland	Open tall woodland
M	Trees 15-30m	Dense forest	Forest	Woodland	Open woodland
LA	Trees 5 - 15m	Dense low forest A	Low forest A	Low woodland A	Open low woodland A
LB	Trees <5m	Dense low forest B	Low forest B	Low woodland B	Open Low woodland B
KT	Mallee tree form (<3m)	Dense tree mallee	Tree mallee	Open tree mallee	Very open tree mallee
KS	Mallee shrub form (<3m)	Dense shrub mallee	Shrub mallee	Open shrub mallee	Very open shrub mallee
S	Shrubs>2m	Dense Thicket	Thicket	Scrub	Open Scrub
SA	Shrubs 1.5 - 2.0m	Dense heath A	Heath A	Low scrub A	Open low scrub A
SB	Shrubs 1 - 1.5m	Dense heath B	Heath B	Low scrub B	Open low scrub B
SC	Shrubs 0.5 - 1.0m	Dense low heath C	Low heath C	Dwarf scrub C	Open dwarf scrub C
SD	Shrubs 0 - 0.5m	Dense low heath D	Low heath D	Dwarf Scrub D	Open dwarf scrub D
GT	Bunch grass >0.5m	Dense tall grass	Tall grass	Open tall grass	Very open tall grass
GL	Bunch grass <0.5m	Dense low grass	Low grass	Open low grass	Very open low grass
H	Hummock grass	Dense hummock grass	Mid dense hummock	Hummock grass	Open hummock grass
VT	Sedges >0.5m	Dense tall sedges	Tall sedges	Open tall sedges	Very open tall sedges
VL	Sedges <0.5m	Dense low sedges	Low sedges	Open low sedges	Very open low sedges
P	Mat plants (single plant)	Dense mat plants	Mat plants	Open mat plants	Very open mat plants
J	Herbaceous spp.	Dense herbs	Herbs	Open herbs	Very open herbs
V	Vines (twiners)	Dense vines	Vines	Open vines	Very open vines
MI	Mistletoes	Dense Mistletoes	Mistletoes	Open Mistletoes	Very open Mistletoes
X	Ferns	Dense ferns	Ferns	Open ferns	Very open ferns
M0	Mosses, liverwort	Dense Mosses	Mosses	Open Mosses	Very open mosses
LI	Lichens	Dense lichens	Lichens	Open Lichens	Very open Lichens

Cover/Abundance Scale

[adapted from Braun-Blanquet (1932, in Gullan *et al.* 1976)]

R solitary plant
I isolated plants
L isolated clumps
T sparsely present; cover small (less than 5%)
1 plentiful, but of small cover (less than 5%)
2 any number of individuals covering 5 - 25% of the area
3 any number of individuals covering 25 - 50% of the area
4 any number of individuals covering 50 - 75% of the area
5 covering more than 75% of the area

Appendix II

DAILY TEMPERATURES (°C) RECORDED DURING THE SOUTH OLARY PLAINS VERTEBRATE FAUNA SURVEY, 27 SEPTEMBER TO 7 NOVEMBER 1992

Location (campsite)	Temperature		Dates 28/9	29/9	30/9	1/10	2/10	3/10
Tiverton	**Sun**	max	19	21	25	24	14	26
		min	8	-3	-2	1	0	5
	Shade	max	18	19	23	21	14	25
		min	11	5	5	8	6	10
Pooginook	**Sun**	max	19	24	26	28	21	
		min	7	1	0	2	5	
	Shade	max	19	19	21	21	21	
		min	9	3	3	4	7	
Mutooroo	**Sun**	max	19.5	19	21.5	26	19	29
		min	11	4	4	4	5.5	9.5
	Shade	max	18	17	22	23	16	26
		min	11.5	5	6	6.5	9	10.5

Location (campsite)	Temperature		Dates 5/10	6/10	7/10	8/10	9/10	10/10
Braemar	**Sun**	max		32.5	30.5	19.5	28	
		min		5	14	8	8	
	Shade	max		30.5	27	19.5	21	
		min		6	14.5	8	8	
Anabama Hut	**Sun**	max	23	29	29	15	24	
		min	7	8	15	10	6	
	Shade	max	19	26	25	18	19	
		min	9	10	14	9	8	
Oakvale	**Sun**	max	30	29.5	34	19.5	23	-
		min	-	8	8	14	11	6.5
	Shade	max	22	25	30	18.5	19	-
		min	-	11.5	12	16	12	9.5

Location (campsite)	Temperature		Dates 12/10	13/10	14/10	15/10	16/10	17/10
Redcliffe	**Sun**	max	25	28	31	33.5	27.5	-
(2 groups)		min	-	9	10	12	10	11.5
	Shade	max	24.5	29.5	34	22.5	18	-
		min	-	10	10.5	13.5	11	11.8
Lilydale	**Sun**	max		38	35	44	45	30
		min		6.5	8	11.5	13	15
	Shade	max		23	28	30	28	20
		min		10	10	11.5	15	13.5

Location (campsite)	Temperature		Dates					
			19/10	20/10	21/10	22/10	23/10	24/10
Tuilkilkey	**Sun**	max	20	20	21	24	27	-
		min	10	10	3	-1	0	2
	Shade	max	18.5	17	20	22	26	-
		min	11	11	8	5	7	8
Caroona	**Sun**	max	27	28	21.5	34	31	-
		min	10	9	9	1	2	5
	Shade	max	19	15	19	21	23	-
		min	12.5	8.5	8	6	6	8
Kia-Ora	**Sun**	max	22	30	36	37	40	-
		min	12	13	0	0	0	1
	Shade	max	18	20	33	33	34	-
		min	10	9	5	4	4	5

Location (campsite)	Temperature		Dates					
			26/10	27/10	28/10	29/10	30/10	31/10
Calperum (2 groups)	**Sun**	max	35	39	36	33	33	-
		min	-	19	16	20	15	14
	Shade	max	33	33	30	32	30	-
		min	-	16	14	18	14	13
Pine Valley	**Sun**	max	42	40	39.5	30.5	32	31
		min	10	15	14.5	15.5	12	12
	Shade	max	32	33	33	27	29	20
		min	14	17	10.5	17.5	15	14

Location (campsite)	Temperature		Dates					
			2/11	3/11	4/11	5/11	6/11	
Chowilla	**Sun**	max	28.5	29.5	25	32	29.5	
		min	4	4.5	4	7	5.5	
	Shade	max	23.5	23.5	21	23	24.5	
		min	7.5	8.5	6.5	9	8.5	
Benda	**Sun**	max	28	33	32	28	35	
		min	2.5	6	6	6	5	
	Shade	max	26	26	26	21	36	
		min	2.5	6	6	6	5	
Canegrass	**Sun**	max		-	26	20	22	
		min		4	2	6	4	
	Shade	max		22	23	19	20	
		min		7	8	7.5	7.5	

Appendix III

SOUTH OLARY PLAINS SURVEY QUADRAT LOCATIONS

Quadrat locations are shown by 1:100,000 mapsheets, listed from southwest to northeast across the survey area. Locations of each mapsheet is shown on the survey area inset below each map.

Detailed location data, physical environment information and floristic vegetation type for each quadrat are listed opposite each map. (The floristic vegetation group numbers correspond to those in Table 4C in the vegetation chapter).

Fauna survey quadrats where permanent photographic monitoring points were established are shown in bold on both the map and list.

Site area codes (i.e the two letter prefix of the quadrat codes) were coded from the site areas as follows:

AD	Anabama Dam	JH	Jack Hall	QI	Quinn
AR	Arbon	JS	Jones Dam	QU	Quondong
BC	Burra Creek	KM	Koomooloo	RB	Roberts
BD	Bundara	KO	Kia-Ora	RC	Redcliffe
BE	Boucauts East Dam	LG	Lang	RO	Ross
BF	Bluff	LM	Lomman	SA	South Anabama
BG	Bendigo	LN	Lindley	SC	Schuppan
BL	Balah	LW	Lords Well	SD	Spring Dam
BN	Benda	LZ	Lock Hazard	SE	Stewarts
BR	Braemar	MC	Manunda Creek	SH	Stud Holme
BU	Bungaree	MD	Maude	SM	South Mutooroo
BY	Bunyung	MG	Mulga	SQ	Square Dam
CA	Caroona	MI`	McInnes	SR	Scrubby Range
CA	Canopus (Danggali)	ML	McLennans Dam	ST	Stuart
CC	Chalk Cliffs	MN	Manunda	SV	Sturt Vale
CK	Cockrum	MS	Mosey	SW	Sampsons Well
CL	Collinsville	MW	Moorowie	TB	Two Brothers
CN	Canegrass	NK	Nikalapko	TG	The Gums
DA	Danggali	NO	Nolans	TI	Tiverton
DB	Devonborough	NT	Netley	TL	Tuilkilkey
DL	Dlorah	OA	Oak Bore	TM	Tilmey
EB	Eastern Border	OB	Oakbank	TO	The Oaks
ES	Elisio	OK	Old Koomooloo	TP	Tipperary Dam
FC	Fiscom	OP	Oulnina Park	TS	T.S.R.
FH	Faraway Hill	OT	Oates	TR	Tourilie
FL	Fords Lagoon	OV	Oakvale	TV	Taylorville
FR	Franklyn	PA	Paradise	TW	Terowie
FJ	Flash Jack	PC	Parcoola	VT	Verity Tank
GB	Glen Bower	PH	Philip	WD	White Dam
GK	Glenlock	PK	Pooginook	WF	Westons Flat
GL	Gluepot	PN	Panaramittee	WK	West Creek
GR	Grampus	PO	Pohlner	WM	Wadnaminga
HB	Hog Back	PP	Pandappa	WN	Winnininnie
HN	Hawks Nest	PR	Paratoo	WT	Wotan
HW	Hideaway	PT	Pitcairn	YB	Yubalia
HY	Hypurna	PV	Pine Valley	YT	Yabbie Tank

SURVEY QUADRATS ON THE FLORIETON MAPSHEET

Quadrat	Latitude (°,',") S)	Longitude (°,'," E)	Alt. (m)	Location (km)			Landform Element	Surface Soil Texture	Floristic Veg.Gp.
AR0101	33,51,34	139,02,56	380	4	NNE	WORLDS END	hill slope	skeletal	2
BC0101	33,51,09	139,11,14	210	6	N	GORDON LAGOON	hill slope	clay loam	31
BC0102	33,51,09	139,10,59	210	6	N	GORDON LAGOON	plain	clay loam	1
BF0101	33,55,48	139,00,22	500	10	NW	ROBERTSTOWN	ridge	clay loam	-
BU0101	33,31,21	139,02,09	585	7	NW	POONUNDA	hill slope	clay loam	19
BU0201	33,31,51	139,02,47	530	6	NW	POONUNDA	hill slope	silt loam	23
CC0101	33,37,44	139,16,16	190	9	NW	BARKERS DAM	drainage depression	light clay	29
CC0201	33,39,23	139,10,33	220	4	SE	THISTLEBEDS	flood out	loam	29
CC0202	33,39,05	139,10,27	220	3	SE	THISTLEBEDS	flood out	loam	27
ES0101	33,57,29	139,14,25	200	15	ENE	ROBERTSTOWN	plain	sandy clay loam	4
GB0101	33,57,53	139,16,17	180	18	NE	FLORIETON	plain	clay loam	21
GB0201	33,56,58	139,21,11	140	12	NNE	FLORIETON	plain	clay loam	2
KM0501	33,34,51	139,21,20	160	8	SW	ONE TREE DAMS	plain	clay loam, sandy	32
KM0502	33,35,13	139,21,16	160	6	SE	THE DUFFER DAM	plain	clay loam, sandy	26
LG0101	33,36,04	139,08,27	300	4	N	THISTLEBEDS	hill slope	loam	21
LM0101	33,30,33	139,07,53	300	6	NNE	SHAMROCK	plain	clay loam	29
MD0201	33,58,18	139,27,58	100	2	NE	WONGA	plain	clay loam	16
MD0301	33,54,09	139,28,42	100	7	SE	FLORIETON	hill slope	clay loam, sandy	33
MD0401	33,52,10	139,21,20	130	1	S	THE GUMS	flood out	sandy clay loam	23
MD0402	33,52,16	139,21,20	130	2	S	THE GUMS	playa/pan	clay loam	29
MS0101	33,52,44	139,16,16	200	14	ENE	FLORIETON	hill crest	clay loam	33
MS0102	33,52,35	139,16,04	200	14	ENE	FLORIETON	plain	clay loam	16
MS0201	33,42,12	139,21,12	140	4	NNE	FINGER POST DAMS	playa/pan	heavy clay	27
MS0202	33,41,17	139,21,21	140	5	NNE	FINGER POST DAMS	playa/pan	heavy clay	29
NO0101	33,39,06	139,27,59	120	4	NE	GRASSVILLE	plain	clay loam	16
NO0102	33,39,03	139,28,11	120	4	NE	GRASSVILLE	plain	clay loam	32
OT0101	33,31,45	139,07,34	310	3	NNE	SHAMROCK	hill slope	sandy clay loam	3
OT0201	33,33,15	139,05,56	385	1	N	POONUNDA	hill slope	sandy loam	31
PH0101	33,37,21	139,10,57	228	5	NE	THISTLEBEDS	plain	clay loam	4
QI0101	33,33,33	139,17,47	190	4	SW	THE DUFFER DAM	plain	light clay	32
RB0101	33,49,34	139,06,44	310	5	E	WORLDS END	ridge	clay loam	21
RC0401	33,46,15	139,28,42	100	11	NE	FLORIETON	plain	clay loam	32
RC0501	33,37,54	139,18,49	160	6	NW	BARKERS DAM	plain	clay loam, sandy	29
RO0101	33,36,35	139,13,27	230	2	NW	CHALK CLIFFS	plain	loam	30
SC0101	33,55,09	139,11,09	240	12	NE	ROBERTSTOWN	plain	sandy loam	2
SH0101	33,47,19	139,07,34	260	1	W	GOVERNMENT DAM	hill slope	clay loam	2
SR0101	33,53,24	139,02,53	450	6	NNE	WORLDS END	hill slope	medium clay	4
SR0201	33,55,47	139,03,02	440	8	NNW	ROBERTSTOWN	hill slope	clay loam	1
TG0101	33,48,51	139,21,08	130	4	N	THE GUMS	plain	sandy loam	31
TG0201	33,48,27	139,14,36	205	2	SE	STH SALT BUSH DM	plain	clay loam	31
TG0202	33,48,14	139,14,40	205	2	SE	STH SALT BUSH DM	plain	clay loam	31
TG0301	33,45,35	139,15,18	180	0	S	KING DAM	plain	clay loam, sandy	31
TS0101	33,36,42	139,05,01	340	3	SSE	MONGOLATA	hill slope	loam	3

SURVEY QUADRATS ON THE CAROONA MAPSHEET

Quadrat	Latitude (°,',") S)	Longitude (°,',") E)	Alt. (m)	Location (km)			Landform Element	Surface Soil Texture	Floristic Veg.Gp.
BD0101	33,04,45	139,10,43	510	10	N	PANDAPPA	open depression	silt loam	1
BD0102	33,04,45	139,10,59	530	10	N	PANDAPPA	hill slope	clay loam	1
BD0103	33,04,45	139,11,18	590	10	N	PANDAPPA	ridge	clay loam	25
BD0104	33,04,38	139,10,32	530	10	N	PANDAPPA	hill footslope	clay loam	22
BD0105	33,04,32	139,10,18	630	10	N	PANDAPPA	ridge	loam	22
BG0101	33,11,32	139,27,57	230	4	NE	BENDIGO H/S	plain	sandy clay loam	27
BG0102	33,11,30	139,27,57	230	4	NE	BENDIGO H/S	plain	sandy clay loam	33
BG0201	33,13,33	139,21,14	210	5	SE	PINE CREEK H/S	plain	sandy clay loam	32
BG0301	33,10,38	139,27,08	220	3	NE	BENDIGO H/S	plain	clay loam, sandy	29
CA0101	33,27,27	139,14,05	220	7	ENE	CAROONA	plain	clay loam	30
CA0102	33,27,27	139,14,02	220	7	ENE	CAROONA	plain	clay loam	30
CA0201	33,29,31	139,07,53	295	3	SW	CAROONA	hill slope	sandy clay loam	30
CA0202	33,29,17	139,08,18	288	2	SW	CAROONA	hill footslope	sandy clay loam	30
CL0101	33,20,58	139,06,04	420	4	SW	COLLINSVILLE H/S	hill slope	silt loam	24
CL0102	33,21,03	139,06,12	360	4	SW	COLLINSVILLE H/S	hill slope	silt loam	24
CL0201	33,21,22	139,13,32	245	9	SSE	COLLINSVILLE H/S	hill slope	silt loam	30
CL0202	33,21,27	139,13,40	251	9	SSE	COLLINSVILLE	plain	sandy loam	30
CL0301	33,17,36	139,21,02	180	3	NNW	WILLARA	plain	clay loam	31
CL0302	33,17,51	139,21,01	177	3	NNW	WILLARA	flood out	clay loam	30
CL0303	33,17,23	139,21,09	178	3	NNW	WILLARA	flood out	clay loam	26
FR0101	33,10,18	139,03,47	410	4	S	FRANKLYN STN	hill footslope	silty clay loam	25
FR0201	33,09,11	139,01,12	530	5	W	FRANKLYN	ridge	silt loam	3
FR0202	33,09,01	139,01,22	500	5	W	FRANKLYN	ridge	silt loam	24
HB0101	33,22,33	139,20,44	240	3	NNE	HOGBACK H/S	ridge	loam	15
HB0102	33,22,32	139,20,58	180	3	NNE	HOGBACK H/S	hill slope	silt loam	30
HB0103	33,22,30	139,21,09	178	3	NNE	HOGBACK H/S	playa/pan	clay loam	27
HB0201	33,21,39	139,21,14	170	4	SSW	WILLARA	plain	sandy loam	30
HB0301	33,26,51	139,06,54	384	4	NW	CAROONA	hill slope	sandy clay loam	18
HB0303	33,26,51	139,07,18	340	4	NW	CAROONA	fan - alluvial	sandy loam	4
HB0401	33,25,57	139,21,11	178	5	NNW	GLENORA	plain	clay loam	20
KO0201	33,27,30	139,22,02	180	2	NNE	GLENORA	hill slope	silt loam	11
KO0202	33,27,20	139,22,12	178	3	NNE	GLENORA	plain	loam	32
MI0101	33,26,36	139,04,31	450	4	ESE	WALLINGA H/S	hill slope	silt loam	24
MW0101	33,18,08	139,03,27	410	9	W	MALLETT	plain	silt loam	10
MW0102	33,17,38	139,02,43	420	9	W	MALLETT	plain	silt loam	3
PO0101	33,26,03	139,03,44	460	3	SE	WALLINGA H/S	fan - alluvial	silty clay loam	24
PP0101	33,09,49	139,07,24	450	5	E	PANDAPPA	plain	loam	31
PP0102	33,10,18	139,07,48	450	4	E	PANDAPPA	hill slope	clayey sand	3
PP0103	33,10,15	139,07,52	450	4	E	PANDAPPA	ridge	skeletal	15
PT0101	33,03,25	139,26,43	290	1	SE	TWELVE MILE DAM	hill footslope	loam	25
PT0102	33,03,07	139,26,30	290	0	WSW	TWELVE MILE DAM	hill footslope	sandy loam	31
PT0103	33,03,28	139,26,18	305	1	NNW	TWELVE MILE DAM	hill footslope	sandy loam	29
SE0101	33,07,23	139,17,31	350	2	SW	WINGOONE HILL	hill slope	skeletal	19
SE0102	33,07,45	139,17,48	310	3	SW	WINGOONE HILL	plain	silt loam	25
SE0103	33,07,09	139,17,16	335	2	SW	WINGOONE HILL	hill footslope	silt loam	1
SE0201	33,08,55	139,12,07	450	4	NE	PANDAPPA	hill footslope	loamy sand	3
SE0202	33,08,22	139,12,23	450	4	NE	PANDAPPA	hill slope	sandy loam	12
SE0203	33,10,16	139,12,55	350	5	E	PANDAPPA	plain	loam	25
SE0301	33,06,47	139,13,15	350	4	SW	STEWARTS OLD STN	plain	loam	2
TL0101	33,03,20	139,17,41	350	2	SW	MACKYS DAM	hill footslope	clay loam	27
TL0102	33,03,25	139,17,30	360	4	SW	MACKYS DAM	hill footslope	loam	27
TL0201	33,05,37	139,16,02	360	2	SSE	TILKILKI H/S	hill footslope	sandy loam	29
TL0202	33,05,15	139,16,01	350	2	SE	TILKILKI	hill footslope	loam	25
TL0203	33,05,09	139,16,22	450	2	SE	TILKILKI H/S	ridge	silt loam	25
TO0101	33,09,35	139,23,39	230	2	SW	THE OAKS H/S	plain	clay loam, sandy	19
TR0101	33,26,32	139,05,26	395	4	ESE	WALLINGA H/S	ridge	silt loam	24
TR0102	33,26,34	139,06,04	500	6	ESE	WALLINGA H/S	ridge	sandy loam	4
TW0101	33,04,01	139,03,25	550	8	NNW	FRANKLYN	ridge	skeletal	3
TW0102	33,04,11	139,03,21	580	8	NNW	FRANKLYN	hill slope	skeletal	25

TW0103	33,04,12	139,03,30	520	8	NNW	FRANKLYN	plain	sandy loam	25
TW0104	33,04,59	139,03,27	490	8	NNW	FRANKLYN	hill footslope	clayey sand	3

SURVEY QUADRATS ON THE KOOMOOLOO MAPSHEET

Quadrat	Latitude (°,',"S)	Longitude (°,',"E)	Alt. (m)	Location (km)			Landform Element	Surface Soil Texture	Floristic Veg.Gp.
BL0101	33,33,53	139,50,15	80	0	E	O'BRIEN DAM	plain	loamy sand	32
BL0102	33,33,49	139,50,27	85	0	E	O'BRIENS DAM	plain	sandy loam	34
BL0201	33,36,53	139,54,09	65	2	S	NTH HIDEAWAY DM	playa/pan	medium clay	27
BL0202	33,37,03	139,54,09	70	2	N	HIDEAWAY DAM	plain	loamy sand	27
BL0301	33,39,05	139,48,07	62	3	E	DINGO DAM	plain	clayey sand	32
BL0401	33,41,35	139,46,27	62	2	NE	LITTLE LAGOON DM	plain	clayey sand	32
BL0402	33,41,25	139,46,35	62	2	NE	LITTLE LAGOON DM	plain	clayey sand	32
BL0501	33,42,30	139,52,32	90	2	SE	BORE TANK	dune crest	sandy loam	3
BL0502	33,42,20	139,52,32	90	1	SE	BORE TANK	swale	sandy clay loam	2
BL0503	33,42,33	139,52,32	89	2	SE	BORE TANK	swale	clay loam	2
BL0601	33,41,55	139,42,26	70	1	W	CENTIPEDE DAM	plain	clay loam, sandy	33
BY0101	33,47,04	139,48,47	50	7	SE	BALAH	plain	sandy loam	2
BY0102	33,46,54	139,48,47	50	7	SE	BALAH	dune footslope	sandy loam	1
BY0103	33,46,38	139,48,59	50	7	SE	BALAH	plain	clay loam	2
BY0201	33,47,36	139,42,25	50	3	NNW	CEMENT DAM	plain	clay loam	30
BY0202	33,47,33	139,42,25	50	3	NNW	CEMENT DAM	plain	clay loam	27
BY0203	33,47,45	139,42,13	50	3	NNW	CEMENT DAM	plain	light clay	27
BY0301	33,48,32	139,43,15	50	2	NNE	CEMENT DAM	plain	clay loam	32
BY0401	33,52,09	139,49,14	40	2	S	BELL CATCH DAM	hill crest	sandy clay loam	1
BY0402	33,52,16	139,49,13	40	2	S	BELL CATCH DAM	plain	clay loam	1
CN0201	33,33,33	139,58,40	80	1	S	CLAYPAN DAM	dune crest	sand	11
CN0202	33,34,16	139,58,08	77	3	SW	CLAYPAN DAM	swale	sand	27
CN0203	33,34,13	139,58,10	80	3	SSW	CLAYPAN DAM	dune crest	sand	11
GL0101	33,47,14	139,55,50	50	1	NNE	JUMBY EAST DAM	dune crest	sandy loam	5
GL0102	33,47,21	139,55,50	50	1	NNE	JUMBY EAST DAM	swale	clay loam	2
KM0101	33,31,45	139,33,29	120	2	NW	BUTCHER DAM	plain	silty clay loam	32
KM0201	33,36,08	139,37,44	100	1	SE	MUSTERING DAM	plain	silty clay loam	32
KM0301	33,36,28	139,34,18	110	1	W	COHEN DAM	plain	clay loam, sandy	32
KM0401	33,37,43	139,33,54	110	2	SW	COHEN DAM	plain	silty clay loam	33
KM0402	33,37,33	139,33,54	110	1	SW	COHEN DAM	plain	clay loam, sandy	32
LN0101	33,50,23	139,39,12	60	2	SE	EMBANKMENT DM	plain	clay loam, sandy	32
LN0201	33,52,27	139,36,03	70	5	NW	ROCKY DAM	plain	clay loam, sandy	31
LN0202	33,52,27	139,36,27	70	4	NW	ROCKY DAM	plain	clay loam, sandy	32
LN0301	33,54,52	139,39,19	50	4	NW	BUNGUNNIA	plain	clay loam	32
LN0401	33,55,60	139,33,47	70	4	NE	WHITES DAM	plain	clay loam	31
LN0501	33,56,38	139,33,27	70	3	NE	WHITES DAM	plain	clay loam	31
MD0101	33,57,54	139,30,07	90	3	SW	WHITES DAM	hill crest	clay loam	31
MD0102	33,57,54	139,30,15	90	3	SW	WHITES DAM	hill crest	clay loam	31
NK0101	33,57,01	139,54,35	50	5	SW	TINDA CATCH	swale	clayey sand	2
NK0102	33,56,19	139,55,07	52	4	SW	TINDA CATCH	closed depression	clayey sand	2
NK0201	33,57,59	139,53,32	40	8	SW	TINDA CATCH	open depression	clayey sand	31
NK0202	33,58,22	139,53,16	40	8	SW	TINDA CATCH	plain	loamy sand	4
NK0301	33,57,41	139,50,35	35	9	SE	ALBERTS DAM	plain	sandy clay loam	31
NK0401	33,59,54	139,49,03	30	10	SE	SHANNON'S DAM	plain	sandy loam	31
NK0501	33,58,22	139,48,02	30	8	SE	SHANNON'S DAM	plain	sandy loam	31
OK0101	33,36,47	139,42,50	80	3	NE	IRLAMS DAM	plain	silty clay loam	33
OK0201	33,40,01	139,41,57	80	2	NE	LITTLE HILLS DAM	plain	silty clay loam	32
RC0201	33,43,45	139,32,50	80	1	NW	WATSON BORE	hill footslope	silty clay loam	33
RC0301	33,44,15	139,33,36	60	0	NE	WATSON BORE	playa/pan	light clay	17
RC0302	33,44,08	139,33,11	70	1	NW	WATSON BORE	plain	silty clay loam	27
ST0101	33,55,52	139,46,23	40	2	SE	SHANNON DAM	playa/pan	medium clay	31
ST0201	33,57,18	139,44,17	30	4	SE	BUNGUNNIA	plain	sandy clay loam	2
ST0202	33,57,25	139,44,21	30	5	SE	BUNGUNNIA	hill crest	clay loam	32
ST0301	33,58,39	139,44,08	40	2	NE	NW BEND SUSTN	plain	clay loam	31
SW0101	33,47,45	139,36,23	60	0	N	SAMSONS WELL DM	playa/pan	medium clay	17
SW0201	33,49,37	139,34,40	80	2	NE	HOGAN BORE	drainage depression	light clay	-
SW0301	33,48,05	139,35,21	80	2	W	SAMSONS WELL DM	hill crest	silty clay loam	32
TV0101	33,55,41	139,58,35	57	2	S	LAUNER'S DAM	closed depression	clayey sand	2
WD0101	33,57,45	139,35,31	60	6	NW	GLEN RUFUS	plain	clay loam	31
WD0201	33,56,40	139,30,55	90	3	NW	WHITES DAM	plain	clay loam	33
WD0202	33,56,46	139,30,59	90	2	NW	WHITES DAM	plain	clay loam	31
WF0101	33,52,21	139,56,33	55	2	SE	SCHMIDTS DAM	playa/pan	sandy clay loam	7
WF0102	33,52,39	139,56,35	55	2	SE	SCHMIDTS DAM	plain	clayey sand	2
WF0103	33,53,15	139,56,38	60	3	N	LIMESTONE DAM	dune crest	sand	5

SURVEY QUADRATS ON THE MURKABY MAPSHEET

Quadrat	Latitude (°,',") S)	Longitude (°,'," E)	Alt. (m)	Location (km)			Landform Element	Surface Soil Texture	Floristic Veg.Gp.
BR0101	33,04,38	139,33,13	300	2	NW	SIEVE DAM	ridge	sandy loam	23
BR0102	33,04,39	139,33,32	364	2	NW	SIEVE DAM	hill slope	sandy loam	23
BR0103	33,04,44	139,34,00	300	1	NNW	SIEVE DAM	fan - alluvial	sandy clay loam	27
BR0201	33,06,22	139,37,36	360	2	E	RANGE DAM	ridge	sandy loam	15
BR0202	33,06,22	139,37,18	280	1	E	RANGE DAM	hill slope	sandy clay loam	27
BR0203	33,06,15	139,36,53	260	1	NE	RANGE DAM	plain	sandy loam	4
BR0204	33,06,13	139,36,42	250	1	NE	RANGE DAM	plain	sandy loam	7
BR0301	33,09,33	139,36,16	250	1	SW	GOVERNMENT DAM	hill crest	silty clay loam	32
BR0302	33,09,24	139,36,36	223	0	S	GOVERNMENT DAM	hill slope	clay loam, sandy	32
BR0401	33,11,56	139,37,09	200	1	W	BRAEMAR H/S	hill slope	sandy clay loam	28
BR0501	33,13,16	139,35,26	200	4	SW	BRAEMAR H/S	plain	sandy loam	32
BR0502	33,13,01	139,35,35	200	4	SW	BRAEMAR H/S	plain	sandy clay loam	28
BR0601	33,17,26	139,33,43	180	1	W	TRACTOR DAM	plain	sandy loam	32
BR0602	33,17,29	139,33,36	190	1	NW	TRACTOR DAM	plain	loamy sand	33
FH0101	33,06,47	139,47,16	150	3	NE	FARAWAY HILL STN	plain	sandy loam	32
FH0102	33,06,31	139,47,28	150	3	NE	FARAWAY HILL STN	plain	clay loam	32
FH0103	33,06,18	139,47,32	150	4	NE	FARAWAY HILL STN	plain	clay loam	32
FH0201	33,11,48	139,44,45	130	3	SE	WOOLSHED DAM	plain	loam	31
FH0202	33,11,58	139,44,37	130	3	SE	WOOLSHED DAM	plain	loam	32
FH0203	33,12,04	139,45,00	130	3	W	WEST FARMERS DM	playa/pan	loam	32
FH0204	33,11,45	139,45,16	130	4	WNW	WEST FARMERS DM	channel bench	clay loam	19
FH0205	33,11,58	139,45,16	130	3	W	WEST FARMERS DM	channel bench	loam	32
FL0101	33,22,17	139,43,07	120	6	NNE	BULLOCK DAM	plain	sandy loam	27
FL0102	33,22,31	139,43,05	120	5	NNE	BULLOCK DAM	plain	silty clay loam	31
FL0201	33,20,46	139,43,45	120	8	NNE	BULLOCK DAM	plain	clay loam,sandy	27
FL0202	33,21,03	139,43,47	120	8	NNE	BULLOCK DAM	dune crest	loamy sand	5
FL0203	33,21,15	139,43,43	120	8	NNE	BULLOCK DAM	plain	sandy loam	7
FL0301	33,23,45	139,56,15	100	4	W	THEODOLITE DAM	other	sandy loam	33
FL0302	33,23,57	139,56,13	100	4	WNW	THEODOLITE DAM	dune crest	sandy loam	33
KO0101	33,23,07	139,33,08	140	2	ENE	THE COFFIN DAMS	plain	sandy loam	33
KO0102	33,23,25	139,33,26	140	2	ENE	THE COFFIN DAMS	plain	sandy loam	32
MC0101	33,02,30	139,52,01	160	2	NE	MANUNDA CREEK	plain	sandy loam	31
MC0102	33,02,21	139,52,16	160	0	NE	MANUNDA CREEK	plain	clay loam	29
SM0101	33,00,53	139,57,34	150	2	NW	STAKER DAM	plain	loam	29
SM0102	33,00,46	139,57,38	150	2	NW	STAKER DAM	plain	sandy loam	27
SM0103	33,00,30	139,57,42	150	2	ESE	KRUGER DAM	plain	sandy loam	27

SURVEY QUADRATS ON THE YUNTA MAPSHEET

Quadrat	Latitude (°,',"S)	Longitude (°,',"E)	Alt. (m)	Location (km)			Landform Element	Surface Soil Texture	Floristic Veg.Gp.
GR0101	32,46,13	139,33,31	350	1	NE	GRAMPUS HILL	ridge	skeletal	29
GR0201	32,51,28	139,31,59	300	1	E	HAMMATT DAM	hill crest	sandy clay loam	32
GR0202	32,51,29	139,32,09	300	1	E	HAMMATT DAM	drainage depression	sandy clay loam	19
MN0101	32,48,26	139,45,24	250	2	SW	SCOBIE HILL	hill slope	clayey sand	27
MN0102	32,48,26	139,45,43	250	2	SW	SCOBIE HILL	hill slope	clayey sand	27
MN0103	32,48,32	139,45,32	220	2	SW	SCOBIE HILL	hill footslope	sandy loam	29
MN0201	32,53,41	139,46,14	250	2	N	OLD MANUNDA DM	hill crest	sandy loam	27
MN0301	32,53,51	139,52,19	300	6	SSW	VICS DAM	ridge	sandy clay loam	15
MN0401	32,58,08	139,53,25	175	3	SSE	CLAYPANS DAM	plain	light clay	27
MN0402	32,59,33	139,54,49	175	4	S	CLAYPANS DAM	playa/pan	medium clay	10
NT0101	32,44,04	139,54,41	250	7	W	NETLEY GAP	hill slope	loam	19
NT0102	32,44,11	139,54,41	250	7	W	NETLEY GAP	plain	sandy loam	33
OP0101	32,36,38	139,51,15	500	2	SE	OULNINA HILL	hill slope	silty clay	24
OP0102	32,35,42	139,50,45	450	0	S	OULNINA HILL	hill footslope	clay loam	4
OP0103	32,36,18	139,50,49	450	1	S	OULNINA HILL	hill slope	loam	5
OP0201	32,37,44	139,47,05	400	0	N	ONE TREE HILL	hill footslope	silt loam	29
PN0101	32,36,58	139,40,42	300	2	W	HORSE PDCK DM	plain	medium clay	19
PN0201	32,38,03	141,00,00	300	1	NE	PANARAMATEE H/S	plain	medium clay	31
PN0401	32,37,59	139,35,25	300	2	NW	GUM WELL	hill footslope	medium clay	14
PR0101	32,40,23	139,32,28	300	4	SE	DARE HILL	hill footslope	medium clay	27
PR0201	32,42,01	139,33,24	300	5	NW	PITCAIRN HILL	channel bench	silty clay loam	27
PR0202	32,42,09	139,32,57	300	5	NW	PITCAIRN HILL	hill footslope	silty clay loam	27
SD0101	32,55,01	139,34,09	400	1	NW	WHT.ELEPHANT BRE	hill footslope	clayey sand	32
SD0102	32,54,55	139,34,20	400	0	NE	WHT.ELEPHANT BRE	hill footslope	clayey sand	3
SD0201	32,54,30	139,35,38	400	2	W	TURNER DAM	ridge	sandy loam	23
SD0301	32,55,05	139,39,47	350	1	SE	TIVERTON OUTSTN	plain	loamy sand	16
SD0302	32,55,21	139,40,26	350	2	SE	TIVERTON OUTSTN	plain	sandy loam	33
TI0101	32,40,20	139,54,05	250	3	E	WHARTON HILL	hill footslope	clay loam	19
TI0102	32,40,20	139,54,17	250	5	E	WHARTON HILL	drainage depression	silt loam	29
TI0201	32,44,02	139,43,48	250	2	E	TIVERTON	hill slope	loam	27
TI0202	32,44,34	139,44,18	250	2	E	TIVERTON	plain	loam	31
WN0101	32,32,23	139,42,41	250	1	N	BIRTHDAY DAM	hill footslope	loam	32
WN0102	32,32,39	139,42,22	350	1	NW	BIRTHDAY DAM	hill slope	silt loam	29
WN0201	32,30,16	139,48,47	400	0	S	NTH WELL DAM	plain	sandy clay loam	1

SURVEY QUADRATS ON THE CADELL/POOGINOOK/OVERLAND CORNER MAPSHEETS

Quadrat	Latitude (°,',") S)	Longitude (°,',") E)	Alt. (m)	Location (km)			Landform Element	Surface Soil Texture	Floristic Veg.Gp.
GK0201	34,02,36	140,01,22	30	8	NE	TAYLORVILLE	plain	sandy loam	5
GK0202	34,02,39	140,01,36	30	8	NE	TAYLORVILLE	plain	sand	1
HN0101	34,02,16	140,25,23	50	4	NNE	HAWKES NEST DAM	dune crest	sand	5
HN0102	34,02,11	140,25,31	50	4	NNE	HAWKES NEST DAM	swale	loam	2
HN0201	34,05,25	140,28,12	40	6	ESE	HAWKES NEST DAM	dune crest	sand	5
HN0202	34,05,20	140,28,04	40	6	ESE	HAWKES NEST DAM	swale	sand	5
PK0101	34,03,31	140,07,26	50	9	N	ATKINDALE H.S.	swale	loamy sand	5
PK0102	34,03,29	140,07,30	50	9	N	ATKINDALE H.S.	dune crest	sand	5
PK0201	34,03,33	140,08,56	60	9	N	ATKINDALE H/S	swale	loamy sand	5
PK0202	34,03,37	140,08,58	60	9	N	ATKINDALE H.S.	dune crest	sand	5
PK0301	34,04,29	140,07,39	50	7	N	ATKINDALE H.S.	open depression	loam	3
PK0401	34,05,57	140,07,09	50	5	NNW	ATKINDALE H.S.	dune crest	sand	3
PK0402	34,05,50	140,07,09	50	5	NNW	ATKINDALE H.S.	swale	sand	2
TV0801	34,01,50	140,19,42	80	2	NW	WILKS DAM	dune crest	sand	5
TV0802	34,02,03	140,19,52	8	2	NW	WILKS DAM	swale	loamy sand	5
WF0001	34,01,25	139,52,56	40	4	E	WESTONS FLAT	dune slope	sand	2
WF0002	34,01,25	139,53,19	35	4	E	WESTONS FLAT	plain	loam	2

SURVEY QUADRATS ON THE PARCOOLA MAPSHEET

Quadrat	Latitude (°,',") S)	Longitude (°,',") E)	Alt. (m)	Location (km)			Landform Element	Surface Soil Texture	Floristic Veg.Gp.
CN0301	33,32,34	140,01,39	80	5	NNE	CANEGRASS H/S	hill slope	clay loam	32
CN0302	33,32,21	140,01,58	83	5	NNE	CANEGRASS H/S	plain	sandy clay loam	11
CN0401	33,34,58	140,05,03	75	6	E	CANEGRASS H/S	playa/pan	light clay	17
CN0402	33,34,58	140,04,51	75	6	E	CANEGRASS H/S	plain	clay loam, sandy	33
CN0501	33,33,27	140,11,43	75	4	NW	JUNCTION DAM	hill crest	sandy loam	1
CN0502	33,33,24	140,11,43	80	4	NW	JUNCTION DAM	plain	sandy loam	33
FJ0101	33,56,06	140,26,42	61	7	SW	FLASH JACK DAM	dune crest	loamy sand	5
FJ0102	33,56,06	140,27,36	60	7	SW	FLASHJACK DAM	plain	clay loam	5
GK0101	33,57,10	140,01,26	63	6	SE	LAUNER'S DAM	dune crest	sand	5
GK0102	33,57,13	140,01,26	57	6	SE	LAUNER'S DAM	swale	clayey sand	2
GL0201	33,43,06	140,06,15	70	3	NE	KANGAROO DAM	plain	loam	2
GL0202	33,43,35	140,05,51	70	2	NE	KANGAROO DAM	plain	loamy sand	5
GL0401	33,45,39	140,15,10	45	12	E	GLUEPOT H.S.	swale	sandy clay loam	3
GL0402	33,45,47	140,15,10	50	12	E	GLUEPOT H.S.	dune crest	sand	5
GL0403	33,45,32	140,15,10	50	12	E	GLUEPOT H.S.	dune crest	loamy sand	3
GL0501	33,45,51	140,20,52	38	6	ESE	OLD ROAD DAM	dune slope	sand	5
HW0101	33,41,49	140,25,53	82	6	SSE	9 MILE TANK	dune crest	sand	3
HW0102	33,41,13	140,25,49	82	5	SSE	9 MILE TANK	plain	clayey sand	1
HW0103	33,41,13	140,25,41	82	5	SSE	9 MILE TANK	dune footslope	loamy sand	5
HW0104	33,40,60	140,25,38	90	4	SSE	9 MILE TANK	dune crest	sand	-
HW0201	33,45,49	140,25,51	90	10	SW	HIDEAWAY HUT	plain	sandy clay loam	33
HW0202	33,45,52	140,25,32	90	12	SW	HIDEAWAY HUT	playa/pan	sandy loam	13
HW0203	33,45,42	140,25,51	90	10	SW	HIDEAWAY HUT	dune crest	sand	3
PC0101	33,37,58	140,06,07	60	2	S	DEAD FINISH DAM	dune crest	clay loam	1
PC0102	33,37,54	140,06,07	60	2	S	DEAD FINISH DAM	dune crest	loamy sand	1
TV0201	33,47,59	140,01,01	60	4	NE	FINAL DAM	plain	loamy sand	3
TV0202	33,47,59	140,01,30	60	3	NE	FINAL DAM	plain	sandy loam	2
TV0301	33,54,34	140,12,22	60	2	SW	MIDDLE DAM	playa/pan	clayey sand	2
TV0302	33,54,24	140,12,26	60	1	SW	MIDDLE DAM	dune slope	sand	2
TV0303	33,54,14	140,12,26	60	1	SW	MIDDLE DAM	dune crest	sand	5
TV0401	33,53,35	140,19,50	50	2	ESE	OAKS DAM	closed depression	clayey sand	22
TV0402	33,53,38	140,20,13	60	3	ESE	OAKS DAM	dune crest	sand	5
TV0403	33,55,02	140,18,35	55	4	S	OAKS DAM	swale	clayey sand	1
TV0501	33,58,48	140,16,40	72	2	SE	17 MILE DAM	dune crest	sand	5
TV0502	33,58,45	140,16,39	65	2	SE	17 MILE DAM	swale	clayey sand	5
TV0601	33,57,03	140,11,47	70	3	S	FIRST DAM	dune crest	sand	5
TV0602	33,57,06	140,11,45	65	3	S	FIRST DAM	swale	clayey sand	2
TV0701	33,59,07	140,06,01	60	0	N	12 MILE DAM	hill crest	clayey sand	13
YB0101	33,34,56	140,15,58	58	4	ESE	JUNCTION DAM	swale	sand	5
YB0102	33,34,50	140,16,02	58	4	E	JUNCTION DAM	dune crest	sand	12
YB0201	33,35,55	140,26,03	62	7	NNE	9 MILE TANK	plain	sand	2
YB0202	33,36,08	140,25,59	64	7	NNE	9 MILE TANK	dune crest	sand	13
YT0101	33,32,32	140,27,06	62	2	W	NANYAH DAM	open depression	sandy loam	33
YT0102	33,32,34	140,27,06	62	2	W	NANYAH DAM	open depression	clayey sand	12

SURVEY QUADRATS ON THE LILYDALE MAPSHEET

Quadrat	Latitude (°,',") S)	Longitude (°,'," E)	Alt. (m)	Location (km)			Landform Element	Surface Soil Texture	Floristic Veg.Gp.
CN0101	33,28,43	140,06,47	85	1	E	NTH CANEGRASS TK	hill crest	clayey sand	33
CN0102	33,28,49	140,06,20	80	1	E	NTH CANEGRASS TK	plain	clayey sand	27
LW0101	33,27,37	140,21,20	76	3	SE	GOOD FRIDAY DAM	swale	sandy clay loam	34
LW0102	33,27,45	140,21,16	77	3	SE	GOOD FRIDAY DAM	dune slope	sandy loam	2
LW0103	33,27,34	140,19,50	78	1	SE	GOOD FRIDAY DAM	plain	sandy loam	2
LW0104	33,27,20	140,19,41	78	0	E	GOOD FRIDAY DAM	plain	clay loam	32
OB0101	33,03,52	140,26,13	95	2	ENE	BOUNDARY DAM	dune crest	sand	4
OB0102	33,03,49	140,26,46	95	3	ENE	BOUNDARY DAM	swamp	clay loam	20
OB0103	33,03,43	140,27,13	95	4	ENE	BOUNDARY DAM	swale	sandy loam	34
PV0101	33,18,20	140,12,40	100	2	NE	PINE VALLEY H/S	dune crest	sand	5
PV0201	33,18,38	140,14,53	95	6	E	PINE VALLEY H/S	plain	sandy clay loam	33
PV0202	33,18,39	140,15,32	90	7	E	PINE VALLEY H/S	playa/pan	heavy clay	17
PV0301	33,25,20	140,10,52	80	2	E	RSL DAM	plain	clay loam	16
PV0302	33,25,07	140,10,28	80	2	NE	RSL DAM	playa/pan	heavy clay	20
PV0303	33,24,60	140,10,05	81	1	NE	RSL DAM	plain	heavy clay	27
PV0304	33,25,11	140,10,05	81	1	NE	RSL DAM	plain	clay loam	33
PV0401	33,16,13	140,11,06	100	2	SE	GLOEDE DAM	dune crest	sand	4
QU0101	33,03,28	140,11,59	125	12	NW	QUONDONG VALE H	plain	loam	33
QU0102	33,03,19	140,11,60	120	12	NW	QUONDONG VALE H	dune slope	sand	22
QU0103	33,03,58	140,11,59	110	12	NW	QUONDONG VALE H	open depression	loamy sand	14
SM0201	33,07,02	140,02,57	140	1	SE	ELMORE DAM	lain	clay loam	31
SM0202	33,07,13	140,03,01	140	1	SE	ELMORE DAM	plain	loamy sand	33
SM0301	33,07,22	140,11,57	115	10	SW	QUONDONG VALE H	dune crest	loamy sand	5
SM0302	33,07,32	140,11,42	110	13	SW	QUONDONG VALE H	plain	sandy loam	33
SV0101	33,09,29	140,05,34	118	1	ENE	SEVEN MILE DAM	drainage depression	sandy clay loam	29
SV0102	33,09,29	140,05,42	119	2	ENE	SEVEN MILE DAM	dune crest	loamy sand	22
SV0103	33,09,10	140,05,50	118	2	NE	SEVEN MILE DAM	plain	sandy clay loam	32
SV0201	33,15,60	140,00,32	110	3	SW	STURTVALE H/S	closed depression	medium clay	31
SV0202	33,16,06	140,00,28	110	3	SW	STURTVALE H/S	hill crest	sandy clay loam	32
SV0301	33,17,27	140,06,31	100	5	NE	WHITE HOPE DAM	plain	clayey sand	33

SURVEY QUADRATS ON THE ANABAMA MAPSHEET

Quadrat	Latitude (°,',″ S)	Longitude (°,',″ E)	Alt. (m)	Location (km)			Landform Element	Surface Soil Texture	Floristic Veg.Gp.
AD0101	32,39,50	140,05,14	340	2	SW	ANABAMA DAM	hill slope	loam	1
AD0102	32,39,24	140,05,22	340	2	SW	ANABAMA DAM	open depression	loam	6
BE0101	32,42,55	140,24,51	190	3	WSW	GREAT EASTN DM	plain	clay loam	32
BE0102	32,43,39	140,24,01	190	5	SW	GREAT EASTN DM	channel bench	clay loam	14
BE0201	32,45,47	140,24,46	190	1	NNW	BOUCAUTS EAST TK	plain	clay loam	32
BE0301	32,45,40	140,21,19	190	2	WSW	BOUCAUTS EST DM	plain	clay loam	18
BN0101	32,32,24	140,04,09	350	1	ESE	BRUCES DAM	plain	clay loam	4
BN0102	32,32,18	140,04,25	350	2	ESE	BRUCES DAM	plain	clay loam	18
BN0201	32,34,06	140,07,08	375	1	N	SALTWELL	hill slope	sandy loam	1
BN0202	32,34,13	140,07,16	375	1	N	SALTWELL	hill slope	skeletal	8
BN0203	32,34,19	140,07,01	350	1	WNW	SALTWELL	stream channel	sandy loam	1
BN0301	32,35,57	140,07,11	300	3	S	SALTWELL	stream channel	clayey sand	1
BN0302	32,35,50	140,07,07	300	3	S	SALTWELL	plain	clay loam, sandy	18
DB0101	32,31,04	140,23,54	290	3	NNE	WILKS WELL	hill slope	loam	32
DB0201	32,33,55	140,20,11	280	2	NNW	KNOB WELL	hill slope	loam	9
DB0202	32,33,45	140,20,42	280	3	N	KNOB WELL	hill slope	loam	9
DB0301	32,37,40	140,24,26	200	1	NE	DARK HILL DAM	plain	clay loam	27
DB0401	32,37,56	140,22,43	220	2	W	DARK HILL DAM	plain	loam	28
DB0501	32,39,58	140,18,40	220	2	E	NEW GRANITE DAM	hill footslope	loam	29
DB0502	32,39,32	140,19,03	220	3	E	NEW GRANITE DAM	hill footslope	clay loam	29
DL0101	32,40,31	140,10,20	270	4	NNW	DLORAH DOWNS H/S	plain	silty clay loam	33
DL0102	32,40,08	140,10,09	270	4	NNW	DLORAH DOWNS H/S	hill slope	clay loam, sandy	6
DL0201	32,38,57	140,11,46	260	0	W	WADNAMINGA DAM	drainage depression	silty clay loam	8
DL0202	32,38,34	140,11,34	255	1	NW	WADNAMINGA DAM	ridge	loam	6
ML0101	32,43,45	140,08,00	300	3	SE	MCLENNANS DAM	hill footslope	loam	7
ML0102	32,43,48	140,08,12	300	4	SE	MCLENNANS DAM	ridge	sandy clay loam	33
ML0201	32,45,13	140,08,49	280	2	N	BOULDER DAM	hill crest	sandy clay loam	6
ML0202	32,44,57	140,08,46	285	2	N	BOULDER DAM	plain	loam	32
SA0101	32,46,59	140,15,01	250	1	E	ANABAMA EAST DM	ridge	silt loam	29
SA0102	32,47,06	140,15,09	230	2	ESE	ANABAMA EAST DM	hill slope	loam	19
SA0201	32,46,54	140,18,14	200	2	SW	WILKS DAM	plain	clay loam	29
SA0301	32,51,36	140,17,31	180	3	SE	ANABAMA TANK	plain	clay loam	29
SA0401	32,51,09	140,14,28	180	3	WSW	ANABAMA TANK	plain	clay loam	6
SA0501	32,49,29	140,07,45	240	1	S	GORGE DAM	hill footslope	sandy loam	29
SA0601	32,49,06	140,06,31	220	2	W	GORGE DAM	plain	loam	29
TB0101	32,52,51	140,01,57	190	3	ENE	DIAMOND DAM	plain	loam	32
TB0201	32,53,32	140,06,30	180	3	SW	TOBACCO BUSH DM	plain	loam	33
VT0102	32,51,10	140,29,36	140	3	NE	OAKBANK DAM	plain	clay loam, sandy	33
WM0101	32,33,42	140,12,23	300	2	E	COUNTESS DAM	plain	clay loam, sandy	18
WM0102	32,33,52	140,12,23	300	2	E	COUNTESS DAM	stream channel	sandy clay loam	8
WM0103	32,34,05	140,12,23	300	2	E	COUNTESS DAM	hill slope	sandy loam	4
WM0201	32,33,17	140,14,26	300	3	NW	BURDONS TANK	plain	clay loam, sandy	31

SURVEY QUADRATS ON THE CHOWILLA MAPSHEET

Quadrat	Latitude (°,',"S)	Longitude (°,',"E)	Alt. (m)	Location (km)			Landform Element	Surface Soil Texture	Floristic Veg.Gp.
FC0101	33,55,20	140,41,38	50	1	NW	FISCOM DAM	dune slope	loamy sand	2
FC0102	33,54,43	140,41,11	55	2	NW	FISCOM TANK	dune crest	sand	1
FC0201	33,58,22	140,41,51	55	2	SE	FISCOM DAM	dune crest	sand	22
FC0202	33,58,26	140,41,53	60	2	SE	FISCOM DAM	swale	sand	4
FJ0201	33,54,10	140,31,15	60	2	N	FLASHJACK DAM	plain	loamy sand	18
FJ0202	33,54,10	140,31,11	60	2	N	FLASHJACK DAM	plain	clay loam	1
FJ0203	33,53,12	140,31,15	60	4	N	FLASHJACK DAM	plain	loamy sand	1
FJ0301	33,51,09	140,32,07	60	4	NE	FROGAMERRY DAM	dune crest	sand	5
FJ0302	33,51,22	140,32,07	60	4	NE	FROGAMERRY DAM	drainage depression	clay loam	18
FJ0303	33,51,38	140,32,06	60	4	E	FROGAMERRY DAM	plain	sandy clay loam	1
FJ0401	33,51,03	140,38,44	50	2	NNW	LONG DAM	plain	loamy sand	14
FJ0402	33,50,48	140,38,42	55	2	NNW	LONG DAM	plain	sand	1
HY0201	33,35,46	140,57,25	60	2	NNW	23 MILE DAM	dune slope	sandy loam	34
HY0301	33,35,40	140,59,17	60	2	SSW	ROSE DAM	plain	sandy clay loam	34
HY0401	33,33,17	140,49,39	55	5	ESE	NANYA DAM	swale	loamy sand	3
HY0601	33,35,53	140,53,16	45	5	SW	HYPURNA H/S	dune slope	loamy sand	3
JH0101	33,38,05	140,54,05	60	1	SE	BIG DAM	dune slope	sand	5
JH0201	33,38,47	140,54,53	60	3	SE	BIG DAM	plain	sandy clay loam	33
JH0301	33,42,23	140,51,27	69	3	W	BERTRAM DAM	dune slope	sand	4
JH0302	33,42,10	140,50,04	40	2	E	GILES DAM	plain	sand	4
JH0401	33,42,13	140,59,16	40	3	SE	23 MILE DAM	plain	clay loam	32
OA0101	33,42,10	140,35,00	84	3	SE	RED BAND TANK	dune crest	sand	2
OA0102	33,41,54	140,34,53	83	2	SE	RED BAND TANK	swale	sand	2
OA0201	33,43,38	140,35,58	65	3	NW	BURNT CAMP	swale	sand	2
OA0202	33,43,32	140,35,44	69	3	NW	BURNT CAMP	dune crest	sand	5
PA0101	33,46,39	140,59,35	47	2	SSW	18 MILE DAM	dune slope	loamy sand	18
PA0102	33,46,47	140,59,25	41	3	SSW	18 MILE DAM	plain	sandy loam	26
PA0201	33,50,28	140,56,45	50	1	N	BOX TREE W/HOLE	dune crest	sandy loam	5
PA0202	33,50,34	140,56,45	41	1	N	BOX TREE W/HOLE	plain	sandy loam	3
PA0301	33,52,30	140,57,13	55	3	S	LAKE LIMBRA	dune slope	sandy loam	33
SQ0201	33,35,06	140,40,52	65	2	SSW	ROUND DAM	plain	clayey sand	2
TM0101	33,50,60	140,48,55	50	2	S	WINACK DAM	dune crest	sand	5
TM0102	33,50,44	140,48,58	50	2	S	WINACK DAM	plain	sand	1
TM0201	33,53,57	140,51,44	60	2	W	COOMBOOL SWAMP	dune slope	loamy sand	1
TM0202	33,54,05	140,52,01	60	1	W	COOMBOOL SWAMP	swale	sandy loam	8
TM0301	33,55,41	140,49,48	50	4	N	TIMLY DAMS	dune crest	sand	5
WT0101	33,46,22	140,43,38	60	3	N	CATALOGUE DAM	swale	sand	2
WT0102	33,46,35	140,43,42	60	2	N	CATALOGUE DAM	dune slope	sand	3
WT0103	33,46,41	140,43,50	60	2	N	CATALOGUE DAM	dune footslope	sand	26
WT0201	33,47,05	140,49,32	60	4	E	WOTAN DAM	dune slope	sand	3
WT0202	33,47,08	140,49,41	58	4	E	WOTAN DAM	plain	sand	2
YT0201	33,35,21	140,32,43	80	2	NW	YABBIE TANK	dune crest	sand	5
YT0202	33,35,37	140,33,02	75	2	NW	YABBIE TANK	swale	sand	2
YT0301	33,31,35	140,39,00	78	5	NW	ROUND DAM	dune crest	sand	5
YT0302	33,31,31	140,39,00	78	6	SE	ROUND DAM	dune crest	sand	34

SURVEY QUADRATS ON THE CANOPUS MAPSHEET

Quadrat	Latitude (°,',” S)	Longitude (°,',” E)	Alt. (m)	Location (km)			Landform Element	Surface Soil Texture	Floristic Veg.Gp.
CA1101	33,29,05	140,48,40	60	2	E	BRITANNIA DAM	plain	sandy clay loam	34
CA1102	33,29,10	140,48,30	60	2	E	BRITANNIA DAM	plain	sandy clay loam	34
CA1201	32,34,55	140,39,33	70	2	N	TARGET MARK DAM	dune slope	clayey sand	5
CA1202	33,28,22	140,39,57	65	2	N	TARGET MARK DAM	plain	sandy loam	3
DA0101	33,04,01	140,50,58	90	2	WNW	STN DAM	plain	loamy sand	11
DA0201	33,07,39	140,38,39	80	10	SE	OAKBANK STN	plain	loam	11
DA0301	33,08,60	140,44,26	80	2	NNE	RAINBOW DAM	dune slope	sand	5
DA0302	33,09,08	140,44,37	80	2	NNE	RAINBOW DAM	dune slope	sand	5
DA0401	33,16,43	140,49,51	90	2	NW	ACHERNAR DAM	swale	sand	4
DA0402	33,16,53	140,49,38	90	2	NNW	ROUND DAM	swale	sand	33
DA0501	33,22,40	140,50,12	80	1	S	MUCKETT DAM	plain	loamy sand	2
DA0601	33,25,52	140,32,23	60	0	NE	CHRISTMAS BORE	plain	sandy loam	2
DA0602	33,25,46	140,32,30	60	0	NE	CHRISTMAS BORE	plain	loamy sand	14
DA0701	33,29,42	140,32,30	80	1	NW	FARAWAY BORE	plain	sandy loam	2
DA9901	33,07,39	140,36,20	75	9	SSE	OAKBANK O/S	hill slope	loamy sand	4
EB0101	33,22,58	140,59,29	70	3	NE	MORNINGTON DAM	plain	clay loam, sandy	34
EB0102	33,22,42	140,59,50	70	3	NE	MORNINGTON DAM	dune footslope	clayey sand	22
EB0103	33,23,05	140,59,50	75	3	NE	MORNINGTON DAM	dune crest	sand	5
PV0501	33,12,53	140,30,31	80	2	S	HARD DAM	plain	light clay	27
TP0101	33,14,06	140,42,37	75	1	N	TIPPERARY DAM	dune slope	clayey sand	4
TP0102	33,14,01	140,42,37	70	1	N	TIPPERARY DAM	plain	light clay	32
TP0103	33,14,18	140,42,37	75	1	N	TIPPERARY DAM	dune crest	clayey sand	32

SURVEY QUADRATS ON THE OAKVALE MAPSHEET

Quadrat	Latitude (°,',") S)	Longitude (°,'," E)	Alt. (m)	Location (km)			Landform Element	Surface Soil Texture	Floristic Veg.Gp.
CK0101	32,35,10	140,34,06	180	2	WNW	COCKRUM DAMS	plain	loam	28
CK0102	32,34,05	140,34,26	175	3	NW	COCKRUM DAMS	flood out	loam	19
CK0201	32,32,51	140,38,28	190	2	E	ALDERMANS CATCH	plain	clay loam	27
CK0202	32,33,01	140,38,28	190	2	E	ALDERMANS CATCH	drainage depression	medium clay	27
CK0203	32,33,17	140,38,28	190	2	SE	ALDERMANS CATCH	plain	clay loam	27
CK0301	32,31,30	140,40,12	180	2	SW	PEGLINE DAM	hill crest	silt loam	27
CK0401	32,32,12	140,36,41	200	2	W	ALDERMANS CATCH	hill slope	silt loam	28
JS0101	32,38,04	140,50,43	130	2	N	JONES DAM	channel bench	sand	10
JS0102	32,37,58	140,50,44	140	2	N	JONES DAM	plain	loam	6
JS0201	32,38,27	140,48,12	140	5	E	JUBILEE DAMS	plain	loam	6
JS0202	32,38,43	140,48,29	140	5	E	JUBILEE DAMS	plain	loam	7
LZ0101	32,46,18	140,50,50	130	2	NE	LOCH HAZARD DAM	plain	loamy sand	26
LZ0102	32,46,18	140,51,13	130	2	NE	LOCH HAZARD DAM	drainage depression	sandy loam	14
LZ0201	32,44,08	140,51,33	130	2	S	COTTONBUSH TANK	drainage depression	sandy loam	14
LZ0202	32,44,00	140,51,50	130	1	S	COTTONBUSH TANK	drainage depression	sandy loam	26
LZ0301	32,45,20	140,55,46	120	3	S	NEW YEAR DAM	plain	clay loam, sandy	33
LZ0302	32,45,23	140,55,43	120	3	S	NEW YEAR DAM	plain	clay loam, sandy	33
LZ0303	32,45,30	140,56,25	120	3	SE	NEW YEAR DAM	plain	sandy loam	34
MG0101	32,40,12	140,33,53	150	6	SW	MULGA DAM	plain	sandy clay loam	32
MG0102	32,40,09	140,34,05	150	5	SW	MULGA DAM	plain	clay loam	32
MG0201	32,42,49	140,37,32	150	2	NW	GAIRLOCH DAM	plain	light clay	32
MG0202	32,42,52	140,37,47	150	2	NW	GAIRLOCH DAM	plain	light clay	33
OV0101	32,58,06	140,46,43	95	2	NE	WEST DAM	closed depression	sandy clay loam	27
OV0201	32,59,18	140,55,42	100	1	E	BROOKS BORE	hill/mountain	sand	5
OV0202	32,59,18	140,54,32	80	1	W	BROOKS BORE	swale	sandy loam	3
OV0301	32,59,18	140,58,31	100	3	SW	PURPLE CATCH	dune crest	sandy loam	34
OV0302	32,59,18	140,56,51	100	3	E	BROOKS BORE	swale	loamy sand	33
OV0401	32,52,57	140,50,27	100	0	N	PARINGA DAM	flood out	sandy loam	14
OV0402	32,53,17	140,50,53	100	1	E	PARINGA DAM	stream channel	clay loam, sandy	14
OV0501	32,52,09	140,54,48	100	2	ENE	MULGA DAM	plain	sandy loam	34
OV0502	32,51,53	140,54,60	100	3	ENE	MULGA DAM	plain	sandy clay loam	33
OV0503	32,51,40	140,56,01	100	4	ENE	MULGA DAM	stream channel	light clay	32
VT0101	32,50,48	140,30,19	140	4	SW	VERITY TANK	plain	clay loam	32
VT0201	32,46,25	140,31,45	150	2	NW	SATIRE DAM	plain	clayey sand	33
WK0101	32,36,34	140,51,22	155	4	SW	WEST CREEK DAM	plain	clay loam	27
WK0201	32,34,56	140,51,49	175	2	SW	WEST CREEK DAM	playa/pan	clay loam	27
WK0301	32,31,09	140,52,24	200	1	SW	BLACK HILL DAM	plain	loam	28
WK0302	32,31,25	140,52,12	200	2	SW	BLACK HILL DAM	plain	loam	27
WK0401	32,31,22	140,49,24	200	2	NW	BULL DAM	plain	loam	28
WK0402	32,31,22	140,49,01	200	3	NW	BULL DAM	plain	loam	27

Appendix IV

PLANT SPECIES TAXONOMIC CHANGES SINCE THE SOUTH OLARY PLAINS VEGETATION SURVEY

Taxa and changes stated are only relevant to the survey area. Complete current taxonomy is in Jessop (1993).

* = names used in the analysis (i.e. new taxonomy if changes were direct, or old taxonomy where changes were not direct and new and old names required grouping).

Old name	New name
*Acacia aneura**	*Acacia aneura.* var. *aneura* *Acacia ayersiana* var. *latifolia*
Acacia ligulata	*Acacia ligulata** *Acacia cupularis*

[By geographic location, all specimens in the survey area were designated as *A. ligulata*]

Old name	New name
Callitris collumelaris	*Callitris glaucophylla**
*Eremophila glabra**	*Eremophila glabra* ssp. *glabra* *Eremophila glabra* ssp. *murrayana.*
Eucalyptus leucoxylon	*Eucalyptus leucoxylon* ssp. *pruinosa**
Goodenia affinis	*Goodenia willisiana**
Helichrysum ambiguum	*Chrysocephalum semicalvum semicalvum**
Hordeum sp.	*Critesion sp.* *
Hordeum glaucum	*Critesion murinum* ssp. *glaucum**
Hordeum leporinum	*Critesion murinum* ssp. *leporinum**
*Myoporum platycarpum**	*Myoporum platycarpum* ssp. *platycarpum*
Salvia lanigera	*Salvia verbenaca* form B*
Swainsona stipularis var.	*Swainsona stipularis**
Triodia irritans	*Triodia irritans* complex*
Zyyophyllum ammophilum *	*Zygophyllum ammophilum* *Zygophyllum simile*
*Zyyophyllum billardieri**	*Zygophyllum angustifolium* *Zygophyllum confluens*

Appendix V

SOUTH AUSTRALIAN VEGETATION STRUCTURAL FORMATIONS
[adapted from Specht (1970) and Muir (1977)]

Life Form/ Height Class	Canopy Cover of Tallest Stratum			
	Dense (70-100%)	**Mid-dense (30-70%)**	**Sparse (10-30%)**	**Very sparse (<10%)**
Trees < 30m	Tall closed forest	Tall open forest	Tall woodland	Tall open woodland
Trees 10-30m	Closed forest	Open forest	Woodland	Open woodland
Trees 5-10m	Low closed forest	Low open forest	Low woodland	Low open woodland
Trees <5m	Very low closed forest	Very low open forest	Very low woodland	Very low open woodland
Mallee tree (>3m)	Closed tree mallee	Tree mallee	Open tree mallee	Very open tree mallee
Mallee shrub (<3m)	Closed shrub mallee	Shrub mallee	Open shrub mallee	Very open shrub mallee
Shrubs > 2m	Tall closed shrubland	Tall shrubland	Tall open shrubland	Tall very open shrubland
Shrubs 1-2m	Closed shrubland	Shrubland	Open shrubland	Very open shrubland
Shrubs < 1m	Low closed shrubland	Low shrubland	Low open shrubland	Low very open shrubland
Hummock grasses	Closed Hummock grassland	Hummock grassland	Open hummock grassland	Very open hummock grassland
Tussock grasses	Closed (tussock) grassland	(Tussock) grassland	Open (tussock) grassland	Very open (tussock) grassland
Sedges	Closed sedgeland	Sedgeland	Open sedgeland	Very open sedgeland
Herbs	Closed herbland	Herbland	Open herbland	Very open herbland
Ferns	Closed fernland	Fernland	Open fernland	Very open fernland

Trees - woody; perennial; erect; canopy raised well above the ground. Depth of canopy is usually less than or equal to two thirds of the total tree height. Single stemmed, or if multistemmed, fewer than five individual trunks resulting from branching of a single short trunk, that is not a mallee-like lignotuber. Height usually >2m.
Mallees - genus *Eucalyptus;* multi-stemmed, trunks arising from lignotuber. Shrub mallee - five or more trunks. Tree mallee - usually less than five trunks.
Shrubs- woody; perennial; erect, procumbent or weeping; foliage occupies all or part of total plant height; multiple stems and branches arising from a rootstock or very short common trunk; generally <5m tall.
Hummock Grass - Genera *Triodia* or *Plectrachne* only.
Grasses (tussock) - family Poaceae (Graminae); leaf sheath always split.
Sedges - herbaceous, usually perennial, erect, generally tufted; arise from stolons, tubers, bulbs, rhizomes or seeds. Leaf sheath never split. Includes Cyperaccae, Juncaceae, Restionaceae, Typhaceae and Xyridaceae and other sedge-like forms.
Herbs - herbaceous or slightly woody; annual or sometimes perennial; erect or creepers; rarely exceeds 0.5m height.
Ferns - vascular cryptogram of Order Filicales.

Appendix VI

PLANT SPECIES RECORDED FROM THE SOUTH OLARY PLAINS SURVEY AREA

Species are arranged in alphabetic order of family. Plant taxonomy follows Jessop (1993) and common names are from the SA FLORA database.

* Introduced species

(nv) Non-current taxonomy, probably sensu. Jessop and Toelken (1986).

@ Record possibly just outside the current survey area i.e. riverine species in the case of columns 4,5,6 & 13 or north of survey area (columns 9 & 10).

$ Questionable identification as far outside known range of the species according to Jessop (1993) and P. Lang (pers. comm.) and specimen not vouchered.

Conservation status codes are shown in bold following the scientific name, listed in sequence Australian (species)/South Australian/Regional, according to Briggs and Leigh (1995) and Lang and Kraehenbuhl (1994). Regional status refers only to the Murray region as Eastern has not yet been assessed.

E **Endangered** - rare and in danger of becoming extinct in the wild.
V **Vulnerable** - rare and at risk from potential threats or long term threats which could cause the speices to become endangered in the future.
T **Threatened** - likely to be either endangered or vulnerable but insufficient data for a more precise assessment.
R **Rare** - having a low overall frequency of occurrence: confined to a restricted range or scattered sparsely over a wider area. Not currently exposed to significant threats but warranting monitoring and protective measures to prevent reduction of populations.
K **Uncertain** - likely to be either threatened or rare but insufficient data for a more precise assessment.
U **Uncommon** - less common species of interest but not rare enough to warrant special protective measures.
N Not of particular significance/Common.
Not yet assessed but flagged as being of possible significance.

The thirteen columns indicate the source of plant species records as follows:

p Presumed from a different identification

1 South Olary Plains survey, D.E.N.R., 1995 (this survey), site data
2 South Olary Plains survey, D.E.N.R., 1995 (this survey), opportunistic data
3 University of S.A. (1988-1994; J.Gibbs, pers. comm.), Danggali Conservation Park
4 T.A.F.E. (1981), Danggali Conservation Park and Chowilla Regional Reserve
5 Barratt and Choate (1983). Barratt and White (1993) (Chowilla Regional Reserve) and Barratt and Kutsche (1994) (Calperum Station).
6 S.A. National Parks and Wildlife Service park records (Pooginook, Pandappa, White's Dam & Cooltong Conservation Parks)
7 Barker (1970), Quondong Station
8 Brett (1990), Morgan to Yunta area
9 Barber and Linton (1989), Olary 1:250 000 mapsheet
10 Tiver (1994), Olary & half Chowilla 1:250, 000 mapsheet
11 Jessup (1948), Counties Eyre, Burra and Kimberly
12 Native Vegetation Management Section, D.E.N.R. clearance application assessments (agricultural areas)
13 Field Naturalist's Society of South Australia, Botany Club (pers.comm.), conservation parks and non-floodplain riverland area

Scientific Name	Common Name	Source
ADIANTACEAE		
Cheilanthes austrotenuifolia	rock fern	1
C. distans **-NK**	bristly cloak-fern	1
C. lasiophylla **-NU**	woolly cloak-fern	1 6 8 10
C. sieberi ssp. *sieberi* **-NK**	Sieber's rock-fern	1 3 4 9 10
C. sp.	rock fern	1
C. tenuifolia (nv)		11
AGAVACEAE		
* *Agave americana*	century plant	

		1	2	3	4	5	6	7	8	9	10	11	12	13
AIZOACEAE														
Carpobrotus modestus	inland pigface								8					13
C. modestus/rossii		1												
C. rossii	karkalla										10			
C. sp	pigface					5.								
Disphyma crassifolium ssp. *clavellatum*	round-leaf pigface	1				5	6	7						13
Glinus lotoides **-NU**	hairy carpet-weed							7						
Gunniopsis quadrifida @	Sturts pigface										10			
* *Mesembryanthemum crystallinum*	common iceplant										10	11	12	13
* *M. nodiflorum*	slender iceplant	1				5	6							13
* *M.* sp.						5	6							
* *Psilocaulon tenue*	match-head plant			3	4									13
Sarcozona praecox	sarcozona	1		3										
Tetragonia eremaea	desert spinach	1		3	4		6		8		10		12	13
T. eremaea/tetragonoides	native spinach	1												
T. implexicoma	bower spinach	1												
T. sp.		1												
T. tetragonioides	New Zealand spinach	1		3	4	5		7		9		11		
Trianthema triquetra	red spinach										10			
AMARANTHACEAE														
Alternanthera denticulata	lesser joyweed													13
Ptilotus exaltatus var. *exaltatus*	tall mulla mulla	1	2	3	4	5			8		10		12	13
P. gaudichaudii var. *parviflorus*	paper foxtail			3							10			
P. nobilis var. *nobilis* **-NK**	yellow tails			3										
P. obovatus var. *obovatus*	silver mulla mulla	1		3	4	5	6	7	8	9	10	11	12	13
P. polystachyus var. *polystachyus*	long-tails	1									10	11		
P. polystachyus var. *polystachyus* forma *polystachyus*	long-tails			3										
P. polystachyus var. *polystachyus* forma *rubriflorus*	red long-tails			3										
P. seminudus	rabbit-tails	1	2										12	13
P. sessilifolius var. *sessilifolius*	crimson foxtail			3				7						
P. sp.		1		3			6							13
P. spathulatus forma *spathulatus*	pussytail	1				5	6					11	12	13
AMARYLLIDACEAE														
Calostemma purpureum	pink garland-lily													13
Crinum flaccidum **-NV**	Darling lily					5					10			
ANACARDIACEAE														
* *Schinus areira*	pepper-tree		2							9	10			
ASCLEPIADACEAE														
* *Asclepias rotundifolia*	broad-leaved cotton-bush													13
Marsdenia australis	native pear	1		3	4	5	6				10			13
Rhyncharrhena linearis **-N#**	climbing purple-star	1		3		5	6							
Sarcostemma viminale ssp. *australe*	caustic bush										10			
ASPLENIACEAE														
Pleurosorus rutifolius **-NR**	blanket fern	1												
AZOLLACEAE														
Azolla filiculoides	Pacific azolla													13
A. sp														13
BORAGINACEAE														
* *Buglossoides arvensis*	sheepweed										10			
Cynoglossum sp.		1												
* *Echium italicum*	Italian bugloss													13
* *E. plantagineum*	Salvation Jane	1	2	3			6		8	9	10	11		13
* *E.* sp.		1												
Halgania andromedifolia **-NU**	scented blue-flower		2										12	13
H. cyanea	rough blue-flower	1	2	3	4	5	6				10		12	13
* *Heliotropium amplexicaule*	blue heliotrope										10			
H. asperrimum	rough heliotrope	1												
* *H. curassavicum*	smooth heliotrope													13
* *H. europaeum*	potato weed	1		3	4	5		7			10	11		13
* *H. supinum*	prostrate heliotrope			3		5		7						13

H. undulatum		1
Myosotis australis @	austral forget-me-not	13
* *Neatostema apulum*	hairy sheepweed	1 10 13
Omphalolappula concava	burr stickseed	1 3 4 6 9 10 13
Plagiobothrys plurisepaleus	white rochelia	1 3 4 13
CAMPANULACEAE		
Isotoma petraea **-NR**	rock isotome	1 10
Wahlenbergia communis	tufted bluebell	1 5 10
W. fluminalis	river bluebell	13
W. gracilenta	annual bluebell	1 3 4 10 13
W. luteola	yellow-wash bluebell	10 13
W. sp.	native bluebell	1 3 4 5 6 11
W. stricta ssp. *stricta*	tall bluebell	1 10 13
W. tumidifructa **-NR**	swollen-fruit bluebell	8 10 13
CARYOPHYLLACEAE		
* *Arenaria leptoclados*	delicate sandwort	13
* *Gypsophila tubulosa*	annual chalkwort	3 4
* *Herniaria cinerea*	rupturewort	1 3 4 10 13
* *Polycarpon tetraphyllum*	four-leaf allseed	10
Scleranthus minusculus **-UU**	cushion knawel	13
S. pungens	prickly knawel	1 3 6 9 10
* *Silene apetala*	mallee catchfly	1 12
* *S. gallica*		10
* *S. nocturna*	Mediterranean catchfly	10 13
* *S.* sp.		1
* *Spergula arvensis* $[1]	corn spurrey	4
* *Spergularia diandra*	lesser sand-spurrey	9 10 13
* *S. media*	coast sand-spurrey	13
* *S. rubra*	red-spurrey	1 3 4 13
* *S.* sp.		1 6
CASUARINACEAE		
Allocasuarina verticillata	drooping sheoak	1 11 12
Casuarina pauper	black oak	1 3 4 5 6 7 8 9 10 11 12 13
CHENOPODIACEAE		
Atriplex acutibractea ssp. *acutibractea*		1 3 5 7 8 10 12 13
A. angulata	fan saltbush	1 2 5 7 9 10
A. eardleyae	small saltbush	1 3 5 6 7 10 13
A. holocarpa	pop saltbush	1 5 9 10
A. limbata **-NU**	spreading saltbush	1 7 9 10
A. lindleyi ssp.		1 7 9
A. lindleyi ssp. *conduplicata*		1 5 10
A. lindleyi ssp. *inflata*		1 3 4 5 6 7 10 12 13
A. lindleyi ssp. *lindleyi*		5
A. muelleri $[2]	Muellers saltbush	11 13
A. nummularia		2 5 6 10 13
A. paludosa ssp.		5 12 13
* *A. prostrata*	mat saltbush	13
A. rhagodioides **-NU**	river saltbush	5 6 11 13
A. semibaccata	berry saltbush	5 11 13
A. sp.	saltbush	1 4 5 6 9 12 13
A. spongiosa	pop saltbush	5 7 8 9 11 12
A. stipitata	mallee saltbush	1 2 3 4 5 6 8 9 10 11 12 13
A. suberecta	lagoon saltbush	13
A. velutinella	sandhill saltbush	9 10 11
A. vesicaria ssp.	saltbush	1 4 5 6 7 8 9 10 11 12 13
A. vesicaria ssp. *calcicola*		1 3
A. vesicaria ssp. *macrocystidia*		1 3
* *Chenopodium album*	fat hen	13
C. carinatum (nv)		11
C. cristatum	crested goosefoot	1 3 4 10 11 13
C. curvispicatum	cottony goosefoot	1 2 3 5 10 12 13

[1] Questionable identification as previously only known from Southern Lofty, Northern Lofty & South-Eastern regions.
[2] Questionable identification as previoulsy only known from Lake Eyre region.

		1	2	3	4	5	6	7	8	9	10	11	12	13
C. desertorum ssp.	desert goosefoot	1	2			5	6	7				11	12	
C. desertorum ssp. *anidiophyllum*	mallee goosefoot	1		3		5			8		10			
C. desertorum ssp. *desertorum*	desert goosefoot	1		3		5					10		12	13
C. desertorum ssp. *microphyllum*	small-leaf goosefoot	1		3								11		
C. desertorum ssp. *rectum*	erect goosefoot													13
C. erosum				3										
C. gaudichaudianum				3	4	5	6						12	13
C. melanocarpum forma *melanocarpum*	black crumbweed			3		5					10			
* *C. murale*	nettle-leaf goosefoot		2					7			10			13
C. nitrariaceum	nitre goosefoot	1		3	4	5	6	7	8	9		11		13
C. pumilio	clammy goosefoot	1						7			10			13
C. sp.	goosefoot	1												
C. truncatum		1		3										
Dissocarpus biflorus var. *biflorus* **-NK**	twin-horned copperburr	1		3		5			8	9	10			
D. paradoxus		1	2	3	4	5	6	7	8	9	10	11	12	13
D. sp.		1			4									
Einadia nutans ssp.		1			4	5	6	7	8		10	11	12	13
E. nutans ssp. *nutans*	climbing saltbush			3						9				13
E. nutans ssp. *oxycarpa*				3										
Enchylaena tomentosa var. *tomentosa*	ruby saltbush	1	2	3	4	5	6	7	8	9	10	11	12	13
Eriochiton sclerolaenoides		1	2	3	4	5	6		8	9	10	11	12	13
Halosarcia pergranulata ssp.				3										
H. pergranulata ssp. *pergranulata*						5								13
H. sp.	samphire	1		3	4	5								13
Maireana aphylla **-NR**	cotton-bush	1		3	4		6		8	9	10	11	12	13
M. appressa **-NU**		1		3		5		7		9	10	11		13
M. astrotricha **-NU**	grey bluebush	1						7	8	9	10			
M. brevifolia	short-leaf bluebush	1	2	3	4	5	6	7	8	9	10	11	12	13
M. ciliata	hairy fissure-weed									9				
M. coronata	crown fissure-weed	1								9				
M. decalvans **-E-**	black cotton-bush					5						11		
M. enchylaenoides	wingless bluebush													13
M. erioclada	rosy bluebush	1		3		5	6	7			10		12	13
M. excavata **-K-**	bottle bluebush											11		
M. georgei	satiny bluebush	1		3		5		7		9		11		13
M. georgei/turbinata		1									10			
M. integra		1				5				9	10			
M. oppositifolia	salt bluebush													13
M. pentagona @ **-RR**	hairy bluebush					5								
M. pentatropis	erect bluebush	1	2	3		5	6		8	9			12	13
M. planifolia	low bluebush											11		
M. pyramidata	black bluebush	1		3	4	5	6	7	8	9	10	11	12	13
M. radiata	grey bluebush	1	2	3		5							12	13
M. rohrlachii **RRR**	Rohrlach's bluebush	1												13
M. sedifolia	pearl bluebush	1	2	3	4	5	6	7	8	9	10	11	12	13
M. sp.	bluebush	1					6							13
M. suaedifolia **-VV**	lax bluebush		2											
M. tomentosa ssp. *urceolata* $[3]				3	4	5	6							13
M. trichoptera	mallee bluebush	1		3		5		7	8	9	10		12	13
M. triptera	three-wing bluebush	1	2	3		5	6				10	11		13
M. turbinata	top-fruit bluebush	1							8				12	13
M. villosa @	silky bluebush									9				
Malacocera sp.		1												
M. tricornis	goat-head	1				5			8	9				
Osteocarpum acropterum var.	bonefruit					5		7				11		
O. acropterum var. *acropterum* **-NR**	small-wing bonefruit	1							8	9				13
O. acropterum var. *deminutum* **-RR**	wingless bonefruit										10			
O. dipterocarpum	two-wing bonefruit									9				
O. sp.		1												
Pachycornia triandra @ **-UU**	desert glasswort					5	6							13
Rhagodia candolleana ssp. *candolleana*	seaberry saltbush													13
R. crassifolia	fleshy saltbush	1										11	12	13
R. parabolica	mealy saltbush	1	2			5	6		8		10	11	12	13
R. preissii ssp. *preissii*	mallee saltbush												12	
R. sp.	saltbush	1												
R. spinescens	spiny saltbush	1	2	3	4	5	6		8	9	10	11	12	13

[3] Questionable identification as previously only known from Lake Eyre, Gairdner-Torrens & Flinders Ranges regions.

R. spinescens var. *deltophylla* (nv)						5	6	7					12	
R. ulicina	intricate saltbush	1	2	3		5	6		8	9	10		12	13
Salsola kali	prickly saltwort	1		3	4	5	6		8	9	10	11	12	13
Sclerolaena brachyptera **-NU**	short-wing bindyi	1		3		5		7	8	9	10	11		13
S. convexula	tall bindyi	1				5								
S. cuneata	tangled bindyi	1									10			
S. decurrens **-NR**	green bindyi					5					10			
S. diacantha	grey bindyi	1	2	3		5	6	7	8	9	10		12	13
S. divaricata **-N#**	tangled bindyi	1	2	3		5				9	10			
S. eriacantha	silky bindyi									9				
S. intricata	tangled bindyi	1		3	4						10			
S. lanata	wooly bindyi	1												
S. lanicuspis **-N#**	spinach bindyi	1							8	9	10			
S. limbata **-NR**	pearl bindyi	1												
S. muricata var. *muricata*	black roly-poly					5								13
S. obliquicuspis	oblique-spined bindyi	1		3		5	6		8	9	10	11	12	13
S. parviflora	small-flower bindyi	1	2	3	4	5					10	11	12	13
S. patenticuspis	spear-fruit bindyi	1	2	3		5			8	9	10		12	13
S. sp.	bindyi	1	2			5	6			9				13
S. tricuspis **--U**	three-spine bindyi	1				5	6			9		11		13
S. uniflora	grey bindyi	1	2	3	4	5	6			9	10	11		13
S. ventricosa	salt bindyi	1								9	10			
Sclerostegia medullosa **$**[4]						5								
S. sp.								7						
S. tenuis	slender glasswort	1							8		10			
CHLOANTHACEAE														
Dicrastylis verticillata **-NU**				3		5	6						12	13
COMPOSITAE														
Actinobole uliginosum	flannel cudweed	1		3	4		6				10		12	13
Angianthus preissianus	salt cup-flower												12	
A sp.		1												
A. tomentosus	hairy cup-flower	1				5	6				10		12	13
* *Arctotheca calendula*	Capeweed			3	4							11		13
* *Aster subulatus*	wild aster										10			13
Asteridea athrixioides forma *athrixioides*	wirewort	1												
Blennospora drummondii	dwarf beauty-heads	1												
Brachycome ciliaris var.	variable daisy	1		3	4	5	6	7		9				13
B. ciliaris var. *brachyglossa*	rayless variable-daisy			3							10			
B. ciliaris var. *ciliaris*	variable daisy	1		3							10		12	13
B. ciliaris var. *lanuginosa*	wooly variable daisy	1		3	4	5			8	9				13
B. goniocarpa	dwarf daisy	1												
B. lineariloba	hard-headed daisy	1		3	4		6			9	10			13
B. perpusilla	tiny daisy	1												
B. sp.		1				5	6			9				13
B. trachycarpa **-NU**	inland daisy	1		3							10			
Bracteantha bracteata **-NU**	golden everlasting		2							9	10		12	13
* *Calendula arvensis*	field marigold	1									10			
Calocephalus sonderi	pale beauty-heads					5								
Calotis cuneifolia **-UU**	purple burr-daisy			3	4	5	6							13
C. cymbacantha	showy burr-daisy										10			13
C. erinacea	tangled burr-daisy					5	6				10		12	13
C. hispidula	bogan flea	1		3	4		6	7		9				13
C. lappulacea **-KK**	yellow burr-daisy										10			
C. plumulifera	wooly-headed burr-daisy										10			
C. scabiosifolia var. *scabiosifolia* **-UK**	rough burr-daisy													13
C. scapigera **-#R**	tufted burr-daisy						6							13
C. sp.		1		3	4									13
* *Carduus tenuiflorus*	slender thistle	1	2											
* *Carthamus lanatus*	saffron thistle	1		3		5	6		8		10	11		13
* *C.* sp.	star-thistle				4									
Cassinia arcuata **-UR**	Chinese scrub	1												
C. laevis **-N#**	curry bush	1		3	4		6			9	10			13
C. uncata	sticky cassinia									9				
* *Centaurea calcitrapa*	star thistle									9		11		

[4] Questionable identification as previously only known from Lake Eyre region

* *C. melitensis*	Maltese cockspur	1	2			5		7			10			13
* *C. solstitialis*	St Barnabys thistle											11		
* *C.* sp.		1												
Centipeda cunninghamii	common sneezeweed	1		3	4	5								13
C. minima **-NU**	spreading sneezeweed													13
C. sp.		1				5								
C. thespidioides	desert sneezeweed	1		3	4			7			10			13
* *Chondrilla juncea*	skeleton weed													13
Chrysocephalum apiculatum	common everlasting	1	2	3	4	5	6				10	11	12	13
C. pterochaetum @											10			
C. semicalvum ssp. *semicalvum*	hill everlasting	1				5					10			
C. semipapposum	clustered everlasting	1		3	4	5	6			9	10			13
Chthonocephalus pseudevax	ground-heads	1		3	4					9				13
* *Cirsium vulgare*	spear thistle		2	3	4						10			13
* *Conyza bonariensis*	flaxleaf fleabane										10			13
Craspedia chrysantha	golden billybuttons			3										
C. pleiocephala	soft billybuttons	1		3	4					9	10	11		
C. sp.					4									13
Cratystylis conocephala	bluebush daisy	1	2	3		5	6	7	8		10	11	12	13
* *Cynara cardunculus*	artichoke thistle		2									11		
Dimorphocoma minutula @											10			
* *Dittrichia graveolens*	stinkwort	1	2	3	4	5		7		9		11		13
Elachanthus pusillus **-UU**	elachanth	1												13
Epaltes australis **-NU**	spreading nut-heads			3	4	5								
E. sp.		1												
Eriochlamys behrii **-NK**	woolly mantle							7			10			13
Erodiophyllum elderi	Koonamore daisy	1	2					7			10	11		
Euchiton sphaericus	Japanese cudweed													13
* *Gazania linearis*														13
Gnaphalium involucratum (nv)											10			
G. japonicum (nv)														13
* *G. polycaulon*						5								
G. sp.				3	4									13
Gnephosis arachnoidea		1			4						10			13
G. sp.		1		3										
G. tenuissima	dwarf cup-flower			3	4						10			13
Haeckeria punctulata **-RK**		1					6				10			
* *Hedypnois rhagadioloides*				3	4						10			13
* *Helianthus annuus*	sunflower										10			
Helichrysum leucopsideum	satin everlasting	1	2								10		12	13
H. sp. (nv)		1	2							9				
Helipterum sp. (nv)		1					6							
Hyalosperma demissum	moss daisy	1												13
H. glutinosum ssp. *glutinosum*	golden sunray	1		3	4				8					13
H. semisterile	orange sunray	1							8		10	11		13
H. sp.		1												
* *Hypochaeris glabra*	smooth catsear	1							8	9	10			13
* *H. radicata*	rough catsear	1										11		13
* *H.* sp.	catsear	1												
Isoetopsis graminifolia	grass cushion	1		3	4				8	9	10			13
Ixiochlamys nana	small fuzzweed	1									10			
Ixiolaena chloroleuca @											10			
I. leptolepis	stalked ixiolaena	1				5	6	7		9	10		12	13
I. leptolepis/tomentosa		1												
I. sp.		1												
I. tomentosa	woolly ixiolaena								8		10			
* *Lactuca serriola*	prickly lettuce										10			13
Lemooria burkittii	wires-and-wool	1		3	4					9	10			13
* *Leontodon taraxacoides* ssp. *taraxacoides* $[5]	lesser hawkbit				4									13
Leptorhynchos baileyi **-NR**											10			
Millotia greevesii ssp. *greevesii* var. *greevesii*	creeping millotia								8		10			
M. macrocarpa		1												13
M. muelleri	common bow-flower	1												13
M. myosotidifolia	broad-leaf millotia			3							10			13
M. perpusilla **-NR**	tiny bow-flower	1		3	4						10			
M. sp.		1			4									

[5] Questionable identification as previously only known from Southern Lofty & South-Eastern regions.

M. tenuifolia var.	soft millotia			3	4									13
Minuria cunninghamii	bush minuria	1		3	4				8		10			13
M. denticulata	woolly minuria	1									10			
M. integerrima	smooth minuria													13
M. leptophylla	minnie daisy	1						7		9	10		12	
M. sp.		1			4				8					13
Myriocephalus rhizocephalus var. *rhizocephalus* **-UR**	woolly heads			3	4									
M. sp.		1												
Olearia brachyphylla	short-leaf daisy-bush	1											12	13
O. calcarea **-UR**	crinkle-leaf daisy-bush	1					6				10		12	
O. decurrens	clammy daisy-bush	1		3	4	5	6				10			13
O. floribunda var. *floribunda*	heath daisy-bush		2										12	
O. lanuginosa **-UR**	woolly daisy-bush												12	
O. lepidophylla	club-moss daisy-bush	1				5	6							13
O. magniflora **-UU**	splendid daisy-bush	1				5	6						12	13
O. minor					4								12	
O. muelleri	Mueller's daisy-bush	1	2	3		5	6	7			10	11	12	13
O. pannosa ssp. *pannosa* **VVV**	silver daisy-bush												12	
O. passerinoides ssp. *passerinoides* **-UU**	feather daisy-bush	1	2	3	4	5							12	13
O. pimeleoides ssp. *pimeleoides*	pimelea daisy-bush	1	2	3	4		6	7	8	9	10	11	12	13
O. rudis **-UR**	purple daisy-bush													13
O. sp.	daisy-bush	1												
O. subspicata	spiked daisy-bush	1		3							10			13
O. teretifolia **-UV**	cypress daisy-bush					5	6							13
* *Onopordum acanthium* ssp. *acanthium*	Scotch thistle										10	11		
* *O. acaulon*	stemless thistle	1	2	3	4	5			8	9	10	11		13
Othonna gregorii	fleshy groundsel			3	4						10			
Ozothamnus retusus -##	notched bush-everlasting											11		13
* *Picris hieracioides* var.						5								
Podolepis canescens **-NU**	grey copper-wire daisy									9	10		12	
P. capillaris	wiry podolepis	1	2	3	4	5	6				10			13
P. jaceoides **-RK**	showy copper-wire daisy												12	
P. rugata var. *rugata*	pleated podolepis													13
P. sp.		1												
P. tepperi		1											12	
Podotheca angustifolia	sticky longheads	1				5							12	13
Pogonolepis muelleriana	stiff cup-flower	1							8		10			13
Polycalymma stuartii	poached-egg daisy					5	6				10		12	13
Pseudognaphalium luteoalbum	cudweed			3	4			7			10			13
Pterocaulon sphacelatum	apple-bush	1	2					7			10			13
* *Reichardia tingitana*	false sowthistle	1				5					10			13
Rhodanthe corymbiflora	white cluster everlasting	1									10			
R. floribunda	white paper-daisy	1		3	4			7		9	10			
R. laevis	smooth sunray			3	4									
R. microglossa	small everlasting	1								9	10			
R. moschata	musk daisy	1		3	4	5					10			13
R. polygalifolia	milkwort everlasting	1		3	4					9	10			
R. pygmaea	pigmy sunray	1		3	4		6		8	9	10			13
R. sp.	everlasting	1								9				13
R. stricta	slender everlasting	1									10			
R. stuartiana	clay everlasting	1		3	4									13
R. tietkensii	Tietken's everlasting													13
R. troedelii @											10			
R. uniflora	woolly sunray										10			
Rutidosis helichrysoides	grey wrinklewort										10			
Senecio anethifolius **-NR**	feathery groundsel	1	2								10			
S. cunninghamii var.										9				
S. cunninghamii var. *serratus*	shrubby groudsel									9	10			
S. glomeratus **-NR**	swamp groundsel	1												
S. glossanthus	annual groundsel	1		3	4		6			9	10			13
S. lautus	variable groundsel	1		3	4	5	6			9	10	11	12	13
S. magnificus	showy groundsel							7		9	10			
S. quadridentatus	cotton groundsel	1	2	3			6				10	11		13
S. runcinifolius **-NU**	thistle-leaf groundsel										10			13
S. sp.	groundsel	1							8					
Sigesbeckia sp.											10			
* *Silybum marianum*	variegated thistle		2	3	4									
* *Sonchus oleraceus*	common sow-thistle	1		3	4	5	6				10	11		13

* *S.* sp.	sow-thistle	1				5					10			
* *S. tenerrimus*	clammy sow-thistle	1	2				6		8		10			
* *Taraxacum officinale*	dandelion	1		3	4	5	6			9				13
Trichanthodium skirrophorum	woolly yellow-heads	1							8		10			
Triptilodiscus pygmaeus **-##**	small yellow-heads	1												
* *Urospermum picroides*	false hawkbit										10			
Vittadinia australasica var.	New Holland daisy			3										
V. cervicularis var. *cervicularis*	waisted New Holland daisy	1		3							10			13
V. cuneata var.	New Holland daisy	1	2	3		5				9				13
V. cuneata var. *cuneata* forma *cuneata*	New Holland daisy	1												
V. cuneata var. *morrisii*	New Holland daisy	1												
V. dissecta var. *hirta*	dissected New Holland diasy	1	2	3		5			8		10		12	13
V. eremaea	desert New Holland daisy			3							10			13
V. gracilis	woolly New Holland daisy	1		3		5					10		12	13
V. megacephala	giant New Holland daisy													13
V. pterochaeta	rough New Holland daisy										10			
V. sp.	New Holland daisy	1		3		5	6			9			12	13
V. sulcata @											10			
V. triloba (nv)					4	5	6	7				11		13
Waitzia acuminata var. *acuminata*	orange immortelle			3	4	5	6				10			13
* *Xanthium californicum*	Californian burr													13
* *X. spinosum*	Bathurst burr	1		3	4	5		7		9	10	11		
CONVOLVULACEAE														
* *Convolvulus arvensis*	field bindweed	1												
C. erubescens	Australian bindweed	1				5	6	7			10	11		13
C. eyreanus **-NR**		1												13
C. microsepalus		1												
C. microsepalus/remotus		1												
C. remotus		1	2			5			8		10		12	13
C. sp.		1												
CRASSULACEAE														
Crassula colorata var.		1		3	4	5							12	13
C. colorata var. *acuminata*	dense stonecrop	1												
C. colorata var. *colorata*	dense stonecrop										10			
C. colorata/sieberana		1												
C. helmsii	swamp crassula													13
C. sieberiana ssp. *tetramera*	Australian crassula	1		3	4		6				10		12	13
C. sp.		1												13
CRUCIFERAE														
* *Alyssum linifolium*	flax-leaf alyssum	1		3	4			7	8		10			13
Arabidella eremigena **-NK**	priddiwalkatji			3	4									
A. filifolia **-RR**		1												
A. glaucescens		1												
A. nasturtium **-NK**	yellow cress	1								9				
A. procumbens	creeping cress	1												
A. sp		1												
A. trisecta	shrubby cress	1		3	4	5	6	7	8	9	10			13
Blennodia trisecta (nv)												11		
* *Brassica juncea*	Indian mustard									9				
* *B.* sp.										9				
* *B. tournefortii*	long-fruited wild turnip	1		3	4	5					10			13
* *Carrichtera annua*	Wards weed	1		3	4		6		8	9	10	11		13
* *Diplotaxis tenuifolia*	Lincoln weed		2	3	4			7			10			
Geococcus pusillus	earth cress	1		3	4									
Harmsiodoxa blennodioides	hairypod cress	1		3	4						10			13
H. brevipes var.		1												
H. brevipes var. *brevipes*	short cress	1		3	4					9				
H. sp.		1												
* *Hymenolobus procumbens*	oval purse													
* *Lepidium africanum*	common peppercress	1	2								10			13
L. fasciculatum	bundled peppercress		2								10	11		
L. hyssopifolium	common peppercress					5	6					11		13
L. leptopetalum **-NU**	shrubby peppercress	1		3	4	5	6				10	11		13
L. oxytrichum	green peppercress			3							10			13
L. oxytrichum/papillosum		1												

L. papillosum	warty peppercress	1 3 9
L. phlebopetalum	veined peppercress	1 5 9 10
L. sagittulatum	fine-leaved peppercress	1 10
L. sp.		1 4
Menkea australis	fairy spectacles	1 3 4 13
Pachymitus cardaminoides	sand cress	11
Phlegmatospermum cochlearinum	downy cress	1 10
P. eremaeum **KKK**	spreading cress	1
* *Rapistrum rugosum* ssp. *rugosum*	turnip weed	3 4
* *Sisymbrium erysimoides*	smooth mustard	1 3 4 5 10 13
* *S. irio*	London rocket	1 3 6 13
* *S. orientale*	wild mustard	1 5 10 11 13
* *S.* sp.		1
Stenopetalum lineare	narrow thread-petal	1 3 4 10 11 13
S. sp.	thread-petal	1
S. sphaerocarpum	round-fruit thread-petal	1 3 4 13
S. velutinum @	downy thread-petal	10
CUCURBITACEAE		
* *Citrullus lanatus*	bitter melon	3 4 7 10 11 13
* *Cucumis myriocarpus*	paddy melon	1 3 4 5 7 10
CUPRESSACEAE		
Callitris glaucophylla	white cypress-pine	1 2 3 4 5 7 9 10 11
C. preissii **-NN**	southern cypress pine	1 2 3 4 5 6 11 12
C. sp.	native pine	1 6
C. verrucosa	mallee cypress pine	1 2 3 4 5 6 10 12 13
CYPERACEAE		
Cyperus gymnocaulos	spiny flat-sedge	10
C. squarrosus	bearded flat-sedge	10
Eleocharis pallens **-NK**	pale spike-rush	10
Fimbristylis dichotoma	common fringe-rush	10
Gahnia filum	smooth cutting-grass	12
G. lanigera	black grass saw-sedge	1 12
G. trifida **-NV**	cutting grass	12
Lepidosperma sp.	sword-sedge	1 11
L. viscidum	sticky sword-sedge	1 12
Schoenus breviculmis **-NR**	matted bog-rush	2
S. sp.	bog-rush	1 3
S. subaphyllus	desert bog-rush	1 2 3 5 6 10 12 13
DILLENIACEAE		
Hibbertia riparia	guinea-flower	3 4 13
H. virgata	twiggy guinea-flower	1 13
EPACRIDACEAE		
Acrotriche patula **-NR**	shiny ground-berry	1 12
Astroloma humifusum	native cranberry	2
EUPHORBIACEAE		
Bertya mitchellii	Mitchell bertya	1 5 6 13
Beyeria lechenaultii	pale turpentine bush	1 3 4 5 6 8 10 11 12 13
B. opaca	dark turpentine bush	1 2 3 4 5 6 10 12 13
B. sp.		1
Euphorbia australis	caustic weed	1 9 10
E. drummondii	caustic weed	1 3 4 5 6 9 10 11 13
E. sp.		1
E. tannensis ssp. *eremophila*	bottle tree caustic	1 6 7 10 11 13
Phyllanthus saxosus **-UV**	rock spurge	12
P. sp.		5 9
Poranthera microphylla	small poranthera	13
P. sp.		1
* *Ricinus communis*	castor oil plant	2 10
Sauropus rigens	stiff spurge	1
FRANKENIACEAE		
Frankenia crispa	hoary sea-heath	8

		1	2	3	4	5	6	7	8	9	10	11	12	13
E. pauciflora var.	southern sea-heath												12	13
E. pauciflora var. *fruticulosa*	southern sea-heath	1												
E. pauciflora var. *gunnii*				3										
E. serpyllifolia	thyme sea-heath	1				5			8		10			
E. sp.	sea-heath	1												13
FUMARIACEAE														
* *Fumaria* sp.		1												
GENTIANACEAE														
* *Centaurium spicatum*	spike centaury							7			10			13
GERANIACEAE														
* *Erodium aureum*		1			4					9	10			
* *E. botrys*	long storks bill	1					6					11		13
* *E. cicutarium*	common storks bill	1			4					9	10	11		13
E. crinitum	blue storks bill	1				5					10			13
E. crinitum/cygnorum		1												
E. cygnorum ssp.					4							11		13
E. cygnorum ssp. *cygnorum*	blue storks bill	1												
E. cygnorum ssp. *glandulosum*		1									10			
E. sp.		1		3						9				
Geranium retrorsum	native geranium	1												
G. sp.	cranes-bill	1												
Pelargonium australe	australian pelargonium													13
GOODENIACEAE														
Dampiera dysantha														13
D. lanceolata var.														13
D. marifolia	velvet dampiera												12	13
D. rosmarinifolia	wild rosemary												12	13
D. sp.														
Goodenia albiflora **-UV**	white goodenia	1											12	
G. cycloptera	serrated goodenia	1										11		
G. fascicularis	silky goodenia	1						7	8		10			
G. glauca **-NU**	pale goodenia													13
G. lunata	stiff goodenia													13
G. pinnatifida **-#U**	cut-leaf goodenia	1		3	4									13
G. pusilliflora **-NN**	small-flower goodenia	1		3	4						10			13
G. robusta	woolly goodenia	1											12	13
G. sp.		1					6							13
G. varia	sticky goodenia		2										12	13
G. willisiana	silver goodenia	1	2			5	6						12	13
Scaevola depauperata	skeleton fanflower	1		3		5					10			13
S. parvibarbata @	small-beard fanflower										10			
S. spinescens	spiny fanflower	1	2	3	4	5	6	7			10		12	13
Velleia arguta	spur velleia	1									10			
V. connata **-NU**	cup velleia					5							12	13
V. paradoxa **-##**	spur velleia			3	4									13
GRAMINEAE														
* *Aira caryophyllea*	silvery hair-grass											11		13
Amphibromus sp.														13
Amphipogon caricinus var. *caricinus*	long grey-beard grass		2	3		5							12	13
Aristida behriana **-NR**	brush wire-grass											11		
A. contorta **-NR**	mulga grass	1		3						9	10			
A. holathera var. *holathera* **-NR**				3	4					9				
A. nitidula **-NR** @	brush threeawn									9	10			
A. sp.										9				
Astrebla lappacea @	curly Mitchell grass										10			
* *Avena barbata*	bearded oat	1							8		10			
* *A. fatua*	wild oat											11		13
* *A. sativa*	cultivated oat													13
* *A.* sp.														13
* *Briza maxima*	large quaking-grass											11		
Bromus arenarius	sand brome			3	4					9	10			
* *B. catharticus*	prairie grass		2								10			
* *B. lanceolatus*	Mediterranean brome	1												

		1	2	3	4	5	6	7	8	9	10	11	12	13
* *B. madritensis*	Madrid brome										10	11		13
* *B. rigidus*	rigid brome											11		
* *B. rubens*	red brome	1					6		8	9	10			13
* *B.* sp.		1				5	6							
* *Chloris gayana*	Rhodes grass													13
C. pectinata	comb chloris										10			
C. truncata	windmill grass											11		
* *Critesion marinum*	sea barley			3	4									
* *C. murinum* ssp.						5								13
* *C. murinum* ssp. *glaucum*	northern barley-grass	1							8		10			
* *C. murinum* ssp. *leporinum*	barley-grass	1								9	10	11		13
* *C.* sp.		1					6							
Cymbopogon ambiguus **-NR**	scented grass	1						7	8	9	10	11		
C. obtectus **-NV**	silky-heads	1												
* *Cynodon dactylon*	couch-grass													13
Dactyloctenium radulans	button grass										10	11		
Danthonia caespitosa	common wallaby-grass	1				5				9	10		12	13
D. geniculata	kneed wallaby-grass	1												
D. pilosa var. *pilosa* **-#K**	hairy wallaby-grass													13
D. semiannularis **-RR**												11		
D. setacea var. *setacea*	small-flower wallaby-grass	1												13
D. sp.	wallaby grass	1		3	4	5	6	7	8				12	13
D. tenuior	short-awn wallaby-grass	1												
* *Desmazeria rigida*	rigid fescue											11		
Dichanthium sericeum @											10			
Digitaria brownii **-NK**	cotton grass	1								9	10			
D. sp.		1												
* *Echinochloa* sp.										9				
* *Ehrharta calycina*	perennial veldt grass													13
Elymus scabrus var. *scabrus*	native wheat-grass										10			
Enneapogon avenaceus	common bottle-washers	1		3		5		7	8	9	10			
E. caerulescens var. *caerulescens* @											10			
E. cylindricus	jointed nineawn							7		9	10			
E. intermedius	tall bottlewashers	1		3										
E. nigricans	black-heads			3		5					10			13
E. polyphyllus **-NK**	leafy nineawn									9				
E. sp.		1								9				
Enteropogon acicularis	umbrella grass							7		9	10			13
Eragrostis australasica **-N#**	cane-grass	1	2	3	4	5		7			10			13
* *E. barrelieri*	pitted lovegrass										10			
E. dielsii var. *dielsii*	mulka grass	1	2	3	4	5		7		9	10	11		13
E. eriopoda	woollybutt	1								9	10			
E. falcata **-NR**	sickle lovegrass										10			
E. lacunaria **-RR**	purple lovegrass										10			
E. laniflora **-NK**	hairy-flowered woollybutt	1						7						
E. leptocarpa	drooping lovegrass										10			
E. parviflora **-NR**	weeping lovegrass										10			
E. setifolia **-NR**	narrow-leaved neverfail					5		7		9	10			
E. sp.		1								9				
Eriochloa australiensis @	Australian cupgrass										10			
* *Hainardia cylindrica*	common barb-grass													13
* *Hordeum* sp.							6							
* *H. vulgare*										9				
* *Lamarckia aurea*	golden-top					5					10			13
* *Lolium loliaceum*	rigid ryegrass				4									
* *L. rigidum*	Wimmera ryegrass			3										
* *L.* sp.														
* *L. subulatum* (nv)												11		
Panicum decompositum var. *decompositum*	native millet										10			
P. effusum var. *effusum* **-##**	hairy panic							7						
Paspalidium basicladum		1									10			
P. constrictum	knotty-butt paspalidium	1					6					p		13
P. gracile (nv)	slender panic			3										
P. jubiflorum **-NN**	Warrego summer-grass					5								13
* *Pentaschistis airoides*	false hair-grass			3	4									
* *Phalaris paradoxa*	paradoxa canary-grass								8					
* *Poa annua*	annual meadow-grass			3										
P. sp.	meadow-grass	1												

		1	2	3	4	5	6	7	8	9	10	11	12	13
* *Rostraria cristata*	annual cats tail													13
* *R. pumila*	tiny bristle-grass	1		3	4					9	10			
* *R.* sp.		1												
* *Schismus barbatus*	Arabian grass	1		3		5	6		8	9	10	11	12	13
Sporobolus actinocladus	ray grass										10			
Stipa acrociliata	graceful spear-grass	1									10			13
S. drummondii	cottony spear-grass										10			13
S. elegantissima	elegant spear-grass	1		3	4	5	6				10	11	12	
S. eremophila	desert spear-grass	1									10	11		
S. mollis	soft spear-grass	1												
S. nitida	Balcarra grass	1		3			6	7	8	9	10			13
S. nodosa	smooth spear-grass	1							8	9	10			
S. platychaeta	flat-awn spear-grass	1				5				9	10			
S. scabra group	falcate-awn spear-grass	1				5					10			
S. scabra ssp. *falcata*	slender spear-grass									9				
S. scabra ssp. *scabra*	rough spear-grass	1												
S. sp.	spear-grass	1	2		4	5	6			9			12	13
S. trichophylla										9				
S. variabilis	variable spear-grass			3	4	5						11		
Themeda triandra	kangaroo grass	1										11		
Tragus australianus	bur grass										10	11		
Triodia irritans complex	spinifex	1	2	3		5	6	7		9	10	11	12	
T. scariosa ssp. *scariosa*	spinifex													13
Tripogon loliiformis	five-minute grass					5				9	10			
Triraphis mollis	purple heads										10			
* *Vulpia myuros*				3							10	11		
GYROSTEMONACEAE														
Codonocarpus cotinifolius **-NU**	desert poplar	1	2	3	4	5	6				10		12	13
C. pyramidalis **VVV**	slender bell-fruit	1										11		
HALORAGACEAE														
Glischrocaryon behrii	golden pennants													13
G. sp.		1												
Gonocarpus elatus	hill raspwort	1	2											
G. mezianus	broad-leaf raspwort		2											
G. tetragynus	small-leaf raspwort	1												
Haloragis acutangula forma	smooth raspwort													13
H. aspera **-#U**	rough raspwort	1									10			
H. odontocarpa forma *pterocarpa*	mulga nettle		2										12	
H. sp.	raspwort			3										
Myriophyllum sp.	water-milfoil													13
M. verrucosum **-N#**	red water-milfoil					5					10			
HYPOXIDACEAE														
Hypoxis glabella var. *glabella*	tiny star	1												
IRIDACEAE														
* *Gynandriris setifolia*	thread iris	1										11		13
* *Romulea rosea* var. *australis*	Guildford grass											11		
JUNCACEAE														
Juncus bufonius	toad rush													13
J. sp.														13
JUNCAGINACEAE														
Triglochin calcitrapum	spurred arrowgrass	1												
T. centrocarpum	dwarf arrowgrass	1		3	4									13
LABIATAE														
Ajuga australis form *A* **-NN**	Australian bugle										10			13
A. sp						5	6							
* *Marrubium vulgare*	horehound	1	2	3	4	5	6		8	9	10	11	12	13
Mentha australis **-##**	river mint			3	4									
Prostanthera aspalathoides	scarlet mintbush	1	2			5	6				10		12	13
P. sp.				3						9				
P. striatiflora **-NR**	striated mintbush	1					6			9				
* *Salvia aethiopis*	woolly sage											11		

		1	2	3	4	5	6	7	8	9	10	11	12	13
* *S. reflexa*	mintweed	1												
* *S.* sp.		1				5								
* *S. verbenaca* form	wild sage	1	2	3	4	5	6			9	10	11		13
* *S. verbenaca* form *B*	wild sage	1	2	3	4			7						
Teucrium albicaule **--T**														13
T. racemosum **-NU**	grey germander	1	2	3	4	5	6	7	8		10	11		13
Westringia eremicola **-NN**	slender westringia												12	
W. rigida	stiff westringia	1	2	3	4	5	6				10	11	12	13
W. sp.		1												
LAURACEAE														
Cassytha melantha	large dodder-laurel	1	2			5	6					11	12	13
C. pubescens **-N#**	downy dodder-laurel												12	
C. sp.	dodder laurel	1												
LEGUMINOSAE														
Acacia acanthoclada **-UU**	harrow wattle	1				5	6						12	13
A. acinacea (nv) **-N#**	wreath wattle											11	12	
A. aneura (nv)		1		3	4	5	6	7			10			
A. aneura var. *aneura*	mulga	1												
A. argyrophylla	silver mulga-bush										10			
A. ayersiana var. *latifolia*	broad-leaf mulga	1			4									
A. beckleri	Beckler's rock wattle										10			
A. brachybotrya	grey mulga-bush	1	2	3	4	5					10	11	12	13
A. burkittii	pin-bush wattle	1	2	3	4			7		9	10			
A. calamifolia	wallowa	1		3						9	10	11	12	
A. carnei @ **VV-**	needle wattle									9	10			
A. colletioides	wait-a-while	1	2	3	4	5	6	7	8	9	10	11	12	13
A. continua @ **-NK**	thorn wattle			3						9	10			
A. hakeoides	hakea wattle	1		3		5	6	7					12	13
A. halliana	Hall's wattle			3										
A. ligulata	umbrella bush	1		3	4	5	6				10	11	12	13
A. loderi **-RR**	nealie	1	2	3			6			9	10			13
A. microcarpa (nv)	manna wattle			3	4							11		13
A. montana **-RV**	mallee wattle						6						12	
A. notabilis **-NU**	notable wattle	1		3								11		13
A. nyssophylla	wait-a-while	1	2	3	4	5	6				10		12	13
A. oswaldii	umbrella wattle	1	2	3	4	5	6	7			10	11	12	13
A. papyrocarpa	western myall	1												
A. paradoxa	kangaroo thorn											11		
A. pendula **-KK**	weeping myall										10			
A. pycnantha	golden wattle	1					6					11		
A. rhigiophylla **RRV**	dagger-leaf wattle		2											
A. rigens	nealie	1	2	3	4	5	6				10		12	13
A. rivalis $[6] @	silver wattle									9				
A. rupicola **-NV**	rock wattle			3										
A. salicina	Broughton willow									9	10			
A. sclerophylla	hard-leaf wattle	1	2	3	4	5							12	13
A. sp		1				5				9				
A. spilleriana **RKK**	round-leaf mulga-bush	1											12	
A. spinescens	spiny wattle			3							10	11		13
A. stenophylla	river cooba				4	5	6							13
A. tetragonophylla	dead finish	1								9	10			
A. victoriae ssp. *victoriae* **-NR**	elegant wattle	1	2					7	8	9	10	11	12	
A. wattsiana **RNE**	dog wattle		2											
A. wilhelmiana	dwarf nealie	1		3		5	6						12	13
Aotus subspinescens	sandhill pea													13
* *Astragalus sesameus*	purple milk-vetch	1	2								10			
A. sp		1									10			
Bossiaea walkeri **-NU**	cactus pea			3									12	13
Cassia eremophila (nv)						5						11		
C. nemophila var. (nv)						5								
C. nemophila var. *coriacea* (nv)				3		5	6	7	8	9			12	
C. nemophila var. *nemophila* (nv)				3	4			7	8	9	10		12	
C. nemophila var. *zygophylla* (nv)				3				7						
C. sturtii (nv)				3	4	5					10	11		

[6] Questionable identification as previously only known from Lake Eyre, Gairdner-Torrens & Flinders Ranges regions.

Daviesia arenaria **-UR**	sandhill bitter-pea	5 13
D. benthamii ssp.	bitter-pea	1 3 4 5 13
D. benthamii ssp. *benthamii* -UU	dryland bitter-pea	1 2 3 5 6 12 13
D. benthamii ssp. *humilis* **-RR**	mallee bitter-pea	1
D. genistifolia	broom bitter-pea	3 13
D. leptophylla **-NK**	narrow- leaved bitter-pea	5
D. sp.	bitter pea	13
D. ulicifolia	gorse bitter-pea	13
Eutaxia microphylla var. *diffusa* **-UU**	large-leaf eutaxia	3
E. microphylla var. *microphylla*	common eutaxia	1 2 3 4 5 6 12 13
Glycine canescens **-NV**	silky glycine	1
G. clandestina var. *sericea* -#-	twining glycine	1 9 10
Indigofera australis var. *australis*	Australian indigo	10 13
I. sp.		13
Lotus cruentus	redflower lotus	1 2 5 9 10 11
* *Medicago littoralis*	strand medic	10
* *M. minima* var. *minima*	small burr-medic	1 2 3 4 6 8 9 10 11 13
* *M. polymorpha* var. *polymorpha*	toothed medic	1 3 4 8 9 10 11 13
* *M. sativa* ssp.	lucerne	13
* *M.* sp.		1 5 6 9 13
* *M. truncatula*	barrel medic	1 6 9 10 11
* *Melilotus indica*	King Island melilot	13
* *Prosopis juliflora* @	mesquite	10
Psoralea cinerea	annual scurf-pea	10
P. pallida **-NR**	white scurf-pea	12 13
P. sp.	scurf-pea	13
Senna artemisioides nothossp. *artemisioides* x *coriacea*		1
S. artemisioides nothossp. *artemisioides* x ssp *filifolia*		1
S. artemisioides nothossp. *artemisioides*	silver senna	1 3 4 5 6 9 10 11
S. artemisioides nothossp. *coriacea*	desert senna	1 2 3 4 5 6 12 13
S. artemisioides nothossp. *sturtii*	grey desert senna	13
S. artemisioides ssp.	desert senna	1 5
S. artemisioides ssp. *alicia*		5
S. artemisioides ssp. *filifolia*	fine-leaf desert senna	1 2 3 5 12 13
S. artemisioides ssp. *petiolaris*	flat-stalk senna	1 2 3 4 5 6 7 8 9 10 11 12 13
S. artemisioides ssp. *zygophylla*	desert senna	3 10 13
Sphaerolobium minus **-RK**	leafless globe-pea	3 13
Swainsona colutoides **-NR**	bladder swainson-pea	3
S. fissimontana	Broken Hill pea	1 10
S. formosa	Sturt pea	10
S. microphylla ssp. *minima* -#U	small-leaf Swainson-pea	3 5 6 13
S. murrayana	Murray swainson-pea	10
S. oliveri		1 3 4
S. oroboides	variable swainson-pea	10 13
S. phacoides ssp. *phacoides*	dwarf swainson-pea	2 10
S. sp.	swainson-pea	8 9 12 13
S. stipularis	orange swainson-pea	1 8 10
S. swainsonioides @	downy swainson-pea	10
S. viridis **K--**	creeping Darling pea	7 10
Templetonia egena	broombush templetonia	1 2 3 4 5 6 7 8 10 11 12 13
T. sulcata **-UU**	flat templetonia	2 5 6 12 13
* *Trifolium angustifolium*	narrow-leaf clover	11
* *T. arvense* var. *arvense*	hares foot clover	11 13
* *T.* sp.		1
* *T. tomentosum*	woolly clover	11 13
Trigonella suavissima	sweet fenugreek	10 11
* *Vicia monantha* ssp.		2 10 13
* *V.* sp.		1

LILIACEAE

Arthrocnemum sp (nv)		4
Arthropodium strictum	common vanilla-lily	11 13
Asparagus officinalis	edible asparagus	13
* *Asphodelus fistulosus*	onion weed	1 2 5 6 7 8 9 10 11 12 13
Bulbine bulbosa **-NR**	bulbine-lily	11
B. semibarbata	annual bulbine-lily	1 3 4 6 13
B. sp.	bulbine-lily	1
Chamaescilla corymbosa var. *corymbosa* **-NR**	blue squill	1

?*Corynotheca licrota* **-RR**		13
Dianella longifolia var. *porracea* **-NK**	pale flax-lily	5 6 13
D. revoluta var.	black-anther flax-lily	1 2 5 6 12 13
D. sp.		1 3 4 6
Lomandra collina	sandhill mat-rush	3 4 5 6 12 13
L. densiflora **-NR**	soft tussock mat-rush	2
L. effusa	scented mat-rush	1 3 4 5 6 9 10 12 13
L. glauca (nv)		12
L. leucocephala ssp. *robusta*	woolly mat-rush	1 2 3 4 5 6 10 12 13
L. multiflora ssp. *dura*	hard mat-rush	1 2 11
L. nana	small mat-rush	12
L. sp.		3
Thysanotus baueri	mallee fringe-lily	1 3 4 6 10 12
T. patersonii	twining fringe-lily	1
Wurmbea centralis @	inland star-lily	10
W. dioica ssp. *dioia*	early star-lily	1 2 5 9 10 11
Xanthorrhoea quadrangulata **-NR**	rock grass-tree	1 10 11

LIMONIACEAE

* *Limonium lobatum*	winged sea-lavender	1 10 13
* *L. sinuatum*	perennial sea-lavend	13

LINACEAE

Linum marginale **-NU**	native flax	1

LOGANIACEAE

Logania nuda **-NU**	leafless logania	1 12 13

LORANTHACEAE

Amyema gibberulum var. *gibberulum* $[7]	twin-flower mistletoe	4 6
A. linophyllum ssp. *orientale* **-UU**	casuarina mistletoe	1 3 13
A. maidenii ssp. *maidenii* @	pale-leaf mistletoe	10
A. miquelii	box mistletoe	1 3 4 5 6 10 12 13
A. miraculosum ssp. *boormanii*	fleshy mistletoe	1 3 4 9 13
A. pendulum ssp. *pendulum* **-NK**	drooping mistletoe	3 6
A. preissii	wire-leaf mistletoe	1 3 4 5 6 10 12 13
A. sp	mistletoe	1
Lysiana exocarpi ssp. *exocarpi*	Harlequin mistletoe	1 2 3 4 5 6 9 10 12 13

MALVACEAE

Abutilon cryptopetalum $[8]	hill lantern-flower	5
A. fraseri **-NK**	dwarf lantern-flower	1 6 10
A. halophilum	plains lantern-flower	1 10
A. leucopetalum @	desert lantern-flower	10
A. malvaefolium	mallow lantern-flower	1 7
A. otocarpum **-NR**	desert lantern-flower	1 3 10
A. sp.	lantern-flower	1 9
Hibiscus krichauffianus	velvet-leaf hibiscus	7 9
Lavatera plebeia	Australian hollyhock	1 3 8 10 11
* *L.* sp.		4
Lawrencia glomerata	clustered lawrencia	10 12 13
L. squamata	thorny lawrencia	1 5 8 10 12
* *Malva parviflora*	marshmallow	1 9 10 11 13
* *M.* sp.		3 4 13
Malvastrum americanum	malvastrum	1 7 10
Malvella leprosa	alkali sida	7
Radyera farragei **-NR**	desert rose mallow	3 4 7 10
Sida ammophila **-NU**	sand sida	p
S. calyxhymenia (nv)	tall sida	4 10
S. corrugata var.		1 5 7 9 11
S. corrugata var. *A*		8 10
S. corrugata var. *angustifolia* **-#-**	corrugated sida	3 4 10 13
S. fibulifera **-NR**	pin sida	1 10
S. intricata	twiggy sida	1 5 7 8 10 11 13
S. petrophila	rock sida	1 2 9 11

[7] Questionable identification as previously only known from North-Western, Lake Eyre, Nullarbor & Gairdner-Torrens regions.

[8] Questionable identification as previously only known from North-Western, Lake Eyre, Gairdner-Torrens, Flinders Ranges and Eyre Peninsula regions.

S. sp.		1								9				13
S. trichopoda **-N#**	high sida	1												
MARSILEACEAE														
Marsilea drummondii	common nardoo			3	4	5		7			10	11		13
M. hirsuta **-NR**	short-fruit nardoo	1												13
M. sp.		1		3	4									
MYOPORACEAE														
Eremophila alternifolia	narrow-leaved fuchsia-bush	1	2	3		5	6			9	10	11	12	
E. behriana **-NE**	rough emubush												12	
E. bignoniiflora **-VV**	bignonia emubush			3	4									
E. crassifolia	thick-leaved emubush	1				5	6						12	13
E. deserti		1	2	3	4	5	6				10	11		13
E. divaricata ssp. *divaricata*	spreading emubush			3	4	5	6					11		13
E. duttonii	Harlequin fuchsia-bush	1								9	10			
E. freelingii @	limestone fuchsia									9	10			
E. glabra ssp.		1	2	3	4	5	6	7					12	13
E. glabra ssp. *glabra*	tar bush	1									10			
E. glabra ssp. *murrayana*	tar bush	1	2								10			
E. longifolia	berrigan	1	2	3	4	5	6	7	8	9	10	11	12	13
E. macdonnellii $[9]						5								
E. maculata var. *maculata* **-N#**	spotted emubush	1	2	3	4	5	6	7	8		10	11		13
E. oppositifolia var. *oppositifolia*	weeooka	1	2	3	4	5	6	7		9	10	11	12	13
E. scoparia	broom emubush	1	2	3	4	5	6	7	8	9	10	11	12	13
E. serrulata **-NR**	green fuchsia-bush	1					6				10	11		
E. sp.		1	2			5	6			9				
E. sturtii	turpentine bush	1	2	3	4	5	6		8	9	10	11		13
Myoporum montanum **-NN**	native myrtle	1							8		10			
M. platycarpum ssp.	false sandalwood	1	2	3	4	5	6		8	9	10	11	12	13
M. platycarpum ssp. *platycarpum*	false sandalwood	1						7						13
M. sp.		1								9				
MYRTACEAE														
Baeckea crassifolia	desert baeckea	1	2	3		5	6							13
Callistemon teretifolius	needle bottlebrush											11		
Calytrix tetragona	common fringe-myrtle												12	
Eucalyptus 'anceps'/rugosa					4	5	6							13
E. brachycalyx	gilja	1					6				10	11	12	
E. camaldulensis var. *camaldulensis*	river red gum	1	2		4	5	6			9		11	12	13
E. camaldulensis var. *obtusa*	northern river red gum									p	10			
E. cyanophylla	blue-leaf mallee					5	6				10		12	13
E. dumosa	white mallee	1	2	3	4	5	6				10		12	13
E. flindersii @	Flinders grey mallee										10			
E. gillii @	curly mallee										10			
E. gracilis	yorrell	1	2	3	4	5	6	7	8	9	10	11	12	13
E. incrassata	ridge-fruit mallee	1	2	3	4	5	6				10		12	13
E. intertexta **-NK**	gum coolibah									9	10			
E. largiflorens	river box				4	5	6				10	11	12	13
E. leptophylla	narrow-leaf red mallee	1		3		5	6						12	13
E. leucoxylon ssp. *pruinosa*	inland South Aust. blue gum	1										11		
E. odorata	peppermint box	1										11	12	
E. oleosa	red mallee	1	2	3	4	5	6	7		9	10	11	12	13
E. porosa	mallee box	1		3		5	6			9	10	11	12	
E. socialis	beaked red mallee	1	2	3	4	5	6		8	9	10		12	13
Leptospermum coriaceum	sandhill tea-tree	1				5	6						12	13
L. sp.		1												
Melaleuca acuminata	mallee honey-myrtle													13
M. lanceolata	dryland tea-tree	1	2	3	4	5	6				10	11	12	13
M. uncinata	broombush	1												13
NYCTAGINACEAE														
Boerhavia diffusa (nv)													12	
B. dominii/schomburgkiana											10			
B. sp.								7						

[9] Questionable identification as previously only known from North-Western, Lake Eyre, Gairdner-Torrens and flinders Ranges regions.

OLEACEAE		
Jasminum didymum ssp. *lineare* **-#R**	native jasmine	1 10 13
OPHIOGLOSSACEAE		
Ophioglossum polyphyllum **-#-**	large adders tongue	4
ORCHIDACEAE		
Pterostylis biseta	two-bristle green-hood	1 13
P. excelsa	dryland green-hood	10
P. mutica	midget green-hood	3 4
P. sp.	green-hood	1 6
OROBANCHACEAE		
Orobanche cernua var. *australiana* **-UR**	Australian broomrape	10
OXALIDACEAE		
Oxalis perennans	native sorrel	1 4 5 6 7 10 11 13
* *O. pes-caprae*	soursob	4 9 13
O. sp.		1 3 9
PAPAVERACEAE		
* *Argemone subfusiformis* ssp. *subfusiformis* @		10
* *Glaucium corniculatum* var. *corniculatum*	bristly horned-poppy	10
PITTOSPORACEAE		
Billardiera cymosa	sweet apple-berry	1 13
B. sp.	apple-berry	3
B. versicolor **-UR**	yellow-flower apple-berry	p 6
Bursaria spinosa	sweet bursaria	1 11 12
Pittosporum phylliraeoides var. *microcarpa*	native apricot	1 3 4 5 6 7 9 10 11 12 13
PLANTAGINACEAE		
* *Plantago bellardii*	hairy plantain	1 13
* *P. coronopus*	bucks-horn plantain	13
P. cunninghamii	sago weed	10
P. drummondii	sago weed	1 3 4 8 9 10 13
* *P. lanceolata* var. *lanceolata*	ribgrass	11
* *P. scabra*	rough plantain	10
P. sp.	plantain	1
P. sp. *B*	little plantain	13
P. turrifera **-NU**	small sagoweed	1
P. varia	variable plantain	7
POLYGONACEAE		
* *Acetosa vesicaria*	rosy dock	1 3 4 10
* *Emex australis*	three-cornered jack	1 2 3 4 10 13
Muehlenbeckia diclina ssp. *diclina* **-NR**	weeping lignum	5 13
M. florulenta	lignum	1 2 3 4 5 6 7 8 10 11 13
* *Polygonum aviculare*	wireweed	7 10 11
P. plebeium **-NU**	small knotweed	5
* *Rumex crispus*	curled dock	10
R. crystallinus **-NR**	shiny dock	13
PORTULACACEAE		
Calandrinia eremaea	small purslane	1 3 4 6 10 13
C. granulifera	pigmy purslane	13
C. polyandra var. *polyandra* $[10]		3 4
C. ptychosperma	creeping parakeelya	5
C. sp.		1 13
Portulaca oleracea	common purslane	7 10
PRIMULACEAE		
* *Anagallis arvensis*	pimpernel	1 9 10
PROTEACEAE		

[10] Questionable identification as previoulsly only known from North-Western, Lake Eyre, Nullarbor, Gairdner-Torrens, Flinders Ranges & Eyre Peninsula regions.

Grevillea huegelii	comb grevillea	1 2 3 4 5 6 7 8 10 11 12 13
G. ilicifolia var. *ilicifolia*	holly-leaf grevillea	2
G. lavandulacea var. *sericea* **-UR**	spider-flower	2
G. pterosperma	sandhill grevillea	1 2 3 5 6 13
Hakea leucoptera	silver needlewood	1 2 3 4 5 6 7 8 10 11 12 13
H. rugosa **-NV**	dwarf hakea	2
H. tephrosperma **-RR**	hooked needlewood	3
RANUNCULACEAE		
Clematis microphylla	small-leaved clematis	1 11
* *Myosurus minimus* var. *australis*	mousetail	13
Ranunculus pentandrus var. *platycarpus*	smooth buttercup	1
R. pumilio var.	ferny buttercup	1 10
R. sessiliflorus var.		3
R. sessiliflorus var. *sessiliflorus*	small-flower buttercup	1 4
R. sp.		
RESEDACEAE		
* *Reseda luteola*	wild mignonette	1 2 10 11
* *R.* sp.		
RHAMNACEAE		
Cryptandra amara var.	cryptandra	2 5 6 11
C. amara var. *amara*	spiny cryptandra	2
C. amara var. *longiflora* **-RK**	long-flower cryptandra	1 2 12 13
C. leucophracta	white cryptandra	2 13
C. propinqua	silky cryptandra	1 13
C. sp.		1 3
C. tomentosa	velvet cryptandra	3 13
Pomaderris paniculosa ssp. *paniculosa*	mallee pomaderris	2
Spyridium phlebophyllum	inland spyridium	1 6 10
S. sp.		1
S. subochreatum var.	velvet spyridium	13
Trymalium wayae **-UR**	grey trymalium	12
RUBIACEAE		
Asperula conferta	common woodruff	1
Galium gaudichaudii	rough bedstraw	5
G. migrans		1 10
* *G. murale*	small bedstraw	13
G. sp.		1
* *Sherardia arvensis*	field madder	11
Synaptantha tillaeacea @		10
RUTACEAE		
Boronia coerulescens ssp. *coerulescens*	blue boronia	1 2 3 5 6 12 13
Correa glabra	smooth correa	12
Eriostemon angustifolius ssp. *angustifolius* **-RR**		1
E. linearis @	narrow-leaved wax-flower	10
Geijera linearifolia	sheep bush	1 2 3 12 13
G. parviflora **-K-**	wilga	2 3 4 6 9 10 13
Phebalium bullatum	silvery phebalium	3 5 13
SANTALACEAE		
C. spicatum $[11]	spiked sour-bush	4
Exocarpos aphyllus	leafless ballart	1 2 3 4 5 6 8 9 10 11 12 13
E. sparteus	broom ballart	5 6 12 13
E. strictus **-RR**	pale-fruit ballart	3 4 5 6 13
Santalum acuminatum **-NN**	quandong	1 2 3 4 5 6 7 9 10 12 13
S. lanceolatum **-NE**	plumbush	10
S. murrayanum **-UU**	bitter quandong	3 5 6 10 12 13
S. sp.		1 4 11
S. spicatum **-R-**	sandalwood	3 6
SAPINDACEAE		
Alectryon oleifolius ssp. *canescens*	bullock bush	1 2 3 4 5 6 7 8 9 10 11 12 13

[11] Questionable identification as previously only known from Kangaroo Island & South-Eastern regions.

Dodonaea baueri	crinkled hop-bush	1									10		12	13
D. bursariifolia	small hop-bush	1	2	3		5	6				10		12	13
D. hexandra	horned hop-bush					5								
D. lobulata **-NU**	lobe-leaved hop-bush	1	2			5	6			9	10	11	12	13
D. microzyga var. *microzyga*	brilliant hop-bush									9	10			
D. stenozyga	desert hop-bush	1		3		5	6						12	13
D. viscosa ssp.		1			4									
D. viscosa ssp. *angustissima*	narrow-leaved hop-bush	1	2	3	4	5	6			9	10	11	12	13
D. viscosa ssp. *cuneata* **-UU**	wedge-leaved hop-bush			3										
D. viscosa ssp. *spatulata*	sticky hop-bush			3										
SCROPHULARIACEAE														
Limosella curdieana var.	large mudwort										10			13
?Peplidium foecundum	dwarf peplidium													13
Stemodia florulenta	bluerod					5		7						13
SOLANACEAE														
Cyphanthera myosotidea														13
* *Datura ferox*	fierce thornapple	1	2											
* *D. stramonium*	common thornapple		2											
Duboisia hopwoodii	pituri	1		3	4	5	6				10			13
D. hopwoodii x *Grammosolen dixonii*														13
Grammosolen dixonii **-UU**		1				5	6						12	13
Lycium australe	Australian boxthorn	1	2	3	4	5	6	7	8	9	10	11	12	13
* *L. ferocissimum*	African boxthorn	1	2	3	4	5	6			9	10	11	12	13
* *Nicotiana glauca*	tree tobacco	1	2	3		5		7			10	11		13
N. goodspeedii	small-flower tobacco	1	2	3	4			7	8		10			13
N. maritima	coast tobacco													13
N. occidentalis ssp. *obliqua*											10			
N. sp.		1	2			5	6		8			11		13
N. velutina	velvet tobacco					5					10		12	13
Solanum cleistogamum	shy nightshade	1												
S. coactiliferum	tomato-bush	1		3	4	5								13
* *S. elaeagnifolium*	silver-leaf nightshade									9				
S. ellipticum	velvet potato-bush	1								9	10	11		
S. esuriale	quena	1	2	3				7	8	9	10		12	
* *S. nigrum*	black nightshade	1	2	3	4	5			8	9	10	11		13
S. petrophilum	rock nightshade	1	2								10			
S. simile	Kangaroo apple			3	4									
S. sp.	night-shade/potato-bush	1				5								13
S. sturtianum	Sturt's nightshade	1	2							9	10			13
STACKHOUSIACEAE														
Stackhousia megaloptera **-NK**	dune candles					5								13
S. monogyna	creamy candles		2											
S. sp.		1		3										
STERCULIACEAE														
Gilesia biniflora	western tar-vine							7						
Lasiopetalum baueri	slender velvet-bush												12	
TAMARICACEAE														
* *Tamarix aphylla* @	athel pine										10			
THYMELAEACEAE														
Pimelea glauca	smooth riceflower											11		
P. micrantha	silky riceflower						6				10			13
P. microcephala ssp. *microcephala*	mallee riceflower	1	2	3	4	5	6			9	10		12	13
P. simplex ssp. *continua*	desert riceflower			3	4						10			13
P. simplex ssp. *simplex*	desert riceflower										10		12	
P. stricta	erect riceflower	1											12	
P. trichostachya	spiked riceflower					5								13
UMBELLIFERAE														
* *Bupleurum semicompositum*														13
* *Conium maculatum*	hemlock		2								10			
Daucus glochidiatus	native carrot	1		3			6			9	10			13
D. sp.					4									

		1	2	3	4	5	6	7	8	9	10	11	12	13
* *Foeniculum vulgare*	fennel											11		
Trachymene cyanopetala	purple parsnip													13
URTICACEAE														
Parietaria cardiostegia	smooth nettle	1												
P. cardiostegia/debilis	smooth nettle	1												
P. debilis	smooth nettle	1		3	4						10			13
P. sp.		1												
* *Urtica urens*	small nettle			3		5								
VERBENACEAE														
* *Verbena officinalis*	common verbena	1	2					7			10			
* *V. supina*	trailing verbena	1		3	4		6							13
VIOLACEAE														
Hybanthus floribundus ssp. *floribundus*	shrub violet					5	6						12	13
ZYGOPHYLLACEAE														
Nitraria billardierei	nitre-bush	1	2	3	4	5	6	7	8	9	10	11	12	13
* *T. terrestris*	caltrop							7			10	11		
Zygophyllum ammophilum	sand twinleaf	1												13
Z. ammophilum (nv)	sand twinleaf	1	2		4					9	10	11	12	
Z. angustifolium	scrambling twinleaf	1												
Z. apiculatum	common twinleaf	1	2	3	4	5	6			9	10		12	13
Z. aurantiacum	shrubby twinleaf	1												13
Z. aurantiacum (nv)	shrubby twinleaf	1	2	3	4	5	6	7	8		10	11	12	
Z. billardierei (nv)	coast twinleaf	1	2	3	4				8				12	13
Z. confluens		1												13
Z. crenatum	notched twinleaf	1			4					9	10	11	12	
Z. eremaeum	pale-flower shrubby twin-leaf	1			4	5					10			13
Z. glaucum	pale twinleaf	1	2	3	4	5				9	10	11		13
Z. humillimum **K--**	small-fruit twinleaf									9				
Z. iodocarpum	violet twinleaf	1		3	4					9	10	11		13
Z. ovatum	dwarf twinleaf	1		3	4	5			8		10		12	13
Z. prismatothecum @	square-fruit twinleaf										10			
Z. simile		1												13
Z. sp.		1				5				9				
Z. tesquorum $[12]					4									

[12] Questionable identification as previously only known from ?North-Western & Lake Eyre regions.

Appendix VII

SCIENTIFIC AND COMMON NAMES OF PLANT SPECIES FOUND AT SITES ON THE SOUTH OLARY PLAINS SURVEY

Only species with a frequency of greater than two are listed.

Scientific name	Common name
Abutilon fraseri	dwarf lantern-flower
Abutilon halophilum	plains lantern-flower
Abutilon malvaefolium	mallow lantern-flower
Acacia aneura	
Acacia brachybotrya	grey mulga-bush
Acacia burkittii	pin-bush wattle
Acacia calamifolia	wallowa
Acacia colletioides	wait-a-while
Acacia farnesiana	sweet acacia
Acacia hakeoides	hakea wattle
Acacia ligulata	umbrella bush
Acacia loderi	nealie
Acacia myrtifolia var. angustifolia	narrow-leaf myrtle wattle
Acacia notabilis	notable wattle
Acacia nyssophylla	wait-a-while
Acacia oswaldii	umbrella wattle
Acacia pycnantha	golden wattle
Acacia rigens	nealie
Acacia sclerophylla	hard-leaf wattle
Acacia victoriae ssp. victoriae	elegant wattle
Acacia wilhelmiana	dwarf nealie
Actinobole uliginosum	flannel cudweed
Alectryon oleifolius ssp. canescens	bullock bush
Alyssum linifolium	flax-leaf alyssum
Amyema miquelii	box mistletoe
Amyema miraculosum ssp. boormanii	fleshy mistletoe
Amyema preissii	wire-leaf mistletoe
Arabidella nasturtium	yellow cress
Arabidella procumbens	creeping cress
Arabidella trisecta	shrubby cress
Aristida contorta	mulga grass
Asphodelus fistulosus	onion weed
Asteridea athrixioides forma athrixioides	wirewort
Atriplex acutibractea ssp. acutibractea	
Atriplex angulata	fan saltbush
Atriplex holocarpa	pop saltbush
Atriplex lindleyi ssp. inflata	
Atriplex stipitata	mallee saltbush
Atriplex vesicaria	bladder saltbush
Baeckea crassifolia	desert baeckea
Beyeria lechenaultii	pale turpentine bush
Beyeria opaca	dark turpentine bush
Brachycome ciliaris	variable daisy
Brachycome lineariloba	hard-headed daisy
Brachycome trachycarpa	inland daisy
Brassica tournefortii	long-fruited wild turnip
Bromus rubens	red brome
Bulbine semibarbata	annual bulbine-lily
Bursaria spinosa	sweet bursaria
Calandrinia eremaea	small purslane
Calendula arvensis	field marigold
Callitris glaucophylla	white cypress-pine
Callitris verrucosa	mallee cypress pine
Calotis hispidula	bogan flea
Carrichtera annua	Wards weed
Carthamus lanatus	saffron thistle
Cassinia arcuata	Chinese scrub
Cassinia laevis	curry bush
Cassytha melantha	large dodder-laurel
Casuarina pauper	black oak
Centaurea melitensis	Maltese cockspur
Centipeda thespidioides	desert sneezeweed
Chamaescilla corymbosa var. corymbosa	blue squill
Cheilanthes austrotenuifolia	rock fern
Cheilanthes lasiophylla	woolly cloak-fern
Cheilanthes sieberi ssp. sieberi	Sieber's rock-fern
Chenopodium curvispicatum	cottony goosefoot
Chenopodium desertorum	desert goosefoot
Chenopodium nitrariaceum	nitre goosefoot
Chrysocephalum apiculatum	common everlasting
Chrysocephalum semicalvum ssp. semicalvum	hill everlasting
Chrysocephalum semipapposum	clustered everlasting
Chthonocephalus pseudevax	ground-heads
Convolvulus erubescens	Australian bindweed
Convolvulus microsepalus	
Convolvulus remotus	
Craspedia pleiocephala	soft billybuttons
Crassula colorata	
Crassula sieberiana ssp. tetramera	Australian crassula
Cratystylis conocephala	bluebush daisy
Critesion murinum ssp. glaucum	northern barley-grass
Cryptandra amara var. longiflora	long-flower cryptandra
Cymbopogon ambiguus	scented grass
Danthonia caespitosa	common wallaby-grass
Danthonia setacea var. setacea	small-flower wallaby-grass
Daucus glochidiatus	native carrot

Scientific name	Common name
Daviesia benthamii ssp. benthamii	dryland bitter-pea
Daviesia benthamii ssp. humilis	mallee bitter-pea
Dianella revoluta	black-anther flax-lily
Disphyma crassifolium ssp. clavellatum	round-leaf pigface
Dissocarpus biflorus var. biflorus	twin-horned copperburr
Dissocarpus paradoxus	
Dittrichia graveolens	stinkwort
Dodonaea baueri	crinkled hop-bush
Dodonaea bursariifolia	small hop-bush
Dodonaea lobulata	lobe-leaved hop-bush
Dodonaea stenozyga	desert hop-bush
Dodonaea viscosa ssp. angustissima	narrow-leaved hop-bush
Echium plantagineum	Salvation Jane
Einadia nutans	
Elachanthus pusillus	elachanth
Enchylaena tomentosa var. tomentosa	ruby saltbush
Enneapogon avenaceus	common bottle-washers
Enneapogon intermedius	
Eragrostis australasica	cane-grass
Eragrostis dielsii var. dielsii	mulka grass
Eremophila alternifolia	narrow-leaved fuchsia-bush
Eremophila crassifolia	thick-leaved emubush
Eremophila deserti	
Eremophila glabra	
Eremophila longifolia	berrigan
Eremophila maculata var. maculata	spotted emubush
Eremophila oppositifolia var. oppositifolia	weeooka
Eremophila scoparia	broom emubush
Eremophila serrulata	green fuchsia-bush
Eremophila sturtii	turpentine bush
Eriochiton sclerolaenoides	
Erodiophyllum elderi	Koonamore daisy
Erodium aureum	
Erodium cicutarium	common storks bill
Erodium crinitum	blue storks bill
Erodium cygnorum ssp. glandulosum	
Eucalyptus brachycalyx	gilja
Eucalyptus camaldulensis	river red gum
Eucalyptus dumosa	white mallee
Eucalyptus gracilis	yorrell
Eucalyptus incrassata	ridge-fruit mallee
Eucalyptus leptophylla	narrow-leaf red mallee
Eucalyptus oleosa	red mallee
Eucalyptus porosa	mallee box
Euphorbia drummondii	caustic weed
Euphorbia tannensis ssp. eremophila	bottle tree caustic
Eutaxia microphylla var. microphylla	common eutaxia
Exocarpos aphyllus	leafless ballart
Frankenia serpyllifolia	thyme sea-heath
Galium migrans	
Geijera linearifolia	sheep bush
Geococcus pusillus	earth cress
Glycine canescens	silky glycine

Scientific name	Common name
Glycine clandestina var. sericea	twining glycine
Gnephosis arachnoidea	
Goodenia fascicularis	silky goodenia
Goodenia pinnatifida	cut-leaf goodenia
Goodenia pusilliflora	small-flower goodenia
Goodenia willisiana	silver goodenia
Grevillea huegelii	comb grevillea
Hakea leucoptera	silver needlewood
Halgania cyanea	rough blue-flower
Haloragis aspera	rough raspwort
Harmsiodoxa brevipes	
Helichrysum leucopsideum	satin everlasting
Heliotropium europaeum	potato weed
Herniaria cinerea	rupturewort
Hyalosperma demissum	moss daisy
Hyalosperma glutinosum ssp. glutinosum	golden sunray
Hyalosperma semisterile	orange sunray
Hypochaeris glabra	smooth catsear
Hypochaeris radicata	rough catsear
Hypoxis glabella var. glabella	tiny star
Isoetopsis graminifolia	grass cushion
Isotoma petraea	rock isotome
Ixiolaena leptolepis	stalked ixiolaena
Lavatera plebeia	Australian hollyhock
Lawrencia squamata	thorny lawrencia
Lemooria burkittii	wires-and-wool
Lepidium leptopetalum	shrubby peppercress
Lepidium oxytrichum	green peppercress
Lepidium papillosum	warty peppercress
Lepidium phlebopetalum	veined peppercress
Leptospermum coriaceum	sandhill tea-tree
Logania nuda	leafless logania
Lomandra effusa	scented mat-rush
Lomandra leucocephala ssp. robusta	woolly mat-rush
Lotus cruentus	redflower lotus
Lycium australe	Australian boxthorn
Lycium ferocissimum	African boxthorn
Lysiana exocarpi ssp. exocarpi	Harlequin mistletoe
Maireana aphylla	cotton-bush
Maireana appressa	
Maireana astrotricha	grey bluebush
Maireana brevifolia	short-leaf bluebush
Maireana erioclada	rosy bluebush
Maireana georgei	satiny bluebush
Maireana integra	
Maireana pentatropis	erect bluebush
Maireana pyramidata	black bluebush
Maireana radiata	grey bluebush
Maireana sedifolia	pearl bluebush
Maireana trichoptera	mallee bluebush
Maireana triptera	three-wing bluebush
Maireana turbinata	top-fruit bluebush
Malacocera tricornis	goat-head
Malva parviflora	marshmallow
Marrubium vulgare	horehound
Marsdenia australis	native pear
Medicago minima var. minima	small burr-medic
Medicago polymorpha var. polymorpha	toothed medic
Medicago truncatula	barrel medic
Melaleuca lanceolata	dryland tea-tree
Menkea australis	fairy spectacles

Scientific name	Common name
Mesembryanthemum nodiflorum	slender iceplant
Millotia macrocarpa	
Millotia perpusilla	tiny bow-flower
Minuria cunninghamii	bush minuria
Minuria leptophylla	minnie daisy
Muehlenbeckia florulenta	lignum
Myoporum platycarpum	false sandalwood
Nicotiana goodspeedii	small-flower tobacco
Nitraria billardierei	nitre-bush
Olearia brachyphylla	short-leaf daisy-bush
Olearia calcarea	crinkle-leaf daisy-bush
Olearia decurrens	clammy daisy-bush
Olearia lepidophylla	club-moss daisy-bush
Olearia magniflora	splendid daisy-bush
Olearia muelleri	Mueller's daisy-bush
Olearia passerinoides ssp. passerinoides	feather daisy-bush
Olearia pimeleoides ssp. pimeleoides	pimelea daisy-bush
Olearia subspicata	spiked daisy-bush
Omphalolappula concava	burr stickseed
Onopordum acaulon	stemless thistle
Oxalis perennans	native sorrel
Parietaria cardiostegia	smooth nettle
Parietaria debilis	smooth nettle
Paspalidium constrictum	knotty-butt paspalidium
Phlegmatospermum cochlearinum	downy cress
Pimelea microcephala ssp. microcephala	mallee riceflower
Pittosporum phylliraeoides var. microcarpa	native apricot
Plagiobothrys plurisepaleus	white rochelia
Plantago bellardii	hairy plantain
Plantago drummondii	sago weed
Plantago turrifera	small sagoweed
Pleurosorus rutifolius	blanket fern
Podolepis capillaris	wiry podolepis
Podolepis tepperi	
Podotheca angustifolia	sticky longheads
Pogonolepis muelleriana	stiff cup-flower
Prostanthera aspalathoides	scarlet mintbush
Prostanthera striatiflora	striated mintbush
Ptilotus exaltatus var. exaltatus	tall mulla mulla
Ptilotus obovatus var. obovatus	silver mulla mulla
Ptilotus spathulatus forma spathulatus	pussytail
Reichardia tingitana	false sowthistle
Rhagodia parabolica	mealy saltbush
Rhagodia spinescens	spiny saltbush
Rhagodia ulicina	intricate saltbush
Rhodanthe corymbiflora	white cluster everlasting
Rhodanthe floribunda	white paper-daisy
Rhodanthe microglossa	small everlasting
Rhodanthe moschata	musk daisy
Rhodanthe polygalifolia	milkwort everlasting
Rhodanthe pygmaea	pigmy sunray
Rhodanthe stricta	slender everlasting
Rhyncharrhena linearis	climbing purple-star
Rostraria pumila	tiny bristle-grass
Salsola kali	prickly saltwort
Salvia verbenaca form	wild sage
Santalum acuminatum	quandong
Scaevola spinescens	spiny fanflower
Schismus barbatus	Arabian grass
Schoenus subaphyllus	desert bog-rush
Scleranthus pungens	prickly knawel
Sclerolaena brachyptera	short-wing bindyi
Sclerolaena cuneata	tangled bindyi
Sclerolaena diacantha	grey bindyi
Sclerolaena divaricata	tangled bindyi
Sclerolaena lanicuspis	spinach bindyi
Sclerolaena obliquicuspis	oblique-spined bindyi
Sclerolaena parviflora	small-flower bindyi
Sclerolaena patenticuspis	spear-fruit bindyi
Sclerolaena uniflora	grey bindyi
Sclerolaena ventricosa	salt bindyi
Sclerostegia tenuis	slender glasswort
Senecio anethifolius	feathery groundsel
Senecio glossanthus	annual groundsel
Senecio lautus	variable groundsel
Senecio quadridentatus	cotton groundsel
Senna artemisioides nothossp. artemisioides	silver senna
Senna artemisioides nothossp. coriacea	desert senna
Senna artemisioides ssp. filifolia	fine-leaf desert senna
Senna artemisioides ssp. petiolaris	flat-stalk senna
Sida corrugata	corrugated sida
Sida fibulifera	pin sida
Sida intricata	twiggy sida
Sida petrophila	rock sida
Sida trichopoda	high sida
Sisymbrium erysimoides	smooth mustard
Sisymbrium irio	London rocket
Solanum coactiliferum	tomato-bush
Solanum ellipticum	velvet potato-bush
Solanum esuriale	quena
Solanum nigrum	black nightshade
Solanum petrophilum	rock nightshade
Sonchus oleraceus	common sow-thistle
Stenopetalum lineare	narrow thread-petal
Stipa acrociliata	graceful spear-grass
Stipa elegantissima	elegant spear-grass
Stipa nitida	Balcarra grass
Stipa nodosa	smooth spear-grass
Stipa platychaeta	flat-awn spear-grass
Stipa scabra ssp. scabra	rough spear-grass
Stipa scabra group	falcate-awn spear-grass
Templetonia egena	broombush templetonia
Tetragonia eremaea	desert spinach
Tetragonia tetragonioides	New Zealand spinach
Teucrium racemosum	grey germander
Thysanotus baueri	mallee fringe-lily
Triodia irritans complex	spinifex
Vittadinia cuneata	New Holland daisy
Vittadinia cuneata var. cuneata forma cuneata	New Holland daisy
Vittadinia cuneata var. morrisii	New Holland daisy
Vittadinia dissecta var. hirta	dissected New Holland daisy
Vittadinia gracilis	woolly New Holland daisy
Wahlenbergia sp.	native bluebell
Westringia rigida	stiff westringia
Wurmbea dioica ssp. dioica	early star-lily

Scientific name	Common name	Scientific name	Common name
Xanthium spinosum	Bathurst burr	*Zygophyllum crenatum*	notched twinleaf
Zygophyllum ammophilum	sand twinleaf	*Zygophyllum eremaeum*	pale-flower shrubby twin-leaf
Zygophyllum angustifolium	scrambling twinleaf		
Zygophyllum apiculatum	common twinleaf	*Zygophyllum glaucum*	pale twinleaf
Zygophyllum aurantiacum	shrubby twinleaf	*Zygophyllum iodocarpum*	violet twinleaf
Zygophyllum billardierei	coast twinleaf	*Zygophyllum ovatum*	dwarf twinleaf
Zygophyllum confluens		*Zygophyllum simile*	

Appendix VIII

MAMMAL SPECIES RECORDED FROM THE SOUTH OLARY PLAINS SURVEY AREA

Species are listed by scientific name in taxnomic order of family using the nomenclature of Kemper and Queale (1990).

Conservation status codes are shown in bold following the scientific name. The first code is the Australian status according to *the Commonwealth Endangered Species Protection Act 1992* (codes X, E & V only) (based on the 'ANZECC List of Threatened Vertebrate Fauna, April 1991') and updated from the Australian marsupial action plan (Kennedy, 1992) and the rodent action plan (Lee, 1995). [Codes in brackets for bats are from the draft recovery plan (Richards and Hall, 1994)]. The second code is the South Australian classification from Threatened Species Strategy Steering Committee (1993). The status of mammal species have not yet been assessed on a regional basis. Notes on South Australian regional locations are from Kemper and Queale (1990), Watts and Aslin (1981) (rodents) and Reardon and Flavel (1991) (bats). Australian distributions are from Kennedy (1992).

Conservation status code definitions are:

X **Extinct** - species not definitely located in the wild during the past 50 years.

pX **Probably extinct.**

E **Endangered** - taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating.

V **Vulnerable** - taxa believed likely to move into endangered category in the near future if the causal factors continue operating.

pV **Potentially vulnerable.**

R **Rare** - taxa with small populations in South Australia that are not at present endangered or vulnerable but are at risk.

I **Indeterminate** - taxa suspected of belonging to the endangered, vulnerable or rare categories but for which insufficient information is currently available.

U **Uncommon** - taxa occurring at relatively low numbers in South Australia but not rare.

O vagrant or seasonal visitor

The seven columns indicate the source of mammals species records as follows:

1 South Olary Plains survey, D.E.N.R., 1995 (this survey), site data
2 South Olary Plains survey, D.E.N.R, 1995 (this survey), opportunistic data
3 University of S.A. (1994), Danggali Conservation Park
4 South Australian Museum Mammal Section records prior to 1992 (whole area)
5 S.A. National Parks & Wildlife Service records & S.A National Estate Vertebrate Database (Pooginook, Pandappa, Danggali and Cooltong Conservation Parks)
6 Field Naturalist's Society of South Australia, Mammal Club (B. Thomas, pers.comm.), Calperum, Bungunnia and Collinsville Stations, Pooginook and Danggali Conservation Parks.

P No museum specimens from area but species may probably or possibly (still) occur there (C. Kemper, pers. comm.) - see notes in text.

H No museum records from area but thought to have been there historically (i.e. post European occupation) [deduced from known preferred habitats and historical records from nearby areas, i.e. from Watts and Aslin, 1981; Wakefield, 1966 (Blandowski expedition to NW Victoria) and S.A. Museum records]. Some of these species are riverine, or of more mesic habitats, that may have once occurred further north into the survey area.

F Sub-fossil material of locally extinct species (i.e. could be up to several thousand years old), found on current survey at Anabama Hill (column two) or by University of S.A. at Danggali Conservaton Park in 1988 (column three). Material identified by G. Medlin at S.A. Museum.

Common Name	Scientific Name	Source						
TACHYGLOSSIDAE								
Tachyglossus aculeatus	Short-beaked Echidna	1	2	3	4	5	6	
BURRAMYIDAE								
Cercartetus concinnus[1]	Western Pygmy-possum				4?			
DASYURIDAE								
Antechinomys laniger **pVR**	Kultarr		F		P?			H
Dasycercus cristicauda **VE**	Mulgara		F					
Dasyurus geoffroii[2] **EX**	Western Quoll							H?
Dasyurus maculatus[3] **pVX**	Spotted-tailed Quoll				4?			
Ningaui yvonneae	Yvonne's Ningaui			3	4		6	
Phascogale calura[4] **EX**	Red-tailed Phascogale			F				H?
Planigale gilesi **-U**	Paucident Planigale				P			H
Planigale tenuirostris **-U**	Narrow-nosed Planigale	1						
Sminthopsis crassicaudata	Fat-tailed Dunnart	1	2	3	4	5		
Sminthopsis macroura	Stripe-faced Dunnart	1		3	4			
Sminthopsis murina **-U**	Common Dunnart	1	F	3	4	5	6	
Sminthopsis cf. *psammophila* **VV**	Sandhill Dunnart			F				
MACROPODIDAE								
Lagorchestes leporides **XX**	Eastern Hare-wallaby							H
Macropus fuliginosus	Western Grey Kangaroo	1	2	3	4	5	6	
Macropus giganteus[5] **-V**	Eastern Grey Kangaroo		2		4			
Macropus robustus	Common Wallaroo (Euro)	1	2		4	5	6	
Macropus rufus	Red Kangaroo	1	2	3	4	5	6	
Onychogalea fraenata[6] **EX**	Bridled Nailtail Wallbay							H?
Onychogalea lunata[7] **XX**	Crescent Nailtail Wallaby		F					H?
Petrogale xanthopus[8] **pVR**	Yellow-footed Rock-wallaby		2					H
MYRMECOBIIDAE								
Myrmecobius fasciatus **EX**	Numbat							H
PERAMELIDAE								
Chaeropus ecaudatus **pXX**	Pig-footed Bandicoot							H
Isoodon cf. *auratus* **EX**	Golden Bandicoot			F				
Macrotis lagotis **VX**	Greater Bilby							H
Perameles bougainville **EX**	Western Barred Bandicoot			F				H
PHALANAGERIDAE								
Trichosurus vulpecula **pV-**	Common Brushtail		F					H
POTORIDAE								
Bettongia lesueur **EX**	Burrowing Bettong							H
Bettongia penicillata **EE**	Brush-tailed Bettong							H
VOMBATIDAE								
Lasiorhinus latifrons[9] **-U**	Hairy-nosed Wombat		2			5	6	H

[1] Only records are from Overland Corner in 1892, but location is probably very imprecise. Species tends to occur in more mesic, shrubbier habitats.
[2] Occurred historically just south of survey area and could possibly have occurred in more arid areas.
[3] Only records are from Overland Corner and Quondong Vale (?), donated pre 1915, but very dubious as this species tends to occur in more mesic (wetter) habitats.
[4] Only known historically from Mt Lofty Ranges region, northern S.A. and north-western Victoria.
[5] Only one museum record from near Overland Corner in 1992, and a single survey observation - see text for details.
[6] Possibly occurred in area historically as known from adjacent areas in N.S.W. and Victoria (historically).
[7] Historically known from south-western W.A., central Australia and north-western Victoria.
[8] Bones collected on current survey from ground surface so presumably recent but not sub-fossil (see text). Sub-fossils also collected.
[9] Active warrens recorded on Kia-ora Station and Pooginook Conservation Park but these are known local populations reintroduced to the area in 1971 (St John and Saunders, 1989). [Species previously thought to be locally extinct in the South Olary Plains.]

Common Name	Scientific Name	Source						
MURIDAE								
Leggadina forresti **-R**	Forrest's Mouse		F		P			H
Leporillus apicalis **XX**	Lesser Stick-nest Rat		F	F				H
Leporillus conditor **VE**	Greater Stick-nest Rat		F					H
* *Mus domesticus*	House Mouse	1	2	3	4	5	6	
Notomys cf. *fuscus*[10] **VE**	Dusky-Hopping Mouse		F	F				
Notomys longicaudatus **XX**	Long-tailed Hopping-mouse		F	F				
Notomys cf. *mitchelli*[11]	Mitchell's Hopping-mouse						6?	H
Pseudomys australis **V-**	Plains Mouse/Rat		F	F				H
Pseudomys bolami	Bolam's Mouse	1	F	3	4	5		
Pseudomys desertor **IR**	Desert Mouse		F					H
Pseudomys gouldii **XX**	Gould's Mouse		F	F?				H
* *Rattus rattus*[12]	Black Rat			3?	P			
Rattus villosissimus[13]	Long-haired (Plague) Rat		F					
EMBALLONURIDAE								
Saccolaimus flaviventris **-O**	Yellow-bellied Sheathtail Bat				P			
MOLOSSIDAE								
Mormopterus planiceps	Little Mastiff-bat					5		
Mormopterus planiceps ('big penis')	Little Mastiff-bat	1	2					
Mormopterus planiceps ('little penis')	Little Mastiff-bat		2	3	4			
Tadarida australis	White-striped Mastiff-bat		2	3	4	5	6	
PTEROPODIDAE								
Pteropus scapulatus **-O**	Little Red Flying-fox				P			
VESPERTILIONIDAE								
Chalinolobus gouldii	Gould's Wattled Bat	1	2	3	4	5	6	
Chalinolobus morio	Chocolate Wattled Bat				P			
Chalinolobus picatus **(R)R**	Little Pied Bat			3	4	5	6	
Vespadelus (Eptesicus) baverstocki	Inland Eptesicus	1	2	3	4	5		
Vespadelus (Eptesicus) regulus	King River Eptesicus		2	3	4	5		
Vespadelus (Eptesicus) vulturnus	Little Forest Eptesicus				4	5		
Nyctophilus geoffroyi	Lesser Long-eared Bat	1	2	3	4	5		
Nyctophilus timoriensis **-U**	Greater Long-eared Bat		2	3	4	5	6	
Scotorepens balstoni	Western Broad-nosed Bat		2		4	5		
LEPORIDAE								
* *Lepus capensis* **-U**	Brown Hare	1	2			5		
* *Oryctolagus cuniculus*	Rabbit	1	2	3	4	5	6	
CANIDAE								
* *Canis familiaris dingo*	Dingo							H
* *Vulpes vulpes*	Fox	1	2	3	4	5	6	
FELIDAE								
* *Felis catus*	Cat	1	2	3		5	6	
BOVIDAE								
* *Bos taurus*	Cattle	1				5		
* *Capra hircus*	Goat	1	2	3		5	6	
* *Ovis aries*	Sheep	1	2	3		5		

[10] Sub-fossil material is probably this species as too small for *N. mitchelli*. *N. fuscus* sub-fossils have also been found in the Flinders Ranges (Medlin, 1993).
[11] Possible old burrows found on Pooginook C. P. by F.N.S. Mammal Club but species tends to occur in mallee with more diverse shrubby understorey.
[12] Record from Danggali Conservation Park was bones found in fox scats but unconfirmed identification.
[13] Possibly historically occurred this far south. Extant in northern S.A..

Appendix IX

BIRD SPECIES RECORDED FROM THE SOUTH OLARY PLAINS SURVEY AREA

Species are listed by common name in taxonomic order of Family using the nomenclature of Parker and Horton (1990). Where common and scientific names differ from those recommended by the Royal Australasian Ornithologists Union... (RAOU - Blakers *et al.*, 1984; Christidis and Boles, 1994) the latter is given in parentheses. To be consistently accurate, subspecies are not listed unless they are morphologically distinct enough to be easily identified in the field.

* Introduced species

† Denotes records listed in the RAOU S.A. database that are *not* shown in the RAOU Atlas (Blakers *et al.*,1984) or listed in Parker and Horton (1990) as occurring in the appropriate regions. Therefore, they are treated as unconfirmed records but may possibly occur as vagrants or seasonal visitors. Similarly, a few other species, although recorded by two sources, require confirmation. These are indicated with footnotes

Conservation status codes are shown in bold following the common name. The first code is the Australian status according to the Commonwealth *Endangered Species Protection Act 1992* (codes E & V) (based on the 'ANZECC List of Threatened Vertebrate Fauna, April 1991') and *The Action Plan For Australian Birds* (Garnett, 1992) (codes R & I); the second is the state status according to the South Australian *National Parks and Wildlife Act 1972* schedule, and the third is from the state classification of Parker and Horton (1990) which has been updated in Threatened Species Strategy Steering Committee (1993) and Carpenter and Reid (1994). Bird species of the pastoral regions have not yet been assessed on a regional basis.

Status code definitions are:

E Endangered - taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating.

V Vulnerable - taxa believed likely to move into endangered category in the near future if the causal factors continue operating.

R Rare - taxa with small populations in South Australia that are not at present endangered or vulnerable but are at risk.

I Indeterminate - taxa suspected of belonging to the endangered or vulnerable categories but for which insufficient information is currently available.

The ten columns indicate the source of bird species records as follows:

1 Forward & Robinson (1995), site data (this survey)
2 Forward & Robinson (1995), opportunistic data
3 University of S.A. (1994), Danggali Conservation Park
4 T.A.F.E. (1981), Danggali Conservation Park & Chowilla Regional Reserve
5 Royal Australasian Ornithologists Union records from the RAOU S.A. Database and RAOU Atlas (Blakers *et al.*, 1984), (whole area)
6 S.A. National Parks & Wildlife Service records & S.A National Estate Vertebrate Database (Danggali, Pooginook, Pandappa, White Dam & Cooltong Conservation Parks) (includes raw data from Reid & Vincent, 1979)
7 South Australian Ornithological Association records from Calperum & Sturtvale Stations, 1984 & 1989 respectively
8 Native Vegetation Management Section clearance application assessments (agricultural areas)
9 S.A. N.P.W.S. scientific research permit records - species lists from various private bird-banders (central & southern areas)
10 Additional records for South Olary Plains region and for species accorded conservation significance - mostly from publications of Boehm (various), Mack (1970) and Pearse (various).

Common Name	Scientific Name	Source									
STRUTHIONIDAE											
*Ostrich	*Struthio camelus*										10
CASUARIIDAE											
Emu	*Dromaius novaehollandiae*	1	2	3	4	5	6	7	8		

Common Name	Scientific Name	Source									
MEGAPODIIDAE											
Malleefowl **E(V)[1]EV**	*Leipoa ocellata*	1	2	3	4	5	6	7	8		
PHASIANIDAE											
Stubble Quail	*Coturnix novaezelandiae*	1		3	4	5	6	7			
ANATIDAE											
Chestnut Teal	*Anas castanea*			3		5	6				
Australasian Grey Teal	*Anas gracilis*	1	2		4	5	6	7		9	
• Mallard[2]	*Anas platyrhynchos*					5					
Australasian Shoveler **-RR**	*Anas rhynchotis*		2		4	5	6				10
Pacific Black Duck	*Anas superciliosa*		2	3	4	5	6	7		9	
Hardhead (White-eyed Duck)	*Aythya australis*		2			5	6	7			
Musk Duck **-VU**	*Biziura lobata*					5	6				10
Cape Barren Goose	*Cereopsis novaehollandiae*										10
Wood (Maned) Duck	*Chenonetta jubata*	1	2	3	4	5	6	7		9	
Black Swan	*Cygnus atratus*				4	5	6	7			
Plumed Whistling-Duck	*Dendrocygna eytoni*	10									
Pink-eared Duck	*Malacorhynchus membranaceus*		2	3	4	5	6	7			
Blue-billed Duck	*Oxyura australis*					5					10
Freckled Duck **RVV**	*Stictonetta naevosa*					5	6				10
Mountain Duck (Australian Shelduck)	*Tadorna tadornoides*				4	5	6				
TURNICIDAE											
Button-quail	*Turnix* sp.	1	2								
Painted Button-quail **-VV**	*Turnix varia*					5					10
Little Button-quail	*Turnix velox*	1	2			5	6	7			
CORACIIDAE											
Dollarbird	*Eurystomus orientalis*					5					
DACELONIDAE											
Laughing Kookaburra	*Dacelo novaeguineae*			3		5	6		8		
Red-backed Kingfisher	*Halcyon pyrrhopygia* *(Todiramphus pyrrhopygia)*	1	2			5	6	7	8		
Sacred Kingfisher	*Halcyon sancta (Todiramphus sanctus)*				4	5	6				
Kingfisher	*Halcyon* sp.	1									
MEROPIDAE											
Rainbow Bee-eater	*Merops ornatus*	1	2		4	5	6	7	8		
CUCULIDAE											
Fan-tailed Cuckoo	*Cacomantis flabelliformis* *(Cuculus pyrrhophanus)*			3		5	6				
Horsfield's Bronze-cuckoo	*Chrysococcyx basalis*	1	2	3	4	5	6	7		9	
Black-eared Cuckoo	*Chrysococcyx osculans*	1	2	3		5	6	7	8	9	
Shining Bronze-Cuckoo	*Chrysococcyx lucidus*										10
Pallid Cuckoo	*Cuculus pallidus*	1	2	3	4	5	6	7		9	
PSITTACIDAE											
Red-winged Parrot	*Aprosmictus erythropterus*										10
	Barnardius sp.						6				
Ringneck Parrot	*Barnardius zonarius*	1		3			6				
Mallee Ringneck	*Barnardius (zonarius) barnardi*	1	2		4	5	6	7	8	9	
Port Lincoln Ringneck	*Barnardius (zonarius) zonarius*	1		3		5					
Sulphur-crested Cockatoo	*Cacatua galerita*					5					10
Major Mitchell (Pink Cockatoo) **-VV**	*Cacatua leadbeateri*	1	2	3	4	5	6	7	8	9	10
Little Corella	*Cacatua sanguinea*	1	2	3	4	5	6				
Long-billed Corella[†]	*Cacatua tenuirostris*					5					
Red-tailed Black Cockatoo	*Calaptorhynchus banksii*										10
Galah	*Eolophus (Cacatua) roseicapilla*	1	2	3	4	5	6	7	8	9	

[1] Originally classified as endangered but recently reassessed and updated by Garnett (1992) to vulnerable.

[2] Possible hybrid with *A. superciliosus* (Pacific Black Duck)

Purple-crowned Lorikeet	*Glossopsitta porphyrocephala*	1	2	3		5			8		
Common Name	**Scientific Name**	**Source**									
Swift Parrot	*Lathamus discolor*										10
Budgerigah	*Melopsittacus undulatus*	1	2	3	4	5	6	7	8		
Bourke's Parrot†	*Neophema bourki*					5					10
Blue-winged Parrot **-VV**	*Neophema chrysostoma*	1	2	3		5		7			10
Elegant Parrot **--I**	*Neophema elegans*		2			5	6				10
Scarlet-chested Parrot **RRR**	*Neophema splendida*			3		5	6			9	10
Blue Bonnet	*Northiella (Psephotus) haematogaster*	1	2	3	4	5	6	7	8	9	
Cockatiel	*Nymphicus hollandicus*	1	2		4	5	6	7	8		
Adelaide Rosella	*Platycercus elegans 'adelaidae'*					5			8		
Yellow Rosella	*Platycercus elegans flaveolus*					5	6				
Regent Parrot **(V)**[3]**VV**	*Polytelis anthopeplus*		2	3	4	5	6	7			10
Red-rumped Parrot	*Psephotus haematonotus*	1	2	3		5	6		8		
Mulga Parrot	*Psephotus varius*	1	2	3	4	5	6	7	8	9	
Rainbow Lorikeet	*Trichoglossus haematodus*			3		5					
APODIDAE											
Fork-tailed Swift	*Apus pacificus*					5					10
Spine-tailed Swift (White-throated Needletail)	*Hirundapus caudacutus*					5					
TYTONIDAE											
Barn Owl	*Tyto alba*		2		4	5					
Masked Owl	*Tyto novaehollandiae*										10
STRIGIDAE											
(Southern) Boobook Owl	*Ninox novaeseelandiae*	1	2	3		5	6	7			
EUROSTOPODIDAE											
Spotted Nightjar	*Eurostopodus argus*	1	2	3	4	5	6	7	8	9	
AEGOTHELIDAE											
Australian Owlet-nightjar	*Aegotheles cristatus*	1	2	3		5	6	7		9	
PODARGIDAE											
Tawny Frogmouth	*Podargus strigoides*	1	2	3	4	5	6	7	8	9	
COLUMBIDAE											
* Feral Pigeon	*Columba livia*					5	6				
Diamond Dove	*Geopelia cuneata*	1	2	3		5					
Peaceful Dove	*Geopelia placida*	1	2			5	6	7		9	
Crested Pigeon	*Ocyphaps lophotes*	1	2	3	4	5	6	7	8	9	
Common Bronzewing	*Phaps chalcoptera*	1	2	3	4	5	6	7	8	9	
OTIDIDAE											
Australian Bustard **-VV**	*Ardeotis australis*		2			5	6		8		10
RALLIDAE											
Eurasian Coot	*Fulica atra*		2		4	5	6	7			
Dusky Moorhen	*Gallinula tenebrosa*		2			5					
Black-tailed Native-hen	*Gallinula ventralis*	1	2	3	4	5		7		9	
(Buff) Banded Rail	*Gallirallus (Rallus) philippensis*					5					
Purple Swamphen	*Porphyrio porphyrio*					5					10
Australian Spotted Crake	*Porzana fluminea*		2			5					
Baillon's (Marsh) Crake†	*Porzana pusilla*					5					10
Spotless Crake† **-R-**	*Porzana tabuensis*					5					
PEDIONOMIDAE											
Plains-wanderer	*Pedionomus torquatus*										10
SCOLOPACIDAE											
Common Sandpiper†	*Actitis hypoleucos*					5					
Sharp-tailed Sandpiper	*Calidris acuminata*					5				9	
Curlew Sandpiper	*Calidris ferruginea*					5					10
Red-necked Stint	*Calidris ruficolis*					5					10

[3] Recently classified by Garnett (1992) as vulnerable.

Common Name	Scientific Name	Source									
Latham's Snipe	*Gallinago hardwickii*										10
Wood Sandpiper	*Tringa glareola*					5					
Greenshank	*Tringa nebularia*					5					
Marsh Sandpiper	*Tringa stagnatilis*					5					10
BURHINIDAE											
Southern Stone Curlew (Bush Thick-knee) **--E**	*Burhinus grallarius (B. magnirostris)*					5			8		10
RECURVIROSTRIDAE											
Banded Stilt	*Cladorhynchus leucocephalus*		2			5					
White-headed Stilt (Black-winged, Pied Stilt)	*Himantopus leucocephalus*					5		7			
Red-necked Avocet	*Recurvirostra novaehollandiae*					5					10
CHARADRIIDAE											
Double-banded Dotterel(Plover)[†]	*Charadrius bicinctus*					5					
Red-capped Dotterel(Plover)	*Charadrius ruficapillus*					5					10
Oriental Dotterel(Plover)	*Charadrius veredus*					5					10
Black-fronted Dotterel(Plover)	*Elseyornis (Charadrius) melanops*		2		4	5	6	7		9	
Red-kneed Dotterel(Plover)	*Erythrogenys cinctus*		2			5		7		9	
Masked/Spur-winged Plover(Lapwing)	*Hoplopterus (Vanellus) miles*				4	5	6	7		9	
Banded Plover(Lapwing)	*Hoplopterus (Vanellus) tricolor*	1	2		4	5		7		9	
Inland (Australian) Dotterel	*Peltohyas austalis*		2		4	5					
Lesser Golden Plover[†]	*Pluvialis fulva (P. dominica)*					5					
Grey Plover[†]	*Pluvialis squatarola*					5					
GLAREOLIDAE											
Australian Pratincole	*Stiltia isabella*	1	2			5		7			
LARIDAE											
Whiskered (Marsh) Tern	*Chlidonias hybridus*		2			5					
Gull-billed Tern	*Gelochelidon nilotica*					5					10
Caspian Tern	*Hydroprogne caspia*					5	6				
Silver Gull	*Larus novaehollandiae*				4	5	6				
Crested Tern	*Sterna bergii*										10
Roseate Tern	*Sterna dougallii*										10
ACCIPITRIDAE											
Collared Sparrowhawk	*Accipiter cirrhocephalus*	1	2	3		5		7			
Brown Goshawk	*Accipiter fasciatus*	1	2	3		5	6	7	8	9	
Grey (White) Goshawk	*Accipiter novaehollandiae*					5				9	
Wedge-tailed Eagle	*Aquila audax*	1	2	3	4	5	6	7	8	9	
Swamp (Marsh) Harrier	*Circus aeruginosus*					5					
Spotted Harrier	*Circus assimilus*	1	2	3		5		7			
Black-shouldered Kite	*Elanus caeruleus (E. notatus)*		2			5					
Little Eagle	*Hieraaetus morphnoides*	1	2	3		5	6	7			
Whistling Eagle (Whistling Kite)	*Haliastur sphenurus*		2	3		5	6				
Black Kite	*Milvus migrans*	1	2	3	4	5		7		9	
FALCONIDAE											
Brown Hawk (Brown Falcon)	*Falco berigora*	1	2	3	4	5		7		9	
Nankeen (Australian) Kestrel	*Falco cenchroides*	1	2	3	4	5	6	7	8	9	
Grey Falcon	*Falco hypoleucos*										10
Little Falcon (Australian Hobby)	*Falco longipennis*		2	3		5		7			
Peregrine Falcon (**-VR** if ssp. *macropus*)	*Falco peregrinus*		2	3	4	5	6	7		9	10
Black Falcon	*Falco subniger*	1	2			5					
PODICIPEDIDAE											
Great Crested Grebe	*Podiceps cristatus*										10
Hoary-headed Grebe	*Poliocephalus poliocephalus*		2	3	4	5	6			9	
Black-throated (Australasian) Grebe	*Tachybaptus novaehollandiae*		2		4	5	6	7		9	
ANHINGIDAE											
Darter **--R**	*Anhinger melanogaster*		2			5	6				
PHALACROCORACIDAE											
Great (Black) Cormorant	*Phalacrocorax carbo*					5	6	7			

Common Name	Scientific Name	Source									
Little Pied Cormorant	*Phalacrocorax melanoleucos*		2			5	6				
Little Black Cormorant	*Phalacrocorax sulcirostris*		2			5	6	7			
Pied Cormorant	*Phalacrocorax varius*					5					10
ARDEIDAE											
Great (White) Egret	*Ardea alba*					5	6				
White-faced Heron	*Ardea novaehollandiae*		2	3	4	5	6	7		9	
Pacific (White-necked) Heron	*Ardea pacifica*		2		4	5	6	7		9	
Cattle Egret	*Bulbulcus ibis*					5					
Little Bittern	*Ixobrychus minutus*		2			5					
Nankeen (Rufous) Night Heron	*Nycticorax caledonicus*					5	6				
THRESKIORNITHIDAE (PLATALEIDAE)											
Yellow-billed Spoonbill	*Platalea flavipes*		2			5					
Royal Spoonbill	*Platalea regia*					5					10
Glossy Ibis **--R**	*Plegadis falcinellus*					5					10
Sacred Ibis	*Threskiornis aethiopicus*					5	6				
Straw-necked Ibis	*Threskiornis spinicollis*					5				9	
PELECANIDAE											
Australian Pelican	*Pelecanus conspicillatus*				4	5	6				
CLIMACTERIDAE											
White-browed Treecreeper	*Climacteris affinis*	1	2	3	4	5	6	7		9	
Brown Treecreeper	*Climacteris picumnus*	1	2	3	4	5	6	7	8	9	
MALURIDAE											
Superb Blue (Fairy) Wren	*Malurus cyaneus*					5	6				
Variegated (Fairy) Wren	*Malurus lamberti*		2			5	6	7	8	9	
Purple-backed Wren	*Malurus lamberti assimilis*	1		3		5	6	7		9	
White-winged (Fairy) Wren	*Malurus leucopterus*	1	2	3	4	5	6	7	8	9	
Blue Wren (Fairy-wren)	*Malurus* sp.		2								
Splendid Blue (Fairy) Wren	*Malurus splendens*	1	2	3		5	6	7	8	9	
Black-backed (Fairy) Wren	*Malurus splendens melanotus*	1	2		4	5	6				
AMYTORNITHIDAE											
Striated Grasswren **IVV**	*Amytornis striatus*		2	3	4	5	6	7	8	9	10
MELIPHAGIDAE											
Spiny-cheeked Honeyeater	*Acanthogenys rufogularis*	1	2	3	4	5	6	7	8	9	
Red Wattlebird	*Anthochaera carunculata*	1	2	3	4	5	6	7	8		
Little Wattlebird	*Anthochaera chrysoptera*										10
Gibberbird	*Ashbyia lovensis*										10
Pied Honeyeater **--R**	*Certhionyx variegatus*	1	2	3		5	6	7		9	10
Blue-faced Honeyeater **-RR**	*Entomyzon cyanotis*					5	6				
White-fronted Chat	*Ephthianura albifrons*	1	2	3	4	5	6	7	8	9	
Orange Chat	*Ephthianura aurifrons*	1	2		4	5					
Crimson Chat	*Ephthianura tricolor*	1	2	3	4	5	6	7			
Painted Honeyeater	*Grantiella picta*										10
Yellow-throated Miner	*Manorina flavigula*	1	2	3	4	5	6	7	8	9	
Noisy Miner	*Manorina melanocephala*		2	3		5	6				
Black-eared Miner **EEE**	*Manorina melanotis*		2			5	6				10
Purple-gaped Honeyeater[4]	*Meliphaga (Lichenostomus) cratitius*			3		5					10
Fuscous Honeyeater[†] [5] **--R**	*Meliphaga (Lichenostomus) fusca*					5	6				10
White-eared Honeyeater	*Meliphaga (Lichenostomus) leucotis*	1	2	3	4	5	6	7	8	9	
Yellow-plumed Honeyeater	*Meliphaga (Lichenostomus) ornata*	1	2	3	4	5	6	7	8	9	
White-plumed Honeyeater	*Meliphaga (Lichenostomus) penicillata*	1	2			5	6				
Grey-fronted Honeyeater	*Meliphaga (Lichenostomus) plumula*	1		3		5	6	7		9	
Singing Honeyeater	*Meliphaga (Lichenostomus) virescens*	1	2	3	4	5	6	7	8	9	

Common Name **Scientific Name** **Source**

[4] Danggali record unlikely this far north-east but possible as listed by Parker and Horton (1990) in the South East, Murray Mallee, Mt Lofty, Eyre & Yorke Peninsulas & Adelaide Plains regions and by Blakers *et al.* (1984) northwest of Morgan.

[5] N.P.W.S. record by a reputable ornithologist in Cooltong Conservation Park but *M. fusca* is listed by Parker & Horton (1990) & Blakers *et al.* (1984) as only occurring in the South East region (as a vagrant). However, this species has been recorded by Boehm (1944, in 1957) near Sutherlands, southeast of Robertstown (which is in the south-western corner of the survey area and by Mark (1976) on Manunda Station).

		1	2	3	4	5	6	7	8	9	10
Brown-headed Honeyeater	*Melithreptus brevirostris*	1	2	3	4	5	6	7	8	9	
White-naped Honeyeater	*Melithreptus lunatus*		2		4	5					
Honeyeater	*Melithreptus* sp.	1									
Little Friarbird	*Philemon citreogularis*										10
White-fronted Honeyeater	*Phylidonyris albifrons*	1	2	3		5	6	7	8	9	
New Holland Honeyeater	*Phylidonyris novaehollandiae*										10
Striped Honeyeater **-VV**	*Plectorhyncha lanceolata*	1	2	3	4	5	6	7	8	9	10
Black Honeyeater	*Sugomel (Certhionyx) niger*			3		5	6	7	8		
Regent Honeyeater	*Xanthomyza phrygia*										10
PARDALOTIDAE											
Spotted Pardalote	*Pardalotus punctatus*					5					
Striated Pardalote	*Pardalotus striatus*	1	2	3	4	5	6	7	8	9	
Yellow-rumped Pardalote **-V-**	*Pardalotus xanthopygus*	1	2	3		5	6	7	8	9	10
ACANTHIZIDAE											
Inland Brown Thornbill	*Acanthiza apicalis*	1	2	3		5	6	7	8	9	
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	1	2	3	4	5	6	7	8	9	
Slender-billed (Samphire) Thornbill **IVV**	*Acanthiza iredalei*		2			5					10
Little (Yellow) Thornbill	*Acanthiza nana*			3		5			8		
Thornbill	*Acanthiza* sp.		2								
Chestnut-rumped Thornbill	*Acanthiza uropygialis*	1	2	3	4	5	6	7	8	9	
Southern (Common) Whiteface	*Aphelocephala leucopsis*	1	2	3	4	5	6	7	8	9	
Western (Rufous) Fieldwren (Calamanthus)	*Calamanthus (Sericornis) campestris*	1	2	3		5					
Shy Heathwren (Shy Hylcola) **-VV**	*Hylacola (Sericornis) cauta*	1	2	3		5	6		8	9	10
Redthroat	*Pyrrholaemus (Sericornis) brunneus*	1	2	3		5	6	7	8		
Weebill	*Smicrornis brevirostris*	1	2	3	4	5	6	7	8		
EOPSALTRIIDAE											
(Varied) Sittella	*Daphoenositta chrysoptera*	1	2	3		5	6	7	8		
Southern Scrub-robin	*Drymodes brunneopygia*	1	2	3		5	6				
Hooded Robin	*Melanodryas cucullata*	1	2	3	4	5	6	7	8		
Jacky Winter	*Microeca leucophaea*	1	2	3	4	5	6	7	8	9	
Red-capped Robin	*Petroica goodenovii*	1	2	3	4	5	6	7		9	
Scarlet Robin	*Petroica multicolor*										10
POMATOSTOMIDAE											
Chestnut-crowned Babbler	*Pomatostomus ruficeps*	1	2	3	4	5	6	7		9	
Babbler	*Pomatostomus* sp.		2								
White-browed Babbler	*Pomatostomus superciliosa*	1	2	3	4	5	6	7	8	9	
CINCLOSOMATIDAE											
Chestnut Quail-thrush **-VV**	*Cinclosoma castanotum*	1	2	3	4	5	6	7	8	9	10
Cinnamon Quail-thrush	*Cinclosoma cinnamomeum*					5					
Quail-thrush	*Cinclosoma* sp.	1									
Chirruping Wedgebill	*Psophodes cristatus*	1	2	3		5					
CORCORACIDAE											
White-winged Chough **--V**	*Corcorax melanorhamphos*	1	2	3	4	5	6	7	8	9	10
Apostlebird **--R**	*Struthidea cinerea*	1	2	3	4	5	6	7		9	10
PACHYCEPHALIDAE											
Grey Shrike-thrush	*Colluricincla harmonica*	1	2	3	4	5	6	7	8	9	
Crested Bellbird	*Oreoica gutturalis*	1	2	3	4	5	6	7	8	9	
Gilbert's Whistler **--R**	*Pachycephala inornata*	1	2	3		5	6				10
Golden Whistler	*Pachycephala pectoralis*			3		5	6				
Rufous Whistler	*Pachycephala rufiventris*	1	2	3	4	5	6	7	8	9	
Red-lored Whistler **VVV**	*Pachycephala rufogularis*		2	3		5					10
CORVIDAE											
Black-faced Woodswallow	*Artamus cinereus*	1	2	3		5	6	7			
Dusky Woodswallow	*Artamus cyanopterus*	1	2	3	4	5	6	7		9	
White-breasted Woodswallow	*Artamus leucorhynchus*				3	4	5				

Common Name	Scientific Name	Source									
Little Woodswallow[6] --**R**	*Artamus minor*			3							
Masked Woodswallow	*Artamus personatus*	1	2	3	4	5	6	7	8		
Woodswallow	*Artamus* sp.	1	2								
White-browed Woodswallow	*Artamus superciliosus*	1	2	3	4	5	6	7	8	9	
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	1	2	3	4	5	6	7	8	9	
White-bellied Cuckoo-shrike	*Coracina papuensis*										10
Little Crow	*Corvus bennetti*	1	2	3		5	6	7	8		
Australian Raven	*Corvus coronoides*	1	2	3	4	5	6	7	8	9	
Little Raven	*Corvus mellori*	1	2	3		5	6	7	8		
Crow/Raven	*Corvus* sp.	1	2				6				
Pied Butcherbird	*Cracticus nigrogularis*	1		3		5	6	7			
Grey Butcherbird	*Cracticus torquatus*	1	2	3	4	5	6	7	8	9	
Australian Magpie	*Gymnorhina tibicen*	1	2	3		5	6	7	8	9	
White-backed Magpie	*Gymnorhina tibicen leoconota*		2		4		6				
Black-backed Magpie	*Gymnorhina tibicen tibicen*						6			9	
White-winged Triller	*Lalage sueurii*	1	2	3	4	5	6	7	8		
Ground Cuckoo-shrike	*Pteropodocys (Coracina) maxima*	1	2	3	4	5	6		8		
Grey Currawong	*Strepera versicolor*	1	2	3	4	5	6	7	8	9	
DICRURIDAE											
(Australian) Magpie-lark	*Grallina cyanoleuca*	1	2	3	4	5	6	7	8	9	
Restless Flycatcher	*Myiagra inquieta*	1	2	3		5	6	7	8		
Grey Fantail	*Rhipidura fuliginosa*			3	4	5	6				
Willie Wagtail	*Rhipidura leucophrys*	1	2	3	4	5	6	7	8	9	
MUSCICAPIDAE											
* Blackbird	*Turdus merula*		2			5					
STURNIDAE											
* (Common/European) Starling	*Sturnus vulgaris*	1	2	3	4	5	6	7	8		
HIRUNDINIDAE											
White-backed Swallow	*Chermoeca leucosternum*	1	2	3	4	5	6	7			
Fairy Martin	*Hirundo (Cecropis) ariel*		2			5				9	
Welcome Swallow	*Hirundo neoxena*	1	2	3	4	5	6	7		9	
Tree Martin	*Hirundo (Cecropis) nigricans*	1	2	3	4	5	6	7	8	9	
ZOSTEROPIDAE											
Silvereye	*Zosterops lateralis*	1				5	6	7	8	9	
SYLVIDAE											
Clamorous Reed-warbler	*Acrocephalus stentoreus*		2			5					
Brown Songlark	*Cinclorhamphus cruralis*	1	2	3		5	6	7		9	
Rufous Songlark	*Cinclorhamphus mathewsi*	1	2			5	6	7	8	9	
Songlark	*Cinclorhamphus* sp.		2								
Little Grassbird	*Megalurus gramineus*		2			5		7			
ALAUDIDAE											
* Skylark	*Alauda arvensis*	1				5					
Singing Bushlark	*Mirafra javanica*					5					10
NECTARINIIDAE											
Mistletoe Bird	*Dicaeum hirundinaceum*	1	2	3	4	5	6	7		9	
PASSERIDAE											
* House Sparrow	*Passer domesticus*		2		4	5	6	7			
MOTACILLIDAE											
Richard's Pipit	*Anthus novaeseelandiae*	1	2	3	4	5	6	7		9	
ESTRILDIDAE											
Diamond Firetail **IVV**	*Emblema guttatum*					5					10
Zebra Finch	*Poephila guttata*	1	2	3		5	6		8	9	

[6] Record possible but unlikely as listed by Parker & Horton (1990) in the Flinders Ranges, Western Pastoral, Northern Arid & Murray Mallee regions and by Blakers *et al.* (1984) in northern areas only. However, has been recorded by (Condon, 1969) at Lake Merreti on the River Murray on Calperum Station.

* Goldfinch *Carduelis carduelis* 5 6

Number of Species		
Source	**Indigenous**	**Alien**
1	123	2
2	160	3
3	127	1
4	99	2
5	231	5
6	102	3
7	123	2
8	78	1
9	92	0
10	66	1
Total	251	6

Total Number of Species: 257

Appendix X

SCIENTIFIC AND COMMON NAMES OF BIRD SPECIES FOUND ON THE SOUTH OLARY PLAINS SURVEY

Scientific Name	Common Name
Acanthiza apicalis	Inland Brown Thornbill
Acanthiza chrysorrhoa	Yellow-rumped Thornbill
Acanthiza iredalei	Slender-billed (Samphire) Thornbill
Acanthiza uropygialis	Chestnut-rumped Thornbill
Acanthogenys rufogularis	Spiny-cheeked Honeyeater
Accipiter cirrhocephalus	Collared Sparrowhawk
Accipiter fasciatus	Brown Goshawk
Acrocephalus stentoreus	Clamorous Reed-warbler
Aegotheles cristatus	Australian Owlet-nightjar
Alauda arvensis	Skylark
Amytornis striatus	Striated Grasswren IVV
Anas gracilis	Australasian Grey Teal
Anas rhynchotis	Australasian Shoveler
Anas superciliosa	Pacific Black Duck
Anhinger melanogaster	Darter
Anthochaera carunculata	Red Wattlebird
Anthus novaeseelandiae	Richard's Pipit
Aphelocephala leucopsis	Southern (Common) Whiteface
Aquila audax	Wedge-tailed Eagle
Ardea novaehollandiae	White-faced Heron
Ardea pacifica	Pacific (White-necked) Heron
Ardeotis australis	Australian Bustard
Artamus cinereus	Black-faced Woodswallow
Artamus cyanopterus	Dusky Woodswallow
Artamus personatus	Masked Woodswallow
Artamus superciliosus	White-browed Woodswallow
Aythya australis	Hardhead (White-eyed Duck)
Barnardius zonarius	Mallee Ringneck
Cacatua leadbeateri	Major Mitchell (Pink Cockatoo)
Cacatua sanguinea	Little Corella
Calamanthus (Sericornis) campestris	Western (Rufous) Fieldwren (Calamanthus)
Certhionyx variegatus	Pied Honeyeater
Chenonetta jubata	Wood (Maned) Duck
Chermoeca leucosternum	White-backed Swallow
Chlidonias hybridus	Whiskered (Marsh) Tern
Chrysococcyx basalis	Horsfield's Bronze-cuckoo
Chrysococcyx osculans	Black-eared Cuckoo
Cincloramphus cruralis	Brown Songlark
Cincloramphus mathewsi	Rufous Songlark
Cinclosoma castanotum	Chestnut Quail-thrush
Circus assimilus	Spotted Harrier
Cladorhynchus leucocephalus	Banded Stilt
Climacteris affinis	White-browed Treecreeper
Climacteris picumnus	Brown Treecreeper
Climacteris sp.	Treecreeper
Colluricincla harmonica	Grey Shrike-thrush
Coracina novaehollandiae	Black-faced Cuckoo-shrike
Corcorax melanorhamphos	White-winged Chough
Corvus bennetti	Little Crow
Corvus coronoides	Australian Raven
Corvus mellori	Little Raven
Coturnix novaezelandiae	Stubble Quail
Cracticus nigrogularis	Pied Butcherbird
Cracticus torquatus	Grey Butcherbird
Cuculus pallidus	Pallid Cuckoo
Daphoenositta chrysoptera	(Varied) Sittella
Dicaeum hirundinaceum	Mistletoe Bird
Dromaius novaehollandiae	Emu
Drymodes brunneopygia	Southern Scrub-robin
Elanus caeruleus (E. notatus)	Black-shouldered Kite
Elseyornis (Charadrius) melanops	Black-fronted Dotterel(Plover)
Eolophus (Cacatua) roseicapilla	Galah
Epthianura albifrons	White-fronted Chat
Epthianura aurifrons	Orange Chat
Epthianura tricolor	Crimson Chat
Erythrogonys cinctus	Red-kneed Dotterel(Plover)
Eurostopodus argus	Spotted Nightjar
Falco berigora	Brown Hawk (Brown Falcon)
Falco cenchroides	Nankeen (Australian) Kestrel
Falco longipennis	Little Falcon (Australian Hobby)
Falco peregrinus	Peregrine Falcon
Falco subniger	Black Falcon
Fulica atra	Eurasian Coot
Gallinula tenebrosa	Dusky Moorhen
Gallinula ventralis	Black-tailed Native-hen
Geopelia cuneata	Diamond Dove
Geopelia placida	Peaceful Dove
Glossopsitta porphyrocephala	Purple-crowned Lorikeet
Grallina cyanoleuca	(Australian) Magpie-lark
Gymnorhina tibicen	Australian Magpie
Halcyon pyrrhopygia	Red-backed Kingfisher
Haliastur sphenurus	Whistling Eagle (Whistling Kite)
Hieraaetus morphnoides	Little Eagle
Hirundo (Cecropis) ariel	Fairy Martin
Hirundo (Cecropis) nigricans	Tree Martin
Hirundo neoxena	Welcome Swallow
Hoplopterus (Vanellus) miles	Masked/Spur-winged Plover(Lapwing)
Hoplopterus (Vanellus) tricolor	Banded Plover(Lapwing)
Hylacola (Sericornis) cauta	Shy Heathwren (Shy Hylcola)
Ixobrychus minutus	Little Bittern
Lalage sueurii	White-winged Triller
Leipoa ocellata	Malleefowl
Malacorhynchus membranaceus	Pink-eared Duck
Malurus lamberti	Variegated (Fairy) Wren

Scientific Name	Common Name
Malurus leucopterus	White-winged (Fairy) Wren
Malurus splendens	Splendid Blue (Fairy) Wren
Manorina flavigula	Yellow-throated Miner
Manorina melanocephala	Noisy Miner
Manorina melanotis	Black-eared Miner
Megalurus gramineus	Little Grassbird
Melanodryas cucullata	Hooded Robin
Meliphaga (Lichenostomus) eucotis	White-eared Honeyeater
Meliphaga (Lichenostomus) rnata	Yellow-plumed Honeyeater
Meliphaga (Lichenostomus) penicillata	White-plumed Honeyeater
Meliphaga (Lichenostomus) lunula	Grey-fronted Honeyeater
Meliphaga (Lichenostomus) virescens	Singing Honeyeater
Melithreptus brevirostris	Brown-headed Honeyeater
Melithreptus lunatus	White-naped Honeyeater
Melopsittacus undulatus	Budgerigah
Merops ornatus	Rainbow Bee-eater
Microeca leucophaea	Jacky Winter
Milvus migrans	Black Kite
Myiagra inquieta	Restless Flycatcher
Neophema chrysostoma	Blue-winged Parrot
Neophema elegans	Elegant Parrot
Neophema splendida	Scarlet-chested Parrot
Ninox novaeseelandiae	Boobook Owl (Southern Bobook)
Northiella (Psephotus) aematogaster	Blue Bonnet
Nymphicus hollandicus	Cockatiel
Ocyphaps lophotes	Crested Pigeon
Oreoica gutturalis	Crested Bellbird
Pachycephala inornata	Gilbert's Whistler
Pachycephala rufiventris	Rufous Whistler
Pachycephala rufogularis	Red-lored Whistler
Pardalotus striatus	Striated Pardalote
Pardalotus xanthopygus	Yellow-rumped Pardalote

Scientific Name	Common Name
Passer domesticus	House Sparrow
Peltohyas austalis	Inland (Australian) Dotterel
Petroica goodenovii	Red-capped Robin
Phalacrocorax melanoleucos	Little Pied Cormorant
Phalacrocorax sulcirostris	Little Black Cormorant
Phaps chalcoptera	Common Bronzewing
Phylidonyris albifrons	White-fronted Honeyeater
Platalea flavipes	Yellow-billed Spoonbill
Plectorhyncha lanceolata	Striped Honeyeater
Podargus strigoides	Tawny Frogmouth
Poephila guttata	Zebra Finch
Poliocephalus poliocephalus	Hoary-headed Grebe
Polytelis anthopeplus	Regent Parrot
Pomatostomus ruficeps	Chestnut-crowned Babbler
Pomatostomus superciliosa	White-browed Babbler
Porzana fluminea	Australian Spotted Crake
Psephotus haematonotus	Red-rumped Parrot
Psephotus varius	Mulga Parrot
Psophodes cristatus	Chirruping Wedgebill
Pteropodocys (Coracina) maxima	Ground Cuckoo-shrike
Pyrrholaemus (Sericornis) runneus	Redthroat
Rhipidura fuliginosa	Grey Fantail
Rhipidura leucophrys	Willie Wagtail
Smicrornis brevirostris	Weebill
Stiltia isabella	Australian Pratincole
Strepera versicolor	Grey Currawong
Struthidea cinerea	Apostlebird
Sturnus vulgaris	(Common/European) Starling
Sugomel (Certhionyx) niger	Black Honeyeater
Tachybaptus novaehollandiae	Black-throated (Australasian) Grebe
Trichoglossus haematodus	Rainbow Lorikeet
Turdus merula	Blackbird
Turnix velox	Little Button-quail
Tyto alba	Barn Owl
Zosterops lateralis	Silvereye

Appendix XI

REPTILE AND AMPHIBIAN SPECIES RECORDED FROM THE SOUTH OLARY PLAINS SURVEY AREA

Species are listed by scientific name in taxnomic order of family using the nomenclature of Edwards and Tyler (1990) which has been updated by the South Australian Museum (M. Hutchinson, pers. comm.). Alternative common and scientific names are shown in parentheses.

Conservation status codes are shown in bold following the scientific name. The first code is the Australian status according to *the Commonwealth Endangered Species Protection Act 1992* (codes E & V only) (based on the 'ANZECC List of Threatened Vertebrate Fauna, April 1991'); the second is also a national status, according to *The Action Plan for Australian Reptiles* (Cogger *et al*., 1993) and the third is the South Australian classification from Threatened Species Strategy Steering Committee (1993) and M. Hutchinson (pers. comm.). The status of reptiles species have not yet been assessed on a regional basis.

Status code definitions are:

E **Endangered** - taxa in danger of extinction and whose survival is unlikely if the causal factors continue operating.

V **Vulnerable** - taxa believed likely to move into endangered category in the near future if the causal factors continue operating.

R **Rare** - taxa with small populations in South Australia that are not at present endangered or vulnerable but are at risk.

I **Indeterminate** - taxa suspected of belonging to the endangered, vulnerable or rare categories but for which insufficient information is currently available.

The seven columns indicate the source of amphibian species records as follows:

1 Forward & Robinson (1995), site data (this survey)
2 Forward & Robinson (1995), opportunistic data
3 University of S.A. (1994), Danggali Conservation Park
4 South Australian Museum Herpetology Section records prior to 1992 (whole area)
5 S.A. National Parks & Wildlife Service records & S.A National Estate Vertebrate Database (Pooginook, Pandappa, White Dam & Cooltong Conservation Parks)
6 Field Naturalist's Society of South Australia, Herpetology Club (pers.comm.) (Pooginook and Danggali Conservation Parks)
7 Morley and Morley (1984), Danggali Conservation Park

Common Name	Scientific Name	Source						
REPTILES								
CHELIDAE								
Chelodina longicollis	Common Long-necked Tortoise (Eastern Snake-necked Turtle)				4	5		
AGAMIDAE								
Amphibolurus nobbi	Nobbi	1	2	3	4	5	6	7
Ctenophorus decresii	Tawny Dragon	1	2		4			
Ctenophorus fordi	Mallee Dragon	1	2	3	4	5	6	7
Ctenophorus pictus	Painted Dragon	1	2	3	4	5	6	7
Pogona barbata	Eastern Bearded Dragon				4			
Pogona vitticeps	Central Bearded Dragon	1	2	3	4	5	6	7
Tympanocryptis lineata	Five-lined Earless Dragon	1			4	5		7
Tympanocryptis tetraporophora	Eyrean Earless Dragon	1			4			
GEKKONINAE								
Gehyra '2N=44'	Southern Rock Dtella	1	2		4		6	
Gehyra variegata	Tree Dtella	1	2	3	4			7
Heteronotia binoei	Bynoe's Gecko	1	2	3	4	5	6	7
Phyllodactylus marmoratus	Marbled Gecko				4			

DIPLODACTYLINAE

		1	2	3	4	5	6	7
Diplodactylus byrnei	Pink-blotched Gecko	1	2		4			
Diplodactylus damaeus	Beaded Gecko	1	2		4	5	6	7
Diplodactylus tessellatus	Tessellated Gecko	1	2		4			
Diplodactylus vittatus	Eastern Stone (Wood) Gecko	1	2		4			7
Nephrurus levis	Smooth Knob-tailed Gecko	1	2		4			7
Nephurus milii	Barking (Thick-tailed) Gecko	1	2		4	5		
Oedura marmorata **--R**	Marbled Velvet Gecko	1			4			
Rhynchoedura ornata	Beaked Gecko	1	2		4	5		7
Strophurus elderi	Jewelled Gecko	1	2	3	4	5		7
Strophurus williamsi	Eastern Spiny-tailed Gecko	1	2	3	4			7
Strophurus intermedius	Southern Spiny-tailed Gecko				4			7

PYGOPODINAE

		1	2	3	4	5	6	7
Aprasia inaurita	Red-tailed Worm-lizard	1	2		4			
Aprasia pseudopulchella[1] **-VR**	Flinders Worm-lizard		2					
Delma australis	Barred Snake-lizard	1			4		6	7
Delma butleri	Spinifex Snake-lizard	1	2		4			7
Delma molleri	Adelaide Snake-lizard	1						
Lialis burtonis	Burton's LeglessLizard	1		3	4		6	7
Pygopus lepidopodus	Common Scaly-foot				4			7

SCINCIDAE

SPHENOMORPHOUS GROUP

		1	2	3	4	5	6	7
Ctenotus atlas	Southern Spinifex Ctenotus	1	2	3	4		6	7
Ctenotus brachyonyx	Eastern Ctenotus	1			4			7
Ctenotus brooksi	Sandhill Ctenotus				4			7
Ctenotus regius	Eastern Desert Ctenotus	1	2	3	4		6	7
Ctenotus robustus	Eastern Striped Skink	1	2		4	5		7
Ctenotus schomburgkii	Sandplain Ctenotus	1	2	3	4			7
Ctenotus strauchii	Short-legged Ctenotus	1						
Ctenotus uber	Spotted Ctenotus	1	2		4	5		
Eremiascincus richardsonii	Broad-banded Sand Swimmer	1	2		4			7
Hemiergis decresiensis	Three-toed Earless Skink				4			
Hemiergis millewae	Rusty Earless Skink	1			4			
Hemiergis peronii	Four-toed Eastern Skink				4			
Lerista dorsalis	Southern Four-toed Slider	1	2		4			
Lerista labialis	Eastern Two-toed Slider	1			4			
Lerista muelleri	Dwarf Three-toed Slider	1	2		4		6	7
Lerista punctatovittata	Spotted Slider	1	2	3	4		6	7
Lerista xanthura	Yellow-tailed Slider				4			

EGERNIA GROUP

		1	2	3	4	5	6	7
Cyclodomorphus melanop (*C. branchialis*)	Spinifex Slender Bluetongue				4			7
Egernia inornata	Desert Skink	1	2	3	4	5	6	7
Egernia stokesii	Gidgee (Spiny-tailed) Skink	1	2					
Egernia striolata	Tree Skink	1	2	3	4		6	7
Tiliqua adelaidensis[2] **EEE**	Pygmy (Adelaide) Bluetongue		2					
Tiliqua occipitalis	Western Bluetongue	1	2					7
Tiliqua rugosa	Sleepy Lizard / Shingle Back	1	2	3	4	5	6	7
Tiliqua scincoides	Eastern Bluetongue	1						

EUGONGYLUS GROUP

		1	2	3	4	5	6	7
Cryptoblepharus carnabyi	Speckled Wall Skink	1	2	3	4		6	7
Cryptoblepharus plagiocephalus	Desert Wall Skink	1	2		4	5		
Lampropholis guichenoti	Garden Skink				4			

[1] Specimen found just outside (east of) survey boundary.
[2] Specimen found just outside (east of) survey boundary.

Menetia greyii	Dwarf Skink	1	2	3	4	5	6	7
Morethia adelaidensis	Adelaide Snake-eye	1	2		4			
Morethia boulengeri	Common Snake-eye	1	2	3	4		6	7
Morethia obscura	Mallee Snake-eye	1	2		4			7
VARANIDAE								
Varanus gouldii	Sand (Gould's) Goanna	1	2	3	4	5	6	7
TYPHLOPIDAE								
Ramphotyphlops australis	Southern Blind Snake	1	2		4			7
Ramphotyphlops bituberculatus	Rough-nosed Blind Snake	1	2		4			7
BOIDAE								
Morelia spilota **-(V)[3]R**	Carpet (Diamond) Python				4			
ELAPIDAE								
Demansia psammophis	Yellow-faced Whipsnake			3	4	5		7
Echiopsis curta **--R**	Bardick				4			7
Notechis scutatus	Eastern Tiger Snake					5		
Pseudechis australis	Mulga (King Brown) Snake	1	2	3	4			7
Pseudonaja modesta	Five-ringed Snake	1	2		4	5		7
Pseudonaja nuchalis	Western Brown Snake (Gwardar)	1	2	3	4		6	7
Pseudonaja textilis	Eastern Brown Snake	1	2		4	5	6	
Simoselaps australis	Coral Snake	1			4			7
Suta nigriceps	Mitchell's Short-tailed Snake	1	2		4		6	7
Suta spectabilis	Mallee Black-headed Snake	1	2		4			
Suta suta	Curl Snake		2		4			
Vermicella annulata **-IR**	Common Bandy-bandy				4			7
AMPHIBIANS								
HYLIDAE								
Litoria peroni	Peron's Tree Frog				4			
Litoria raniformis **--V**	Golden Bell Frog		2		4			
LEPTODACTYLIDAE								
Limnodynastes dumerili	Bull (Eastern Banjo) Frog		2		4			
Limnodynastes fletcheri	Long-thumbed Frog				4			
Limnodynastes tasmaniensis	Marbled (Spotted Grey) Frog		2		4		6	
Neobatrachus centralis	Trilling Frog	1	2		4			
Neobatrachus pictus		1						
Neobatrachus sudelli[4]		1		3	4			
Crinia parinsignifera	Plains Froglet				4			
Crinia signifera	Brown Froglet				4			

[3] The vulnerable south-western W.A. race *M. s. imbricata* is thought to occur in S.A. as well as *M. s. variegata* so it is not known yet which one these records are. Further taxonomic work needs to be completed.

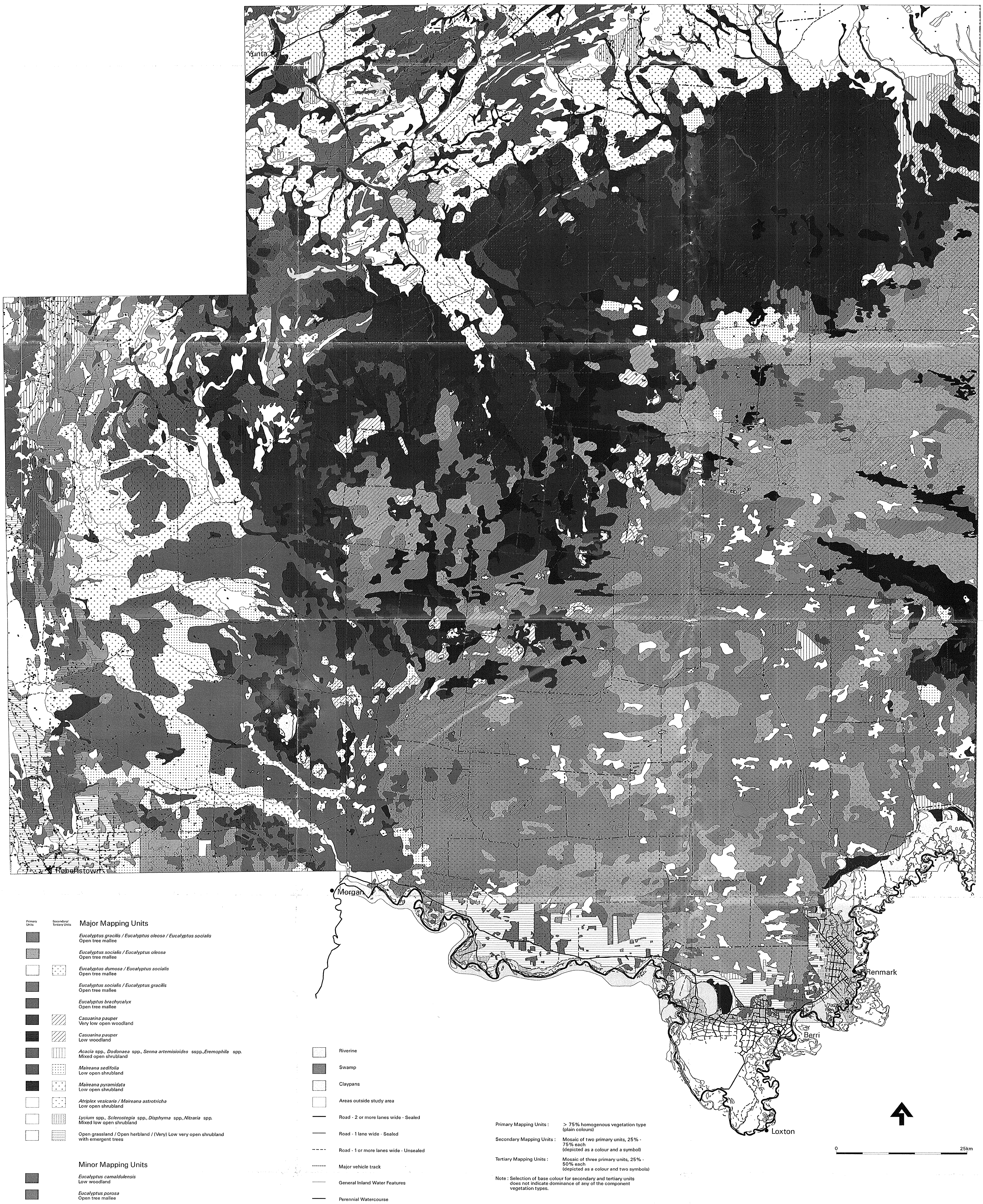
[4] According to Edwards and Tyler (1990) this species only occurs in the South East Region but it is now known to occur in the River Murray valley and northwards about 100kms. It is very similar to, and easily confused with, *N. centralis* which occurs further north but there is an overlap zone.

Appendix XII

SCIENTIFIC AND COMMON NAMES OF REPTILE AND AMPHIBIAN SPECIES FOUND AT SITES ON THE SOUTH OLARY PLAINS SURVEY

Scientific name	Common name
Amphibolurus nobbi	Nobbi
Aprasia inaurita	Red-tailed worm-lizard
Cryptoblepharus carnabyi	Speckled Wall Skink
Cryptoblepharus plagiocephalus	Desert Wall Skink
Ctenophorus decresii	Tawny Dragon
Ctenophorus fordi	Mallee Dragon
Ctenophorus pictus	Painted Dragon
Ctenotus atlas	Southern Spinifex Ctenotus
Ctenotus brachyonyx	Eastern Ctenotus
Ctenotus regius	Eastern Desert Ctenotus
Ctenotus robustus	Eastern Striped Skink
Ctenotus schomburgkii	Sandplain Ctenotus
Ctenotus strauchii	Short-legged Ctenotus
Ctenotus uber	Spotted Ctenotus
Delma australis	Barred Snake-lizard
Delma butleri	Spinifex Snake-lizard
Delma molleri	Adelaide Snake-lizard
Demansia psammophis	Yellow-faced Whip Snake
Diplodactylus byrnei	Pink-blotched Gecko
Diplodactylus damaeus	Beaded Gecko
Diplodactylus tessellatus	Tessellated Gecko
Diplodactylus vittatus	Eastern Stone (Wood) Gecko
Egernia inornata	Desert Skink
Egernia stokesii	Gidgee (Spiny-tailed) Skink
Egernia striolata	Tree Skink
Eremiascincus richardsonii	Broad-banded Sand Swimmer
Gehyra '2N=44'	Southern Rock Dtella
Gehyra variegata	Tree Dtella
Hemiergis millewae	Rusty Earless Skink
Heteronotia binoei	Bynoe's Gecko
Lerista dorsalis	Southern Four-toed Slider
Lerista labialis	Eastern Two-toed Slider
Lerista muelleri	Dwarf Three-toed Slider
Lerista punctatovittata	Spotted Slider
Lialis burtonis	Burton's LeglessLizard
Menetia greyii	Dwarf Skink
Morethia adelaidensis	Adelaide Snake-eye
Morethia boulengeri	Common Snake-eye
Morethia obscura	Mallee Snake-eye
Neobatrachus centralis	Trilling Frog
Neobatrachus pictus	
Neobatrachus sudelli	
Nephrurus levis	Smooth Knob-tailed Gecko
Nephrurus milii	Barking (thick-tailed) Gecko
Oedura marmorata	Marbled Velvet Gecko
Pogona vitticeps	Central Bearded Dragon
Pseudechis australis	Mulga (King Brown) Snake
Pseudonaja modesta	Five-ringed Snake
Pseudonaja nuchalis	Western Brown Snake (Gwardar)
Pseudonaja textilis	Eastern Brown Snake
Ramphotyphlops australis	Southern Blind Snake
Ramphotyphlops bituberculatus	Rough-nosed Blind Snake
Rhynchoedura ornata	Beaked Gecko
Simoselaps australis	Coral Snake
Strophurus elderi	Jewelled Gecko
Strophurus williamsi	Eastern Spiny-tailed Gecko
Suta nigriceps	Mitchell's Short-tailed Snake
Suta spectabilis	Mallee Black-headed Snake
Tiliqua occipitalis	Western Bluetongue
Tiliqua rugosa	Sleepy Lizard/Shingle Back
Tiliqua scincoides	Eastern Bluetongue
Tympanocryptis lineata	Five-Lined Earless Dragon
Typanocryptis tetraporophora	Eyrean Earless Dragon
Varanus gouldii	Sand (Gould's) Goanna

VEGETATION
South Olary Plains



Primary Units	Secondary/ Tertiary Units	Major Mapping Units
		Eucalyptus gracilis / Eucalyptus oleosa / Eucalyptus socialis Open tree mallee
		Eucalyptus socialis / Eucalyptus oleosa Open tree mallee
		Eucalyptus dumosa / Eucalyptus socialis Open tree mallee
		Eucalyptus socialis / Eucalyptus gracilis Open tree mallee
		Eucalyptus brachycalyx Open tree mallee
		Casuarina pauper Very low open woodland
		Casuarina pauper Low woodland
		Acacia spp., *Dodonaea* spp., *Senna artemisioides* sspp.,*Eremophila* spp. Mixed open shrubland
		Maireana sedifolia Low open shrubland
		Maireana pyramidata Low open shrubland
		Atriplex vesicaria / Maireana astrotricha Low open shrubland
		Lycium spp., *Sclerostegia* spp., *Disphyma* spp.,*Nitraria* spp. Mixed low open shrubland
		Open grassland / Open herbland / (Very) Low very open shrubland with emergent trees

Minor Mapping Units

- *Eucalyptus camaldulensis* Low woodland
- *Eucalyptus porosa* Open tree mallee
- *Sida petrophila / Ptilotus obovatus* var. *obovatus* Low open shrubland
- *Callitris glaucophylla* Low open forest
- *Allocasuarina verticillata* Low woodland
- Cleared / Agricultural (cropping) land
- Residential / Agricultural (vineyards/orchards)

- Riverine
- Swamp
- Claypans
- Areas outside study area
- Road - 2 or more lanes wide - Sealed
- Road - 1 lane wide - Sealed
- Road - 1 or more lanes wide - Unsealed
- Major vehicle track
- General Inland Water Features
- Perennial Watercourse
- Pastoral Property Boundaries
- Conservation Park Boundaries
- Claypans
- Tank - Small Dam - Bore - Well
- Homestead / Shed

Primary Mapping Units : > 75% homogenous vegetation type (plain colours)

Secondary Mapping Units : Mosaic of two primary units, 25% - 75% each (depicted as a colour and a symbol)

Tertiary Mapping Units : Mosaic of three primary units, 25% - 50% each (depicted as a colour and two symbols)

Note : Selection of base colour for secondary and tertiary units does not indicate dominance of any of the component vegetation types.

Map source : 1:86,000 colour aerial photography. Vegetation communities are described in full in Forward and Robinson (1996).

Mapped by : Department of Environment and Natural Resources, Kensington.

Produced by : Geographic Analysis and Research Unit, Department of Housing and Urban Development.

Projection : Transverse Mercator

Analysis : ESRI, ARC/INFO

Date : February 1996

DATABASES

BIOLOGICAL SURVEY SOUTH AUSTRALIA

FIRE HISTORY

South-east South Olary Plains

1977	1976 - 1978	1985
1985	1978	1982 - 1988
1988	1975 - 1981	1986
1973	1979	1984 - 1988
1974	1980	
1973 - 1975	1981	
1975	1982	
1976	1984	
1975 - 1979	1984 - 1985	
1977		

Road - 2 or more lanes wide - Sealed
Road - 1 lane wide - Sealed
Road - 1 or more lanes wide - Unsealed
Major vehicle track
General Inland Water Features
Perennial Watercourse
Conservation Park Boundaries

0 25km

Map Source: 1:86,000 and 1:40,000 colour aerial photography, and 1:50,000 and 1:100,000 black and white aerial photo-mosaics.
Fire histories are described in Forward and Robinson (1996).

Produced by: Information and Data Analysis Branch, Department of Housing and Urban Development

Mapped by: Department of Environment and Natural Resources, Kensington

Projection: Transverse Mercator

Analysis: ESRI, ARC/INFO

Date: December 1995

SOUTH AUSTRALIA

ENVIRONMENTAL & SOCIO-ECONOMIC DATABASES

BIOLOGICAL SURVEY SOUTH AUSTRALIA