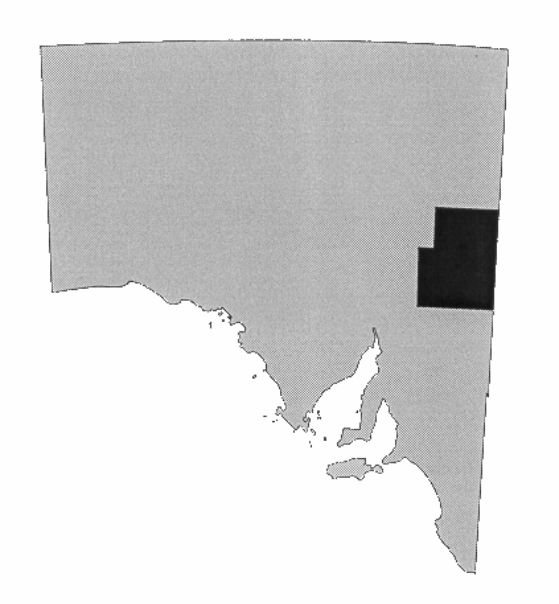
A BIOLOGICAL SURVEY of the NORTH OLARY PLAINS SOUTH AUSTRALIA

1995-1997



BIOLOGICAL SURVEY
SOUTH AUSTRALIA

Editors

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A.C. Robinson

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

1997

Research and collation of information presented in this report was undertaken with funding provided by Environment Australia (formerly the Australian Nature Conservation Agency). The project was undertaken for the National Reserves System Cooperative Program (Project Number N502)

The report may be cited as:

Playfair, R.M. and Robinson, A.C. (1997) (Eds)
A Biological Survey of the North Olary Plains, South Australia, 1995-1997
(Natural Resources Group, Department of Environment and Natural Resources, South Australia)

Copies of the report may be accessed in the library:

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CARTOGRAPHY AND DESIGN

Geographical Analysis and Research Unit
Department of Housing and Urban Development
All geographical data from Statewide Map Library,
Environmental Data Base of South Australia

Biological Survey & Research, Resource Management Branch,
Department of Environment and Natural Resources

Printed by Endeavour Print Pty Ltd
P O Box 578, Morphett Vale, S A, 5162

ISBN 0 7308 5823 5

Cover Photograph:
Pearl Bluebush and Bladder Saltbush communities with Bullock Bush grove overlooked by Mt Victor
Photo: R. Playfair

Abstract

From July to September 1995, 381 sites were surveyed in the North Olary Plains area from Yunta in the south and Lake Callabonna in the north, and between the Flinders Ranges and the New South Wales border. General landform information and a complete plant species list was obtained at each site. Subsequent analysis resulted in the description of 29 floristically distinct plant communities in the region, and the production of a map showing their distribution.

Geometrically rectified, classified Landsat TM imagery and aerial photography were used to assist in the extrapolation of vegetation boundaries from site based data.

Aerial survey was used to confirm and edit mapping, resulting in high levels of confidence in the mapped boundaries.

9121 plant records were added to the South Australian Environmental Database, and 1400 specimens lodged with the South Australian State Herbarium. 41 of the plant species recorded were new records for the Eastern Botanical Region of South Australia.

Codonocarpus pyramidalis and *Acacia carnei*, both of National conservation significance and *Maireana pentagona* and *Malacocera gracilis*, of South Australian conservation significance were recorded.

It was found that previous mapping of the South Strzelecki Desert as *Zygochloa* hummock grasslands is incorrect. These dunes are covered predominantly with *Acacia* spp. shrublands and *Zygochloa paradoxa* was absent. Previously unrecorded Sedgelands in the Coonee Creek are reported here.

In September 1996, 48 of the above sites were revisited, and a survey of vertebrates was undertaken using pitfall, Elliot and cage traps, as well as foraging for reptiles and mammals and observing birds. 452 mammal, 1643 bird, 505 reptile and 21 amphibian records were added to the South Australian Environmental Database, and about 450 specimens lodged with the South Australian Museum.

Overall, the survey produced:

- 29 floristic vegetation groups encompassing a total of 448 plant species.
- 22 mammal species listed (8 introduced).
- 125 bird species listed.
- 50 reptile and 2 amphibian species listed.

No vertebrates of conservation significance were recorded, however, significant specimens were added to the South Australian Museum collections and some minor range extensions were noted for some species.

These surveys constitute a component of a complete "Conservation Values Assessment" of the region. At present no conservation reserves are established in this area, and this detailed information will assist in any future decisions to manage any specific parts for conservation purposes.

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Figures

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Acknowledgments

This project would not have been possible without the cooperation and efforts of the following people :

1. Research and collation of information presented in this report was undertaken with funding provided by the Environment Australia (formerly the Australian Nature Conservation Agency). The project was undertaken for the National Reserves System Cooperative Program (Project Number N502)
2. Vegetation project co-ordination and report preparation - R. Playfair, M. Hyde, A. Robinson.
3. Vertebrate report preparation - A. Robinson, R. Playfair, J. Foulkes, M. Hutchinson, J. Matthew, S Laver, M. De Jong and G. Carpenter.
4. Geological report preparation - M. Benbow.
5. Technical and field assistance - P. Farmer, J. Foulkes, S. Laver, A. Robinson, J. Mathew, K. Casperson, I. Hopton, D. Hopton, R. Foster, S. Bemmer, M. De Jong, R. Storr, L. Queale, R. Noye, R. Poore, S. McKenney, A. Herbert, D. Armstrong, T. Celebrezze, S. Milne and D. Ladd.
6. Computing assistance - S. Graham, S. Spackman, S. Laver, S. Kinnear, R. Lawrence (ISB/GAR, DHUD).
7. Geographic Information Systems - L. Malcolm (GAR, DHUD), T. Hudspith, T. Scholz, J. Phillips.
8. Image Analysis - D. Hart, J. Cameron (RIG, DENR).
9. Previous studies - We are grateful for the advice and permission to use data and imagery from the Pastoral Management Branch, DENR.
10. Administrative assistance - M. Wilson.
11. We are also grateful for the support received from the numerous landholders and lessees in the area to establish sites on their properties.

Introduction

by A. C. Robinson[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 mid 1997, ten major regions have been studied by the Biological Survey and Research Section, Natural Resources Group of DENR: Offshore Islands (1971-1982), South East Coast (1982-1983), Nullarbor (1984), Gawler Ranges (1985), Yellabinna (1987), Kangaroo Island (1989-1990), Murray Mallee (1990-1991), South Olary Plains (1991-1992), North Olary Plains (1995-1996), and South East (1991 & 1997). Other comparable surveys which have been conducted by consultants or NGO's under the auspices of the Biological Survey of South Australia include Cooper Creek (1983,1991), Strzelecki Dunefields (1988-1992), Diamantina River (1994), Tallaringa (1988 & 1993), Lake Eyre South (1996-1997). 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 Mount Lofty Ranges (1985), the Western Murray Flats (1992), the Mid North (1992), Burra Hills (1994), Yorke Peninsula (1994) and South Eyre Peninsula (1996).

Ongoing vegetation and vertebrate surveys are being conducted in the Anangu-Pitjantjatjara Lands of north-western SA(1992-), the Stony Deserts (1994-), and the Sandy Deserts (1997-). Vegetation surveys are currently underway for the Eastern Eyre Peninsula (1995-) and the state's Coastal Dunes and Clifftops (1995-). In addition, the same methods have been used for numerous smaller-scale surveys conducted by various government and non-government organisations.

This report covers a vegetation and vertebrate survey of the North Olary Plains. The vegetation survey was undertaken from July to September 1995, while the vertebrate survey was undertaken in August 1996.

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

In May 1994 the Resource Management Branch of the South Australian Department of Environment and Natural Resources received a grant from the National Reserves System Cooperative Program of the Australian Nature Conservation Agency (ANCA) to conduct project N502, *Conservation Values of the North Olary Plains*. At the time this was planned to run from May 1994 to May 1996. Due to pressure of other biological survey projects, it was necessary for the Biological Survey and Research Section of the Resource Management Branch of DENR to let a consultancy to carry out this project. The successful consultant, Resource Monitoring and Planning, began the first Phase of the project in June 1995. Accordingly an appropriate variation to the project was negotiated with ANCA dated February 1996.

A previous report (Playfair, Hyde & Robinson 1996) describes the results of the vegetation survey and includes a vegetation map. These results and the map are also included in this report. The land system mapping and range condition assessment are currently being completed in the North Olary Plains by Pastoral Management Officers from the Resource Management Branch of DENR and these data are still not complete enough to publish at the time of printing.

This, the final report on the project, will therefore incorporate all of the above-mentoned information and the vertebrate data collected during the second phase. The standard layout for reporting on the Biological Survey of South Australia has been adopted for presentation. The objectives of the Biological Survey of South Australia in relation to the North Olary Plains project are detailed below.

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

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biodiversity conservation and ecologically sustainable development.

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

1. To observe, collect and identify the species of plants and vertebrate fauna present in the area in 1995 and 1996, by sampling an array of fixed quadrats representing the geographical and biological diversity of the region.
2. To establish a comprehensive data base of the flora and associated vertebrate communities of the North Olary Plains in South Australia which is amenable to analyses involving direct ecological comparisons, and compatible with similar data collected from adjacent areas in South Australia, 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 SA, and NSW.
5. To evaluate the conservation status of species and communities typical of the North 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 1995-1996 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 ecological change in the region.
8. To provide baseline biological data for future research by government and non-government organisations.

THE SURVEY AREA

The North Olary Plains survey area covers a large part of the eastern sheep pastoral country in South Australia. The study area is defined by the standard 1:100,000 topographic map sheet boundaries (Fig. 1). It stretches from just south of the Barrier Highway north to the northern tip of Lake Frome, and is bounded in the west by the eastern edge of the Flinders Ranges and in the east by the SA / NSW border.

The study area covers two major environmental regions and the southern extent of a third (Fig. 1). From south to north, the study area covers the Olary Spur Environmental Region (number 5.2), which is an area of 18,960 km^2 containing eight environmental associations. Laut *et al.* (1977) describe the region as a low easterly, trending upland branching off the northerly trending Flinders Ranges. It comprises hogback ridges on metasediments and rounded granite hills, with shallow loamy soils supporting open shrublands of mulga, hopbush and turpentine bush or a low cover of saltbush and bluebush, locally with open mallee. Gentle footslopes and pediments commonly form extensive elongated intramontane plains with deeper duplex soils characteristically covered with saltbush and bluebush with scattered mulga and false sandalwood.

To the north, the Southern Frome Basin Environmental Region (number 5.3) covers an area of 16,700 km^2 containing seven environmental associations. It is described as part of a large internal drainage basin probably of structural origin, the centre of which is occupied by Lake Frome. The plain, which is mainly covered with shallow calcareous earths, has a low shrubland of saltbush and bluebush, often with a low open woodland or tall shrubland overstorey. It is nearly featureless except in the north near Lake Frome where sand dunes occur more frequently. These dunes support a low woodland or tall shrubland with an understorey of bluebush and ephemeral herbs. Streams from the Olary Spur do not reach the lake but flood out at a small distance from the upland, however some larger streams from the Flinders Ranges to the west intermittently reach the lake.

The northern limit of the study area falls in the Lake Eyre Basin Environmental Region (number 8.4). It covers the southern extent of two environmental associations. The Lake Frome Environmental Association is described as a chain of interconnected salt lakes with gypsum dunes along the eastern margins. Where vegetation occurs it consists of tall shrubland, ephemeral herbland and chenopod shrubland. The Strzelecki Desert Environmental Association is an extensive dunefield with numerous small claypans with a cover of chenopod shrubland, hummock grassland and grassland.

The total survey area is 45,864 km^2. Figures 2 - 15 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 in the south and cattle in the north. The south western edges extend into the agricultural perpetual leasehold areas where the native vegetation is substantially modified and fragmented. There are no areas set aside as conservation reserves in the entire region.

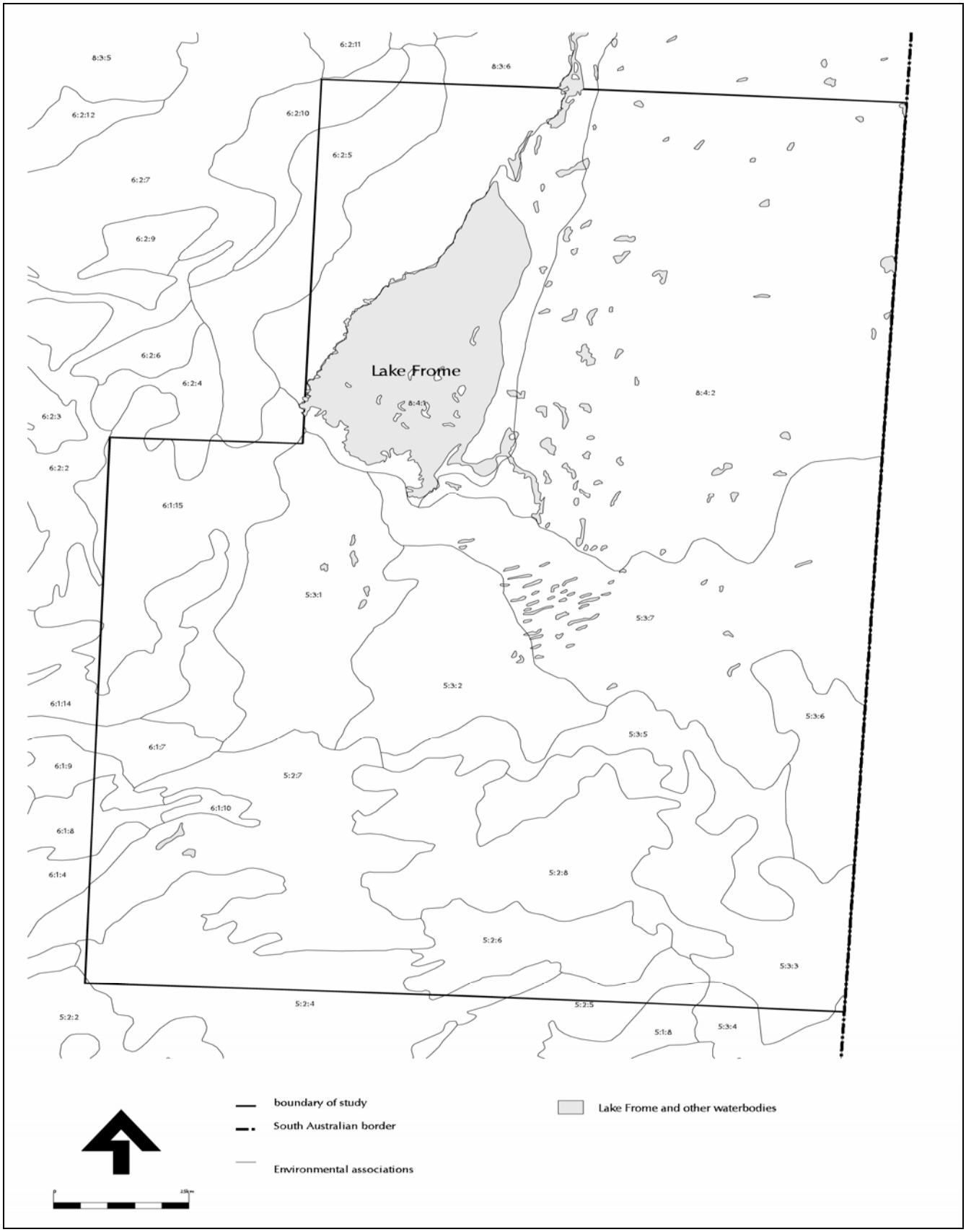

Figure 1 The North Olary Plains Biological Survey area showing Environmental Associations (Laut *et.al.*, 1977)

Figure 2 Aerial view of a typical Canegrass swamp in scalded Saltbush plains on Benagerie Station
Photo: R. Playfair

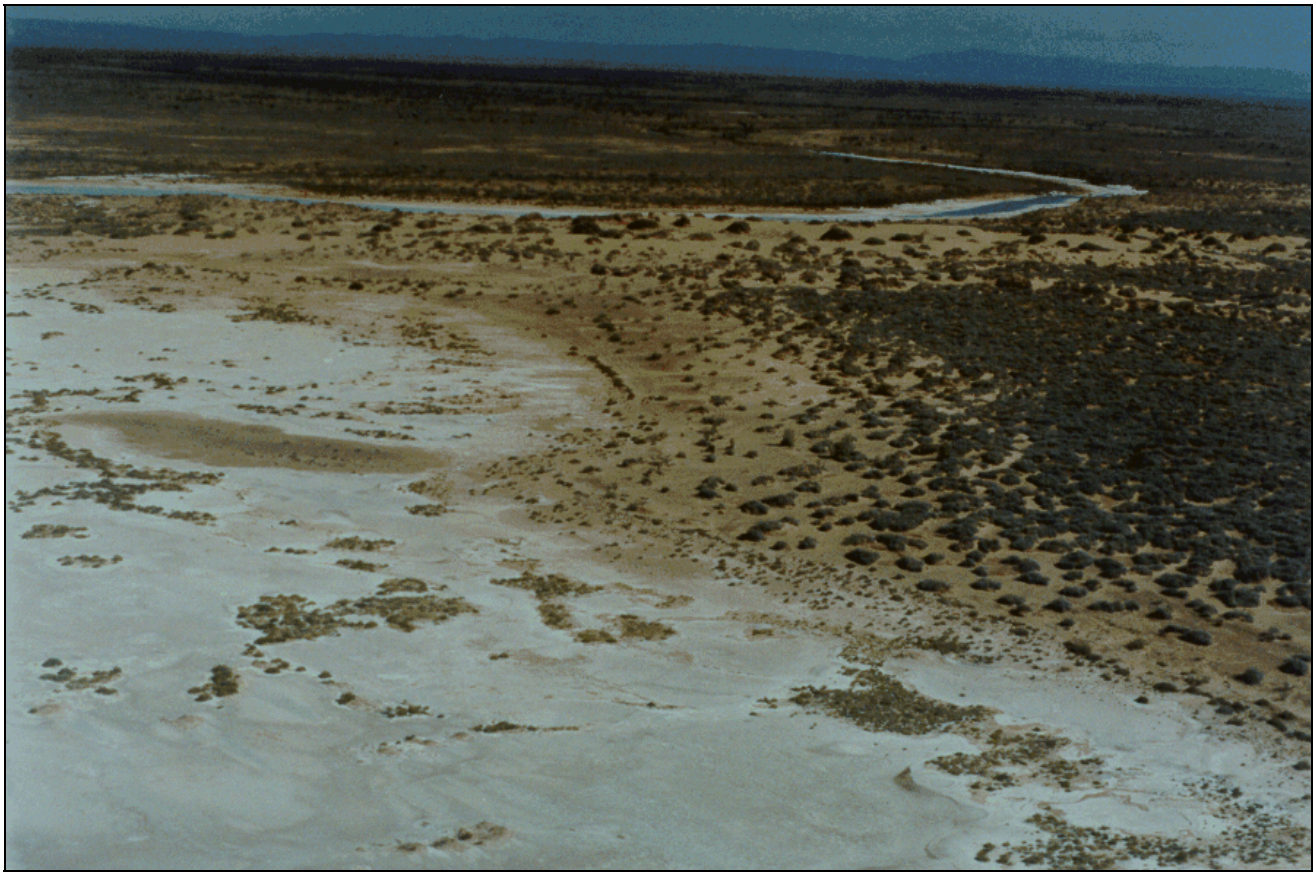

Figure 3 Aerial view of Samphires, Blackbush and Nitrebush communities on the fringe of southern Lake Frome
Photo: R. Playfair

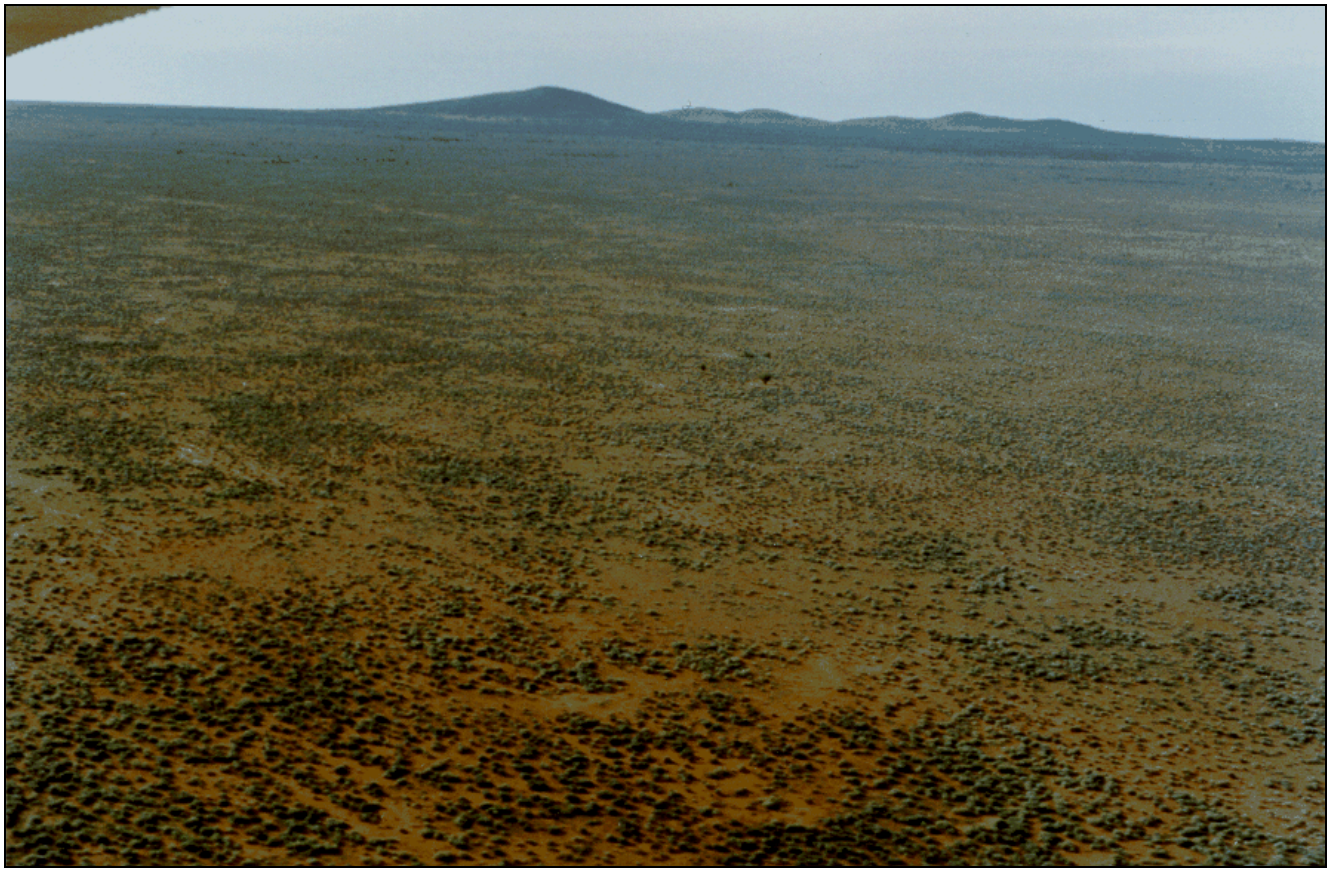

Figure 4 Low Bluebush / Bladder Saltbush mosaic on Curnamona Station
Photo: R. Playfair

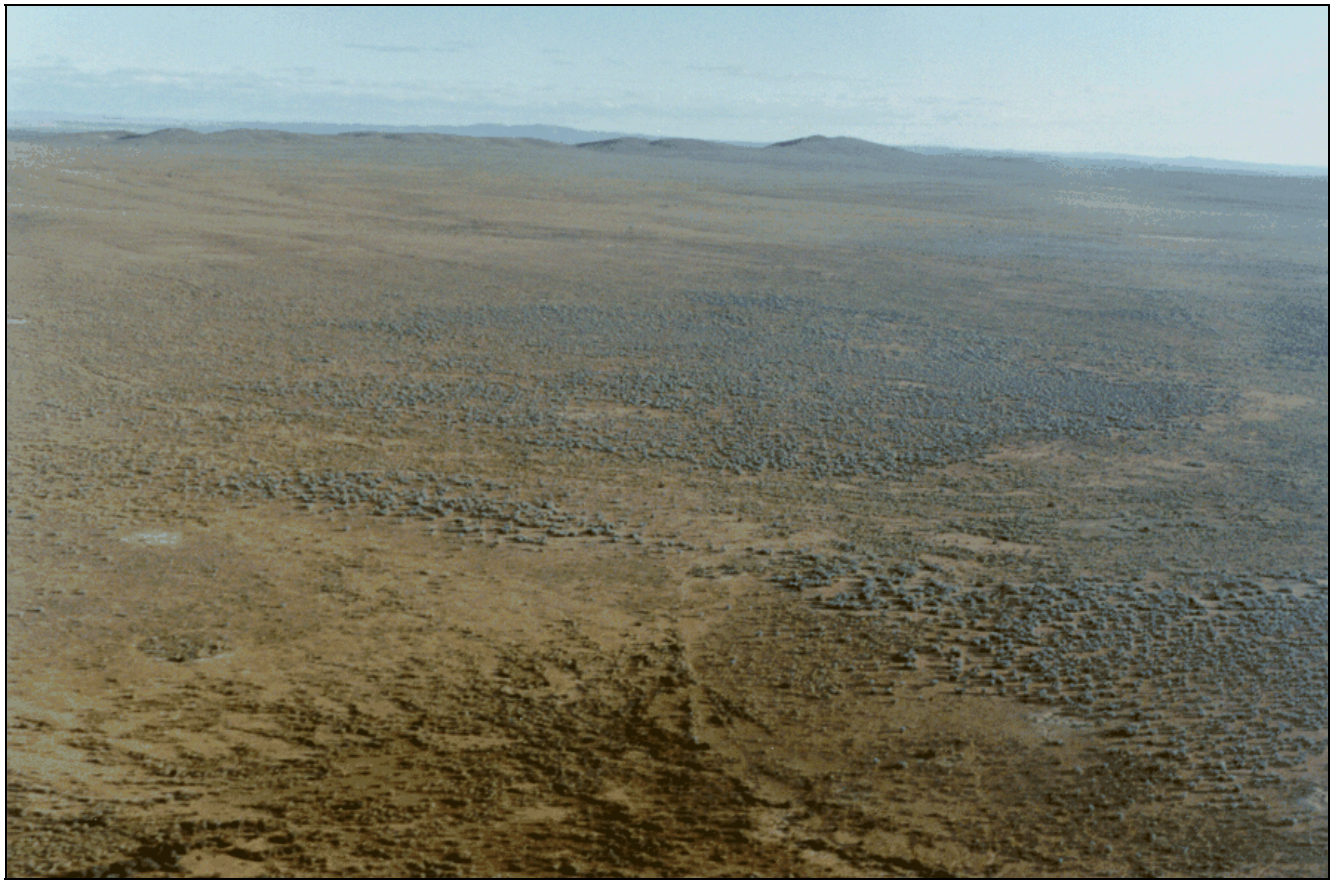

Figure 5 Bladder Saltbush / Pearl Bluebush mosaic south of Manna Hill
Photo: R. Playfair

Figure 6 Blackbush shrubland on plains south of Martin's Well HS
Photo: R. Playfair

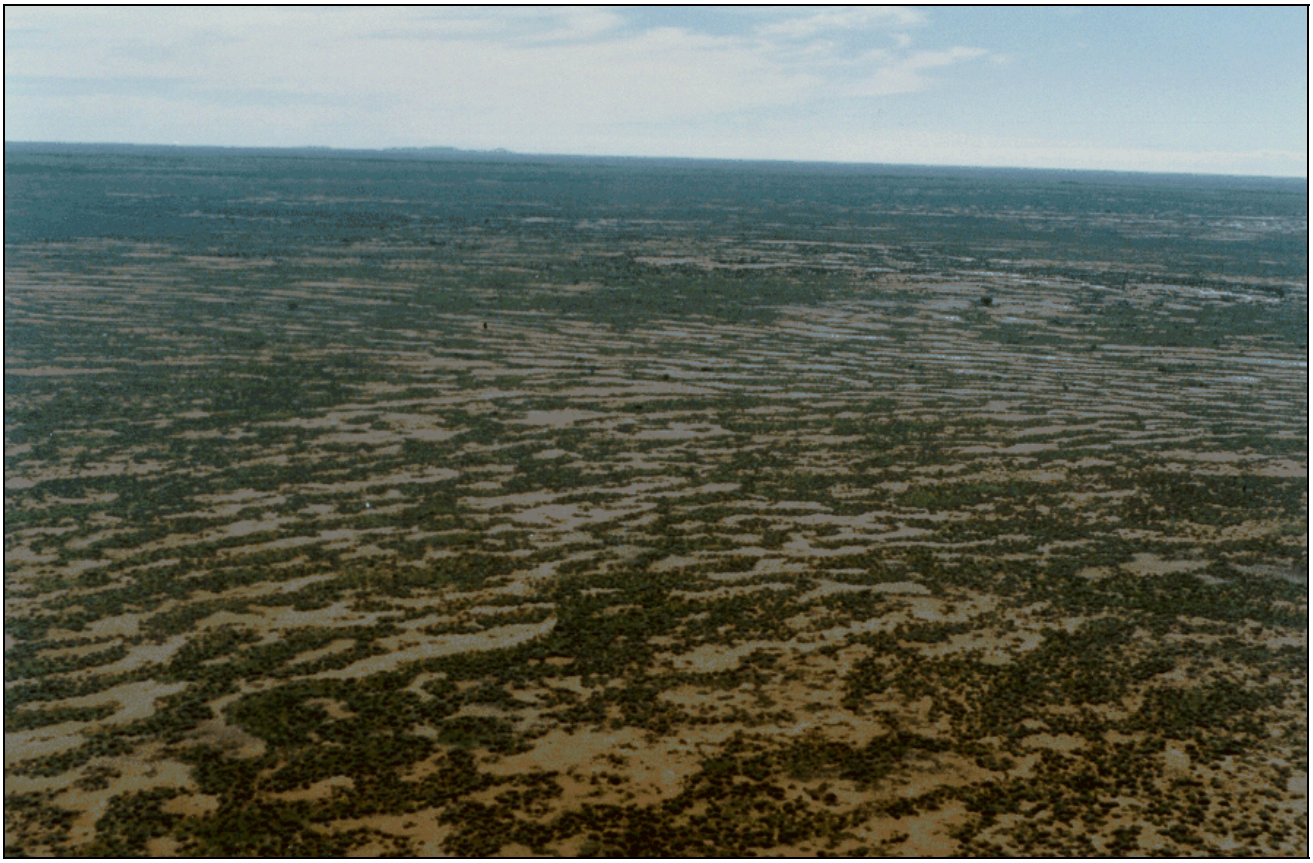

Figure 7 Bladder Saltbush shrubland with bare scalds on Kalabity Station
Photo: R. Playfair

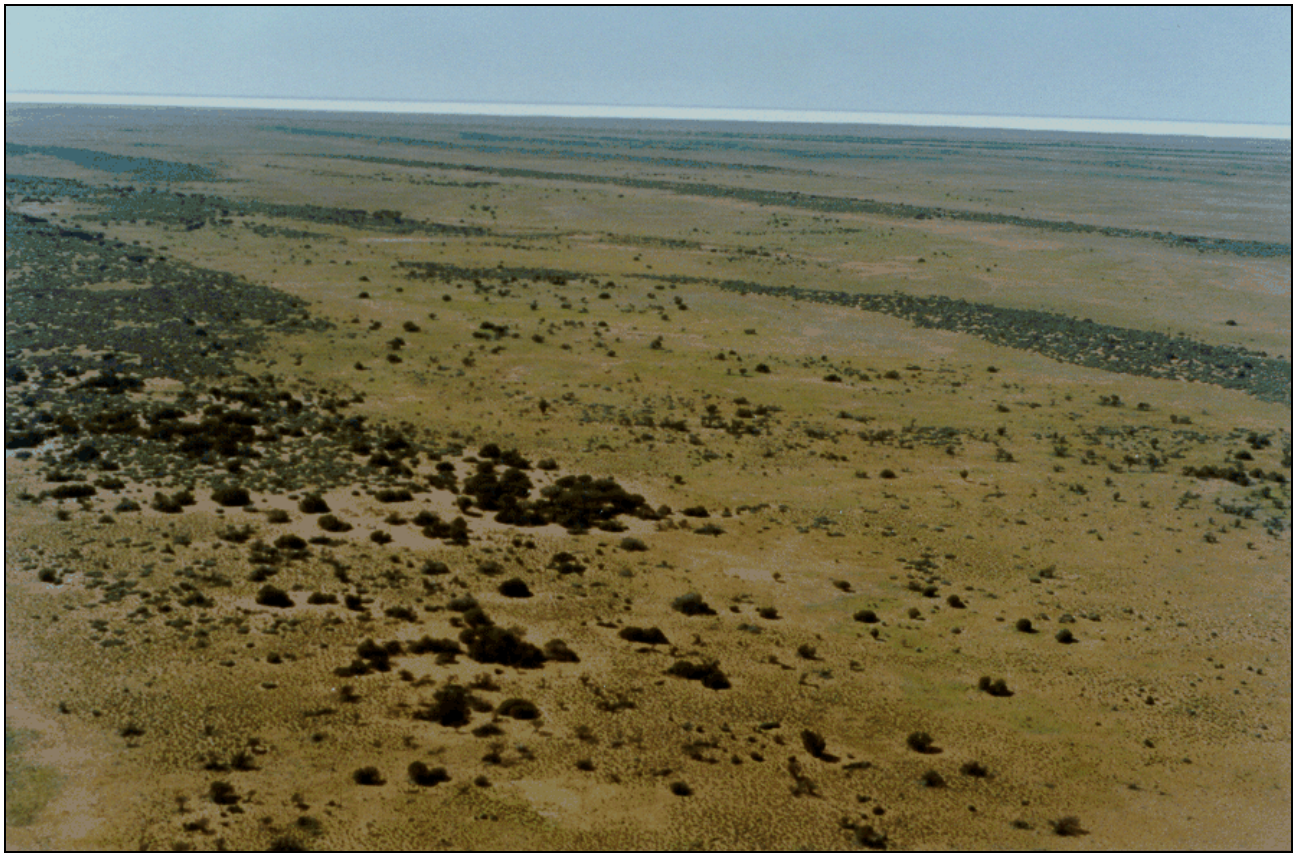

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Figure 9 Nitrebush run-on areas in flood damaged area south of Martin's Well HS Photo: R. Playfair

Figure 10 Umbrella Bush dunes with sparse Mulga grassy swales on Lakeside Station
Photo: R. Playfair

Figure 11 Desert Senna / Hopbush sandy rises ("woody weeds") on Curnamona Station
Photo: R. Playfair

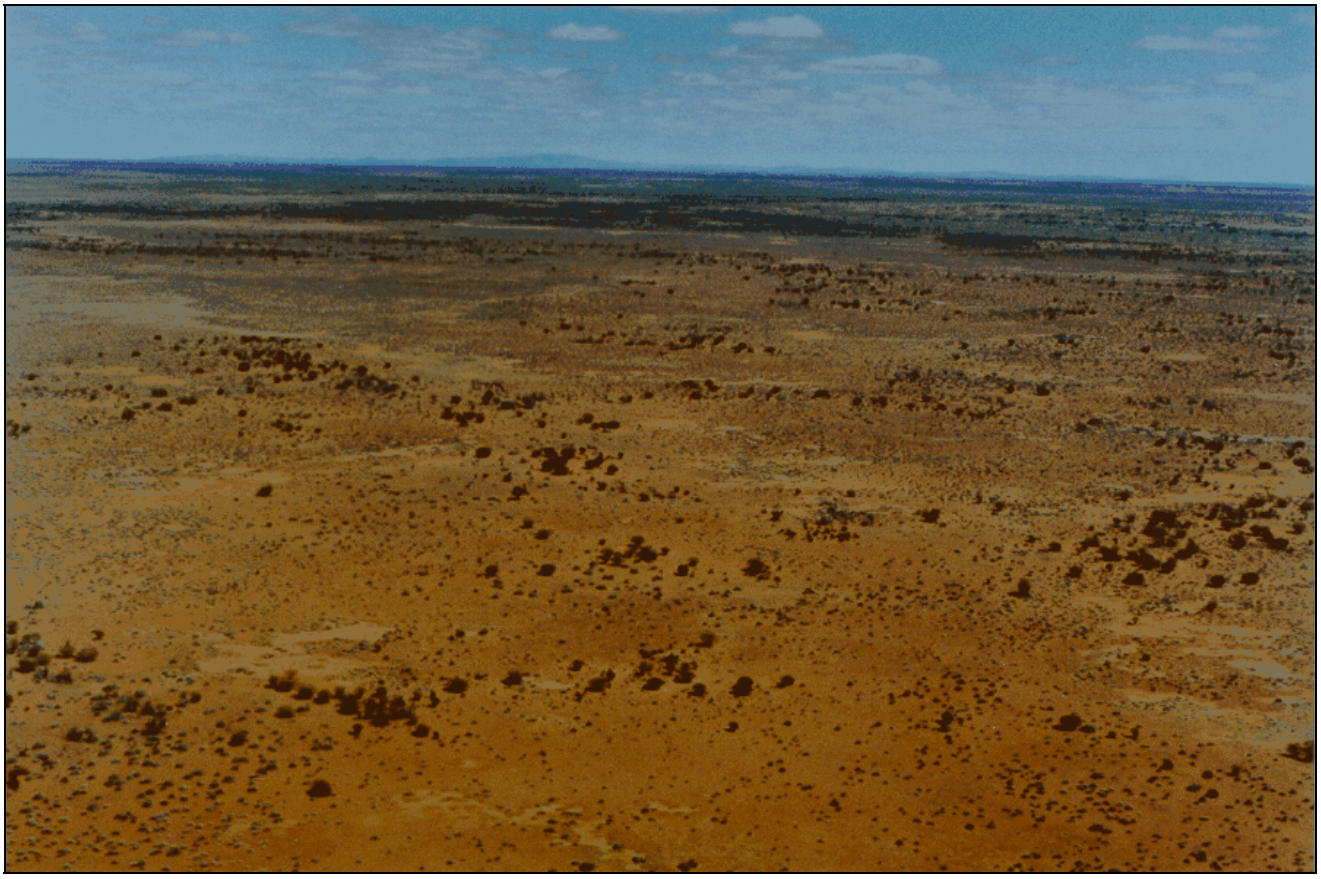

Figure 12 Mosaic of Senna / Hopbush rises and Low Bluebush plains on northern Curnamona Station
Photo: R. Playfair

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Photo: R. Playfair

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Photo: R. Playfair

Figure 15 Red Mallee community on Melton Station
Photo: R. Playfair

Background

CLIMATE

by R. M. Playfair[1]

Climatic Controls

The North Olary Plains survey area has an arid climate with hot to extremely hot, very dry summers and cold to mild, dry winters. Rainfall is low and unreliable, characterised by extremely infrequent heavy falls. There is no seasonal pattern over most of the area, although in the south west (where the highest average annual totals occur), winter rains show less variability than summer falls.

Seasonal variation of the weather is controlled by the location of large-scale high pressure systems which are part of the global sub-tropical ridge. During the warmer part of the year (November to March), the ridge is located south of the area and the prevailing surface winds are from the southern quadrant. During autumn the ridge generally moves north and remains over the continent from April until September. During winter the survey area is south of the ridge axis, and winds generally have a westerly component (north-north west to south-south west).

Weak orographic lifting by the low hills of the Olary Spur produce slightly higher average rainfalls over the elevated ground. The uplands which consist of a series of ridges, generally aligned north east/south west, influence temperatures (especially daily minima) and may cause localised wind effects. On winter nights cold air may accumulate in valleys and depressions.

Winds

While large scale pressure features determine the broadscale wind flow, topography can have a marked effect on local wind speed and direction, particularly overnight and early in the morning, when stable conditions allow localised wind regimes to be set up.

In summer (December to February) winds are generally light to moderate and the prevailing airstream is from the south to south east.

In autumn winds are frequently light and more variable, but still show a south east to south west tendency. Through the cooler months (late May to August), westerly and even northerly winds are common. During spring, winds are again variable in direction but the strongest winds are generally from the northerly and westerly quadrants.

In general the most frequent strong winds occur during the period from late winter through spring, while a relative lull occurs during April and May. Gales (in excess of 62 kph) are uncommon, but the highest monthly frequency (<<1 per year) occurs during the period September and October.

Rainfall

Rainfall across the survey area is unreliable with no marked seasonality. Average annual rainfall ranges from 250mm in the west (eg. Yunta, Fig.16) to less than 175mm (eg. Mulyungarie, Fig.17) on the plains in the far north east.

Widespread significant rainfall is infrequent, but is most likely to result from tropical inflow in summer (from the north or north east), or from slow moving cut-off low pressure systems, or north west cloud bands at any time of the year. These latter systems, which originate over the north east Indian Ocean, are associated with a well established north westerly flow aloft, but at mean sea level, easterly, north easterly, or even light variable winds, may prevail.

Rainfall in the warmer months is highly erratic, and most often in the form of heavy showers, associated with thunderstorms. It is in this season that extreme falls may occur. In some years, certain conditions can produce prolonged widespread rain.

Meteorological Drought Years

The term drought refers to an acute water shortage. Although the amount of available water depends to a large extent upon storage (in the soil, in artesian basins and in dams and reservoirs) and in losses from evaporation, the best single indicator of water availability is rainfall. Gibbs and Maher (1967) showed that the years with an annual total in the first decile range (ie., the lowest 10% of falls on record) correspond well with droughts recorded in other sources. Using this guide and rainfall records from a number of stations, 11 years since 1900 are identified as those in which drought affected extensive parts of the area. These years are 1902, 1922, 1927, 1940, 1943, 1944, 1948, 1965, 1967, 1977, and 1982.

[1] R. M. Playfair, Resource Monitoring and Planning Pty Ltd, P O Box 2, DAW PARK, SA, 5041

Some droughts such as those at the turn of the century, in the late 1920s, and the early 40s, lasted beyond 12 months over large parts of the area.

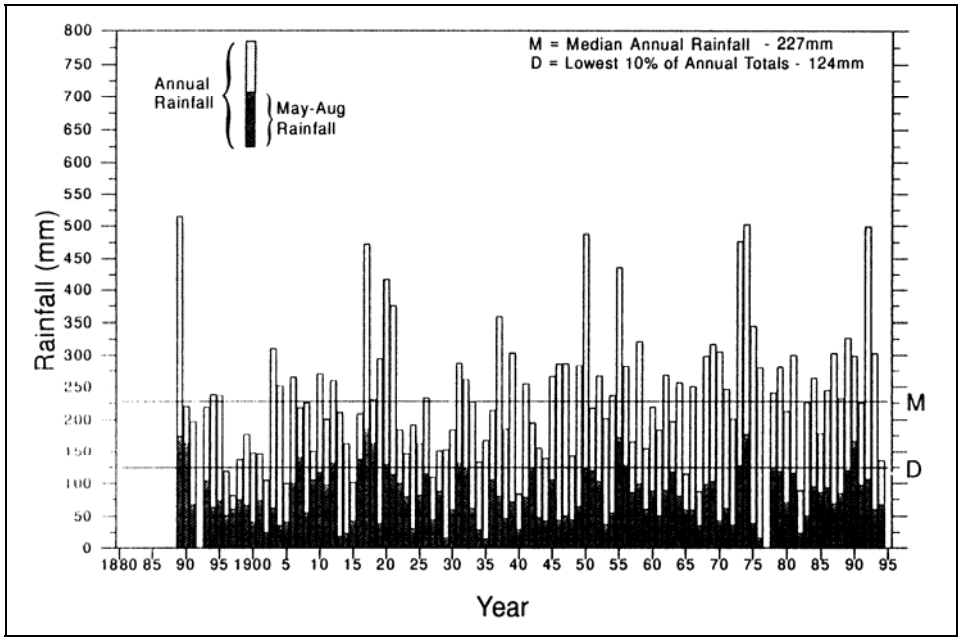


Figure 16 The historical rainfall record for Yunta (elevation 303m).

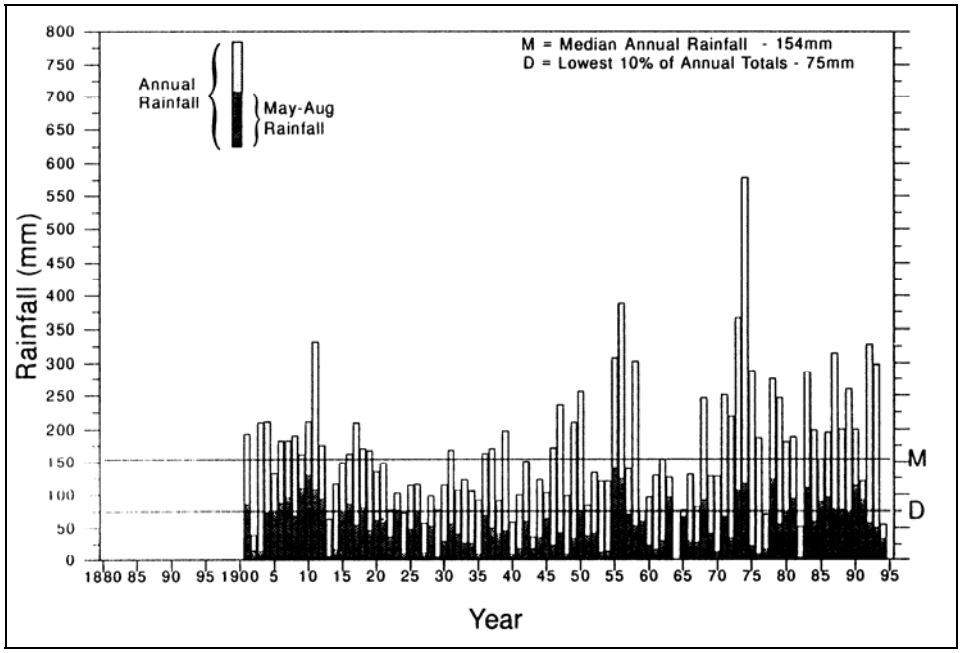
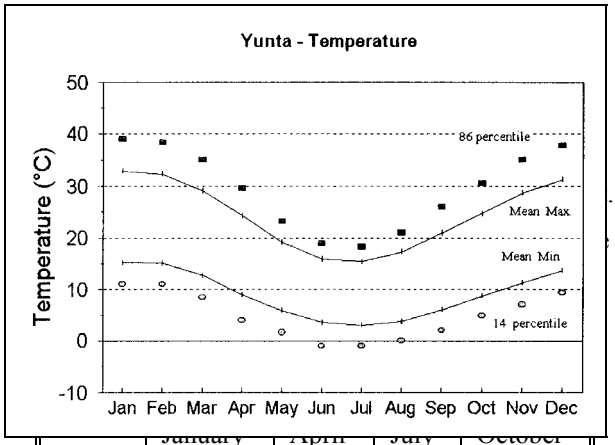


Figure 17 The historical rainfall record for Mulyungarie (elevation 90m).



	January	April	July	October
North	425	200	75	275
South	350	175	75	225

Table 1. Average monthly evaporation estimates for the mid-season months. Estimates are to the nearest 25mm.

Temperature

Temperatures are influenced by elevation and other features of the local environment. For example, maximum temperatures are reduced by around 1.0°C on average, for every 100m increase in elevation. Minimum temperatures are also reduced at elevated sites, but cold air drainage into local depressions will also affect minimum temperature distributions.

Climatological charts of mean maximum and minimum temperatures across the survey area for the mid-season months, January, April, July and October are available from the Bureau of Meteorology (1988). Observed daily temperatures are available from Yunta (elevation 303 metres) and the three observing sites at Broken Hill.

In the hotter part of the year (November to March) average daily maximum temperatures exceed 28°C, and during January and February average over 32°C. Average minimum temperatures for the period November to March are in the low to mid teens on the uplands, and the mid to high teens over lower areas. The mildest (warmest) overnight temperatures occur in January and February (Fig. 18).

For the cooler months (April to October) average maximum daily temperatures range from around 25^{o}C in April and October to near 15^{o}C in winter. In elevated areas average minimum temperatures are less than 10°C and dip to around 3^{o}C or lower in July. At Yunta daily minimum temperatures below zero have been recorded in each month between April and October. In the north, average minimum temperatures range from the low teens in April and October to around 5^{o}C in July, and below zero temperatures are most likely to occur in the period June to August.

Figure 18 Mean monthly maximum and minimum temperatures (solid lines) for Yunta. The 86 percentile for maximum temperatures (square symbols) and the 14 percentile for minimum temperatures (oval symbols) are also shown. On one day in seven the maximum (minimum) temperatures will exceed (not exceed) these limits.

Frost

Frosts occur in the cooler part of the year, generally on calm, clear nights when there is little moisture in the air. The frequency of frost is dependent on local surface features (including vegetation and soil moisture) and topography. Some locations, such as hollows and depressions especially in elevated areas, are more prone to frost than others.

At the elevated site of Yunta, frosts have been reported throughout the period from April to November. On average, 46 frost-days per year, with the highest frequency (10 to 12 per month) during the winter months, June to August.

Sunshine Hours

Across the District, the annual average bright sunshine per day is 8.5 hours. It varies from 10.5 hours in January to around 7 hours in the north, and 6.5 hours in the south during July.

Data availability

This climatology has been summarised from information prepared by the Bureau of Meteorology for the North East Soil Conservation Board.

Weather and climate observations are available from Yunta and Broken Hill (three sites). Many more rainfall observations are undertaken by a volunteer network, and records are available from 45 observing sites in the area, although not all these are part of the national rainfall observation network in operation today. All climate and rainfall observations are quality controlled and archived in the national climate data-bank, and made available to researchers and other interested users.

More information is available from:

Bureau of Meteorology
25 College Rd (PO Box 421)
Kent Town SA 5071

Ph: (08) 8366 2222
Fax: (08) 8366 2293

GEOLOGY AND GEOMORPHOLOGY

M.C. Benbow[1]

INTRODUCTION

The North Olary Plains encompasses the region that is occupied by Lake Frome and extends to the margins of the north eastern Flinders Ranges and northern Olary Ranges. It is also bounded to the east, in New South Wales, by the Barrier Ranges (Fig. 19).

A unifying theme of the North Olary Plains is the ephemeral, centripetal drainage into or toward Lake Frome, a depressed region that lies close to, or below, sea level. The drainage dissects broad alluvial plains between Lake Frome and the ranges, while to the east of Lake Frome it is largely relict and choked by sands of the dunefield of the Strzelecki Desert (Figs. 20, 21, 22). Seen in a broader context, the region occupies the south western extremity of the Lake Eyre drainage system that also includes Lake Eyre and the surrounding dunefields of the Tirari and Simpson Deserts. It is in the lowlands centred on Lake Frome that sediments accumulated in basins at various times after the Precambrian, particularly during the Mesozoic and Cainozoic.

The uplands are largely the surface expression of the large fold-belt of the Adelaide Geosyncline (Appendix XI) and inliers of older, crystalline basement rocks (Figs. 23). Here old pre-Cretaceous (see Fig. 19) exhumed surfaces lie high in the landscape (Fig. 20). The current topography has been largely inherited from the Middle-Late Eocene, a time of active incision by ancient rivers, with subsequent modification by younger episodes of erosion.

The North Olary Plains encompasses the area contained within the FROME, CURNAMONA, OLARY (northern half), PARACHILNA (eastern one-third) and ORROROO (northeast) 1:250 000 map sheets. The definition of this biological survey region therefore contrasts with the adjacent South Olary Plains which was defined by Laut *et.al*. (1977) purely on the basis of environmental criteria.

GEOMORPHOLOGY

Major physiographic regions are:

1. Uplands and intermontane plains of the Flinders Ranges and Olary Ranges
2. Flanking alluvial plains
3. Lake Frome
4. Dunefield of the Strzelecki Desert (Fig. 19).

Uplands and intermontane plains of the Flinders Ranges and Olary Ranges

The uplands and intermontane plains are part of a large mountain fold belt (800km long) that includes the Mt. Lofty Ranges and formed on Proterozoic and Cambrian sediments of the Adelaide Geosyncline (Figs. 19, 20, 23). In the study area there are also several regions in which ranges have formed on older crystalline basement rocks, notably in the Mt. Painter region and in the northern part of the Olary Ranges.

Characteristic topography of the fold belt is ridge and valley, and amplitude is commonly 200-400m (Figs. 14, 68). Relief is particularly rugged in the north (eg. Gammon Ranges) where resistant quartzites form precipitous bluffs.

Shape and orientation of the ranges is determined largely by the fold belt's geological structure and rock lithology (Figs. 14, 17). In the south, range shape and orientation is broadly sigmoidal and south westerly-north easterly (respectively) (ie. in the Nackara Arc). West of Lake Frome the fold belt is less regular and dome and basin topography is common in the Central Flinders Zone. Topography of the Olary Ranges is decidedly less rugged than that of the Flinders Ranges and southwest-northeast oriented, low, hogbacks are typical.

The terrain of the Precambrian basement inliers includes topography more typical of granitic terrains. Thus in the northern Olary Ranges there are rounded granite hills with typical tor forms and these may have associated cross-cutting narrow valleys with flat floors as in the Mount Victoria and Triangle Hill areas (Fig. 52). Isolated basement pinnacles or hills lie further north within the margin of the flanking alluvial plains (eg. Nancatee Hill and Moolenlooloo Hill).

There is an ancient summit surface or high planation surface referred to as the Freeling Heights Surface in the north eastern Flinders Ranges (Twidale, 1967; Twidale and Campbell, 1993) (Fig. 20). It has formed on different rock types, eg. granite as well as Freeling Heights Quartzite, and is recognisable over a wider area, that is, to the southwest and northwest. This high surface is of the exhumed and etch type. It is partially exhumed since marine sediments of Early Cretaceous age have been partially removed from it by erosion and it is of the etch type since there is no associated weathered carapace. Around the northeast margin of the Flinders Ranges, this old surface has been warped and faulted and it can be traced (by drill holes) to the east beneath sediments of the younger basins.

The current topography of the uplands had its precursor during the middle Tertiary. Valley and ridges formed during the Middle-Late Eocene are believed to have by and

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large remained as such ever since. (Evidence for inversion of relief is limited.) During the Eocene, the old summit surface was incised and intermontane plains formed, indicated by valley infilling sediments of this age beneath the Willochra Plain to the west of the study area (Binks, 1970). The present day intermontane plains thus mark old palaeovalleys but younger and more recent erosional episodes have led to some dissection and formation of new plains.

On ORROROO, for example, extensive, broad intermontane alluvial flood plains formed where the Precambrian strata (eg. mudstones) are less resistant to erosion - these include the Koonamore and Nackara Plains both of which lie in the Koonamore Drainage Basin (Binks, 1970). Apart from the Siccus Plains which drain to the northeast toward Lake Frome, most of the drainage in this region is internal. There is however an overall northeasterly component in the drainage reflecting broad structure. Koonamore Lakes in the northeast are seasonally wet and are flanked by gypsum ridges or lunettes.

Some drainage, as on the southern side of the Olary Ranges, is directed towards the Murray Plains (Fig. 19).

Alluvial plains

Alluvial plains flank the uplands and are dissected by ephemeral creeks that flow largely into or toward the central depression occupied by Lake Frome (Figs. 4, 7, 9, 12, 19, 20). The width of these plains ranges from 40-100km and elevation drops away from >100m adjacent to the Flinders Ranges to <10m near Lake Frome. Gradients are therefore gentle, particularly north of the Olary Ranges. The character of this broad region varies, determined by the degree of dissection and variable influence of superimposed aeolian dunes and elevation.

The Frome Plains (ie. east of the Flinders Ranges) are described by Callen (1981, p.6) as being a "complex of coalescing low-angle fans, rising from 0.5m above sea level at the edge of Lake Frome to 70m near the ranges" and are described as being "virtually featureless, apart from occasional creeks ... and low gravel ridges." A small area of scattered dunes is developed on Paralana and Caldina 1:100 000 map sheets (Fig. 24).

In the far north, adjacent to the Flinders Ranges, lies the Paralana High Plain (Callen, 1981). It is characterised by its elevation (ie. 100-150m AHD) that is distinctly above the surrounding Frome Plains to the east. It apparently once formed part of the Lake Frome Plains but sometime in the late Cainozoic was uplifted along with part of the Flinders Ranges.

Callen (1990) informally referred to the alluvial plains north of the Olary Ranges, as the "Curnamona Plains". Here, drainage is mostly northerly with some headwaters existing in the Olary Ranges (Figs. 7, 19, 24). The "central claypan area", near the margin of the Strzelecki Desert, is typified by the occurrence of scattered, isolated, dune-like low ridges perhaps part of an older, degraded dune system (Fig. 24). There are also north-south oriented chains of claypans which pass northwards into similarly oriented lakes within the Strzelecki Desert which Wasson (1983a,b) considered may relate to older lake margins.

The Passmore River area to the west is characterised by numerous old creeks or palaeorivers of Pleistocene age which are cross-cut by, but parallel with, the modern drainage. This older drainage is subtle and is partly outlined by changes in vegetation. It is partly anastomosing.

Callen (1990) recognised a large alluvial palaeofan, referred to as the Paralana Fan, on the Lake Frome Plains adjacent to Lake Frome.

To the south, adjacent to and within the Olary Ranges are large tracts of alluvial plain characterised by gilgai or subtle micro-relief, that are comprised of stony ridges (1-3m high) and intervening flats that contour the landscape (Figs. 7, 25). A typical feature of the inland stony deserts, the ridges are here largely constructed of quartz and ironstone.

Adjacent to the east margin of the Flinders Ranges are relict mesas, which, prior to dissection, formed extensive but older Pleistocene alluvial plains. Still older and less common, are silcrete capped, horizontal and gently tilted mesas.

Lake Frome

The Lake Frome playa lies mostly at or just below sea level (+0.5 to -3.0m, AHD), and is 100km long and up to 40km wide (Figs. 19, 24, 26). It is linked at its northern end, via Salt Creek, to Lake Callabonna and in contrast to Lake Eyre, it rarely fills. Callen (1983, p.2) attributed this to the large size of the lake in relation to the drainage area, but it may also be due to the difficulty of water traveling along the aeolian sand choked drainage. While Lake Eyre filled during the floods of 1972-74, water barely reached the shores of Lake Frome.

This apparently featureless surface contains islands that project well above the southern coastal cliffs (Figs. 66, 67). They are aeolian and resemble elongate barchan dunes (Callen, 1983). Mound Springs and yet larger aeolian dunes or lee-side lunettes up to 30m high flank the eastern shore (Fig. 65). Still older Pleistocene beach ridges can be traced around much of Lake Frome, reflecting a lake of once greater extent. Low angle alluvial fans (some have coalesced to form aprons) rim part of the western and southern shore (eg. Pasmore Delta) and have partly built out over the lake's surface (Fig. 24). Associated are beaches, spits and bars. Immediately south of this playa is an old (Pleistocene) cliffline 2.5m AHD.

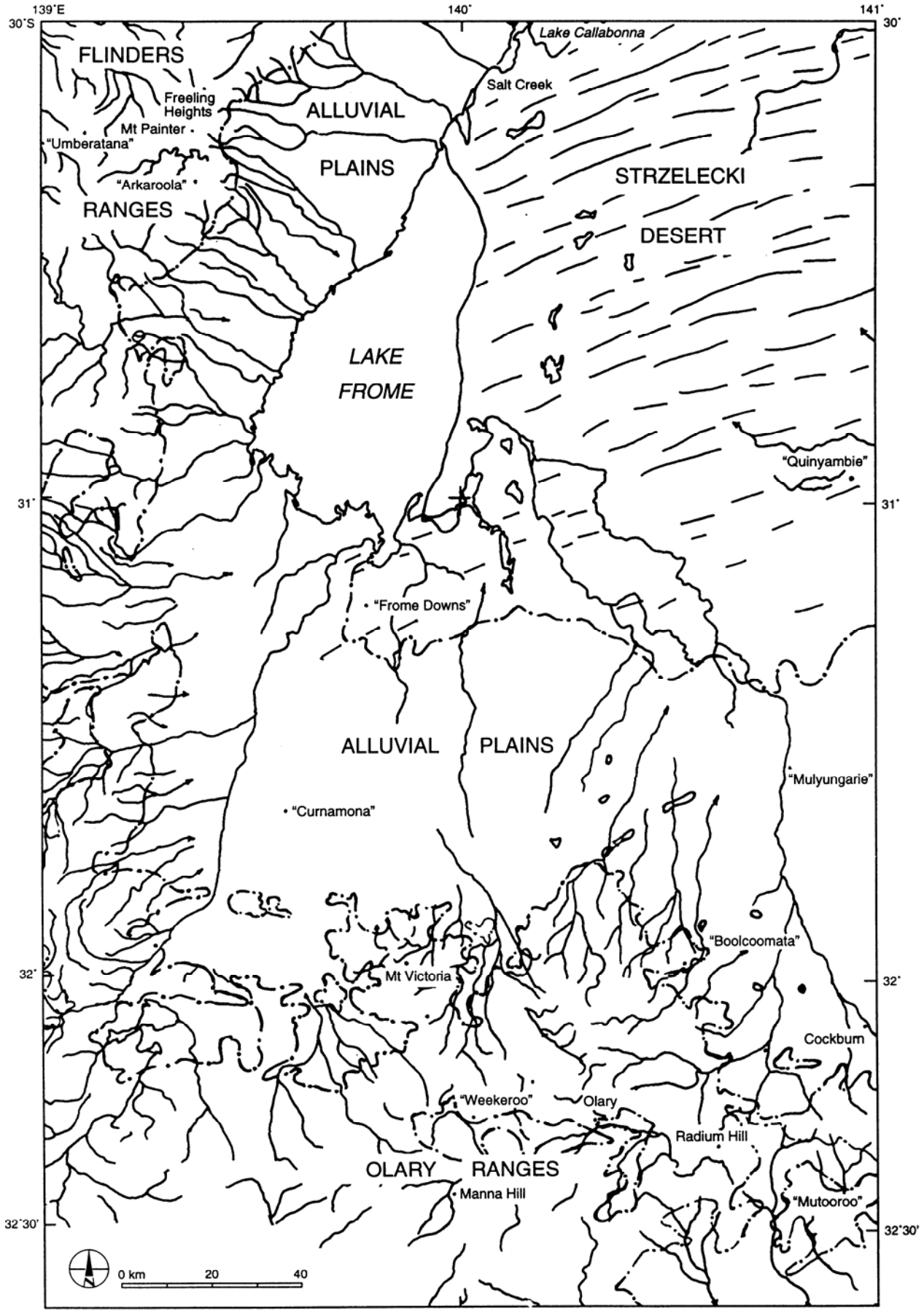

Figure 19 **Physiography of the North Olary Plains**

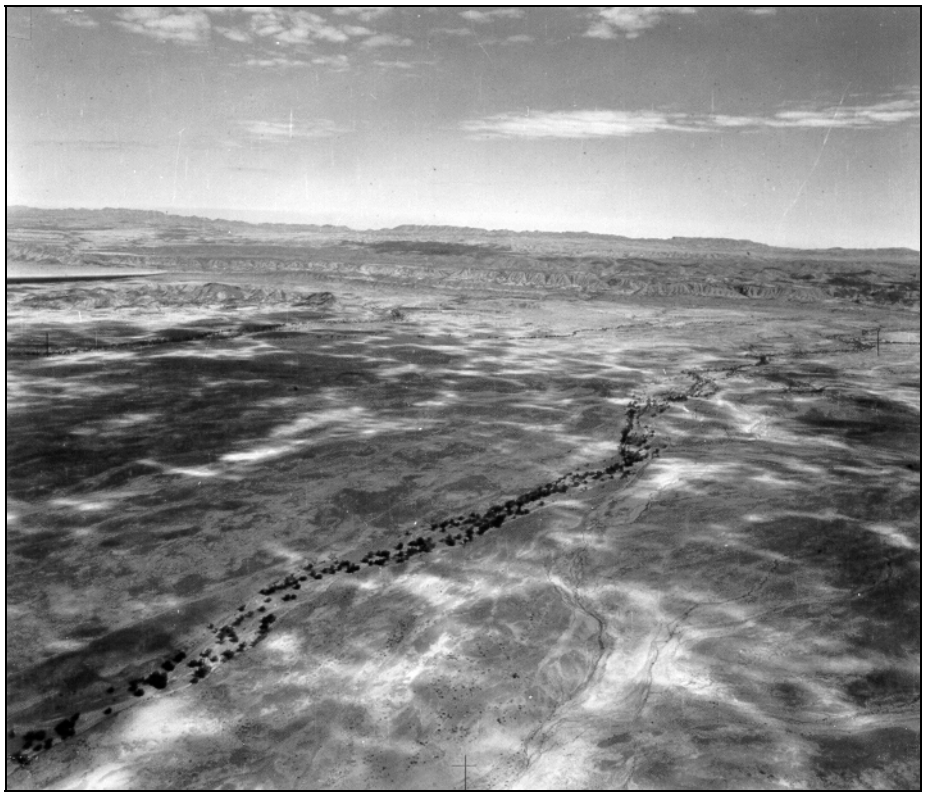

Figure 20 **Aerial view of the alluvial plains west of Lake Frome, the Flinders Ranges (and Freeling Heights Surface) in the background. Courtesy of MESA.**

Figure 21 **Coonee Creek section exposes modern red brown aeolian sand overlying the Coonarbine and Eurinilla Formations. Courtesy of MESA.**

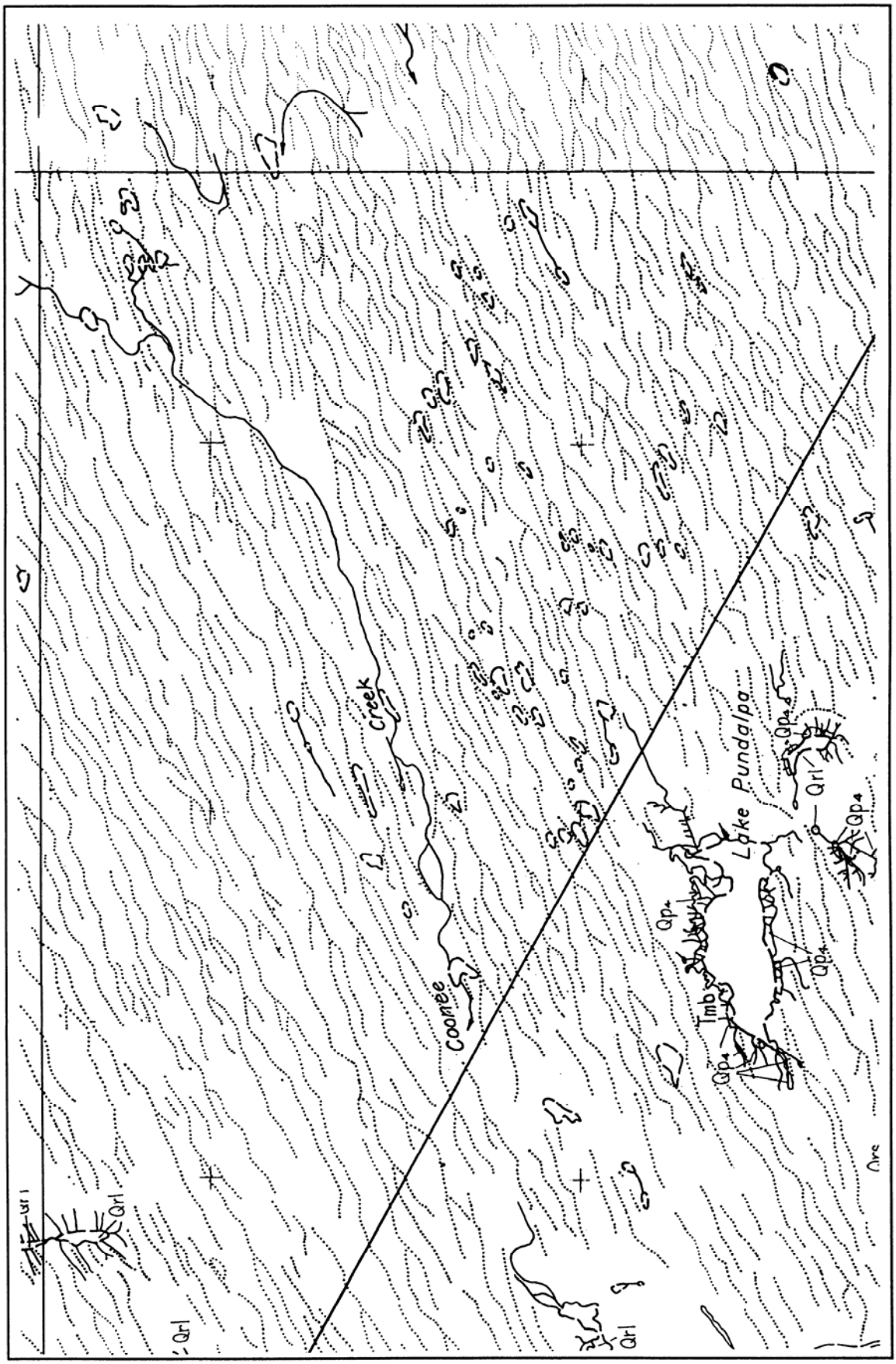

Figure 22 **Geology of part of the Strzelecki Desert showing the dunefield in the vicinity of Coonee Creek. Taken from Callen (1975).**

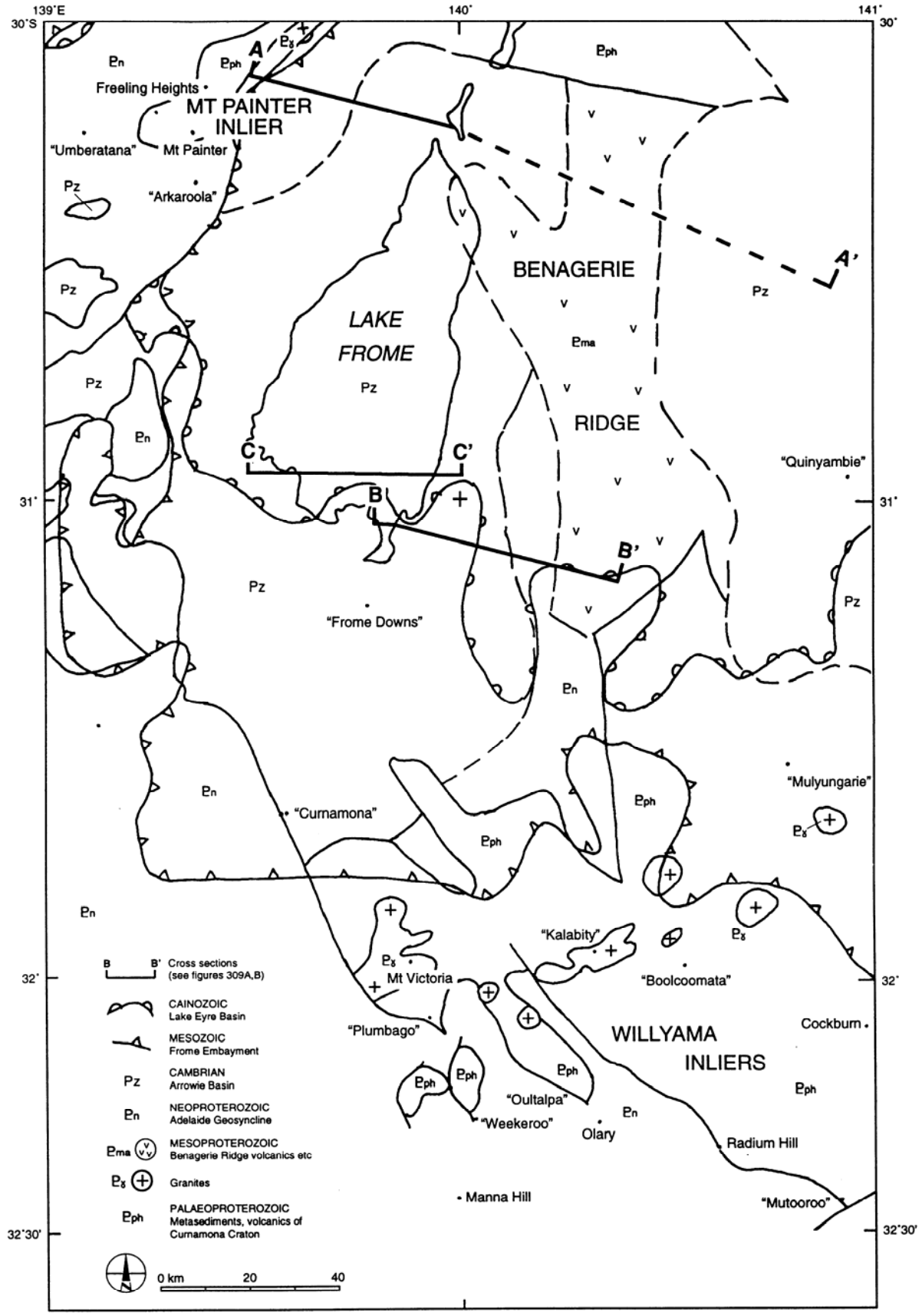

Figure 23 **Regional geology of the North Olary Plains. (Location of geological cross sections - see Figure 27 - also portrayed.) Taken from Rankin and Parker (1993).**

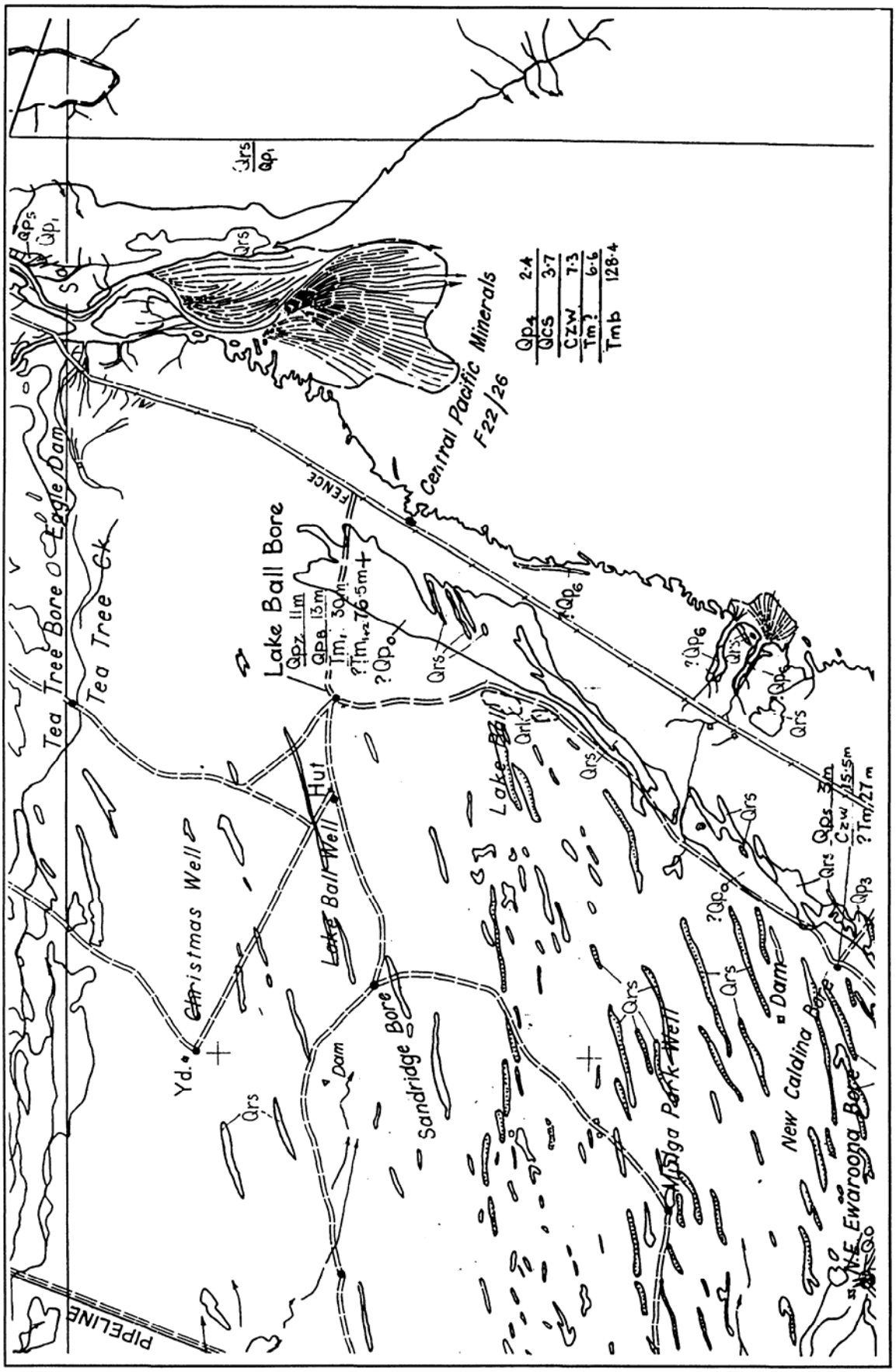

Figure 24 **Geology of part of the alluvial plains in the vicinity of the NW margin of Lake Frome. Note the delta where Salt Creek debouches onto the lake's northern limit. Taken from Callen (1975).**

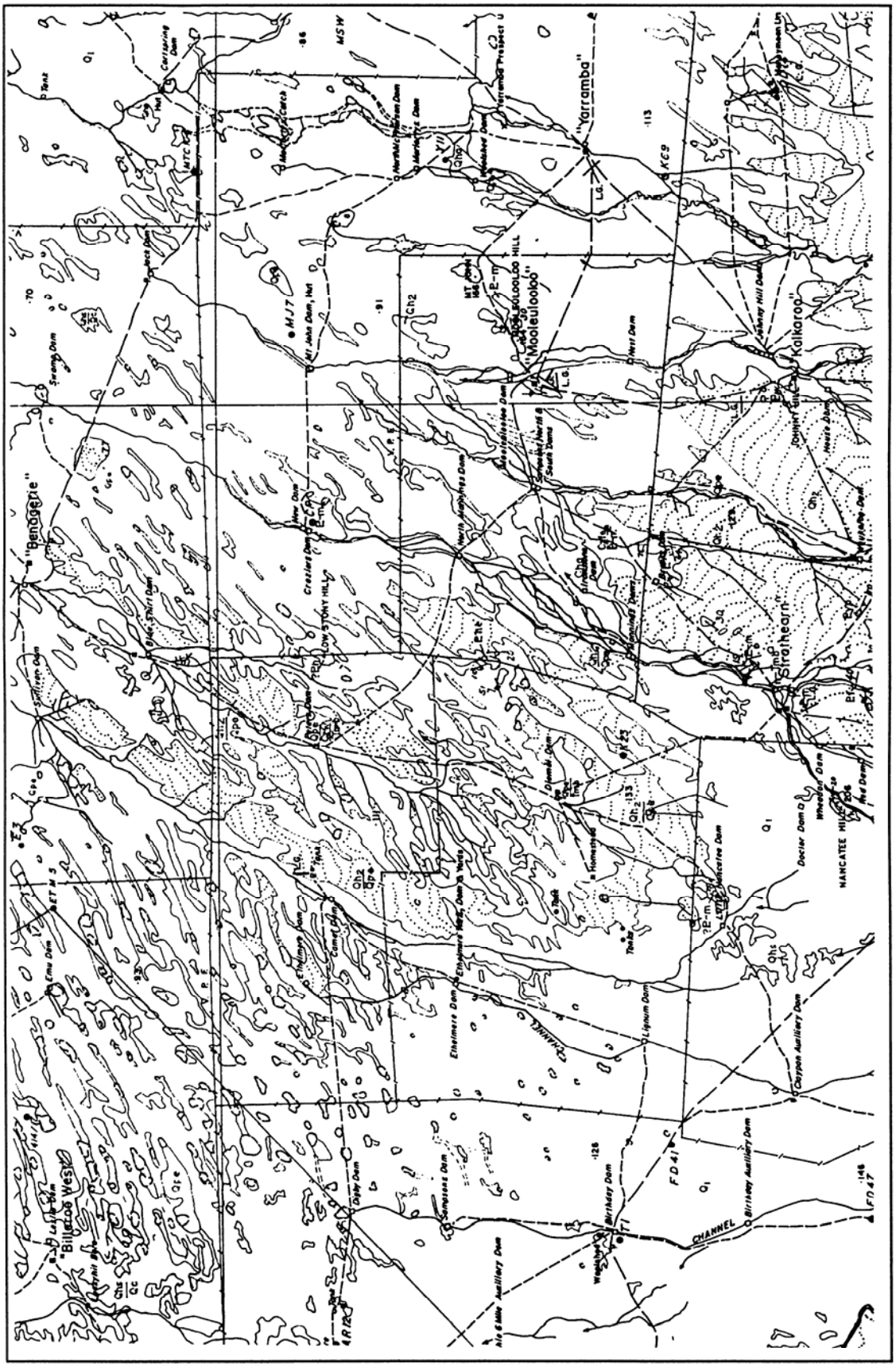

Figure 25 **Geology of the alluvial plains S and SE of Lake Frome. The "central claypan area" and gilgai mantled fans (denoted Qh2) W and S of "Benagerie" are shown (respectively). Also note outliers of crystalline basement of the Olary Inliers (eg. Ph, P-m). Taken from Callen (1986).**

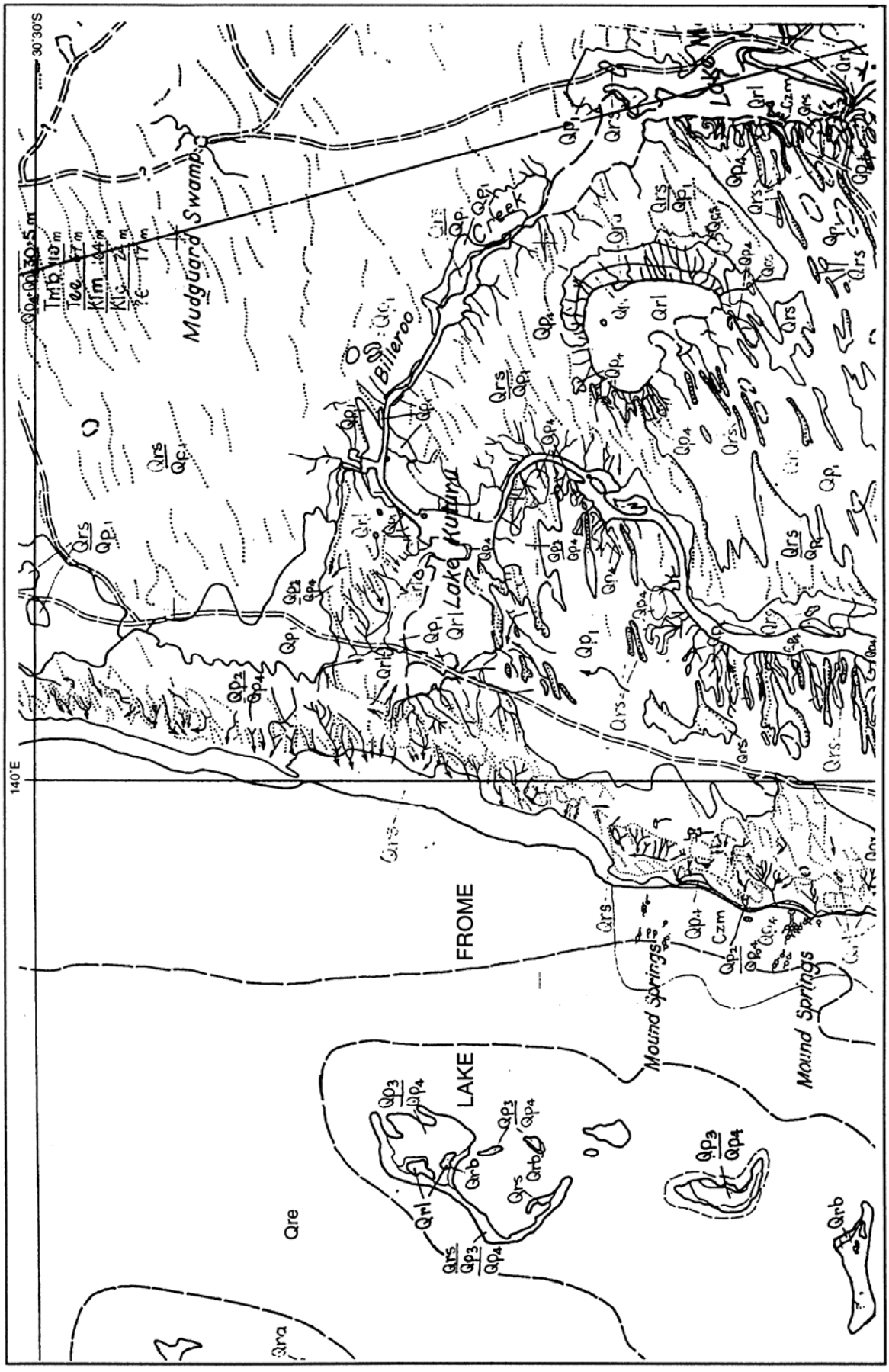

Figure 26 **Geology of SE Lake Frome region. Taken from Callen (1975).**

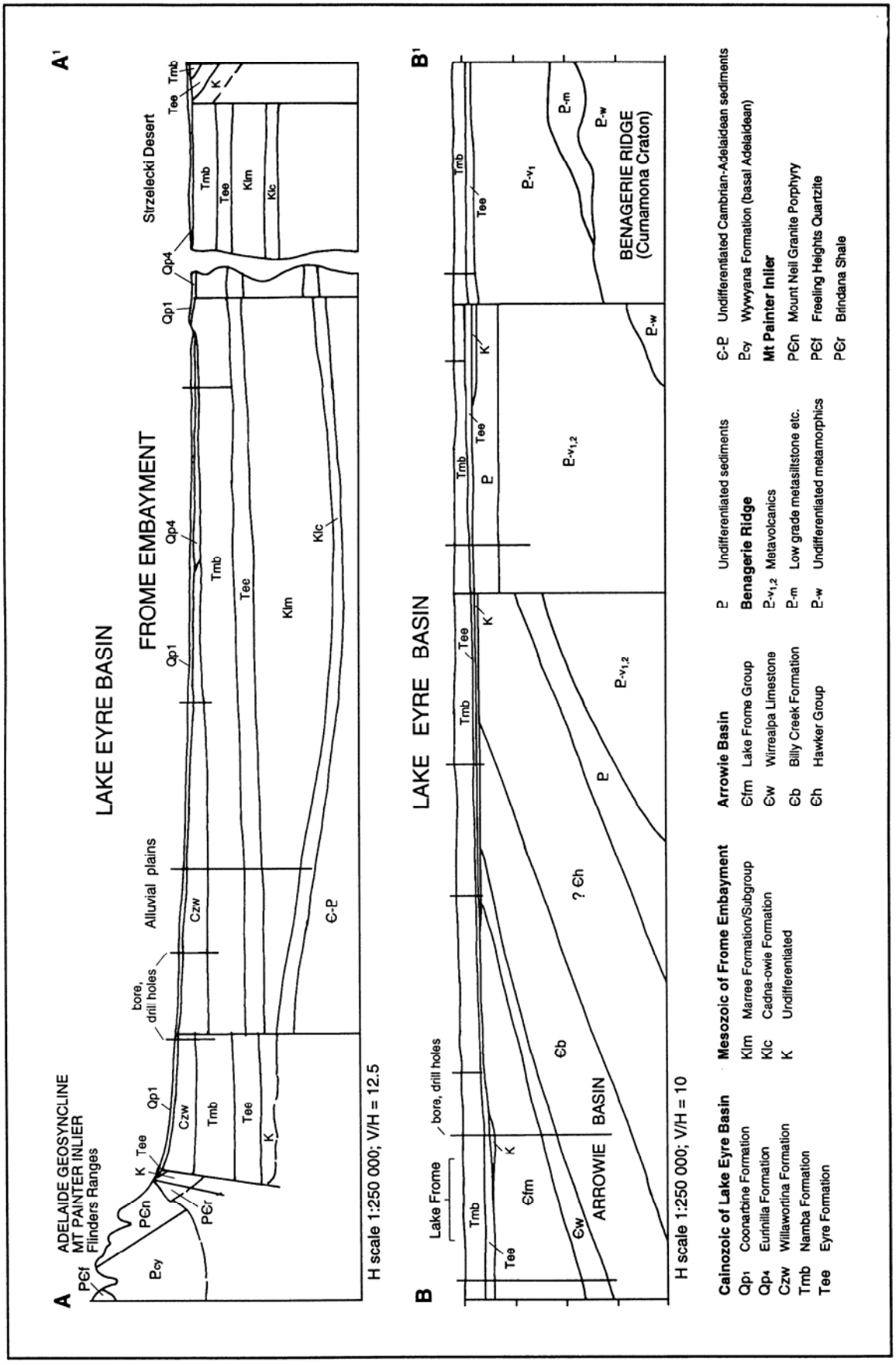

Figure 27A **Geological cross-sections. Taken from Callen (1975, 1986).**

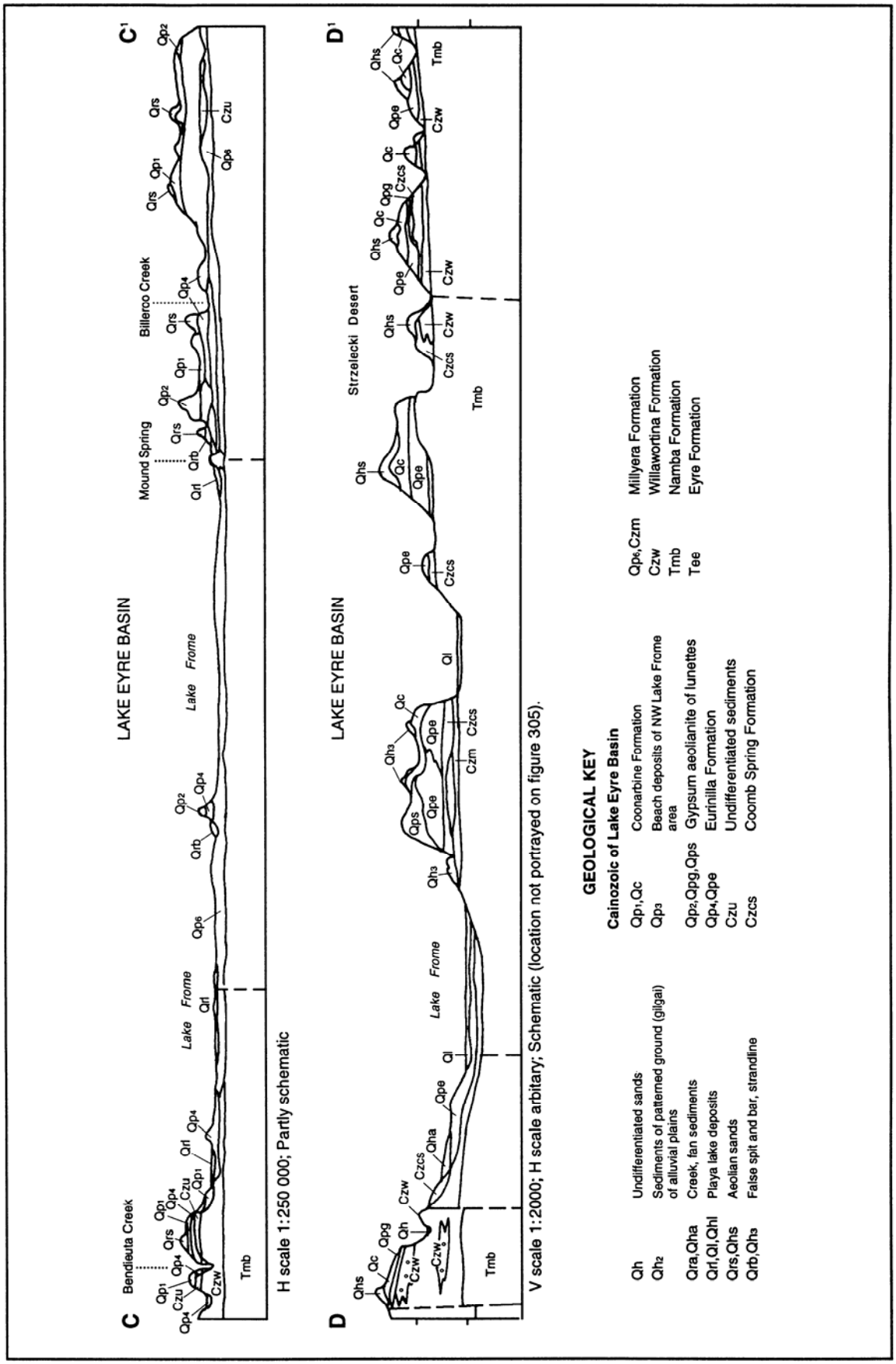

Figure 27B **Geological cross-sections. Taken from Callen (1975, 1986).**

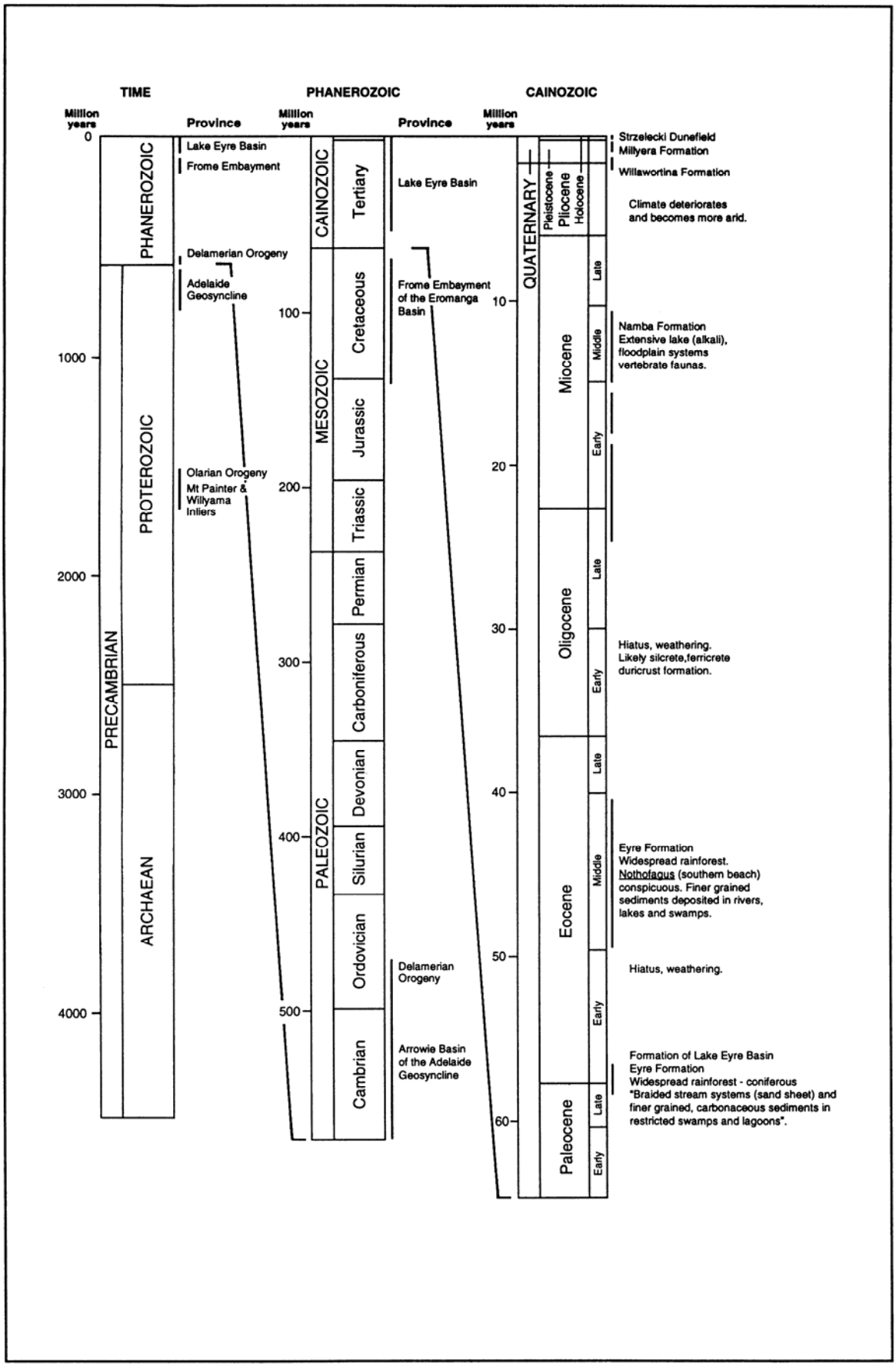

Figure 28 **Geological time, provinces and selected events.**

Strzelecki Desert

The southern part of this Desert occupies the north eastern part of the North Olary Plains (Fig. 19). This dunefield forms part of the larger continental anticlockwise whorl of dunes that includes the Simpson Desert to the north and the Great Victoria Desert to the far west. The study area lies on the east margin of the whorl and immediately south of its east-west oriented main axis (King, 1960; Jennings, 1968; Bowler, 1976; Sprigg, 1979; Callen *et.al*. 1983; Wasson, 1983 a,b; Wasson *et.al.*, 1988; also see Krieg *et.al*., 1990). These dunefields cover approximately 40% of Australia and are by far the dominant landform of the continent.

Predominant landforms are parallel longitudinal dunes and interdune corridors or swales (Figs. 54, 55, 22, 26). Dune types include the very short, narrow, crested-linear type (eg. around the margins) and narrow-crested linear type (predominant). Other dune types are either not present or minor (eg. parabolic). Y-junctions point mostly ENE, that is, in the direction of "the resultant of sand-moving wind" (Wasson *et.al.*, 1988,p.98).

Orientation of the dunes is WSW-ENE but to the north of the study area, it changes to become northerly, eventually having a small westerly component. Dune length ranges from <1km to >20km, dune height averages 15m, while average dune spacing is ½-1km. Consistency in these parameters testifies to "a high order of spatial coherence and persistence" (Wasson *et.al.*, 1988, p.89). Small claypans are locally present along the swales and there are scattered small playas. Ephemeral creeks comparable to, but smaller than, the Cooper and Strzelecki or Warburton, ie. the Coonee and Yandama, flow across the Desert toward or into Lake Frome (Fig. 22). Also drainage of the Plains can be traced into the Strzelecki Desert. Some creeks now terminate at small playa lakes. Here drainage is largely choked by the sands of the dunefield and prior to dunefield formation was much more extensive and possibly terminated on the east side of an ancestral Lake Frome.

As in other parts of the continental dunefield (eg. Benbow, 1992), there is variation in surface elevation reflecting an older, pre-dune topography. There is also a regional west to east increase in surface elevation from around 5-90m AHD. In fact, the Strzelecki Desert sits on an old alluvial plain that is linked to the Barrier Ranges.

The south, plains-bounded, margin of the Desert, is less well defined than the western, Lake Frome-bounded margin.

GEOLOGY

Palaeo-Mesoproterozoic - Willyama and Mt. Painter Inliers and the Curnamona Craton

Cores or inliers of ancient Precambrian basement rocks (eg. gneiss, schist and granite) occur exposed in the north eastern Flinders Ranges (Mt. Painter Inlier) and northern part of the Olary Ranges (Willyama Inliers) (Figs. 52, 23, 27, 28). They lie on the margin of, and form part of, a large Proterozoic province that is for the most part buried and covered by basinal sediments beneath Lake Frome (Parker, 1993 and references therein). The buried part of this province is referred to as the Curnamona Craton. To the east, in New South Wales, the exposed province rocks contain the rich lead, zinc and silver mineralisation of Broken Hill.

Little is known about the Curnamona Craton. It is a basement block approximately 250km in diameter and is clearly defined by its aeromagnetic properties (ie. anomalies). Outcrops, which occur along the southern part of the north-south oriented Benagerie Ridge, an uplifted, structural feature of the Craton, and drillholes, indicate similar rocks as are exposed in the inliers (Figs. 25, 27).

The sequence of the inliers and the Curnamona Craton include Palaeoproterozoic metamorphic rocks overlain by, or intruded by, Mesoproterozoic volcanics and granites respectively (Fig. 27). The Freeling Heights Quartzite forms part of the rugged landscape of the Mt. Painter Inlier and is part of the sequence of metamorphic rocks that is in excess of 6km thick.

These rocks have had a complex structural and metamorphic history (eg. Olarian Orogeny of 1700-1580 million years ago) (Fig. 28). Stabilisation (cratonisation) of the Curnamona Craton took place around 1450 million years ago; thus this part of the Palaeo-Mesoproterozoic province has remained largely undeformed since.

Neoproterozoic-Cambrian - Adelaide Geosyncline

Most of the rocks of the Flinders Ranges and Olary Ranges are sediments that belong to the Adelaide Geosyncline, a complex succession of superimposed and adjacent basins (Preiss, 1987, 1993; Gravestock, 1995). Total sediment thickness is in excess of 30km making this one of the most complete geological records for this time in the Earth's history. These rocks have been weakly metamorphosed and folded while the equivalent rocks overlying the Curnamona Craton (beneath Lake Frome) remain relatively little deformed and flat lying.

Stratigraphic details and units are too complex and numerous respectively to describe here. The sedimentary record can be broadly divided into five groups based on the nature of the sediments and where the major breaks in deposition occur. Numerous sedimentary rock types were deposited. For example sandstones, that are now indurated and weakly metamorphosed, were deposited a number of times (eg. Paralana, ABC Range and Rawnsley Quartzites) and outcrop to form the impressive and beautiful ranges.

The basal Callanna Group rocks mark the onset of subsidence of the Geosyncline and rifting with associated volcanic activity over 800 million years ago (Fig. 28). Sediments were deposited in non-marine and marginal marine rift-valley settings. Evaporitic minerals attest to some aridity. Sedimentation in the Geosyncline commenced west of Lake Frome (Paralana Quartzite) and as a result of extension in the continental crust, over 0.6km of flood basalts (Wooltana Volcanics) were extruded on the surface.

The overlying and younger Burra Group marks the record of marine transgression or inundation of seas and sediments were deposited in a range on non-marine and marine environments, particularly riverine and deltaic.

After a major hiatus, widespread glaciation (at several levels) is recorded in the Umberatanna Group (eg. Sturt Tillite equivalent and Elatina Formation). The Wilpena Group is significant for it includes near the top (of the Proterozoic) the Ediacara Member (of the Rawnsley Quartzite) which contains the well known assemblage of soft-bodied metazoans such as jelly fish, worms and sea pens, the first appearance of these faunas on Earth.

Another major time-break or hiatus occurred at the Precambrian (ie. Proterozoic) -Cambrian boundary before deposition recommenced with the Hawker Group and finally Lake Frome Group. In the North Olary Plains region the Benagerie Ridge of the Curnamona Craton acted as a barrier between focii of deposition (eg. east-west oriented Arrowie Basin to the west and beneath Lake Frome). In fact during the Cambrian the tectonic setting and depositional history differed markedly from the older, Precambrian record of the Geosyncline. The Cambrian sediments include deltaic sandstones and coastal to offshore marine carbonates. At this time Australia lay in very low, ie. equatorial, latitudes as part of the super-continent of Gondwana (Ziegler *et.al.*, 1979). The fossil record of these rocks (as elsewhere in the world) eg. shelly faunas, trilobites and archaeocyatha, mark the sudden appearance on Earth of new life forms including those with hard skeletons.

Sedimentation ceased in the Adelaide Geosyncline and around 470 million years ago there followed the Delamerian Orogeny which deformed the sedimentary record and gave rise to a major fold-belt (Fig. 28). Arcuate folds are prominent and differences in fold style and orientation have enabled tectonic subdivision (reflected in the geomorphology of the Flinders, Mt. Lofty and Olary Ranges as described above). Associated intrusion of granites (eg. Mudnawatana Granite in the Mt. Painter Inlier) and low grade (burial) metamorphism also took place.

In the study area there followed a prolonged period (from 470 -150 million years ago) for which there is no sedimentary record; weathering and erosion would have been significant at this time.

Mesozoic - Frome Embayment

Sediments of this age are largely restricted to the northern part of the North Olary Plains and thin toward the south (Figs. 23, 27). Outcrops are known to occur only along part of the eastern flank of the Flinders Ranges and are there very limited in extent where upfaulted against the uplands. These sediments occupy a lobe, the Frome Embayment (Forbes, 1966), of the very large Eromanga Basin and include the important aquifers of the Great Artesian Basin.

The Cretaceous Cadna-owie Formation (or Paralana Sandstone on COPLEY) (0-52m thick) comprises a basal pebble bed, marginal marine sand, in part boulder-bearing, micaceous mud, and comparatively minor limestone. There are possibly older (ie. Jurassic), localised conglomerates and sands immediately underlying this formation in the centre of the Embayment. The conformably overlying Maree Subgroup (0-275m) comprises predominantly grey to black, in part carbonaceous, micaceous muds and mudstones that were deposited in marine environments. Plant remains may be present and shells (bivalves) and other marine organisms (eg. foraminifers) may be common.

The Eromanga Basin, a large epicratonic basin, formed as a broad continental downwarp as the supercontinent, Gondwana, fragmented (Fig. 28). The Cadna-owie Formation was deposited in coastal seas and adjacent non-marine environments such as rivers and swamps during the onset of very widespread inundation by shallow seas of the continent. This was also a time of global sea level rise. Evidence suggests a reasonably uniform landscape, ie. no great trans-continental ranges were present, and breaks in sedimentation may be taken to suggest oscillating shoreline locations. Climate was markedly seasonal such that rivers and shorelines could ice-up during winter (Frakes and Francis, 1988). Seasonal or periodic ice build-up may have been responsible for transport of boulders offshore.

The Maree Subgroup was deposited in large shallow seas and the climate is believed to have been even cooler at this time than during Cadna-owie Formation time (Krieg *et.al.*, 1995 and references therein). Seas retreated in the mid-to-late Cretaceous that is, toward the end of the Mesozoic and a prolonged period of non-deposition followed.

Cainozoic - Lake Eyre Basin

The Lake Eyre Basin is a large continental downwarp superimposed in part on the Eromanga Basin (Figs. 23, 27, 28). Related to subsidence was the development of drainage (Lake Eyre drainage basin) that today covers a substantial part of the continent, with the termination focused on the large inland playa lakes (eg. Lakes Frome and Eyre). The study region lies in the southern part of what is referred to as the Callabonna Sub-basin. Here, the basin margin is in part defined by faults along the margin of the Flinders Ranges. Reactivation of old faults defined local features of deposition - thus Lake Frome occupies a region of subsidence between upfaulted north-south oriented structures.

Sedimentation during the last 65 million years was episodic and non-marine as there was no prolonged connection with the sea (eg. via the Murray Basin to the south). Equivalent sediments were also deposited in the intermontane valleys within the Flinders Ranges, but these are far more restricted in their extent and thickness.

As most of the region is topographically low, the Cainozoic succession is largely obscured by the thin, blanketing cover of the youngest part of the record, that is, of the Quaternary (1.6 million years to the present day) (Figs. 22 - 27).

Deposition took place during three major intervals as Australia migrated northwards and as the climate, overall, if episodically, deteriorated from humid temperate or sub-tropical to the marked aridity of today (Fig. 28).

During the early Cainozoic widespread fluvial sands were deposited (Eyre formation) (Fig. 27). Adjacent to the Olary Ranges the sediments are confined to palaeochannels which to the north pass into an extensive blanket typically 10-75m thick (Callen, 1981, 1990). The formation occurs mostly in the subsurface, but isolated outcrops occur upfaulted along the margin of the Flinders Ranges.

At the base there are lags with clasts of well rounded and polished agate, black chert, fossil wood and quartz, as well as other resistant lithologies that were derived and reworked from the Mesozoic. The sands are in part carbonaceous and the upper and younger part in the north is finer grained and includes carbonaceous muds that were deposited on riverine plains and in swamps and lagoons.

Deposition took place when southern Australia lay at relatively high latitudes (ie. 50-65°S) as the continent continued its separation from Antarctica. Rainforest very likely covered much of the Lake Eyre Basin and the subdued ancestral uplands, as indicated by fossil pollens, spores and leaves. Initially, rainforests were dominated by conifers when climate was humid and cool temperate. Some time later, *Nothofagus* (the southern beech) was a prominent component. Toward the end of Eyre Formation time rainforest became restricted to moist valleys and sclerophyllous vegetation (including *Eucalyptus*) became more important.

The changing climate patterns of this time and for the Cainozoic as a whole, not only reflect the continent's northward drift from near the pole toward the equator, but also the changing configuration of the continents (ie. sea and atmosphere circulation).

During the middle Cainozoic there followed a long interval of non-deposition and weathering. Silcrete duricrust which extensively mantles the landscape north of the study area, over the Stony Deserts region, is limited in the North Olary Plains to the margin of the uplands, and may have formed at this time (ie. Wopfner, 1974, 1978).

Evidence from elsewhere (eg. the Murray and St. Vincent Basins) indicates *Nothofagus* dominated cool temperate rainforest (Benbow *et.al.*, 1995 and references therein). Climates cooled globally (during the Early Oligocene) a likely consequence of the development of the circum - Antarctic polar current, as the last connection with the Australian continent (ie. south of Tasmania) was severed. Seas withdrew (also globally), exposing more of the continental margin.

Gentle warping and subsidence effectively divided the Lake Frome region from that of Lake Eyre.

The second major interval of Cainozoic deposition commenced later in the middle Cainozoic (ie. Late Oligocene) related to inundation of the continent's southern margin by the sea (eg. as recorded by the deposition of marine limestones south of the Olary Ranges in the Murray Basin).

Sediments deposited at this time (Namba Formation) are characterised by grey, green, to white argillaceous and calcareous muds and mudstones (Fig. 27). Limestone and dolomite are included, whilst sands are less prominent. The formation occurs mainly subsurface as an extensive sheet 20-100m thick. All that remained of the Benagerie Ridge after deposition were isolated monadnocks of crystalline basement of the Curnamona Craton. Outcrops occur associated with the playa lakes south and east of Lake Frome, particularly Lakes Millyera, Tarkarooloo and Namba. Possibly equivalent sediments (ie. Avondale Clay (Coates, 1973a,b)) occur in the intermontane basins and flank the eastern margin of the Flinders Ranges (as on COPLEY; see Coates, 1973a,b).

The Namba Formation contains highly significant vertebrate remains which provide important information about evolution of the Australian faunas and about climate (see Callen, 1990 and references therein, pp.42,43). Faunas include abundant reptiles, fish and birds (eg. pelicans, flamingo), and ancestral marsupials (eg. koalas, possums, dasyurids).

Notable depositional environments include (alkali) playa lakes in which carbonates were precipitated (mainly west of the Benagarie Ridge) (eg. see Benbow *et.al.*, 1995). Sands would have been deposited in low energy streams and possibly lake margins. Climate must have been warm and dry enough (perhaps seasonally) to allow deposition of the carbonates, but periodically wet to enable lakes to fill or be inundated.

The vertebrate faunas, particularly the arboreal marsupials, indicate forested lake and river margins. For part of the time at least, this formation may have been deposited in large permanent lakes as indicated by freshwater dolphins. Some (perhaps riverine) connection with the sea is also implied.

The fossil plant record from the northern margin of the Murray Basin, south of the Olary Ranges, indicates mixed rainforest dominated by myrtaceous genera and *Nothofagus*, at least for part of the time.

[Note that age constraints for the Namba Formation are poor. Numerous time breaks are likely during the time that sediments were deposited (ie. 25-15 million years ago).]

There is some evidence to suggest that the youngest part of the Namba Formation was deposited in the Late (perhaps latest) Miocene and Early Pliocene (Callen, 1990; Benbow *et.al.*, 1995). However much of the Late Miocene is generally regarded as being a time of non-deposition when climate in Australia became generally more arid as global temperatures dropped and the Antarctic icesheet expanded.

Early Pliocene pollens and spores from largely outside the study area (Benbow *et.al.*, 1995; but also see Callen *et.al.*, 1995, p.194) as in the palaeochannels on northern Eyre Peninsula (including the Yellabinna biological survey region) indicate the presence of *Casuarina*, *Eucalyptus*, grasses, composites and Chenopodiaceae. Apparently, however, rainforest survived in isolated suitable sites.

Around the time of the Late Pliocene during another lull in sedimentation, widespread silcretes developed in the continental interior. In the study area Callen (1990) regards the rare and isolated, silcrete capped mesa occurrences adjacent to the Olary Range to be of this age.

Uplift of the Flinders Ranges (in particular) and the Olary Ranges occurred sometime during the Late Pliocene or possibly Early Pleistocene and led to the building of alluvial fans adjacent to the ranges. This is the first Cainozoic record of fans being constructed in the vicinity of the uplands. Sediments - the Willawortina Formation - are thickest (up to 150m) adjacent to the Flinders Ranges and overall geometry is wedge shaped, thinning toward Lake Frome (Fig. 27).

The Willawortina Formation consists of red and green muds, carbonates and conglomerates. Sediments are poorly sorted particularly the coarser sediments which may be matrix-supported. Equivalent sediments - the Avondale Clay - occur within the Flinders Ranges (Coates, 1973a,b). The carbonates were deposited in lakes, located not only out on the alluvial plain but also adjacent to the Flinders Ranges. Callen and Benbow (1995) believe the position of the western margin of Lake Frome fluctuated widely, from within a few kilometres of the Ranges to east of the current position.

This formation forms the high plains (eg. Paralana High Plains) adjacent to the Flinders Ranges. It also outcrops extensively in the Pasmore River area - good sections may occur in old river channels dissecting this part of the alluvial plains.

The Quaternary record (ie. the last 1.6 million years), and part of the Late Pliocene record, is marked in Europe and North America by alternating glacial and interglacial episodes as the polar ice-caps waxed and waned (1-3km vertically). It is generally acknowledged that changes in the Earth's orbital parameters (of Milankovitch) are the trigger forcing this cyclicity (eg. Hayes *et.al.*, 1976; Imbrie and Imbrie, 1980; Berger, 1988; also see Sprigg, 1979).

In Australia it was only in Tasmania and in a restricted part of the Australian Alps that similar conditions prevailed. For much of the continent, including the Lake Frome region, climate fluctuated between relatively wet and dry times as the lakes and deserts expanded and retreated. However, climate was overall markedly arid compared with those times earlier in the Cainozoic when rainforest covered much of Australia.

The features of the inland continental record at this time are the reddening of the sediments and accumulation of calcareous (eg. calcrete) and gypseus horizons (eg. Figs. 7, 21). The drainage systems were reactivated episodically, lake and water table levels fluctuated and toward the end there were times of widespread dune-building as global atmospheric circulation intensified.

Thus the Quaternary saw the development of the modern landscape, of deserts, alluvial plains and playa lakes that typifies the North Olary Plains (Figs. 19, 23).

The inland record differs from the southern coastal record where the impact of rapid sea level fluctuations (of up to 120m) exposed and covered the continental shelves. It is also far less complete than the oceanic record leading to difficulties of interpretation and dating. Thus the inland geological record is complicated in detail and stratigraphic interpretation has varied.

It is because of the rapid changes in climate that all elements of the environment were not necessarily in equilibrium, and this would have been reflected in changing patterns of flora and fauna. Wettest and driest (windiest) times may not have exactly coincided with warmest (interglacial) and coolest (glacial) times (respectively) but may have been to some degree out of phase (eg. Kershaw and Nanson, 1993). Highest water tables (and exposure on Lake Frome) may have occurred during the transition into a cool and windy glacial episode and not corresponded exactly during a peak or "sub"-interglacial time (eg. Wasson, 1983). Thus changes in the environment may have lagged behind changes in climate.

In the North Olary Plains region during the Quaternary, there were widespread episodes of riverine sand deposition, particularly in the desert country and alluvial fans built out from the ranges. The former may reflect greater activity and inland penetration of monsoonal and/or El Nino-related weather systems and climate patterns. The timing of fan construction, may not have been coincident due to more localised weather patterns over the ranges.

Widespread riverine deposition occurred between approximately 150-130,000 and 60-50,000 years ago. The Eurinilla Formation is characterised by being a bright red brown, in part clayey or muddy sand that is usually poorly sorted (Figs. 21, 27). (The Pooraka Formation of the intermontane valleys, basins and range flanks is partially equivalent (see Coates, 1973a,b)). This formation occurs beneath both the alluvial plains and Strzelecki Desert and was deposited as a blanket 0-20m thick. It is portrayed on the geological maps as being generally mantled by a very thin overlay of younger, reworked (including aeolian) sands on the alluvial plains. Outcrops are restricted to around, or in the vicinity of, the playa lakes (Fig. 25). Southeast of Lake Frome, in the "central clay pan area" numerous parallel, dune-like exposures are interpreted to be this formation (Callen, 1986).

Perhaps older (ie. Callen 1981, 1986, 1990) or equivalent (Callen and Benbow, 1995) sediments accumulated in the lakes (Millyera Formation) and beach ridges (Coomb Spring Formation) (Figs. 27, 28). Lake-full stages are indicated at approximately 150,000, 110,000 and 60-45,000 years ago (Callen and Benbow, 1995). During the maximum lake-full stage Lakes Frome, Callabonna and Eyre may have been joined.

The Coomb Spring Formation forms some of the prominent (lake-parallel) ridges around Lake Frome and is comprised of white to yellow quartz sand. The Millyera Formation lake deposits include laminated green muds (in part fish-bearing), algal limestone and sand. The famous Callabonna vertebrate faunas are derived from this sequence and include *Diprotodon* and *Genyornis* as well as forerunners to our modern faunas (eg. koalas, kangaroos and possums). Again outcrops of this formation are restricted to the vicinity of playa lakes.

Widespread aeolian deposition (Coonarbine Formation) and formation of the Strzelecki Desert east of Lake Frome, commenced in earnest during the Late Pleistocene (Figs. 22, 27, 28). The aeolian sands overly and were derived from the alluvial plain sediments (eg. Eurinilla Formation). Whilst the Strzelecki Desert was the main focus in the study area for aeolian activity and dune-building, isolated dunes were built up on the alluvial plains.

A number of aeolian episodes have been identified (Figs. 27, 28). Peak phases are dated at 20-15,000 (ie. last glacial maximum) 9-7,000 and 5,000 years ago (Callen and Benbow, 1995, Fig 11-24). Sands of earlier episodes are commonly paler coloured and contain old calcareous soils.

The modern Holocene (ie. last 10,000 years) dune sands are mobile even though vegetated. A broad colour zonation of surface sands exists out from the margin of Lake Frome (Wasson, 1983; also see Wopfner and Twidale, 1967). Adjacent to the lake sands are pale brown and pass eastwards through a transitional zone 10-20km wide before grading into red brown desert sands. Wasson (1983) found that the pale brown sands have large quantities of clay pellets which were derived by deflation of the lake's surface. This compositional difference is very likely reflected in the vegetation.

Today Lake Frome and the smaller playa lakes contain thin Holocene lake sands and muds. The latter are non-laminated to laminated and may contain remains of fish, plants and algae. The surface of Lake Frome is windswept and veneered by sand and thin salt crusts. Gypsum may impregnate the sediments immediately below the surface.

The Holocene lake sediments of Lake Frome intertongue with, and grade into, alluvial fan, red brown sands at the lake margin (Figs. 24, 26).

The last major episode of lacustrine deposition occurred around 8-4,000 years ago. Since then summer monsoons have shifted back towards north eastern Australia and tree and shrub vegetation (eg. *Callitris*) has retreated (Callen, 1990 and references therein).

Also during the Holocene some reworking of red brown sands and muddy sands of the alluvial plains has taken place. Both wind and water have played their part in erosion and deposition. Patterned or gilgai terrain developed over Eurinilla and Coonarbine Formations adjacent to the Olary Ranges on proximal fans and to the north east on distal fans of the Barrier Ranges (Figs. 7, 25). The former are notable for the stone ridges of quartz gibber.

In summary then, the rocks of the North Olary Plains record a complex geological history from Proterozoic times, when the Earth's crust was more mobile, to the present day (Fig. 28).

Climate changed during the Cainozoic from more equable and humid times to the marked aridity of today as has been the case for most of the continent. The modern environments are dynamic and sensitive to change whether that be due to natural or man-induced factors. The rapid fluctuations in climate of the last 2 million years (eg. of the order of 10^3-10^4 years) resulted in similarly rapid changes in physiography and surface geology. Thus the Strezelecki Desert retreated and expanded as Lake Frome and the alluvial plains expanded and retreated (respectively).

These changes have affected the region's fauna and flora (even if there were lag times) and will continue to change in the future. Human-related factors, such as changes in the atmosphere's composition, are likely to result in more rapid, even if non-cyclical, change.

ECONOMIC GEOLOGY

The most significant resource of the region has been water, which has been used in the pastoral industry (ie. sheep and cattle). There are numerous base metal prospects in the Precambrian basement rocks (eg. uranium and copper) and non-metallic minerals (eg. gypsum, clays) also occur in the younger cover rocks (see Coats, 1973a; Callen, 1991, 1990; Forbes, 1991; and references therein).

In the north, artesian water flows from the Mesozoic aquifers of the Great Artesian Basin and is derived from the Great Dividing Range region in eastern Australia. The flow rate in the Strezelecki Desert region (on Frome) was reduced by some 25-50% over the period 1930-1970. This was a result of bores not being capped and thus flowing freely over the surface. For some years now Mines and Energy South Australia has been capping such wells off to conserve this precious resource.

To the south and within the ranges water is derived from relatively localised run-off and pumped from a range of aquifers. Water quality is more variable here. Over the Olary Ranges water quantity and quality is generally poor. Good supplies however, do occur within the Flinders Ranges, but quality diminishes eastwards.

Water from the upper part of the Namba Formation is highly saline, as is that from the springs on Lake Frome. Of interest is the fact that individual aquifers are not connected.

The Curnamona Craton is under-explored for base metals and currently there is a government-led exploration initiative for Broken Hill-style mineralisation in the Olary region. Olympic Dam-style uranium-copper-silver-gold mineralisation has also been explored.

There has been extensive exploration for uranium and a significant number of prospects have been found. The Radium Hill Mine (NE OLARY) was mined for radium (up to 1931) and 1 million tonnes of davidite averaging 1.2kgm/*t* uranium oxide was worked from 1954 to 1961. Other occurrences include Crocker Well with 10,000*t* of 500ppm uranium oxide and in the Mount Painter area 2,400,000*t* (up to 2.3kgm/*t*) uranium oxide have been proven.

Sedimentary occurrences of uranium also exist in Tertiary rocks and include the Beverley (15,900 tonnes of uranium oxide) and Honeymoon deposits. The latter occurs in palaeochannel - confined sands of the Eyre Formation.

Gold has been worked from the Olary region. The Teetulpa Goldfield discovered in 1886 was the richest alluvial field in South Australia and produced some 2-3,000kgm of gold. Small production has been made in recent years from the Kirkeek's Treasure Mine of the Nillinghoo Goldfield. Other notable gold fields include Mannahill and Wadnaminga.

Relatively small quantities of other base metals such as copper (eg. Mutooroo Mine), cobalt and tungsten have been found. Iron occurs in the Precambrian sediments (eg. Braemar ironstone facies of the Pualco Tillite). These occurrences are currently regarded as being uneconomic.

Industrial minerals such as feldspar, mica, beryl, clay, graphite and diamond have been worked sporadically over the years in the Olary region. Economic potential exists for gypsum in the lunettes and palygorskite-sepiolite clays in the Namba Formation.

Hydrocarbon potential in the Cambrian Arrowie Basin has been considered and limited drilling has been carried out.

LAND-USE HISTORY

by A. C. Robinson[1]

ABORIGINAL HISTORY

There is a very long Aboriginal history in the North Olary Plains with rock engravings or petroglyphs from the Karolta site 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 similar country in the vicinity of the Willandra Lakes to the SE. 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.

When Europeans arrived there were thought to be five tribal areas within the region and these have been mapped by Tindale (1974) (Fig. 29). Over recent years there has been some criticism of earlier writers who thought in terms of clear-cut tribal boundaries. It has become evident, particularly through native title negotiations that traditional territorial boundaries were far more sophisticated than was originally thought. These tribal areas were utilised 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.

Pirlatapa

Encompassing the area between the eastern edge of the Flinders Ranges and Lake Frome in the north west of the North Olary Plains survey area. There was a derogatory term applied to them by the adjacent Flinders Ranges tribes referring to the poor soil of their country which literally translated as ‘resembling dung’.

Ngu’runta

The tribal area of this group extended from modern Quinyambie south to Mulyungerie and into NSW to the west of the Barrier Ranges.

Jadliura

The plains from the eastern side of the Flinders Ranges, south to Koonamore and east to Bimbowrie enclosed their territory. Like the other groups in the survey area they practised circumcision, but at the time of European settlement they were actively resisting the further rite of sub-incision which was being imposed by the tribes to the west.

Ngadjuri

They occupied the central Flinders Ranges and the western portion of the Olary Ranges. This represented the eastern extent of the circumcision rite at the time of European settlement and they were actively trying to impose this practise on the River Murray groups to the south and the Wiljakali to the east. As a part of the Aboriginal groups who now identify themselves collectively as the Adnyamathanha people, many of the stories from the Flinders Ranges extend into the North Olary Plains survey area and beyond. One such story involves a Bronzewing Pigeon (Marnbi) which escaped from a hunters net near Varaata (Baratta). It was wounded and as it flew it stopped at various places shedding white feathers (white quartz) and drops of blood (mineral deposits). It stopped at Waukaringa then flew east to Teetulpa Station and Broken Hill (Vulhanha). It then followed the Barrier Ranges northward stopping at Tibooburra and then on to Mt Isa where its spirit rested (Tunbridge, 1988).

Wiljakali

Encompassing the eastern Olary and the Barrier Ranges, they lived in small family groups with their movements very much controlled and directed by seasonal conditions. They probably only included 60-80 people at any one time and they spoke a dialect of the Bargundji language (‘river talk’) which was widely used throughout this region. Their use of the rockholes at Mootwingee in NSW is discussed by Gerritsen (1976). The Mootwingee rockholes held some water even in drought years and in years of normal rainfall were an important place where the scattered clans of the tribe could gather to trade, communicate and perform the ceremonies to sustain their land. These gatherings were part of an extensive trading network throughout Aboriginal Australia with pitjuri coming from north central Queensland, stone axe blanks for the New England area of NSW and even pearl shell from the Kimberley coast of WA. The last gathering at the rockholes was in the mid 1850’s when the first white explorers entered the area. Detribalisation, starvation and disease followed breaking a cultural tradition that had sustained and nourished them since the Dreamtime.

EUROPEAN HISTORY

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European exploration

The European history of the North Olary Plains Survey Area began in 1844 when Charles Sturt, seeking to solve the mystery of the character of inland Australia, penetrated further into the interior than any previous explorer. The Aboriginal people told Sturt prior to his departure from the Darling River that the area he was heading into to the west would involve crossing ranges covered with sharp pointed stones and great rocks that would fall and crush him to death. If he did get across to the low country on the other side and into the North Olary Plains survey area he would find neither grass or wood to light a fire with, while the native wells were very deep. Sturt's cattle would not be able to drink from them, and in addition they were very salty. He managed to cross the Barrier Ranges and made it over the sand dunes as far as Lake Callabonna returning, exhausted by the country, to his Darling River depot.

The South Australian Surveyor General Edward Frome explored the plains to the east of the Flinders Ranges in 1843. He was attempting to understand more about the horseshoe of salt lakes to the north of the ranges which it was thought blocked the way into the interior. He was forced to turn around near the northern tip of Lake Torrens and on his return reported that 'no country.....was available for either agricultural or pastoral purposes'.

In spite of these poor reports from the northern explorers, stock was pouring into the colony along the overland route pioneered in 1838 by Joseph Hawdon and his partner Charles Bonney along the River Murray to the south. Overland Corner developed as a major staging post and 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).

The growth of 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 and the chenopod shrublands to the north began in earnest. The pressure was on to expand pastoralism in the new colony into the northern rangelands. Early grazing of this area took advantage of wet seasons by herding stock out into the unsettled areas after heavy rains and retreating to properties as the country dried out.

The first pastoral leases over the survey area were taken out in the 1860's and required that leases be stocked with 8 cattle or 50 sheep to the square mile within 12 months of taking up the land. Rent on 'third quality lands' which covered the pastoral area was set at 10/- per square mile. Although the first pastoralists had some difficulty initially in achieving these stocking rates, the flocks multiplied rapidly to the point where significant and possibly irreversible overgrazing occurred on most properties. Dixon (1892) noted that 'The destructive effects of settlement upon the indigenous flora of Australia is nowhere more apparent than in the purely pastoral districts where rainfall is decidedly scanty. Through the immense region known as the Riverina and to the extreme western and northern runs of South Australia, the injury to the original vegetation by overstocking has assumed so great a magnitude as to entail a national loss'. He went on to observe that 'The effects of this destruction had begun to be felt at each period of drought more and more, and now the rabbit plague comes to finish the devastation begun by injudicious stocking, so that throughout the territories above-mentioned hundreds of square miles are found which (except during favourable seasons when rainfall is sufficient for the growth of annual grasses and herbs) have ceased to carry stock. He further stated that 'from the diminished yields of wool and the tremendous losses of stock which each drought now entails, extensive squatting properties fall into the hands of financial institutions who find that the "runs" which formerly produced thousands of pounds per annum now require an income to be spent on them, as it is only in the very wet seasons that a surplus over the expenditure may be expected'. His words were prophetic, in 1896 the South Australian Government was faced with purchasing the improvements of expiring leases in the north east at a cost of 1,325,000 pounds. It could not afford this payment and elected instead to offer lessees extended terms and improved conditions with the incoming tenants to pay for the lease improvements. Despite the abundant evidence of stock causing land degradation it was not until 1939 that the Pastoral Act of 1936 was finally amended to include provision for the Pastoral Board to limit the number of stock on a lease where the land was likely to be permanently injured if the stock remained.

By this time the damage had been done and Jessup (1948) speaking of the bluebush country of the north east stated that 'The floristic composition of the pastures has almost certainly been greatly modified by stocking. Areas which are now shrublands of bluebush probably at one time carried other more palatable species. It is impossible to assess the original condition of these pastures'. He went on to state that continued reduction of bluebush by stock grazing 'causes the appearance of bindyis, principally *Bassia* (now *Sclerolaena*) *patenticuspis* following winter rain and spear grass, *Stipa nitida* following summer rains. Eventually overgrazing results in the complete destruction of the bluebushes. The land has lost its protective cover and the rate of soil loss is greatly increased. On the sandy loam and loam soils overlying heavier textured subsoils, loss of surface soil brings about serious consequences. The exposed subsoil does not readily absorb water and constitutes a very poor seed bed. Formation of gullies in sloping land results from the lack of plant cover and the increased rate of run off of water is now lost by evaporation from swamps into which watercourses drain. The bindyis and spear grasses lack the permanency and drought resistance of the bluebushes. Heavy winds and the blasting action of wind-borne soil particles are capable of destroying the patchy cover of herbaceous species in a surprisingly short time'.

Since these depressing judgements of the impact of rangeland grazing in the North Olary Plains survey area were written, there has been a gradual improvement, and, at least in some areas, cover of perennial shrubs is increasing. Whether it is possible to return to the levels of productivity that provided massive profits for the first

pastoralists in this area grazing the pristine natural vegetation of the 1860's remains to be seen, and the rate of recovery will undoubtedly take many more years than it took to degrade this precious resource in the first place.

Mutooroo Station

The pastoral development of the chenopod shrublands of the North Olary Plains survey area is exemplified by the history of the Mutooroo Pastoral Company and is described in a book (Mutooroo Pastoral Company, 1951) released to commemorate their 50th anniversary in 1948. At that time, as now, the company managed the Mutooroo and Mulyungarie pastoral leases (Fig. 30).

In 1865-6 the South Australian Government surveyed a road from Burra to the Barrier District of New South Wales. This road known as the Pegline followed the line of the few wells then in existence and was designed to provide pastoralists along the River Darling with a dependable route for teamsters transporting wool and stores, and a convenient track for moving sheep to and from the South Australian markets. In 1868 Thomas Elder secured extensive leases along this important route through what was described at the time as 'waste lands of the Crown'. With his partner Peter Waite who actually managed the stations on the ground, Elder set about developing the leases for grazing and increasing their sheep numbers. They very soon realised the advantages of fencing of paddocks over the traditional practice at the time of shepherding the sheep. As rapidly as possible, additional waters mainly dams, were established together with substantial homesteads and other outbuildings, first on the Paratoo Leases in the south west part of their holdings, and then, from 1880, on the Mutooroo lease. The Paratoo leases expired in 1888 and the Government paid for the improvements then divided the area into smaller leases and again offered these leases to the public. Elder and Waite, no doubt influenced by the completion of the Peterborough to Broken Hill railway in 1887 and their reduced dependence on the Pegline, did not apply for these new leases but at the same time applied for and were granted the leases over Mulyungarie and Lake Charles and so their holdings were changed to those covered by the present Mutooroo Pastoral Company.

Apart from the droughts and rabbit plagues already mentioned, the lessees of the Mutooroo stations fought a long battle to protect their flocks from dingoes. The change from shepherding to fencing sheep into paddocks made them much more vulnerable to dingo predation and it was quickly discovered that the only successful method of combating dingoes was the erection of substantial high netting fences and poisoning and trapping both inside and outside the fence. By 1904 dogs had been fenced out of the Mulyungarie and Lake Charles leases and it was not until 1947 with the creation of the dog Fence Board, that the government took responsibility for construction and maintenance of the overall South Australian Dog Fence, a part of which included that erected on the Lake Charles lease.

Following the disastrous drought years in the 19th Century, droughts occurred in this region in 1938, 1940, 1944, 1945 and 1948. In the worst drought of 1944-45 nearly 25% of the sheep perished.

A series of more personal reminiscences about daily life on the Mutooroo Pastoral Company stations can be found in Adamson (1983). He states that 'The country produced a sturdy breed of men whose exploits I've endeavoured to record'. He 'knew all the paddocks and roads, the names of the trees and grasses, the number of sheep each paddock should safely stock, how to lay a strychnine bait and treat a dog which had accidentally found one. I also learned how to string a line of fence, cut one hundred posts, shoot and skin a kangaroo and peg out its skin, track an emu and find its nest and drove a mob of sheep in the summer heat without knocking them up'. The pastoral properties throughout the North Olary Plains survey area are managed by people with these sorts of skills and a vast accumulated experience on their country, and the challenge for the future is to gradually recover the land from the massive damage done to it during those early years of pastoral settlement.

CONSERVATION

No areas in the North Olary Plains are set aside for conservation. The University of Adelaide has responsibility for the Koonamore Vegetation Reserve which was fenced from the Koonamore pastoral lease in 1925 and has now been free of sheep grazing for 72 years and has had rabbits excluded since 1981. This relatively small area provides one of the very few benchmarks throughout the arid rangelands of Australia where the long-term recovery of the natural vegetation following removal of grazing by introduced animals can be studied (see Previous Biological Studies section of this report for further details).

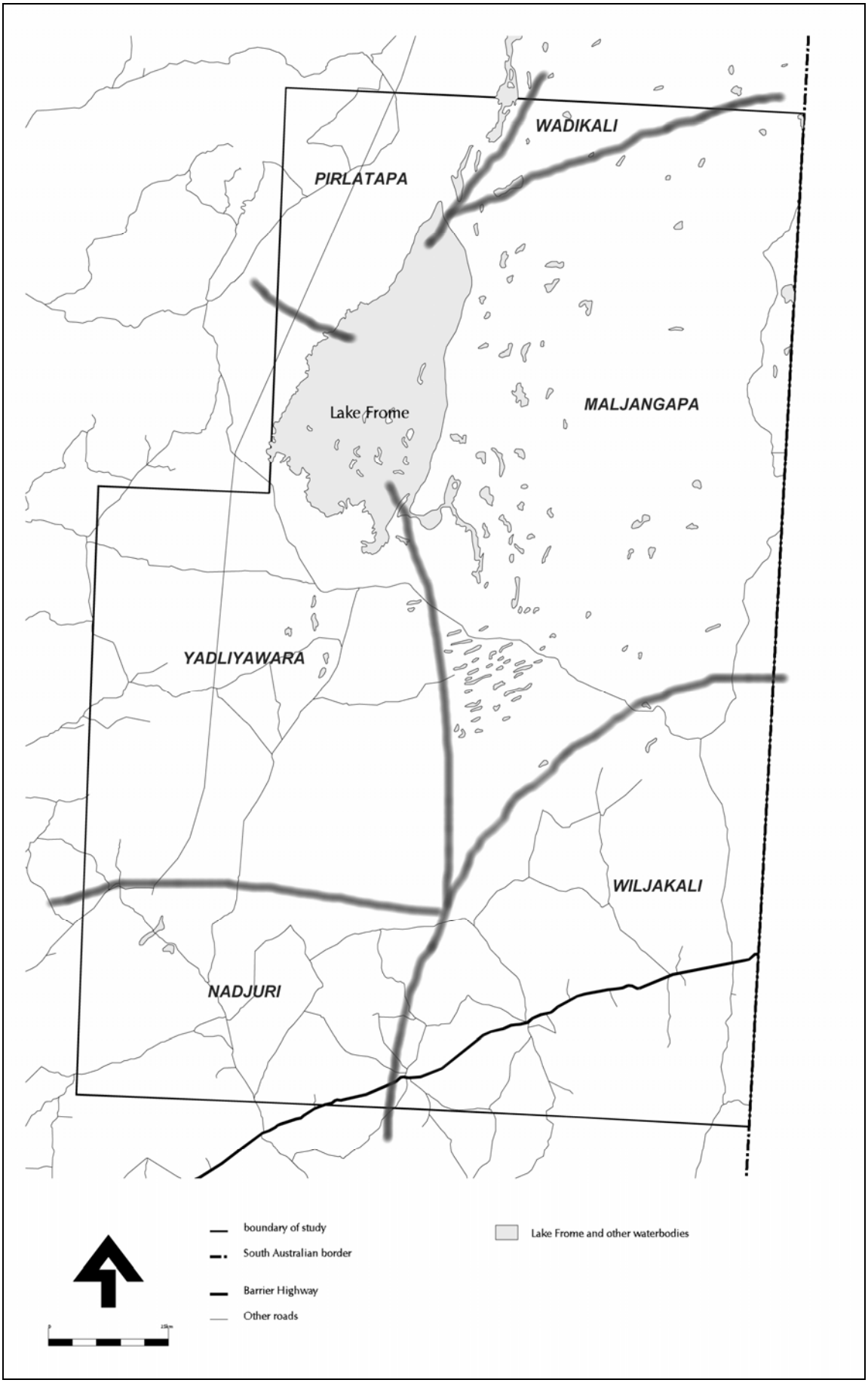

Figure 29 Aboriginal tribal areas (Tindale, 1974).

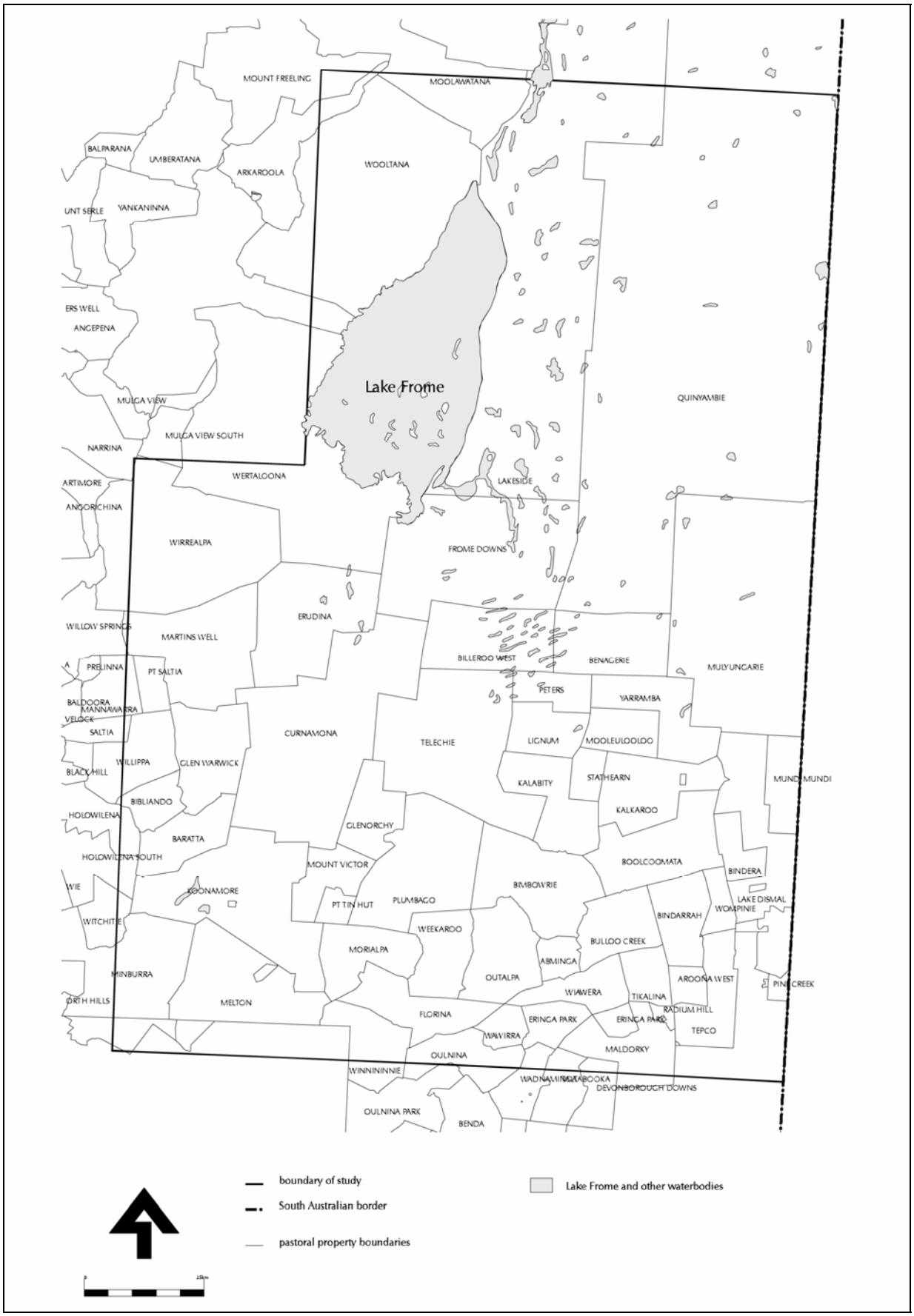

Figure 30 Pastoral Properties in the North Olary Plains Survey Area (Appendix I).

Methods

by R. M Playfair[1] & M. K Hyde[2]

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 13 km^2 of vegetation, which is equivalent to one quadrat per 4 km^2 of total land area. As the North Olary Plains survey area is pastoral land use, the natural vegetation is more homogeneous, generally continuous, and even less diverse than the South Olary Plains (sampling density of one quadrat per 80 km^2), an average sampling density of approximately one quadrat per 140 km^2 was used.

Sample sites were selected to represent the biological and geographical gradients of the area. In addition, the location of sites where biological data had already been collected were taken into consideration to avoid duplicating sampling effort and to provide more replicates for the statistical analysis.

Reconnaissance trips by air and ground, 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 1:100,000 black and white aerial photo mosaics, sites were selected to represent the range of geographical formations and vegetation patterns visible on the aerial photography. An even distribution of sites across mapsheets, environmental associations and rainfall gradients was sought.

Sites and quadrats were named and coded hierarchically as follows. Groups of sites, *site-areas*, were named after their 1:100,000 mapsheet name, using a three letter code eg. OLA = Olary Mapsheet. Within each Mapsheet, individual *sites* were given a five digit code comprising the aerial photo number eg. OLA01, OLA02 are on the Olary Mapsheet, aerial photo numbers 1 & 2. Where there was more than one site on a photo, they were sequentially numbered. At each site, the *quadrats* were then sequentially numbered eg. OLA01101, OLA01102, OLA02101, OLA02102 etc. Another example is KOO38101, on the Koonamore mapsheet, site number 1 on aerial photo 38, and it is quadrat 01.

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

The final location of each quadrat was determined in the field by the survey workers.

Data collection methods were designed to conform with the standards for the South Australian Environmental Database, and to be compatible with those used on adjacent surveys in South Australia, Victoria and NSW.

VEGETATION FIELD SURVEY

During three months from 5 July 96 to 17 September 96, two teams of botanists and assistants sampled 381 quadrats within the survey area. The distribution of these quadrats is shown in Figure 31 (More details are given in Appendix III).

At each quadrat detailed descriptions of the physical environment and vegetation within a 100 x 100 metre area were recorded on standard data sheets using the procedure detailed in Forward & Robinson (1996). Each quadrat was marked with a numbered jarrah stake and photographed.

Any species of particular interest observed outside these specified quadrats were recorded as 'opportunistic' in field notebooks with location details only.

DATA MANAGEMENT AND TAXONOMY

Survey data are stored in a relational data base *Oracle* in the South Australian Environmental Database, currently administered jointly by the Department of Environment and Natural Resources and the Department of Housing and Urban Development. Data management and editing was undertaken in accordance with the procedures detailed in Forward & Robinson (1996).

One and a half thousand plant voucher specimens were collected and identified using taxonomy according to Jessop (1993).

To minimise the potential confusion of spurious vegetation groupings being created by PATN, some lumping of taxa was performed. At the time of the survey a number of species, mostly sterile, could not be

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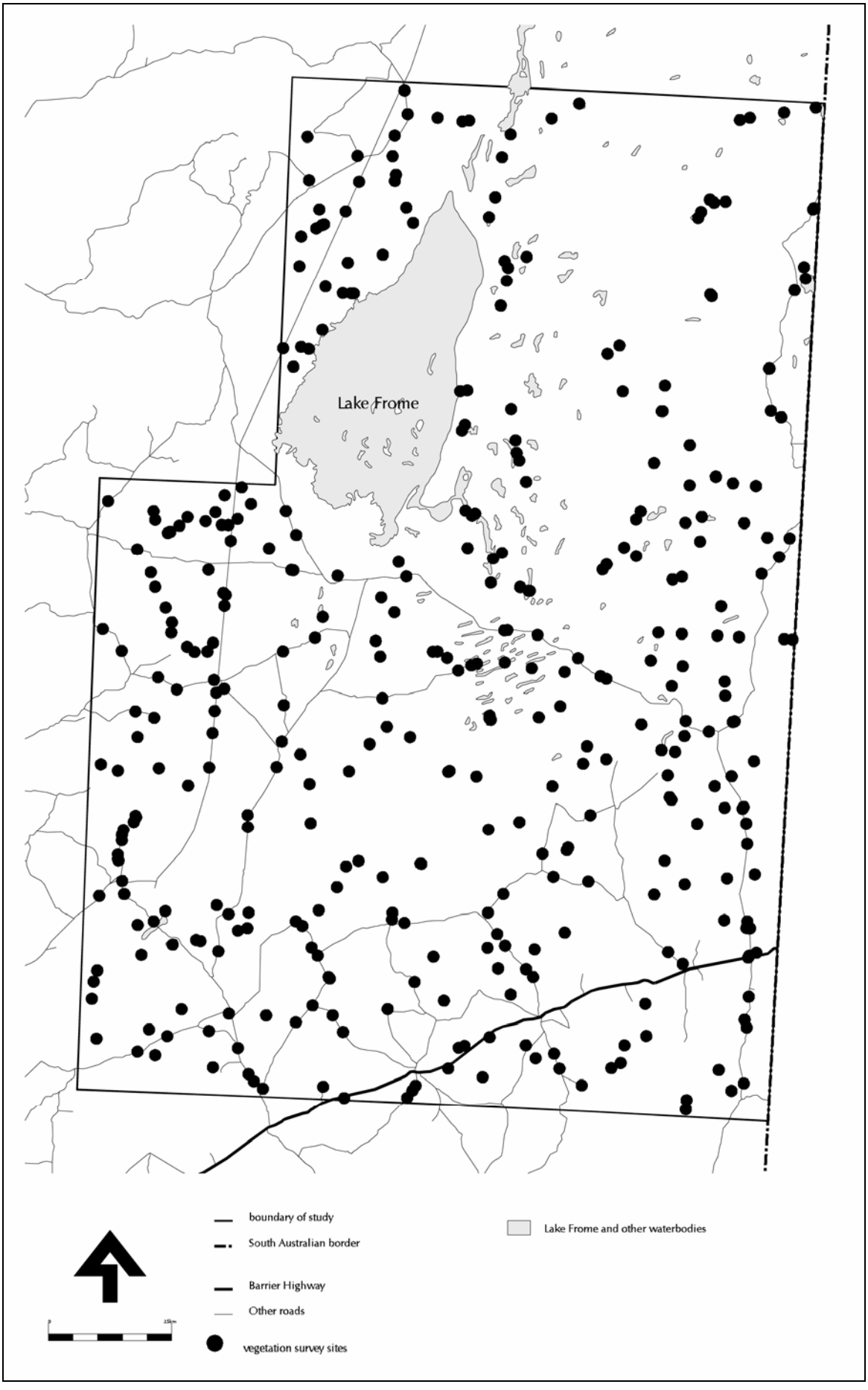

Figure 31 Distribution of vegetation survey quadrats.

consistently identified. so where there were only two possibilities, "slashed" categories were used. This lumping also removed potential misclassifications through incorrect or inconsistent plant identifications across the different datasets. These were:

Convolvulus microsepalus/remotus
Crassula colorata/sieberana
Erodium crinitum/cygnorum
Ixiolaena leptolepis/tomentosa
Lepidium oxytrichum/papillosum
Maireana georgei/turbinata
Parietaria cardiostegia/debilis
Sclerolaena diacantha/uniflora
Solanum ellipticum/quadriloculatum
Tetragonia eremaea/tetragonoides

Some subspecies identifications were inconsistent depending on development and fertility, so prior to analysis, a number of subspecies were lumped together into their specific designation. These were:

Acacia aneura var.
Atriplex lindleyi ssp.
Atriplex vesicaria ssp.
Brachycome ciliaris var.
Chenopodium desertorum ssp.
Crassula colorata/sieberana ssp.
Einadia nutans ssp.
Erodium crinitum/cygnorum ssp.
Harmsiodoxa brevipes var.
Salvia verbenaca form.
Vittadinia cuneata var.

Acacia ayersiana var. *latifolia* was grouped with *A. aneura* because they area sometimes difficult to separate without mature pods, and will probably be taxonomically combined in the near future (O'Leary pers.comm.).

All species that were grouped are indicated on the total survey plant species frequency list (Table 4) in the Vegetation Results chapter.

Due to seasonal factors, at many sites, some grasses could only be identified to genus. The following grass species were lumped:

Danthonia caespitosa, D. geniculata, D. setacea var. *setacea* and *D. tenuior* - lumped into *Danthonia* sp.
Stipa eremophila and *S. mollis* - lumped into *Stipa* sp.
Stipa nitida, S. nitida group, *S. nodosa* and *S. scabra* ssp. *scabra* - lumped into *Stipa scabra* group.

DATA ANALYSIS

Vegetation

The vegetation quadrat data were analysed by clustering techniques using PATN data analysis software (Belbin, 1987) to detect trends and patterns in the data. Detailed descriptions of the methods can be found in Forward & Robinson (1996).

To provide more replicates upon which to base apparent vegetation associations, existing data from within the survey area and a buffer zone of about 20km were imported from other similar survey datasets. Table 2 shows the survey origins of the species lists which ultimately comprised the analysis total dataset.

Table 2 Datasets included in the Vegetation Analysis.

North Olary Plains, 1995	381
South Olary Plains, 1993	74
Rare Rodents, 1993	7
Stony Deserts, 1994	14
Gammon Ranges, NCSSA, 1993	14
Flinders Ranges, 1986 - 1990	457
Pastoral Management Assessments, 1986 - 1994	429
Total	1376

The initial data matrix of all vegetation species and all quadrats consisted of 32,124 records, comprising 1376 rows (quadrats) and 675 columns (species). At this stage the raw matrix still contained some taxa that had only generic or family designations.

After masking the dataset to screen out all records for "not consistently detectable" species, and sites where only 3 or less perennial records remained, the final dataset consisted of 23,901 records comprising 1102 rows (quadrats) and 451 columns (species). PATN tends to dump unusual or species-impoverished quadrats into artificial groups with little floristic similarity and no ecological meaning. Their removal helps to minimise this statistical "noise".

The criterion "not consistently detectable" was used in the masking process in preference to "annual" as some perennial species are not easily detectable or identifiable in some seasons (eg. Liliaceae). Conversely some annual species' structures persist long after death, rendering them easily detectable (eg. Ward's weed, *Carrichtera annua*) and hence can be consistently and accurately identified all year round. All those species listed in Appendix II with + prefix were removed from the analysis.

Each floristic group was described using overstorey dominant species and a structure, sub-dominant overstorey species, understorey dominant species and indicator species (if appropriate). These comprehensive descriptions can be found in the Results section.

Indicator species are defined as species that particularly characterised a group (ie. had a low occurrence in other groups) and thus were significant factors in the classification process. 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.

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

- One or two **overstorey dominant species** which had a high within group proportion of occurrence (preferably >0.8) and medium to high cover/abundance values.
- A **structure** of the overstorey dominants, determined from their "average" cover/abundance and "average" life form.
- **Indicator species** (overstorey or understorey) which had a low number of groups in which they occurred (ie. less than a third of the groups) and a within group high proportion of occurrence.

Close examination and analysis of the final dendrogram and the original 33 groupings, showed some apparent errors in classification. On the basis of complete species lists for those sites which were anomalous, further subdivision and agglomerating of groups occurred:

- 5 sorted into various other groups
- 14 sorted into various other groups
- 2 and 11 amalgamated
- 4,6 and 7 amalgamated
- 25, 26 and 27 amalgamated
- 29 and 30 amalgamated
- 32 and 33 amalgamated
- 34 new group dominated by Samphires
- 35 new group dominated by Canegrass or Lignum
- 36 new group dominated by Sedges
- 37 new group dominated by ephemeral herbs
- 38 new group dominated by *Sclerolaena obliquicuspis* and ephemeral herbs
- 39 new group dominated by Curly Mallee

Limitations of the PATN Analysis

Species lists collated from a variety of different survey datasets contain inherent biases arising from consistent errors in identification from one survey to another, and different perceptions in assigning cover/abundance scores. These can affect the statistical clustering process and group sites inappropriately. The lumping of taxa described above does offset some of these problems, however, some biases still remain. Their effect on the overall clustering is difficult to mask out, but the post-analysis sorting also assisted in their removal.

Areas dominated by annual species and represented by sites with annual-dominated species lists cannot be allocated to a vegetation grouping because all annual records were excluded from the analysis due to the inconsistency of their recording. These sites are, therefore clustered by PATN on the basis of the non-dominant perennial species which remain on their species lists, leading to the potential for inappropriate groupings being created and erroneous group assignments.

VEGETATION MAPPING

Rationale

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 (ie. 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. This usually requires the positioning of a line on a map at some point on a continuum of change from one vegetation type to another. As species composition and the associated environmental factors normally gradually change along a gradient between vegetation types, mapped boundaries represent this ecotonal area., No boundary line should therefore be accepted as highly accurate, but rather treated as an indication of significant local vegetation and environmental change.

The patterns visible on aerial photography and satellite imagery, particularly in the arid zone, generally reflect changes in the underlying soils, geology and landforms as well as the vegetation. Variation in these four factors (vegetation, soil, geology and landform), provide visually interpretive indications of differences in ground reflectance, and separation of the various components which together form these ground cover "signatures" is not simple or consistent. Vegetation mapping therefore becomes the delineation of the vegetation component of the patterns created by a combination of all these factors. It is a subjective exercise, but nonetheless a valuable process for spatially describing large areas covered with varying plant communities.

From knowledge of the vegetation at numerous specific sites and recognition of the associated photo patterns, mapping of vegetation types can be extrapolated to 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 habitats for certain animal species to be predicted.

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 image or aerial photo patterns. However, sometimes characteristic landforms or soil types can reflect a known associated vegetation change (eg. claypans, dunecrests).

Vegetation Mapping Methods

The basic mapping methodology used is detailed in Forward & Robinson (1996) with the added benefit of hardcopies of 1:100,000 geographically rectified Landsat TM imagery of each of the 18 mapsheet areas. These were produced from Landsat 5's Themetic Mapper Bands 1,4, and 5, displayed in blue, green and red respectively, and appropriately visually enhanced. Using colour aerial photographs at scales of between 1:40,000 and 1:89,000, and the imagery annotated with field transect notes and site information, distinct changes in vegetation types were identified and delineated. This mapping was designated to be at a scale of 1:100,000, for ultimate presentation at 1:250,000. Apparent vegetation boundaries were traced from the imagery onto mylar basemaps for subsequent digitising.

Additional site information from previous studies conducted in and around the region were also used to supplement the survey data.

An extra facet of this project involved the use of the raw digital Landsat TM imagery to spectrally classify the study area, as an aid to the extrapolation of detailed vegetation knowledge from surveyed sites to the wider area. This will be discussed in more detail in the next section.

Recognition of different vegetation types was based on visible changes in colour, pattern and texture on the aerial photographs and imagery. With the field information and an understanding of the relationships between landform, soil surface and extent of bare ground, the basic life form formations of, mallee, shrubland, low shrubland and grassland/herbland could usually be identified. Height class differences within these were not discernible, even at 1:40,000, and were inappropriate for mapping at the final presentation scale of 1:250,000.

The mapped polygons were labelled according to the final vegetation groupings as described in the vegetation chapter, and depending on the spatial extent of these vegetation types, polygons were assigned to a "pure" *primary*, class or a *secondary* or *tertiary* class. At this mapping scale much of the area comprised vegetation mosaics which were too intricate to map as *primary* units. Thus *secondary* mapping polygons 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 % of the total area, being considered too minor to be included as part of the mosaic. In these mosaics, no dominance was attributed to any of the vegetation types.

The 1:250,000 vegetation communities distribution map is appended to this report.

Satellite Image Classification

Digital images were obtained from Landsat 5's Thematic Mapper for the satellite overpass on 14 March 1994. Two adjoining scenes were used, Path 97 / Rows 81 and 82. This raw data consists of 7 Bands, 2 in the visible, 2 in the near infra-red, 2 in the mid infra-red and 1 in the thermal part of the electromagnetic spectrum. Spatial resolution is 30m for all bands except the thermal, which is 120m.

These two full scenes were joined, normalised and geographically rectified to conform with the Australian Map Grid using 21 ground control points widely spread across the study area.

This total image was then divided into six sub-images based on the range of landform and vegetation types occurring across the study area. This maximises the variation within each land type and enhances the overall accuracy of the classification.

An ISOCLASS unsupervised classification was performed on each of the subscenes, producing 90 spectral classes for each. These classes were then each examined and assigned to a vegetation cover class, using the extensive knowledge gained from the field survey. This process was iterated until the patterns of vegetation classes satisfactorily matched the actual vegetation. These six subscenes were then patched back together into a single image, edges examined and class discrepancies across boundaries matched as much as possible. A discussion of the methodology and its applicability appears in the Results section.

AERIAL SURVEY

There were two phases of the vegetation survey which involved aerial survey. Flying was done in a C172, high-wing single-engined aircraft with the authors as pilot (MKH) and observer (RMP).

The first phase consisted of an initial reconnaissance flight, which was conducted in June 1995 over the entire survey area to obtain a basic understanding of the total range of plant communities present. A number of GPS locations were also obtained at widely spaced airstrips to provide ground control points for satellite image geometric rectification. Airstrips are particularly suitable as reference points because of their high visibility on imagery.

For editing purposes, the first drafts of the floristic mapping were carried on the second aerial survey in April 1996. All of the areas on the maps requiring clarification to solve ambiguities were overflown and corrections noted directly onto the draft maps. Approximately one hour of flying time per 1:100,000 mapsheet was sufficient to check most of the polygon boundaries. Most of the named communities were easily identified from the air from altitudes of 50 metres or more. The flying was particularly effective after the field work was completed, when the crew were familiar with the region, and able to navigate and orientate themselves easily.

Aerial survey was found to be a very efficient way of checking preliminary mapping when compared with ground checking, because of the ability to easily visit inaccessible areas, travel quickly, and cover entire mapsheets in a single sortie.

VERTEBRATE FAUNA FIELD SURVEY

A sub-set of 48 of the 391 vegetation survey sites were sampled for vertebrate fauna over a two week period from 26 August to 7 September 1996 using three teams of six workers each week. Each team included at least one mammalogist, an ornithologist and herpetologist.

Less quadrats were sampled for the fauna survey because more time and effort is needed to adequately sample fauna. Single quadrats were selected from the vegetation sites to proportionately represent as many of the 29 vegetation groups described in the vegetation data analysis (Playfair *et al.* 1996). Even distribution of quadrats across the entire study area and sampling the complete geographical distribution of each vegetation group was logistically impossible in the time frame available. Six camps were chosen in areas where as many of the vegetation types were accessible and as varied as possible. At each vegetation survey site the quadrat used for fauna sampling was in the dominant vegetation type, although at some sites more minor vegetation types were sampled. In this way, the

maximum number of significant representative habitat types in each geographical area were sampled. Further vegetation information was also collected to add to the comprehensiveness of the habitat descriptions. Due to seasonal factors, significant additions were able to be made to the species lists compiled 12 months earlier. The distribution of the vertebrate fauna survey quadrats is shown in Figure 32.

At each quadrat reptiles and small mammals were sampled using two fenced pitfall trap lines, each 50m long and comprising six pitfall traps ten metres apart with each pit 150 mm in diameter and 400 mm deep. One trapline was established on the original vegetation quadrat and the other at least 200m away in the same vegetation type to minimise interaction and provide replicate information about that vegetation type. A separate line of 15 Elliott traps and two cage traps was established adjacent to each trapline, 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.

A line of micro-pitfall plastic vials (20mm diameter, 80 mm deep, filled with 70% alcohol) was laid parallel to each macro-pitfall line to collect invertebrates for the SA Museum. Likewise any invertebrates found in the macro-pitfalls were preserved for later identification. Invertebrate information was not analysed for this conservation significance study.

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 other 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 all bat records were opportunistic. Mist nets were erected and monitored for a few hours in the evenings, in suitable weather conditions, and harp traps 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. 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 South Australian Museum for future taxonomic studies.

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 IX. Further descriptive information regarding the landform and vegetation type at the vertebrate quadrats is included in Appendix III.

VERTEBRATE DATA ANALYSIS

The PATN analysis process, without any attempt at ordination, was undertaken as described in Forward and Robinson (1996).

Table 3 Trapping effort during the North Olary Plains Vertebrate Fauna Survey.

Week	Group	Camp	Pit trap nights	Elliott trap nights	Cage trap nights	Mistnet hours	Harp trap nights
26/8-31/8	**A**	Cockburn	384	948	128	0	0
	B	Bimbowrie	336	960	128	0	4
	C	Wooltana	372	930	124	0	2
1/9-4/9	**A**	Coonee	384	948	128	10	3
	B	Koonamore	336	960	128	0	0
	C	Billeroo West	384	960	128	0	2
Total (trap nights)			2196	5706	764	10	11

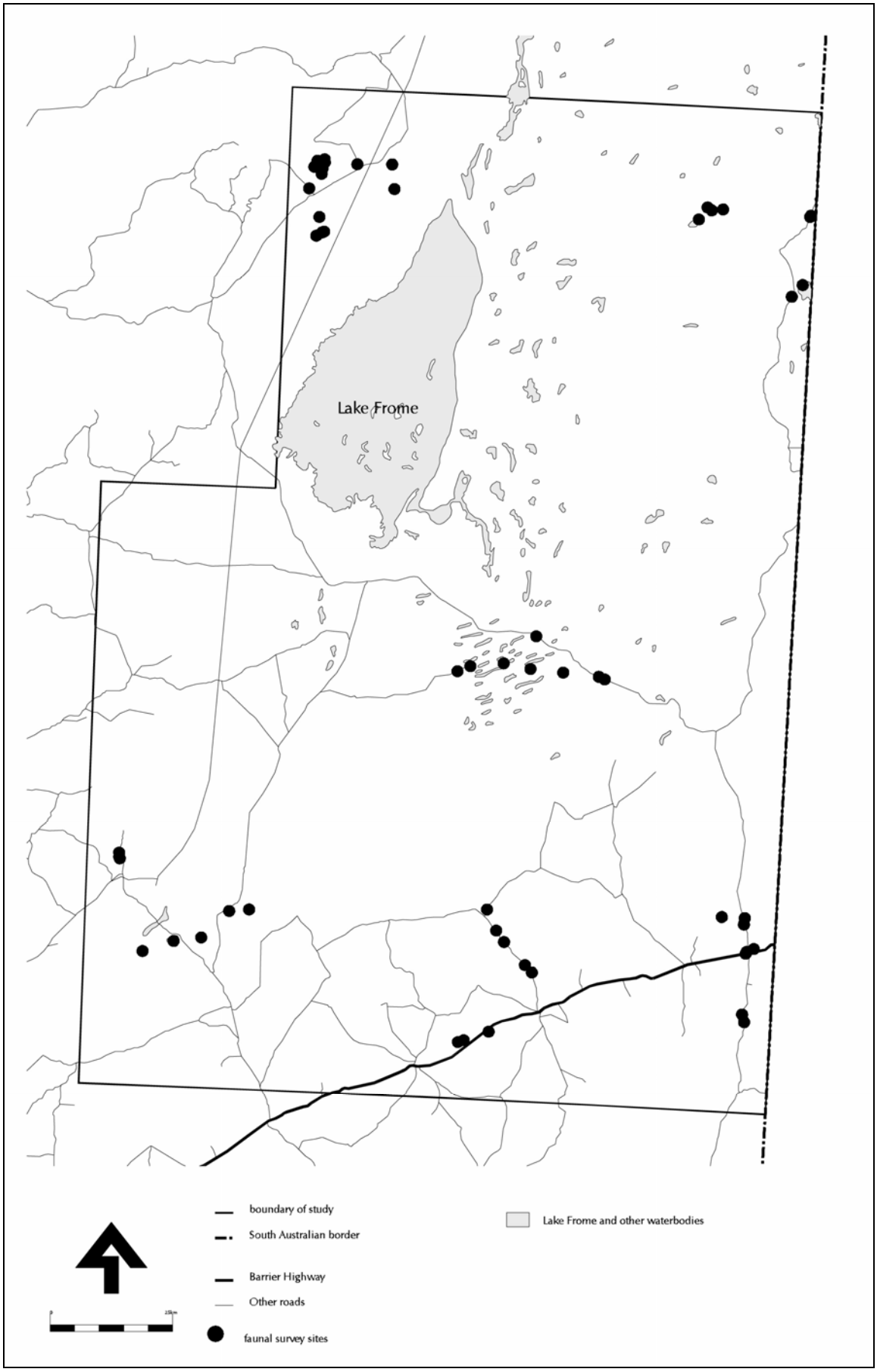

Figure 32 Distribution of vertebrate fauna survey quadrats.

CONSERVATION VALUES ANALYSIS

Multivariate analysis for indications of correlations between environmental variables such as presence / absence of a significant species as a function of presence / absence of other factors was undertaken using GLIM (a statistical computer modelling software package - Generalis Linear Interactive Modelling).
This modelling procedure consisted of testing for relationships between variables of conservation interest (in this case the vegetation type, landform element etc.) to determine any levels of correlation.
There were insufficient records of most threatened species to enable GLIM analysis except for the 7 records of *Acacia carnei* which showed no significant correlation with other environmental variables.
Coupled with GLIM, there was also to be undertaken a spatial analysis of representativeness and irreplaceability of the various vegetation types using the ArcInfo vegetation coverage and grid cells of up to 10km^2 over the entire study area. The software for performing this complex analysis is still under development (Pressey & Nicholls, 1989; 1991. Pressey *et al*., 1996. Underhill, 1994. Margules *et al.*, 1988. Woinarski *et al.* 1994.) and was unable to process the data available. A qualitative assessment was therefore undertaken on the basis of apparent conservation value using species richness, presence of threatened species and percentage introduced plants as criteria.

Figure 33
A team putting in a Pitfall trapline in saline claypan habitat.
Photo: R. Playfair

Figure 34
Foraging for reptiles added significantly to the captures beyond those caught in traps.
Photo: R. Playfair

Figure 35
Specimens of reptiles, preserved in formalin, ready to be submitted to the State Museum for their collections
Photo: R. Playfair

Figure 36
Harp Traps were positioned opportunistically, wherever bats were expected, usually away from the quadrats
Photo: S. Laver

Results

VEGETATION

by M. K. Hyde[1] and R. M. Playfair[2]

INTRODUCTION

The vegetation of the North Olary Plains region has not previously been comprehensively surveyed, nor has data of a regional nature been published unlike many other parts of South Australia. A large number of research papers dealing with Chenopod and arid vegetation ecology from specific sites within the region have been published, particularly from Koonamore Station, but it was not their intention to address the nature of the vegetation of the region as whole.

The first map of South Australian vegetation by Prescott (1929) is very general and small scale and provides little detail of this survey area.

The second, that of Wood (1937), shows boundaries which broadly approximate those of this survey, but whose vegetation community descriptions differ significantly.

Specht's 1972 map of the study area is correct in its depiction of the boundary between the sand dunes and the chenopod plains, but he clearly did not visit the region and most other detail is incorrect. He has classified the dune region as *Zygochloa* Hummock Grassland but this species was only recorded once in the present survey. The dune vegetation is actually tall shrubland and low open woodland with no hummock grasses present. These maps also show a Low bluebush (*Maireana astrotricha*) community extending from New South Wales across the plains south and west of Lake Frome to Lake Callabonna. In fact this community is found principally south of Lake Frome and the other plains areas are different vegetation communities.

Boomsma and Lewis (1980) published a map of South Australian vegetation based on Specht and also erroneously attributed grassland vegetation to the dune fields.

Laut *et al* (1977) list *Zygochloa* hummock grassland as co-dominant in the dunefields on the dune crests with *Acacia ligulata* shrubland. This may be the case in the northern Strzelecki Desert, but is not the case in the south. The same applies to their classification of the swales as a Bluebush (*Maireana astrotricha*) community. The present survey found traces of this community locally occurring in swales east of Lake Frome, but certainly not dominant.

Maps by Carnahan (1989) showing the vegetation of the whole of Australia at a scale of 1:5,000,000 show approximately the boundary of the north-eastern dune fields, but incorrectly label it as tall shrubland dominated by *Acacia* and *Hakea* in the swales. This also may have been interpolated incorrectly from the northern Strzelecki Desert as is probably the case on the maps of Specht, Boomsma and Lewis, and Laut *et al*. detailed above.

The previously published papers and maps which are based on information and data from within the North Olary Plains study area can be classified into six main groups.

They are:

- Research projects which are based on data from a single location or small area within the study area;
- Vegetation surveys of specific land areas within, or adjoining the study area;
- Studies of individual species of conservation significance in the study area;
- Broad area surveys which include the present study area;
- Broad area vegetation mapping which includes the present study area;
- Standard taxonomic literature which includes the plants of the study area.

Because so little of the vegetation literature pertaining to the study area deals with vegetation patterns and communities on a scale compatible with the present study, the references have not been discussed in detail, but have been tabulated to reflect their belonging to one of the six main groups above.

1. **Research projects which are based on data from a single location or small area within the study area.**
   Anderson 1967; Barker and Lange 1969; Carrodus 1962; Carrodus and Specht 1965; Carrodus, Specht and Jackman 1965; Charley and Cowling 1968; Crocker and Wood 1947; Fatchen 1978; Hall et al 1964; Jessup 1969; Osborn 1925 1928; Osborn and

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Wood 1923; Osborn Wood and Paltridge 1931 1932; Stephens 1973; Wood 1936;

2. **Vegetation surveys of specific land areas within, or adjoining the study area;**
   Beadle 1945; Burrows and Beale 1969; Close and Williams 1982; Collins 1923; Douglas 1981; Remote Sensing Applications Branch 1983; Tiver 1994; Williams and Levitzke 1980a, 1980b, 1980c;
3. **Studies of individual species of conservation significance in the study area;**
   Auld 1990, 1993; Benson 1991; Crisp 1976; Davies 1995;Lang & Kraehenbuehl 1993(update); Whibley 1979;
4. **Broad area surveys which include the present study area;**
   Barber and Linton 1989; Blackburn and Baker 1951; Davies 1982; Lange and Fatchen 1990; Laut et al 1977a 1977b; Leigh 1981; Pipeline Authority of SA 1981; Specht and Cleland 1961 1963; Specht, Roe and Broughton 1974; Sturt 1849;
5. **Broad area vegetation mapping which includes the present study area;**
   Boomsma and Lewis 1980; Carnahan 1989a 1989b; Moore 1980; Prescott 1929; Specht 1972; Wood 1937
6. **Standard taxonomic literature which includes the plants of the study area.**
   Catcheside 1980: Cleland 1976(reprint); Cunningham et.al 1981; Filson and Rogers 1979; Jessop 1981 1993; Jessop and Toelken 1986 ; Whibley and Symons 1992;

The T.G. Osborn Reserve, an experimental exclosure on Koonamore station operated by the Botany Department of the University of Adelaide, is the focus of a large number of the papers listed above (particularly in the first category). Five hundred hectares of overgrazed chenopod shrubland was fenced in 1925, and the recovery of the plant communities and their general ecology has been monitored since.

Studies of particular species in group 3 are of *Acacia carnei*, except a single paper (Crisp 1976) on *Acacia barrattensis*.

An Adelaide University PhD thesis by Tiver (1994) is the most comprehensive research dealing with the study area. It includes the southern quarter of the study area and also covers the northern quarter of the South Olary Plains survey region. Although focusing on vegetation sampling theory, this thesis looked at the effects of herbivores on recruitment of perennial plants and found that sheep were significantly more influential than rabbits in preventing regeneration.

Like the preceding survey of the South Olary Plains, this survey addresses the vegetation of a South Australian region which has only been treated in a cursory manner previously. A number of published errors and inconsistencies carried forward through the literature have been corrected by this present survey and map publication.

TOTAL SPECIES

A total of 448 currently accepted taxa were found during the North Olary Plains survey. Frequencies of all taxa which occurred at survey sites are listed in Table 4. Appendix V lists the total taxa in the Eastern Region of South Australia valid at 17 May 1995 (S A Environmental Database) and gives the listings from other vegetation studies in the Region.

Table 4 Species Occurrence Frequencies for the 381 Surveyed Sites

* Introduced species
(NC) Non-current taxonomy

Species	Freq.
Tetragonia eremaea	276
Calotis hispidula	170
Rhagodia spinescens	140
**Schismus barbatus*	140
Gramineae sp.	133
Maireana pyramidata	129
Sclerolaena obliquicuspis	129
Atriplex vesicaria ssp.	124
Maireana astrotricha	113
Rhodanthe floribunda	111
Erodium cygnorum ssp. *glandulosum*	110
Atriplex holocarpa	109
Salsola kali	108
Enchylaena tomentosa var.	103
Enneapogon avenaceus	98
Rhodanthe moschata	92
Omphalolappula concava	89
Brachycome lineariloba	85
**Brassica tournefortii*	82
**Carrichtera annua*	81
Craspedia pleiocephala	80
Sclerolaena divaricata	77
Stenopetalum lineare	76
Bulbine semibarbata	72
Daucus glochidiatus	72
**Asphodelus fistulosus*	71
Plantago drummondii	65
Acacia victoriae ssp.	64
Zygophyllum ammophilum	61
Senecio lautus	58
Maireana aphylla	56
**Alyssum linifolium*	55
Dissocarpus paradoxus	55
Stipa nitida	54
Zygophyllum iodocarpum	52
Eriochiton sclerolaenoides	50
Sclerolaena decurrens	50
**Sisymbrium erysimoides*	49
**Erodium cicutarium*	48
Rhodanthe pygmaea	48
Sclerolaena limbata	46
Rhodanthe microglossa	44
Alectryon oleifolius ssp. *canescens*	43
Harmsiodoxa brevipes var.	43
**Sonchus oleraceus*	43
**Echium plantagineum*	42
Sclerolaena brachyptera	42
Calotis cymbacantha	41
Polycalymma stuartii	41
Casuarina pauper	40
Convolvulus remotus	40
Eremophila sturtii	40
Senna artemisioides ssp. *petiolaris*	39
Vittadinia eremaea	39
Enneapogon cylindricus	38
**Medicago polymorpha* var. *polymorpha*	38
Tripogon loliiformis	37
Dodonaea viscosa ssp. *angustissima*	36
Harmsiodoxa blennodioides	36
Species	**Freq.**
Gnephosis arachnoidea	35
Acacia aneura var. *aneura*	34
Enneapogon sp.	34
Lotus cruentus	34
Nitraria billardierei	34
Maireana sedifolia	33
**Medicago minima* var. *minima*	32
**Rostraria pumila*	32
Sclerolaena diacantha	32
Sclerolaena ventricosa	32
**Acetosa vesicaria*	31
Zygophyllum prismatothecum	31
Eremophila duttonii	30
Minuria cunninghamii	30
Portulaca oleracea	30
Sida intricata	30
Sclerolaena lanicuspis	29
Senecio glossanthus	29
Euphorbia drummondii	28
Gunniopsis quadrifida	28
Ixiolaena leptolepis	27
Rhodanthe stricta	26
Sclerolaena uniflora	26
Acacia ligulata	25
Acacia tetragonophylla	25
**Centaurea melitensis*	25
Goodenia pinnatifida	25
Maireana turbinata	25
Acacia ayersiana var. *latifolia*	24
Eragrostis xerophila	24
Hyalosperma demissum	24
Sclerolaena intricata	24
Sida petrophila	24
Zygophyllum crenatum	24
Actinobole uliginosum	23
Aristida contorta	23
Atriplex limbata	23
Eragrostis eriopoda	23
Pimelea simplex ssp.	23
Ptilotus obovatus var. *obovatus*	23
Abutilon fraseri	21
Atriplex stipitata	21
Erodium crinitum	21
Calotis plumulifera	20
Danthonia caespitosa	20
Gnephosis eriocarpa	20
Maireana georgei	20
Pimelea simplex ssp. *simplex*	20
Brachycome ciliaris var. *ciliaris*	19
Brachycome ciliaris var. *lanuginosa*	19
Erodium cygnorum ssp. *cygnorum*	19
Lemooria burkittii	19
Lepidium phlebopetalum	19
Sida corrugata var.	19
'Convolvulus erubescens (NC)'	18
Goodenia fascicularis	18
Ptilotus obovatus var.	18
Solanum ellipticum	18
Solanum ellipticum/quadriloculatum	18
Species	**Freq.**
Cheilanthes lasiophylla	17
Cymbopogon ambiguus	17
Lepidium oxytrichum	17
Santalum lanceolatum	17

Acacia oswaldii	16
Dissocarpus biflorus var.	16
Dodonaea microzyga var. *microzyga*	16
Eremophila freelingii	16
Oxalis perennans	16
Podolepis capillaris	16
*Senna artemisioides nothos*sp. *coriacea*	16
Solanum petrophilum	16
Swainsona sp.	16
Atriplex pseudocampanulata	15
**Bromus rubens*	15
**Critesion murinum* ssp. *glaucum*	15
Eucalyptus largiflorens	15
Malvastrum americanum	15
Minuria integerrima	15
Myoporum platycarpum ssp.	15
Sida fibulifera	15
Dissocarpus biflorus var. *biflorus*	14
Enteropogon acicularis	14
Eragrostis sp.	14
Eremophila longifolia	14
Erodiophyllum elderi	14
Goodenia pusilliflora	14
Isoetopsis graminifolia	14
Amyema miraculosum ssp. *boormanii*	13
Astrebla pectinata	13
Callitris glaucophylla	13
Dodonaea lobulata	13
Eremophila glabra ssp.	13
Erodium cygnorum ssp.	13
Zygophyllum aurantiacum	13
Einadia nutans ssp. *nutans*	12
**Hypochaeris glabra*	12
Sida sp.	12
Teucrium racemosum	12
Amyema maidenii ssp. *maidenii*	11
Maireana eriantha	11
Maireana excavata	11
Nicotiana velutina	11
**Salvia verbenaca form A*	11
Santalum acuminatum	11
Solanum sturtianum	11
Angianthus brachypappus	10
Arabidella nasturtium	10
Atriplex angulata	10
Bromus arenarius	10
**Carthamus lanatus*	10
Dactyloctenium radulans	10
Dichanthium sericeum ssp.	10
Eragrostis australasica	10
Geococcus pusillus	10
Maireana appressa	10
Maireana brevifolia	10
Sclerolaena bicornis	10
Senecio magnificus	10
Stipa scabra ssp.	10
Aristida nitidula	9
Crassula colorata var.	9
Eragrostis dielsii var. *dielsii*	9
**Erodium aureum*	9
Millotia greevesii ssp. *greevesii* var. *greevesii*	9
Species	**Freq.**
Osteocarpum acropterum var. *acropterum*	9
Sclerolaena sp.	9
Zygophyllum howittii	9
Arabidella trisecta	8
Eucalyptus socialis	8
Glycine clandestina var.	8
**Malva parviflora*	8
Minuria denticulata	8
Othonna gregorii	8
Pimelea microcephala ssp. *microcephala*	8
Pterocaulon sphacelatum	8
Sclerolaena patenticuspis	8
Tragus australianus	8
Vittadinia sulcata	8
'Euphorbia tannensis ssp. *(NC)'*	7
Atriplex velutinella	7
Einadia nutans ssp.	7
Exocarpos aphyllus	7
Gnephosis tenuissima	7
Hakea leucoptera	7
Lepidium papillosum	7
**Marrubium vulgare*	7
Pittosporum phylliraeoides var. *microcarpa*	7
Scaevola parvibarbata	7
Senna artemisioides ssp. *filifolia*	7
Sida ammophila	7
Stipa sp.	7
Acacia salicina	6
Atriplex sp.	6
Calotis erinacea	6
Cheilanthes sieberi ssp. *sieberi*	6
Chenopodium nitrariaceum	6
Eremophila scoparia	6
Eucalyptus camaldulensis var.	6
Frankenia serpyllifolia	6
Goodenia lunata	6
Haloragis sp.	6
**Lycium ferocissimum*	6
Lysiana exocarpi ssp. *exocarpi*	6
Paspalidium constrictum	6
Phlegmatospermum cochlearinum	6
Rhodanthe corymbiflora	6
Senecio anethifolius	6
Senna artemisioides ssp. *quadrifolia*	6
Triraphis mollis	6
Wurmbea dioica ssp. *dioica*	6
**Xanthium spinosum*	6
**Acetosella vulgaris*	5
Arthropodium sp.	5
Atriplex nummularia ssp.	5
Crassula sieberiana ssp. *tetramera*	5
Eremophila alternifolia	5
Maireana pentagona	5
Maireana pentatropis	5
Malacocera biflora	5
Malacocera gracilis	5
Phyllanthus lacunarius	5
Prostanthera striatiflora	5
Sclerostegia tenuis	5
*Senna artemisioides nothos*sp. *artemisioides*	5
Sporobolus actinocladus	5
Stipa acrociliata	5
Triodia scariosa ssp. *scariosa*	5
**'unverified species - nv`*	4
Acacia burkittii	4
Species	**Freq.**
Acacia carnei	4
Acacia victoriae ssp. *victoriae*	4
Aristida personata	4
Aristida sp.	4
Arthropodium minus	4
Atriplex lindleyi ssp. *lindleyi*	4
Blennodia pterosperma	4
Cassinia laevis	4
Compositae sp.	4
Danthonia sp.	4

Erodium sp.	4
**Herniaria cinerea*	4
Hyalosperma semisterile	4
Lepidium sp.	4
Maireana integra	4
Malacocera tricornis	4
Millotia greevesii ssp.	4
**Onopordum acaulon*	4
Podolepis arachnoidea	4
**Salvia verbenaca form B*	4
Sclerolaena holtiana	4
Senecio cunninghamii var. *serratus*	4
**Spergularia diandra*	4
Trianthema triquetra	4
Vittadinia sp.	4
Zygophyllum sp.	4
Acacia calamifolia	3
Atriplex acutibractea ssp.	3
Chrysocephalum semicalvum ssp. *Semicalvum*	3
**Cucumis myriocarpus*	3
Eucalyptus gillii	3
Gnephosis drummondii	3
Halosarcia sp.	3
Harmsiodoxa brevipes var. *brevipes*	3
Ixiochlamys cuneifolia	3
Ixiolaena chloroleuca	3
Leguminosae sp.	3
Lepidium fasciculatum	3
Leucochrysum molle	3
Lycium australe	3
Maireana lobiflora	3
Marsilea drummondii	3
Minuria annua	3
Minuria leptophylla	3
Muehlenbeckia florulenta	3
Olearia pimeleoides ssp. *pimeleoides*	3
Panicum decompositum var. *decompositum*	3
Parietaria debilis	3
Pimelea microcephala ssp.	3
Rhagodia parabolica	3
Rhodanthe polygalifolia	3
Scaevola spinescens	3
Schoenia ramosissima	3
Solanum chenopodinum	3
Stipa eremophila	3
Stipa nodosa	3
Tephrosia sphaerospora	3
**Vicia monantha*	3
Vittadinia cuneata var.	3
**Vulpia muralis*	3
Wahlenbergia communis	3
Wahlenbergia luteola	3
Westringia rigida	3
Abutilon halophilum	2
**Anagallis arvensis*	2
Species	**Freq.**
Aristida holathera var. *holathera*	2
Atriplex semibaccata	2
**Calendula arvensis*	2
Calotis lappulacea	2
**Cenchrus ciliaris*	2
Centipeda minima	2
Crassula sp.	2
**Critesion* sp.	2
Cyperus laevigatus	2
**Digitaria sanguinalis*	2
**Dittrichia graveolens*	2
Elachanthus pusillus	2
Enneapogon nigricans	2
Eragrostis falcata	2
Eremophila deserti	2
Eucalyptus gracilis	2
Euphorbia sp.	2
Goodenia sp.	2
Halosarcia indica ssp.	2
**Heliotropium europaeum*	2
Hibiscus sturtii var. *grandiflorus*	2
Indigofera sp.	2
Lawrencia glomerata	2
Leptorhynchos baileyi	2
**Limonium lobatum*	2
Maireana ciliata	2
Maireana sp.	2
Maireana tomentosa ssp. *urceolata*	2
Muehlenbeckia sp.	2
**Nicotiana glauca*	2
Panicum laevinode	2
Paractaenum novae-hollandiae ssp. *reversum*	2
Pleurosorus rutifolius	2
Sclerolaena cuneata	2
Sclerolaena longicuspis	2
Sida trichopoda	2
Stipa platychaeta	2
**Tamarix aphylla*	2
Trichanthodium skirrophorum	2
Wahlenbergia sp.	2
'Danthonia eriantha (SYN)'	1
Abutilon leucopetalum	1
Abutilon otocarpum	1
Acacia beckleri	1
Amyema miquelii	1
Amyema preissii	1
Arthropodium strictum	1
Asperula sp.	1
Atriplex intermedia	1
Atriplex spongiosa	1
Atriplex vesicaria ssp. *calcicola*	1
Bolboschoenus caldwellii	1
Brachycome dentata	1
Bulbine bulbosa	1
Calandrinia eremaea	1
Calostemma purpureum	1
Calotis latiuscula	1
Centipeda thespidioides	1
Chenopodiaceae sp.	1
Chenopodium auricomum	1
Chloris truncata	1
Chrysocephalum semicalvum ssp.	1
Codonocarpus pyramidalis	1
Cratystylis conocephala	1
Dianella longifolia var. *porracea*	1
Species	**Freq.**
Digitaria brownii	1
Digitaria sp.	1
Dodonaea stenozyga	1
**Emex australis*	1
Enneapogon polyphyllus	1
Eremophila latrobei ssp.	1
Eremophila oppositifolia var.	1
Eriachne aristidea	1
Eucalyptus intertexta	1
Euphorbia tannensis ssp. *eremophila*	1
Frankenia crispa	1
**Galium murale*	1
Glycine canescens	1
Glycyrrhiza acanthocarpa	1
Halosarcia halocnemoides ssp. *longispicata*	1
Halosarcia indica ssp. *leiostachya*	1

Halosarcia pergranulata ssp.	1
Hibiscus krichauffianus	1
Hibiscus sp.	1
**Hypochaeris radicata*	1
Indigofera helmsii	1
Ixiolaena tomentosa	1
Juncus aridicola	1
Juncus sp.	1
**Lamarckia aurea*	1
Lepidium rotundum	1
Loranthaceae sp.	1
Lotus sp.	1
Lysiana sp.	1
Malacocera sp.	1
Malvaceae sp.	1
Marsdenia australis	1
Melaleuca glomerata	1
Myoporum platycarpum ssp. *platycarpum*	1
Nicotiana goodspeedii	1
Osteocarpum acropterum var.	1
Species	**Freq.**
Oxalis sp.	1
Panicum sp.	1
Paspalidium sp.	1
Plagiobothrys plurisepaleus	1
Podolepis muelleri	1
Ptilotus sp.	1
Rostellularia adscendens ssp. *adscendens* var.	1
**Rostraria cristata*	1
**Salvia verbenaca form*	1
Sclerolaena eriacantha	1
Sclerostegia medullosa	1
Senecio cunninghamii var.	1
Senecio glomeratus	1
Senecio quadridentatus	1
Senna artemisioides nothossp. *sturtii*	1
Senna artemisioides ssp. *helmsii*	1
Sida corrugata var. *A (N.N.Donner 7573)*	1
Solanum esuriale	1
**Solanum nigrum*	1
**Solanum retroflexum*	1
Stemodia florulenta	1
Stipa flavescens	1
Streptoglossa adscendens	1
Stuartina hamata	1
Swainsona oliveri	1
Swainsona stipularis	1
Themeda triandra	1
Thysanotus sp.	1
Trichodesma zeylanicum	1
Typha domingensis	1
Velleia arguta	1
Vittadinia pterochaeta	1
Wahlenbergia gracilenta	1
Wahlenbergia tumidifructa	1
Zygochloa paradoxa	1

PLANT COMMUNITIES

As discussed in the previous chapter, a numerical PATN analysis was performed on the site data to derive a number of floristic groups. These results were then viewed subjectively, based on the authors' field experience with the vegetation patterns in the survey area, to arrive at a series of discrete communities which were both mappable and made floristic sense.

These communities are described on the following pages. An explanation of the community description pages is given below:

- The community name is derived from the species most prominent in the community, in combination with a structural vegetation or topographic descriptor which reflects the typical occurrence of the community. The species may not be the most abundant or dominant, but will usually be clearly visible from the ground and air.
- Floristic Group is the group which was originally derived from the PATN analysis. This has been included to allow cross-referencing of the raw data if required. The number of members is the number of sites which have been assigned to this community grouping during PATN analysis and subsequent hand-sorting and included in the statistics tables.
- Vegetation structural descriptions are based on the classification described in Forward & Robinson (1996) and presented in Appendix X of this report.
- The distribution maps show all sites which were assigned to each community during the analysis.
- Distributional descriptions are based on the location of the sites assigned to the community by the analysis, and the maps included in this report.
- Most frequently occurring species are the most common, and visible species in the community. They are in order of their indicator value, not necessarily their abundance.
- The survey site numbers listed are those from the present survey only (North Olary Plains Survey) which have been assigned to a particular community.
- The descriptions and indication of vegetation condition are subjective, and derived from the authors' (MKH and RMP) field notes and experience.

Table 5 contains the full list of communities.

Most communities form close, complex mosaics with other communities at various places within the study area and have been displayed as single units on the accompanying maps. The floristic group number of communities with which each of the mapped communities forms mosaics is given in the third column below.

Table 5 Plant Communities and the Associations mapped as mosaics.

Floristic Group No.	Community Name	Forms mosaic with:
One	*Enneapogon cylindricus / Acacia tetragonophylla* Open grassland	
Two	*Acacia victoriae* Very open grassland	8, 18, 28
Three	*Astrebla pectinata* Open grassland	5, 31
Four	*Maireana sedifolia* Low open shrubland	22, 32
Five	*Senna / Eremophila / Rhagodia spinescens* Open shrubland	3, 25, 29
Eight	*Nitraria billardierei* Low open shrubland	2, 28, 37
Nine	*Eucalyptus socialis* Open tree mallee	21
Ten	*Maireana aphylla* Low open shrubland	17, 19
Fifteen	*Gunniopsis quadrifida* Low open shrubland	19, 20, 28
Sixteen	*Atriplex vesicaria* Low open shrubland	22, 32
Seventeen	*Eucalyptus largiflorens* Low open woodland	2, 10, 8
Eighteen	*Eucalyptus camaldulensis* Woodland	2
Nineteen	*Dodonaea viscosa* ssp. *angustissima* Open shrubland	10, 15, 20, 28, 32
Twenty	*Acacia aneura* Very low open woodland	15,19
Twenty one	*Acacia aneura / Acacia victoriae / Sida petrophila* Very open low woodland	4, 9, 39
Twenty two	*Casuarina pauper* Low woodland	16,39,4
Twenty-three	*Acacia ligulata* Very open shrubland	24
Twenty-four	*Acacia aneura / Enneapogon* spp. Low open woodland	23
Twenty-five	*Maireana astrotricha* Low open shrubland	5, 29
Twenty eight	*Maireana pyramidata* Low open shrubland	2, 15, 18, 19, 32
Twenty-nine	*Sclerolaena brachyptera / Maireana aphylla* Low very open shrubland	5, 25
Thirty-one	*Sclerolaena divaricata* Low very open shrubland	3, 35
Thirty two	*Atriplex vesicaria / Maireana astrotricha* Low open shrubland	44, 16, 19, 25, 28
Thirty-four	*Halosarcia* Low open shrubland	
Thirty-five	*Eragrostis australasica / Muehlenbeckia florulenta* Open shrubland	31
Thirty-six	*Cyperus laevigatus* Sedgeland	
Thirty-seven	*Rhodanthe floribunda* Herbland	8
Thirty-eight	*Sclerolaena obliquicuspis* Low very open shrubland	32
Thirty-nine	*Eucalyptus gillii* Open tree mallee	21, 22

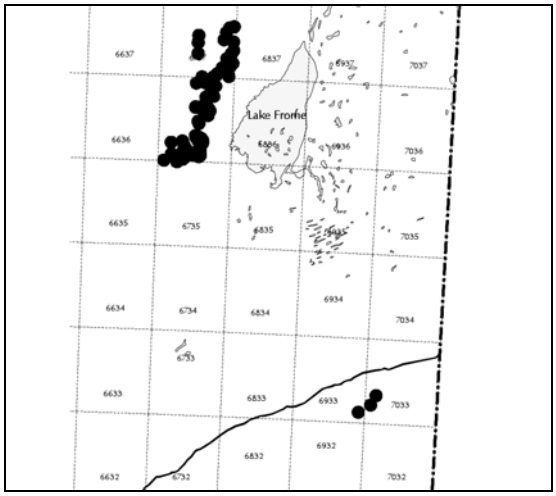
The proportion of the total survey area covered by these mosaics is tabulated and summarised in Appendix IV. These figures are given as total areas and percentages for each of the mapped mosaics and then another table is presented which summarises the areas covered by 10 of the major associations in their 'pure' form and in conjunction with other vegetation types.

Enneapogon cylindricus / Acacia tetragonophylla Open grassland

Floristic Group One: 98 members

Vegetation Structure:
Varies from a very open shrubland, commonly consisting of *Acacia tetragonophylla* (Dead Finish), *A. victoriae* ssp. *victoriae* (Elegant Wattle), *A. aneura* (Mulga) and *Eremophila freelingii* (Rock Fuchsia Bush) over sparse low shrubs of *Senna* spp. and *Dodonaea lobulata* with *Solanum* spp. (Nightshades) and *Enneapogon* spp.(Bottlewashers) in the ground layer, to an open to very open tussock grassland with very sparse emergent shrubs. This structural variation occurs within a similar suite of species, but through differing densities.

Distribution:
Occurring along the eastern slopes of the Flinders Ranges, and on the north and south slopes of the Olary Spur.



Most frequently occurring species:
Enneapogon cylindricus
Solanum ellipticum/quadriloculatum
Acacia tetragonophylla
Eremophila freelingii
Ptilotus obovatus
Acacia victoriae
Sclerolaena obliquicuspis
Enchylaena tomentosa
Sida fibulifera

North Olary Plains Survey Sites:
MIN06201, MIN10101, OLA12401

Description:
This community is characterised by the very sparse, bare appearance of the ground, and the gravely surface strew usually present. The shrubs tend to be dwarfed when present. It is usually found on rocky, sloping sites where the surface is densely strewn with gravels derived from numerous outcrops. The underlying geology is usually shales, calcareous shales and siltstones.

Rabbit warrens are common in these shales, and the total grazing pressure is often quite high. Shrub regeneration is usually poor, and in many areas only a tussock grassland of *Enneapogon cylindricus* with *Sclerolaena obliquicuspis* remains. Where the ground is very rocky, even the tussock grass is sparse.

Because the community is naturally very sparse and open, the grazing pressure of sheep and rabbits has severely reduced plant densities to sometimes extremely low levels, leaving the community characteristically looking very bare, and in some areas erosion gullying has been brought about through the removal of vegetation cover, exposing the highly erodible, weakly structured, fine textured soils.

This community is closely related to the ***Acacia aneura / Acacia victoriae / Sida petrophila*** **Very open low woodland** community, which in most instances is found adjoining it on the higher, steeper slopes.

Vegetation Condition:
Usually highly altered particularly by rabbit and goat grazing to communities of low diversity.

Most frequently occurring species in *Enneapogon cylindricus / Acacia tetragonophylla* Open grassland community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	% Occur.	Cover/Abundance T	1	2	3	4	5
	Enneapogon cylindricus	83	82					
	Solanum ellipticum/quadriloculatum	71	70					
	Acacia tetragonophylla	68	67					
	Eremophila freelingii	68	67					
	Ptilotus obovatus var. *obovatus*	68	67					
+	*Acetosa vesicaria*	66	65					
	Acacia victoriae ssp. *victoriae*	63	62					
	Sclerolaena obliquicuspis	63	61	1				
	Sida fibulifera	57	56					
	Enchylaena tomentosa var. *tomentosa*	53	52					
+	*Salsola kali*	53	52					
	Acacia aneura var.	48	47					
	Sida petrophila	44	43					
	Senna artemisioides nothossp. *coriacea*	43	42					
	Malvastrum americanum	41	40					
	Santalum lanceolatum	38	37					
	Lysiana exocarpi ssp. *exocarpi*	37	36					
	Convolvulus microsepalus/remotus	36	35					
	Dodonaea microzyga var. *microzyga*	36	35					
	Sclerolaena divaricata	36	35					
	Aristida nitidula	34	33					
	Abutilon leucopetalum	33	32					
+	*Euphorbia australis*	31	30					
	Maireana astrotricha	31	30					

Figure 37
***Enneapogon cylindricus / Acacia tetragonophylla* Open grassland**
Site MIN10101. Very Open Low Grass. *Enneapogon* sp. over *Tetragonia eremaea*

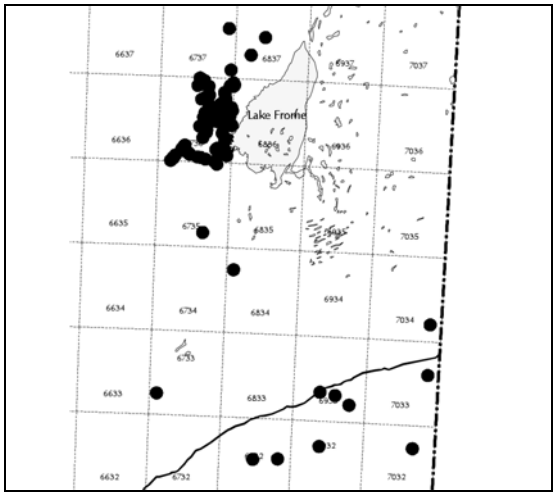
Acacia victoriae Very open shrubland

Floristic Group Two: 106 members

Vegetation Structure:
This community is usually a tall open shrubland, or tall very open shrubland dominated by *Acacia victoriae* ssp. *victoriae* (Elegant Wattle). Occasionally it forms a closed shrubland. The chenopods *Maireana pyramidata* (Blackbush) and *Rhagodia spinescens* (Spiny saltbush) are prominent in the understorey. *Malvastrum americanum* (Spiky Malvastrum), an introduced species, is common in this community along the eastern edge of the Flinders Ranges.

Distribution:
This community is found along the drainage lines, creeks, and rivers which flow onto the plains both north and south from the eastern end of the Olary Spur. It also occurs in the Olary and Wawirra Creek systems which are within the Spur.

Along the eastern edge of the Flinders Ranges it is found in creeks and on floodplains on the lower slopes and adjacent plains.



Most frequently occurring species:
Acacia victoriae
Rhagodia spinescens
Maireana pyramidata
Sclerolaena limbata
Malvastrum americanum
Enneapogon cylindricus
Enneapogon avenaceus

North Olary Plains Survey Sites:
CUR01301, KOO30201, MIN05101, MUL13101, OLA08101, OLA09101, OLA12301, PAR05301, PAR07201, REA03301, REA11202

Description:
The community is often associated with the ***Maireana pyramidata* Low open shrubland** community which occurs on the adjacent floodplains, the ***Eucalyptus camaldulensis* Woodland** community, or where heavy disturbance through flood events and high grazing pressure has occurred, ***Nitraria billardierei* Low open shrubland**. In these instances the community forms a narrow line along the stream channel.

Vegetation Condition:
Because of the often high soil moisture conditions this community is extensively invaded by fleshy and semi-succulent introduced species such as *Asphodelus fistulosus* (Onionweed), *Medicago polymorpha* (Burr medic) and *Sisymbrium erysimoides* (Smooth mustard). It is often highly disturbed by stock because of their preference for drainage lines, and can contain large numbers of woody and annual weeds.

Most frequently occurring species in ***Acacia victoriae*** **Very open shrubland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**% Occur.**	**Cover/Abundance T**	**1**	**2**	**3**	**4**	**5**
	Acacia victoriae ssp. *victoriae*	76	69	3	9			
	Rhagodia spinescens	62	57	6	3			
	Maireana pyramidata	54	57	1				
	Sclerolaena limbata	49	51	1				
	Malvastrum americanum	47	50					
	Enneapogon avenaceus	46	46	3				
	Enneapogon cylindricus	45	45	3				
	Sclerolaena obliquicuspis	45	45	1	2			
+	*Acetosa vesicaria*	44	44	2	1			
	Enchylaena tomentosa var. *tomentosa*	41	41	2	1			
+	*Salsola kali*	40	42	1				
	Dissocarpus paradoxus	38	38	2	1			
	Convolvulus microsepalus/remotus	36	37	1	1			
	Sida fibulifera	30	31	1				
	Ptilotus obovatus var. *obovatus*	30	32					

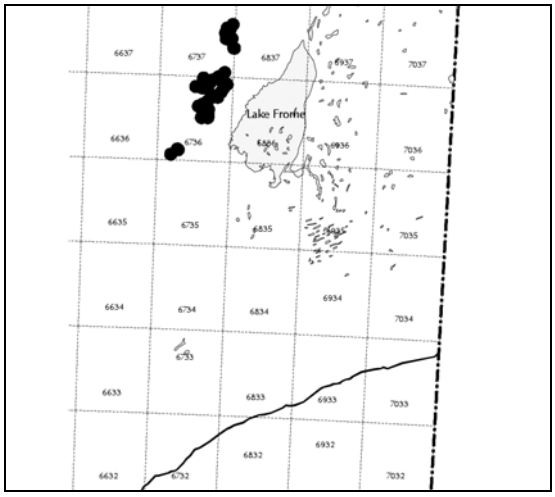
Figure 38
Acacia victoriae **Very open shrubland**
Site MIN05101. Tall Shrubland. *Acacia victoriae* ssp. *victoriae* and *Lycium ferocissimum* over *Asphodelus fistulosus* and *Xanthium spinosum*

Astrebla pectinata Open grassland

Floristic Group Three: 42 members

Vegetation Structure:
Either a Tussock, or Open Tussock Grassland; or a Low, or Low Open Shrubland depending on the season. After rain the tussock grass *Astrebla pectinata* (Mitchell Grass) is dominant for a few months, and at other times *Sclerolaena divaricata* (Poverty bush) and *S. longicuspis* (Long-spined poverty bush) are prominent. The perennial daisy *Ixiolaena leptolepis* (Plover daisy) is also common in this community.

Distribution:
This community is found mainly in the western portion of the survey area, where it grows on the outwash plains between the eastern edge of the Flinders Ranges and Lake Frome. Very small and unmappable traces of the community are also scattered throughout the central portion of the area.



Most frequently occurring species:
Ixiolaena leptolepis
Sclerolaena divaricata
Sclerolaena longicuspis
Enneapogon avenaceus
Astrebla pectinata
Convolvulus microsepalus
Rhodanthe microglossa

North Olary Plains Survey Sites:
None. All the survey sites included in the analysis which represent this community are from the Flinders Ranges survey.

Description:
This community is associated with puffy, fine-textured, highly erodable gilgai soils, usually with a scattering of surface stone. It changes dramatically in appearance after rain when the Mitchell grass grows vigorously and forms a lush pasture. In other seasons *Sclerolaena* spp. are prominent, often as dead, skeletal low shrubs, and very few plants higher than 0.3m are present. The ***Maireana aphylla* Low open shrubland** community occurs as a mosaic with the Mitchell grass, as does the ***Sclerolaena divaricata* Herbland**, particularly in the west.

Vegetation Condition:
This community has been heavily grazed, but its great natural variability may make it reasonably resilient to such impacts. *Sclerolaena divaricata* and *S. longicuspis* tend to become dominant where the Mitchell grass and other palatable species have been removed.

Most frequently occurring species in the ***Astrebla pectinata*** **Open grassland** community, with the frequency of each cover abundance score.

	Species	**%**	**Cover/Abundance**					
	+ is an annual or seasonally non-detectable species	**Occur.**	**T**	**1**	**2**	**3**	**4**	**5**
	Ixiolaena leptolepis/tomentosa	76	31		1			
	Sclerolaena divaricata	73	30		1			
	Sclerolaena longicuspis	69	29					
	Enneapogon avenaceus	61	26					
	Astrebla pectinata	59	23	1	1			
+	*Rhodanthe microglossa*	54	23					
	Convolvulus microsepalus/remotus	50	21					
+	*Gnephosis arachnoidea*	50	21					
	Maireana astrotricha	50	20	1				
	Sclerolaena limbata	47	20					
+	*Acetosa vesicaria*	45	19					
	Eragrostis setifolia	42	17	1				
	Malvastrum americanum	40	16	1				
	Sclerolaena brachyptera	40	17					
	Sclerolaena lanicuspis	40	17					
	Sida fibulifera	40	17					
	Brachycome ciliaris var.	38	16					
	Enneapogon cylindricus	38	16					
+	*Goodenia fascicularis*	38	16					
+	*Rhodanthe floribunda*	38	16					
	Sida trichopoda	38	16					
	Eremophila duttonii	33	14					
	Ptilotus obovatus var. *obovatus*	33	14					

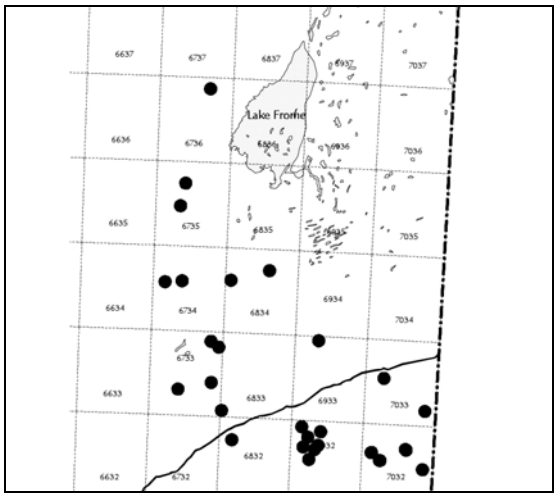
Figure 39
Astrebla pectinata **Open grassland**
Near Kemp's Bore on Martin's Well Station in association with the ***Maireana aphylla*** **Low open shrubland** community.

Maireana sedifolia Low open shrubland

Floristic Group Four: 45 members

Vegetation Structure:
A low, open shrubland often dominated by *Maireana sedifolia* (Pearl bluebush). *Eriochiton sclerolaenoides* (Woolly fruit copperburr) and *Maireana pyramidata* (Blackbush) can also be locally dominant. Occasionally tall shrubs of *Senna* sspp., or trees of *Casuarina pauper* (Blackoak) occur as sparse emergents.

Distribution:
A community principally of hill foot-slopes, it is distributed widely in the southern portion of the survey area where the Chenopod communities of the plains adjoin hills. It is particularly common south of, and within the hills of the Olary Spur. Some occurrences were recorded along the northern margin of the Spur and the eastern fringe of the Flinders Ranges. In the area south of Mount Frome, low, rocky "jump-up rises" of ironstone are dominated by this community.



Most frequently occurring species:
Maireana sedifolia
Sclerolaena obliquicuspis
Maireana pyramidata
Eriochiton sclerolaenoides
Carrichtera annua
Stipa scabra

North Olary Plains Survey Sites:
CUR06201, CUR07201, KOO11101, KOO12101, KOO29101, KOO32101, MIN07201, MIN12101, OLA01301, REA01201, WIL03101, WIL03210, WIN10101

Description:
Generally occurring on stony rises and hill sides, often where shales and ironstone are present. Some of the occurrences are on very low rises on the plains. The community often occurs in small and localised patches where suitable edaphic conditions occur and has therefore been mapped most frequently as a mosaic with other communities. It forms a complex mosaic with the ***Atriplex vesicaria / Maireana astrotricha*** **Low open shrubland** community and is usually found growing adjacent to, and interspersed with this latter community.

Vegetation Condition:
In some places the Bluebush has been almost completely removed by sheep, rabbit, goat and kangaroo grazing. Generally in this community the Bluebush is still present as the dominant shrub and the annual and understorey plants show varying degrees of grazing impact.

Most frequently occurring species in ***Maireana sedifolia* Low open shrubland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**%** **Occur.**	**Cover/Abundance** **T**	**1**	**2**	**3**	**4**	**5**
	Sclerolaena obliquicuspis	80	18	15	3			
	Maireana sedifolia	75	9	6	15	4		
	Maireana pyramidata	66	25	5				
	Eriochiton sclerolaenoides	57	11	10	5			
+	*Tetragonia eremaea/tetragonoides*	57	18	6	2			
+*	*Carrichtera annua*	46	10	8	2	1		
+	*Rhodanthe pygmaea*	46	9	9	3			
+	*Omphalolappula concava*	44	14	6				
+	*Calotis hispidula*	42	11	8				
	Enchylaena tomentosa var. *tomentosa*	42	19					
	Maireana astrotricha	37	13	3	1			
+	*Brachycome lineariloba*	35	15	1				
	Danthonia caespitosa	33	5	7	3			
+*	*Sonchus oleraceus*	33	15					
	Enneapogon avenaceus	31		6				
	Stipa scabra group	31	4	3	4	3		
	Enneapogon avenaceus	31			1			
	Enneapogon avenaceus	31	7					
	Myoporum platycarpum ssp.	31	14					

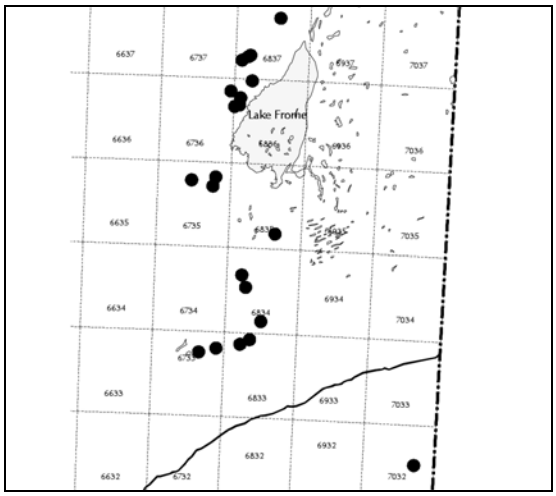
Figure 40
***Maireana sedifolia* Low open shrubland**
Site MIN07201. Low shrubland. *Maireana sedifolia*, *M. astrotricha* and *Atriplex vesicaria* over *Tetragonia eremaea* and *Sclerolaena obliquicuspis*

Senna / Eremophila / Rhagodia spinescens Open shrubland

Floristic Group Five: 22 members

Vegetation Structure:
This community is an open to dense tall shrubland dominated by *Eremophila sturtii* (Turpentine), *E. duttonii* (Harlequin Fuchsia Bush*)*, or *Senna artemisioides sspp.* (Desert Sennas). *Rhagodia spinescens* (Spiny Saltbush) is usually present, often with *Dodonaea microzyga* var. *microzyga* (Brilliant Hop Bush) as middle level shrubs and *Sclerolaena obliquicuspis* (Limestone Copperburr) and *Enneapogon avenaceus* (Bottle Washers) in the ground layer.

Distribution:
This community occurs in the western and southern plains portions of the survey area, where it is usually found on low sandy rises. These are sometimes remnants of old dune systems, and sometimes very shallow depositional areas of aeolian material in predominantly flat plains.



Most frequently occurring species:
Eremophila sturtii
Eremophila duttonii
Rhagodia spinescens
Sclerolaena obliquicuspis
Enneapogon avenaceus
Maireana pyramidata
Senna artemisioides ssp*. petiolaris*

North Olary Plains Survey Sites:
CUR06401, CUR06501, FRO01101, FRO03101, KOO10101, KOO12201, PAR01401, PAR07301, PAR07401, PAR11101, PAS14101, REA02701, REA03101, REA06201, WIN01101, WIN01201

Description:
In the north-western portion of the survey area this community forms a discrete series of mappable low dunes which have been denuded. Here it is generally associated with the surrounding ***Maireana aphylla*** **Low open shrubland** and ***Astrebla pectinata*** **Open grassland** communities. On the plains between Lake Frome and the Olary Spur, the areas of this community become small, sparse and fragmented, and are mostly only mappable as a mosaic, generally with the ***Maireana astrotricha*** **Low open shrubland** and the ***Atriplex vesicaria / Maireana astrotricha*** **Low open shrubland** communities. Most of the dominant shrubs are unpalatable to sheep, and in this area represents what pastoralists refer to as a "woody weed invasion", which has come about through preferential grazing pressure over an extended period, coupled with low regeneration rates of the palatable chenopod species of the surrounding plains. On Bimbowrie, this community is mosaiced with the ***Maireana pyramidata*** **Low open shrubland** community in the river flats adjacent to the major watercourses. Small stands of *Casuarina pauper* are commonly found throughout this community, particularly south of Lake Frome.

Vegetation Condition:
Most examples of this community are in reasonable condition, although the presence of the shrubs may represent a disclimax situation caused by past grazing of palatable species. Extensive insect damage has occurred in this community specifically near Bimbowrie wher it is actually killing the plants and reducing the overall area of its coverage.

Most frequently occurring species in the ***Senna / Eremophila / Rhagodia spinescens*** **Open shrubland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**% Occur.**	**Cover/Abundance T**	**1**	**2**	**3**	**4**	**5**
	Rhagodia spinescens	86	16	3				
	Sclerolaena obliquicuspis	72	5	11				
+	*Tetragonia eremaea/tetragonoides*	72	1	14	1			
	Enneapogon avenaceus	68		13	2			
	Enchylaena tomentosa var. *tomentosa*	59	12	1				
	Eremophila sturtii	59	3	9		1		
	Senna artemisioides ssp. *petiolaris*	59	5	4	4			
	Maireana pyramidata	54	11		1			
+	*Omphalolappula concava*	54	9	3				
	Eremophila duttonii	50	6	4	1			
	Sclerolaena limbata	50	6	5				
+	*Calotis hispidula*	45	5	5				
	Dissocarpus paradoxus	45	9	1				
	Acacia victoriae ssp. *victoriae*	41	8	1				
+	*Salsola kali*	41	8	1				
+	*Acetosa vesicaria*	36	1	5	2			
	Dodonaea microzyga var. *microzyga*	36	3	3	2			
	Eriochiton sclerolaenoides	36	5	3				
	Sida intricata	36	5	3				
	Solanum ellipticum/quadriloculatum	36	7	1				
	Ptilotus obovatus var. *obovatus*	31	6	1				
	Santalum lanceolatum	31	6	1				

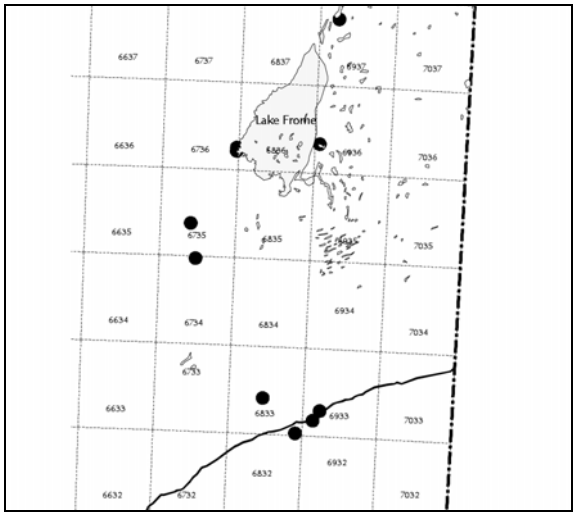
Figure 41
Senna / Eremophila / Rhagodia spinescens **Open shrubland**
Site PAR11101. Open shrubland. *Eremophila duttonii, Senna artemisioides* ssp. *petiolaris* with emergent *Santalum lanceolatum* over *Maireana aphylla, Aristida contorta, M. lobiflora, Enneapogon avenaceus* and *Eragrostis eriopoda.*

Nitraria billardierei Low open shrubland

Floristic Group Eight:10 members

Vegetation Structure:
This community is a low, or low open shrubland dominated by *Nitraria billardierei* (Nitre bush). In some of the more harsh environments such as the gypsum sands at the north-eastern tip of Lake Frome, the *N. billardierei* has only a few annual herb species growing with it. In the south, along the drainage lines of the Olary Spur it can be accompanied by low shrubs from the surrounding chenopod communities.

Distribution:
Although it is confined to drainage lines and floodouts, it is spread throughout the study area, and is common in the south where high levels of disturbance from grazing or flooding have occurred in the past. In some of the more extreme environments such as along the eastern shore of Lake Frome, and fringing the salt lakes in the central part of the study area where it is naturally occurring, it is not neccessarily an indication of stock disturbance.



Most frequently occurring species:
Nitraria billardierei
Maireana pyramidata
Sclerolaena obliquicuspis

North Olary Plains Survey Sites:
CNB07201, CTB01201, OLA10101, OLA10401, REA07201, WIL02301, WIN08101, WIN12401

Description:
In most instances *Nitraria billardierei* is the only shrub species present in this community. This is a natural phenomena in the extreme environments of the gypsum dune fields and where severe flooding occurs. The distinctive hemispherical mounds of the Nitre bush appear to have the effect of trapping wind-blown soil particles as well as stabilising the soil beneath them. This, coupled with the often bare areas between bushes eroding easily, leads to significant mounding of soil under bushes, sometimes up to a metre deep. Along the Barrier Highway, in the southern portion of the survey area, the presence of this community is probably a reflection of historic high grazing pressures. It commonly forms a mosaic with the ***Acacia victoriae* Very open shrubland**, and ***Maireana pyramidata* Low open shrubland** communities in the Olary Spur district, and occassionally with the ***Atriplex vesicaria / Maireana astrotricha* Low open shrubland** community on the southern plains.

Vegetation Condition:
This community usually reflects a degraded state and is extremely low in biodiversity. Disturbance within the community appears low in the extreme environments, but is much higher in the southern districts along the Barrier Highway.

Most frequently occurring species in the ***Nitraria billardierei*** **Low open shrubland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**%** **Occur.**	**Cover/Abundance** **T**	**1**	**2**	**3**	**4**	**5**
	Nitraria billardierei	100	2	2	5	1		
	Sclerolaena obliquicuspis	50		4	1			
+	*Tetragonia eremaea/tetragonoides*	50		3	2			
+*	*Carrichtera annua*	40		2	2			
	Atriplex vesicaria ssp.	40	1	3				
+*	*Medicago minima* var. *minima*	30	1	2				
+*	*Sisymbrium erysimoides*	30	2	1				
	Zygophyllum ammophilum	30	1	1	1			
+	*Atriplex holocarpa*	30		3				
	Maireana pyramidata	30		3				
	Rhagodia spinescens	30		3				

Figure 42
Nitraria billardierei **Low open shrubland**
Site OLA10401. Low shrubland. *Nitraria billardierei* over *Carrichtera annua* and *Tetragonia eremaea.*

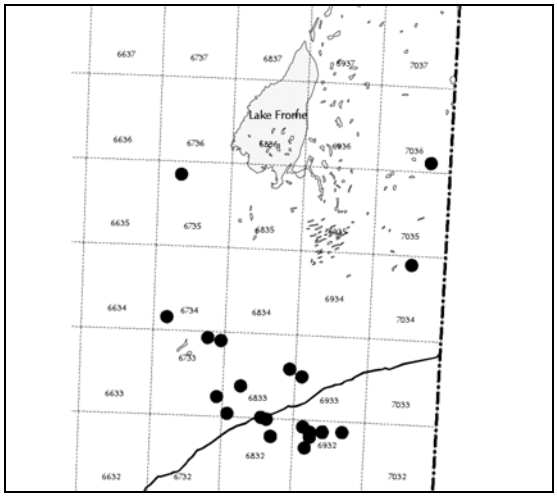
Eucalyptus socialis Open tree mallee

Floristic Group Nine: 28 members

Vegetation Structure:
This community is a low woodland, or open low woodland dominated by the mallee species *Eucalyptus socialis* (Red mallee). *Eucalyptus gracilis* (Yorrell), *Myoporum platycarpum* (False sandalwood) and *Alectryon oleifolius* (Bullock bush) are also sometimes present in the overstorey. The understorey is usually very sparse, and characterised by small chenopod shrubs and *Zygophyllum* spp. (Twinleafs).

Distribution:

This community is approaching the northern limit of its range in this study area, and occurs only in the southern portion where it grows as small patches in the Olary Spur, and along the eastern fringe of the Flinders Ranges.



Most frequently occurring species:
Eucalyptus socialis
Enchylaena tomentosa
Myoporum platycarpum
Maireana pentatropis
Zygophyllum auranticum
Sclerolaena obliquicuspis

North Olary Plains Survey Sites:
KOO05101, KOO06101, KOO35101, OLA04201, REA01401, WIL09401, WIN06101

Description:
These woodlands are usually found on shallow, often calcareous stony soils. The community is usually found as small discrete patches in low-lying areas along creeks within hills. The patches sometimes extend onto the hillslopes. In the hills of the Olary Spur, north of Manna Hill, this community grows as a mosaic with the ***Acacia aneura / Acacia victoriae / Sida petrophila*** **Very open low woodland** community. In the rugged hills of the Bibliando area, an outlier of the Flinders Ranges, it is also forms extensive mosaics with the ***Eucalyptus gillii*** **Open tree mallee** community and the ***Casuarina pauper*** **Low woodland** community.

Vegetation Condition:
All examples of this community have a heavily grazed understorey.

Most frequently occurring species in the ***Eucalyptus socialis*** **Open tree mallee** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**% Occur.**	**Cover/Abundance T**	**1**	**2**	**3**	**4**	**5**
	Eucalyptus socialis	84	2	3	13	3		
	Enchylaena tomentosa var. *tomentosa*	76	16	3				
	Myoporum platycarpum ssp.	60	15					
	Sclerolaena obliquicuspis	56	6	7				
+	*Tetragonia eremaea/tetragonoides*	56	12	2	1			
	Maireana pentatropis	48	6	4	2			
+	*Salsola kali*	48	12					
	Maireana pyramidata	44	10	1				
+*	*Carrichtera annua*	40	5	4	1			
	Rhagodia spinescens	40		1				
+*	*Schismus barbatus*	40	7	3				
	Rhagodia spinescens	40	9					
+*	*Sonchus oleraceus*	40	10					
	Maireana sedifolia	36	9					
	Alectryon oleifolius ssp. *canescens*	32	6	2				
	Atriplex vesicaria ssp.	32	6	1	1			
	Dissocarpus paradoxus	32	7	1				
	Eucalyptus gracilis	32	2	1	2	3		
	Sclerolaena diacantha	32	6	2				

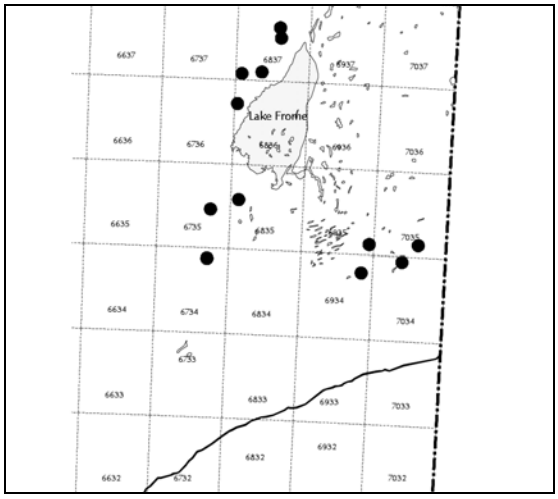
Figure 43
Eucalyptus socialis **Open tree mallee**
Site OLA04201. Mallee. *Eucalyptus socialis* over *Dissocarpus paradoxus*, *Sclerolaena limbata*, *Zygophyllum auranticum* and *Z. iodocarpum*

Maireana aphylla Low open shrubland

Floristic Group Ten: 22 members

Vegetation Structure:
This community varies from a closed, to open shrubland dominated by *Maireana aphylla* (Cottonbush). *Rhagodia spinescens* (Spiny saltbush) and a number of swamp habitat species such as *Muehlenbeckia florulenta* (Lignum) are also found in the overstorey. The grasses *Eragrostis setifolia* (Neverfail) and *Enneapogon avenaceus* (Bottlewashers) are common understorey species.

Distribution:
This community is confined to drainage lines and floodout areas. It is found throughout the study area, but is most widespread on the plains north of Cockburn and in the Mulyungarie area. It also occurs in association with the low-lying areas of the ***Astrebla pectinata*** **Open grassland** north-west of Lake Frome.



Most frequently occurring species:

Maireana aphylla
Rhagodia spinescens
Enneapogon avenaceus

North Olary Plains Survey Sites:
KAL03201, MUL02101, PAR03201, PAR03401, PAR07101, PAR11201, PAS06301, REA08101, WIL02401

Description:
Some of the examples of this community consist of *Maireana aphylla* as the only overstorey species over herbs and grasses. This state is probably a function of continuous heavy grazing pressure. In contrast, some of the sites are very diverse with a number of moisture reliant species co-dominant, and a rich understorey of small shrubs and herbs. These are probably the least disturbed areas. This community can form a mosaic with the ***Eucalyptus largiflorens*** **Low open woodland** and ***Dodonaea viscosa*** **ssp. *angustissima* Open shrubland** communities. The ***Sclerolaena brachyptera / Maireana aphylla*** **Low very open shrubland** community may be ecologically related, but the presence of a wider variety of *Sclerolaena* spp. makes them floristically distinct groups.

Vegetation Condition:
The condition varies from high diversity with low disturbance to low diversity, highly disturbed.

Most frequently occurring species in the ***Maireana aphylla* Low open shrubland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**%** **Occur.**	**Cover/Abundance** **T**	**1**	**2**	**3**	**4**	**5**
	Maireana aphylla	100		7	14	1		
	Rhagodia spinescens	77.	10	5	2			
	Enneapogon avenaceus	59.	8	2	3			
+	*Tetragonia eremaea/tetragonoides*	50	5	6				
	Sclerolaena diacantha	40.	4	4	1			
+	*Aristida contorta*	36.	4	2	2			
	Maireana astrotricha	36.	4	3	1			
	Eragrostis setifolia	36.	6		2			
	Maireana pyramidata	31.	5	2				
	Sclerolaena divaricata	31.	5	2				
+	*Calotis hispidula*	31.	7					

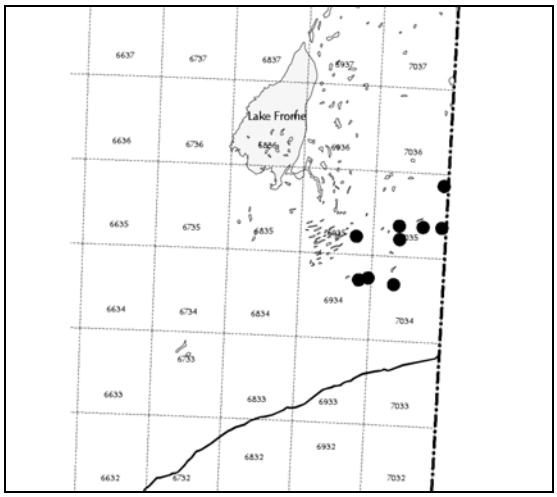
Figure 44
***Maireana aphylla* Low open shrubland**
Site MUL02101. Low Shrubland. *Maireana aphylla, Rhagodia spinescens* and *Maireana pyramidata* with emergent *Acacia tetragonophylla* and *Santalum acuminatum* over *Sclerolaena limbata* and *S. obliquicuspis*.

Gunniopsis quadrifida Low open shrubland

Floristic Group Fifteen: 21 members

Vegetation Structure:
This community ranges from a low very open, to a low medium dense shrubland. *Maireana astrotricha* (Low bluebush) and *Rhagodia spinescens* (Spiny saltbush) are common dominant shrubs. *Gunniopsis quadrifida* (Sturt's pigface) is often locally dominant and is an indicator of this community. Occasionally tall shrubs of *Eremophila sturtii* (Turpentine) or *Senna* spp., or the tree *Acacia aneura* (Mulga) are present as overstorey.

Distribution:
This community is found in the central eastern portion of the study area on low sandy rises and plains, adjoining the New South Wales border. It occurs mainly on the Lake Charles mapsheet, but extends west as far as the southern shores of Lake Frome.



Most frequently occurring species:
Gunniopsis quadrifida
Sclerolaena decurrens
Rhagodia spinescens
Maireana astrotricha
Atriplex limbata

North Olary Plains Survey Sites:
BEN13201, KAL06201, KAL07101, LCH03301, LCH08101, LCH09201, LCH10101, LCH11201, MUL05201

Description:
This community is confined to the study area between the northern edge of the ***Atriplex vesicaria / Maireana astrotricha*** **Low open shrubland** and the southern edge of the ***Acacia ligulata*** **Very open shrubland** of the Strzelecki Desert.

It usually occurs as a mosaic with the ***Acacia aneura*** **Very open low woodland** community, and may even form an understorey to the latter. On the eastern portion of the Lake Charles mapsheet this relationship is particularly strong. In the western portion of its range the community is a more open chenopod shrubland, with only occassional patches of the ***Acacia aneura*** **Very open low woodland** community present.

Vegetation Condition:
This community may have a naturally sparse shrub overstorey, so it is difficult to estimate the effects of grazing, and it is likely that stock trampling has a considerable impact. Some sites more remote from stock influences have a rich diversity of ephemeral herbs at ground level.

Most frequently occurring species in the ***Gunniopsis quadrifida*** **Low open shrubland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	% Occur.	Cover/Abundance T	1	2	3	4	5
	Sclerolaena decurrens	95	9	8	2	1		
	Maireana astrotricha	71	12	3				
	Rhagodia spinescens	66	10	4				
	Atriplex limbata	57	9	3				
	Gunniopsis quadrifida	57	4	5	3			
	Eremophila sturtii	42	7	1	1			
+	*Tetragonia eremaea/tetragonoides*	42	4	4	1			
+	*Bulbine semibarbata*	38	3	5				
	Enneapogon avenaceus	38	5	2	1			
	Sclerolaena diacantha	38	2	6				
	Tripogon loliiformis	38	4	4				
+	*Salsola kali*	38	8					
+	*Craspedia pleiocephala*	33	5	2				
	Dissocarpus paradoxus	33	3	3	1			
+	*Rhodanthe moschata*	33	3	4				
+	*Aristida contorta*	33	3		4			
	Enchylaena tomentosa var. *tomentosa*	33	7					

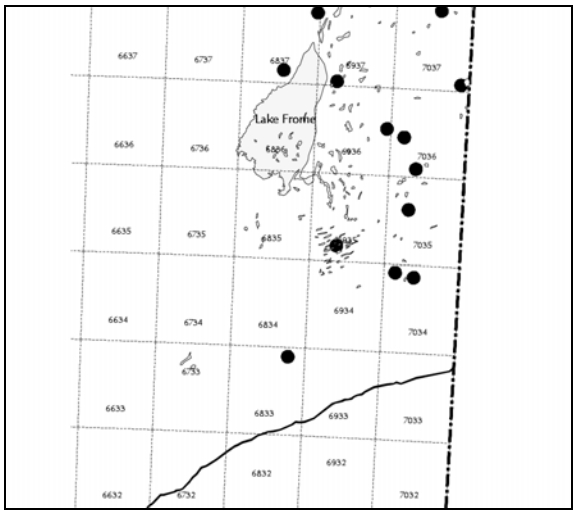
Figure 45
Gunniopsis quadrifida **Low open shrubland**
Site LCH11201. Tall open shrubland. *Eremophila sturtii* and *Dodonaea viscosa* ssp. *angustissima* over *Gunniopsis quadrifida*, *Maireana aphylla*, *Tetragonia eremaea* and *Bulbine semibarbata*.

Atriplex vesicaria **Low open shrubland**

Floristic Group Sixteen: 15 members

Vegetation Structure:
The structure of this community varies from low open shrubland to (rarely) tall shrubland, but it is predominantly low and dominated by *Atriplex vesicaria* (Bladder saltbush) with other chenopods. *Acacia ligulata* or *Senna artemisioides* ssp. *petiolaris* are occassionally present as emergents. The understorey is rich in daisies with *Senecio lautus* (Variable groundsel) and *Rhodanthe* spp. (Everlastings) very common.

Distribution:
This community is found on low sand dunes in the transition zone between the southern edge of the dune fields and the northern edge of the chenopod plains. It is also found throughout the dunefields where low sandy rises (or sub-dunes) occur in the swales. A few examples extend southward into the plains particularly on the Benagerie mapsheet where it forms a mosaic with the many ***Eragrostis australasica / Muehlenbeckia florulenta*** **Open shrubland**.



Most frequently occurring species:
Senecio lautus
Erodium cygnorum ssp. *glandulosum*
Atriplex vesicaria
Salsola kali
Rhagodia spinescens
Tripogon loliiformis

North Olary Plains Survey Sites:
BEN12301, CNB06301, CNE03301, CNE12201, CTB09101, LCH05101, MUL01201, MUL02401, PAR02201, PAR08101, THU07201, THU10101, WIN03101

Description:
This community has a close floristic relationship with the ***Gunniopsis quadrifida*** **Low open shrubland** however, the soil texture is usually more sandy, which may be an important factor determining the community composition. Strong flushes of ephemeral understorey species follow good rains, providing opportunistic fodder for sheep in particular.

Vegetation Condition:
In the north trampling by cattle has undoubtedly caused significant impact to the community breaking up the light soil. In the southern sheep grazing areas many examples seem relatively intact, possibly because of the ephemeral growth pattern of many of the sub-dominant species.

Most frequently occurring species in the ***Atriplex vesicaria*** **Low open shrubland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**%** **Occur.**	**Cover/Abundance** **T**	**1**	**2**	**3**	**4**	**5**
+	*Erodium cygnorum* ssp.	66	2	8				
	Senecio lautus	66	1	9				
+	*Tetragonia eremaea/tetragonoides*	60	4	4	1			
	Atriplex vesicaria ssp.	60	3	6				
	Rhagodia spinescens	60	8	1				
+	*Salsola kali*	60	9					
	Tripogon loliiformis	53	2	6				
+	*Bulbine semibarbata*	46	1	6				
	Gunniopsis quadrifida	46	4	3				
	Maireana astrotricha	46	4	3				
	Sclerolaena decurrens	46	7					
+	*Atriplex holocarpa*	40	5	1				
	Maireana aphylla	40	5	1				
+	*Rhodanthe floribunda*	40	2	3	1			
+	*Rhodanthe moschata*	40	3	3				
+*	*Schismus barbatus*	40	3	3				
+*	*Brassica tournefortii*	33	3	2				
	Enneapogon avenaceus	33	3	2				
+	*Gnephosis eriocarpa*	33	1	3	1			
	Maireana pyramidata	33	4	1				

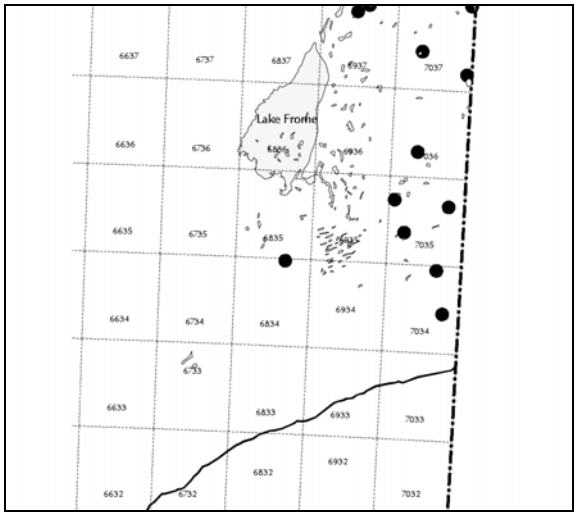
Figure 46
Atriplex vesicaria **Low open shrubland**
Site CNE12201. Low open shrubland. *Atriplex vesicaria*, *Sclerostegia medullosa* and *Gunniopsis quadrifida* with *Acacia ligulata* emergent over *Senecio lautus*, *Erodium cygnorum* ssp. *glandulosum* and *Minuria cunninghamii*.

Eucalyptus largiflorens Low open woodland

Floristic Group Seventeen: 12 members

Vegetation Structure:
Woodlands or low woodlands which are either sparse or very sparse, dominated by *Eucalyptus largiflorens* (River Box). The understorey is usually very sparse, and often composed almost completely of introduced species and annuals. There is usually no middle shrub layer.

Distribution:
This community is found along watercourses, and fringing lakes and swamps, mainly in the north-eastern portion of the study area, north and east of the south-eastern corner of Lake Frome. Its range within the study area does not overlap that of ***Eucalyptus camaldulensis* Woodland** community which is found near to the ranges in the south and west of the region.



Most frequently occurring species:
Eucalyptus largiflorens
Tetragonia eremaea
Brassica tournefortii

North Olary Plains Survey Sites:
CNE03201, CNE08201, CNE12501, CUR03201, LCH04101, LCH06101, LCH08201, MUL03401, MUL10301, THU08101

Description:
Confined to waterways and edges of inundated areas, this community is usually found as narrow bands around swamps and small lakes. In the cattle grazing region in the north east, the understorey is virtually non-existent due to trampling and browsing, whereas further south in the sheep grazing country, swamp species such as *Muehlenbeckia florulenta* (Lignum), *Maireana aphylla* (Cottonbush), *Eragrostis australasica* (Canegrass) and *Marsilea drummondii* (Nardoo) are commonly growing under the tree canopy.

On the eastern edge of the Lake Charles mapsheet near the New South Wales border *Eucalyptus largiflorens* is growing as a low open woodland over a wide area of grassy floodplain with *Casuarina pauper* (Black oak) and *Callitris glaucophylla* (Native pine).

Vegetation Condition:
Condition is variable, but generally poor, because the community acts as a focus for stock for shade, and the proximity to many dams and tanks near the creeklines in which it grows.

Most frequently occurring species in the ***Eucalyptus largiflorens*** **Low open woodland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**%** **Occur.**	**Cover/Abundance** **T**	**1**	**2**	**3**	**4**	**5**
	Eucalyptus largiflorens	100		6	6			
+	*Tetragonia eremaea/tetragonoides*	83	7	3				
+*	*Brassica tournefortii*	58	2	5				
+	*Salsola kali*	41	3	2				
+*	*Schismus barbatus*	41	4	1				
	Zygophyllum ammophilum	41	4	1				
+	*Craspedia pleiocephala*	41	5					
+	*Atriplex holocarpa*	33	3	1				
+	*Bulbine semibarbata*	33	3	1				
	Enchylaena tomentosa var. *tomentosa*	33	3	1				
+	*Rhodanthe moschata*	33	4					

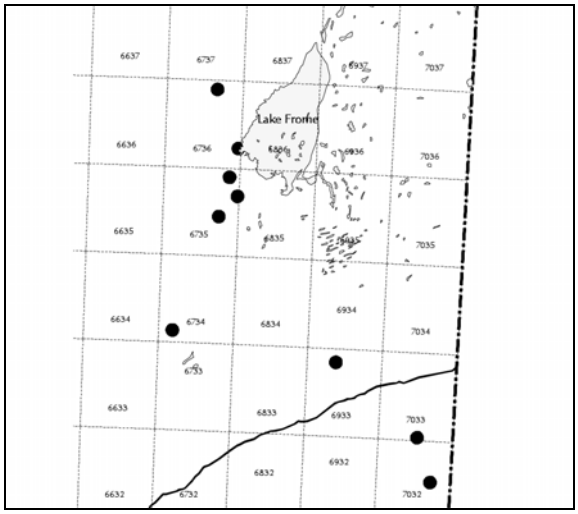
Figure 47
Eucalyptus largiflorens **Low open woodland**
Site MUL10301. Woodland. *Eucalyptus largiflorens* over *Maireana aphylla* and *Marsilea drummondii*.

Eucalyptus camaldulensis Woodland

Floristic Group Eighteen: 11 members

Vegetation Structure:
An open forest or woodland formation dominated by *Eucalyptus camaldulensis* (Red gum). The understorey is often composed of sparse shrubs and tussock grasses in the hills and ranges, or annual and introduced species on the plains.

Distribution:
This community is widespread in the south and west of the study area, both in the hills and on the plains. It is not found in the sand dune region of the north east. It forms in lineaments along the significant drainage channels flowing into Lake Frome. Within the study area the range of this community does not overlap that of the ***Eucalyptus largiflorens*** **Low open woodland** community. The latter is confined to the plains and dune fields of the north-east.



Most frequently occurring species:
Eucalyptus camaldulensis
Enchylaena tomentosa
Sisymbrium erysimoides
Rhagodia spinescens
Tetragonia eremaea

North Olary Plains Survey Sites:
OLA01101, MIN11201, REA03201, REA06101, REA08201, WIL09301

Description:
This familiar community is widely spread in central Australia. The Red gums form lines along watercourses and sometimes form dense forest communities in floodout areas. As these relatively moist and shady areas form a focus for stock to shelter, the ground storey is often severely impacted and consists mainly of introduced species such as *Sisymbrium erysimoides* (Smooth mustard).

Isolated groves of *Acacia salicina* (Broughton Willow) and *Atriplex nummularia* (Old Man Saltbush) are associated with this community in the area close to the southern margin of Lake Frome. On the plains, and often in quite dense patches, *Melaleuca glomerata* (Inland Paperbark) dominates the understorey in the stream channels, particularly in the middle to lower reaches of the major drainage lines running east from the Flinders Ranges into Lake Frome.

In the south west of the study area around Erudina and Willippa, large stands of dead or dying saplings of *Eucalyptus camaldulensis* can occur on floodplains where flood events have stimulated germination, but rainfall in subsequent seasons has not been high enough to sustain continued growth.

Vegetation Condition:
In the Flinders Ranges good examples of the community are common, but in the Olary Spur and on the plains, stock impacts may have been higher, and this community is mostly in poor condition. Condition is also related to available soil moisture which decreases farther from the creeks' sources and major catchments in the hills.

Most frequently occurring species in the ***Eucalyptus camaldulensis* Woodland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**%** **Occur.**	**Cover/Abundance** **T**	**1**	**2**	**3**	**4**	**5**
	Eucalyptus camaldulensis var.	82	2	1	3	2	1	
	Enchylaena tomentosa var. *tomentosa*	72		4	4			
+*	*Sisymbrium erysimoides*	63		3	2	2		
	Rhagodia spinescens	54	3	3				
+	*Tetragonia eremaea/tetragonoides*	54	1	4	1			
	Acacia victoriae ssp. *victoriae*	45	3	1	1			
	Malvastrum americanum	45	2	3				
	Melaleuca glomerata	45	4	1				
+*	*Centaurea melitensis*	45	3	1	1			
	Acacia salicina	36	2	2				
+*	*Carrichtera annua*	36	1	1	1	1		
+*	*Sonchus oleraceus*	36	3	1				

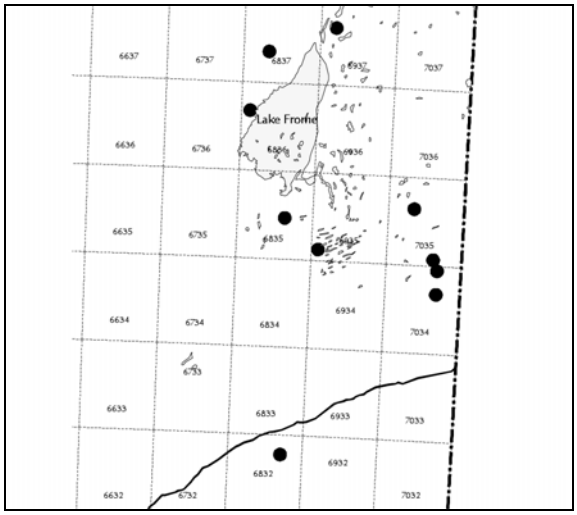
Figure 48
***Eucalyptus camaldulensis* Woodland**
Site MIN11201. Open forest. *Eucalyptus camaldulensis* over *Sisymbrium erysimoides* and *Medicago polymorpha*

Dodonaea viscosa spp. *angustissima* Open shrubland

Floristic Group Nineteen: 16 members

Vegetation Structure:
A tall shrubland varying from open, to closed. *Dodonaea viscosa* ssp. *angustissima* (Sticky hopbush) is the principal dominant species, with *Eremophila sturtii* (Turpentine), *Casuarina pauper* (Black oak) and *Senna artemisioides* ssp. *petiolaris* also locally dominant. The understorey is composed of low chenopod shrubs.

Distribution:
The sites recorded during this survey are mostly at the north-eastern edge of the plains between the southern edge of Lake Frome and the New South Wales border. A few sites are also located at the edge of the dunefields at the north-western corner of Lake Frome.



Most frequently occurring species:
Dodonaea viscosa ssp. *angustissima*
Atriplex limbata
Eremophila sturtii
Maireana pyramidata
Sclerolaena diacantha

North Olary Plains Survey Sites:
BEN11201, CTB03101, FRO01401, LCH05201, LCH12201, MUL03301, MUL06401, PAR05201, PAS11201

Description:
This community may be a reflection of heavy grazing pressure around watering points where it is sometimes very dense in conjunction with other "woody weeds". However it is also found in less disturbed areas of paddocks, generally on low sandy rises, and appears to be a naturally occurring community. *D. viscosa* seed production is prolific and the well-drained sandy rises provide an opportunistic seedbed with little competition for this species as well as the coloniser *Eremophila sturtii*. Disturbance probably allows it to spread into adjoining communities. It is confined to low dunesand rises, and may be a successional phase associated with the establishment or denudation of the taller dunes.

Vegetation Condition:
The condition of the overstorey is generally reasonable due to the relatively low palatability of the shrubs, but the ground layer is often sparse and highly disturbed by stock which easily break up the surface crust of the structureless sands.

Most frequently occurring species in the ***Dodonaea viscosa* spp. *angustissima* Open shrubland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**%** **Occur.**	**Cover/Abundance** **T**	**1**	**2**	**3**	**4**	**5**
	Dodonaea viscosa ssp. *angustissima*	100	3	3	6	4		
	Atriplex limbata	43	7					
	Enneapogon avenaceus	37	4	2				
	Maireana astrotricha	37	3	3				
	Maireana pyramidata	37	4	2				
+	*Salsola kali*	37	5	1				
	Sclerolaena diacantha	37	5	1				
+	*Tetragonia eremaea/tetragonoides*	37	1	5				
	Eremophila sturtii	37	5		1			
	Rhagodia spinescens	37	5		1			
	Atriplex vesicaria ssp.	31	4	1				
+	*Rhodanthe moschata*	31	4	1				
	Sclerolaena decurrens	31	4	1				
	Senna artemisioides ssp. *petiolaris*	31	3	2				

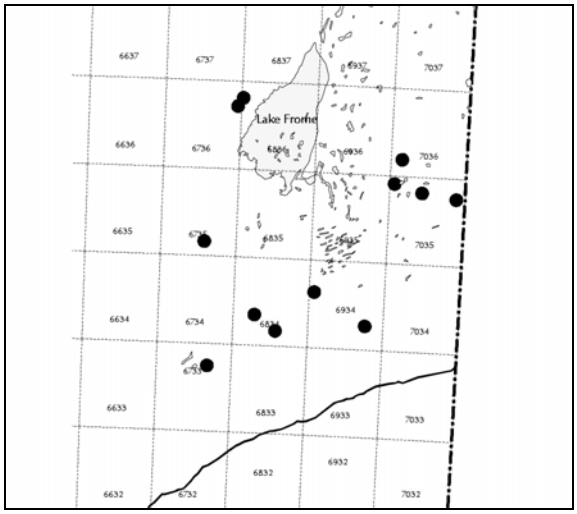
Figure 49
***Dodonaea viscosa* spp. *angustissima* Open shrubland**
Site PAR05201. Tall shrubland. *Dodonaea viscosa* ssp. *angustissima* over *Senna artemisioides* ssp. *petiolaris, Eremophila duttonii* and *Eragrostis eriopoda*.

Acacia aneura Very open low woodland

Floristic Group Twenty: 12 members

Vegetation Structure:
This community is a very low woodland, or a very low open woodland dominated by *Acacia aneura* (Mulga) or occasionally *Alectryon oleifolius* ssp. *canescens*. The understorey is open and mainly comprised of annual grasses and herbs. The introduced species *Brassica tournefortii* (Long fruited wild turnip) and *Schismus barbatus* (Arabian grass) are often prominent.

Distribution:
This community is found on the southern edge of the north-eastern dunefields in the swales, or further south, scattered throughout the southern half of the study area, occurring either on the very low remnant dunes and in the swales, or on sandy plains.



Most frequently occurring species:
Tetragonia eremaea
Acacia aneura
Alectryon oleifolius
Brassica tournefortii
Schismus barbatus

North Olary Plains Survey Sites:
CUR09201, CUR14301, KAL04301, KAL13301, KOO11201, LCH01101, LCH02101, LCH06301, REA10201, THU10201

Description:
The overstorey species often take a shrub habit, and occasionally form a dense thicket. In the southern portion of the area adjacent to the Olary Spur this community is often found growing along the creeklines. In these instances, there is a high proportion of introduced species in the understorey.

Vegetation Condition:
The understorey is often depleted through grazing pressure in the watercourses with which it is associated in the south. Stock movement particularly in the cattle country has broken up the surface crust of the light soil, leaving many areas bare and consequently subject to introduced species invasion.

Most frequently occurring species in the ***Acacia aneura* Very open low woodland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	% Occur.	Cover/Abundance T	1	2	3	4	5
+	*Tetragonia eremaea/tetragonoides*	91	5	5	1			
	Acacia aneura var.	83	1	9				
	Alectryon oleifolius ssp. canescens	50	2	3	1			
+*	*Brassica tournefortii*	50	3	2	1			
+	*Rhodanthe moschata*	50	4	2				
+	*Salsola kali*	50	5	1				
+*	*Schismus barbatus*	50	2	3			1	
+	*Calotis hispidula*	41	2	3				
	Enchylaena tomentosa var. *tomentosa*	41	3	2				
	Maireana pyramidata	41	4	1				
+	*Omphalolappula concava*	41	4	1				
	Rhagodia spinescens	41	3	2				
+	*Rhodanthe floribunda*	41	2	3				
	Sclerolaena obliquicuspis	41	1	3	1			
	Amyema maidenii ssp. *maidenii*	33	3	1				
	Dissocarpus paradoxus	33	1	3				
	Enneapogon avenaceus	33	1	2	1			
+	*Erodium cygnorum* ssp.	33	2	1	1			
	Zygophyllum ammophilum	33	2	2				

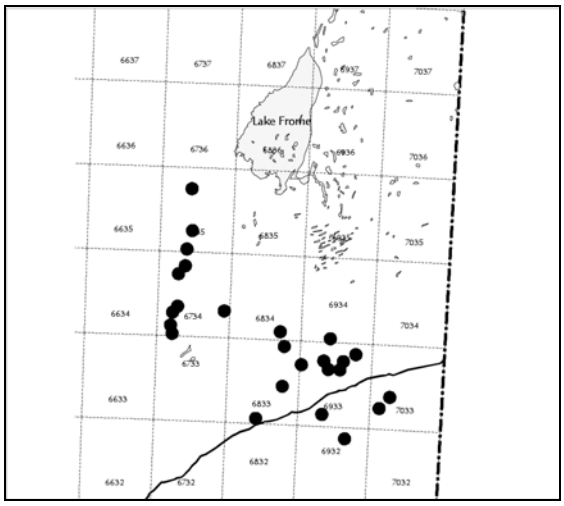
Figure 50
***Acacia aneura* Very open low woodland**
Site LCH01101. Very low woodland. *Acacia aneura* with *Casuarina pauper* emergent over *Salsola kali* and *Brassica tournefortii*.

Acacia aneura / Acacia victoriae / Sida petrophila Very open low woodland

Floristic Group Twenty-one: 31 members

Vegetation Structure:
This is very low woodland, to very low open woodland where the dominant overstorey species is *Acacia aneura* (Mulga). The understorey varies from dense shrubs, to very open herbs and grasses depending on the grazing pressure which has occurred at the site.

Distribution:
This community is confined to rocky hills in the Olary Spur and eastern Flinders Ranges in the south and south-west of the study area.



Most frequently occurring species:
Acacia aneura
Ptilotus obovatus
Sida petrophila
Solanum ellipticum/quadriloculatum
Cheilanthes lasiophylla
Eremophila freelingii
Acacia tetragonophylla
Enchylaena tomentosa

North Olary Plains Survey Sites:
CUR15301, KAL12501, MIN07101, MIN10201, OLA01401, OLA02101, OLA04101, OLA05101, OLA05301, OLA05501, OLA10601, REA01101, REA03501, REA07401, REA10301, WIL01201, WIL03401, WIL06101, WIL06401, WIL08201, WIL09101, WIL09201, WIN03201, WIN09201, WIN11101

Description:
In many parts of this community the Mulga is dying off without recruitment, and only dead stumps and trunks remain of what was moderately dense woodland. Mulga seedlings are amongst the most palatable of all the available fodder in this community for goats, rabbits, sheep and kangaroos. This preferential grazing pressure over time has brought about a dominance of *Eremophila freelingii*, *Dodonaea lobulata*, and in severe cases *Sida petrophila* and *Stipa* spp. The underlying soil is loamy, but usually very shallow and high levels of surface stone protect the surface crust. There is widespread visible evidence that goat impact is high, but recent rabbit and goat control measures in parts of the Olary Spur may allow some regeneration if low populations are maintained in the long term.

Vegetation Condition:
Where this community occurs in relatively small patches on outcrops, or isolated low hills, and is easily accessible from the surrounding plains, it has been heavily impacted by grazing. In the body of the Olary Spur where access by domestic stock is more difficult in the rugged terrain, examples of this community with higher diversity and better ground cover are present, however goats have had a significant impact.

Most frequently occurring species in the ***Acacia aneura / Acacia victoriae / Sida petrophila*** **Very open low woodland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**% Occur.**	**Cover/Abundance T**	**1**	**2**	**3**	**4**	**5**
	Ptilotus obovatus var. *obovatus*	93	9	19	1			
+	*Tetragonia eremaea/tetragonoides*	87	9	16	2			
	Solanum ellipticum/quadriloculatum	74	14	8	1			
	Sida petrophila	67	3	14	3		1	
	Acacia aneura var.	64	8	8	3	1		
	Cheilanthes lasiophylla	61	10	9				
	Enchylaena tomentosa var. *tomentosa*	58	14	4				
	Acacia tetragonophylla	54	11	5	1			
+	*Calotis hispidula*	54	7	10				
+	*Brachycome lineariloba*	51	8	8				
+*	*Sisymbrium erysimoides*	48	4	10	1			
	Abutilon fraseri	45	11	3				
+*	*Echium plantagineum*	45	10	4				
	Eremophila freelingii	45	6	6	2			
+*	*Erodium cicutarium*	45	7	7				
+	*Erodium cygnorum ssp.*	45	4	9	1			
	Cymbopogon ambiguus	42	10	3				
+	*Rhodanthe moschata*	42	3	10				
	Acacia victoriae ssp. *victoriae*	42	13					
	Dodonaea lobulata	38	5	5	2			
	Maireana pyramidata	38	8	3	1			
	Stipa scabra group	38	7	5				
	Sclerolaena obliquicuspis	35	4	4	3			
	Solanum petrophilum	35	11					
+	*Daucus glochidiatus*	32	4	6				
	Dissocarpus paradoxus	32	7	2	1			
+	*Lepidium oxytrichum*	32	8	2				
+	*Oxalis perennans*	32	7	3				
+	*Rhodanthe microglossa*	32	3	7				

Figure 51
***Acacia aneura / Acacia victoriae / Sida petrophila* Very open low woodland**
Site WIL09101. Low grass. *Sida petrophila* with *Acacia victoriae* emergent over *Sclerolaena obliquicuspis, Enneapogon cylindricus* and *E. nigricans*

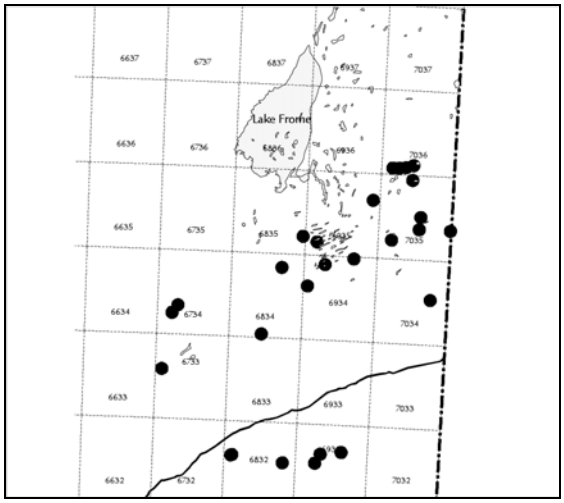
Figure 52
***Acacia aneura / Acacia victoriae / Sida petrophila* Very open low woodland**
Site OLA01401. Very low woodland. *Acacia aneura* and *A. tetragonophylla* over *Sida petrophila, Ptilotus obovatus* and *Solanum petrophilum*.

Casuarina pauper Low woodland

Floristic Group Twenty-two: 30 members

Vegetation Structure:
This community ranges in structure from an open forest to a low open woodland. It is dominated by *Casuarina pauper* (Black oak), and *Alectryon oleifolius* (Bullock bush) is also common in the overstorey. The understorey varies, ranging from dense chenopods to virtually bare ground. *Atriplex vesicaria* (Bladder saltbush), *Enchylaena tomentosa* (Ruby saltbush) and *Rhagodia spinescens* (Spiny saltbush) are often prominent.

Distribution:
Casuarina pauper is widespread in the study area, except for the hilly portions of the Olary Spur. Although widespread, these groves are particularly characteristic of the central plains south of Lake Frome, and of the southern edge of the dunefields close to the New South Wales border.



Most frequently occurring species:
Casuarina pauper
Enchylaena tomentosa
Alectryon oleifolius
Rhagodia spinescens
Atriplex vesicaria
Atriplex stipitata

North Olary Plains Survey Sites:
BEN06101, BEN11301, CUR03101, KAL01301, LCH02201, LCH06201, LCH09101, LCH10201, LCH11301, MUL06101, PAS15101, WIL06301, WIL09601

Description:
This community becomes floristically distinct where stands greater than about 0.5 hectare occur. These woodlands form a mosaic on the plains north of the Olary Spur with the ***Atriplex vesicaria / Maireana astrotricha*** **Low open shrubland** and ***Maireana astrotricha*** **Low open shrubland** communities. The community is also found further north along the New South Wales border where it is growing as a mosaic in the ***Acacia aneura / Enneapogon spp.*** **Low open woodland** of the northern dune fields. It is also widespread in the central-eastern region in combination with the ***Gunniopsis quadrifida*** **Low open shrubland** community. On some very rocky footslope sites in the Bibliando area (outlier of the Flinders Ranges) it forms monospecific stands over a thick layer of quartzite scree. Although this is a significant community by virtue of its wide range, most occurrences are unmappable because of their small size, and are mapped only as mosaics with other communities. Where the stands of Black oak are smaller than about 0.5 hectare, the surrounding community forms an understorey, and the Black oaks have the status of emergents in this other community.

Vegetation Condition:
The condition of this vegetation is variable. In sheep grazing areas the understorey is highly depleted near creeks and watering points, but further from water, the condition often improves. In the cattle areas, the soil surface is compacted and loosened and plant diversity low because the cattle use these groves for shelter. Kangaroos also use them for shelter, and considerable damage is often visible under groves of trees on the open plains, where these animals are abundant.

Most frequently occurring species in the ***Casuarina pauper*** **Low woodland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**% Occur.**	**Cover/Abundance T**	**1**	**2**	**3**	**4**	**5**
	Casuarina pauper	96	3	10	11	4	1	
+	*Tetragonia eremaea/tetragonoides*	70		8	2	11		
	Enchylaena tomentosa var. *tomentosa*	66		4	1	15		
+*	*Schismus barbatus*	60		3	15			
	Alectryon oleifolius ssp. *canescens*	53		16				
	Atriplex vesicaria ssp.	46	5	5	4			
	Rhagodia spinescens	46	8	5	1			
+	*Salsola kali*	43	10	2	1			
	Maireana pyramidata	40	7	3	2			
+	*Rhodanthe moschata*	40	7	5				
+	*Calotis hispidula*	36	8	3				
	Atriplex stipitata	33	7	2	1			
	Maireana astrotricha	33	3	4	3			
+	*Bulbine semibarbata*	30	7	2				

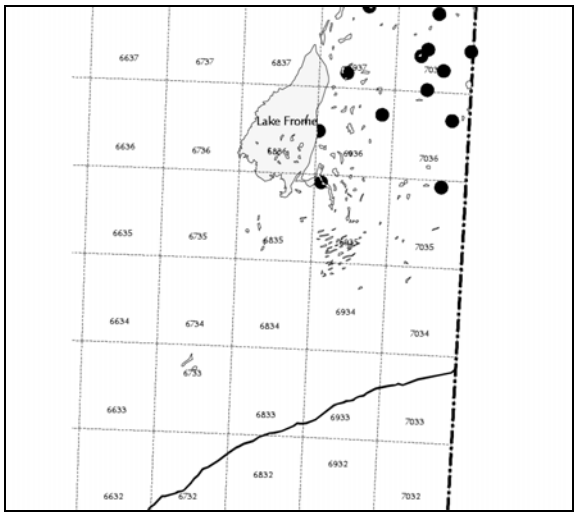
Figure 53
Casuarina pauper **Low woodlands**
Site LCH10201. Low open forest. *Casuarina pauper* over *Dissocarpus paradoxus* and *Enchylaena tomentosa.*

Acacia ligulata Very open shrubland

Floristic Group Twenty-three: 13 members

Vegetation Structure:
A tall open shrubland dominated by *Acacia ligulata* (Umbrella bush). *Callitris glaucophylla* (Native pine), *Casuarina pauper* (Black oak) and *Alectryon oleifolius* (Bullock bush) are present as emergents and sometimes form dense stands. The understorey is usually sparse tussock grasses and annual herbs.

Distribution:
This community is confined to the crests and flanks of sand dunes in the north-east corner of the study area. It extends south-west to the southern shores of Lake Frome. Minor occurrences are also found around Caldina Creek on Wooltana in low dunes overlying the Flinders Ranges outwash plains.



Most frequently occurring species:
Acacia ligulata
Senecio lautus
Brassica tournefortii
Polycalymma stuartii

North Olary Plains Survey Sites:
BEN01101, CNB04201, CNB06401, CNE02101, CNE08101, CNE08401, CNE09101, CNE11201, CTB10101, LCH03101, THU06201

Description:
The ground layer plants of this community are mostly ephemerals and may be very dense (the daisies in particular) after rain. The emergent species *Casuarina pauper* and *Callitris glaucophylla* become less common in the western half of the dunefields and are not present in dunes along the eastern shores of Lake Frome. An ephemeral flush of *Salsola kali* occurs after rains in the dunefields on the north-east margin of Lake Frome.

This dunefield was mapped by Specht (1972) as being dominated by *Zygochloa paradoxa* (Sandhill canegrass). This survey found no trace of this latter species, except for very isolated occurrences close to the south-west margins of Lake Frome. *Acacia ligulata* was found to be almost ubiquitous throughout the dunes. In the southern extremities of this community's range, and on the plains west of Lake Frome, the ***Dodonaea viscosa* ssp. *angustissima* Open shrubland** community sometimes incorporates patches of *Acacia ligulata*.

Vegetation Condition:
Many of the ground layer plants are ephemerals and were not apparent during the survey because of very low rainfall in the preceeding five years. However in a few places where recent rainfall had occurred species diversity was high. This suggests that the vegetation condition may be reasonable. Disturbance is severe near watering points. High rabbit numbers in some districts have adversely affected the botanical diversity.

Most frequently occurring species in the ***Acacia ligulata*** **Very open shrubland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**% Occur.**	**Cover/Abundance T**	**1**	**2**	**3**	**4**	**5**
	Acacia ligulata	100	3	4	5	1		
+*	*Brassica tournefortii*	92	1	8	3			
+	*Salsola kali*	92	3	9				
+	*Polycalymma stuartii*	84	3	8				
+*	*Schismus barbatus*	61		2	6			
	Casuarina pauper	38		1	4			
	Senecio lautus	38	5					
	Zygophyllum ammophilum	38	5					
+	*Blennodia pterosperma*	30	2	2				
+	*Bulbine semibarbata*	30	2	2				
+	*Euphorbia drummondii*	30	3	1				
+	*Tetragonia eremaea/tetragonoides*	30	3	1				
	Dodonaea viscosa ssp. *angustissima*	30	3	1				

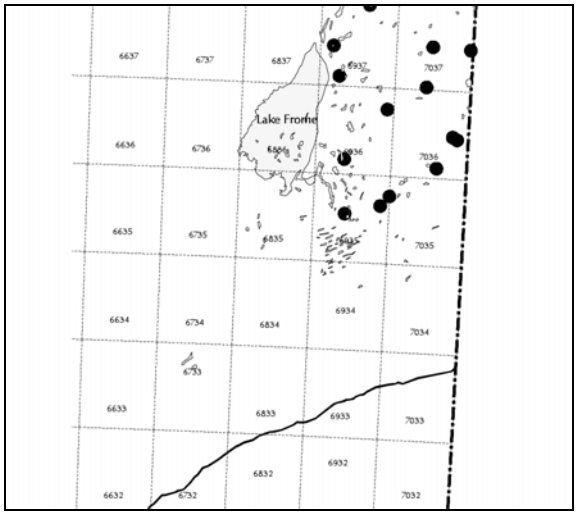
Figure 54
Acacia ligulata **Very open shrubland**
Site CNE09101. Tall open shrubland. *Acacia ligulata* over *Brassica tournefortii*, *Polycalymma stuartii*, *Aristida holathera*, *Enneapogon cylindricus* and *Eragrostis* sp.

Acacia aneura / Enneapogon spp. Low open woodland

Floristic Group Twenty-four: 16 members

Vegetation Structure:
This community is very variable and ranges from very low open woodland to very open herbland. Very open grassland is also present. There are usually no significant middle level shrubs. *Acacia aneura* (Mulga) is spread throughout this community although it is often so sparse that it has not been recorded at some of the survey sites. *Enneapogon avenaceus* (Bottlewashers) and *Salsola kali* (Roly-poly) are common in the understorey. Annual daisies and saltbushes are also common.

Distribution:
The community is closely associated with the dune system in the north east of the study area where it covers the great majority of the inter-dune swales. It is also widespread along the eastern shores of Lake Frome, and south of the dunefields where the dunes have been removed by wind action and the surface has become one vast swale in vegetation terms.



Most frequently occurring species:
Salsola kali
Enneapogon avenaceus
Acacia aneura
Brassica tournefortii

North Olary Plains Survey Sites:
BEN05201, BEN06201, CNB06101, CNB11201, CNE08501, CNE09301, CNE11101, CTB02201, CTB06201, CTB09201, LCH04201, THU09101, THU09210, THU11101

Description:
This is the main community between the eastern shore of Lake Frome and the start of the dune system. Here the *Acacia aneura* is very sparsely, although evenly distributed and the herb layer is prominent. South of the dunefields and nearer to the New South Wales border, the *Acacia aneura* forms a denser overstorey with a tussock grass ground layer. In the swales, the community is variable and may variously take the form of *Acacia aneura* woodland, chenopod shrubland, or herbfield, along a single swale.

Vegetation Condition:
Weed invasion of this community is often very heavy. Cattle cause considerable damage near watering points, and also along the adjacent swales by using them as pathways. Stocking levels are reasonably low within the dune system and more diverse and intact examples of this vegetation type remain at a distance from watering points. Rabbit impacts are considerable in the areas where their numbers are high.

Most frequently occurring species in the ***Acacia aneura / Enneapogon* spp. Low open woodland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	% Occur.	Cover/Abundance T	1	2	3	4	5
+*	*Brassica tournefortii*	87	7	3	4			
+	*Salsola kali*	75	7	4	1			
+	*Atriplex holocarpa*	62	8	1	1			
+	*Bulbine semibarbata*	62	4	5	1			
	Enneapogon avenaceus	62	1	9				
+*	*Schismus barbatus*	62	2	5	3			
+	*Gnephosis eriocarpa*	50	2	3	3			
+	*Tetragonia eremaea/tetragonoides*	50	5	3				
+	*Erodium cygnorum* ssp.	43	5	2				
	Senecio lautus	43	3	3	1			
+	*Polycalymma stuartii*	37		2	4			
	Acacia aneura var.	31	3	2				
+	*Craspedia pleiocephala*	31	2	3				
	Zygophyllum ammophilum	31	4	1				
+	*Harmsiodoxa brevipes* var.	31	5					

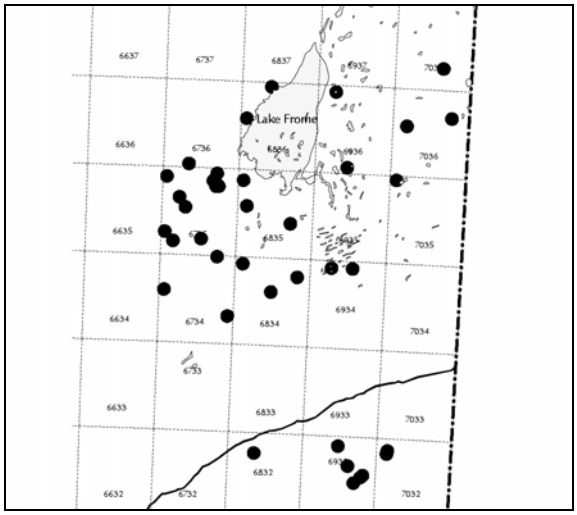
Figure 55
***Acacia aneura / Enneapogon spp.* Low open woodland**
Site CNE09301. Tussock grassland. Emergent *Acacia aneura* over *Enneapogon cylindricus*, *Enneapogon* sp., *Eragrostis* sp. and *Gnephosis eriocarpa*.

Maireana astrotricha Low open shrubland

Floristic Group Twenty-five: 153 members

Vegetation Structure:
The structure varies from a low shrubland to a low very open shrubland, and is dominated by *Maireana astrotricha* (Low bluebush). Other chenopods are also present. *Sclerolaena diacantha* (Two-spined copperburr) and *S. obliquicuspis* (Limestone copperburr) are prominent also. Small groves of *Casuarina pauper* are scattered throughout the community.

Distribution:
Although scattered throughout the survey area, the principal occurrence of this community is north of the ***Atriplex vesicaria / Maireana astrotricha*** **Low open shrubland** community. The sites are concentrated on the plains south of Lake Frome on the Curnamona mapsheet and along the New South Wales border on the Lake Charles mapsheet.



Most frequently occurring species:
Maireana astrotricha
Enneapogon avenaceus
Maireana pyramidata
Sclerolaena diacantha
Sclerolaena obliquicuspis
Atriplex vesicaria

North Olary Plains Survey Sites:
CNB01101, CNB11101, CUR01201, CUR04101, CUR07101, FRO02201, FRO03201, KAL01201, LCH01201, PAS01201, PAS06401, PAS11101, REA01501, REA02101, REA02201, REA02301, REA02401, REA04101, REA04201, REA09101, REA09201, REA10101, THU04101, THU06101, WIL02101, WIL03101, WIL08101

Description:
This is one of the most important sheep grazing communities in the North-eastern Pastoral district. It differs from the ***Atriplex vesicaria / Maireana astrotricha*** **Low open shrubland** community in the *Sclerolaena* species present, and the overall dominance of *A. vesicaria*, though these communities do overlap floristically. The ***Maireana astrotricha*** **Low open shrubland** occur more on the red duplex soils than the sandier soil preferred by the ***Atriplex vesicaria / Maireana astrotricha*** **Low open shrubland** community. *Casuarina pauper* is scattered throughout this community, usually as an emergent, with the surrounding plains community forming an understorey to it, but where the groves exceed about 0.5 hectare, the understorey becomes that of the ***Casuarina pauper*** **Low woodland** community. Where the shrub layer has become depleted, *Sclerolaena* spp. and grasses begin to dominate, and these areas have been mapped as a mosaic with the ***Sclerolaena obliquicuspis*** **Low very open shrubland** community. A major fire scar exists south of Curnamona HS where the Bluebush community has been converted to the "pure" ***Sclerolaena obliquicuspis*** **Low very open shrubland**. Patches of the ***Senna / Eremophila / Rhagodia spinescens*** **Open shrubland** are also mosaiced with this community.

Vegetation Condition:
Historically, most of this vegetation type has been heavily and continuously grazed, and is highly altered in some areas, particularly on the plains south of Lake Frome, where *Sclerolaena* spp. tend to dominate. In the Koonamore / Mt Victor area, recent invasions of *Eremophila sturtii* and the associated "woody weeds", particularly in slightly sandy areas, are seen by pastoralists as an indication of severe preferential grazing pressure. Condition, even within a paddock is quite variable, and clearly related to distance from water points and proximity to southern fencelines.

Most frequently occurring species in the ***Maireana astrotricha* Low open shrubland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	% Occur.	Cover/Abundance T	1	2	3	4	5
	Maireana astrotricha	86	26	47	57	2		
	Enneapogon avenaceus	72	28	44	39			
	Maireana pyramidata	54	56	15	12			
	Sclerolaena diacantha	52	42	22	17			
	Rhagodia spinescens	50	73	5				
	Sclerolaena obliquicuspis	45	38	28	4			
	Atriplex vesicaria ssp.	45	54	14	1			
	Eriochiton sclerolaenoides	40	28	22	12			
+	*Aristida contorta*	39	34	16	10			
+	*Tetragonia eremaea/tetragonoides*	37	31	24	2			
	Sclerolaena decurrens	35	20	24	11			
	Atriplex limbata	35	43	11				

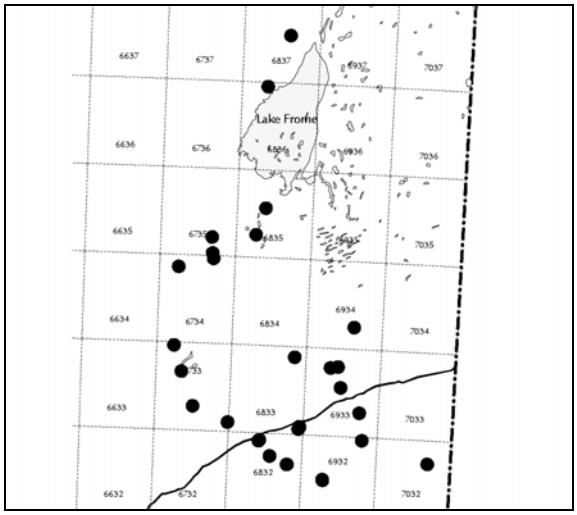
Figure 56
***Maireana astrotricha* Low open shrubland**
Site KAL01201. Low open shrubland. *Maireana astrotricha* and *Atriplex vesicaria* over *Rhodanthe floribunda* and *Gnephosis arachnoidea*.

Maireana pyramidata Low open shrubland

Floristic Group Twenty-eight: 73 members

Vegetation Structure:
This community is a shrubland, ranging from tall, to low and open. It is dominated by *Maireana pyramidata* (Blackbush). In some locations it is represented by mono-specific stands of *M. pyramidata*, and in other instances it may have shrubs of *Dodonaea*, *Senna*, *Eremophila* or *Acacia* present. Introduced herbs and grasses are prominent in the understorey.

Distribution:
This community is widely distributed south of Lake Frome, where it grows in drainage lines, and on valley floors in the Olary Spur. In the southern third of the survey area, where stocking pressures have been quite high historically, this community has replaced other more palatable chenopods.



Most frequently occurring species:
Maireana pyramidata
Rhagodia spinescens
Enneapogon avenaceus
Acacia victoriae
Tetragonia eremaea
Atriplex vesicaria
*Maireana astrotricha***North Olary Plains Survey Sites:**
FRO02301, KAL09101, KOO02101, KOO14101, KOO33101, KOO41101, OLA01201, OLA01501, OLA05401, OLA12201, PAR03301, PAS06101, PAS13101, REA11101, REA11301, WIL01101, WIL02501, WIN03301, WIN12201, WIN12301**Description:**This community is often growing in complex mosaics with the others associated with waterways; the ***Acacia victoriae* Very open shrubland**; the ***Eucalyptus largiflorens* Low open woodland**; and the ***Eucalyptus camaldulensis* Woodland**. It is the principal community covering the valley floors within the hills of the Olary Spur. There is considerable evidence to suggest that this community is an indicator of preferential grazing pressure, because low densities of the more palatable chenopod species are often present, and many introduced species occur within this vegetation type. *Acacia carnei*, listed as a rare species found in the study area, is also often associated with this community.**Vegetation Condition:**Because this community grows in water courses, alluvial flood plains and valley floors where stock activity is focussed, the level of disturbance is relatively high. It is also found where other chenopod communities have been heavily grazed in the past and therefore in some cases is an indicator community of high disturbance. The next stage in this disturbance continuum is where *Nitraria billardierei* also colonises and all palatable chenopods disappear. There are numerous examples where this is the case, from Willippa to areas south of the Barrier Highway.

Most frequently occurring species in the ***Maireana pyramidata*** **Low open shrubland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**% Occur.**	**Cover/Abundance T**	**1**	**2**	**3**	**4**	**5**
	Maireana pyramidata	98	2	25	44	1		
	Rhagodia spinescens	72	44	8	1			
+	*Tetragonia eremaea/tetragonoides*	67	25	17	6	1		
	Enneapogon avenaceus	53	15	21	3			
	Atriplex vesicaria ssp.	52	23	9	6			
	Acacia victoriae ssp. *victoriae*	47	31	3	1			
	Maireana astrotricha	45	21	12				
+	*Calotis hispidula*	37	11	13	3			
	Maireana georgei	35	22	4				
+*	*Schismus barbatus*	34	9	14	2			
	Sclerolaena obliquicuspis	34	14	9	2			
	Sclerolaena lanicuspis	32	19	5				
	Eremophila sturtii	31	21	2				

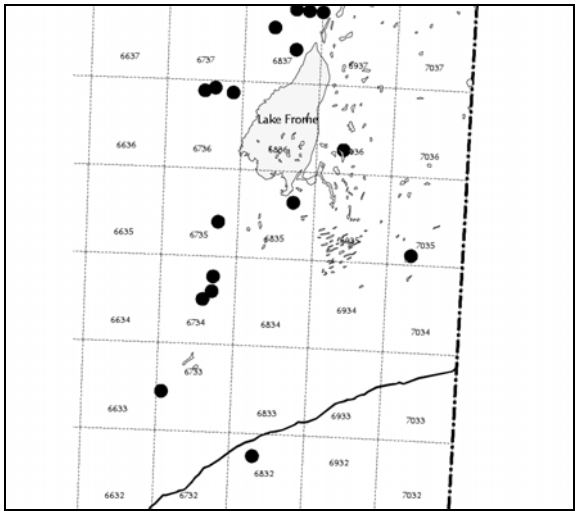
Figure 57*Maireana pyramidata* Low open shrubland
Site OLA05401. Tall open shrubland. *Maireana pyramidata, Rhagodia spinescens* with emergent *Dodonaea viscosa* ssp. *angustissima, Alectryon oleifolius* ssp. *canescens* over *Sclerolaena divaricata* and *Tetragonia eremaea*.

Sclerolaena brachyptera / Maireana aphylla Low very open shrubland

Floristic Group Twenty-nine: 63 members

Vegetation Structure:
Usually a low or low open shrubland, this community is often dominated by *Maireana aphylla* (Cottonbush). It contains a number of *Sclerolaena* spp. in the understorey (although they may sometimes be dominant), including *S. brachyptera* (Short-winged copperburr) and *S. ventricosa* (Salt copperburr).

Distribution:
This community is found throughout the study area on flood-out areas and in drainage lines.



Most frequently occurring species:
Sclerolaena brachyptera
Sclerolaena ventricosa
Sclerolaena divaricata
Eragrostis setifolia
Maireana aphylla

North Olary Plains Survey Sites:
CNB08101, KOO24101, LCH01101, PAR01101, PAR01101, PAR01301, PAR02101, PAR03101, PAR06101, PAS07101, REA08301, WIL02201, WIL04101, WIL04201

Description:
This community is similar in appearance to the ***Maireana aphylla* Low open shrubland** community, but can be distinguished from it by the presence of *Sclerolaena brachyptera* and *Sclerolaena ventricosa*. Both occur on depositional soils composed of fine alluvium in very slight depressions. These parts stay wetter longer than the surrounding area after rain. It is not clear why these two communities are floristically distinct, in spite of growing in similar environments in the same region. The ***Maireana aphylla* Low open shrubland** community is confined to the northern edge of the eastern plains, whilst this present community is more widely spread.

Vegetation Condition:
Because the wetter areas which support this community are favoured by stock, particularly for opportunistic ephemeral growth, they are often quite degraded.

Most frequently occurring species in the ***Sclerolaena brachyptera / Maireana aphylla*** **Low very open shrubland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**% Occur.**	**Cover/Abundance T**	**1**	**2**	**3**	**4**	**5**
	Sclerolaena brachyptera	87	12	33	10			
	Sclerolaena ventricosa	82	9	21	21	1		
	Sclerolaena divaricata	68	20	21	2			
	Eragrostis setifolia	62	23	13	3			
	Maireana aphylla	57	27	7	1	1		
	Atriplex vesicaria	55	21	8	5	1		
	Enneapogon avenaceus	55	23	12				
+	*Atriplex angulata*	54	12	20	2			
	Maireana astrotricha	44	23	4	1			
+	*Salsola kali*	38	14	10				
	Maireana pyramidata	36	21	2				
	Rhagodia spinescens	36	19	4				
	Astrabla pectinata	35	9	10	3			
+	*Atriplex lindleyi* ssp.	35	17	4	1			
	Sida intricata	33	19	1	1			
	Dissocarpus biflorus var.	32	13	7				
	Sporobolus actinocladus	32	12	6	2			
	Dissocarpus paradoxus	30	13	6				

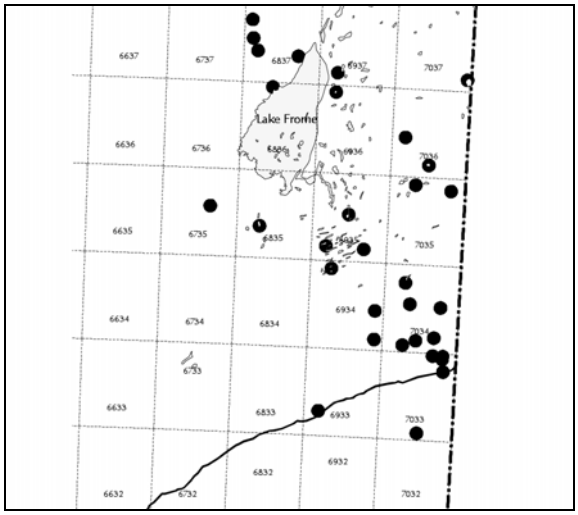
Figure 58
Sclerolaena brachyptera / Maireana aphylla **Low very open shrubland**
Site LCH11101. Low shrubland. *Maireana aphylla* over *Tetragonia eremaea, Atriplex holocarpa* and *Graminae sp.*.

Sclerolaena divaricata Low very open shrubland

Floristic Group Thirty-one: 39 members

Vegetation Structure:
This community is a low open, or low very open shrubland dominated by *Sclerolaena divaricata* (Poverty bush). In dry seasons when the *Sclerolaena* spp. has died and the plants dispersed, the community may be a very open tussock grassland. Occasionally *Eragrostis australasica* (Canegrass) is sparsely present when the community is growing in claypans.

Distribution:
The community occurs throughout the eastern and northern portions of the study area.



Most frequently occurring species:
Sclerolaena divaricata

North Olary Plains Survey Sites:
BEN05401, BEN12201, BEN13101, CNB01201, CNE12401, CTB09301, FRO02101, KAL01101, KAL10201, KAL13401, LCH01301, LCH03201, MIN02101, MIN02201, MIN02301, MIN02701, MIN11101, MUL01101, MUL05301, MUL06501, MUL11101, MUL11301, MUL12101, OLA10501, PAR05101, PAR06201, PAR09101, PAR10101, PAS10101, REA05101, THU07101, THU11301

Description:
Mostly confined to silty clay soils and gilgais, this community is also found in claypans and in low lying areas. It forms a mosaic with the ***Atriplex vesicaria / Maireana astrotricha*** **Low open shrubland** community with the *A. vesicaria* on the slightly raised, sandier, better drained soils and this community in the lower portions of the plain. It also occurs in most claypans and small lakes in the region, although in these cases it is sometimes simply an understorey to the ***Maireana aphylla*** **Low open shrubland** or the ***Eragrostis australasica / Muehlenbeckia florulenta*** **Open shrubland** communities. It can also be found where the ***Atriplex vesicaria / Maireana astrotricha*** **Low open shrubland** community has been badly degraded. It often appears to be a degraded state of the ***Maireana aphylla*** **Low open shrubland** and ***Astrebla pectinata*** **Open grassland** communities, where the more palatable species have been depleted through grazing, or by prolonged drought conditions.

Vegetation Condition:
In areas such as pans and lakes which are unattractive to stock, this vegetation type provides a cover to hold the soil together, though in itself it is low in perennial diversity. However the occurrences on better drained sites are probably representative of severe previous degradation of the original communities.

Most frequently occurring species in the ***Sclerolaena divaricata*** **Low very open shrubland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	% Occur.	Cover/Abundance T	1	2	3	4	5
	Sclerolaena divaricata	90	3	13	17	2		
+	*Tetragonia eremaea/tetragonoides*	54	9	10	2			
+	*Plantago drummondii*	49	6	13				
+	*Calotis hispidula*	46	11	7				
+	*Zygophyllum iodocarpum*	46	9	9				
+	*Atriplex holocarpa*	38	7	6	2			
	Dissocarpus paradoxus	38	4	11				
+	*Rhodanthe floribunda*	38	8	7				
	Sclerolaena ventricosa	35	4	7	3			
+	*Daucus glochidiatus*	33	8	5				
+*	*Schismus barbatus*	33	7	6				
	Atriplex vesicaria ssp.	33	9		4			
	Maireana aphylla	30	7	3	1	1		
	Sclerolaena brachyptera	30	7	5				

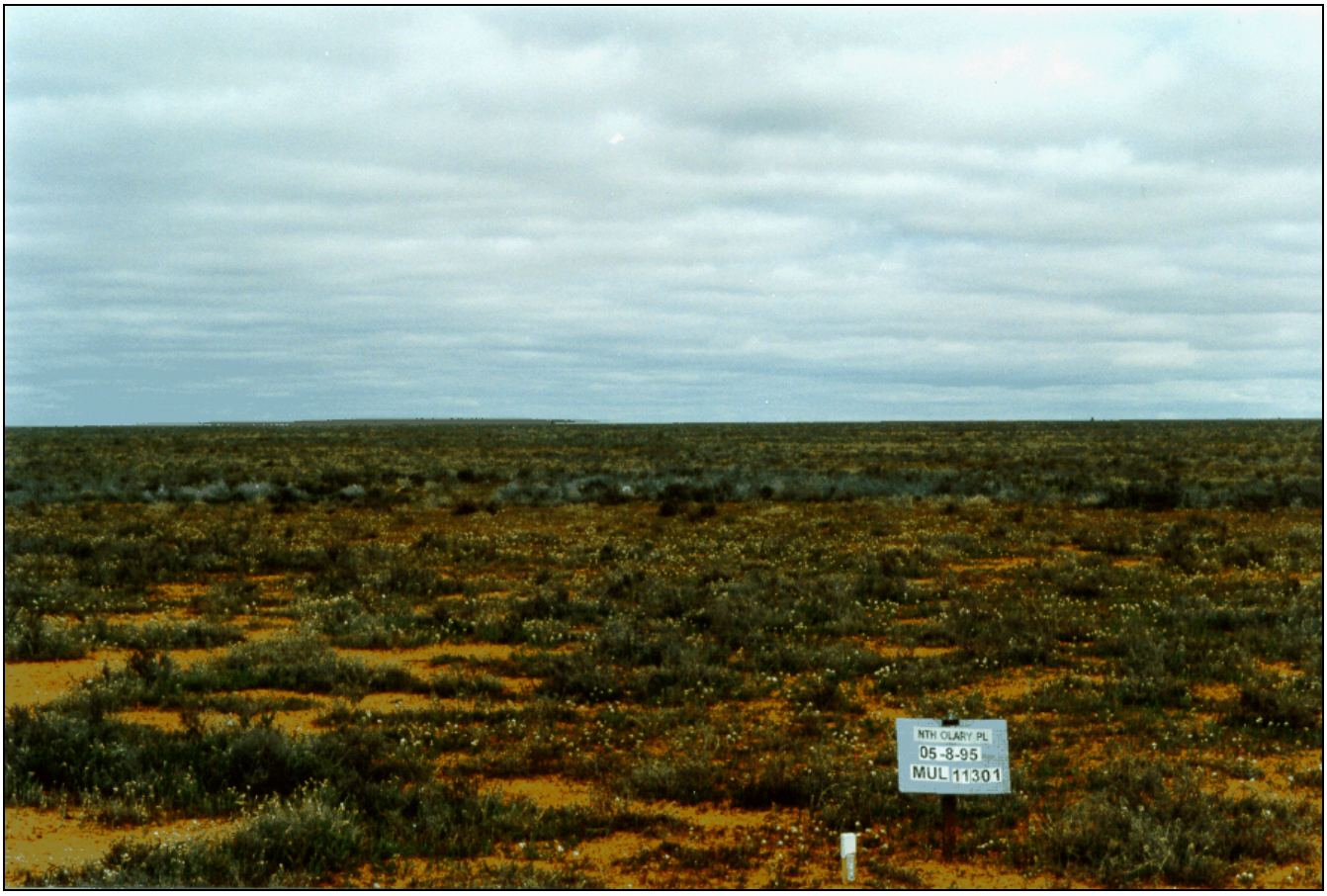


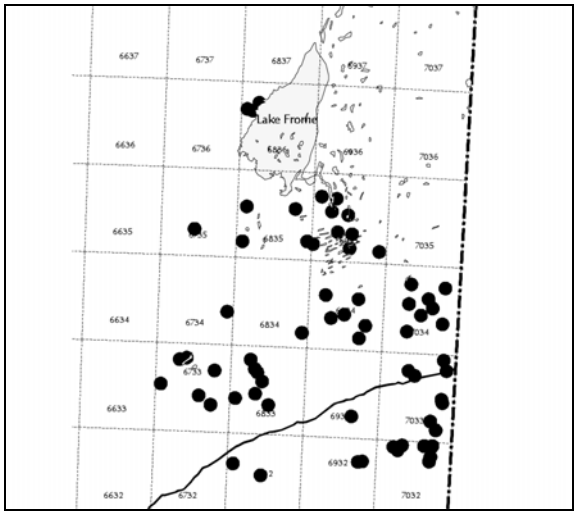
Figure 59
Sclerolaena divaricata **Low very open shrubland**
Site MUL11301. Low shrubland. *Sclerolaena divaricata* over *Rhodanthe floribunda* and *Calotis hispidula*.

Atriplex vesicaria / Maireana astrotricha Low open shrubland

Floristic Group Thirty-two: 220 members

Vegetation Structure:
This community varies from low shrubland to low open shrubland. *Atriplex vesicaria* (Bladder saltbush) is present at all, and dominant at most sites. *Maireana astrotricha* (Low bluebush) is widespread, as is *Maireana pyramidata* (Blackbush) and *Rhagodia spinescens* (Spiny saltbush). *Sclerolaena* spp. (Copperburrs) and daisies are prominent in the understorey. Grasses can be seasonally very common. Groves of *Casuarina pauper* are found spread throughout most areas of this community, locally forming a woodland.

Distribution:
This community is found throughout the southern portion of the study area, south of Lake Frome. It is confined to plains and low rises, and absent from the low hills of the Olary Spur. Extensive areas of outwash to the north of the low Olary Spur hills have produced a distinctive pattern of bare scalds often with a sparse cover of quartz pebbles within this community.



Most frequently occurring species:
Atriplex vesicaria
Maireana astrotricha
Enneapogon avenaceus
Sclerolaena decurrens
Sclerolaena ventricosa
Maireana pyramidata
Sclerolaena brachyptera
Sclerolaena obliquicuspis
Rhagodia spinescens

North Olary Plains Survey Sites:
BEN04101, BEN04201, BEN04301, BEN05301, BEN08201, BEN09101, BEN11101, BEN12401, BEN14101, CUR15101, CUR15201, FRO01201, FRO01301, KAL04201, KAL06101, KAL08101, KAL09201, KAL13101, KAL13201, KOO08101, KOO09101, KOO16101, KOO18101, KOO27101, KOO34101, MIN01201, MIN01401, MIN02401, MIN02601, MIN09101, MIN09201, MIN12201, MIN12301, MUL02301, MUL03201, MUL05401, MUL06201, MUL06301, MUL09101, MUL10101, MUL11201, OLA12101, PAS06201, PAS08101, PAS12101, REA07301, WIL08301, WIN01301, WIN01401, WIN01501, WIN05301, WIN07101, WIN08401, WIN09101

Description:
A very important community for sheep grazing (particulary during drought) throughout South Australia, the areas of ***Atriplex vesicaria / Maireana astrotricha*** **Low open shrubland** community between the Barrier Highway and Lake Frome have been a focus of pastoral land use for about 150 years. This community is rich in native grasses and herbs which provide excellent opportunistic grazing particularly with the ephemeral flush after rain. *Casuarina pauper* groves are scattered throughout this community. The ***Maireana sedifolia*** **Low open shrubland** community is interspersed where rises and stony ground occur, particularly in the south, and it gives way to the ***Sclerolaena divaricata*** **Low very open shrubland** community north of the Honeymoon area and grades into the ***Maireana astrotricha*** **Low open shrubland** community north of Koonamore.

Vegetation Condition:
Heavy grazing to stem butts actually kills *Atriplex vesicaria*, but *Maireana astrotricha* can still regenerate from butts, however *M. astrotricha* is preferred by sheep, so it is usually only in prolonged drought or extreme grazing conditions where this botanical composition change occurs. Another botanical compositional change which is evident in some of the southern parts of the survey area occurs when under extreme conditions, grazing pressure favours the survival of the less palatable *A. stipitata* over *A. vesicaria*. The balance between these species is often an indication of historical extreme situations. Though many areas have a long history of heavy grazing, there is still much of this community which is in reasonable condition.

Most frequently occurring species in the ***Atriplex vesicaria / Maireana astrotricha*** **Low open shrubland** community, with the frequency of each cover abundance score.

	Species	**%**	**Cover/Abundance**					
	+ is an annual or seasonally non-detectable species	**Occur.**	**T**	**1**	**2**	**3**	**4**	**5**
	Atriplex vesicaria ssp.	100	4	50	155	10	1	
	Maireana astrotricha	83	51	69	62	1		
	Enneapogon avenaceus	56	47	55	22			
	Sclerolaena ventricosa	56	66	41	17			
	Sclerolaena brachyptera	51	65	35	11	1		
	Maireana pyramidata	50	87	20	3			
	Rhagodia spinescens	47	100	3				
+	*Tetragonia eremaea/tetragonoides*	46	49	44	9			
	Sclerolaena decurrens	44	46	33	17			
	Sclerolaena lanicuspis	43	64	21	9			
	Dissocarpus biflorus var.	35	61	14	1			
	Sclerolaena obliquicuspis	34	40	26	8	1		
	Sclerolaena divaricata	33	59	14				
+	*Calotis hispidula*	30	23	40	4			
	Sclerolaena diacantha	30	44	20	2			
	Tripogon loliiformis	30	34	28	4			

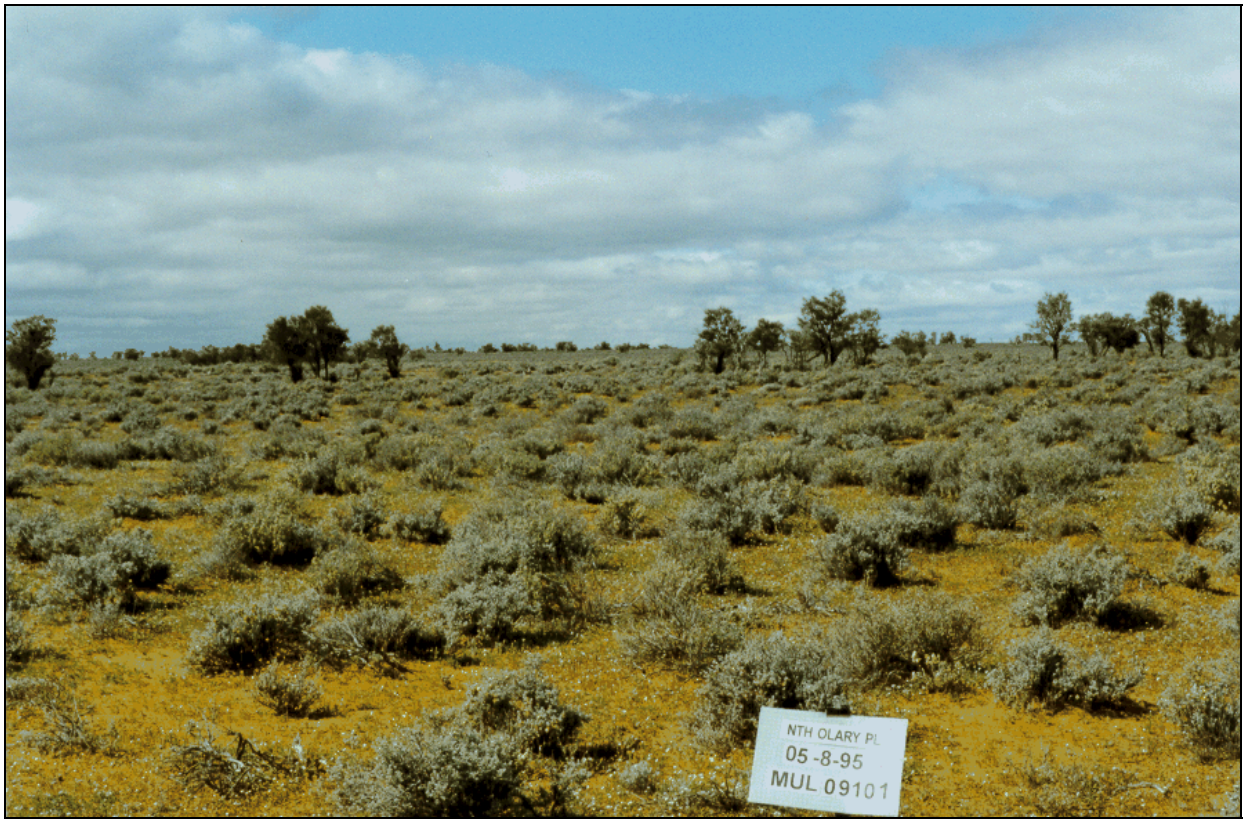


Figure 60
***Atriplex vesicaria / Maireana astrotricha* Low open shrubland**
Site MUL09101. Low shrubland. *Atriplex vesicaria* and *Maireana astrotricha* with emergent *Casuarina pauper* over *Craspedia pleiocephala*, *Rhodanthe floribunda*, *Calotis plumulifera*, *Tetragonia eremaea* and *Sclerolaena intricata*.

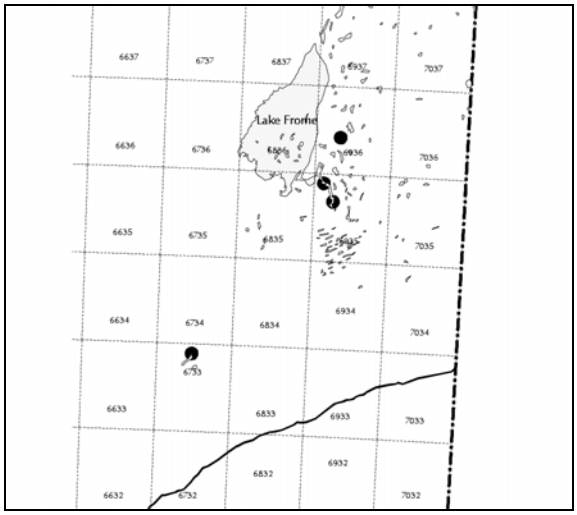
Figure 61
Aerial view of "pure" *Atriplex vesicaria / Maireana astrotricha* Low open shrubland with no emergent species, north of Manna Hill

Halosarcia Low open shrubland

Floristic Group Thirty-four: 4 members

Vegetation Structure:
This community is a low shrubland, varying from closed to very open. *Halosarcia indica* (Samphire) is the most common dominant. Only a few annual species were recorded with the samphire, most commonly *Atriplex holocarpa* (Pop saltbush).

Distribution:
Samphires are found throughout the study area wherever highly saline and frequently inundated conditions occur. They fringe most saltlakes and a number of claypans. On Koonamore Station in the south-west, this community covers some extensive depressions in the chenopod plains communities.



Most frequently occurring species:
Halosarcia indica
Atriplex holocarpa
Halosarcia pergranulata ssp.

North Olary Plains Survey Sites:
BEN01201, BEN04401, CNB08201, KOO03101

Description:
Usually this community forms a dense, narrow fringe around the numerous saltlakes in the area. It grows onto the salt surface and is often flanked on the landward, less saline higher ground by the ***Nitraria billardierei* Low open shrubland** Often shrubs of *Halosarcia* spp. can be found scattered across the surface of the lakes where the single shrubs form small depositional mounds. When on the salt surfaces the samphires are growing alone, but where found on less saline clayey anaerobic soils there is usually an understorey of annual herbs present.

Vegetation Condition:
The dominance of unpalatable species in this community renders it extremely unattractive to sheep and cattle and is probably little impacted by pastoralism, and in relatively natural condition.

Most frequently occurring species in the ***Halosarcia*** **Low open shrubland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**%** **Occur.**	**Cover/Abundance** **T**	**1**	**2**	**3**	**4**	**5**
	Halosarcia sp.	75	1			1		1
+	*Atriplex holocarpa*	75	3					
	Zygophyllum ammophilum	50	1	1				
	Senecio lautus	50	2					
+	*Tetragonia eremaea/tetragonoides*	50	2					
+	*Brachycome lineariloba*	25		1				
+	*Bulbine semibarbata*	25		1				
	Enneapogon avenaceus	25		1				
	Gunniopsis quadrifida	25		1				
	Halosarcia indica ssp.	25		1				
	Halosarcia pergranulata ssp.	25		1				
	Panicum decompositum var. *decompositum*	25		1				
+	*Polycalymma stuartii*	25		1				
+	*Rhodanthe floribunda*	25		1				
	Sclerolaena divaricata	25		1				
+	*Zygophyllum howittii*	25		1				
	Atriplex limbata	25	1					
	Atriplex vesicaria ssp.	25	1					
+*	*Brassica tournefortii*	25	1					

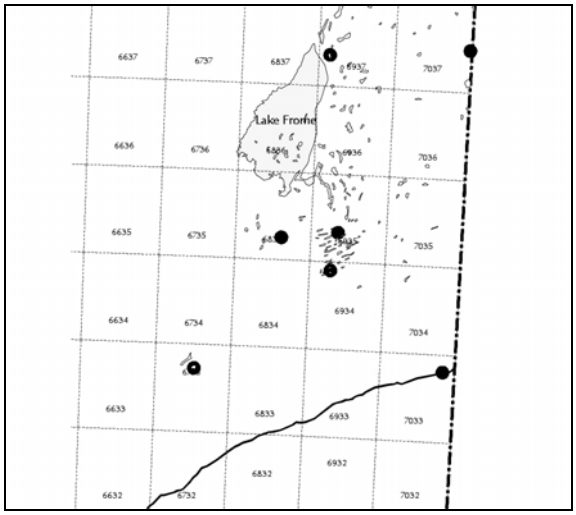
Figure 62
Halosarcia **Low open shrubland**
Site BEN01201. Very open low shrubland. *Halosarcia sp.*

Eragrostis australasica / *Muehlenbeckia florulenta* Open shrubland

Floristic Group Thirty-five: 8 members

Vegetation Structure:
Either a closed grassland dominated by *Eragrostis australasica* (Canegrass), or a shrubland dominated by *Muehlenbeckia* spp. (Lignum). The ground layer is usually sparse and composed of ephemeral herbs and annual saltbushes.

Distribution:
This community is found throughout the study area and grows wherever suitable swamps or claypans occur. South of the major dunefields around the Benagerie area, depressions supprting this community are common.



Most frequently occurring species:
Eragrostis australasica
Tetragonia eremaea
Sclerolaena divaricata
Calotis hispidula

North Olary Plains Survey Sites:
BEN08101, CNE09201, CTB06101, KAL01401, KOO15101, MIN02501, PAS15301

Description:
Most examples are spatially quite small, rarely exceeding 1-2 hectares. This community is typically found at the centers of non-saline claypans and depressions with the ***Sclerolaena divaricata*** **Low very open shrubland** community growing around the edges. The ***Eucalyptus largiflorens*** **Low open woodland** may also fringe the edges of this community.

Vegetation Condition:
In the north, cattle grazing damage is significant, and usually considerable trampling damage is evident. The sites in the sheep grazing districts, however are in better condition possibly because of the low palatability to sheep of the species present.

Most frequently occurring species in the ***Eragrostis australasica* / *Muehlenbeckia florulenta* Open shrubland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	% Occur.	Cover/Abundance T	1	2	3	4	5
+	*Tetragonia eremaea/tetragonoides*	75	3	2	1			
+	*Calotis hispidula*	50	1	3				
	Sclerolaena divaricata	50	2	1	1			
	Eragrostis australasica	50			2	2		
+	*Salsola kali*	50	4					
+	*Atriplex pseudocampanulata*	37	1	1	1			
+	*Atriplex holocarpa*	37	2	1				
+	*Daucus glochidiatus*	37	2	1				
+	*Brachycome lineariloba*	25		1	1			
	Dissocarpus biflorus var.	25	1	1				
	Enneapogon avenaceus	25	1	1				
	Eragrostis eriopoda	25		1	1			
+	*Erodium cygnorum* ssp.	25		2				
	Maireana aphylla	25	1	1				
+*	*Medicago polymorpha* var. *polymorpha*	25	1	1				
	Muehlenbeckia florulenta	25		1			1	
+	*Plantago drummondii*	25		1	1			
+*	*Schismus barbatus*	25		2				
	Senecio lautus	25	1	1				
	Atriplex vesicaria ssp.	25	2					
	Enchylaena tomentosa var. *tomentosa*	25	2					
	Rhagodia spinescens	25	2					
	Sclerolaena intricata	25	2					
+	*Teucrium racemosum*	25	2					

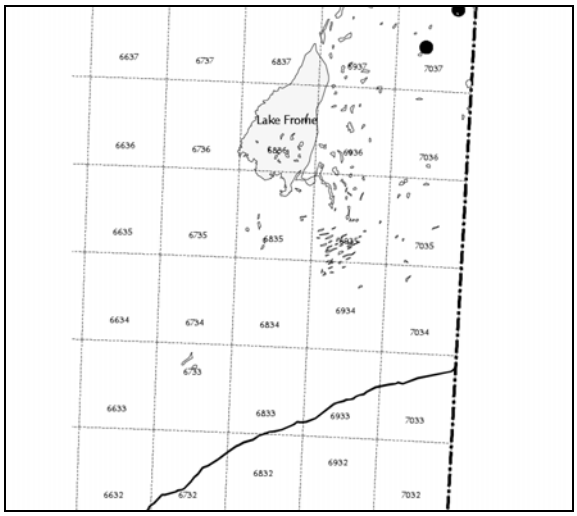
Figure 63
***Eragrostis australasica* / *Muehlenbeckia florulenta* Open shrubland**
Site KAL01401. Tall Grassland. *Eragrostis australasica* over *Sclerolaena divaricata* and *Dissocarpus biflorus.*

Cyperus laevigatus Sedgeland

Floristic Group Thirty-six: 2 members

Vegetation Structure:
This community is a closed sedgeland dominated by *Cyperus laevigatus* (Boredrain sedge) or *Typha domingensis* (Bullrush). *Tamarix aphylla* (Athel pine) is prominent as an emergent.

Distribution:
The community is restricted to the Coonee Creek and associated lakes and bore-drains in the far north-east of the study area.



Most frequently occurring species:
Cyperus laevigatus

North Olary Plains Survey Sites:
CNE03101, CNE08301

Description:
This community grows densely where bore water is permanantly flowing in the Coonee Creek. In other areas it is growing in small sparse patches. The species diversity is probably greater than the two survey sites included here suggest. The introduced species *Tamarix aphylla* is growing all the way along the creek system from the New South Wales border to its end at Rotten Swamp, and in a few places forms dense groves.

Vegetation Condition:
Cattle using the bore water where it runs in Coonee Creek have completely destroyed all vegetation on the creek banks. The sedgeland is confined to the deeper pools where trampling is less severe.

Most frequently occurring species in ***Cyperus laevigatus*** **Sedgeland** Community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**%** **Occur.**	**Cover/Abundance** **T**	**1**	**2**	**3**	**4**	**5**
	Cyperus laevigatus	100		1				1
+	*Atriplex holocarpa*	50		1				
	Typha domingensis	50	1	1				
	Bolboschoenus caldwellii	50	1					
	Tamarix aphylla	50	1					

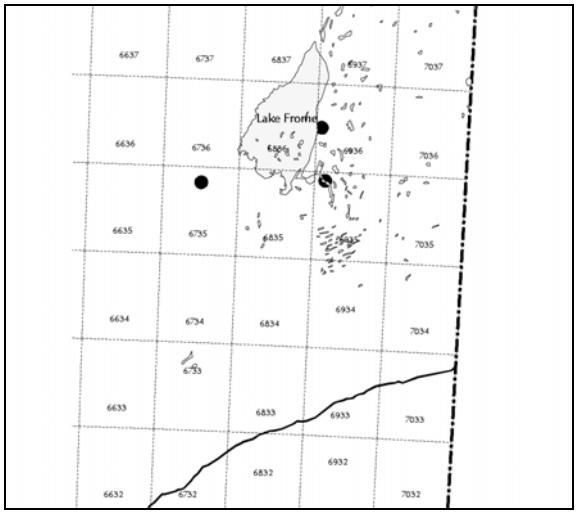
Figure 64
Cyperus laevigatus **Sedgeland**
Site CNE03101. Sedgeland. *Typha domingensis* with emergent *Tamarix aphylla* over *Cyperus laevigatus*, *Bolboschoenus caldwellii* and *Juncus* sp.

Rhodanthe floribunda Herbland

Floristic Group Thirty-seven: 3 members

Vegetation Structure:
An open, to very open herbfield dominated by *Rhodanthe floribunda* (white sunray). *Salsola kali* (roly-poly) and *Teucrium racemosum* (grey germander) can be locally common after rain. After poor seasons this community may be bare soil with only very sparse *Enneapogon avenaceus* (bottlewashers) tussocks present.

Distribution:
This community is found on gypsum sands on the down-wind side of Lake Frome and the other larger lakes in the central northern portion of the survey area. It also occurs on the islands of Lake Frome which are gypsaceous sands.



Most frequently occurring species:
Rhodanthe floribunda
Salsola kali
Teucrium racemosum
Enneapogon avenaceus
Sclerolaena obliquicuspis

North Olary Plains Survey Sites:
BEN01301, CNB04101, REA02601

Description:
This community grows in halo-shaped crescents around the eastern side of each salt lake. On the shores of the lakes it merges into the ***Nitraria billardierei* Low open shrubland**. On the landward side it adjoins the ***Acacia aneura / Enneapogon* spp. Low open woodland** community. *Gunniopsis quadrifida* shrubs are scattered throughout and are moderately dense on some of the islands in Lake Frome.

Vegetation Condition:
The condition of the vegetation is highly variable in such an ephemeral community, and difficult to assess without multiple visits. Cattle damage is visible and obvious near water points. The number of rabbit warrens is very high. Where rain had recently fallen, ephemeral herb growth was diverse and prolific.

Most frequently occurring species in the ***Rhodanthe floribunda*** **Herbland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**%** **Occur.**	**Cover/Abundance** **T**	**1**	**2**	**3**	**4**	**5**
+	*Rhodanthe floribunda*	100	1	2				
+	*Craspedia pleiocephala*	66		2				
	Enneapogon avenaceus	66		2				
	Sclerolaena obliquicuspis	66		1		1		
+	*Stenopetalum lineare*	66		2				
+	*Tetragonia eremaea/tetragonoides*	66		1		1		
+	*Salsola kali*	66	2					
*	*Asphodelus fistulosus*	33		1				
+	*Bulbine semibarbata*	33		1				
+	*Calotis hispidula*	33		1				
+	*Erodium cygnorum* ssp.	33		1				
+	*Omphalolappula concava*	33		1				
+	*Pimelea simplex* ssp.	33		1				
+	*Rostraria pumila*	33		1				
+*	*Brassica tournefortii*	33			1			
	Sclerolaena limbata	33			1			
	Senecio lautus	33			1			
	Gunniopsis quadrifida	33	1					
	Maireana pyramidata	33	1					
+	*Polycalymma stuartii*	33	1					
	Rhagodia spinescens	33	1					
	Vittadinia eremaea	33	1					

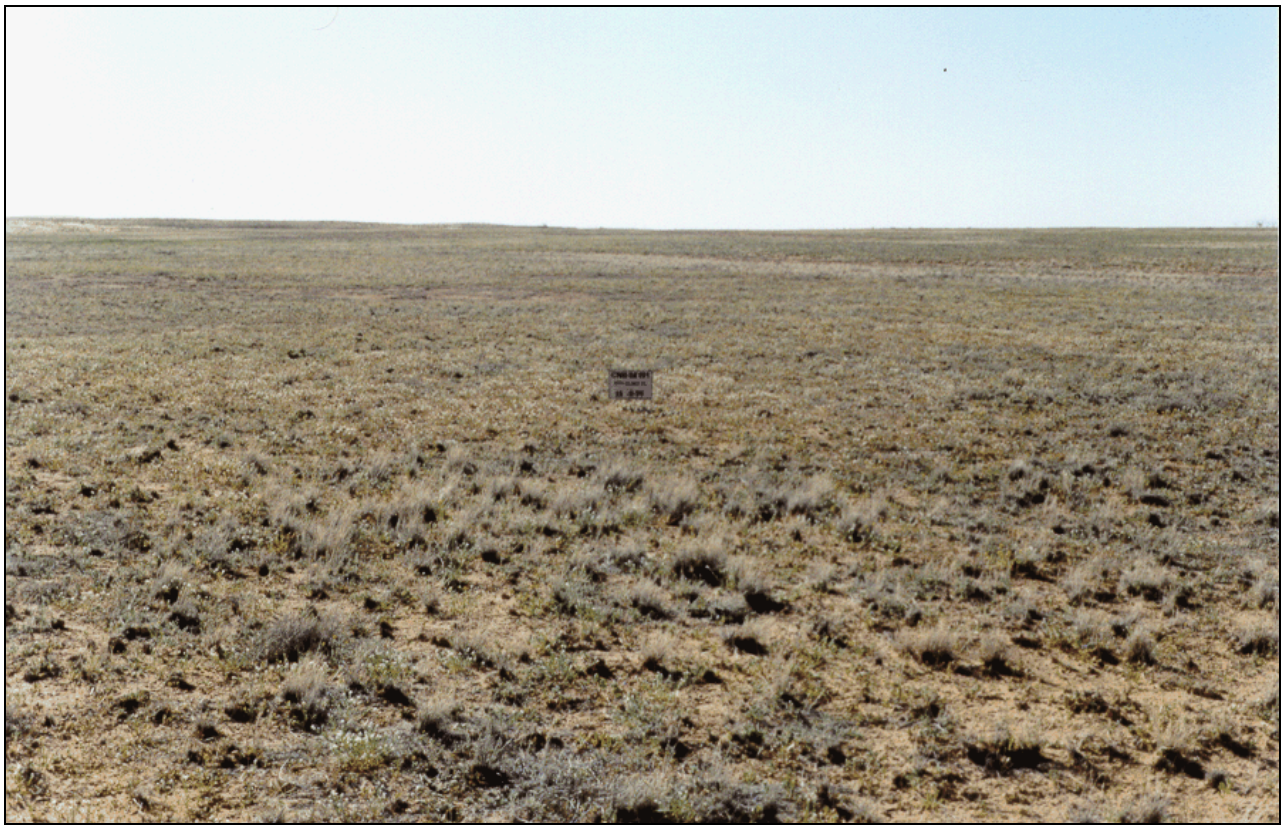


Figure 65
Rhodanthe floribunda **Herbland**
Site CNB04101. Herbs. *Rhodanthe floribunda, Craspedia pleiocephala, Brassica tournefortii.*

Figure 66
Unstable sand drifts on the margins of some of the islands in Lake Frome covering the **sparse** ***Nitraria billardierei***.

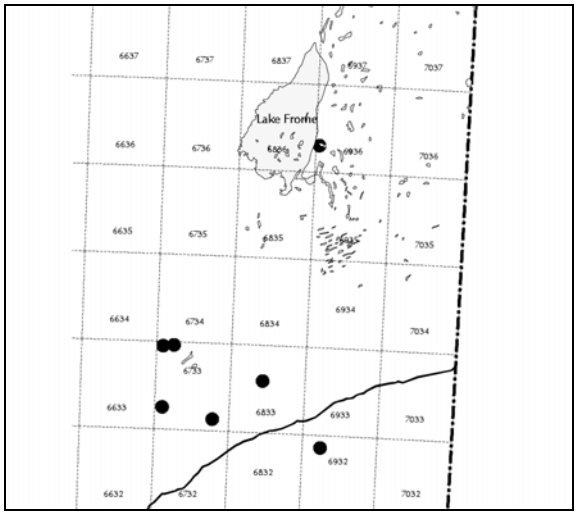
Figure 67
Deep consolidated gypseous sediments on the larger Lake Frome islands support ***Gunniopsis quadrifida*** **and** ***Maireana pyramidata.***

Sclerolaena obliquicuspis Low very open shrubland

Floristic Group Thirty-eight: 11 members

Vegetation Structure:
This community is either open low shrubland dominated by *Sclerolaena obliquicuspis* (Limestone copperburr), or herbfield dominated by various introduced species including *Asphodelus fistulosus* (Onion weed) and *Carrichtera annua* (Ward's weed).

Distribution:
Recorded mainly in the south-western part of the study area. Some of the mapped occurrences are on perpetual lease land currently managed for pastoral use, but some of which may have been cropped last century. Wherever it occurs it usually represents many years of continuous, heavy grazing.



Most frequently occurring species:
Enneapogon avenaceus
Sclerolaena obliquicuspis
Calotis hispidula
Eriochiton sclerolaenoides

North Olary Plains Survey Sites:
CNB07101, KOO01101, KOO02201, KOO30101, KOO40101, WIN05101

Description:
This herbfield community appears to have been created by continuous heavy grazing by stock and rabbits, and exacerbated by fire in some cases. One mapped area south of Curnamona Homestead is a fire scar in the ***Maireana astrotricha* Low open shrubland** community where the dominant shrubs have been almost entirely removed, the intensity of the fire apparently sufficient to destroy the viability of the seed store in the soil.

Vegetation Condition:
Generally very low plant diversity and dominated by unpalatable species, the presence of this vegetation type represents a degraded environment.

Most frequently occurring species in the ***Sclerolaena obliquicuspis* Low very open shrubland** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**%** **Occur.**	**Cover/Abundance** **T**	**1**	**2**	**3**	**4**	**5**
	Enneapogon avenaceus	73	2	5	1			
	Sclerolaena obliquicuspis	64	1	3	3			
+	*Calotis hispidula*	45	3	2				
	Eriochiton sclerolaenoides	45	3	1	1			
+	*Rhodanthe pygmaea*	45	4	1				
+	*Tetragonia eremaea/tetragonoides*	45	1	4				
+*	*Schismus barbatus*	36	1	3				
*	*Asphodelus fistulosus*	36	1		2		1	
+*	*Carrichtera annua*	36	1	1		1	1	
	Lotus cruentus	36	4					
+	*Omphalolappula concava*	36	2	2				

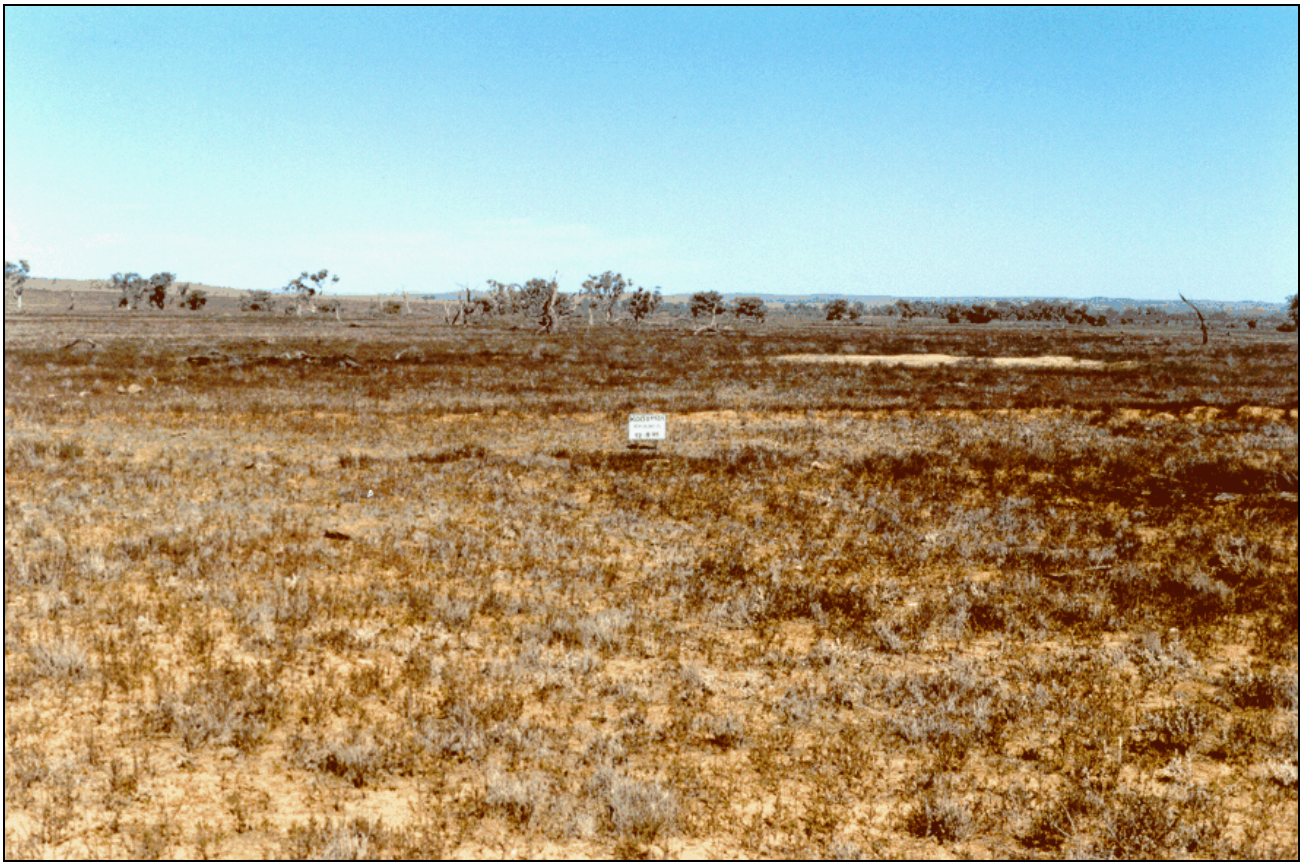


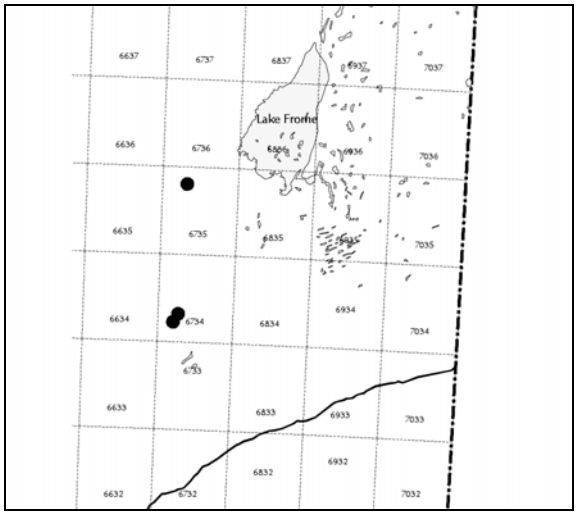
Figure 68
***Sclerolaena obliquicuspis* Low very open shrubland**
Site KOO01101. Herbs. *Sclerolaena obliquicuspis* and *Carrichtera annua* over *Enneapogon avenaceus*

Eucalyptus gillii Open tree mallee

Floristic Group Thirty-nine: 3 members

Vegetation Structure:
Ranging from very open woodland to tall sparse shrubland, this is a mallee community dominated by *Eucalyptus gillii* (Curly mallee). The understorey is very sparse and is comprised of sparse small shrubs, some grasses and *Triodia* sp. (Porcupine grass) hummocks.

Distribution:
This community occurs in discrete areas in the Flinders Ranges, where it grows on rocky hillslopes and rises in association with only certain lithological types. In this survey it is recorded only in the Bibliando area at the western edge of the study area in an outlier of the Ranges, and in the footslopes of Mount Frome.



Most frequently occurring species:
Eucalyptus gillii
Triodia scariosa ssp. *scariosa*
Senna artemisioides ssp.

North Olary Plains Survey Sites:
REA01301, WIL06201, WIL09501

Description:
This community is associated particularly with the Balcanoona Formation limestones and shales in the northern Flinders Ranges. It occurs in bands in the hilly areas corresponding with particular geological formations and shallow calcareous soils. In the Bibliando Dome area it is found on the hillsides and valley floors, interspersed with areas of ***Casuarina pauper* Low woodland**, ***Eucalyptus socialis* Open tree mallee**, and the ***Acacia aneura / Acacia victoriae / Sida petrophila* Very open low woodland** communities. The understorey shrub layer is highly variable and contains many of the species from these adjacent communities.

Vegetation Condition:
These areas have been only lightly grazed by sheep. However large numbers of feral goats have inhabited the rocky hills supporting this community and have probably had a significant impact particularly on the understorey composition and the regeneration of overstorey species.

Most frequently occurring species in the ***Eucalyptus gillii*** **Open tree mallee** community, with the frequency of each cover abundance score.

	Species + is an annual or seasonally non-detectable species	**% Occur.**	**Cover/Abundance** **T**	**1**	**2**	**3**	**4**	**5**
	Eucalyptus gillii	100			3			
	Triodia irritans complex	67	1		1			
+	*Calotis hispidula*	67	2					
	Danthonia caespitosa	67	2					
	Stipa scabra group	67	2					
	Casuarina pauper	33		1				
	Eremophila scoparia	33		1				
	Eriochiton sclerolaenoides	33		1				
	Eucalyptus gracilis	33		1				
	Eucalyptus largiflorens	33		1				
+	*Lemooria burkittii*	33		1				
	Senna artemisioides nothossp. *coriacea*	33			1			
	Acacia calamifolia	33	1					
	Acacia oswaldii	33	1					
	Alectryon oleifolius ssp. *canescens*	33	1					
	Atriplex velutinella	33	1					
	Cassinia laevis	33	1					
	Dissocarpus paradoxus	33	1					
	Enneapogon avenaceus	33	1					
	Eremophila glabra	33	1					
+	*Euphorbia drummondii*	33	1					
+	*Gnephosis arachnoidea*	33	1					
+	*Goodenia fascicularis*	33	1					
+	*Isoetopsis graminifolia*	33	1					
	Maireana excavata	33	1					
	Maireana pentatropis	33	1					
	Maireana turbinata	33	1					
	Myoporum platycarpum ssp.	33	1					
+	*Pimelea simplex ssp.*	33	1					
+	*Portulaca oleracea*	33	1					
	Ptilotus obovatus var. *obovatus*	33	1					
+	*Rhodanthe pygmaea*	33	1					
+	*Salsola kali*	33	1					
	Sclerolaena lanicuspis	33	1					
	Senna artemisioides ssp. *petiolaris*	33	1					
	Sida petrophila	33	1					
	Solanum ellipticum/quadriloculatum	33	1					
	Solanum sturtianum	33	1					
+	*Tetragonia eremaea/tetragonoides*	33	1					
	Zygophyllum crenatum	33	1					
+	*Zygophyllum iodocarpum*	33	1					
	Zygophyllum prismatothecum	33	1					

Figure 69
***Eucalyptus gillii* Open tree mallee**
Site WIL06201. Open Tree Mallee. *Eucalyptus gillii*, *Myoporum platycarpum* ssp., *Casuarina pauper* over *Triodia scariosa* ssp. *scariosa* and *Eriochiton sclerolaenoides*

Figure 70
Looking SSW from Barratta Mines area in the Bibliando Dome over **the mosaic of *Eucalyptus gillii* Open tree mallee and *Acacia aneura / Acacia victoriae / Sida petrophila* Very open low woodland communities.**

CONSERVATION CONSIDERATIONS

Significant Species

A number of species recorded during this survey have conservation significance. Brief notes about their occurrences are given here. Because no conservation ratings have been generated for plants in the regions of South Australia outside of the agricultural districts, local conservation significance of species within the study area cannot be listed.

Acacia carnei. **Rated nationally vulnerable.**

This species was recorded at four survey sites. It was also encountered at a large number of further locations during the field checking of the draft vegetation map. Where possible these locations were recorded and will be published separately.

It mostly grows in the ***Maireana pyramidata*** **Low open shrubland** community where it forms dense thickets by suckering. Typically these thickets are on sandy rises and mounds formed by the shrubs capturing windblown sand which deposits beneath them. Often the surrounding soil surface is bare sand. This is partly due to the active sandy nature of the mounds the plants are on, and partly due to severe grazing by rabbits which use the thorny shrubs as shelter for warren establishment. No regeneration was seen, although sparse flowering and a few seed pods were noted. On most plants inspected, the flowers had developed into large complex shaped galls instead of forming normal seed pods.

Populations are scattered throughout the southern plains district of the study area. In the south, it is growing along the valley of Pine creek between Mutooroo homestead and Corella outstation south of Cockburn. A large population is growing near the Barrier Highway in the vicinity of Mingary rail siding and along the adjacent creek banks. It is also scattered along the drainage line which runs south of Mulyungarie homestead toward Cockburn. In this latter area it extends onto the plains in the north-eastern portion of Boolcoomata Station. Further north, one site record is at the northern boundary of Mulyungarie Station in *Callitris* woodland on sand dunes. This is atypical of the normal habitat of *Acacia carnei*. Near Bimbowrie Station the species is growing along the valley floor south-east of the homested, and westwards on the flood plains south of Plumbago homestead, and toward Four Brothers Homestead. South of Plumbago it is growing on sandy hill foot slopes on soils derived from the adjacent hills which support the ***Acacia aneura / Acacia victoriae / Sida petrophila*** **Very open low woodland** community. Further west on Curnamona station it grows on small sandy rises in the ***Maireana astrotricha*** **Low open shrubland** community.

Davies (1995) has set up exclosures on Wertaloona station near the southern end of Lake Frome to study the effects of stock and rabbit grazing on regeneration of the species.

Condocarpus pyramidalis **Rated nationally vulnerable.**

This species was only encountered once during the survey. Two plants were included in a survey site in the valley floor within the northern part of the Bibliando Dome approximately ten kilometres north of Bibliando homestead. This geological dome structure is a part of the Flinders Ranges and the plant communities here are also those of the Flinders Ranges. The low trees are growing in a sparse woodland of the ***Acacia aneura / Acacia victoriae / Sida petrophila*** **Very open low woodland** community where it meets the valley floor. They were fruiting prolifically, but no young plants were visible.

Maireana pentagona **Rated rare in South Australia.**

Previously only recorded in the Lake Eyre and Murray regions in South Australia. The five site records in this survey represent an extension of the known range of the species which links the previous regional records in South Australia. Further systematic collection in the central and eastern portions of the state may reduce its conservation rating to a less critical one.

Malococera gracilis **Rated uncommon in South Australia.**

This species is endemic to South Australia. It has been recorded previously at Lake Callabonna, on the northern boundary of the study area, and was recorded at five sites in this survey.

New Regional Records

41 of the 448 taxa recorded at survey sites during the survey are new records in the Eastern Region.

This number, when included with the other three species of significance discussed above, is consistent with the ten percent of species having conservation significance which were recorded in three previous surveys by this author (MKH) in South Australia (disused rail corridors in the Mid-North, *Eucalyptus odorata* woodlands in the agricultural districts, and native Grasslands in the temperate region of the state).

Species of interest are *Aristida personata* which has only been recorded once previously in South Australia (at Aldinga in the South Lofty Region), and *Tamarix aphylla* which is not recorded as naturalised in South Australia but was found by this survey to be a seriously invasive weed of the north-eastern drainage areas within the dune system.

The species which represent new records are grouped into families and tabulated below (Table 6) with the number of records during this survey appended.

Table 6 Species Recorded During the North Olary Plains Survey which were previously unrecorded in the Eastern Botanical Region

Compositae	
Hyalosperma demissum	24
**Hypochaeris radicata*	1
Ixiochlamys cuneifolia	3
Leptorhynchos baileyi	2
Podolepis arachnoidea	4
Podolepis muelleri	1
Senecio glomeratus	1
Centipeda minima	2
Gnephosis drummondii	3
Chenopodiaceae	
Maireana eriantha	11
Maireana excavata	11
Maireana pentagona	5
Maireana tomentosa ssp. *urceolata*	2
Sclerolaena holtiana	4
Sclerostegia medullosa	1
Halosarcia halacnemoides ssp. *longispicata*	1
Malacocera biflora	5
Graminae	
Stipa acrociliata	5
Stipa flavescens	1
**Vulpia muralis*	3
Aristida personata	4
**Digitaria sanguinalis*	2
Eriachne aristidea	1
Liliaceae	
Arthropodium strictum	1
Bulbine bulbosa	1
Calostemma purpureum	1
Dianella longifolia var. porracea	1
Leguminosae	
Indigofera helmsii	1
Swainsona oliveri	1
Glycine clandestina var.	8
Cyperaceae	
Bolboschoenus caldwellii	1
Cyperus laevigatus	1
Geraniaceae	
Erodium cygnorum ssp. *cygnorum*	19
Rubiaceae	
**Galium murale*	1
Campanulaceae	
Wahlenbergia luteola	3
Polygonaceae	
**Acetosella vulgaris*	5
Tamaricaceae	
**Tamarix aphylla*	2
Typhaceae	
Typha domingensis	1
Cruciferae	
Lepidium rotundum	1
Acanthaceae	
Rostellularia adscendens ssp. *adscendens*	1
Solanaceae	
**Solanum retroflexum*	1

Stock Impacts

There is no doubt that most of the plant communities in the study area have been altered by stock grazing. The flocks moved in soon after settlement and by 1860 the land along the Barrier Highway was under Pastoral Lease. By 1870 the southern half of the study area was all taken up by Pastoral Leases and was completely stocked. Because the stock impacts were focussed around watering points, the alteration of the vegetation proceeded in a patchy manner as new water points were established, a process still continuing today.

The ***Maireana astrotricha* Low open shrubland** community is an example of a mapped community which is the product of alteration. Osborn, Wood and Paltridge (1932) surveyed a number of transects in Saltbush (*Atriplex vesicaria*) plains communities, one north of Frome Downs homestead. It was a pristine example of the ***Atriplex vesicaria / Maireana astrotricha* Low open shrubland** community then because the nearby tank was new and stock only recently introduced. When re-surveyed forty-five years later (Fatchen, 1978) all the *A. vesicaria* had been removed leaving a sparse cover of *Maireana astrotricha* and some adventitious *M. aphylla* and *M. pyramidata* shrubs. This latter community is the ***Maireana astrotricha* Low open shrubland** community of the present survey.

Jessup (1969) describes the complete removal of *Atriplex vesicaria* shrubs and their replacement by ***Sclerolaena* Low very open shrubland** and *Enneapogon* grassland in the north-western paddock of Bimbowrie Pastoral lease, and used the "over-the-fence" contrast with Telechie, where it was still present, as his experimental control. The *Sclerolaena*s in this case are *S. decurrens* and *S. ventricosa* which the present survey found normally to be associated with the ***Atriplex vesicaria / Maireana astrotricha* Low open shrubland** community.

However further north-east on Kalkaroo this survey has mapped a complex of the ***Atriplex vesicaria / Maireana astrotricha* Low open shrubland** community intersecting the ***Sclerolaena divaricata* Low very open shrubland** in a lobed pattern associated with soil changes. In this instance *A. vesicaria* is present and not present respectively at sites as close together as 150 metres, although the grazing history is identical.

On Koonamore at the T.G. Osborn Vegetation Reserve, where an area of vegetation highly altered by grazing, was enclosed the regrowth of *Atriplex vesicaria* was vigorous when a seed source was available and rainfall was suitable.

It can be seen therefore that great care must be taken before floristic differences are explained by stock grazing pressure. In the examples on Bimbowrie and Kalkaroo above, it can be seen that the indicator presence of particular *Sclerolaena* species suggests removal of the *Atriplex vesicaria*, or natural absence respectively.

In the dune fields *Zygochloa paradoxa* has been reported by a number of authors as dominant on the dune crests, and an *Atriplex vesicaria* / *Maireana astrotricha* shrubland growing extensively in the swales. The former species was only recorded once in the present survey and seems to have been mistakenly described as present by other authors. However the chenopod shrubland is still present as a trace, and is very likely to have been reduced by grazing pressure over most of the area.

Some floristic changes are undoubtedly caused by preferential grazing however. The increased density of some shrub species including *Eremophila sturtii* and *Dodonaea viscosa* ssp.*angustissima* around tanks and dams, and *Maireana pyramidata* on valley floors is due to their relative unpalatability allowing them to increase or persist at the expense of other species.

There is no doubt that grazing will reduce the regeneration of shrubs and trees. Germination events are largely controlled by specific sets of climatic parameters which only occur periodically, and grazing of the seedlings reduces recruitment of these species. This effect is compounded in the case of relatively short-lived species which require more frequent recruitment to maintain their populations. However care must also be used in assessing to contribution of grazing to changes in the structural composition of vegetation in this region. The climate is highly variable, and periods between specific episodes required for recruitment events may exceed the normal life expectancy of particular species, causing dramatic changes in the vegetation structure. It is against this natural dynamism that grazing alterations are occurring.

The parts of the study area where cattle are grazed show considerable alteration of the vegetation by soil surface disturbance. This is significant up to 1 km of watering points, and under shade trees elsewhere. Most of the ***Eucalyptus largiflorens*** **Low open woodland** communities have virtually no ground-layer plants because of trampling. The clay soils of the small lakes and pans is often churned as if rotary hoed, preventing plant growth. Even in paddocks with low stocking rates, the watercourses have been substantially altered.

Rabbit Impacts

Rabbits were established in the region by the late 1800's and subsequently reached plague proportions on occasion when good seasons allowed. Wood (1937) describes a single pastoral lessee destroying more than one million rabbits in four months in this region in the 1920's. Most authors of vegetation studies in this survey area, most recently Davies (1995), agree that rabbits are able to prevent any regeneration of trees and shrubs by browsing of seedlings. It is therefore possible, although unlikely, that rabbits have entirely removed species from some communities. The apparent error of Wood (1937) and Specht (1972), which is reiterated in Laut et al (1977) of reporting the presence of *Hakea leucoptera* in the dune fields of the south Strzelecki Desert may be the result of all recruitment potential being destroyed by rabbit browsing of seedlings over a long period. The present survey encountered this species only occasionally on the plains south of the dunefield.

In parts of the adjacent Flinders Ranges, massive reduction in rabbit populations by the Rabbit Calicivirus during 1995 was followed immediately by significant increases in the numbers of seedlings of many species, which had previously rarely been seen. This same process would be expected within the plant communities of the North Olary Plains if similar rabbit reduction occurs.

Introduced Species

Weed distribution in the survey area is strongly patterned. The sites on the four mapsheets covering the Barrier Highway - the four southerly sheets - contain weed percentages higher than those further north. On the Olary mapsheet for example, the average percentage of introduced species is approximately 20 - 25%. In contrast on the Coonee mapsheet in the far north-eastern corner of the study area many of the sites contain no weeds, and the average is about 10% of species. This north - south difference is due to two main factors. The annual average rainfall decreases from about 200mm at the southern edge of the survey area to less than 125 mm near Lake Callabonna at the northern edge of the study area. Coupled with this is the historic, and present degree of intensity of agricultural development decreasing toward the north. On Koonamore mapsheet where some areas have been cropped in the past, weed levels are approximately 25 - 30% of species.

The two most widespread weed species are *Schismus barbatus* and *Brassica tournefortii*. Both are the main weedy species of the dune fields, and are also found elsewhere in the survey area where light soils occur. *Schismus barbatus* often forms the bulk of the ground layer biomass in the ***Acacia aneura / Enneapogon*** spp. **Low open woodland** where the *Enneapogon* has been destroyed by cattle trampling. *Brassica tournefortii* is common on loose sand on the dunes.

In the south, the two most common weeds are *Asphodelus fistulosus* and *Carrichtera annua*. Both have become very common where cropping was attempted, and are also widespread on the central plains. *Carrichtera annua* is more widespread and found further north as it seems to tolerate lower soil moisture regimes and poorer soils.

Alyssum linifolium is found throughout the chenopod plains communities. As it is such a small plant its biomass is low, but the populations may be quite dense in places.

Another relatively widespread weed is *Sisymbrium erysimoides*. This species is confined to microhabitats which are shaded and retain soil moisture, and is found in the ***Acacia aneura / Acacia victoriae / Sida petrophila*** **Very open low woodland** community under shrubs and in rock crevices, and in river beds where the tree canopy cover is high.

The pasture weeds such as *Echium plantagineum* and *Medicago* species are common along the Barrier Highway and in the perpetual lease area in the south-west of the study area. *Lycium ferocissimum* was only recorded at 6 sites, but is wide spread in the southern third of the study area, mainly in watercourses, around dams and in areas of high disturbance.

PASTORAL LEASE ASSESSMENT

Officers of the Pastoral Management Branch of the Department of Environment and Natural Resources have been carrying out assessments of condition, producing paddock-based management guidelines and setting up monitoring photo-points on all Pastoral Leases in the region since 1990. They are due to be completed by December 1997. The large amounts of data collected through this process will greatly assist the overall management of this area for future productivity and conservation.

Figure 71
The Variable Groundsel, *Senecio lautus*, can form spectacular carpets of flowers on the slopes of sand dunes
Photo: A. Robinson

Figure 72
Prickley Knawel, *Scleranthus pungens,* confined to rocky hills in the area.
Photo: A. Robinson

Figure 73
The Low Bluebush, *Maireana astrotricha* can form pure stands in some parts of the survey area.
Photo: A. Robinson

Figure 74
Sturts Desert-pea, *Swainsona formosa* covers large areas with its spectacular displays following good rainfall.
Photo:A. Robinson

SATELLITE IMAGE ANALYSIS AND INTERPRETATION

When compared with conventional aerial photography, the use of Landsat TM imagery for vegetation mapping has both advantages and disadvantages.

Some advantages are:

- optical and spectral uniformity over an entire scene covering 185 km x 185 km
- ability to be geometrically rectified to conform to a base map
- ability to digitally enhance and statistically classify individual picture elements

Some disadvantages are:

- high level of technical expertise and sophisticated hardware and software are required for presentation and analysis
- spatial resolution of 30m makes discerning narrow, small, or heterogeneous features difficult

The final classified image produced from the unsupervised classification and class labelling procedure consisted of 21 classes (Figures 75, 77, 79, 81), most of which are related to the vegetation groupings described above. They are:

- *Casuarina pauper* rises and flats
- *Acacia aneura / Dodonaea lobulata* hills
- *Acacia tetragonophylla / A. victoriae / Enneapogon* spp. low hills
- *Acacia ligulata* dunes
- *Dodonaea viscosa* dunes
- *Eremophila duttoni / Senna artemisioides* sspp. sandy rises
- *Acacia victoriae / Maireana pyramidata* drainage areas and run-ons
- *Astrebla pectinata / Maireana aphylla* gilgai flats
- *Acacia aneura / Graminae* spp. open swales
- *Maireana pyramidata* flats and run-ons
- *Maireana astrotricha / M. pyramidata* plains
- *Atriplex vesicaria* plains
- *Maireana astrotricha / Atriplex vesicaria* plains
- *Maireana sedifolia / Atriplex vesicaria* plains
- *Sclerolaena divaricata* plains
- *Sclerolaena obliquicuspis / Enneapogon* spp. plains
- *Nitraria billardierei* flats and run-ons
- *Nitraria billardierei / Maireana pyramidata* flats and run-ons
- *Eragrostis australasica / Muehlenbeckia florulenta* swamps
- Bare ground
- Water

Some difficulty was encountered in labelling the classes within the images due to the high variability of spectral signature, even within a vegetation grouping, and also a lack of sufficiently large areas of "pure" vegetation types to provide confidence in the accuracy once it was extrapolated to another part of the image.

Consequently, some vegetation groupings, whilst being floristically distinct are not spectrally separable. Mallee communities in this area are an example. The unsupervised classification at a level of 90 classes in a subscene, encompassed insufficient interclass variation to differentiate this vegetation group. For a similar reason, some areas were mislabelled. An example is an area known to be Lignum swamp classified the same as another area in a different part of the image, known to be sparse Mulga on hillslopes. Running the classification process at a finer level and producing for example, 150 classes which then required accurate labelling, whilst potentially providing a more accurate classification, and enabling separation of these groups also makes this labelling task significantly more complex and difficult.

Notwithstanding these factors, a useful level of accuracy was obtained for assisting in mapping at a scale of 1:250,000 in this region. Figures 75 - 82 show some of the features of this classification.

In the dunes area of the northeast (Coonee mapsheet), spectral variability allowed good differentiation between dunes and swales, so that even at a scale of 1:50,000 (Figures 75, 76), this classification is a good reflection of reality. Variation in the wetlands area shows sedgelands being classified as Canegrass / Lignum swamp and the fringe of *Eucalyptus largiflorens* classified as *Maireana pyramidata*. At a scale of 1:250,000 however, this wetland area can only sensibly be mapped as a single vegetation unit.

The examples shown for the Paralana mapsheet area on the north-west margin of Lake Frome (Figures 77-80) highlight these factors of scale. At 1:100,000 (Figures 77, 78), there are some minor classification errors such as Redgum creeks and *Senna* spp. shrublands on low escarpments not being picked out adequately. At a scale of 1:250,000, the overall picture given by that classification (Figures 79, 80) is reasonably close to reality. The concept of a mosaic of different vegetation types being spatially mixed is also expressed here in a more meaningful way than is possible on polygon-based GIS map products. The low sandy rises of Senna spp. and *Dodonaea viscosa* spread in varying densities over the *Maireana aphylla* / *Astrebla pectinata* Open grassland as portrayed in Figures 78 and 80 reflects the real situation very well.

In the more complex country of the low hills near Olary (Figures 81, 82), where the natural vegetation patterns have been significantly altered through management so that the relationships between the geophysical characteristics of the land and the vegetation are inconsistent, the classification accuracy is lower. Even at ground level, mapping boundaries and assigning vegetation groupings is more difficult than further north. Nonetheless, at 1:250,000, the big picture is close to the truth. Again, the mosaic portrayal at 1:100,000 (Figure 81) gives a good spatial indication of the vegetation distribution.

It cannot be denied that satellite imagery contains a wealth of information about the earth's surface, but the interpretation of these data is imprecise and subjective.

The accuracy problems associated with using this methodology are directly related to the quality of the

ground level information which is used to label the spectral classes. Because the underlying soil and geology usually contribute more to the spectral signature than the very sparse arid zone vegetation, a strong reliance must be made on the relationships between soils / geology / landform and the vegetation. These relationships vary considerably from region to region and season to season, and an intimate understanding of them is crucial to the overall accuracy of such automated classifications.

Indications from this region suggest that in the pastoral / arid zone where vegetation / landform / edaphic relationships are more stable than in the highly altered agricultural fringe, a higher level of classification accuracy may be possible. A similar vegetation mapping project completed recently in the South Australian arid zone (Copley et.al. 1995) supports this suggestion.

These classifications are a useful tool, along with conventional aerial photography and visual interpretation (which discerns patterns as well as colours) of satellite imagery to assist in mapping areas of land which cannot physically be surveyed at ground level.

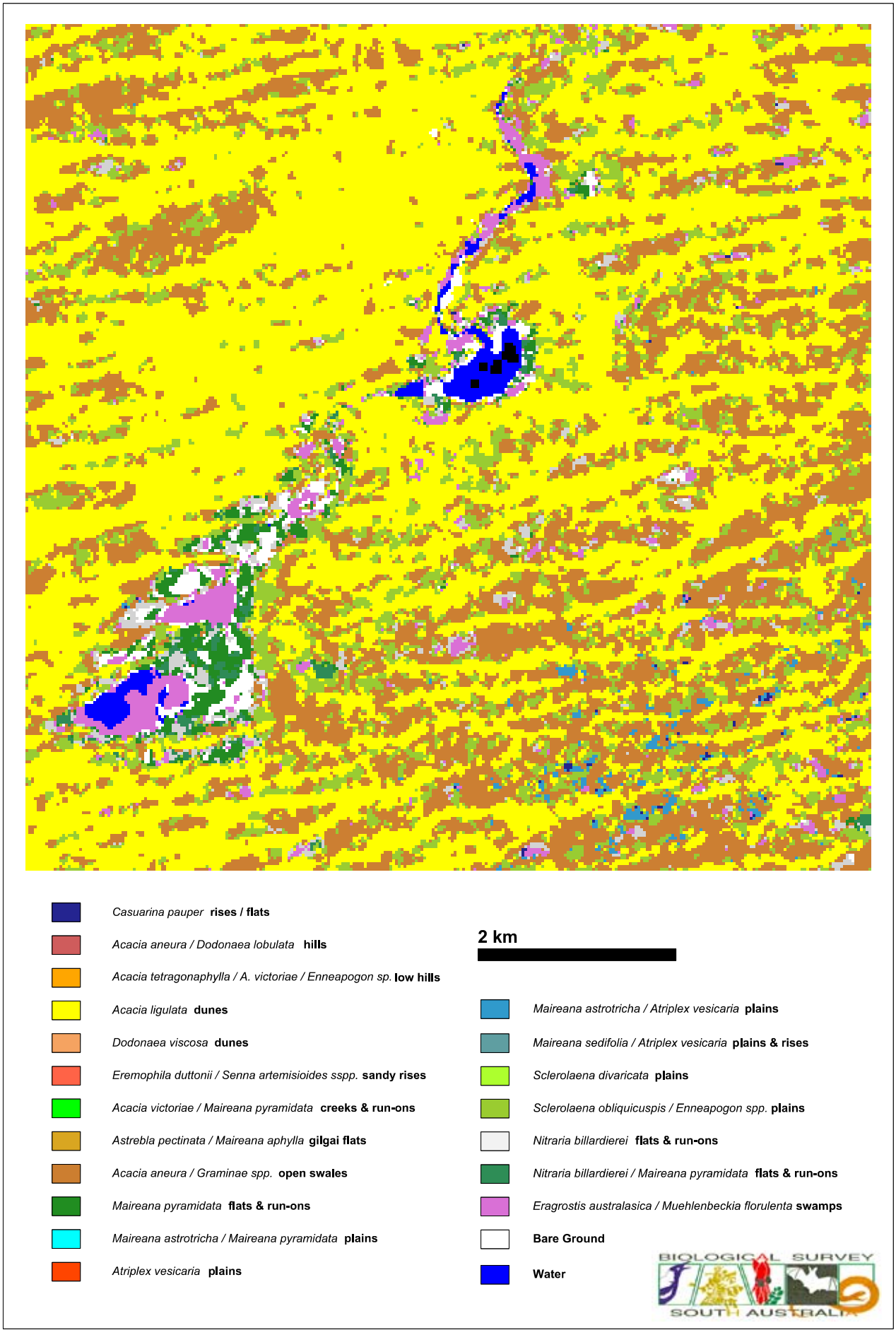


Figure 75 **Classified image of dunefields and wetlands of Coonee Creek.**

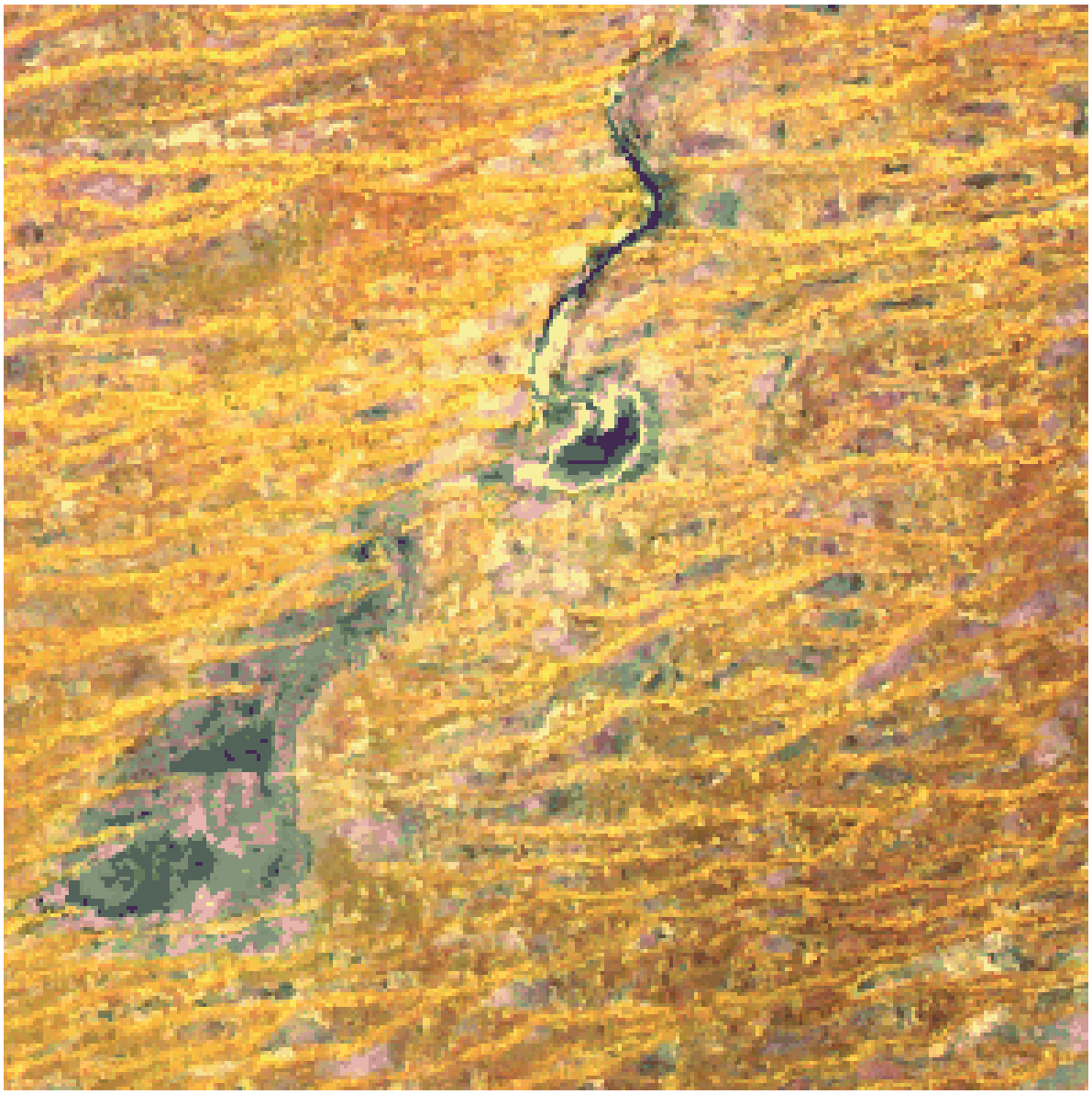


Figure 76 **Unclassified Image of dunefields and wetlands of Coonee Creek.**

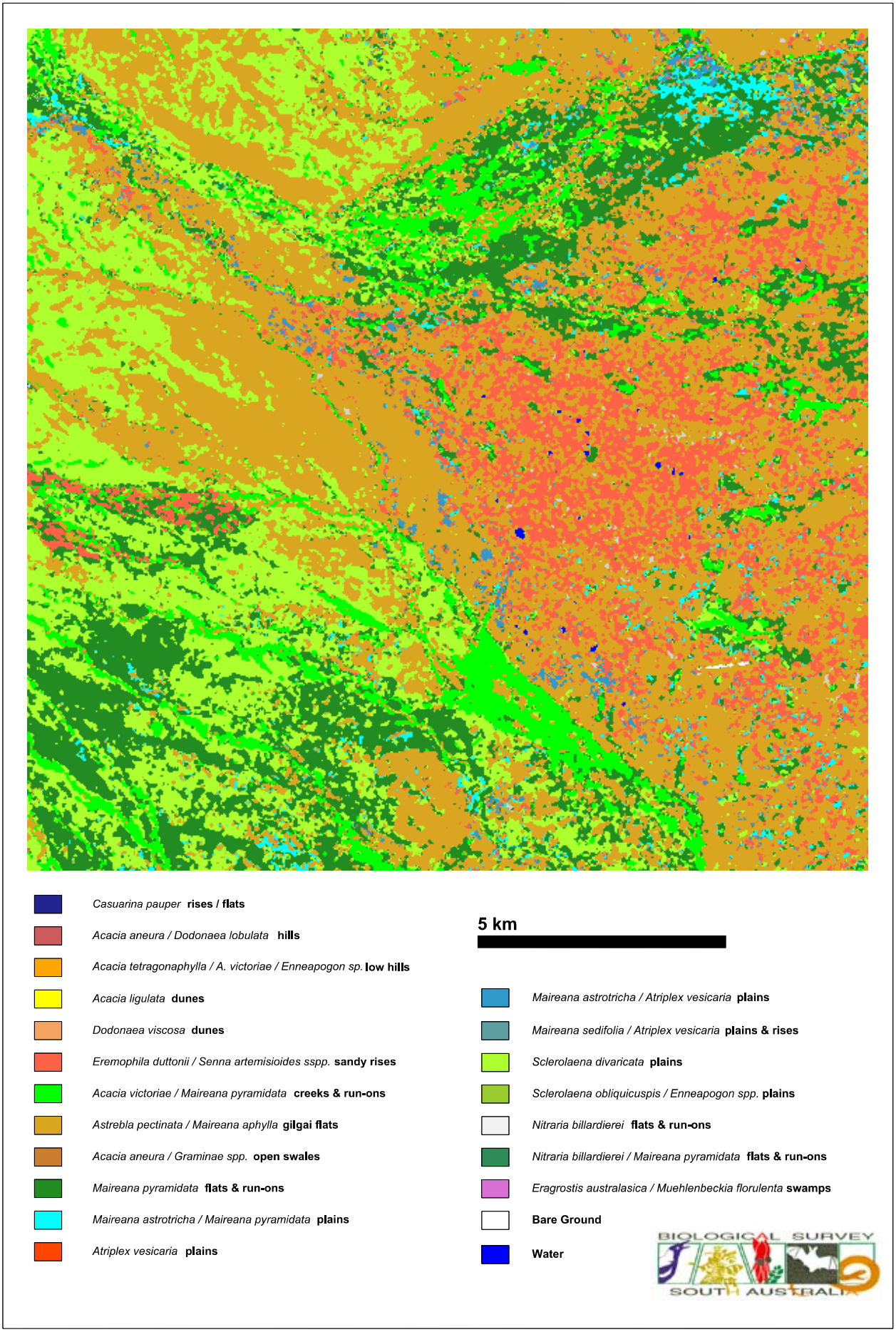


Figure 77 **Classified image of drainage features and Mitchell grass / Cottonbush plains on Wooltana.**

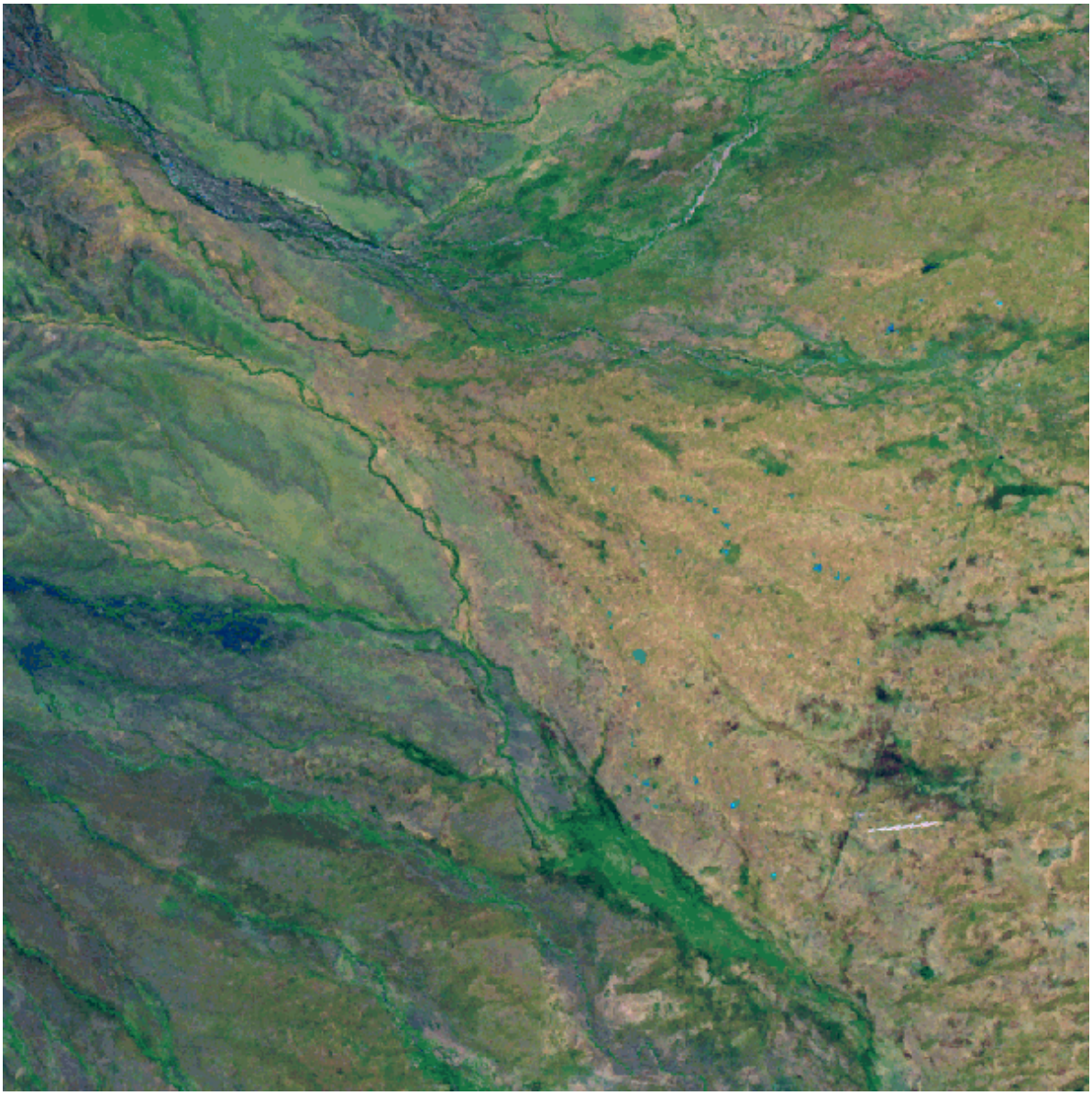


Figure 78 **Unclassified Image of drainage features and Mitchell grass / Cottonbush plains on Wooltana.**

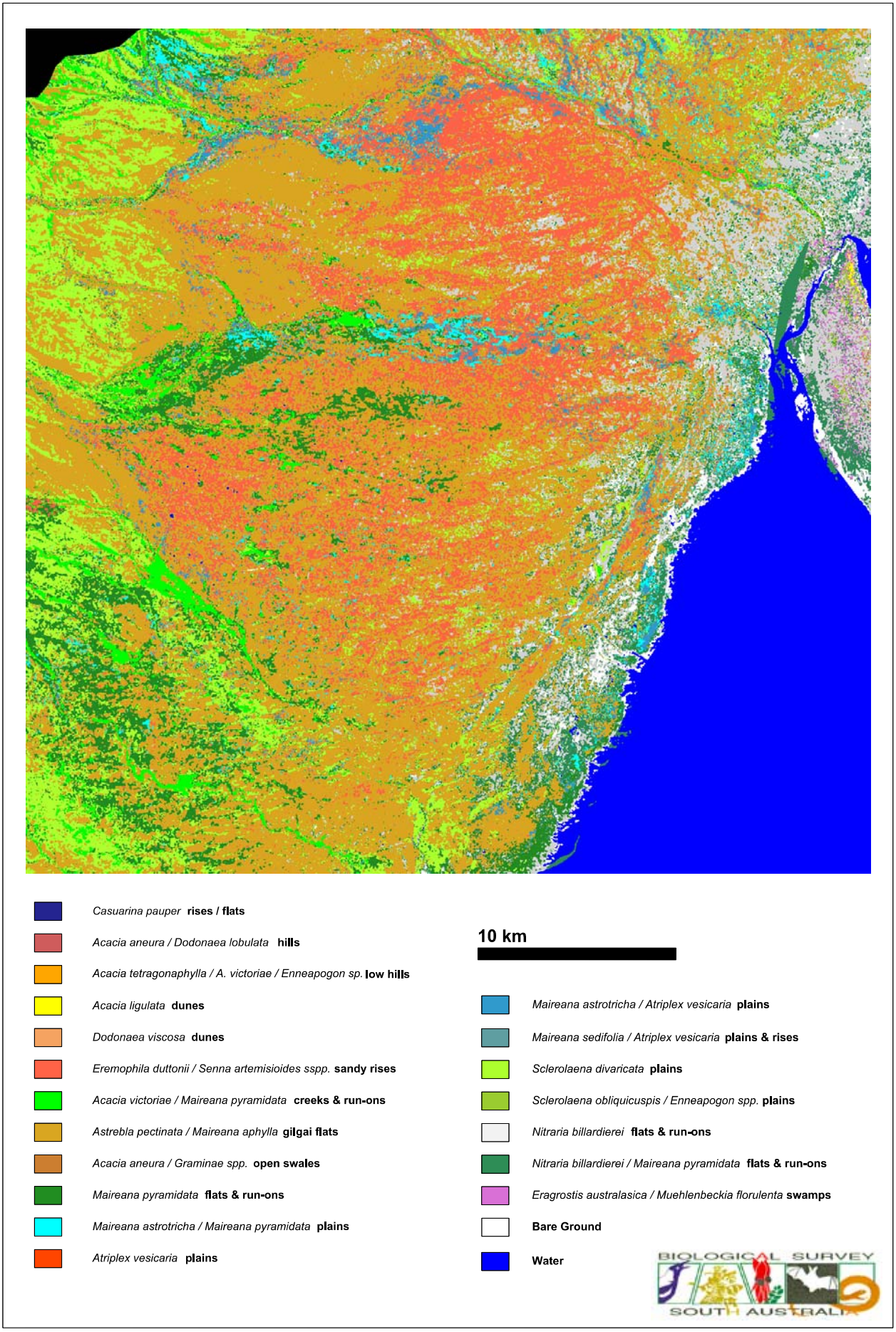


Figure 79 **Classified Image of north-west margin of Lake Frome.**

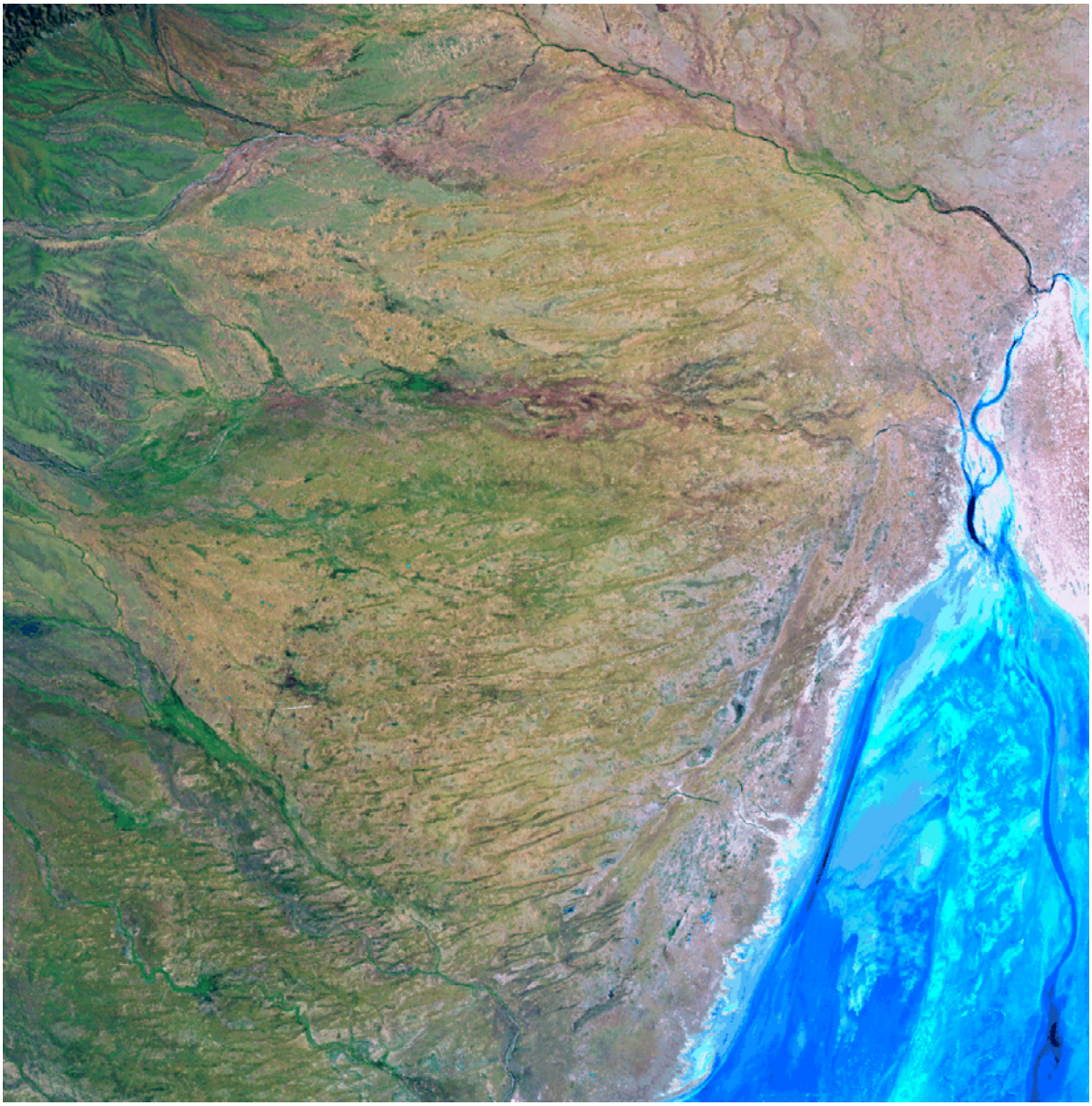


Figure 80 **Unclassified Image of north-west margin of Lake Frome.**

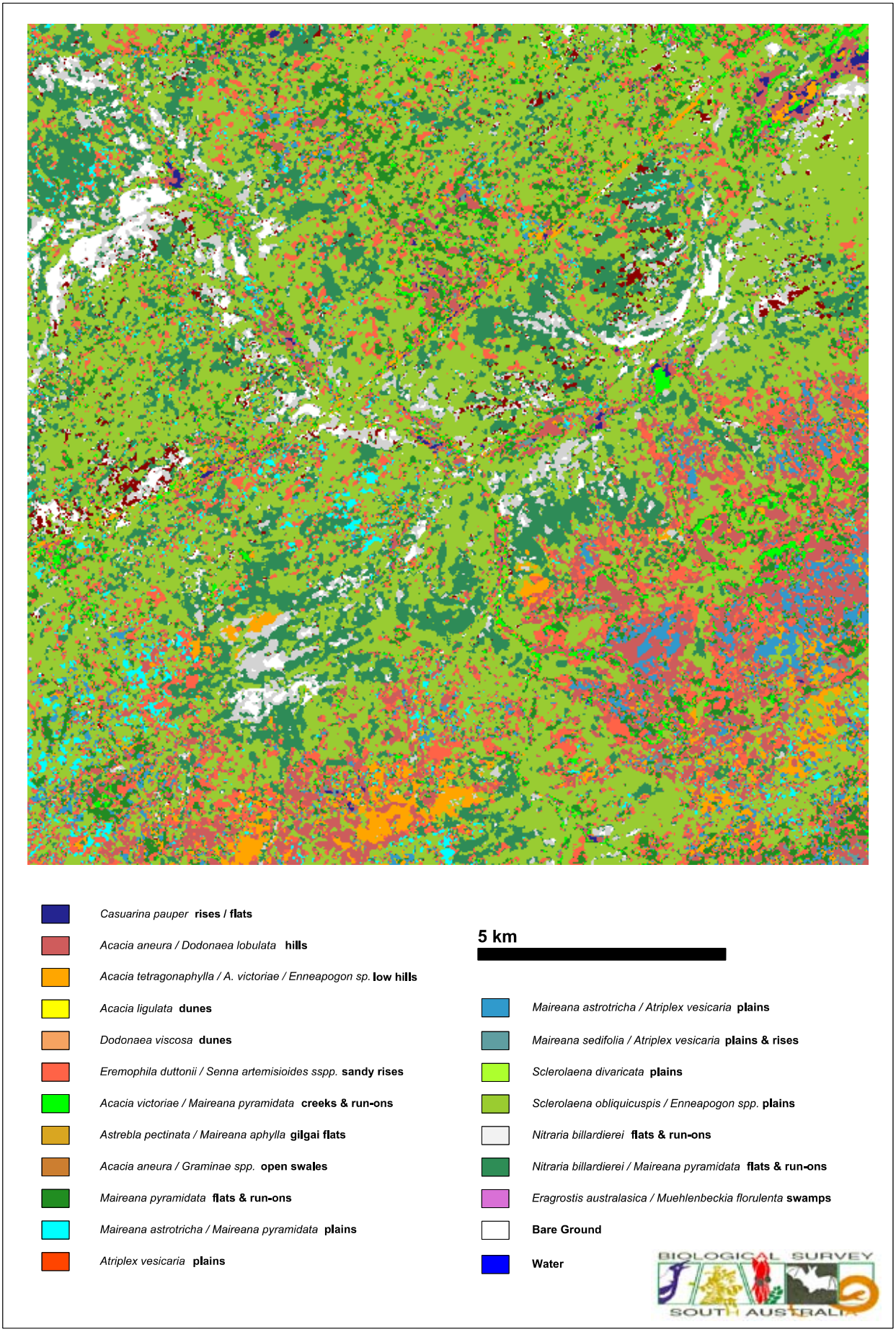


Figure 81 **Classified Image of drainage features and low hills around Olary.**

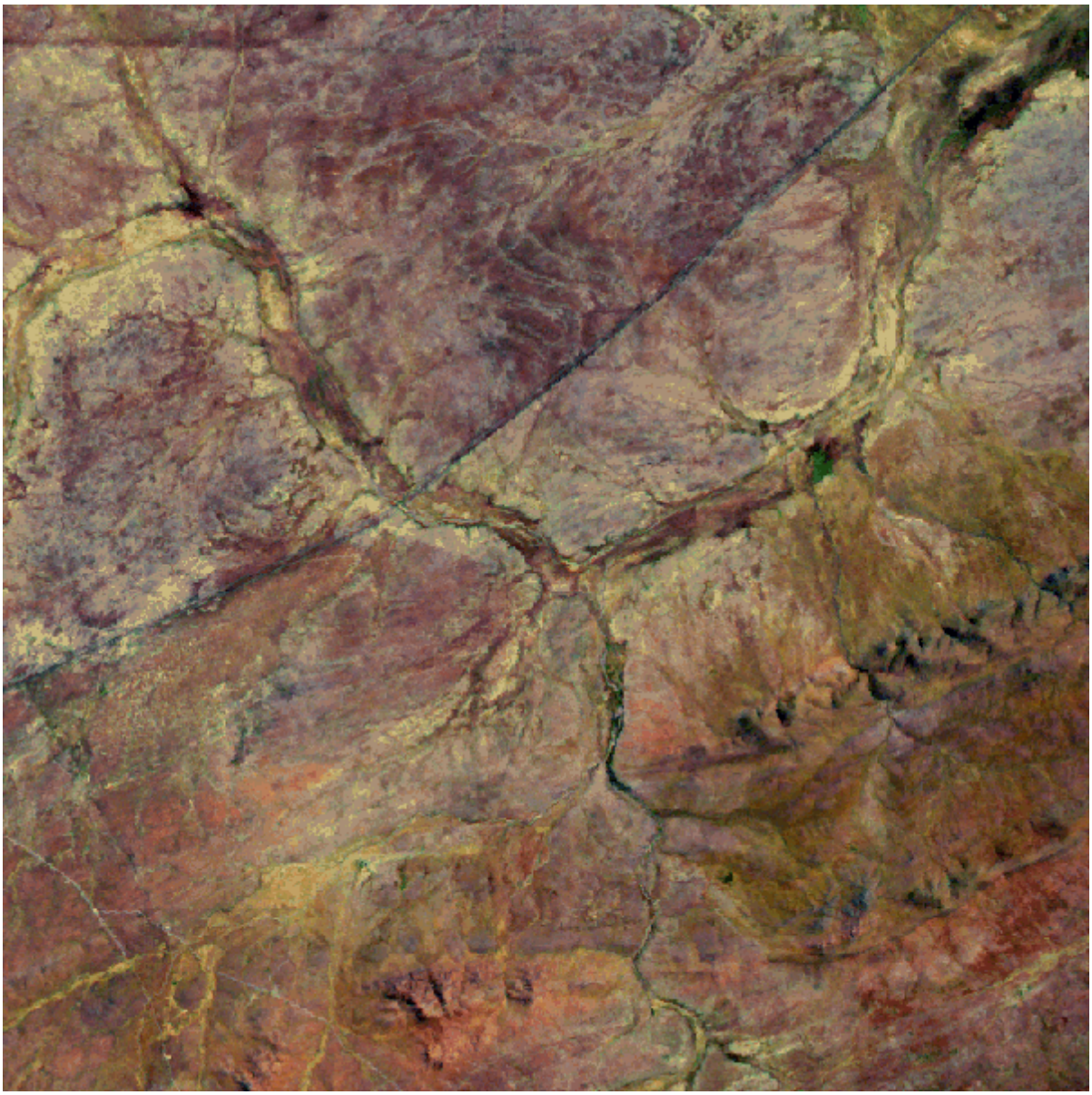


Figure 82 **Unclassified Image of drainage features and low hills around Olary.**

MAMMALS

by R. M. Playfair[1], A. C Robinson[2] and J. N. Foulkes[2]

INTRODUCTION

No structured, comprehensive regional recording or trapping of mammals has been undertaken in the North Olary Plains, until 1994 when certain areas were targeted in search of rare rodents. Very little information has been published on the North Olary Plains mammals.

South Australian Museum records from the North Olary Plains date back to 1890, but most of these (77%) are from the last thirty years (since 1966).

Figure 87 shows the distribution of the 170 South Australian Museum mammal records from the North Olary Plains area prior to this survey. Records are concentrated around the edges of the area near towns, along main access routes. Before 1996, 29 extant species, 8 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

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 estimated from the limited information in historical documents. As very little field work has been previously conducted in this area, and particularly because most small mammals are nocturnal and can usually only be recorded by trapping, some species may not have been recorded. Records from this survey of species occurring in the study area are summarised in Table 8. The frequency is the number (maximum 48) of quadrats at which the species was recorded, and the opportunistic column is the number of locations at which a species was recorded.

The complete list of all mammal species recorded from the North Olary Plains area is presented in Appendix VII, and includes those currently known to occur, as well as species which could have occurred prior to European settlement.

A total of 55 species from 15 families is listed in Appendix VII, of which the North Olary Plains survey confirmed 22 extant species representing 9 families still living in the area (5 native and 4 introduced). 20 species were recorded on quadrats and an additional one through opportunistic observations. There were no new records for the area and sub-fossil material was recorded for a further 23 species, most of which are now locally extinct. Therefore, of the 46 native species known or thought to have been in the region, since European occupation, 13 (28%) are now thought to be extinct in South Australia, 3 are endangered, 3 are vulnerable and 6 are rare (Appendix VII).

The total number of mammal species and records recorded by quadrat and opportunistic methods during the survey period is shown in Table 8. These total numbers are really indicative only of the relative abundances of these species. The recording of opportunistic sightings or captures favours some species, particularly the larger and more recognisable ones over others. Likewise, the records at quadrats include tracks, diggings and other recognisable sign.

Red Kangaroos, House Mice, foxes and rabbits appeared to be the most abundant at the survey quadrats, as these animals are easily observed, and leave abundant and readily identifiable sign.

The most abundant species recorded opportunistically were the Red Kangaroos, Western Grey Kangaroos Rabbits, and Euros. Care must also be exercised when interpreting these figures, because of the difficulty in recording small, cryptic or nocturnal mammals opportunistically. Most bat trapping was attempted at opportunistic locations as the specified survey sites were not generally suitable. Insufficient captures were made to get an accurate picture of bat diversity and abundance.

The South Australian Mammal Club, on a field survey in August 1977 visited three sites in the north of the North Olary Plains survey area. Within a 7km radius of New Quinyambie, the first South Australian sightings of *Macropus giganteus* north of the lower SE, were recorded. Three *Nyctophilus geoffroyi* and two *Tadarida australis* were also captured and evidence of many *M. fuliginosus, M. rufus,* echidna, cats and foxes was observed. East of Rotten Swamp, 17 *Mormopterus planiceps* were found in a tree hollow, and *N. geoffroyi, Scotorepens greyii, Sminthopsis crassicaudata, Leggadina forresti*, *Mus domesticus*., *Notomys fuscus, Rattus villosisimus* plus rabbits, cats and foxes were sighted.

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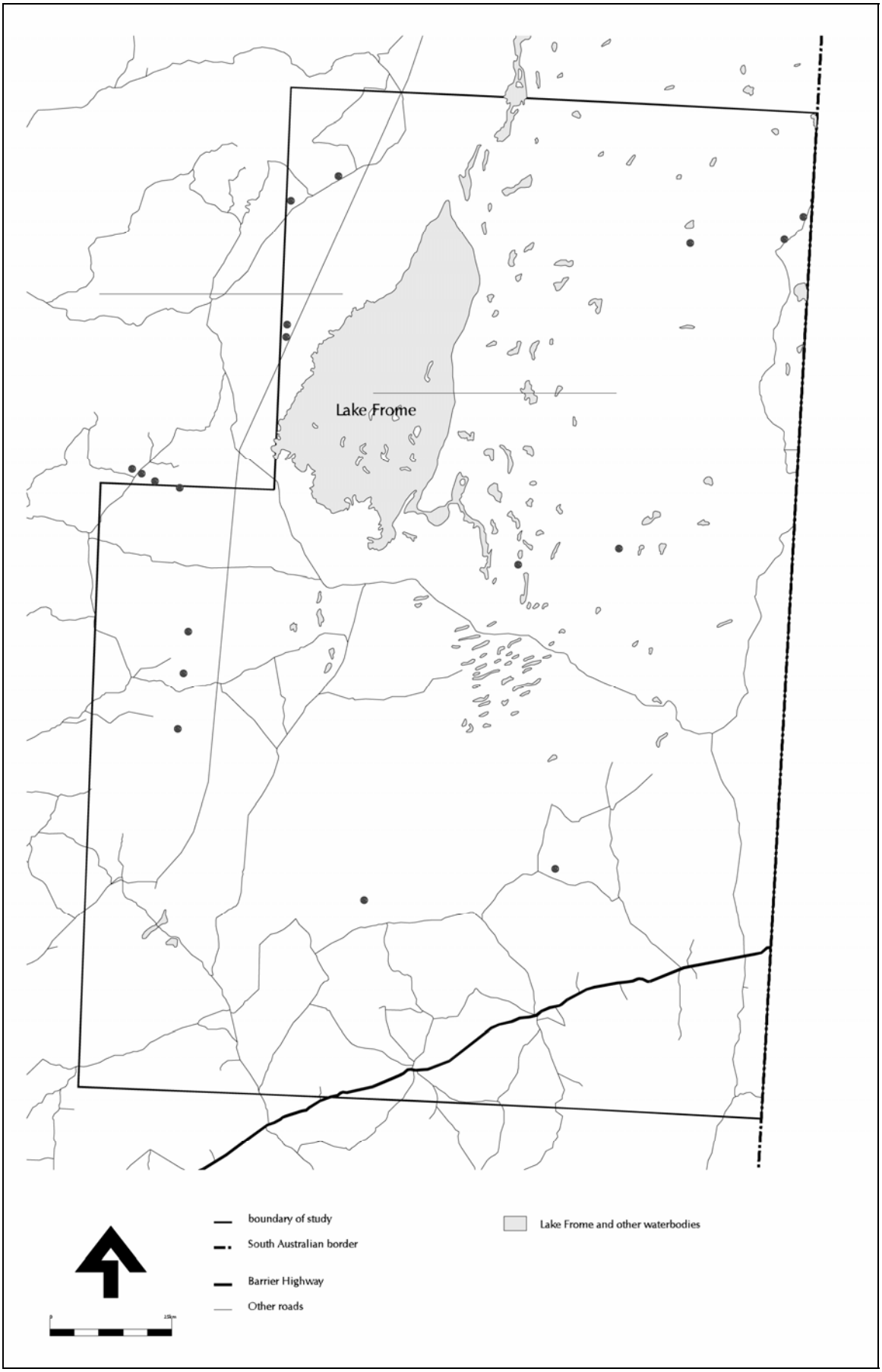

Figure 87 **Distribution of the mammal records held in the SA Museum from the North Olary Plains area. (locations of Chambers Gorge and Balcanoona Creek sub-fossil records are also shown).**

Table 8 Mammals Recorded during the North Olary Plains survey.

SPECIES	COMMON NAME	Freq.	Opp.	Total	Conservation Rating		
					Nat. [1]	SA [1]	Arid NSW [2]
Macropus rufus	Red Kangaroo	20	76	96	-	-	-
**Oryctolagus cuniculus*	European Rabbit	30	13	43	-	-	-
**Vulpes vulpes*	European Fox	22	6	28	-	-	-
Macropus fuliginosus	Western Grey Kangaroo	3	20	23	-	-	-
**Mus domesticus*	House Mouse	20	1	21	-	-	-
Canis familiaris	Dog / Dingo	11	7	18	-	-	-
Macropus robustus	Euro	7	9	16	-	-	-
**Felis catus*	Cat	12	3	15	-	-	-
**Bos taurus*	Cattle	11	3	14	-	-	-
Sminthopsis crassicaudata	Fat-tailed Dunnart	10	-	10	-	-	C
**Ovis aries*	Sheep	9	-	9	-	-	-
**Capra hircus*	Goat	4	4	8	-	-	-
Sminthopsis macroura	Striped-faced Dunnart	7	-	7	-	-	Sp
Leggadina forresti	Forrest's Mouse	5	-	5	-	R	S
Planigale tenuirostris	Narrow-nosed Planigale	5	-	5	-	U	Sp
Nyctophilus geoffroyi	Lesser Long-eared Bat	-	4	4	-	-	-
Tachyglossus aculeatus	Echidna	4	-	4	-	-	-
Macropus giganteus	Eastern Grey Kangaroo	1	1	2	-	V	-
Notomys fuscus	Dusky Hopping-mouse	2	-	2	V	E	Ex
Planigale gilesi	Giles' Planigale	1	-	1	-	U	Sp
**Equus caballus*	Horse	1	-	1	-	-	-
Pseudomys bolami	Bolam's Mouse	1	-	1	-	-	R

Notes:

* Introduced species

1. National and South Australian conservation status codes:

X	Extinct
E	Endangered
V	Vulnerable
R	Rare
U	Uncommon
-	not listed

(From Commonwealth *Endangered Species Protection Act 1992,* updated by Kennedy (1992), Lee (1995), Richards and Hall (1994). The S A status is from Kemper and Queale (1990)

2. Arid NSW conservation status codes:

C	Common
S	Stable and secure
Sp	Sparse
R	Rare
Ex	Presumed extinct
-	not listed

(From Dickman, 1993 and Dickman & Read, 1992)

PATN ANALYSIS

The initial mammal data matrix contained 187 records; 22 species at 48 quadrats. No meaningful cluster analysis is possible on a dataset this size, taking into account the need to mask out all domestic ungulates (cattle, sheep and goats) being common but irregularly distributed; bats, due to non-systematic sampling, and species which are difficult to detect consistently (fox, cat and echidna), and all ubiquitous species (rabbits and kangaroos). This masking results in a data matrix of 31 records (20 quadrats and 7 species).

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 incidence by quadrat. The two-way table showed 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 often only one species found at each quadrat. Ordination of the analysis results was not warranted with such data.

SPECIES OF PARTICULAR INTEREST

Tables 8, 9 and Appendix VII include the conservation status of all the confirmed and sub-fossil mammal species from the North Olary Plains on an National and Statewide 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 North Olary Plains.

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 (ANZECC.) 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 SA 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.

In the following lists **F** indicates known to have occurred in the area through sub-fossil material found recently (ie. species occurred there pre and possibly post European occupation). These species are listed more completely in Table 9.

Extinct in Australia

Crescent Nailtail Wallaby *Onychogalea lunata* **F**
Lesser Stick-nest Rat *Leporillus apicalis* **F**
Long-tailed Hopping-mouse *Notomys longicaudatus* **F**
Gould's Mouse *Pseudomys gouldii* **F**

Extinct in South Australia (nationally threatened)

Golden Bandicoot *Isoodon auratus* (E) **F**
Western Quoll *Dasyurus geoffroii* (E) **F**
Red-tailed Phascogale *Phascogale calura* (E) **F**
Bilby *Macrotis lagotis* (V) **F**

Endangered or Vulnerable in Australia

Plains Rat *Pseudomys australis* **F**

Endangered or Vulnerable in South Australia

Mulgara *Dasycercus cristicauda/hilleri* (E)
Greater Stick-nest Rat *Leporillus conditor* (V)
Dusky Hopping Mouse *Notomys fuscus* (V)
Common Brushtail Possum *Trichosurus vulpecula* (V)

Rare in South Australia

Kultarr *Antechinomys laniger*
Yellow-footed Rock-Wallaby *Petrogale xanthopus xanthopus*
Eastern Grey Kangaroo *Macropus giganteus*
Forrest's Mouse *Leggadina forresti*
Little Pied Bat *Chalinolobus picatus*

Rare in South Australia

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 at Kinchega National Park in NSW 100km east of the study area (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 was found on Erudina Station 120km north of Yunta in 1988. 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 containing Kultarr remains has been found at Anabama Hill just south of the study area, and Moro and Chambers Gorges, in the fringe of the Flinders Ranges, confirming that it historically occurred in this area.

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 NSW. 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. Extensive study of extant populations on Bimbowrie, north of the highway have been under way since 1992, including studies on the effect of removing fox predation.

Sites were not specifically selected during this survey to record the presence of Yellow-footed Rock-Wallabies, because all the populations in the area are documented, and with the ongoing research work, many are increasing (P. Alexander pers. comm.).

Eastern Grey Kangaroo *Macropus giganteus*

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.

Distinguishing between the two grey kangaroo species is difficult, the Western Grey Kangaroo (*M. fuliginosus*) being generally slightly smaller and more brown in colour, whereas *M. giganteus* is predominantly grey.

During the current survey two definite sightings were made on Bimbowrie and Lake Dismal Stations. This is notable, as is the single sighting by Forward & Robinson (1996), as it confirms the species' existence in the area, a significant distance from known populations in NSW and central eastern SA.

Forrest's Mouse ***Leggadina forresti***

Little is known of the biology of this widespread and common native rodent, and 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"(latitude of Yunta). It inhabits tussock grasslands, low shrublands and Mulga woodlands of the arid Australian inland, and appears to be herbivorous, feeding on seeds and green vegetation. It probably does not need access to drinking water, sheltering by day in a burrow. It is known to breed after winter rains, but may be capable of breeding throughout the year.

Little Pied Bat ***Chalinolobus picatus***

This small evening bat occurs in the arid mallee region near the SA / NSW border where it predominantly roosts in caves but is known to use trees and buildings. Classified as rare in Australia and South Australia, it is distributed from south-west Queensland through central NSW to north-eastern SA. The main reason for this species' decline is the destruction of roosting sites, particularly the loss of mature trees through clearance (Richards & Hall, 1994).

Although not recorded on the North Olary Plains survey, this species has been caught in Western New South Wales. The SA Museum has records from Mutooroo Station on the southern boundary of the study area and it is known from Kinchega National Park in NSW, (Ellis & Henle, 1988).

Uncommon species

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 South Australia it occurs in the northern areas and is classified as uncommon.

It was recorded at 5 locations widely spread over the entire survey area. In all cases, the habitat was a low or very low open shrubland.

Table 9 Sub-fossil Records recovered from Owl Pellets close to the North Olary Plains Survey Area.

Common Name	*Scientific Name*	Status	Q	MG	CG	BC	AH
Forrest's Mouse	*Leggadina forresti*	**-R**			✓	✓	✓
Lesser Stick-nest Rat	*Leporillus apicalis*	**XX**		✓	✓	✓	✓
Greater Stick-nest Rat	*Leporillus conditor*	**VE**		✓	✓		✓
House Mouse	*Mus domesticus*	**CC**	✓	✓	✓		✓
Short-tailed Hopping Mouse	*Notomys amplus*	**XX**		✓	✓		
Fawn Hopping Mouse	*Notomys cervinus*	**CC**			✓		
Dusky Hopping Mouse	*Notomys fuscus*	**EE**	✓	✓	✓	✓	
Long-tailed Hopping-mouse	*Notomys longicaudatus*	**XX**		✓	✓	✓	✓
Plains Rat	*Pseudomys australis*	**V-**		✓	✓	✓	✓
Bolam's Mouse	*Pseudomys bolami*	**CC**		✓	✓	✓	✓
Desert Mouse	*Pseudomys desertor*	**IR**		✓	✓	✓	✓
Gould's Mouse	*Pseudomys gouldii*	**XX**		✓	✓	✓	✓
Long-haired Rat	*Rattus villosissimus*	**CC**		✓	✓	✓	✓
Ghost Bat	*Macroderma gigas*	**RX**		✓		✓	
Short-beaked Echidna	*Tachyglossus aculeatus*	**CC**					✓
Kultarr	*Antechinomys laniger*	**pVR**		✓	✓		✓
Kowari	*Dasycercus byrnei*	**RR**			✓		
Mulgara	*Dasycercus cristicauda/hilleri*	**VE**		✓	✓	✓	✓
Western Quoll	*Dasyurus geoffroii*	**EX**		✓	✓		
Red-tailed Phascogale	*Phascogale calura*	**EX**		✓	✓		
Narrow-nosed Planigale	*Planigale tennuirostris*	**-U**			✓		
Fat-tailed Dunnart	*Sminthopsis crassicaudata*	**CC**	✓		✓		✓
Common Dunnart	*Sminthopsis macroura*	**-U**		✓	✓	✓	✓
Crescent Nailtail Wallaby	*Onychogalea lunata*	**XX**		✓	✓		✓
Yellow-footed Rock Wallaby	*Petrogale xanthopus*	**pVR**					✓
Pig-footed Bandicoot	*Chaeropus ecaudatus*	**pXX**			✓		✓
Golden Bandicoot	*Isoodon auratus*	**EX**		✓	✓	✓	
Western Barred Bandicoot	*Perameles bougainville*	**EX**			✓		✓
Common Brushtail Possum	*Trichosurus vulpecula*	**PV-**			✓		✓
Burrowing Bettong	*Bettongia leseur*	**EX**			✓		
Desert Rat-kangaroo	*Caloprymnus campestris*	**XX**			✓		
Greater Bilby	*Macrotis lagotis*	**VX**		✓	✓		

X = extinct
E = endangered
V = vulnerable
pV = potentially vulnerable
R = rare
U = uncommon
I = indeterminate
C = common

Locations of deposits

Q Old Quinyambie Homestead
MG Moro Gorge
CG Chambers Gorge
BC Balcanoona Creek
AH Anabama Hill

SUB-FOSSIL DEPOSITS

Sub-fossil material from owl pellets relevant to the study area has been collected from Anabama Hill (**AH**) (Forward & Robinson 1996), Balcanoona Creek (**BC**) (Tunbridge 1991), Moro Gorge (**MG**) (G. Medlin pers. comm.) and Chambers Gorge (**CG**) (Medlin 1993). During the survey, some owl pellets were also recovered from the Old Quinyambie Homestead (**Q**) in the far north east of the study area. Analysis of this material is not yet complete. The range of species' remains contained in these various deposits is shown in Table 9.

Interpretation of these results with respect to animals which inhabit the plains is difficult because the owls would forage both in the plains and the adjoining hills, returning to the caves to roost. It is only in protected areas such as these caves where these owl pellets have survived the rigours of the weather to provide this historical information. Those pellets recovered from Old Quinyambie Homestead are probably quite recent, the buildings having only been uninhabited for about 15 years.

Red-tailed Phascogale *Phascogale calura*

The arid-adapted Red-tailed Phascogale was widely distributed throughout inland Australia at the time of European settlement. For unknown reasons, but perhaps in response to competition from feral cats, it is now locally extinct, and restricted to small populations in south western Australia. It is an agile climber but it finds most of its food (small vertebrates and larger arthropods) on the ground. Sub-fossil records exist from Chambers Gorge and Moro Gorge, on the western fringe of the survey area.

Mulgara *Dasycercus cristicauda/hilleri*

The Mulgara was formerly widespread across arid parts of Northern Territory, Western Australia and northern and western South Australia but now known only to occur in isolated pockets in those areas. However, sub-fossil remains have been found in the eastern fringe of the Flinders Ranges at Balcanoona Creek, Moro Gorge and Chambers Gorge (Medlin, 1993), and at Anabama Hill and World's End, indicating that it extended much further south than previously thought.

Golden Bandicoot *Isoodon 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 deposits containing remains of this species have been located at Balcanoona Creek, Moro Gorge and Chambers Gorge in the eastern margin of the Flinders Ranges (Medlin, 1993). Fossil remains have also been found at Lake Victoria in south-western NSW (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 before 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 this species from sub-fossil deposits at Balcanoona Creek, Moro Gorge and Chambers Gorge in the eastern margin of the Flinders Ranges. The location of this species in the sub-fossil site at Anabama Hill also is further south than previously known.

Dusky Hopping-mouse *Notomys fuscus*

The Dusky Hopping-mouse, *Notomys fuscus* was once distributed over much of central Australia, and is now restricted to north-eastern South Australia and south-western Queensland. First recorded in central Australia on the Horn Expedition in 1895, *N. fuscus* has since been collected over a wide geographic range from as far west as Ooldea, SA. (Wood-Jones 1925, Finlayson 1939) to south-west Queensland.

Studies of sub-fossil owl pellets reveal that *N. fuscus* was once abundant as far south as Chambers Gorge in the Flinders Ranges and Anabama Hill, south of Olary (Medlin 1993) and populations have also been recorded from the northern edge of the Simpson Desert (Queensland Museum records). Available records suggest *N. fuscus* is specific to sandy areas with a preference for sand ridges.

A recent study (Moseby *et.al.* in press) has found evidence throughout the Strzelecki Desert, east and south of the Strzelecki Creek in South Australia and in an isolated group of dunes south-east of the Diamantina River in south-west Queensland. Despite the extensive historical distribution of *N. fuscus*, all records since 1971 have been restricted to limited localities in south-west Queensland, the Cobbler Sandhills and southern Strzelecki Desert in South Australia. Populations were located in a variety of sand dune habitats (excepting *Triodia* dominated) in the dune fields throughout these areas, implying the species is a habitat generalist on its preferred substrate of sand. Preferred habitats range from extremely degraded dune and sand plain systems in the southern Strzelecki Desert, supporting mostly ephemeral plants, to well vegetated dunes covered by Sandhill Canegrass *Zygochloa paradoxa* in south-west Queensland. Relatively dense populations of *N. fuscus* were only recorded in the vicinity of major drainage systems.

Prior to this study the IUCN rated this species as Endangered (IUCN 1994). Decline in the number and geographic spread of recent collections, suggests the species has undergone a severe range contraction since European settlement and may still be declining. The IUCN Australasian Rodent Specialist Group estimates a range reduction of greater than 90% since European settlement (Lee 1995). Recent capture rates imply a total population of less than 10,000 but greater than 2500 individuals (the level below which a species is considered endangered). Moseby *et.al* (in press) reaffirmed the species decline since European settlement and recommend that the present vulnerable status of the species (IUCN Rodent Specialist Group) be maintained.

Plains Rat *Pseudomys australis*

Species in the *Pseudomys australis* complex were historically widely distributed in a variety of habitats over southern Australia. By 1990 the group had apparently declined to a single species in the centre of its former range in the north-western Lake Eyre Basin, in gibber plain areas (Breed & Head 1990). Past collection of the species has only occurred following exceptional annual rainfall. A recent study to define the current distribution of *P. australis* and to determine its preferred habitats during the usual prolonged dry periods has extended the known distribution along a belt of gibber habitats running from north-west of Lake Eyre on the Northern Territory border to south of Lake Eyre South, and a discrete population inhabiting gibber tableland west of Lake Torrens (Brandle *et.al*. in press). Plains Rats were found in low lying patches of deep cracking clay associated with minor drainage features and small depressions of cracking clay 'gilgai' common on some gibber plains. No specimens have been collected from New South Wales or Queensland since 1936 (Breed & Head 1990). The conservation status of *P. australis* is currently listed by IUCN as vulnerable (Lee 1995) on the basis of extreme fluctuations in extent of occurrence, severely

fragmented populations and suspected continuing decline (IUCN 1994).

Common Brushtail Possum *Trichosurus vulpecula*

The Common Brushtail Possum was once widespread and, in places, common in the arid and semi-arid zone. Very few records are known for the region and historical accounts indicate the brushtail possum was not very common, with the last record being from Olary Creek in 1978 (Kerle *et.al* 1992). During the survey, a resident of Cockburn stated they were occasionally found at homesteads in the past. They are now restricted to a small number of populations in Central Australia, all of which are declining and in urgent need of conservation management. Possums were dependant in the arid zone on a diverse understorey of plants to provide a range of food throughout the normally dry times. Severe overgrazing following European pastoral settlement destroyed much of the critical shrub component and rabbits continue to restrict re-establishment. These lower density possum populations centred on restricted areas of higher productivity in dry times were also very vulnerable to fox predation. Unlike the possums of the forests and woodlands of the higher rainfall areas, they often lived in burrows, rather than in tree hollows. Brushtail possums are now extinct throughout the North Olary Plains.

Ghost Bat *Macroderma gigas*

The Ghost Bat is Australia's only carnivorous bat, and the largest of the microchiropterans. They feed on other bats, birds and even occasionally hunt reptiles and frogs on the ground. They require large, and relatively warm and humid caves in which to roost. They were once widely distributed as far south as the Flinders Ranges, where they have been recorded from sub-fossil and mummified remains and possibly were present until about 200 years ago (Richards & Hand, 1995). *M. gigas* has disappeared from much of its former range in arid Australia since European settlement and is patchily distributed through northern and north-eastern Australia. There is a probability that the southern Australian populations were in decline prior to European settlement due to increasing aridity over the last 10,000 years.

INTRODUCED SPECIES

Excluding the domestic stock, four introduced species were numerous and widespread throughout the South Olary Plains (rabbits, house mice, foxes and cats).

House mice were quite widespread, and in some quadrats they were the only small native terrestrial mammals recorded. Many of these locations were nearer main roads and settlements, suggesting that the House Mouse may have displaced some of the small native mammals.

Foxes and less often, cats were also widely observed throughout the survey area. Given their generally cryptic behaviour, it suggests that they may be far more abundant than the survey data would suggest, and raises concerns about their actual impact on the remaining small native fauna (although rabbits and House Mice would be a significant component of their diets).

The European rabbit was less abundant than it has been in the past, as evidenced by the number of disused warrens, particularly in the sandy areas. This is mainly due to the recent reintroduction of virulent strains of Myxomatosis and the spread of Rabbit Calicivirus introduced into the area in October 1995.

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 (ie. 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 practices, 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 rabbit, kangaroo (and goats in places) numbers in the North Olary Plains and their substantial combined grazing impact on native pastures is of great concern, as 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 SA.

Kangaroo numbers, artificially increased by free water availability, are annually assessed throughout most of the pastoral areas, and controlled by the DENR, 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 for foxes.

Some projects are currently being undertaken to eradicate introduced pests to enable populations of threatened native species to stabilise and expand or be reintroduced into areas. Through the total grazing pressure study recently commenced in the Olary Hills 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, valuable information is being gained into the interactions between feral and native populations.

In another project being conducted by the Department of Environment and Natural Resources in the Olary Hills, significant increases in Yellow-footed Rock-wallaby numbers have been noticed after three years of pest control (pers. comm. P. Alexander). 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 have been reintroduced and plans are underway for other releases.

In the North Olary Plains survey area, 13 species are nationally or locally extinct. These are known to have occurred in the area but have disappeared since European occupation. The remaining species need protection, especially in light of the large numbers of thriving introduced species and ongoing pastoral land use. Areas of good quality natural habitat must be maintained to support these remaining populations. In the longer term it may even be possible to re-introduce some species.

Figure 88
The Fat-tailed Dunnart, *Sminthopsis crassicaudata*, a common small mammal of the treeless plains.
Photo: S. Doyle.

Figure 89
Red Kangaroos, *Macropus rufus* copulating. This species has increased markedly through changes to the area by the grazing industry.
Photo: DENR.

Figure 90
The Yellow-footed Rock-wallaby, *Petrogale xanthopus*, has made a significant recovery in the Olary Ranges through integrated pest management around key colonies.
Photo: A. Robinson.

Figure 91
Bolam's Mouse, *Pseudomys bolami*, a native rodent recorded from several sites in the survey area.
Photo:A. Robinson.

BIRDS

by R. M Playfair[1], M. C. De Jong[2] and J. S. Matthew[3]

INTRODUCTION

The birds of the North Olary Plains have been poorly documented, with few comprehensive regional accounts having been published. Those lists which are available (McGilp 1923; Black 1975; Pedler & Ragless 1978) provide valuable information on the status and habitat preferences of the birds in the area at that time.

An exhaustive review of the literature, published or otherwise has not been attempted here, a strong reliance being placed on the Royal Australasian Ornithologists Union's (RAOU) *Atlas of Australian Birds* (Blakers *et.al*. 1984). Distributional material published in the ornithological journals *Emu* and *South Australian Ornithologist*, and in the *South Australian Ornithological Association Newsletter*, as well as unpublished material held by that organisation, would need to be consulted for a thorough review of past accounts of distributions.

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 those of the forest and mallee further south. (Reid *et.al*. 1990). There are two steep gradients in avian species richness (frequency) in South Australia identified by Gentilli (1992). 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) (Schodde 1982). Mack (1970) noted that the bird communities of the southern mallee patches were much richer than those of the blackoak open woodlands and chenopod shrublands, but that these latter habitats, after good rains, could be rapidly colonised by large numbers of mobile bird species, including chats, budgerigars and woodswallows.

Schodde (1990) has reviewed the avifauna of the mallee biome at the continental level from a biogeographical and evolutionary perspective, identifying the characteristic suite of mallee bird species. He contends that the mallee biome, as a significant structural vegetation formation with its obvious floristic links to southern wetter forests (Eucalypt dominated), has provided an evolutionary pathway for the development of certain species, found today in the mulga, chenopod and spinifex landscapes of arid Australia.

The transition from the mallee to the arid-zone communities occurs abruptly and reflects the limits of agricultural development. There is an interaction between topography and climate, with mean annual rainfall declining quickly to the east of the escarpment of the Flinders Ranges. The north-south gradient is much more gradual. 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.

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 VI.

TOTAL SPECIES

During the North Olary Plains survey 125 species were identified. 95 of these species were recorded at the 48 vertebrate survey sites. A further 30 species were recorded only through opportunistic observations (away from sites).

Table 7 is a listing of all the birds recorded during this survey, in descending order of frequency, along with their habitat preference (Shodde 1994) and an indication of their population trend in the arid part of western New South Wales (Smith & Smith 1994).

A complete list of all bird taxa recorded from the North Olary Plains region in the current and previous studies is shown in Appendix VI.

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Table 7 Birds Recorded during the North Olary Plains Survey.

SPECIES	COMMON NAME	Habitat [1]	No [2]	Opp.	Total	Trend [3]
Dromaius novaehollandiae	Emu	U	22	36	48	I
Milvus migrans	Black Kite	U	30	12	42	N
Corvus coronoides	Australian Raven	U	36	5	41	I
Malurus leucopterus	White-winged Wren	TG,CS,HG	33	7	40	D
Psophodes cristatus	Chirruping Wedgebill	CS	26	11	37	D
Aquila audax ssp. audax	Wedge-tailed Eagle	U	21	15	36	I
Eolophus roseicapillus	Galah	U	24	12	36	I
Poephila guttata	Zebra Finch	U	26	7	33	I
Anthus novaeseelandiae	Richard's Pipit	TG,CS	28	4	32	I
Falco cenchroides	Australian Kestrel	U (TG,CS)	21	9	30	I
Melopsittacus undulatus	Budgerigar	U	21	7	28	N
Meliphaga virescens	Singing Honeyeater	U	22	4	26	N
Artamus cinereus	Black-faced Woodswallow	MU,TG	18	6	24	I
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	U	20	3	23	N
Northiella haematogaster	Blue Bonnet	U	10	13	23	N
Gymnorhina tibicen	Australian Magpie	RE	15	7	22	I
Ocyphaps lophotes	Crested Pigeon	U	18	4	22	I
Aphelocephala leucopsis	Southern Whiteface	U	16	5	21	I
Malurus lamberti	Variegated Wren	U	17	2	19	N
Dicaeum hirundinaceum	Mistletoe Bird	U	14	4	18	N
Chrysococcyx basalis	Horsfield's Bronze-cuckoo	U	15	2	17	N
Epthianura aurifrons	Orange Chat	CS	11	5	16	N
Manorina flavigula	Yellow-throated Miner	RE,MA	10	6	16	I
Pomatostomus ruficeps	Chestnut-crowned Babbler	MU,CA,MA	12	4	16	N
Cacatua sanguinea	Little Corella	U	14	1	15	I
Nymphicus hollandicus	Cockatiel	U	10	4	14	D
Rhipidura leucophrys	Willie Wagtail	U	10	4	14	I
Calamanthus campestris	Western Fieldwren	CS	11	1	12	D
Petroica goodenovii	Red-capped Robin	U	9	3	12	N
Barnardius zonarius	Ring-necked Parrot	U	6	5	11	N
Corvus bennetti	Little Crow	U	11	-	11	I
Psephotus varius	Mulga Parrot	U	6	5	11	N
Cracticus torquatus	Grey Butcherbird	MA,CA,PE	8	2	10	N
Falco berigora	Brown Falcon	U	4	10	10	N
Hirundo nigricans	Tree Martin	RE,PE	5	5	10	N
Acanthiza uropygialis	Chestnut-rumped Thornbill	U	7	2	9	N
Cincloramphus cruralis	Brown Songlark	TG,CS	8	1	9	I
Hoplopterus tricolor	Banded Lapwing	W	1	7	8	I
Pachycephala rufiventris	Rufous Whistler	CA,RE,MU	5	3	8	N
Smicrornis brevirostris	Weebill	U	7	1	8	N
Acanthiza chrysorrhoa	Yellow-rumped Thornbill	U	5	2	7	N
Certhionyx variegatus	Pied Honeyeater	MU,HG	4	3	7	N
Epthianura tricolor	Crimson Chat	CS,MU	5	2	7	N
Grallina cyanoleuca	Magpie-lark	U	3	4	7	I
Pardalotus striatus	Striated Pardalote	PE,RE,MA	5	2	7	D
Accipiter cirrhocephalus	Collared Sparrowhawk	U	3	3	6	N
Cincloramphus mathewsi	Rufous Songlark	U	1	5	6	I
Cinclosoma cinnamomeum	Cinnamon Quail-thrush	CS	3	3	6	D
Coracina novaehollandiae	Black-faced Cuckoo-shrike	U	3	3	6	N
Pyrrholaemus brunneus	Redthroat	MU,CA	4	2	6	D
Circus assimilis	Spotted Harrier	TG,CS	1	4	5	N
Cuculus pallidus	Pallid Cuckoo	U	2	3	5	N
Hieraaetus morphnoides	Little Eagle	U	3	2	5	N
Hirundo ariel	Fairy Martin	U	2	3	5	I
Hirundo neoxena	Welcome Swallow	U	2	3	5	I
Lalage sueurii	White-winged Triller	U	3	2	5	N
Meliphaga penicillata	White-plumed Honeyeater	RE	3	2	5	I
Sugomel niger	Black Honeyeater	MU,HG	5	-	5	N
Anas superciliosa	Pacific Black Duck	W	1	3	4	N
Artamus leucorhynchus	White-breasted Woodswallow	RE	2	2	4	I
Epthianura albifrons	White-fronted Chat	CS	3	1	4	I
Geopelia placida	Peaceful Dove	RE	3	1	4	I
Hoplopterus miles	Masked Lapwing	W	1	3	4	I
Phaps chalcoptera	Common Bronzewing	U	2	2	4	D
Columba livia	Feral Pigeon	U	-	3	3	N
Malacorhynchus membranaceus	Pink-eared Duck	W	-	3	3	I
Tachybabtus novaehollandiae	Australasian Grebe	W	-	3	3	I
Charadrius ruficapillus	Red-capped Dotterel	W	-	3	3	I

Anas gracilis	Grey Teal	W	1	2	3	N
Cheramoeca leucosternum	White-backed Swallow	U	2	1	3	I
Colluricincla harmonica	Grey Shrike-thrush	U (RE)	3	-	3	N
Coturnix novaezelandiae	Stubble Quail	TG	2	1	3	D
Megalurus gramineus	Little Grassbird	W	2	1	3	N
Melanodryas cucullata	Hooded Robin	U	3	-	3	D
Oreoica gutturalis	Crested Bellbird	U	2	1	3	N
Pardalotus rubricatus	Red-browed Pardalote	RE	1	2	3	N
Passer domesticus	House Sparrow	U	1	2	3	N
Turnix velox	Little Button-quail	TG,CS	2	1	3	D
Anas rhyncotis	Australian Shoveller	W	-	2	2	D
Himantopus himantopus	Black-winged Stilt	W	-	2	2	I
Recurvirostra novaehollandiae	Red-necked Avocet	W	-	2	2	I
Chlidonias hybrida	Whiskered Tern	W	-	2	2	N
Aythya australis	Hardhead	W	-	2	2	N
Falco longipennis	Little Falcon	U	-	2	2	N
Ninox novaeseelandiae	Boobook Owl	PE,RE	-	2	2	N
Geopelia cuneata	Diamond Dove	MU	-	2	2	D
Erythrogonys cinctus	Red-kneed Dotterel	W	-	2	2	I
Calidris acuminata	Sharp-tailed Sandpiper	W	-	2	2	N
Accipiter fasciatus	Brown Goshawk	U	1	1	2	N
Ashbyia lovensis	Gibberbird	CS	1	1	2	N
Climacteris picumnus	Brown Treecreeper	PE,RE,MA	2	-	2	N
Elseyornis melanops	Black-fronted Dotterel	W	1	1	2	I
Eurostopodus argus	Spotted Nightjar	MA	1	1	2	N
Halcyon pyrrhopygia	Red-backed Kingfisher	U	1	1	2	N
Merops ornatus	Rainbow Bee-eater	U	1	1	2	N
Mirafra javanica	Singing Bushlark	TG	2	-	2	I
Peltohyas australis	Inland Dotterel	CS	1	1	2	I
Pomatostomus superciliosus	White-browed Babbler	U	2	-	2	N
Fulica atra	Eurasian Coot	W	-	1	1	N
Porzana fluminea	Australian Crake	W	-	1	1	N
Ardea novaehollandiae	White-faced Heron	W	-	1	1	I
Gallinula ventralis	Black-tailed Native Hen	W	-	1	1	N
Podargus strigoides	Tawny Frogmouth	U	-	1	1	N
Rhipidura fuliginosa	Grey Fantail	U	-	1	1	N
Microeca leucophaea	Jacky Winter	PE,RE,MA	-	1	1	N
Aegotheles cristatus	Australian Owlet-Nightjar	MA,PE	-	1	1	N
Cygnus atratus	Black Swan	W	-	1	1	I
Sterna nilotica	Gull-billed Tern	W	-	1	1	N
Elanus scriptus	Letter-winged Kite	TG,CS	-	1	1	D
Neophema chrysostoma	Blue-winged Parrot	TG,CS	-	1	1	N
Chenonetta jubata	Maned Duck	MU	-	1	1	I
Falco peregrinus	Peregrine Falcon	U	-	1	1	N
Tyto alba	Barn Owl	U	-	1	1	N
Struthidea cinerea	Apostlebird	U	-	1	1	N
Acanthiza apicalis	Inland Thornbill	CA,RE	1	-	1	D
Aphelocephala nigricincta	Banded Whiteface	HG	1	-	1	I
Artamus personatus	Masked Woodswallow	U	1	-	1	N
Artamus superciliosus	White-browed Woodswallow	U	1	-	1	N
Cracticus nigrogularis	Pied Butcherbird	U	1	-	1	I
Falco subniger	Black Falcon	U	1	-	1	D
Melithreptus brevirostris	Brown-headed Honeyeater	PE,MA	1	-	1	N
Pardalotus punctatus	Spotted Pardalote	PE,MA	1	-	1	D
Phylidonyris albifrons	White-fronted Honeyeater	MA,HG	1	-	1	N
Tadorna tadornoides	Australian Shelduck	W	1	-	1	I
Zosterops lateralis	Silvereye	PE	1	-	1	I

Notes

1 Habitat Codes

U	Ubiquitous
W	Wetlands
CA	Casuarina pauper Woodland
CS	Chenopod Shrubland
MA	Mallee
MU	Acacia aneura Woodland
PE	Upland Eucalypt Woodland
RE	Riverine Eucalypt Woodland
TG	Tussock Grassland
HG	Hummock Grass & Acacia ligulata Dunefields

adapted from Schodde 1994

2 Number of sites (out of 48) at which this species was recorded during this survey

3 Trend Codes

I	Increased

D Decreased
N No significant change adapted from Smith & Smith 1994

PATN ANALYSIS

The final bird matrix for analysis contained 720 records (95 species at 48 quadrats). All single occurrence records were masked out. One quadrat, CNE08301 formed a single-quadrat group, but was not masked out as it was the only wetland site surveyed, and consequently had a strong relationship to those species dependant on this habitat type. The final matrix analysed contained 694 records, consisting of 69 species at 48 quadrats.

A first cut analysis was undertaken on this dataset after removing species only recorded at one site.

Another masking was undertaken, removing all species that are very mobile, high flying, seasonal, nomadic, migratory, ubiquitous or highly irregular in occurrence (ie. species that generally are not significantly habitat-specific), but leaving in those species only recorded at a single site. This substantially decreased the records available for analysis to 278 (47 species at 48 quadrats).

The apparent groupings shown by this analysis are not clear, mainly due to insufficient data, however, the groups which emerged from the analysis performed for the South Olary Plains (Forward & Robinson 1996) with a much larger dataset, in an adjacent area to the south do appear to match fairly closely with the observations from this area.

The three main species groupings were for blackoak woodlands, mallee woodlands and chenopod shrublands.

Frequent, characteristic species of the blackoak woodlands were:
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*)
Brown Treecreeper (*C. picumnis*)
Hooded Robin (*M. cucullata*)
Inland Thornbill (*A. apicalis*)

Frequent, characteristic species of the minor (in extent in this survey area) habitats dominated by Mallee Eucalypts, sometimes in sandy country with spinifex were:

Ringneck Parrot (*B. zonarius*)
Grey Shrike-thrush (*C. harmonica*)
Striated Pardalote (*P. striatus*)
Weebill (*S. brevirostris*)
Tree Martin (*H. nigricans*)
Brown Treecreeper (*C. picumnus*)
Chestnut Quail-thrush (*C. castonotum*)

Frequent, characteristic species of the open chenopod shrublands include:

Richard's Pipit (*A. novaeseelandiae*)
Australian Kestrel (*F. cenchroides*) (raptorial but prey are ground dwellers)
White-winged Fairy-wren (*M. leucopterus*)
White-fronted Chat (*E. albifrons*)
Brown Songlark (*C. cruralis*)
Black-faced Woodswallow (*A. cinereus*)
Western Fieldwren (*C. campestris*)
Orange Chat (*Ephthianura aurifrons*)
Chestnut-crowned Babbler (*P. ruficeps*)
Chirruping Wedgebill (*P. cristatus*)
Southern Whiteface (*A. leucopsis*)
Grey Butcherbird (*C. torquatus*)
Redthroat (*P. brunneus*)
Emu (*D. novaehollandiae*)

Almost all these species are ground-feeding specialists, specific to low shrublands. Most feed, rest and breed at ground or low shrub level. The sparse nature of both blackoak and Mulga patches in the study area means that many of these chenopod-preferring species are also found where there is some tree cover overhead. This causes some overlap and confusion when attempting to interpret these data from an assumed habitat specific viewpoint.

SPECIES OF PARTICULAR INTEREST

Of the species found on the current survey, 16 are threatened nationally or in South Australia.

In the notes below, the Australian conservation status is from the Commonwealth Endangered Species Protection Act 1992 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), Simpson & Day (1994) and Stephens (1992). Distribution maps have been reproduced here from Simpson & Day (1994).

SPECIES OF NATIONAL SIGNIFICANCE

Plains Wanderer *Pedionomis torquatus*

Preferred habitat for this species is native grasslands or old stubble. Nationally vulnerable. Although it resembles the quail in outward appearance and choice of habitat, the Plains Wanderer is now considered to be more closely related to the waders. The Plains Wanderer is one of the hardest birds to observe due to it's well camouflaged plumage and nocturnal habits making accurate population assessments difficult. However, there have been concerns since early this century about the decline of this species (D'Ombrian, 1926) and populations are now more restricted. Causes have been attributed to introduced grasses, grazing and clearing (Simpson & Day, 1994). It is sparsely distributed across it's range in groups of one, two and up to five individuals and is nomadic, though they may be sedentary where permanent habitat exists. Breeding is from spring to early autumn with most breeding from September to December.

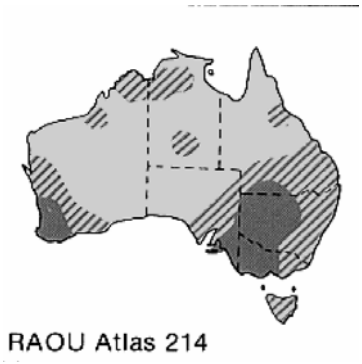
Distribution of the Plains Wanderer

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.

This is the rarest of several Australian waterfowl that breed primarily on the ephemeral wetlands of inland eastern Australia. The population size appears to fluctuate greatly. Large numbers may irrupt from breeding strongholds when they dry out, giving an impression of abundance, but such events are interspersed with long periods of apparent scarcity. Though fully protected, it is vulnerable to accidental shooting by hunters, especially when concentrated in coastal drought refugia. The Freckled Duck's most important breeding areas are in the immense temporary swamps created by floodwaters within the Lake Eyre and Bulloo Drainage Divisions. It also breeds in several swamps within the Murray-Darling Division, notably those along the Paroo and Lachlan rivers and others within the Riverina district. Swamps within the Millicent Basin of South Australia and Victoria are also used. During extensive inland droughts the species is forced to disperse. At such times other areas in south-eastern Australia become critical as refugia, especially certain wetlands in the Murray River Basin, south-eastern Queensland and southern South Australia (Blakers et al. 1984, Martindale 1986, Marchant and Higgins 1990). In inland eastern Australia the Freckled Duck breeds in freshwater wetlands thickly vegetated with Lignum (*Muehlenbeckia florulenta*) within which the birds build their nests (Braithwaite 1976). During times of inland drought, when found closer to the coast, they are at risk of being misidentified as game species and shot during duck-hunting seasons. The species has been recorded on numerous wetland reserves. An inventory of known and potential breeding sites is needed, together with an indication of the importance of each site in contributing to major breeding events. In addition the wild population should be counted at regular intervals to determine long-term trends. The conservation status of Lignum swamps and, in south-western Australia, seasonally flooded paperbark swamps, needs to be evaluated. A captive breeding and release program has been advocated.

Although not recorded during this survey, Freckled Ducks have been observed further south and along the River Murray (Parker *et.al*., 1985). In times of high rainfall they occur further inland on swamps and lagoons (Pearse, 1929, 1937).

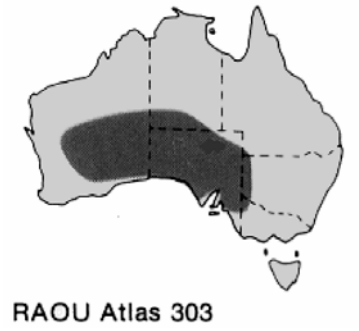


Distribution of the Freckled Duck

Scarlet-chested Parrot ***Neophema splendida***

This parrot is a rarely observed inhabitant of mallee and acacia shrublands in the semi-arid inland of southern Australia. The core of its range lies in the Great Victoria Desert of South and Western Australia but it sometimes irrupts to east and west. Altered fire regimes may have affected the species and increased availability of water in pastoral lands may have favoured competitors. The Scarlet-chested Parrot appears to breed rapidly under suitable conditions; it then becomes locally common, only to disperse and again become scarce until the next favourable season (Blakers et al. 1984). In some seasons it also occupies more open habitats. In the Great Victoria Desert it is most common in the better vegetated areas but is thought to spread out into open desert in favourable seasons (Ford 1971) and in the Northern Territory it is usually seen on hummock grass sandplain.

Classified as rare nationally, and in South Australia, this species was not sighted during the current survey.



Distribution of the Scarlet-chested Parrot

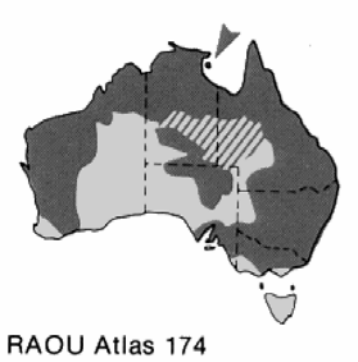
SPECIES OF SOUTH AUSTRALIAN SIGNIFICANCE

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 SA 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.

In southern Australia this bird was once more widespread in grassy woodlands. Its rarity and continuing decline there has been attributed to fox predation, vegetation clearance for agriculture, land degradation through pastoralism. Though not recorded during this survey, in northern Australia and on many continental islands this species remains common, even within towns.

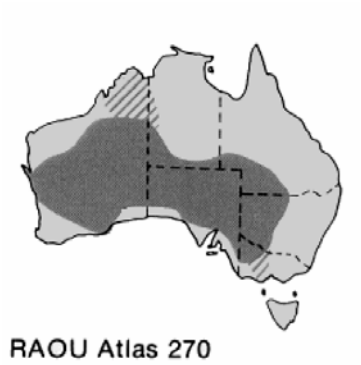


Distribution of the Bush Thick-knee

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). The total population, however, still exceeds 10,000 individuals, some sub-populations are recovering, and most of the southern mallee habitat is now protected. 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 NSW and Victoria and vulnerable in South Australia, the Pink Cockatoo was not recorded during the North Olary Plains Survey.

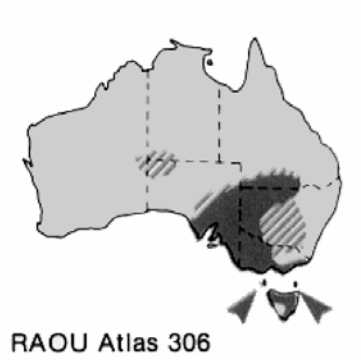


Distribution of the Major Mitchell Cockatoo

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 in winter. Here it inhabits Eucalypt woodland, saltbush shrublands, open grasslands and lignum swamps.

This species is classified as secure in NSW, Victoria and Tasmania but vulnerable in South Australia. An unsure sighting of this bird was made by Pedler & Ragless (1978) near Lake Callabonna, just north of this area, and it is listed by Blakers *et.al* (1984) as occurring in the area. It was observed once opportunistically during this survey when a pair were flushed from Mitchell grass/saltbush plains near Cockburn. It is more likely to be seen as an Autumn/Winter visitor, and most would have left the region by August, when the survey was conducted.

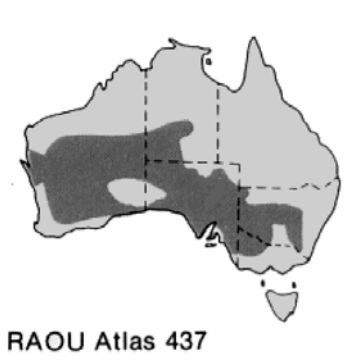


Distribution of the Blue-winged Parrot

Chestnut Quail-thrush ***Cinclosoma castanotum***

A sedentary, ground-frequenting species widely 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.

Classified as nationally secure, rare in NSW and vulnerable in South Australia, it was not recorded during this survey.

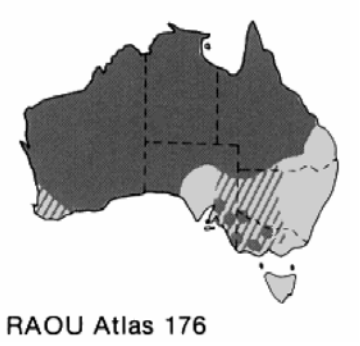


Distribution of the Chestnut Quail-thrush

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 mainland Australia, this bird has been eliminated from much of southern Australia by hunting, fox predation and clearance of its grassland habitat for agriculture. However there are now signs that it is returning in the south and in northern Australia it remains common, though still hunted. In the last two decades it has extended its range in central Queensland following clearance of forest.

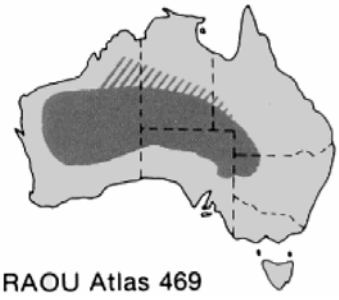
Although classified as secure in Australia, it is extinct in the ACT, endangered in Victoria and vulnerable in NSW and South Australia. In SA it is declining and is locally extinct in some areas. It was not recorded during this survey.



Distribution of the Australian Bustard

Banded Whiteface ***Aphelocephala nigricincta***

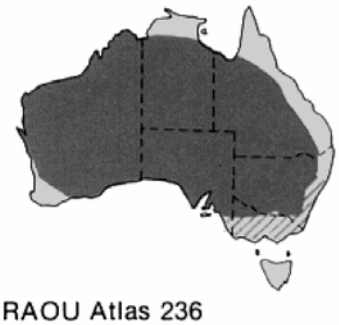
The single record of the Banded Whiteface near Quinyambie in the far north of the study area is significant because it is close to the southern extremity of the known range for this species and is slightly south of the single record for the area from the S A Museum records (near Moolawatana). Blakers *et.al* (1984) also note this species in the region.



Distribution of the Banded Whiteface

Grey Falcon ***Falco hypoleucos***

This falcon is sparsely distributed over a wide geographic area and is nowhere common. There is some evidence that its breeding distribution has contracted in the past few decades. Overgrazing, clearance and other degradation of its open woodland habitat appear to be the greatest threats to the species, possibly affecting prey abundance and nest site availability. Its eggs are much sought after by egg collectors. The Grey Falcon is sighted infrequently over much of continental Australia (Blakers et al. 1984, Olsen and Olsen 1986) and has been seen in New Guinea (Finch 1981). The Grey Falcon has never been considered common. There may be as few as 1,000 pairs of Grey Falcons, giving a total population of fewer than 5,000 individuals. The distribution of the Grey Falcon is centred on inland drainage systems. There it frequents timbered lowland plains, particularly acacia shrublands, crossed by tree-lined watercourses. It also hunts far out into treeless areas and frequents tussock grassland and open woodland, especially in winter. Threats to the Grey Falcon's habitat include continued overgrazing of arid zone rangelands and clearance of the semi-arid zone for marginal farming. Nest site availability, particularly in sparsely treed parts of the inland, may be becoming limited, especially where grazing by exotic herbivores is preventing regeneration. The Grey Falcon was not recorded during this survey, though thought to be in the region.

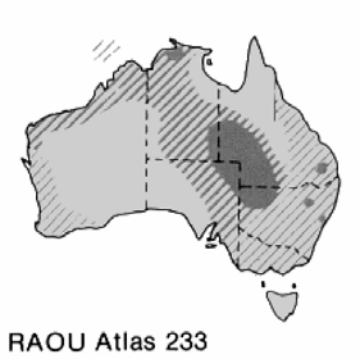


Distribution of the Grey Falcon

Letter-winged Kite ***Elanus scriptus***

The distribution of this nocturnal kite is thought to be centred on the Barkly Tablelands in the eastern Northern Territory and river systems in south-western Queensland, north-eastern South Australia and north-western New South Wales. From there the population occasionally irrupts in response to fluctuations in the population of its main prey, the Long-haired Rat *Rattus villosissimus.*

When this occurs individuals may be recorded almost anywhere on the Australian mainland. However these populations rarely last more than a year after which the kite's distribution again contracts. Both the kite and its prey have survived more than a century of sometimes intensive pastoralism. Though the population may be small, the species is secure. One sighting of this species was made during this survey in open low sandy rises with sparse black oak over chenopods and grasses.

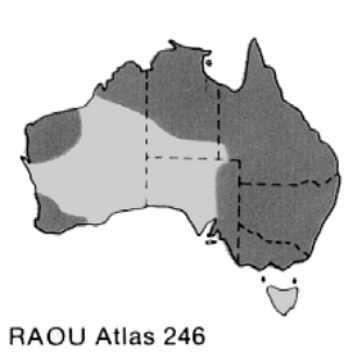


Distribution of the Letter-winged Kite

OTHER NOTABLE SPECIES

Barking Owl ***Ninox connivens***

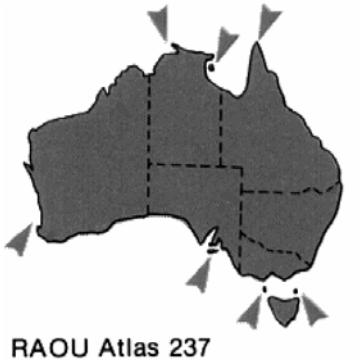
The study area is on the edge of the known range for this quite widespread (though listed as rare in SA) species. It has only been recorded once (an egg; SA Museum) in 1893 at Moolawatana (Parker, SA. 1977). Habitat preference is for riverine eucalypt forests and woodlands in western New South Wales (Schodde 1994) and is thought to be decreasing in its abundance in this core habitat (Smith & Smith 1994). None were recorded during this study, and the other ornithological surveys listed in Appendix VI have not recorded this species in the study area either.



Distribution of the Barking Owl

Peregrine Falcon ***Falco peregrinus***

This spectacular falcon, classified as rare in South Australia is considered threatened by pesticides and falconry over much of its global range and is the subject of intensive conservation management. The population of the Australian subspecies, however, appears to be stable and is affected only in relatively small areas subject to intensive agriculture. In most parts of its Australian range it has coped well with European settlement and breeds in or near a number of cities. Monitoring of breeding birds should continue but the subspecies is under no immediate threat. One sighting was made of a single bird during this survey in low cottonbush dunefields north-west of Lake Frome.

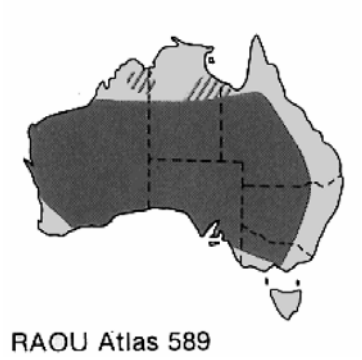


Distribution of the Peregrine Falcon

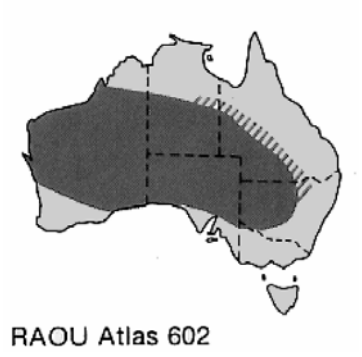
Black Honeyeater ***Sugomel niger***

Black and Pied Honeyeaters (*Certhionyx variegatus*) tend to be found together in similar habitat types. They are both nomadic and extend their range south into South Australia during spring (Ford, 1978). They have similar breeding requirements and make use of nectar resources mainly, but have been observed feeding Ruby saltbush and Spiny saltbush berries and insects to their young. Turpentine bush appeared to be a preferred habitat for the Pied Honeyeater, reflecting favourable breeding conditions at survey time.

Both species were recorded during this survey in the south east and the centre of the survey area. The Black Honeyeater was breeding on Benagerie Station during the survey.



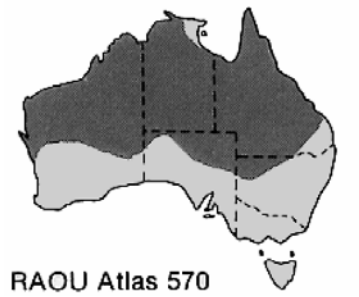
Distribution of the Black Honeyeater



Distribution of the Pied Honeyeater

Red-browed Pardalote ***Pardalotus rubricatus***

Close to the southern extremity of its known range, there were two sightings of this bird in a eucalypt creek-line near Paralana, on the fringe of the Flinders Ranges (north-west of survey area), and a group of three were observed perched in grey box woodland adjacent to Lake Coonee (CNE08201). The SA Museum has a single record from Moolawatana.

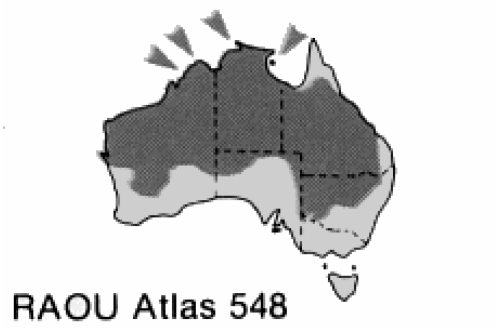


Distribution of the Red-browed Pardalote

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, and into the northern Flinders and Gawler Ranges in South Australia.

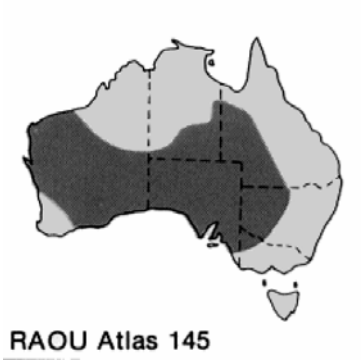
Rare in South Australia, the RAOU Atlas only shows records of this species in the study area and Parker and Horton (1990) list it as occurring in the Flinders Ranges and Northern Arid regions. None were recorded during this survey.



Distribution of the Little Woodswallow

Inland Dotterel ***Peltohyas australis***

This well camouflaged, small ground-dweller inhabits ploughed ground, open sparse plains and gibber areas, nesting on the ground. It occurs over much of inland Australia. During this study, it was only recorded twice, possibly due to its extremely good camouflage or to the limited sampling in the bare gibber areas it prefers.



Distribution of the Inland Dotterel

DISCUSSION

Wetland habitats and waterbirds are not a major feature of this area with its arid climate and the absence of permanent watercourses. However, runoff from significant rainfall events creates extensive shallow ephemeral wetlands which temporarily support rich and abundant waterbird populations. The major creeks which flood out into the study region from the Flinders Ranges and from hills of the Olary Spur are particularly significant. The flowing artesian hot water from Coonee Bore and Moolwatana Bore create extensive permanent wetlands, and constitute the most important non-ephemeral wetlands in the region, but they are also the focus of heavy cattle impact, and their habitat value suffers.

The building of dams for watering stock has provided additional and permanent waterbodies throughout the region. Waterbirds, in limited numbers make use of these artificial habitats.

The provision of permanent waterpoints throughout the region has undoubtedly affected populations of many dryland birds, in addition to its more obvious effect on waterbirds. Reid and Fleming (1992) and Smith and Smith (1994) 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 places in a previously waterless environment.

CONSERVATION CONSIDERATIONS

The survey area contains some bird species which are of national conservation significance:

Vulnerable

Plains Wanderer

Rare

Freckled Duck
Scarlet-chested Parrot

Several species are also rated in South Australia:

Vulnerable or Endangered

Grey Falcon
Bush Thick-knee
Major Mitchell (Pink Cockatoo)
Blue-winged Parrrot

Chestnut Quail-thrush
Australian Bustard
Pied Honeyeater
Brolga
Letter-winged Kite
Banded Whiteface
Apostlebird
Australasian Shoveler
Hardhead

The presence of these rated species and the biogeographical location of the North Olary Plains at a major ecotone, where species of limited distribution often exist, suggest that some serious conservation effort is required. 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 by land use.

With the changing climate, the presence of contiguous and extensive sequences of different vegetation formations across this 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. 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 nesting sites for species requiring large trees with hollows is also a serious problem.

The study area is extensively grazed by sheep, cattle, rabbits, kangaroos and goats in places. With moderate grazing levels and proper management, impact on the natural vegetation can be minimised, but if allowed to become too concentrated in any area over long periods, important avian food sources, nesting material and roosting sites (particularly those in the lower vegetation strata) become 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 (1994) 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. 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, and the position of the Dog Fence, overgrazing remains a problem in some parts. With the fragmented and degraded landscapes which exist in many areas, species which depend on resources at ground and shrub level may not find suitable habitats in which to survive without significant changes in pastoral management.

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 (and other distinctive residents of this habitat) have also declined in chenopod shrublands over parts of their former Australian ranges (Reid and Fleming, 1992).

Regional assessments of the conservation status of birds in the pastoral areas of the State have not yet been attempted, but the alarming decline of some birds in western NSW as documented by Smith & Smith (1994), raises concerns that similar trends are also occurring west of the border.

Figure 83
White-fronted Chats, *Ephthianura albifrons* were nesting in low bushes at the time of the survey
Photo: A. Robinson

Figure 84
The Brown Songlark, *Cincloramphus cruralis* in typical pose on the top of the highest bush around.
Photo: South Australian Ornithological Association

Figure 85
The Red-capped Robin, *Petroica goodenovii*, a bird of the Blackoak woodlands.
Photo: South Australian Ornithological Association

Figure 86
Emus, *Dromaius novaehollandiae* move through the area, and in some seasons penetrate the agricultural districts to the south in large numbers
Photo: S. Doyle

REPTILES AND AMPHIBIANS

by R. M. Playfair[1] and M. N. Hutchinson[2]

INTRODUCTION

Prior to the North Olary Plains survey, there had been no systematic searching or trapping of reptiles and amphibians in the area.

Figure 92 shows the distribution of South Australian Museum reptile records from the North Olary Plains up to 1996. These records are mainly unsystematic and opportunistic collections, concentrated near habitation and along main access routes. Up to 1996, 75 species were confirmed from the area (70 reptiles and 5 amphibians). To date, no information has been published on the herpetofauna of the region.

TOTAL SPECIES

Trapping sites, including tracks and other unmistakable signs, produced 178 records of 39 different reptile species. Opportunistic searches outside quadrats yielded a further 143 records of reptile species. Subsequent to this survey, more pitfall trapping was carried out for an environmental impact assessment of the Beverley Uranium mining area to the north of Paralana Creek in the far north-west of the survey area (A. Herbert, pers. comm.). These additional records have been included in the opportune listing of Table 10 (in brackets). Species are listed in Table 10 in descending order of their total frequency.

50 species of reptile were recorded, 11 of which were not trapped at quadrats, but caught opportunistically. Two amphibian species were recorded.

The single Leopard Ctenotus (*Ctenotus pantherinus)* record is a new species for the region.

Codes in Table 10 denote habitat preferences (or tendencies if bracketed):

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* sp.)

PATN ANALYSIS

The initial reptile matrix for analysis contained 44 quadrats and 39 species (178 records). Several species were masked out.

Tiliqua rugosa was removed because of its ubiquitous nature and mobility during breeding, and all species only occurring at one site. Quadrats with only one species left after this mask were also omitted. Thus the final data matrix contained 31 quadrats and 23 species.

The inclusion of the extra data from the South Olary Plains survey area (Forward & Robinson 1996) did not clarify any of these relationships, and the results of this analysis are not reproduced here. It did, in fact point up a potential problem with this cluster analysis technique when being applied to data from different observers, or from a different time. Significant clustering of sites from within the two surveys occurred, on the basis of similar suites of reptiles recorded, suggesting that similarities within a survey (ie. some bias in the data) were more significant than those between different sites or habitat types.

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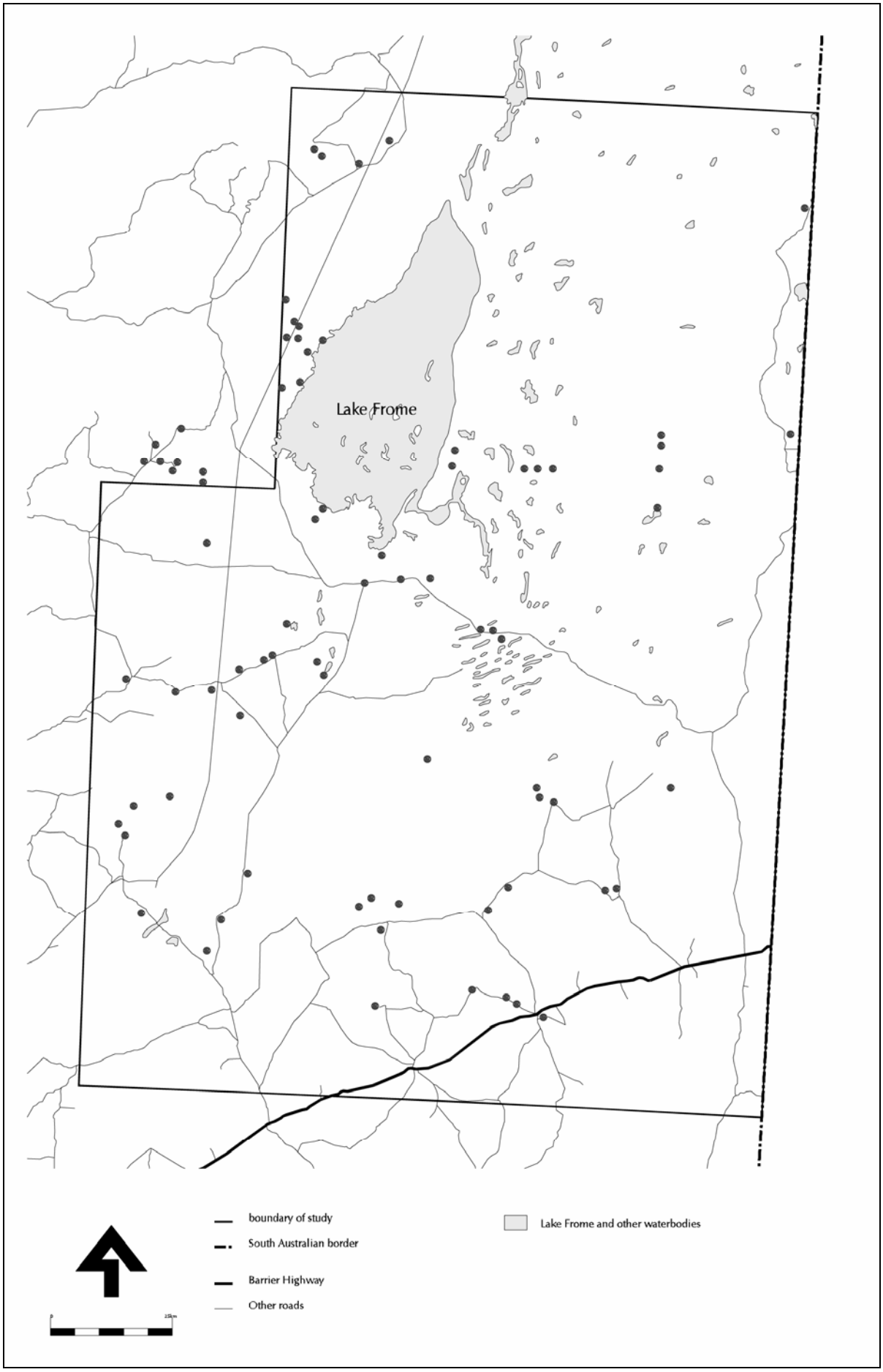

Figure 92 **Distribution of Reptile records held in the SA Museum from the North Olary Plains survey area (locations of Chambers Gorge records are also included).**

Table 10 Reptiles Recorded during the North Olary Plains Survey.

SPECIES	COMMON NAME	Habitat	Frequency	Opportune	Total
Tiliqua rugosa	Sleepy Lizard	G	24	28	52
Gehyra variegata	Tree Dtella	A	13	14 (1)	28
Pogona vitticeps	Central Bearded Dragon	G	9	13	22
Heteronotia binoei	Bynoe's Gecko	G, F	6	11	17
Morethia boulengeri	Common Snake-eye	G, NS, F	8	8 (1)	17
Ctenotus schomburgkii	Sandplain Ctenotus	G	13	2 (1)	16
Lerista labialis	Eastern Two-toed Slider	S	6	5 (4)	15
Morethia adelaidensis	Adelaide Snake-eye	C (H)	9	3 (2)	14
Cryptoblepharus plagiocephalus	Desert Wall Skink	A	2	6 (4)	12
Menetia greyii	Dwarf Skink	G,F	6	5	11
Ctenophorus nuchalis	Central Netted Dragon	S	10		10
Ctenotus regius	Eastern Desert Ctenotus	G (C)	5	2 (3)	10
Ctenotus strauchii	Short-legged Ctenotus	H	5	2 (2)	9
Ctenotus uber	Spotted Ctenotus	H (R)	2	7	9
Diplodactylus byrnei	Pink-blotched Gecko	H, C	7	1	8
Diplodactylus tessellatus	Tessellated Gecko	H, C	6	(1)	7
Lerista punctatovittata	Speckled Slider	S		6 (1)	7
Tympanocryptis tetraporophora	Eyrean Earless Dragon	H, C	4	(3)	7
Ctenotus robustus	Eastern Striped Skink	RH	5	1	6
Varanus gouldii	Sand Goanna	S	6		6
*Ctenotus "olympicus"**	Spotted Ctenotus	H (R)	2	(3)	5
Lerista muelleri	Dwarf Three-toed Slider	G, NS	1	4	5
Tympanocryptis lineata	Five-lined Earless Dragon	G (R)	4	1	5
Eremiascincus fasciolatus	Narrow-banded Sandswimmer	S	1	3	4
Nephurus millii	Barking Gecko	G		4	4
Ctenophorus fordi	Mallee Dragon	M, T	3		3
Ctenophorus pictus	Painted Dragon	G, M	3		3
Rhynchoedura ornata	Beaked Gecko	G	1	1 (1)	3
Strophurus ciliaris	Southern Spiny-tailed Gecko	A	2	(1)	3
Strophurus williamsi	Eastern Spiny-tailed Gecko	A		3	3
Suta spectabilis	Mallee Snake	G		3	3
Gehyra '2N=44'**	Southern Rock Dtella	RH	2		2
Ctenotus brooksi	Sandhill Ctenotus	S	2		2
Ctenotus leonhardii	Common Desert Ctenotus	NS	1	(1)	2
Diplodactylus damaeus	Beaded Gecko	M, S	2		2
Diplodactylus vittatus	Eastern Stone Gecko	G (B) (M)	1	1	2
Egernia striolata	Eastern Tree Skink	A	1	1	2
Pseudonaja nuchalis	Western Brown Snake	G	1	1	2
Suta suta	Curl Snake	H		2	2
Cryptoblepharus carnabyi	Wall Skink	RH, A		1	1
Ctenotus pantherinus	Leopard Ctenotus	RH		(1)	1
Delma butleri	Spinifex Snake-lizard	T	1		1
Egernia margeretae	Masked Rock Skink	RH		1	1
Eremiascincus richardsoni	Broad-banded Sand swimmer	G		1	1
Lerista xanthura	Yellow-tailed Slider	S	1		1
Nephurus levis	Smooth Knob-tailed Gecko	S		1	1
Pseudonaja modesta	Five-ringed Snake	S	1		1
Pygopus nigriceps	Black-headed Scaly-foot	H, R	1		1
Simoselaps fasciolatus	Narrow-banded Snake	S	1		1
Tympanocryptis intima	Smooth-snouted Earless Dragon	H		1	1
Total			**178**	**143 (29)**	**350**

* unpublished but described species closely related to *Ctenotus uber*

** unpublished but described species closely related to *Gehyra variegata*

SPECIES OF PARTICULAR INTEREST

Of the species found during the current survey, none are endangered nationally or in South Australia. There were few surprises in the list of species captured, however the understanding of the distributions and variations of the herpetofauna of the region will benefit from these recordings.

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 a tree-dweller.

In the North Olary Plains survey area, two individuals of this species were captured from under rocks in the granite hills north of Olary.

Leopard Ctenotus *Ctenotus pantherinus*

A large skink (to 31 cm) this species with its unique leopard-like patterning also has a wide and deep body, which is greatly accentuated by its small head.

The preferred habitat is normally sandy terrain, plains, dunes and interdunes with compacting crusting loamy sands, often with fine to coarse gravel and larger stone slabs. *Triodia* or *Plectrachne* hummock grasses are often present, sometimes with an open shrubland or woodland overstorey, but this recording was from chenopod shrubland, quite atypical of their usual habitat. This record is also on the extremity of the known range, and represents a south-easterly range extension for this species.

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 NSW and the other (*C. s. varius*) which occurs through south-western Qld, south-eastern NT, north-eastern S A and far north-western NSW. *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 North Olary Plains survey area is coincident with the area of changeover from *C. s. strauchii* in the south-east to *C. s. varius* in the north-west. This provided the opportunity to examine the genetic distinctiveness and taxonomic validity of these subspecies. The survey was successful in collecting an apparent intergrade specimen (SAM R48350) from the NSW Border at Starvation Dam. This will assist the planned taxonomic revision of this species.

The specimens collected from the North Olary Plains survey area include both subspecies and one example of a taxonomic intergrade. This area is the only place where this is likely, being the region where the ranges of the two subspecies overlap.

Yellow-tailed Slider *Lerista xanthura*

The single specimen caught in the north-east of the survey area on the ground under leaf litter in *Eremophila duttonii / Dodonaea microzyga* shrubland on a low sandy rise is notable only because this species is seldom observed, yet apparently widespread. This record joins the other known ranges of this species in the Simpson Desert and the South Olary Plains.

Eastern Spiny-tailed Gecko *Strophurus williamsi*

This is an eastern species only entering into South Australia along the border with NSW and Qld. The single recording of this species near Cockburn represents the northern limit of its range in South Australia. The South Australian population may be limited by the extent of the Blackoak / Native Pine woodland. This record represents a south-westerly extension of the known range for this species which occurs in the slopes of western NSW and Qld.

Narrow-banded Snake *Simoselaps fasciolatus* (Fig.93)

This record is notable because it is only the second for the region. This individual is similar to the western NSW and Qld specimens, and differs in colour from the Lake Eyre Basin specimens by being paler with narrower and more ragged transverse bands. It may represent an unrecognised genetically distinct form.

AMPHIBIANS

Water-holding Frog *Cyclorana platycephala*

The distribution of this frog is unlike that of any other Australian species, being split into three populations on the mainland, one in Western Australia, a second in the south and a third at mid-latitudes in the Northern Territory. The survey area is on the south-eastern limit of its range.

Although considered to be a water-holding frog adapted to arid conditions, it is equally well adapted for life in water having extensive webbing between its toes. It seems to prefer areas where water persists after rain, such as claypans and shallow roadside pools. While most frogs capture food out of the water, this species can also feed in water. Burrows are dug at the foot of a bush or tree.

During the North Olary Plains survey no specimens were recorded.

Painted Frog *Neobatrachus pictus*

Like many other species, the Painted Frog was once considered to be widely distributed, but it is now thought to be confined to eastern South Australia and western Victoria. All *Neobatrachus spp.* have a sharp, blade-like

structure on the undersurface of the foot to aid digging into the soil. In the Painted Frog, this structure is jet black.

It is usually found only after summer rains when it breeds in grassy marshes, lagoons and temporary roadside pools.

The species' occurrence is seasonal and sporadic, it could easily occur elsewhere. During the North Olary Plains survey no specimens were recorded.

DISCUSSION

Statistical conclusions are difficult from such a small dataset, and the variation due to differences in foraging effort and subsequent opportunistic captures is also quite significant. However, taking these factors into account, the main conclusions to be drawn are that even though total species numbers were low, diversity was as expected from previous knowledge.

This survey essentially confirmed the existing distributional data for the area, even though previous work had been accumulated in a non-systematic way.

A crude indication of reptile diversity, the average species richness is 4.0 reptiles per quadrat (range 1 - 13) compared with 6.0 (range 1 - 16) recorded in the South Olary Plains survey area (Forward & Robinson 1996) and 6.9 for the Yellabinna area on Eyre Peninsula, a large area of relatively undisturbed native vegetation (Armstrong 1992). This seems reasonable, given the predominance of chenopod shrublands and dunefields in the study area which provide a lower diversity of habitats than the mallee and woodlands to the south and on the West Coast.

Many species were entering their breeding season at the time of the vertbrate survey, and were as active as their body temperature would allow, but it is still early for high amounts of activity.

Some further insight is also offered in terms of habitat preference. The clustering, for example of 2 sites BEN12301, an open *Gunniopsis quadrifida* dominated chenopod shrubland with bare scalds and sparse herbs and grasses, and KOO14101, a *Maireana pyramidata / Nitraria billardierei* open chenopod shrubland with bare scalds and sparse herbs and grasses, suggests that vegetation structure, density and amount of unprotected open space may be more important than the floristic composition. For example, *Ctenotus brooksii* (regarded normally as a sand specialist) is syntopic with *Tympanocryptis tetraporophora* (heavy soil / gibber specialist) at quadrat BEN12301. This is in thin sand over heavier soil with a very open chenopod cover. This may provide the sand for *C. brooksii* and the flat open structure for *T. tetraporophora*. Some more examination of the existing data with this hypothesis in view may assist in the understanding of the cohabitation of some species.

BIOGEOGRAPHY

Most of the reptile species found in the North Olary Plains survey area were generally widespread, for example, the Painted Dragon (*Ctenophorus pictus*), Bynoe's Gecko (*Heteronotia binoei*), Dwarf Skink (*Menetia greyii*), Common Snake-eye (*Morethia boulengeri*) and Sleepy Lizard (*Tiliqua rugosa*). These represent species with a wide habitat tolerance, and are typically widespread throughout the south-eastern arid to semi-arid zones of Australia.

Eastern Australian species reaching into the eastern part of South Australia include *Strophurus williamsi*, *Ctenotus strauchii* ssp. *strauchii* and *Lerista punctatovittata*.

Northern and Central Australian species include *Ctenotus pantherinus*, *Tympanocryptis intima* and *Strophurus ciliaris*.

Some species associated with the Flinders Ranges which may be found in the fringes of the study area are *Egernia margaretae*, *E. striolata* and *Ctenotus robustus*.

Several species, for example the Southern Rock Dtella (*Gehyra* '2N=44'), Masked rock Skink (*Egernia margeretae*) and Wall Skinks (*Cryptoblepharus* spp.) occurred predominantly in the south and west of the area, as they prefer rocky outcrops and are more frequently found in the Flinders Ranges.

In the North Olary Plains, other species also showed a preference for Eucalypt habitats, including those with a Spinifex understorey. These include the Beaded Gecko (*Diplodactylus damaeus*), Mallee Dragon *(Ctenophorus fordi*), and Spinifex Snake-lizard (*Delma butleri*).

Those which tended to show a preference for woodland habitats were particularly the arboreal species: Tree Dtella (*Gehyra variegata*) and the wall skinks (*Cryptoblepharus carnabyi/plagiocephalus*).

The most chenopod-preferring species appeared to be the Adelaide Snake-eye (*Morethia adelaidensis*), the Pink-blotched Gecko (*Diplodactylus byrnei*) and the Eyrean Earless Dragon (*Tympanocryptis tetraporophora*).

CONSERVATION CONSIDERATIONS

Reptiles and amphibians have fared better than mammals in terms of extinctions since European settlement, but many are still threatened, endangered or locally extinct.

Of relevance in the far south of the survey area is the effect of mallee clearance resulting in the permanent loss of 70-95% of the original mallee herpetofauna (Cogger 1989). Ehmann and Cogger (1985) also note that in the Murray Mallee region of South Australia and NSW the clearing of mallee lands since the mid 1960s has resulted in the permanent removal of 26 species from those areas. Cogger (1989) has recorded species diversity to be directly proportional to the structural complexity of the understorey vegetation. The substantial habitat alteration through grazing and changed fire regimes has almost certainly affected the abundance of many reptile species. Other threats to reptile populations are predation by introduced carnivores, indirect poisoning from chemicals and perhaps more subtle effects such as soil-compaction (Cogger, 1989). More research is needed to accurately assess the status of many species and populations to understand the key threats.

Figure 93
The spectacularly marked **Narrow-banded Snake, *Simoselaps fasciolatus*** is a rarely seen burrowing snake, found during the survey.
Photo: A. Robinson

Figure 94
The Central Netted Dragon, *Ctenophorus nuchalis* often digs its burrows into the edge of station tracks and can be seen sitting by them on warm days.
Photo: A. Robinson

Figure 95
The **Mallee Dragons, *Ctenophorus fordi*** found in this area belong to a more orange coloured northern population, distinct from the greyer animals of the mallee areas further south.
Photo: A. Robinson

Figure 96
The **Common Scaly-foot, *Pygopus lepidopodus*** is a harmless legless lizard that can be readily distinguished from snakes by its ear openings and the flap-like remains of its hind legs.
Photo: A. Robinson

Conclusions & Conservation Recommendations

by R. M. Playfair[1]

THE NORTH OLARY PLAINS ENVIRONMENT

One aspect which has been obvious from the start is the very low numbers of mammals and reptiles in particular, which were recorded in this survey as well as the previous South Olary Plains survey in 1992. There are of course seasonal, climatic and logistical reasons why such a survey would not necessarily return high abundances, but other factors such as habitat destruction through long term grazing of domestic ungulates and the impact of rabbits and goats and kangaroos are also extremely significant in this apparent lack of native wildlife in this region. It appears that almost in its entirety, this region has become severely degraded in terms of its native wildlife diversity and abundance.

Intensive interpretation is now required on these data outputs to determine whether any of these records or the relationships which show up through the analysis processes actually point to any conservation issues.

The four and a half million hectare area covered by the North Olary Plains includes a variety of environments:

- the sand dune systems of the north-east
- the silty loam outwash plains of the northern Flinders Ranges
- Lake Frome and its gypseous sand margins
- the low hills of the Olary Spur
- the arid plains immediately to the north of the Olary Spur
- the swampy red dunefields south-east of Lake Frome
- outliers of the southern Flinders Ranges
- ephemeral watercourses
- floodouts and claypans of the central plain area.

It constitutes a north-south transition zone between the plains which provide a catchment (including the low hills of the Olary Spur) draining north into Lake Frome and the longitudinal dune systems of the Strzelecki Desert. Lake Frome also acts as a barrier between the southern extremities of these dunefields and the depositional areas fed from the northern Flinders Ranges.

It also constitutes western portion of the Broken Hill Complex (IBRA Region), a large area extending into NSW supporting chenopod shrublands and mulga open shrublands, which is of high priority nationally as a biogeographic region in need of further conservation effort.

BIOLOGICAL COMMUNITIES

Twenty nine different vegetation associations were identified and mapped in the North Olary Plains, with ten major associations extending over large parts of the area:

- *Senna / Eremophila / Rhagodia spinescens* Open shrubland
- *Maireana astrotricha* Low open shrubland
- *Atriplex vesicaria / Maireana astrotricha* Low open shrubland
- *Acacia aneura / A. victoriae / Sida petrophila* Very open low woodland
- *Casuarina pauper* Low woodland
- *Acacia ligulata* Very open shrubland
- *Acacia aneura / Enneapogon* spp. Low open woodland
- *Maireana pyramidata* Low open shrubland
- *Maireana sedifolia* Low open shrubland
- *Sclerolaena divaricata* Low very open shrubland

Native vertebrate species diversity information is insufficient to detect clear patterns.

SPECIES RICHNESS

Information brought together for this report shows that the North Olary Plains supports 1059 plant species (whole Eastern Botanical Region), 55 mammal species, 201 bird species, 71 reptile species and 5 amphibian species. The field survey in 1995 and 1996, with over 11,500 observations of flora and fauna, recorded a reasonable proportion of this total species richness for the area with 448 plants, 22 mammals, 125 birds, 50 reptiles and 2 amphibians.

Compared with the South Olary Plains (Forward & Robinson. 1996), the North Olary Plains survey has a general species richness of about two thirds to three quarters. The trapping effort, in total trap nights was about half that of the South Olary Plains. This reflects an expected lower biological diversity in the more arid north than in the south where rainfall is higher and more reliable.

Table 11 shows the total numbers of flora and fauna species recorded at each fauna survey quadrat used in the analysis. These sites of high species richness provide a very crude indication of potential areas of high

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biodiversity and possible high priority areas for nature conservation. Some extrapolation of this inferred conservation value may be possible, on the assumption that a given habitat type in good condition will support an equally rich range of vertebrate species in another location.

Table 11 Numbers of vascular plant and vertebrate fauna species found at each fauna survey quadrat.

Numbers and quadrats in bold indicate the two highest diversities (number of species) for each biota type.

Quadrat ID	Plants	Mammals	Birds	Reptiles	Amphibians	Total
KOO11201	58	1	**26**	5	0	**90**
OLA01101	**60**	1	24	5	0	**90**
MIN02101	**59**	**4**	22	4	0	**89**
BEN11201	51	2	25	7	0	85
PAR07401	47	2	19	**15**	0	**83**
MIN02601	57	1	21	2	1	82
OLA05301	50	2	22	6	0	80
BEN14201	43	1	21	**13**	1	**79**
PAR03101	44	1	22	4	0	71
BEN11301	44	2	18	6	0	70
PAR03201	46	2	13	6	0	67
WIL09201	32	2	**31**	2	0	**67**
CNE12201	47	3	10	6	0	66
WIL09301	30	1	25	7	0	63
BEN12401	34	2	18	7	1	62
PAR10101	42	1	14	5	0	62
MIN02301	46	**4**	6	5	0	**61**
MIN02501	48	2	8	0	2	60
PAR07201	28	1	24	6	0	59
KOO06101	27	1	22	8	0	58
MIN02201	41	3	13	1	0	58
MIN02701	50	1	6	1	0	58
PAR03401	36	2	14	3	0	55
PAR07301	34	1	14	6	0	55
CNE08401	35	1	14	3	1	54
MIN09101	39	0	12	3	0	54
OLA08101	39	0	13	2	0	54
BEN12301	29	2	11	7	1	50
KOO14101	25	0	21	3	0	49
CNE09301	32	2	13	1	0	48
MIN09201	35	0	9	4	0	48
PAR05101	38	3	4	3	0	48
WIL09401	16	1	25	4	0	46
CNE08501	34	0	11	0	0	45
CNE09101	26	2	13	4	0	45
KOO11101	21	0	20	4	0	45
OLA05601	31	1	11	2	0	45
BEN13101	32	2	6	3	0	43
OLA01201	16	0	24	3	0	43
BEN09101	27	1	6	7	1	42
CNE08201	23	0	17	0	0	40
BEN14101	24	1	7	6	1	39
OLA01301	18	3	14	3	0	38
OLA10501	20	0	8	1	0	29
OLA10401	16	1	6	1	0	24
KOO15101	12	1	9	1	0	23
CNE08301	1	0	20	0	0	21
CNE12401	10	3	6	2	0	21
Total	**1653**	**67**	**738**	**197**	**9**	**2664**

The quadrats with the highest species diversities were:

Total species - KOO11201 and OLA01101
Plants - OLA01101 and MIN02101
Birds - WIL09201 and KOO11201
Mammals - MIN02101 and MIN02301
Reptiles - PAR07401 and BEN14201

KOO11201 is in a mulga / blackoak community on loamy sand with a wide variety of middle level shrubs, chenopods and grasses. Not the richest quadrat for birds, but still providing habitat for at least 26 different species, there are significant amounts of fallen timber from dead mulga which provides micro-habitats for small mammals, reptiles and invertebrates. Three fly families were

captured at this quadrat possibly highlighting a relationship between the abundance of Phoridae flies in particular and general species richness. This quadrat is in the Koonamore Vegetation Reserve and consequently has had no domestic stock running in it for about 70 years, and a comprehensive rabbit control program has been in place since 1981. These factors almost certainly have a bearing on the level of biological diversity. Only 6 introduced plant species (13%) were listed at this quadrat.

OLA01101 represents a red gum lined watercourse with adjacent prickly wattle terraces in a wider landscape of blackbush and saltbush plains. The apparent species richness in this case may be related more to the adjacency of different linear habitat types bringing about a wider range of species in a small geographic area than to a high diversity within a particular habitat type. The situation on a watercourse with 13 introduced plant species (22%) probably indicates a moderate level of disturbance through flooding and stock use. Nevertheless, an above average species richness is still evident.

WIL09201, on a very rocky hillside, sparsely covered with mulga, lobed hopbush, sticky cassinia with occasional emergent coolabahs within 1km of a red gum lined watercourse (WIL09301) and red mallee with spinifex (WIL09401), this site provided the highest bird species richness with 31 unique records. Again, this is probably related to the adjacency of other differing habitat types and the mobility of vertebrate species between them. WIL09301 and WIL09401 both recorded 25 bird species. Pitfall traps could not be dug at this quadrat, so captures of small mammals and reptiles are probably artificially low as a result. About 16% (5 species) of plants are introduced at this quadrat, with evidence of both goat and kangaroo impacts.

MIN02301, in open saltbush plains and soil of clay loam texture, this site is well down the list in terms of total species richness, but it was a quadrat where 4 native mammals were listed, one of which was Forrest's mouse, a rare species in NSW, though stable and secure in South Australia. 5 plant species (11%) were introduced and the area contains only very occasional groves of blackoak which provide a more diverse localised habitat. Only 6 birds, (one raptor), were recorded here. Where these patches are large enough the biodiversity is dramatically increased as at quadrat MIN02101.

MIN02101, by contrast has a sparse overstorey of blackoak over a similar chenopod understorey, thus providing a much richer choice of nesting and feeding sites for birds whilst containing similar quality of habitat for ground dwelling small mammals. With only another 13 plant species (20%), the bird diversity (22 species) has been quadrupled. These blackoak groves appear like richer islands in the poorer chenopod plains.

PAR07401, with the highest variety of reptiles, is in a *Eremophila duttonii / Senna* spp. open shrubland on a low sandy rise in the far north-west of the survey area. It is situated within 2km of a red gum lined creek with prickly wattle terraces and surrounded by cottonbush / Mitchell grass plains. These adjacent habitats probably influence the species diversity in this habitat type. 8 genera of ants out of a possible 20 were recorded here, possibly providing a more reliable food source for small reptiles and insectivorous birds. Only 5% (2 species) of plant species recorded were introduced, and much of the soil surface was bare, unstable sand with very little litter. Reptile recordings were dominated by the small skinks, dragons and geckos, all generally quite common.

BEN14201, a cottonbush run-on area of only moderate plant species richness provides habitat for 13 different native reptiles. Reptile recordings were again dominated by the common small skinks, dragons and geckos. Of note however, is the fact that the other quadrat of high reptile richness (PAR07401) shares very few physical characteristics, with a different soil type, a different vegetation mix and different landscape situation. Similarities only appear to extend to shrub density and structure, and the amount of bare ground between areas of vegetative cover (safety from overhead predators). A hypothesis for determining reptilian habitat preferences may possibly revolve around these factors rather than the more obvious and quantifiable attributes such as vegetation type or soil texture.

SIGNIFICANT SPECIES

A number of ecologically noteworthy flora and fauna species were recorded during the North Olary Plains survey and some species of national and state conservation significance are known to occur in the area.

Plants

Acacia carnei (Needle Wattle)

Codonocarpus pyramidalis (Slender Bell Fruit)

Maireana pentagona (Hairy Bluebush)

Malococera gracilis (Slender soft-horns)

Mammals

Macropus giganteus (Eastern Grey Kangaroo)

Leggadina forresti (Forrest's Mouse)

Birds

Struthidea cinerea (Apostlebird)

Certhionyx variegatus (Pied Honeyeater)

Falco peregrinus (Peregrine Falcon)

Neophema chrysostoma (Blue-winged Parrot)

Anas rhynchotis (Australasian Shoveler)

Sub-fossil material

Bones collected from five sub-fossil deposits on the fringes of the North Olary Plains revealed a large variety of mammal species which occurred historically in the area. They provide a very strong indication that substantial biodiversity decline has occurred in a recent historical context, probably primarily since European settlement.

Introduced species

A significant number of introduced species of flora and fauna occur on the North Olary Plains, comparatively many fewer than in the previously surveyed South Olary Plains (in square brackets):

43 plant species (9% survey total) [160]

2 bird species (1.6% survey total) [6]

9 mammal species (41% survey total) [9]

Higher density of settlements and the intensity of historical land use in the areas to the south are probably factors which partially explain this increase in invasion from exotics further south. The increasing aridity gradient as one goes further north has probably also prevented the spread of introduced plants (from Mediterranean climates) in particular into areas where they cannot survive and reproduce sufficiently well to become widespread.

CAUSES OF POPULATION AND HABITAT DECLINE AND ONGOING THREATS

The decline in numbers of the now endangered, vulnerable or rare flora and fauna species and communities in the region has been brought about by a number of factors. Stephens (1992) has compiled a list of causes of decline and ongoing threats to the environment for the Murray mallee, most of which are also relevant in the North Olary Plains. A very similar suite of degrading factors is described at length by Dickman *et al.* (1993) with particular reference to the decline of native mammal populations in the arid parts of western NSW. The ecological costs of livestock grazing are described in a variety of contexts by Fleischner (1994), Hayward *et al.* (1997) and Auld (1993). The most important of these degrading factors are:

- habitat degradation through long term overgrazing, particularly during drought, by all herbivores. This includes domestic stock, feral goats, rabbits and the various kangaroos
- introduced predators, mainly foxes and cats
- competition with introduced species
- altered fire regimes

Nowhere in the survey area are any of these factors effectively controlled at present.

Reservation of certain areas for biodiversity conservation purposes may be appropriate, but must be complemented by more effective management and broad-scale reduction in the populations of feral species and other threatening processes, if the current species diversity is to be maintained. Long term monitoring of indicators must be undertaken to provide trend information, and reintroductions of species could only be considered where all threatening processes have been removed.

SIGNIFICANT AREAS FOR CONSERVATION - Qualitative Approach

Given that there are no formal conservation reserves in the survey area, any part which has conservation significance for any reason is worthy of examination of its current management with a view to maintaining or preferably enhancing the existing conservation value.

Some species regularly move between adjacent habitats where they are close together, which may be confusing when attempting to describe relationships between species, (or suites of species) and their "preferred" habitat types. However, these areas with a diversity of readily available habitat types, are often places where increased conservation effort can provide the most benefit. The geographic focus need not be large to encompass a range of interdependent habitat types, some of which may be of high conservation value in their own right.

This approach then allows for a broader and less quantitative methodology when attempting to assign conservation value judgements to patches of land. From an ongoing management perspective, these areas for increased conservation focus must be in contiguous blocks to minimise the edge effects incurred by small islands.

Threatened species and species richness

Several areas where endangered and vulnerable species have been recorded are considered to be of conservation significance. Some of these coincide with areas of potentially high species richness and high vertebrate diversity. These areas are worthy of examination to ascertain whether current management can be altered to enhance their biodiversity.

The areas where *Acacia carnei* exists, particularly in the valley south-east of Bimbowrie and adjacent to the Cockburn - Mulyungarie road. In these areas, other diverse habitats are nearby providing a range of different habitat types in close proximity, allowing for a richer species mix.

The other significant plant *Codonocarpus pyramidalis* was only recorded at one quadrat in the valley floor, but within the rocky hills of the geologically unique Bibliando Dome in the far south-west of the survey area. The species richness noted here, again due to adjacency of differing habitat types at quadrats WIL09201, WIL09301 and WIL09401 enhance the conservation value for species richness reasons also.

In terms of vegetation associations which are geographically small within this survey area, the *Callitris glaucophylla* associated with the mulga plains on the NSW border north of Mulyungarie were not specifically sampled except for vegetation, but may represent a different suite of habitat types currently undescribed.

The mallee communities including *Eucalyptus socialis / Eucalyptus dumosa* over *Triodia* (eg. KOO06101) are common and well represented south of the survey area (Forward & Robinson. 1996) and are included in the formalised Reserves system. The *Casuarina pauper* Woodlands are like the mallee, on the northern extremity of their range as dense woodlands and conservation effort further south may provide better quality examples of this habitat type.

The permanent wetland created by Coonee Bore running south to Lake Coonee (Rotten Swamp) as well as the extensive wetlands running east along Yandama Creek from Moolawatana Bore in the far north provide unique

water bird habitat in a region where surface water is extremely scarce all year round.

The combined species richness as demonstrated at quadrat PAR07401 being adjacent also to Mitchell grass plains typified by PAR03101 also point to the need for conservation management on some parts of the plains dissected by the big creeks on Wooltana Station.

SIGNIFICANT AREAS FOR CONSERVATION - Quantitative Approach

No meaningful interpretation was possible from the GLIM analysis due to the inadequate data. Data collection for such analysis must focus on the relevant variables, many of which are poorly sampled in a survey method focussed around mapping from representative site data.

In addition, any conservation analysis must include data from the entire Broken Hill Complex bioregion. The present survey and the previous South Olary Plains survey provide systematically collected data from across the South Australian part of this bioregion. No comparable data has yet been collected in the New South Wales portion.

RECOMMENDATIONS

The North Olary Plains study area currently contains no formal conservation reserves. Recommendations for enhanced conservation management in specific areas is still premature due to the incomplete analysis of the entire bioregion, however an increased awareness of those areas mentioned above by land managers, and pastoral management and conservation-oriented agencies, will assist any negotiations toward future management changes. The bulk of this survey area is held under pastoral leasehold tenure, with some small perpetual leasehold properties along the southern boundary.

The legacy of many years of grazing domestic stock as well as the extra pressure brought to bear by the feral herbivores and the often large populations of kangaroos, means that all of this area has been significantly altered in terms of the diversity of habitats and the abundance of much of the native flora and fauna. Some has been altered to the extent that the seed sources and substrate to support the regeneration of the original vegetation types are no longer there. In these areas, which include the poverty bush (*Sclerolaena divaricata*) plains, blackbush / nitrebush (*Maireana pyramidata / Nitraria billardierei*) run-on areas and flood-outs and the rock sida (*Sida petrophila*)-covered low hills of the Olary Spur, it is debatable whether substantial gains in biodiversity could be made through changing pastoral management practices. The successional pathway may go towards colonisation by exotics and unpalatable species, or there may still be sufficient viable seed reserves in the soil to begin to replace some of the lost original vegetation mixes which historically provided habitat for a more abundant native fauna. The fortuitous assistance in rabbit control effort given by the spread of Rabbit Calicivirus through this region, followed by extensive above average rainfall in early 1997 should provide some significant insights into how the country responds to favourable regeneration conditions. Every effort should be made on the part of landholders, Government agencies, and research institutions to take advantage of the valuable ecological information made available by this unique combination of events.

Ongoing management of the high conservation value areas mentioned above for biodiversity enhancement goals requires some very serious issues to be addressed and resolved. This is likely to require some difficult political and socially significant decisions to be made. These issues relate to whether we are serious about sustainable management of the arid lands. The following actions should form a basis for discussion on the development of ecologically sustainable management practices.

- Liaise with managers and lessees who currently control these areas of potential conservation value, with a view to enhancing their understanding of the other values of these areas, in addition to producing a fodder resource for domestic stock.
- Look at all options for cooperative management for areas of high conservation value, particularly with respect to positioning of water points and total grazing management.
- Institute a monitoring process for those areas highlighted above to determine their biodiversity trend under current management regimes.
- Reassess the current arrangements for the control of kangaroos in the region, taking into account the effect which the Dog Fence has on their movements and population densities.
- Restructure the goat industry to provide incentives for land managers to aim for eradication.
- Augment research effort into the control of rabbits, foxes and feral cats with a view to gaining some broad-scale control over these populations in the short term.

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Appendix I

Pastoral Leases in the North Olary Plains Study Area (see Fig. 30 for maps)

* Perpetual Lease

Abminga
Aroona West
Baratta
Benagerie
Benda
Bibliando
Billeroo West
Bimbowrie
Bindarrah
Boolcoomatta
Bulloo Creek
Bundera
Canewood
Curnamona
Cutana / Tikalina
Devonborough Downs
Eringa Park
Erudina
Florina
Frome Downs
Glen Warwick
Glenorchy
Holowilena
Holowilena South
Kalabity
Kalkaroo
Koonamore
Lake Dismal
Lakeside
Lignum
Lilydale
Maldorkey
Mannawarra
Martins Well
Melton
Minburra
Moolawatana
Mooleulooloo
Morialpa
Mt Falkland
Mt Victor
Mulga View
Mulga View South
Mulyungarie
Mundi Mundi
Mutooroo
Oulnina
Oulnina Park
Outalpa
Peters
Pinda Springs
Pine Creek
Plumbago
Portion of Upalinna
Pt Pine Creek
Pt Saltia
Pt Tin Hut
Quinyambie
Radium Hill
Saltia
Strathearn
Taltabooka
*Teetulpa
Telechie
Tepco
*Wadnaminga
Wawirra
Weekeroo
Wertaloona
Wiawera
Willippa
Willow Springs
Winnininnie
Wirrealpa
Witchitie
Wompinie
Wooltana
Yarramba

Appendix II

Composition of Annual and Introduced Plant species by Site and Vegetation Type

+	not consistently detectable / annual
+*	not consistently detectable / annual, introduced
P	perennial / consistently detectable
P*	perennial / consistently detectable, introduced
§	No. of species on site list upon which PATN groupings were based

Note: All sites with 3 or less in the "for Analysis" column were not included and were assigned to vegetation groupings later. "Veg Group" column is an abbreviation for the associations listed in the Results section.

Site Identifier	Veg Group	Freq +	Freq +*	Freq P	Freq P*	for Analysis §	Total	% Introd	% not in Analysis
BEN01101	A.lig 23	2	2	3		3	7	29%	57%
BEN01201	Samph 34			1		1	1	0%	0%
BEN01301	herbs 37	10	2	4		4	16	13%	75%
BEN04101	A.ves 32	9		4		4	13	0%	69%
BEN04201	A.ves 32	8	1	8		8	17	6%	53%
BEN04301	A.ves 32	17	5	11		11	33	15%	67%
BEN04401	Samph 34	11	2	15		15	28	7%	46%
BEN05201	swale 24	7	2	6		6	15	13%	60%
BEN05301	A.ves 32	12	1	17		17	30	3%	43%
BEN05401	S.divar 31	2		9		9	11	0%	18%
BEN06101	C.paup 22	5	2	3		3	10	20%	70%
BEN06201	swale 24	10	3	6		6	19	16%	68%
BEN08101	Canegr 35	5		8		8	13	0%	38%
BEN08201	A.ves 32	9	1	6		6	16	6%	63%
BEN09101	A.ves 32	8	1	6		6	15	7%	60%
BEN11101	A.ves 32	7		5		5	12	0%	58%
BEN11201	D.vis 19	6		8		8	14	0%	43%
BEN11301	C.paup 22	15	2	11		11	28	7%	61%
BEN12201	A.tet 1	10	1	7		7	18	6%	61%
BEN12301	S.divar 31	12		9		9	21	0%	57%
BEN12401	A.ves rise 16	11	1	7		7	19	5%	63%
BEN13101	A.ves 32	10	1	6		6	17	6%	65%
BEN13201	S.divar 31	6	1	10		10	17	6%	41%
BEN14101	A.ves 32	8	1	6		6	15	7%	60%
BEN14201	M.aph 10	4	1	3		3	8	13%	63%
CNB01101	M.astro 25	7		13	1	14	21	5%	33%
CNB01201	S.divar 31	5		6	1	7	12	8%	42%
CNB04101	herbs 37	8	1	6	1	7	16	13%	56%
CNB04201	A.lig 23	4	1	3		3	8	13%	63%
CNB06101	swale 24	9	2	8		8	19	11%	58%
CNB06301	A.ves rise 16	8	2	10		10	20	10%	50%
CNB06401	A.lig 23	5	2	3		3	10	20%	70%
CNB07101	S.obliq 38	8	1	6	1	7	16	13%	56%
CNB07201	N.bill 8	1	1	4		4	6	17%	33%
CNB08101	M.aph 29	12	1	8	1	9	22	9%	59%
CNB08201	Samph 34	2		3		3	5	0%	40%
CNB11101	M.astro 25	16	2	9	1	10	28	11%	64%
CNB11201	swale 24	4	2	6	1	7	13	23%	46%
CNB11301	A.lig 23	7	2	3	1	4	13	23%	69%
CNE02101	A.lig 23	8	2	5		5	15	13%	67%
CNE03101	Sedge 36	1		4		4	5	0%	20%
CNE03201	E.larg 17	4		2		2	6	0%	67%
CNE03301	A.ves rise 16	10	1	4		4	15	7%	73%
CNE08101	A.lig 23	2		4		4	6	0%	33%
CNE08201	E.larg 17	4	1	3		3	8	13%	63%
CNE08301	Sedge 36			1		1	1	0%	0%
CNE08401	A.lig 23	5	2	4		4	11	18%	64%
CNE08501	swale 24	9	1	8		8	18	6%	56%

Site Identifier	Veg Group	Freq +	Freq +*	Freq P	Freq P*	for Analysis §	Total	% Introd	% not in Analysis
CNE09101	A.lig 23	3	2	7		7	12	17%	42%
CNE09201	Canegr 35	6		3		3	9	0%	67%
CNE09301	swale 24	7	1	7		7	15	7%	53%
CNE11101	swale 24	8	2	2		2	12	17%	83%
CNE11201	A.lig 23	3	1	2		2	6	17%	67%
CNE12201	A.ves rise 16	8	1	12		12	21	5%	43%
CNE12401	S.divar 31	1		4		4	5	0%	20%
CNE12501	E.larg 17	7	2	5		5	14	14%	64%
CTB01101	E.larg 17	3	1	9	1	10	14	14%	29%
CTB01201	N.bill 8	4	1	4		4	9	11%	56%
CTB02101	E.larg 17	9	1	11	1	12	22	9%	45%
CTB02201	swale 24	8	1	6		6	15	7%	60%
CTB03101	D.vis 19	8	1	11		11	20	5%	45%
CTB06101	Canegr 35	6		3		3	9	0%	67%
CTB06201	swale 24	9	2	9	1	10	21	14%	52%
CTB09101	A.ves rise 16	12	2	14	1	15	29	10%	48%
CTB09201	swale 24	6	2	8	1	9	17	18%	47%
CTB09301	S.divar 31	8	1	11		11	20	5%	45%
CTB10101	A.lig 23	5	1	5	1	6	12	17%	50%
CUR01201	M.astro 25	9	1	9		9	19	5%	53%
CUR01301	A.vic 2	8	2	16		16	26	8%	38%
CUR03101	C.paup 22	15	1	10	1	11	27	7%	59%
CUR03201	E.larg 17	6		15		15	21	0%	29%
CUR04101	M.astro 25	16		14		14	30	0%	53%
CUR06201	M.sed 4	7	2	10		10	19	11%	47%
CUR06401	Senna 5	9	2	23		23	34	6%	32%
CUR06501	Senna 5	10	6	32		32	48	13%	33%
CUR07101	M.astro 25	9		15		15	24	0%	38%
CUR07201	M.sed 4	6	1	7		7	14	7%	50%
CUR09201	Mulga pl 20	8	1	11		11	20	5%	45%
CUR11101	C.paup 22	3		33		33	36	0%	8%
CUR14201	Senna 5	13	2	17		17	32	6%	47%
CUR14301	Mulga pl 20	10	1	14	1	15	26	8%	42%
CUR15101	A.ves 32	12	6	14	1	15	33	21%	55%
CUR15201	A.ves 32	15	3	12	1	13	31	13%	58%
CUR15301	A.aneura 21	11	3	14		14	28	11%	50%
FRO01101	Senna 5	4		20		20	24	0%	17%
FRO01201	A.ves 32	2		12		12	14	0%	14%
FRO01301	A.ves 32	5	1	13	1	14	20	10%	30%
FRO01401	D.vis 19	2	2	13		13	17	12%	24%
FRO02101	S.divar 31	5	1	8		8	14	7%	43%
FRO02201	M.astro 25	4		12	1	13	17	6%	24%
FRO02301	M.pyr 28	7		14		14	21	0%	33%
FRO03101	Senna 5	1	1	14		14	16	6%	13%
FRO03201	M.astro 25	1		11		11	12	0%	8%
KAL01101	S.divar 31	7	1	5		5	13	8%	62%
KAL01201	M.astro 25	10	1	4		4	15	7%	73%
KAL01301	C.paup 22	4	1	7		7	12	8%	42%
KAL01401	Canegr 35	6		7		7	13	0%	46%
KAL02101	M.astro 25	12	1	8		8	21	5%	62%
KAL03101	C.paup 22	12	2	10		10	24	8%	58%
KAL03201	M.aph 10	2	1	4		4	7	14%	43%
KAL04101	C.paup 22	12		13		13	25	0%	48%
KAL04201	A.ves 32	9	3	8		8	20	15%	60%
KAL04301	Mulga pl 20	9	1	6		6	16	6%	63%
KAL06101	A.ves 32	8	1	10		10	19	5%	47%
KAL06201	G.quad 15	13	1	13		13	27	4%	52%
KAL07101	G.quad 15	10	2	9		9	21	10%	57%
KAL08101	A.ves 32	13	2	9		9	24	8%	63%
KAL09101	M.pyr 28	10	7	17		17	34	21%	50%
KAL09201	A.ves 32	13	2	10		10	25	8%	60%
KAL10201	S.divar 31	7	3	4		4	14	21%	71%
KAL12501	A.aneura 21	5	4	12		12	21	19%	43%
KAL13101	A.ves 32	5	1	9		9	15	7%	40%
KAL13201	A.ves 32	18	4	11		11	33	12%	67%
KAL13301	Mulga pl 20	2	2	8		8	12	17%	33%
KAL13401	S.divar 31	11	8	11		11	30	27%	63%
KOO01101	S.obliq 38	2	3	6		6	11	27%	45%
KOO02101	M.pyr 28	7	2	18		18	27	7%	33%

KOO02201	S.obliq 38	7	2	12		12	21	10%	43%
KOO03101	Samph 34	1		2		2	3	0%	33%
KOO05101	E.soc 9	4	5	13		13	22	23%	41%
KOO06101	E.soc 9	5	2	12		12	19	11%	37%
KOO08101	A.ves 32	4		11		11	15	0%	27%
Site Identifier	**Veg Group**	**Freq +**	**Freq +***	**Freq P**	**Freq P***	**for Analysis §**	**Total**	**% Introd**	**% not in Analysis**
KOO09101	A.ves 32	7	2	18		18	27	7%	33%
KOO10101	Senna 5	11	5	16		16	32	16%	50%
KOO11101	M.sed 4	5	2	11		11	18	11%	39%
KOO11201	Mulga pl 20	9	6	21		21	36	17%	42%
KOO12101	M.sed 4	5	1	12		12	18	6%	33%
KOO12201	Senna 5	4	3	12	1	13	20	20%	35%
KOO14101	M.pyr 28	4	4	13		13	21	19%	38%
KOO15101	Canegr 35	3	1	2	1	3	7	29%	57%
KOO16101	A.ves 32	5	1	17		17	23	4%	26%
KOO18101	A.ves 32	8	5	10	2	12	25	28%	52%
KOO18201	C.paup 22	1		7		7	8	0%	13%
KOO24101	M.aph 29	8	6	8		8	22	27%	64%
KOO27101	A.ves 32	5	2	4	1	5	12	25%	58%
KOO29101	M.sed 4	7	4	9		9	20	20%	55%
KOO30101	S.obliq 38	5	7	6	1	7	19	42%	63%
KOO30201	A.vic 2	3	5	5	1	6	14	43%	57%
KOO32101	M.sed 4	4	1	5	1	6	11	18%	45%
KOO33101	M.pyr 28	5	5	7	1	8	18	33%	56%
KOO34101	A.ves 32	6	3	4	1	5	14	29%	64%
KOO35101	E.soc 9	1	1	8		8	10	10%	20%
KOO37101	UNCLASS	3	3	6	1	7	13	31%	46%
KOO38101	UNCLASS	1		6	1	7	8	13%	13%
KOO40101	S.obliq 38	1	3	7	1	8	12	33%	33%
KOO41101	M.pyr 28	1	5	6	1	7	13	46%	46%
LCH01101	Mulga pl 20	7	2	4		4	13	15%	69%
LCH01201	M.astro 25	7		3		3	10	0%	70%
LCH01301	S.divar 31	3		2		2	5	0%	60%
LCH02101	Mulga pl 20	4	2	6		6	12	17%	50%
LCH02201	C.paup 22	7	2	7		7	16	13%	56%
LCH03101	A.lig 23	7	2	6		6	15	13%	60%
LCH03201	S.divar 31	5	1	9		9	15	7%	40%
LCH03301	G.quad 15	5	3	11		11	19	16%	42%
LCH04101	E.larg 17	6	2	6		6	14	14%	57%
LCH04201	swale 24	8	2	2		2	12	17%	83%
LCH05101	A.ves rise 16	4	2	5		5	11	18%	55%
LCH05201	D.vis 19	4	2	5		5	11	18%	55%
LCH06101	E.larg 17	4	2	10		10	16	13%	38%
LCH06201	C.paup 22	8	2	13		13	23	9%	43%
LCH06301	Mulga pl 20	6	2	9		9	17	12%	47%
LCH08101	G.quad 15	9	1	12		12	22	5%	45%
LCH08201	E.larg 17	4	2	5		5	11	18%	55%
LCH09101	C.paup 22	8	1	7		7	16	6%	56%
LCH09201	G.quad 15	7	1	4		4	12	8%	67%
LCH10101	G.quad 15	9	2	9		9	20	10%	55%
LCH10201	C.paup 22	7	1	6		6	14	7%	57%
LCH11101	M.aph 29	9	1	2		2	12	8%	83%
LCH11201	G.quad 15	13		10		10	23	0%	57%
LCH11301	C.paup 22	4	1	9		9	14	7%	36%
LCH12101	M.aph 10	4		6		6	10	0%	40%
LCH12201	D.vis 19	7	1	9		9	17	6%	47%
MIN01201	A.ves 32	7	3	3		3	13	23%	77%
MIN01401	A.ves 32	6	4	9		9	19	21%	53%
MIN02101	S.divar 31	11	2	15	1	16	29	10%	45%
MIN02201	S.divar 31	8	4	5		5	17	24%	71%
MIN02301	S.divar 31	14	3	7		7	24	13%	71%
MIN02401	A.ves 32	6	1	7	1	8	15	13%	47%
MIN02501	Canegr 35	10	5	6		6	21	24%	71%
MIN02601	A.ves 32	4	6	14	3	17	27	33%	37%
MIN02701	S.divar 31	10	6	9		9	25	24%	64%
MIN05101	A.vic 2	3	5	8	3	11	19	42%	42%
MIN06201	A.tet 1	7	3	7		7	17	18%	59%
MIN07101	A.aneura 21	15	6	15		15	36	17%	58%
MIN07201	M.sed 4	6	1	8		8	15	7%	47%
MIN09101	A.ves 32	10	2	10		10	22	9%	55%

MIN09201	A.ves 32	8	2	11		11	21	10%	48%
MIN10101	A.tet 1	4		5	1	6	10	10%	40%
MIN10201	A.aneura 21	9	4	15		15	28	14%	46%
MIN11101	S.divar 31	3	3	11		11	17	18%	35%
MIN11201	E.cam 18	4	4	4	1	5	13	38%	62%
MIN12101	M.sed 4	5	3	19	1	20	28	14%	29%
MIN12201	A.ves 32	4	1	5		5	10	10%	50%
MIN12301	A.ves 32	7	3	5	1	6	16	25%	63%
Site Identifier	**Veg Group**	**Freq +**	**Freq +***	**Freq P**	**Freq P***	**for Analysis §**	**Total**	**% Introd**	**% not in Analysis**
MUL01101	S.divar 31	14	1	4		4	19	5%	79%
MUL01201	A.ves rise 16	13		11		11	24	0%	54%
MUL02101	M.aph 10	6	4	10		10	20	20%	50%
MUL02201	E.soc 9	10	3	7		7	20	15%	65%
MUL02301	A.ves 32	17	1	6		6	24	4%	75%
MUL02401	A.ves rise 16	14	2	12		12	28	7%	57%
MUL03201	A.ves 32	11		5	1	6	17	6%	65%
MUL03301	D.vis 19	8		12	1	13	21	5%	38%
MUL03401	E.larg 17	5		4		4	9	0%	56%
MUL05201	G.quad 15	11	1	5		5	17	6%	71%
MUL05301	S.divar 31	9	3	3	1	4	16	25%	75%
MUL05401	A.ves 32	16	2	7		7	25	8%	72%
MUL06101	C.paup 22	8	1	20		20	29	3%	31%
MUL06201	A.ves 32	11	2	7		7	20	10%	65%
MUL06301	A.ves 32	15	2	13		13	30	7%	57%
MUL06401	D.vis 19	15		11		11	26	0%	58%
MUL06501	S.divar 31	16	1	26		26	43	2%	40%
MUL09101	A.ves 32	12	2	9	1	10	24	13%	58%
MUL10101	A.ves 32	13	2	17	1	18	33	9%	45%
MUL10301	E.larg 17	11	3	23	1	24	38	11%	37%
MUL11101	S.divar 31	10	3	6	1	7	20	20%	65%
MUL11201	A.ves 32	11	4	7		7	22	18%	68%
MUL11301	S.divar 31	11	2	2	1	3	16	19%	81%
MUL12101	S.divar 31	14	2	4		4	20	10%	80%
MUL13101	A.vic 2	5	2	2		2	9	22%	78%
OLA01101	E.cam 18	6	4	19		19	29	14%	34%
OLA01201	M.pyr 28	1	1	6		6	8	13%	25%
OLA01301	M.sed 4	4		8		8	12	0%	33%
OLA01401	A.aneura 21	10	5	15		15	30	17%	50%
OLA01501	M.pyr 28	10	3	4		4	17	18%	76%
OLA02101	A.aneura 21	11	7	19		19	37	19%	49%
OLA04101	A.aneura 21	12	1	17		17	30	3%	43%
OLA04201	E.soc 9	1	1	14		14	16	6%	13%
OLA05101	A.aneura 21	13	3	20		20	36	8%	44%
OLA05301	A.aneura 21	8	4	21	1	22	34	15%	35%
OLA05401	M.pyr 28	11		10		10	21	0%	52%
OLA05501	A.aneura 21	12	3	13		13	28	11%	54%
OLA08101	A.vic 2	2	5	10	1	11	18	33%	39%
OLA09101	A.vic 2		3	11	2	13	16	31%	19%
OLA10101	N.bill 8		1	4		4	5	20%	20%
OLA10401	N.bill 8	1	5	5		5	11	45%	55%
OLA10501	S.divar 31	3	1	2		2	6	17%	67%
OLA10601	A.aneura 21	7	5	7		7	19	26%	63%
OLA12101	A.ves 32	4	1	5	1	6	11	18%	45%
OLA12201	M.pyr 28	1	3	6	1	7	11	36%	36%
OLA12301	A.vic 2	1	7	7	2	9	17	53%	47%
OLA12401	A.tet 1	6	3	8		8	17	18%	53%
PAR01101	M.aph 29	12		9	1	10	22	5%	55%
PAR01201	M.aph 29	12		8	1	9	21	5%	57%
PAR01301	M.aph 29	8		16		16	24	0%	33%
PAR01401	Senna 5	12	1	17		17	30	3%	43%
PAR02101	M.aph 29	20	1	24	1	25	46	4%	46%
PAR02201	A.ves rise 16	9	1	13		13	23	4%	43%
PAR03101	M.aph 29	11		11	1	12	23	4%	48%
PAR03201	M.aph 10	11		12		12	23	0%	48%
PAR03301	M.pyr 28	3	1	10		10	14	7%	29%
PAR03401	M.aph 10	3		7		7	10	0%	30%
PAR05101	S.divar 31	8	1	9	1	10	19	11%	47%
PAR05201	D.vis 19			7		7	7	0%	0%
PAR05301	A.vic 2	5		8		8	13	0%	38%
PAR06101	M.aph 29	6		9		9	15	0%	40%

PAR06201	S.divar 31	1		9		9	10	0%	10%
PAR07101	M.aph 10	6		13		13	19	0%	32%
PAR07201	A.vic 2	1		14		14	15	0%	7%
PAR07301	Senna 5	1		10		10	11	0%	9%
PAR07401	Senna 5	4	2	19		19	25	8%	24%
PAR08101	A.ves rise 16	5	1	12		12	18	6%	33%
PAR09101	S.divar 31	4	1	5		5	10	10%	50%
PAR10101	S.divar 31	2		17		17	19	0%	11%
PAR11101	Senna 5	4		17		17	21	0%	19%
PAR11201	M.aph 10	3		15		15	18	0%	17%
PAS01101	UNCLASS	1	3	7		7	11	27%	36%
Site Identifier	**Veg Group**	**Freq +**	**Freq +***	**Freq P**	**Freq P***	**for Analysis §**	**Total**	**% Introd**	**% not in Analysis**
PAS06101	M.pyr 28	3	2	4		4	9	22%	56%
PAS06201	A.ves 32	12		8		8	20	0%	60%
PAS06301	M.aph 10	1		10		10	11	0%	9%
PAS01201	M.astro 25	8	1	12		12	21	5%	43%
PAS06401	M.astro 25	12		7		7	19	0%	63%
PAS07101	M.aph 29	9		5		5	14	0%	64%
PAS08101	A.ves 32	11	2	19	1	20	33	9%	39%
PAS10101	S.divar 31	7	3	10		10	20	15%	50%
PAS11101	M.astro 25	11	3	11	1	12	26	15%	54%
PAS11201	D.vis 19	5	1	7	1	8	14	14%	43%
PAS12101	A.ves 32	12	1	13	1	14	27	7%	48%
PAS13101	M.pyr 28	9	2	16		16	27	7%	41%
PAS14101	Senna 5	15	1	11	1	12	28	7%	57%
PAS15101	C.paup 22	6	2	7		7	15	13%	53%
PAS15201	A.ves 32	8	1	14		14	23	4%	39%
PAS15301	Canegr 35	8	3	15		15	26	12%	42%
REA01101	A.aneura 21	6	1	16		16	23	4%	30%
REA01201	M.sed 4	2		12		12	14	0%	14%
REA01301	E.gill 39	1		9		9	10	0%	10%
REA01401	E.soc 9	3		12		12	15	0%	20%
REA01501	M.astro 25	7	1	12		12	20	5%	40%
REA02101	M.astro 25	8	1	13		13	22	5%	41%
REA02201	M.astro 25	9	1	10		10	20	5%	50%
REA02301	M.astro 25	9		17		17	26	0%	35%
REA02401	M.astro 25	10	1	19		19	30	3%	37%
REA02601	herbs 37	4		4		4	8	0%	50%
REA02701	Senna 5	8		14		14	22	0%	36%
REA03101	Senna 5	7		14		14	21	0%	33%
REA03201	E.cam 18	3	4	8		8	15	27%	47%
REA03301	A.vic 2	8	1	16		16	25	4%	36%
REA03501	A.aneura 21	4		10		10	14	0%	29%
REA04101	M.astro 25	8	4	29		29	41	10%	29%
REA04201	M.astro 25	8	3	14		14	25	12%	44%
REA05101	S.divar 31	3	1	13		13	17	6%	24%
REA06101	E.cam 18	2	2	8		8	12	17%	33%
REA06201	Senna 5	5	1	15		15	21	5%	29%
REA07101	M.sed 4	2	2	7		7	11	18%	36%
REA07201	N.bill 8	2	1	6		6	9	11%	33%
REA07301	A.ves 32	5	1	9		9	15	7%	40%
REA07401	A.aneura 21	10	5	22		22	37	14%	41%
REA08101	M.aph 10	3	1	11		11	15	7%	27%
REA08201	E.cam 18	3	5	8		8	16	31%	50%
REA08301	M.aph 29	7	2	9		9	18	11%	50%
REA09101	M.astro 25	9	3	14		14	26	12%	46%
REA09201	M.astro 25	6	1	10		10	17	6%	41%
REA10101	M.astro 25	10	1	17		17	28	4%	39%
REA10201	Mulga pl 20	6	1	15		15	22	5%	32%
REA10301	A.aneura 21	12	6	23		23	41	15%	44%
REA11101	M.pyr 28	10	1	10		10	21	5%	52%
REA11201	A.vic 2	4	1	18		18	23	4%	22%
REA11301	M.pyr 28	4	6	10	1	11	21	33%	48%
THU04101	M.astro 25	16	1	8		8	25	4%	68%
THU06101	M.astro 25	8	2	6		6	16	13%	63%
THU06201	A.lig 23	5	2	4		4	11	18%	64%
THU07101	S.divar 31	4		4		4	8	0%	50%
THU07201	A.ves rise 16	14	1	9		9	24	4%	63%
THU08101	E.larg 17	9	2	4		4	15	13%	73%
THU09101	swale 24	9	2	2		2	13	15%	85%

THU09201	swale 24	6	2	3		3	11	18%	73%
THU10101	A.ves rise 16	6	1	5		5	12	8%	58%
THU10201	Mulga pl 20	8	2	6		6	16	13%	63%
THU11101	swale 24	11	2	3		3	16	13%	81%
THU11201	E.soc 9	10	2	4		4	16	13%	75%
THU11301	S.divar 31	8	4	6		6	18	22%	67%
WIL01101	M.pyr 28	1	2	11		11	14	14%	21%
WIL01201	A.aneura 21	8		16		16	24	0%	33%
WIL02101	M.astro 25	6	5	10		10	21	24%	52%
WIL02201	M.aph 29	13	1	15	1	16	30	7%	47%
WIL02301	N.bill 8	9	2	12		12	23	9%	48%
WIL02401	M.aph 10	12	3	9	1	10	25	16%	60%
WIL02501	M.pyr 28	7	4	10		10	21	19%	52%
WIL03101	M.sed 4	9	4	14		14	27	15%	48%
Site Identifier	**Veg Group**	**Freq +**	**Freq +***	**Freq P**	**Freq P***	**for Analysis §**	**Total**	**% Introd**	**% not in Analysis**
WIL03401	A.aneura 21	2		18		18	20	0%	10%
WIL04101	M.aph 29	14	3	16	1	17	34	12%	50%
WIL04201	M.aph 29	12	1	17	1	18	31	6%	42%
WIL06101	A.aneura 21	10	3	23		23	36	8%	36%
WIL03201	M.sed 4	2	2	13		13	17	12%	24%
WIL03301	M.astro 25	7	2	9		9	18	11%	50%
WIL06201	E.gill 39	6		14		14	20	0%	30%
WIL06301	C.paup 22			7		7	7	0%	0%
WIL06401	A.aneura 21	6	3	12		12	21	14%	43%
WIL08101	M.astro 25	11	4	11		11	26	15%	58%
WIL08201	A.aneura 21	10	5	16		16	31	16%	48%
WIL08301	A.ves 32	11	1	9		9	21	5%	57%
WIL09101	A.aneura 21	10	5	19		19	34	15%	44%
WIL09201	A.aneura 21	4	4	20		20	28	14%	29%
WIL09301	E.cam 18	5	8	11		11	24	33%	54%
WIL09401	E.soc 9			12		12	12	0%	0%
WIL09501	E.gill 39	6		12		12	18	0%	33%
WIL09601	C.paup 22			9		9	9	0%	0%
WIN01101	Senna 5	7	2	9		9	18	11%	50%
WIN01201	Senna 5	4	2	28		28	34	6%	18%
WIN01301	A.ves 32	4	4	15		15	23	17%	35%
WIN01401	A.ves 32	3	2	9		9	14	14%	36%
WIN01501	A.ves 32	2	1	6		6	9	11%	33%
WIN03101	A.ves rise 16	7	2	12	1	13	22	14%	41%
WIN03201	A.aneura 21	9	4	26		26	39	10%	33%
WIN03301	M.pyr 28	10	2	10		10	22	9%	55%
WIN05101	S.obliq 38	5	5	5		5	15	33%	67%
WIN05301	A.ves 32	6	3	9		9	18	17%	50%
WIN06101	E.soc 9	2	1	9		9	12	8%	25%
WIN07101	A.ves 32	4	1	5		5	10	10%	50%
WIN08101	N.bill 8	4	5	10		10	19	26%	47%
WIN08201	E.soc 9			9		9	9	0%	0%
WIN08401	A.ves 32	4	2	5		5	11	18%	55%
WIN09101	A.ves 32	12	7	4		4	23	30%	83%
WIN09201	A.aneura 21	9	6	11		11	26	23%	58%
WIN10101	M.sed 4	2	2	6	1	7	11	27%	36%
WIN10201	A.ves 32	3	2	8	1	9	14	21%	36%
WIN10301	N.bill 8	1	4	3	1	4	9	56%	56%
WIN11101	A.aneura 21	8	5	17	1	18	31	19%	42%
WIN11201	E.soc 9	2	4	11	1	12	18	28%	33%
WIN12201	M.pyr 28	1	4	9	1	10	15	33%	33%
WIN12301	M.pyr 28	3	4	8	1	9	16	31%	44%
WIN12401	N.bill 8	2	3	8	1	9	14	29%	36%

Appendix III

NORTH OLARY PLAINS SURVEY QUADRAT LOCATIONS

Quadrat locations are shown by 1:100,000 mapsheets, listed in alphabetical order by name.

Detailed location data, physical environment information and floristic vegetation type for each quadrat are listed.

(The floristic vegetation group numbers correspond to those listed in the vegetation chapter).

Fauna survey quadrats where permanent photographic monitoring points were established are shown in **bold**.

BENAGERIE - 6935

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group
BEN01101	408800	6565250	Longitudinal dunefield	dune crest	sand	23
BEN01201	410620	6564000	Plain	lake	light clay	34
BEN01301	411450	6564590	Plain	hill footslope	sand	37
BEN04101	409890	6555150	Plain	plain (incl undulating plain)	silty clay loam	32
BEN04201	419320	6554330	Plain	plain (incl undulating plain)	clay loam, sandy	32
BEN04301	416750	6546070	Plain	plain (incl undulating plain)	sand	32
BEN04401	416990	6552630	Plain	stream channel	silt loam	34
BEN05201	424740	6545280	Longitudinal dunefield	swale	sand	24
BEN05301	427100	6544420	Plain	hill slope	clayey sand	32
BEN05401	427420	6544420	Plain	lake	light clay	31
BEN06101	447830	6552730	Plain	dune crest	sand	22
BEN06201	446820	6551280	Plain	plain (incl undulating plain)	silty clay loam	24
BEN08101	421940	6533380	Plain	lake	silty clay loam	35
BEN08201	421080	6533270	Plain	plain (incl undulating plain)	silty clay loam	32
BEN09101	430180	6532540	Plain	plain (incl undulating plain)	silty clay loam	32
BEN11101	406000	6525000	Plain	plain (incl undulating plain)	sandy clay loam	32
BEN11201	409200	6521740	Plain	plain (incl undulating plain)	loamy sand	19
BEN11301	412660	6523330	Plain	plain (incl undulating plain)	sandy loam	22
BEN12201	414150	6523870	Plain	closed depression	silty clay loam	31
BEN12301	421700	6524590	Plain	plain (incl undulating plain)	sand	16
BEN12401	429100	6523450	Plain	dune footslope	sandy loam	32
BEN13101	438060	6522960	Plain	plain (incl undulating plain)	silt loam	31
BEN13201	441510	6526870	Plain	plain (incl undulating plain)	sandy clay loam	15
BEN14101	447850	6522340	Plain	plain (incl undulating plain)	sand	32
BEN14201	449510	6521720	Plain	flood out	light medium clay	10

COONARBINE - 6936

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group
CNB01101	415270	6621320	Longitudinal dunefield	closed depression	clayey sand	25
CNB01201	415270	6621320	Longitudinal dunefield	closed depression	medium clay	31
CNB04101	407470	6597880	Dunefield	dune/consolidated dune	sand	37
CNB04201	405530	6597540	Dunefield	dune crest	sand	23
CNB06101	448050	6612270	Longitudinal dunefield	hill footslope	sandy loam	24
CNB06301	449620	6599930	Longitudinal dunefield	swale	silty clay loam	16
CNB06401	444920	6609820	Longitudinal dunefield	dune footslope	sand	23
CNB07101	406600	6586930	Rises	hill footslope	sand	38
CNB07201	407340	6588570	Rises	hill footslope	loamy sand	8
CNB08101	421290	6585070	Longitudinal dunefield	closed depression	clay loam, sandy	29
CNB08201	419630	6593410	Longitudinal dunefield	swamp	loamy sand	34
CNB11101	424760	6574010	Longitudinal dunefield	swale	loamy sand	25
CNB11201	422590	6579590	Longitudinal dunefield	fore dune	sand	24
CNB11301	421760	6581670	Longitudinal dunefield	dune slope	sand	23

COONEE - 7037

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group

CNE02101	477280	6675390	Longitudinal dunefield	dune crest	sand	23
CNE03101	489150	6678090	Longitudinal dunefield	stream channel	silt loam	36
CNE03201	497660	6679920	Longitudinal dunefield	flood out	silty clay loam	17
CNE03301	479960	6676140	Longitudinal dunefield	swale	sandy loam	16
CNE08101	467430	6648200	Longitudinal dunefield	lake	medium clay	23
CNE08201	468190	6649890	Longitudinal dunefield	open depression	sandy clay loam	17
CNE08301	470350	6653330	Plain	stream channel	clayey sand	36
CNE08401	471550	6652580	Longitudinal dunefield	dune slope	sand	23
CNE08501	474630	6653000	Longitudinal dunefield	swale	silty clay loam	24
CNE09101	498700	6652630	Longitudinal dunefield	dune slope	sand	23
CNE09201	498830	6652520	Longitudinal dunefield	closed depression	silty clay loam	35
CNE09301	498480	6652240	Longitudinal dunefield	swale	sandy loam	24
CNE11101	471910	6627500	Longitudinal dunefield	swale	silty clay loam	24
CNE11201	472330	6627030	Longitudinal dunefield	dune crest	sand	23
CNE12201	494690	6629900	Plain	plain (incl undulating plain)	clay loam	16
CNE12401	497500	6633280	Flood plain	lake	medium clay	31
CNE12501	496890	6636420	Plain	stream channel	silt loam	17

COOTABARLOW - 6937

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group
CTB01101	426230	6672970	Flood plain	flood out	sandy clay loam	17
CTB01201	415370	6668000	Longitudinal dunefield	swale	sand	8
CTB02101	433480	6677450	Longitudinal dunefield	closed depression	clayey sand	17
CTB02201	433480	6677450	Longitudinal dunefield	closed depression	light clay	24
CTB03101	413390	6661760	Longitudinal dunefield	dune crest	sand	19
CTB06101	410750	6645250	Dunefield	closed depression	light medium clay	35
CTB06201	412130	6650740	Dunefield	closed depression	loamy sand	24
CTB09101	416480	6628170	Longitudinal dunefield	swale	loamy sand	16
CTB09201	416660	6631780	Longitudinal dunefield	dune footslope	sand	24
CTB09301	415630	6633580	Plain	closed depression	light medium clay	31
CTB10101	421510	6635060	Longitudinal dunefield	dune crest	sand	23

CURNAMONA - 6834

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group
CUR01201	362410	6509740	Alluvial plain	plain (incl undulating plain)	loamy sand	25
CUR01301	362440	6499820	Alluvial plain	plain (incl undulating plain)	silty clay loam	2
CUR03101	390670	6505420	Alluvial plain	plain (incl undulating plain)	loamy sand	22
CUR03201	389050	6513080	Alluvial plain	plain (incl undulating plain)	loamy sand	17
CUR04101	397150	6502940	Alluvial plain	plain (incl undulating plain)	sandy clay loam	25
CUR06201	361400	6492860	Alluvial plain	plain (incl undulating plain)	clay loam, sandy	4
CUR06401	367630	6496680	Alluvial plain	plain (incl undulating plain)	clay loam, sandy	5
CUR06501	370560	6488740	Alluvial plain	plain (incl undulating plain)	light clay	5
CUR07101	381100	6492790	Alluvial plain	plain (incl undulating plain)	sandy clay loam	25
CUR07201	386270	6500490	Alluvial plain	plain (incl undulating plain)	light clay	4
CUR09201	371480	6478150	Alluvial plain	plain (incl undulating plain)	clay loam, sandy	20
CUR11101	379560	6461090	Alluvial plain	plain (incl undulating plain)	sandy clay loam	22
CUR14201	381720	6466840	Alluvial plain	sandy plain	loamy sand	5
CUR14301	385020	6468510	Low hills	hill crest	loamy sand	20
CUR15101	401880	6468720	Alluvial plain	plain (incl undulating plain)	sandy clay loam	32
CUR15201	402110	6468660	Alluvial plain	plain (incl undulating plain)	sandy clay loam	32
CUR15301	391840	6464500	Hills	hill slope	sandy clay loam	21

FROME - 6836

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group
FRO01101	367460	6623910	Plain	flat	loamy sand	5
FRO01201	367250	6612110	Plain	flat	loamy sand	32
FRO01301	363870	6606720	Plain	flat	loamy sand	32
FRO01401	361750	6607140	Plain	dune/consolidated dune	sand	19
FRO02101	375260	6622380	Plain	flat	light clay	31
FRO02201	374560	6622390	Plain	flat	loamy sand	25
FRO02301	372280	6622360	Plain	flat	loamy sand	28
FRO03101	356870	6606490	Plain	flat	sandy clay loam	5
FRO03201	359950	6601680	Plain	flat	loamy sand	25

KALABITY - 6934

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group

KAL01101	418400	6509860	Plain	flood out	light clay	31
KAL01201	418400	6509990	Plain	plain (incl undulating plain)	sandy clay loam	25
KAL01301	418800	6508860	Plain	plain (incl undulating plain)	sand	22
KAL01401	418410	6509250	Plain	swamp	silty clay loam	35
KAL02101	431750	6510250	Plain	plain (incl undulating plain)	sandy clay loam	25
KAL03101	437410	6513590	Plain	flood out	sandy clay loam	22
KAL03201	445280	6503160	Plain	flood out	silty clay loam	10
KAL04101	408030	6494180	Plain	plain (incl undulating plain)	sand	22
KAL04201	415730	6493300	Plain	plain (incl undulating plain)	sandy loam	32
KAL04301	408370	6494440	Plain	stream channel	sand	20
KAL06101	436470	6491820	Plain	plain (incl undulating plain)	silty clay loam	32
KAL06201	444460	6498390	Plain	plain (incl undulating plain)	sandy clay loam	15
KAL07101	450670	6499960	Plain	plain (incl undulating plain)	sandy loam	15
KAL08101	419790	6479050	Plain	plain (incl undulating plain)	sandy clay loam	32
KAL09101	434800	6473230	Plain	flood out	sandy loam	28
KAL09201	428050	6481590	Plain	plain (incl undulating plain)	sandy loam	32
KAL10201	447200	6484530	Plain	plain (incl undulating plain)	light clay	31
KAL12501	424800	6461750	Hills	hill slope	sandy loam	21
KAL13101	441660	6475310	Low hills	hill crest	light clay	32
KAL13201	438090	6467140	Low hills	hill footslope	sandy clay loam	32
KAL13301	441340	6474560	Low hills	flood out	silty clay loam	20
KAL13401	447660	6466410	Plain	plain (incl undulating plain)	silty clay loam	31

KOONAMORE - 6733

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group
KOO01101	315220	6455150	Plain	flat	sandy clay loam	38
KOO02101	321950	6456010	Plain	flat	clay loam, sandy	28
KOO02201	322000	6456010	Low hills	hill footslope	sandy loam	38
KOO03101	333380	6452040	Plain	flat	light clay	34
KOO05101	347220	6454410	Hills	hill slope	sandy clay loam	9
KOO06101	355990	6452880	Plain	flat	loamy sand	9
KOO08101	326080	6447860	Plain	flat	clay loam	32
KOO09101	330380	6449060	Plain	flat	clay loam, sandy	32
KOO10101	342170	6444660	Plain	flat	sandy loam	5
KOO11101	350570	6452160	Plain	flat	sandy clay loam	4
KOO11201	343360	6444420	Plain	flat	loamy sand	20
KOO12101	355900	6448600	Plain	flat	clay loam, sandy	4
KOO12201	353380	6447830	Plain	flat	clayey sand	5
KOO14101	327550	6439800	Plain	flat	loamy sand	28
KOO15101	335880	6443040	Plain	open depression	light clay	35
KOO16101	348390	6441920	Plain	flat	sandy loam	32
KOO18101	314990	6431860	Plain	flat	sandy loam	32
KOO18201	315800	6434920	Plain	flat	sandy clay loam	22
KOO24101	314780	6427190	Plain	flat	light clay	29
KOO27101	339270	6425700	Hills	hill slope	sandy clay loam	32
KOO29101	352180	6425230	Plain	flat	sandy clay loam	4
KOO30101	316640	6416460	Rises	hill slope	clay loam, sandy	38
KOO30201	316640	6416440	Plain	flat	light clay	2
KOO32101	330740	6419750	Low hills	hill slope	clay loam, sandy	4
KOO33101	335790	6418190	Plain	flat	light clay	28
KOO34101	347000	6420210	Rises	hill slope	sandy loam	32
KOO35101	355130	6416040	Hills	hill slope	sandy loam	9
KOO37101	327940	6413570	Plain	flat	sandy clay loam	0
KOO38101	332800	6412870	Hills	hill footslope	sandy loam	0
KOO40101	348640	6410440	Low hills	hill slope	sandy loam	38
KOO41101	358390	6409170	Plain	flat	light clay	28

LAKE CHARLES - 7035

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group
LCH01101	455180	6565430	Plain	dune/consolidated dune	sand	20
LCH01201	456280	6567700	Plain	plain (incl undulating plain)	silty clay loam	25
LCH01301	468580	6565280	Plain	flood out	light medium clay	31
LCH02101	472830	6560440	Longitudinal dunefield	plain (incl undulating plain)	sand	20
LCH02201	472930	6567140	Plain	plain (incl undulating plain)	sand	22
LCH03101	484510	6566080	Longitudinal dunefield	dune slope	sand	23
LCH03201	491000	6562530	Plain	plain (incl undulating plain)	silty clay loam	31
LCH03301	497090	6562660	Plain	plain (incl undulating plain)	clayey sand	15
LCH04101	455750	6555480	Longitudinal dunefield	stream channel	sand	17
LCH04201	452330	6557650	Longitudinal dunefield	swale	sand	24
LCH05101	465940	6549610	Plain	plain (incl undulating plain)	sand	16
LCH05201	468460	6550470	Longitudinal dunefield	dune/consolidated dune	sand	19
LCH06101	490010	6552470	Plain	plain (incl undulating plain)	silty clay loam	17
LCH06201	479540	6543100	Plain	plain (incl undulating plain)	sand	22
LCH06301	494530	6557370	Plain	dune crest	sand	20
LCH08101	469280	6535020	Plain	plain (incl undulating plain)	sand	15
LCH08201	462890	6535030	Plain	flood out	sand	17
LCH09101	478960	6535060	Plain	plain (incl undulating plain)	sand	22
LCH09201	484840	6535000	Plain	plain (incl undulating plain)	sand	15
LCH10101	497140	6535120	Plain	plain (incl undulating plain)	sand	15
LCH10201	499370	6535130	Plain	plain (incl undulating plain)	sand	22
LCH11101	467380	6520730	Plain	flood out	silty clay loam	29
LCH11201	470000	6526250	Plain	plain (incl undulating plain)	sandy clay loam	15
LCH11301	461270	6527310	Plain	plain (incl undulating plain)	sandy loam	22
LCH12101	481620	6522750	Plain	flood out	silty clay loam	17
LCH12201	482000	6518950	Plain	plain (incl undulating plain)	sand	19

MINGARY - 7033

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group
MIN01201	470370	6448490	Plain	plain (incl undulating plain)	silty clay loam	32
MIN01401	474490	6445510	Plain	sandy plain	sand	32
MIN02101	485090	6457960	Plain	open depression	silty clay loam	31
MIN02201	491390	6458010	Plain	drainage depression	silty clay loam	31
MIN02301	491250	6456220	Plain	sandy plain	clay loam	31
MIN02401	492230	6456160	Plain	plain (incl undulating plain)	sandy clay loam	32
MIN02501	492420	6448730	Plain	closed depression	light medium clay	35
MIN02601	494320	6449630	Plain	stream channel	sandy loam	32
MIN02701	492180	6448190	Plain	plain (incl undulating plain)	sandy clay loam	31
MIN05101	492910	6437670	Rises	stream channel	sand	2
MIN06201	459940	6422620	Rises	ridge	sandy clay loam	1
MIN07101	465700	6425480	Low hills	hill slope	silt loam	21
MIN07201	464930	6434190	Rises	ridge	sandy loam	4
MIN09101	492110	6431380	Rises	hill slope	sandy clay loam	32
MIN09201	492790	6429280	Rises	hill slope	silty clay loam	32
MIN10101	456710	6416260	Hills	ridge	silt loam	1
MIN10201	459150	6417790	Hills	ridge	sandy clay loam	21
MIN11101	477600	6408660	Rises	hill slope	silty clay loam	31
MIN11201	477530	6406110	Plain	stream channel	silty clay loam	18
MIN12101	492860	6414100	Rises	ridge	clay loam, sandy	4
MIN12201	485860	6417360	Plain	hill crest	silty clay loam	32
MIN12301	489620	6411910	Rises	ridge	clay loam	32

MULYUNGARIE - 7034

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group
MUL01101	465510	6503230	Plain	plain (incl undulating plain)	light medium clay	31
MUL01201	459650	6509900	Plain	plain (incl undulating plain)	sandy loam	16
MUL02101	471620	6511490	Plain	stream channel	silty clay loam	10
MUL02201	478100	6508980	Plain	plain (incl undulating plain)	sand	9
MUL02301	469220	6502980	Plain	plain (incl undulating plain)	sandy clay loam	32
MUL02401	471530	6507390	Plain	plain (incl undulating plain)	sandy loam	16
MUL03201	490770	6501670	Plain	plain (incl undulating plain)	sandy loam	32
MUL03301	484920	6512120	Plain	plain (incl undulating plain)	sand	19
MUL03401	484420	6511920	Plain	stream channel	silty clay loam	17
MUL05201	467590	6496530	Plain	plain (incl undulating plain)	sandy clay loam	15
MUL05301	468980	6489940	Plain	plain (incl undulating plain)	silty clay loam	31
MUL05401	468440	6490620	Plain	plain (incl undulating plain)	sandy clay loam	32
MUL06101	488650	6489110	Plain	flood out	sandy loam	22
MUL06201	483500	6488570	Plain	plain (incl undulating plain)	sandy loam	32
MUL06301	480480	6494320	Plain	plain (incl undulating plain)	silty clay loam	32
MUL06401	484920	6497260	Plain	sandy plain	sand	19
MUL06501	488390	6488620	Plain	plain (incl undulating plain)	sandy loam	31
MUL09101	476310	6483800	Plain	plain (incl undulating plain)	sandy clay loam	32
MUL10101	490180	6478950	Plain	plain (incl undulating plain)	sandy loam	32
MUL10301	489600	6484630	Plain	closed depression	silty clay loam	17
MUL11101	465720	6463870	Plain	plain (incl undulating plain)	silty clay loam	31
MUL11201	468060	6473170	Plain	plain (incl undulating plain)	sandy clay loam	32
MUL11301	473830	6467090	Plain	plain (incl undulating plain)	light medium clay	31
MUL12101	485230	6469330	Plain	plain (incl undulating plain)	silty clay loam	31
MUL13101	492710	6470840	Plain	flood out	clayey sand	2

OLARY - 6933

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group
OLA01101	423760	6450810	Plain	stream channel	sand	18
OLA01201	426060	6447760	Alluvial plain	sandy plain	loamy sand	28
OLA01301	420920	6456470	Hills	hill slope	silty clay loam	4
OLA01401	421320	6446920	Hills	hill slope	clay loam, sandy	21
OLA01501	421320	6446920	Alluvial plain	plain (incl undulating plain)	sandy loam	28
OLA02101	442030	6452210	Low hills	hill slope	sandy clay loam	21
OLA04101	406790	6443700	Hills	hill crest	sandy loam	21
OLA04201	410310	6432000	Low hills	hill crest	sandy clay loam	9
OLA05101	434110	6447200	Low hills	hill slope	sandy loam	21
OLA05301	432130	6441710	Low hills	hill slope	sandy loam	21
OLA05401	428320	6434670	Plain	plain (incl undulating plain)	sandy clay loam	28
OLA05501	424500	6441520	Low hills	hill slope	sandy loam	21
OLA05601	434110	6439770	Low hills	flat	clay loam	28
OLA08101	423250	6422800	Flood plain	plain (incl undulating plain)	clay loam, sandy	2
OLA09101	433170	6421140	Plain	drainage depression	clay loam, sandy	2
OLA10101	412490	6413700	Plain	plain (incl undulating plain)	clay loam, sandy	8
OLA10401	416580	6420050	Plain	plain (incl undulating plain)	clay loam	8
OLA10501	415010	6419470	Plain	plain (incl undulating plain)	clay loam	31
OLA10601	421950	6411850	Low hills	hill slope	clay loam	21
OLA12101	436030	6417800	Plain	plain (incl undulating plain)	sandy clay loam	32
OLA12201	440970	6419320	Plain	plain (incl undulating plain)	clay loam	28
OLA12301	442650	6415330	Plain	flood out	clay loam	2
OLA12401	448940	6411130	Rises	ridge	clay loam, sandy	1

PARALANA - 6837

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group
PAR01101	395320	6671450	Plain	flat	clay loam, sandy	29
PAR01201	385950	6678370	Plain	flat	light medium clay	29
PAR01301	387150	6671990	Plain	flat	light clay	29
PAR01401	383950	6665960	Plain	dune/consolidated dune	sand	5
PAR02101	403920	6671160	Plain	flat	clayey sand	29
PAR02201	402110	6670820	Plain	dune/consolidated dune	sand	16
PAR03101	374180	6659960	Plain	flat	light clay	29
PAR03201	383690	6660410	Plain	flat	sandy clay loam	10
PAR03301	384880	6655390	Plain	dune/consolidated dune	sand	28
PAR03401	384670	6653670	Plain	drainage depression	clayey sand	10
PAR05101	364620	6644860	Plain	flat	light clay	31
PAR05201	371790	6644730	Plain	dune/consolidated dune	clayey sand	19
PAR05301	374980	6652910	Plain	flat	clayey sand	2
PAR06101	388180	6646670	Plain	flat	clay loam, sandy	29
PAR06201	390260	6642610	Plain	closed depression	light clay	31
PAR07101	373140	6630820	Longitudinal dunefield	swale	clay loam, sandy	10
PAR07201	366130	6640890	Flood plain	flood out	light clay	2
PAR07301	365570	6640620	Plain	flat	sandy clay loam	5
PAR07401	364060	6639640	Plain	dune/consolidated dune	sand	5
PAR08101	382510	6633500	Longitudinal dunefield	dune slope	sand	16
PAR09101	360310	6664350	Plain	plain (incl undulating plain)	light clay	31
PAR10101	361410	6652580	Plain	drainage depression	light clay	31
PAR11101	360100	6637190	Plain	flat	loamy sand	5
PAR11201	360090	6629140	Plain	flat	sandy clay loam	10

PASMORE - 6835

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group
PAS01101	363240	6556180	Flood plain	stream channel	light clay	8
PAS01201	360040	6562470	Plain	plain (incl undulating plain)	sandy clay loam	25
PAS06101	375090	6545580	Alluvial plain	flat	loamy sand	28
PAS06201	362970	6546390	Plain	plain (incl undulating plain)	loamy sand	32
PAS06301	362440	6546450	Plain	open depression	light clay	10
PAS06401	362970	6546390	Plain	flat	loamy sand	25
PAS07101	391420	6550290	Dunefield	swale	medium clay	29
PAS08101	393720	6546420	Dunefield	dune slope	sand	32
PAS10101	371660	6534230	Plain	swamp	medium clay	31
PAS11101	390990	6536570	Rises	hill slope	loamy sand	25
PAS11201	387220	6540410	Dunefield	dune crest	sand	19
PAS12101	361390	6524270	Plain	flat	loamy sand	32
PAS13101	369860	6528480	Plain	open depression	clayey sand	28
PAS14101	387830	6524330	Alluvial plain	plain (incl undulating plain)	loamy sand	5
PAS15101	403310	6526570	Alluvial plain	plain (incl undulating plain)	loamy sand	22
PAS15201	402060	6526470	Alluvial plain	plain (incl undulating plain)	loamy sand	32
PAS15301	386370	6528490	Alluvial plain	swamp	sandy clay loam	35

REAPHOOK - 6735

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group
REA01101	329000	6555120	Low hills	hill slope	sandy clay loam	21
REA01201	328390	6554800	Plain	flat	sandy clay loam	4
REA01301	324720	6558150	Low hills	hill slope	sandy loam	39
REA01401	324170	6560450	Low hills	hill slope	sandy clay loam	9
REA01501	311680	6562510	Plain	flood out	sandy loam	25
REA02101	343220	6565870	Plain	flat	sandy clay loam	25
REA02201	340970	6561140	Plain	flat	loamy sand	25
REA02301	344690	6557840	Plain	flat	loamy sand	25
REA02401	342900	6557770	Plain	flat	loamy sand	25
REA02601	333500	6559390	Plain	flat	clay loam	37
REA02701	331400	6556900	Hills	hill footslope	sandy clay loam	5
REA03101	347080	6559630	Plain	flat	sandy loam	5
REA03201	350480	6563900	Flood plain	flood out	silty clay loam	18
REA03301	347730	6568260	Plain	flat	clay loam, sandy	2
REA02501	338420	6558530	Plain	flat	sandy clay loam	21
REA04101	320310	6549830	Plain	flat	clay loam, sandy	25
REA04201	324360	6543680	Plain	flat	sandy clay loam	25
REA05101	339940	6545280	Plain	flat	light clay	31
REA06101	356060	6552090	Flood plain	flood out	silty clay loam	18
REA06201	345550	6553590	Plain	flat	loamy sand	5
REA07101	325760	6539860	Plain	flat	sandy clay loam	4
REA07201	328900	6534370	Flood plain	flood out	light clay	8
REA07301	330820	6530470	Plain	flat	light clay	32
REA07401	330810	6527670	Hills	hill slope	sandy clay loam	21
REA08101	344340	6539240	Plain	flat	light clay	10
REA08201	344990	6538740	Plain	flood out	light clay	18
REA08301	344830	6535740	Plain	flat	light clay	29
REA09101	317640	6522010	Plain	flat	light clay	25
REA09201	312170	6527610	Plain	flat	sandy clay loam	25
REA10101	335290	6524100	Low hills	hill slope	silt loam	25
REA10201	337400	6522810	Low hills	flat	clay loam	20
REA10301	327870	6515380	Hills	hill slope	clay loam, sandy	21
REA11101	342280	6525550	Alluvial plain	flat	sandy clay loam	28
REA11201	340880	6523100	Alluvial plain	flat	clay loam, sandy	2
REA11301	343110	6515500	Flood plain	flood out	sandy clay loam	28

THURLOOKA - 7036

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group
THU04101	460970	6602120	Longitudinal dunefield	dune footslope	sandy loam	25
THU06101	488950	6608300	Longitudinal dunefield	swale	silty clay loam	25
THU06201	489070	6608340	Longitudinal dunefield	dune crest	sand	23
THU07101	460480	6595100	Longitudinal dunefield	closed depression	light medium clay	31
THU07201	460710	6595110	Longitudinal dunefield	plain (incl undulating plain)	sandy clay loam	16
THU08101	468600	6586360	Longitudinal dunefield	interdune corridor	clay loam, sandy	17
THU09101	490090	6596860	Plain	plain (incl undulating plain)	sandy loam	24
THU09201	492970	6595310	Longitudinal dunefield	swale	sandy loam	24
THU10101	469180	6575530	Longitudinal dunefield	swale	sandy clay loam	16
THU10201	459200	6580960	Longitudinal dunefield	dune crest	sand	20
THU11101	480890	6576720	Plain	plain (incl undulating plain)	sandy clay loam	24
THU11201	487150	6576340	Plain	stream channel	sand	9
THU11301	476140	6578220	Plain	drainage depression	light medium clay	31

WILLIPPA - 6734

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group
WIL01101	322240	6505810	Plain	flat	light clay	28
WIL01201	327430	6504350	Hills	hill slope	clay loam	21
WIL02101	346000	6513290	Alluvial plain	plain (incl undulating plain)	loamy sand	25
WIL02201	343500	6501080	Alluvial plain	plain (incl undulating plain)	medium clay	29
WIL02301	333150	6512350	Flood plain	flood out	sandy clay loam	8
WIL02401	343740	6507110	Alluvial plain	plain (incl undulating plain)	medium clay	10
WIL02501	343900	6512080	Alluvial plain	plain (incl undulating plain)	loamy sand	28
WIL03101	329460	6490780	Low hills	hill slope	clay loam	4
WIL03201	318390	6489520	Hills	hill slope	sandy clay loam	4
WIL03301	313680	6490980	Plain	flat	clay loam	25
WIL03401	323230	6498870	Hills	hill slope	sandy clay loam	21
WIL04101	343130	6491750	Alluvial plain	plain (incl undulating plain)	loamy sand	29
WIL04201	337670	6486510	Plain	flat	light clay	29
WIL06101	320770	6473470	Hills	ridge	sandy clay loam	21
WIL06201	323470	6475820	Hills	hill footslope	sandy loam	39
WIL06301	324050	6477180	Hills	hill slope	clayey sand	22
WIL06401	323850	6477560	Hills	hill slope	sandy clay loam	21
WIL08101	354490	6476100	Hills	hill footslope	loamy sand	25
WIL08201	354490	6476100	Hills	hill slope	clay loam	21
WIL08301	354240	6479440	Alluvial plain	plain (incl undulating plain)	sandy clay loam	32
WIL09101	321230	6459530	Hills	hill slope	sandy loam	21
WIL09201	319900	6465020	Hills	ridge	sandy loam	21
WIL09301	319730	6465480	Hills	stream channel	sand	18
WIL09401	319660	6466600	Hills	hill footslope	silty clay loam	9
WIL09501	320500	6470560	Hills	hill footslope	silty clay loam	39
WIL09601	320440	6472010	Hills	plain (incl undulating plain)	sandy clay loam	22

WININNINNIE - 6833

Site Number	Easting	Northing	Landform Pattern	Landform Element	Surface Soil Texture	Veg Group
WIN01101	374960	6454570	Rises	hill slope	sand	5
WIN01201	368920	6451230	Alluvial plain	hill footslope	sandy clay loam	5
WIN01301	370790	6450060	Alluvial plain	plain (incl undulating plain)	sandy clay loam	32
WIN01401	373620	6444330	Alluvial plain	plain (incl undulating plain)	sandy loam	32
WIN01501	375380	6442220	Alluvial plain	hill slope	sandy loam	32
WIN03101	394970	6453180	Alluvial plain	plain (incl undulating plain)	clayey sand	16
WIN03201	394980	6455020	Hills	hill slope	sandy clay loam	21
WIN03301	398400	6452430	Alluvial plain	plain (incl undulating plain)	clayey sand	28
WIN05101	379020	6436270	Rises	hill slope	sandy loam	38
WIN05301	378670	6436660	Alluvial plain	plain (incl undulating plain)	sandy loam	32
WIN06101	402050	6436630	Low hills	hill slope	sandy loam	9
WIN07101	362290	6425300	Rises	hill slope	sandy loam	32
WIN08101	380330	6426340	Plain	flat	clay loam	8
WIN08201	370460	6423900	Low hills	hill slope	clay loam	9
WIN08401	374760	6428710	Low hills	hill slope	sandy loam	32
WIN09101	383400	6421970	Rises	hill slope	silt loam	32
WIN09201	395150	6428860	Hills	hill slope	sandy clay loam	21
WIN10101	359940	6407280	Low hills	hill footslope	clay loam	4
WIN10201	362510	6405400	Alluvial plain	plain (incl undulating plain)	sandy clay loam	9
WIN10301	362510	6405400	Alluvial plain	plain (incl undulating plain)	light medium clay	0
WIN11101	378830	6406860	Hills	hill slope	loam	21
WIN11201	384710	6404060	Alluvial plain	plain (incl undulating plain)	sandy loam	9
WIN12201	403890	6408550	Alluvial plain	plain (incl undulating plain)	sandy clay loam	28
WIN12301	403090	6407160	Alluvial plain	plain (incl undulating plain)	sandy clay loam	28
WIN12401	401800	6405090	Rises	hill slope	sandy clay loam	8

Appendix IV

Percentage of Survey Area covered by Vegetation Associations

Note: Derived from the map of Plant Communities and the Associated mosaics. For Floristic Groups see Table 5, p.59

Area (km^2)	Plant Community	% Total Area
192	1	0.41
426	2	0.90
17	2 / 3	0.04
55	2 / 3 / 25	0.12
11	2 / 18	0.02
640	2 / 28	1.35
133	2 / 28 / 8	0.28
186	2 / 28 / 38	0.39
183	2 / 38	0.39
5	3	0.01
107	3 / 10	0.22
154	3 / 31	0.32
25	4	0.05
531	4 / 5 / 25	1.12
111	4 / 21	0.23
131	4 / 21 / 22	0.28
129	4 / 25 / 31	0.27
96	4 / 32 / 22	0.20
42	4 / 38 / 32	0.09
311	5	0.66
726	5 / 29	1.53
1,223	5 / 32	2.58
81	5 / 38	0.17
359	5 / 38 / 25	0.76
815	8	1.72
209	8 / 28	0.61
89	8 / 34	0.19
97	8 / 37	0.20
14	8 / 38	0.03
116	9	0.24
18	9 / 39	0.04
139	10	0.29
7	10 / 17	0.01
13	10 / 19	0.03
94	15	0.20
1,518	15 / 20	3.20
25	16	0.05
6	16 / 22	0.01
9	16 / 24	0.02
60	17	0.13
13	17 / 10	0.03
126	18	0.27
13	18 / 8	0.03
20	18 / 10	0.04
183	19	0.39
78	19 / 10	0.16
267	19 / 15 / 20	0.56
94	19 / 28 / 15	0.20
1,902	21	4.01
5	21 / 4	0.01
279	21 / 9	0.59
55	21 / 22	0.12
39	22	0.08
22	22 / 28	0.05
1,876	23	3.95
1,032	23 / 24	2.18
2	23 / 25 / 24	0.00
7,818	24	16.48
83	24 / 25 / 16	0.18
767	25	1.62
3,385	25 / 5	7.14
7	25 / 5 / 22	0.01
90	25 / 5 / 38	0.19
1,119	25 / 28	2.36
85	25 / 28 / 29	0.18
278	25 / 31	0.59
939	25 / 32	1.98
335	25 / 32 / 38	0.71
135	25 / 38	0.29
270	28	0.57
295	28 / 5	0.62
749	28 / 32	1.58
26	28 / 38	0.06
627	29	1.32
214	29 / 5 / 32	0.45
2,026	31	4.27
36	31 / 16	0.08
26	31 / 34	0.05
86	31 / 35	0.18
5,564	32	11.73
844	32 / 4	1.78
409	32 / 4 / 38	0.86
443	32 / 8	0.93
227	32 / 8 / 25	0.48
486	32 / 16	1.02
96	32 / 19 / 28	0.20
201	32 / 21	0.42
36	32 / 25 / 4	0.08
312	32 / 38	0.66
65	34	0.14
6	35	0.01
6	36	0.01
23	36 / 17	0.05
4	36 / 17 / 31	0.01
291	37	0.61
278	38	0.59
233	38 / 4	0.49
100	39 / 21 / 22	0.21

Summary of some of the more spatially significant communities derived from table above.

Mapped Community	Area (km^2)	% Survey Area
***Maireana sedifolia* Low open shrubland (4)**	24	0.05
-as a mosaic with other communities	2,530	5.33
***Senna/Eremophila / Rhagodia spinescens* Open shrubland (5)**	320	0.66
-as a mosaic with other communities	6,920	14.59
***Acacia aneura / A. victoriae / Sida petrophila* Very open low woodland (21)**	1,900	4.01
-as a mosaic with other communities	882	1.86
***Casuarina pauper* Low woodland (22)**	40	0.08
-as a mosaic with other communities	420	0.88
***Acacia ligulata* Very open shrubland (23)**	1,875	3.95
-as a mosaic with other communities	1,034	2.18
***Acacia aneura / Enneapogon* spp. Low open woodland(24)**	7,816	16.48
-as a mosaic with other communities	1,130	2.38
***Maireana astrotricha* Low open shrubland (25)**	770	1.62
-as a mosaic with other communities	7,970	16.81
***Maireana pyramidata* Low open shrubland (28)**	270	0.57
-as a mosaic with other communities	3,940	8.3
***Sclerolaena divaricata* Low very open shrubland (31)**	2,025	4.27
-as a mosaic with other communities	710	1.5
***Atriplex vesicaria / Maireana astrotricha* Low open shrubland (32)**	5,560	11.73
-as a mosaic with other communities	6,070	12.8

Appendix V

PLANT SPECIES RECORDED FROM THE NORTH 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

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 Kraehenbuehl (1994). Regional status refers only to the Eastern region.

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 columns indicate the source of plant species records as follows:
1 Playfair, Hyde, and Robinson, 1996. (this survey) Records from survey sites
\+ Hyde 1995. (this survey) Opportunistic records
2 Tiver, 1994 (may include species from a portion of the South Olary Plains)
3 Douglas, 1983 (may include species from a portion of the Flinders Ranges at Balcanoona)
4 Williams and Levitzke, 1980. Strathearn and Kalabity pastoral leases
5 Laut et al., 1977. Entire region
6 Osborn, Wood, Paltridge, 1935. Koonamoore
7 Carrodus, Specht and Jackman, 1965. Koonamoore
8 S A Herbarium specimens from the Eastern Region
Note: many inadequate specimens are lodged with the State Herbarium and are unidentifiable within the current taxonomic system. These are often kept for future taxonomic work and appear on this list as incomplete identifications of specimens at the Herbarium.

Family	Scientific Name	Common Name	Source
ISOETACEAE			
	Isoetes muelleri	rock quillwort	8
OPHIOGLOSSACEAE			
	Ophioglossum lusitanicum	austral adder's-tongue	8
	Ophioglossum polyphyllum	large adder's-tongue	8
ADIANTACEAE			
	Cheilanthes sp.	rock-fern	8
	Cheilanthes distans	bristly cloak-fern	3 8
	Cheilanthes lasiophylla	woolly cloak-fern	1 3 7 8
	Cheilanthes sieberi ssp. *sieberi*	mulga fern	1 3 8
	Paraceterach reynoldsii	scaly rock-fern	3 8
ASPLENIACEAE			
	Pleurosorus rutifolius	blanket fern	1 3 7 8
	Pleurosorus sp.	blanket fern	8
	Pleurosorus subglandulosus	clubbed blanket fern	8
MARSILEACEAE			
	Marsilea drummondii	common nardoo	1 2 4 7 8
	Marsilea hirsuta	short-fruit nardoo	8
	Marsilea sp.	nardoo	8
CUPRESSACEAE			
	Callitris glaucophylla	northern cypress-pine	1 2 3 5 8
	Callitris preissii	southern cypress pine	8
	Callitris sp.	native pine	8
CASUARINACEAE			
	Allocasuarina muelleriana ssp. *muelleriana*	slaty sheoak	3 8
	Allocasuarina verticillata	drooping sheoak	8

Family	Scientific Name	Common Name	Source							
	Casuarina pauper	black oak	1	2	3	4	5	6	7	8
	Casuarinaceae sp.	sheaok family								8
SALICACEAE										
	* *Salix babylonica*	weeping willow								8
URTICACEAE										
	Parietaria cardiostegia	mallee smooth-nettle								8
	Parietaria cardiostegia/debilis	smooth-nettle								8
	Parietaria debilis	smooth-nettle	1	2	3	4			7	8
	* *Urtica urens*	stinging nettle			3					8
PROTEACEAE										
	Grevillea huegelii	comb grevillea		2						8
	Grevillea nematophylla	water bush								8
	Grevillea striata	beefwood								8
	Hakea ednieana	corkbark			3					8
	Hakea leucoptera	needle bush	1	2	3	4			7	8
	Hakea sp.	hakea/needlewood								8
SANTALACEAE										
	Exocarpos aphyllus	leafless ballart	1	2	3			6	7	8
	Santalum acuminatum	quandong	1	2	3			6	7	8
	Santalum lanceolatum	plumbush	1	2	3	4			7	8
	Santalum spicatum **KN**	sandalwood			3			6	7	8
LORANTHACEAE										
	Amyema linophyllum ssp. *orientale*	buloke mistletoe								8
	Amyema maidenii ssp. *maidenii*	pale-leaf mistletoe	1	2	3			6	7	8
	Amyema miquelii	box mistletoe	1	2	3					8
	Amyema miraculosum ssp. *boormanii*	fleshy mistletoe	1							8
	Amyema preissii	wire-leaf mistletoe	1	2	3			6	7	8
	Lysiana exocarpi ssp. *exocarpi*	harlequin mistletoe	1	2	3			6	7	8
	Lysiana subfalcata		+							8
POLYGONACEAE										
	* *Acetosa vesicaria*	wild hops	1		3	4	5			8
	* *Acetosella vulgaris*	dock	1							8
	* *Emex australis*	three-corner jack	1	2						8
	Muehlenbeckia coccoloboides		+							
	Muehlenbeckia diclina ssp. *diclina*	weeping lignum								8
	Muehlenbeckia florulenta	lignum	1	2	3					8
	Persicaria lapathifolia	pale knotweed								8
	* *Polygonum aviculare*	wireweed		2						8
	Polygonum plebeium	small knotweed			3	4				8
	Rumex brownii	swamp dock			3					8
	* *Rumex crispus*	curled dock		2		4				8
	Rumex crystallinus	shiny dock								8
	Rumex dumosus var. *dumosus*	wiry dock								8
	Rumex sp.	dock								8
	Rumex tenax	shiny dock								8
GYROSTEMONACEAE										
	Codonocarpus pyramidalis	slender bell-fruit	1		3					8
NYCTAGINACEAE										
	Boerhavia coccinea	tar-vine								8
	Boerhavia dominii	tar-vine	+	2		4		6	7	8
	Boerhavia schomburgkiana	Schomburgk's tar-vine								8
	Boerhavia sp.	tar-vine								8
	Commicarpus australis	pink gum-fruit			3					8
AIZOACEAE										
	Aizoaceae sp.	pigface family								8
	Disphyma crassifolium ssp. *clavellatum*	round-leaf pigface								8
	Glinus lotoides	hairy carpet-weed				4				8
	Gunniopsis papillata	twin-leaved pigface								8
	Gunniopsis quadrifida	Sturt's pigface	1	2	3	4	5			8
	Gunniopsis sp.	pigface				4				8
	Mollugo cerviana	wire-stem chickweed								8
	* *Psilocaulon tenue*	match-head plant								8
	Sarcozona praecox	sarcozona								8
	Tetragonia eremaea	desert spinach	1	2	3	4		6	7	8
	Tetragonia eremaea/tetragonoides	native spinach								8
	Tetragonia tetragonioides	Warragul cabbage								8
	Trianthema triquetra	red spinach	1	2					7	8
PORTULACACEAE										
	Calandrinia eremaea	small purslane	1	2					7	8
	Calandrinia ptychosperma	creeping parakeelya								8
	Calandrinia sp.	purslane/parakeelya				4				8
	Portulaca oleracea	common pigweed	1	2		4			7	8
CARYOPHYLLACEAE										
	Caryophyllaceae sp.	pink family								8
	* *Gypsophila tubulosa*	annual chalkwort								8
	* *Herniaria cinerea*	rupturewort	1	2						8

Family	Scientific Name	Common Name	Source							
	* *Minuartia mediterranea*	slender sandwort								8
	* *Polycarpon tetraphyllum*	allseed		2						8
	* *Sagina apetala*	annual pearlwort								8
	Scleranthus pungens	prickly knawel		2	3					8
	* *Silene apetala*	sand catchfly								8
	* *Silene nocturna*	Mediterranean catchfly		2						8
	* *Spergularia diandra*	lesser sand-spurrey	1	2						8
	* *Spergularia marina*	salt sand-spurrey								8
	* *Spergularia rubra*	red-spurrey								8
	* *Spergularia* sp.	sand-spurrey				4				8
CHENOPODACEAE										
	Atriplex acutibractea ssp. *acutibractea*	pointed saltbush	1	2	3					8
	Atriplex angulata	fan saltbush	1	2		4			7	8
	Atriplex eardleyae	small saltbush		2				6	7	8
	Atriplex eichleri	Eichler's saltbush				4				8
	Atriplex holocarpa	pop saltbush	1	2						8
	Atriplex intermedia		1							8
	Atriplex limbata	spreading saltbush	1	2		4		6		8
	Atriplex lindleyi ssp.	baldoo			3	4		6		8
	Atriplex lindleyi ssp. *conduplicata*	baldoo		2						8
	Atriplex lindleyi ssp. *inflata*	corky saltbush		2		4			7	8
	Atriplex lindleyi ssp. *lindleyi*	baldoo	1							8
	Atriplex lindleyi ssp. *quadripartita*	baldoo								8
	Atriplex nummularia ssp. *nummularia*	old-man saltbush	1	2			5			8
	Atriplex pseudocampanulata	mealy saltbush	1							8
	Atriplex semibaccata	berry saltbush	1							8
	Atriplex sp.	saltbush	1		3	4				8
	Atriplex spongiosa	pop saltbush	1		3	4	5	6	7	8
	Atriplex stipitata	bitter saltbush	1	2				6	7	8
	Atriplex velutinella	sandhill saltbush	1	2				6		8
	Atriplex vesicaria ssp.	bladder saltbush	1	2	3	4	5	6	7	8
	Atriplex vesicaria ssp. *calcicola*	bladder saltbush	1							8
	Atriplex vesicaria ssp. *macrocystidia*	bladder saltbush								8
	Chenopodiaceae sp.	goosefoot family	1							8
	Chenopodium auricomum	golden goosefoot	1				5			8
	Chenopodium cristatum	crested goosefoot	+	2				6	7	8
	Chenopodium curvispicatum	cottony goosefoot		2						8
	Chenopodium desertorum ssp.	desert goosefoot				4				8
	Chenopodium desertorum ssp. *anidiophyllum*	mallee goosefoot		2						8
	Chenopodium desertorum ssp. *desertorum*	desert goosefoot	+	2	3					8
	Chenopodium desertorum ssp. *rectum*	erect goosefoot								8
	Chenopodium melanocarpum forma melanocarpum	black crumbweed		2						8
	* *Chenopodium murale*	nettle-leaf goosefoot	+	2	3					8
	Chenopodium nitrariaceum	nitre goosefoot	1	2						8
	Chenopodium pumilio	small crumbweed		2	3				7	8
	Chenopodium sp.	goosefoot								8
	Dissocarpus biflorus var. *biflorus*	twin-horned copperburr	1	2	3	4				8
	Dissocarpus paradoxus	ball bindyi	1	2	3			6	7	8
	Dysphania glomulifera ssp.	globular crumbweed								8
	Dysphania glomulifera ssp. *eremaea*	globular pigweed								8
	Dysphania glomulifera ssp. *glomulifera*	globular crumbweed								8
	Dysphania plantaginella	plantain crumbweed								8
	Dysphania platycarpa	flat-fruit crumbweed								8
	Dysphania simulans	erect crumbweed								8
	Dysphania sp.	pigweed								8
	Einadia nutans ssp.	climbing saltbush	1	2		4				8
	Einadia nutans ssp. *nutans*	climbing saltbush	1		3					8
	Einadia nutans ssp. *oxycarpa*	pointed-fruit climbing saltbush								8
	Enchylaena tomentosa var. *tomentosa*	ruby saltbush	1	2		4	5		7	8
	Eriochiton sclerolaenoides	woolly-fruit bluebush	1	2	3			6	7	8
	Halosarcia halocnemoides ssp. *halocnemoides*	grey glasswort			3					8
	Halosarcia halocnemoides ssp. *longispicata*	grey glasswort	1							8
	Halosarcia indica ssp.	brown-head samphire	1							8
	Halosarcia indica ssp. *bidens*	brown-head samphire								8
	Halosarcia indica ssp. *leiostachya*	brown-head samphire	1							8
	Halosarcia nitida	shining glasswort								8
	Halosarcia nitida	shining samphire								8
	Halosarcia pergranulata ssp.	black-seed samphire	1							8
	Halosarcia pergranulata ssp. *divaricata*	black-seed samphire			3					8
	Halosarcia pergranulata ssp. *pergranulata*	black-seed samphire								8
	Halosarcia pterygosperma ssp.*pterygosperma*	green samphire							7	8
	Halosarcia sp.	samphire	1				5			8

Family	Scientific Name	Common Name	Source							
	Maireana aphylla	cotton-bush	1	2	3	4	5		7	8
	Maireana appressa	grey bluebush	1	2		4		6		8
	Maireana astrotricha	grey bluebush	1	2	3	4			7	8
	Maireana brevifolia	short-leaf bluebush	1	2					7	8
	Maireana campanulata	bell-fruit bluebush				4				8
	Maireana carnosa	cottony bluebush								8
	Maireana ciliata	hairy bluebush	1		3				7	8
	Maireana coronata	crown fissure-weed								8
	Maireana eriantha	woolly bluebush	1							8
	Maireana erioclada	rosy bluebush		2					7	8
	Maireana excavata	bottle bluebush	1						7	8
	Maireana georgei	slit-wing bluebush	1		3			6	7	8
	Maireana georgei/turbinata	satiny bluebush								8
	Maireana integra	entire-wing bluebush	1	2	3					8
	Maireana lobiflora	lobed bluebush	1		3				7	8
	Maireana microcarpa	swamp bluebush								8
	Maireana oppositifolia	salt bluebush								8
	Maireana pentagona	hairy bluebush	1							8
	Maireana pentatropis	erect bluebush	1		3					8
	Maireana pyramidata	black bluebush	1	2	3	4	5	6	7	8
	Maireana sedifolia	bluebush	1	2	3	4	5	6	7	8
	Maireana sp.	bluebush/fissure-plant	1							8
	Maireana spongiocarpa	spongy-fruit bluebush			3					8
	Maireana tomentosa ssp.*urceolata*		1							8
	Maireana trichoptera	mallee bluebush		2					7	8
	Maireana triptera	three-wing bluebush		2						8
	Maireana turbinata	top-fruit bluebush	1	2	3					8
	Malacocera albolanata	woolly soft-horns	+							8
	Malacocera biflora		1							8
	Malacocera gracilis **KN**	slender soft-horns	1							8
	Malacocera sp.	woolly saltbush	1							8
	Malacocera tricornis	goat-head soft-horns	1							8
	Osteocarpum acropterum var.	bonefruit	1			4				8
	Osteocarpum acropterum var. *acropterum*	water weed	1		3				7	8
	Osteocarpum acropterum var. *deminutum*	wingless bonefruit		2						8
	Osteocarpum dipterocarpum	two-wing bonefruit			3	4				8
	Rhagodia parabolica	mealy saltbush	1	2	3					8
	Rhagodia sp.	saltbush								8
	Rhagodia spinescens	spiny saltbush	1	2	3	4		6	7	8
	Rhagodia ulicina	spiny saltbush		2	3					8
	Salsola kali	roly-poly	1	2		4		6	7	8
	Scleroblitum atriplicinum	purple goosefoot								8
	Sclerolaena bicornis	goathead burr	1	2					7	8
	Sclerolaena brachyptera	short-wing bindyi	1			4			7	8
	Sclerolaena convexula	tall bindyi		2						8
	Sclerolaena cuneata	poverty-bush	1	2						8
	Sclerolaena decurrens	green copperburr	1	2	3	4				8
	Sclerolaena diacantha	grey bindyi	1		3				7	8
	Sclerolaena diacantha/uniflora	grey bindyi		2						8
	Sclerolaena divaricata	poverty-bush	1	2	3	4			7	8
	Sclerolaena eriacantha	silky copperburr	1			4				8
	Sclerolaena holtiana		1							8
	Sclerolaena intricata	tangled poverty-bush	1	2		4				8
	Sclerolaena lanicuspis	woolly bindyi	1	2	3	4			7	8
	Sclerolaena limbata	pearl copperburr	1		3				7	8
	Sclerolaena longicuspis	long-spine poverty-bush	1		3				7	8
	Sclerolaena obliquicuspis	limestone copperburr	1	2	3			6		8
	Sclerolaena parviflora	small-flower bindyi		2						8
	Sclerolaena patenticuspis	spear-fruit bindyi	1	2	3	4		6	7	8
	Sclerolaena sp.	bindyi	1				5			8
	Sclerolaena tatei	Tate's bindyi								8
	Sclerolaena uniflora	small-spine bindyi	1					6		8
	Sclerolaena ventricosa	salt bindyi	1	2	3	4			7	8
	Sclerostegia medullosa	glasswort	1							8
	Sclerostegia sp.	samphire								8
	Sclerostegia tenuis	slender glasswort	1	2	3	4	5		7	8
AMARANTHACEAE										
	Alternanthera denticulata	lesser joyweed								8
	Alternanthera nodiflora	common joyweed								8
	Alternanthera sp.	joyweed				4				8
	Amaranthus grandiflorus	large-flower amaranth								8
	Amaranthus mitchellii	Boggabri weed								8
	Ptilotus exaltatus var. *exaltatus*	tall mulla mulla		2	3					8
	Ptilotus gaudichaudii var. *parviflorus*	paper foxtail		2						8
	Ptilotus helipteroides var. *helipteroides*	hairy mulla mulla								8
	Ptilotus nobilis var. *nobilis*	regal fox-tail			3				7	8

Family	Scientific Name	Common Name	Source							
	Ptilotus obovatus var.		1						7	8
	Ptilotus obovatus var. *obovatus*	mulla mulla	1	2	3					8
	Ptilotus polystachyus var. *polystachyus*	long-tails		2					7	8
	Ptilotus sp.	mulla mulla	1							8
CACTACEAE										
	* *Opuntia vulgaris*	drooping prickly pear								8
RANUNCULACEAE										
	Clematis microphylla	old man's beard			3					8
	* *Myosurus minimus* var. *australis*	mousetail				4				8
	Ranunculus hamatosetosus	hill buttercup								8
	Ranunculus pentandrus var. *platycarpus*	inland buttercup				4				8
	Ranunculus pumilio var.	ferny buttercup		2						8
	Ranunculus pumilio var. *politus*	small-flower buttercup								8
	Ranunculus pumilio var. *pumilio*	ferny buttercup								8
GUTTIFERAE										
	Hypericum gramineum	small St John's wort								8
PAPAVERACEAE										
	* *Argemone subfusiformis* ssp. *subfusiformis*	Mexican poppy		2		4				8
	* *Glaucium corniculatum* var. *corniculatum*	bristly horned-poppy		2						8
	* *Papaver hybridum*	rough poppy								8
CAPPARACEAE										
	Capparis mitchellii	native orange			3					8
CRUCIFERAE										
	* *Alyssum linifolium*	flax-leaf alyssum	1	2		4				8
	Arabidella filifolia	thread-leaf cress								8
	Arabidella nasturtium	yellow cress	1			4				8
	Arabidella procumbens	creeping cress				4				8
	Arabidella trisecta	shrubby cress	1	2	3	4			7	8
	Blennodia canescens	native stock								8
	Blennodia pterosperma	wild stock	1		3					8
	* *Brassica tournefortii*	long-fruit wild turnip	1	2	3	4				8
	* *Capsella bursapastoris*	shepherd's purse								8
	* *Carrichtera annua*	Ward's weed	1	2	3	4				8
	Cruciferae sp.	cress family								8
	* *Diplotaxis muralis* var. *muralis*	wall rocket								8
	* *Diplotaxis tenuifolia*	Lincoln weed	+	2					7	8
	Geococcus pusillus	earth cress	1			4		6	7	8
	Harmsiodoxa blennodioides	hairypod cress	1	2		4			7	8
	Harmsiodoxa brevipes var. *brevipes*	short cress	1							8
	Harmsiodoxa sp.	native cress								8
	Harmsiodoxa puberula		+							8
	* *Hymenolobus procumbens*	oval purse								8
	* *Lepidium africanum*	common peppercress		2						8
	Lepidium fasciculatum	bundled peppercress	1	2						8
	Lepidium muelleri-ferdinandi	Mueller's peppercress								8
	Lepidium oxytrichum	green peppercress	1	2	3	4				8
	Lepidium papillosum	warty peppercress	1		3	4				8
	Lepidium phlebopetalum	veined peppercress	1	2						8
	Lepidium rotundum	veined peppercress	1		3	4				8
	Lepidium sagittulatum	fine-leaf peppercress		2						8
	Lepidium sp.	peppercress	1							8
	Menkea australis	fairy spectacles								8
	Menkea crassa	fat spectacles								8
	Pachymitus cardaminoides	sand cress								8
	Phlegmatospermum cochlearinum	downy cress	1	2	3	4				8
	* *Sisymbrium erysimoides*	smooth mustard	1	2	3	4				8
	* *Sisymbrium irio*	London rocket			3					8
	* *Sisymbrium orientale*	wild mustard		2		4				8
	* *Sisymbrium* sp.	wild mustard								8
	Stenopetalum lineare	narrow thread-petal	1	2	3	4			7	8
RESEDACEAE										
	* *Reseda luteola*	wild mignonette		2					7	8
CRASSULACEAE										
	Crassula colorata var.	dense stonecrop	1			4			7	8
	Crassula colorata var. *acuminata*	dense stonecrop								8
	Crassula colorata var. *colorata*	dense stonecrop		2						8
	Crassula colorata/sieberana	crassula								8
	Crassula sieberiana ssp. *tetramera*	Australian stonecrop	1	2					7	8
	Crassula sp.	crassula/stonecrop	1							8
PITTOSPORACEAE										
	Bursaria spinosa	sweet bursaria			3					8
	Pittosporum phylliraeoides var. *microcarpa*	native apricot	1	2	3				7	8
ROSACEAE										
	* *Malus sylvestris*	wild crab apple								8
LEGUMINOSAE										
	Acacia aneura	mulga		2	3	4	5	6	7	8

Family	Scientific Name	Common Name	Source							
	Acacia aneura var. *aneura*	mulga	1							8
	Acacia aneura complex	mulga								8
	Acacia argyrophylla	silver mulga-bush		2						8
	Acacia ayersiana var. *latifolia*	broad-leaf mulga	1		3					8
	Acacia barattensis	Baratta wattle								8
	Acacia beckleri	Barrier Range wattle	1	2						8
	Acacia burkittii	sandhill wattle	1	2		4		6	7	8
	Acacia calamifolia	wallowa	1	2		4				8
	Acacia carnei	purple-wood wattle	1	2		4			7	8
	Acacia cibaria	umbrella mulga					5			8
	Acacia colletioides	wait-a-while		2						8
	Acacia continua	thorn wattle		2	3					8
	Acacia farnesiana	sweet acacia								8
	Acacia hakeoides	hakea wattle								8
	Acacia havilandii	needle wattle			3					8
	Acacia ligulata	umbrella bush	1	2	3		5		7	8
	Acacia loderi	eastern myall		2						8
	Acacia murrayana	sandplain wattle								8
	Acacia nyssophylla	spine bush	1	2						8
	Acacia oswaldii	umbrella wattle	1	2	3				7	8
	Acacia paradoxa	kangaroo thorn								8
	Acacia paradoxa hybrid	kangaroo thorn hybrid								8
	Acacia pravifolia	coil-pod wattle								8
	Acacia pycnantha	golden wattle								8
	Acacia salicina	willow wattle	1	2	3				7	8
	Acacia tetragonophylla	dead finish	1	2	3	4				8
	Acacia victoriae ssp. *victoriae*	elegant wattle	1	2		4			7	8
	Acacia wilhelmiana	dwarf nealie								8
	* *Astragalus hamosus*	milk-vetch								8
	* *Astragalus sesameus*	purple milk-vetch		2						8
	Cassia sturtii	grey cassia								8
	Crotalaria eremaea ssp. *eremaea*	bluebush pea	+			4				8
	Daviesia genistifolia **URN**	broom bitter-pea			3					8
	Daviesia stricta	Flinders Ranges bitter-pea								8
	Glycine canescens	silky glycine	1							8
	Glycine clandestina var.		1	2	3					8
	Glycyrrhiza acanthocarpa	native liquorice	1							8
	Goodia lotifolia var. *lotifolia*	golden-tip								8
	Hardenbergia violacea	native lilac								8
	Indigofera australis var. *australis*	austral indigo		2	3	4				8
	Indigofera helmsii		1							8
	Lotus australis	Australian trefoil	1					6		8
	Lotus cruentus	red-flower lotus	1	2	3	4			7	8
	* *Medicago minima* var. *minima*	woolly burr-medic	1	2						8
	* *Medicago polymorpha* var. *polymorpha*	burr-medic	1	2	3	4			7	8
	* *Medicago* sp.	medic								8
	Petalostylis labicheoides		+		3	4				8
	* *Prosopis juliflora*	mesquite		2						8
	Psoralea australasica	tall scurf-pea				4			7	8
	Psoralea cinerea	hoary scurf-pea	+	2						8
	Psoralea parva	small scurf-pea								8
	Psoralea sp.	scurf-pea								8
	Rhynchosia minima	rhynchosia								8
	Senna artemisioides nothossp. *artemisioides*	silver senna	1	2	3				7	8
	Senna artemisioides nothossp. *coriacea*	broad-leaf desert senna	1	2	3				7	8
	Senna artemisioides nothossp. *sturtii*	grey senna	1	2	3	4		6	7	8
	Senna artemisioides ssp.	desert senna								8
	Senna artemisioides ssp. *alicia*	desert senna								8
	Senna artemisioides ssp. *filifolia*	fine-leaf desert senna	1							8
	Senna artemisioides ssp. *helmsii*	blunt-leaf senna	1							8
	Senna artemisioides ssp. *oligophylla*	limestone senna			3					8
	Senna artemisioides ssp. *petiolaris*	flat-stalk senna	1	2	3			6	7	8
	Senna artemisioides ssp. *quadrifolia*	four-leaf desert senna	1							8
	Senna artemisioides ssp. *zygophylla*	twin-leaf desert senna		2	3					8
	Senna cardiosperma ssp. *gawlerensis*	Gawler Ranges senna								8
	Swainsona adenophylla		+			4				8
	Swainsona fissimontana	Broken Hill pea		2						8
	Swainsona flavicarinata	yellow-keel swainson-pea								8
	Swainsona formosa	Sturt's desert-pea		2	3				7	8
	Swainsona murrayana ssp. **KN**	Murray swainson-pea		2						8
	Swainsona murrayana ssp. *eciliata*	Murray swainson-pea								8
	Swainsona murrayana ssp. *murrayana*	slender Darling pea								8
	Swainsona oliveri									8
	Swainsona phacoides ssp. *phacoides*	dwarf swainsona		2	3				7	8
	Swainsona procumbens	Broughton pea								8
	Swainsona pyrophila	yellow Darling pea								8

Family	Scientific Name	Common Name	Source							
	Swainsona sp.	swainson-pea	1		3					8
	Swainsona stipularis	orange Darling pea	1	2						8
	Swainsona swainsonioides	downy Darling pea		2		4				8
	Swainsona tephrotricha	ashy-haired swainsona			3					8
	Swainsona viridis **QN**	creeping Darling pea		2						8
	Templetonia aculeata	spiny mallee-pea								8
	Templetonia egena	desert broombush		2				6	7	8
	Tephrosia sphaerospora	mulga trefoil	1							8
	Trigonella suavissima	channel clover		2		4			7	8
	* *Vicia monantha*	spurred vetch	1	2						8
	* *Vicia sativa* ssp. *nigra*	narrow-leaf vetch								8
	* *Vicia* sp.	vetch								8
OXALIDACEAE										
	Oxalis perennans	native sorrel	1	2					7	8
	Oxalis sp.	native sorrel	1							8
GERANIACEAE										
	* *Erodium aurium*		1	2	3					8
	* *Erodium cicutarium*	common stork's-bill	1	2		4		6		8
	Erodium crinitum	blue stork's-bill	1	2		4			7	8
	Erodium crinitum/cygnorum	blue heron's-bill						6		8
	Erodium cygnorum ssp. *cygnorum*	blue heron's-bill	1			4		6		8
	Erodium cygnorum ssp. *glandulosum*	clammy heron's-bill	1	2					7	8
	Erodium sp.	stork's-bill	1		3					8
	Geranium solanderi var. *solanderi*	native geranium								8
ZYGOPHYLLACEAE										
	Nitraria billardierei	nitre-bush	1	2	3		5		7	8
	* *Peganum harmala*	African rue	+						7	8
	Tribulus eichlerianus	bull-head								8
	* *Tribulus terrestris*	caltrop		2		4		6		8
	Zygophyllum ammophilum	sand twinleaf	1	2		4		6	7	8
	Zygophyllum angustifolium	scrambling twinleaf								8
	Zygophyllum apiculatum	pointed twinleaf		2	3					8
	Zygophyllum aurantiacum	shrubby twinleaf	1		3				7	8
	Zygophyllum aurantiacum/eremaeum	shrubby twin-leaf		2						8
	Zygophyllum billardierei	scrambling twinleaf			3				7	8
	Zygophyllum compressum	rabbit-ears twinleaf								8
	Zygophyllum confluens	forked twinleaf								8
	Zygophyllum crenatum	notched twinleaf	1	2					7	8
	Zygophyllum eremaeum	climbing twinleaf								8
	Zygophyllum howittii	clasping twinleaf	1							8
	Zygophyllum humillimum **KN**	small-fruit twinleaf								8
	Zygophyllum iodocarpum	violet twinleaf	1	2				6	7	8
	Zygophyllum ovatum	dwarf twinleaf		2	3			6	7	8
	Zygophyllum prismatothecum	square-fruit twinleaf	1	2	3			6	7	8
	Zygophyllum sp.	twinleaf	1							8
LINACEAE										
	Linum marginale	wild flax			3					8
EUPHORBIACEAE										
	Adriana klotzschii	coast bitter-bush								8
	Beyeria lechenaultii	pale turpentine bush		2	3					8
	Euphorbia australis	caustic weed		2						8
	Euphorbia drummondii	caustic weed	1	2		4		6	7	8
	Euphorbia parvicaruncula	rough-seeded spurge								8
	Euphorbia sp.	spurge	1							8
	Euphorbia stevenii	bottletree caustic								8
	Euphorbia tannensis ssp. *eremophila*	bottle tree caustic	1	2					7	8
	Euphorbia wheeleri	Wheeler's spurge								8
	Euphorbiaceae sp.	spurge family								8
	Phyllanthus lacunarius	lagoon spurge	1		3	4				8
	Phyllanthus saxosus **UN**	rock spurge								8
	* *Ricinus communis*	castor oil plant	+	2	3	4				8
	Sauropus ramosissimus **KN**									8
	Sauropus rigens	stiff spurge							7	8
	Sauropus trachyspermus	slender spurge	+							8
RUTACEAE										
	Correa glabra	smooth correa								8
	Eriostemon linearis	narrow-leaf wax-flower		2					7	8
	Geijera parviflora	wilga		2						8
ANACARDIACEAE										
	* *Schinus areira*	pepper-tree		2						8
SAPINDACEAE										
	Alectryon oleifolius ssp. *canescens*	bullock bush	1	2	3	4	5	6	7	8
	Atalaya hemiglauca	whitewood					5			8
	Dodonaea baueri	crinkled hop-bush		2	3					8
	Dodonaea lobulata	lobed hop-bush	1	2	3				7	8

Family	Scientific Name	Common Name	Source					
	Dodonaea microzyga var. *microzyga*	brilliant hop-bush	1	2	3	4	7	8
	Dodonaea sp.	hop-bush						8
	Dodonaea stenozyga	desert hop-bush	1					8
	Dodonaea viscosa ssp.	sticky hop-bush						8
	Dodonaea viscosa ssp. *angustissima*	narrow-leaf hop-bush	1	2		4	7	8
	Dodonaea viscosa ssp. *spatulata*	sticky hop-bush						8
STACKHOUSIACEAE								
	Stackhousia muricata	western stackhousia						8
	Stackhousia muricata ssp. *"Perennial"(W.R.Barker 3641)*	yellow candles						8
	Stackhousia muricata ssp. *"Perennial"(W.R.Barker 3641)*	western candles						8
RHAMNACEAE								
	Cryptandra amara var. *longiflora*	long-flower cryptandra						8
	Spyridium phlebophyllum	inland spyridium		2	3			8
MALVACEAE								
	Abutilon fraseri	dwarf lantern-bush	1	2			7	8
	Abutilon halophilum	plains lantern-bush	1	2				8
	Abutilon leucopetalum	desert Chinese-lantern	1	2	3			8
	Abutilon malvaefolium	scrambling lantern-bush						8
	Abutilon otocarpum	desert Chinese-lantern	1	2	3			8
	Abutilon sp.	lantern-bush			3	4		8
	Gossypium sturtianum var. *sturtianum*	Sturt's desert rose			3			8
	Hibiscus krichauffianus	velvet-leaf hibiscus	1					8
	Hibiscus sp.		1					8
	Hibiscus sturtii var. *grandiflorus*	hill hibiscus	1		3			8
	Lavatera plebeia	native hollyhock		2	3		7	8
	Lawrencia glomerata	clustered lawrencia	1	2	3			8
	Lawrencia squamata	thorny lawrencia		2				8
	* *Malva parviflora*	marshmallow	1	2	3	4		8
	Malvastrum americanum	malvastrum	1	2	3		7	8
	Sida ammophila	sand sida	1		3			8
	Sida corrugata var.	corrugated sida	1	2	3		7	8
	Sida corrugata var.*A*	corrugated sida	1	2				8
	Sida corrugata var. *angustifolia*	corrugated sida				4		8
	Sida fibulifera	silver sida	1	2			7	8
	Sida intricata	twiggy sida	1	2			7	8
	Sida petrophila	rock sida	1	2			7	8
	Sida phaeotricha	hill sida						8
	Sida sp.	sida	1					8
	Sida trichopoda	narrow-leaf sida	1	2				8
STERCULIACEAE								
	Gilesia biniflora	western tar-vine						8
	Lasiopetalum behrii	pink velvet-bush						8
	Melhania oblongifolia	velvet hibiscus						8
THYMELAEACEAE								
	Pimelea micrantha	curved riceflower						8
	Pimelea microcephala ssp. *microcephala*	mallee riceflower	1	2	3	4		8
	Pimelea petrophila	rock riceflower						8
	Pimelea simplex ssp.	desert riceflower	1	2	3	4		8
	Pimelea simplex ssp. *continua*	desert riceflower						8
	Pimelea simplex ssp. *simplex*	desert riceflower	1					8
	Pimelea stricta	erect riceflower						8
	Pimelea trichostachya	spiked riceflower			3			8
VIOLACEAE								
	Hybanthus monopetalus	slender violet-bush						8
TAMARICACEAE								
	* *Tamarix aphylla*	Athel pine	1	2				8
FRANKENIACEAE								
	Frankenia crispa	hoary sea-heath	1					8
	Frankenia cupularis							8
	Frankenia serpyllifolia	bristly sea-heath	1	2	3	4		8
	Frankenia sp.	sea-heath			3	4		8
ELATINACEAE								
	Bergia trimera	three-part water-fire						8
CUCURBITACEAE								
	* *Citrullus lanatus*	bitter melon					7	8
	* *Cucumis myriocarpus*	paddy melon	1	2		4	7	8
	Cucurbitaceae sp.	melon family						8
LYTHRACEAE								
	Lythrum wilsonii	Wilson's loosestrife						8
MYRTACEAE								
	Baeckea crassifolia	desert baeckea						8
	Callistemon teretifolius	needle bottlebrush			3			8
	Calytrix tetragona	common fringe-myrtle			3			8
	Eucalyptus aff. viridis	green mallee						8

Family	Scientific Name	Common Name	Source							
	Eucalyptus camaldulensis var.	river red gum	1	2	3	4	5		7	8
	Eucalyptus camaldulensis var. *camaldulensis*	river red gum								8
	Eucalyptus camaldulensis var. *obtusa*	northern river red gum								8
	Eucalyptus coolabah ssp. *arida*	coolibah								8
	Eucalyptus dumosa	white mallee		2	3					8
	Eucalyptus dumosa complex	white mallee								8
	Eucalyptus flindersii	Flinders grey mallee		2	3					8
	Eucalyptus gillii	curly mallee	1	2	3		5			8
	Eucalyptus gracilis	yorrell	1	2						8
	Eucalyptus intertexta	gum-barked coolibah	1	2	3					8
	Eucalyptus largiflorens	river box	1	2						8
	Eucalyptus leptophylla	narrow-leaf red mallee								8
	Eucalyptus microtheca	coolibah								8
	Eucalyptus oleosa	red mallee		2					7	8
	Eucalyptus porosa	mallee box		2	3					8
	Eucalyptus sideroxylon ssp. *sideroxylon*	red ironbark								8
	Eucalyptus socialis	red mallee	1	2	3		5			8
	Melaleuca glomerata	desert paper-bark	1		3		5			8
	Melaleuca lanceolata	dryland tea-tree	+	2	3				7	8
	Myrtaceae sp.	myrtle family								8
HALORAGACEAE										
	Gonocarpus elatus	hill raspwort			3					8
	Gonocarpus sp.	raspwort								8
	Gonocarpus tetragynus	small-leaf raspwort								8
	Haloragaceae sp.	raspwort			3					8
	Haloragis aspera	rough raspwort	+	2		4				8
	Haloragis sp.	raspwort	1							8
	Myriophyllum verrucosum	red water-milfoil		2						8
UMBELLIFERAE										
	Apium prostratum ssp. *prostratum*	native celery								8
	* *Conium maculatum*	hemlock		2						8
	Daucus glochidiatus	native carrot	1	2	3	4			7	8
	Hydrocotyle callicarpa	tiny pennywort								8
	Hydrocotyle sp.	pennywort								8
	Hydrocotyle trachycarpa	wild parsley								8
	Trachymene glaucifolia	wild parsnip			3					8
	Umbelliferae sp.	celery family								8
EPACRIDACEAE										
	Astroloma humifusum	native cranberry			3					8
PRIMULACEAE										
	* *Anagallis arvensis*	blue/scarlet pimpernel	1	2	3					8
	* *Anagallis minima*	chaffweed								8
	Samolus repens	creeping brookweed								8
LIMONIACEAE										
	* *Limonium lobatum*	winged sea-lavender	1	2						8
OLEACEAE										
	Jasminum didymum ssp. *lineare*	native jasmine		2	3					8
LOGANIACEAE										
	Logania nuda	leafless logania								8
GENTIANACEAE										
	* *Centaurium spicatum*	spike centaury		2						8
ASCLEPIADACEAE										
	Marsdenia australis	native pear	1	2	3				7	8
	Sarcostemma viminale ssp. *australe*	caustic bush		2	3				7	8
RUBIACEAE										
	Asperula conferta	common woodruff								8
	Asperula sp.	woodruff	1							8
	Galium gaudichaudii	rough bedstraw			3					8
	Galium migrans	loose bedstraw		2						8
	* *Galium murale*	bedstraw	1							8
	Galium sp.	bedstraw								8
	* *Galium spurium* ssp. *ibicinum*	bedstraw								8
	* *Galium tricornutum*	three-horned bedstraw								8
	Pomax umbellata	pomax			3					8
CONVOLVULACEAE										
	Convolvulaceae sp.	bindweed family								8
	Convolvulus erubescens	Australian bindweed	1	2	3	4		6	7	8
	Convolvulus erubescens/remotus	native bindweed								8
	Convolvulus eyreanus	native bindweed								8
	Convolvulus microsepalus	small-flower bindweed								8
	Convolvulus remotus	grassy bindweed	1	2						8
	Cressa cretica	rosinweed								8
	Evolvulus alsinoides var. *decumbens*	tropical speedwell								8
BORAGINACEAE										
	* *Anchusa arvensis* ssp. *arvensis*	bugloss								8
	Boraginaceae sp.	borage family								8

Family	Scientific Name	Common Name	Source						
	** Buglossoides arvensis*	sheepweed		2					8
	** Echium plantagineum*	Salvation Jane	1	2	3	4		7	8
	** Echium vulgare*	viper's bugloss							8
	Embadium uncinatum	Gawler Ranges slipper-plant							8
	Halgania cyanea	rough halgania		2	3				8
	** Heliotropium curassavicum*	smooth heliotrope							8
	** Heliotropium europaeum*	potato weed	1	2		4	6	7	8
	Heliotropium sp.	heliotrope							8
	** Heliotropium supinum*	prostrate heliotrope				4			8
	Omphalolappula concava	burr stickseed	1	2	3	4	6	7	8
	Plagiobothrys plurisepaleus	white forget-me-not	1			4	6	7	8
	Trichodesma zeylanicum	camel bush	+		3				8
VERBENACEAE									
	** Verbena officinalis*	common verbena				4			8
	** Verbena supina*	trailing verbena			3			7	8
LABIATAE									
	Ajuga australis form A	austral bugle		2	3				8
	Labiatae sp.	mint family							8
	** Marrubium vulgare*	horehound	1	2	3				8
	Plectranthus intraterraneus	purple mintbush			3				8
	Prostanthera striatiflora	striated mintbush	1	2	3			7	8
	** Salvia reflexa*	mintweed							8
	** Salvia verbenaca form*	wild sage	1	2					8
	** Salvia verbenaca form A*	wild sage	1						8
	** Salvia verbenaca form B*	wild sage	1						8
	Teucrium albicaule	scurfy germander							8
	Teucrium racemosum	grey germander	1	2		4		7	8
	Teucrium sessiliflorum	camel bush							8
	Westringia rigida	stiff westringia	1	2	3				8
SOLANACEAE									
	** Datura ferox*	fierce thorn-apple							8
	** Datura inoxia*	downy thorn-apple							8
	** Datura leichhardtii*	native thorn-apple	+	2	3				8
	** Datura* sp.	thorn-apple							8
	** Datura stramonium*	common thorn-apple							8
	Duboisia hopwoodii	pituri		2					8
	Lycium australe	Australian boxthorn	1	2			6	7	8
	** Lycium ferocissimum*	African boxthorn	1	2					8
	** Nicotiana glauca*	tobacco bush	1	2	3	4		7	8
	Nicotiana goodspeedii	small-flower tobacco	1	2				7	8
	Nicotiana simulans	native tobacco			3				8
	Nicotiana sp.	tobacco			3				8
	Nicotiana velutina	velvet tobacco	1	2					8
	Solanum chenopodinum	goosefoot potato-bush	1						8
	Solanum coactiliferum	tomato-bush							8
	Solanum ellipticum	potato-bush	1	2	3			7	8
	Solanum esuriale	quena	1	2					8
	Solanum ferocissimum	spiny potato-bush							8
	** Solanum nigrum*	black nightshade	1	2	3	4		7	8
	Solanum petrophilum	rock nightshade	1	2	3	4			8
	Solanum quadriloculatum	tomato bush	1						8
	** Solanum retroflexum*		1						8
	Solanum sp.	nightshade/potato-bush			3				8
	Solanum sturtianum	Sturt's nightshade	1	2	3	4		7	8
SCROPHULARIACEAE									
	Derwentia decorosa	rock speedwell							8
	Glossostigma cleistanthum	spoon mud-mat							8
	Glossostigma diandrum	two-anther mud-mat							8
	Glossostigma sp.	mud-mat							8
	Limosella curdieana	large mudwort		2		4			8
	Limosella curdieana var. *"curdieana"*	large mudwort							8
	Limosella curdieana var. *"Long-pedicelled"(W.R.Barker 3577)*	large mudwort							8
	Peplidium foecundum	dwarf peplidium							8
	Stemodia florulenta	bluerod	1						8
ACANTHACEAE									
	Rostelluaria adscendens ssp. *adscendens*	pink tongues	1		3				8
OROBANCHACEAE									
	Orobanche cernua var. *australiana*	Australian broomrape		2					8
MYOPORACEAE									
	Eremophila alternifolia	narrow-leaf fuchsia-bush	1	2	3			7	8
	Eremophila deserti	turkey-bush	1	2		4			8
	Eremophila duttonii	harlequin fuchsia-bush	1	2	3	4		7	8
	Eremophila freelingii	rock fuchsia-bush	1	2	3			7	8
	Eremophila glabra ssp. *glabra*	tar bush	1	2	3	4			8
	Eremophila longifolia	weeping emubush	1	2	3	4	6	7	8

Family	Scientific Name	Common Name	Source							
	Eremophila maculata var. *maculata*	spotted emubush		2	3				7	8
	Eremophila oppositifolia var. *oppositifolia*	twin-leaf emubush	1	2	3	4			7	8
	Eremophila scoparia	broom emubush	1	2	3			6	7	8
	Eremophila serrulata	green fuchsia-bush		2	3	4			7	8
	Eremophila sp.	emubush/turkey-bush								8
	Eremophila sturtii	turpentine bush	1	2	3			6	7	8
	Myoporum montanum	native myrtle		2	3	4				8
	Myoporum platycarpum ssp.	false sandalwood	1	2	3		5	6	7	8
	Myoporum platycarpum ssp. *perbellum*	mallee sandalwood								8
	Myoporum platycarpum ssp. *platycarpum*	false sandalwood	1							8
PLANTAGINACEAE										
	** Plantago coronopus* ssp. *coronopus*	bucks-horn plantain								8
	Plantago drummondii	sago weed	1	2						8
	** Plantago scabra*	rough plantain		2						8
	Plantago sp.	plantain			3	4				8
CAMPANULACEAE										
	Isotoma petraea	rock isotome		2	3					8
	Wahlenbergia communis	tufted bluebell	1	2	3					8
	Wahlenbergia gracilenta	annual bluebell	1	2		4			7	8
	Wahlenbergia luteolus	native blubell	1	2					7	8
	Wahlenbergia sp.	native bluebell	1			4				8
	Wahlenbergia stricta ssp. *stricta*	tall bluebell		2	3				7	8
	Wahlenbergia tumidifructa	swollen-fruit bluebell	1	2						8
GOODENIACEAE										
	Goodenia albiflora	white goodenia								8
	Goodenia berardiana	twin-head goodenia								8
	Goodenia calcarata	streaked goodenia								8
	Goodenia cycloptera	serrated goodenia			3					8
	Goodenia fascicularis	silky goodenia	1	2					7	8
	Goodenia havilandii	hill goodenia								8
	Goodenia lunata	stiff goodenia	1							8
	Goodenia pinnatifida	cut-leaf goodenia	1	2		3				8
	Goodenia pusilliflora	small-flower goodenia	1	2		3				8
	Goodenia sp.	goodenia	1							8
	Goodenia vernicosa	wavy goodenia								8
	Goodeniaceae sp.	goodenia family								8
	Scaevola collaris		+		3					8
	Scaevola humilis	inland fanflower								8
	Scaevola parvibarbata	small-beard fanflower	1	2						8
	Scaevola sp.	fanflower								8
	Scaevola spinescens	spiny fanflower	1	2	3	4				8
	Velleia arguta	spur velleia	1	2						8
	Velleia paradoxa	spur velleia			3					8
COMPOSITAE										
	Actinobole uliginosum	flannel cudweed	1	2		4			7	8
	Anemocarpa podolepidium	rock everlasting								8
	Angianthus brachypappus	spreading cup-flower	1			4				8
	Angianthus tomentosus	hairy cup-flower		2						8
	** Aster subulatus*	wild aster		2						8
	Asteridea athrixioides forma athrixioides	wirewort								8
	Brachycome campylocarpa	large white daisy								8
	Brachycome ciliaris var.	variable daisy								8
	Brachycome ciliaris var. *brachyglossa*	rayless variable-daisy		2						8
	Brachycome ciliaris var. *ciliaris*	variable daisy	1	2	3					8
	Brachycome ciliaris var. *lanuginosa*	woolly variable daisy	1	2	3	4				8
	Brachycome debilis	weak daisy								8
	Brachycome dentata	toothed daisy	1		3					8
	Brachycome eriogona **KN**	woolly-seed daisy		2						8
	Brachycome goniocarpa	dwarf daisy								8
	Brachycome iberidifolia	Swan River daisy								8
	Brachycome lineariloba	hard-head daisy	1	2		4			7	8
	Brachycome perpusilla	tiny daisy								8
	Brachycome sp.	native daisy								8
	Bracteantha bracteata	golden everlasting		2	3					8
	** Calendula arvensis*	field marigold	1	2						8
	Calocephalus platycephalus	billybuttons								8
	Calotis cymbacantha	showy burr-daisy	1	2		4			7	8
	Calotis erinacea	tangled burr-daisy	1	2		4				8
	Calotis hispidula	bogan flea	1	2	3	4		6	7	8
	Calotis lappulacea	yellow burr-daisy	1	2						8
	Calotis latiuscula	leafy burr-daisy	1		3					8
	Calotis multicaulis	woolly-headed burr-daisy		2		4				8
	Calotis plumulifera	woolly-headed burr-daisy	1	2						8
	Calotis porphyroglossa	channel burr-daisy								8
	Calotis sp.	burr-daisy								8
	** Carthamus lanatus*	saffron thistle	1	2					7	8

Family	Scientific Name	Common Name	Source						
	Cassinia laevis	curry bush	1	2	3	4		7	8
	* *Centaurea melitensis*	Maltese cockspur	1	2	3	4			8
	Centipeda cunninghamii	common sneezeweed							8
	Centipeda minima	sneezeweed	1						8
	Centipeda thespidioides	desert sneezeweed	1	2		4			8
	Chrysocephalum apiculatum	common everlasting		2					8
	Chrysocephalum pterochaetum	shrub everlasting		2	3				8
	Chrysocephalum semicalvum ssp. *semicalvum*	hill everlasting	1	2	3				8
	Chrysocephalum semipapposum	clustered everlasting		2	3				8
	Chrysocephalum sp.	everlasting							8
	* *Cirsium vulgare*	spear thistle		2	3				8
	Compositae sp.	daisy family	1						8
	* *Conyza bonariensis*	flaxleaf fleabane		2					8
	Craspedia chrysantha	golden billy-buttons							8
	Craspedia glauca	billy-buttons							8
	Craspedia pleiocephala	soft billy-buttons	1	2	3	4		7	8
	Craspedia sp.	billy-buttons							8
	Cratystylis conocephala	bluebush daisy	1	2					8
	* *Cynara cardunculus*	artichoke thistle							8
	* *Dittrichia graveolens*	stinkwort	1					7	8
	Elachanthus glaber	shiny elachanth							8
	Elachanthus pusillus	elachanth	1						8
	Elachanthus sp.	elachanth							8
	Epaltes australis	spreading nut-heads							8
	Eriochlamys behrii	woolly mantle		2					8
	Erodiophyllum elderi	Koonamore daisy	1	2			6	7	8
	Euchiton sphaericus	annual cudweed							8
	Flaveria australasica	yellow twin-stem							8
	* *Gnaphalium polycaulon*	western cudweed							8
	Gnephosis arachnoidea	spidery button-flower	1	2	3				8
	Gnephosis drummondii		1						8
	Gnephosis eriocarpa	native camomile	1		3				8
	Gnephosis tenuissima	dwarf cup-flower	1	2			6		8
	Haeckeria punctulata	sticky haeckeria		2					8
	* *Helianthus annuus*	sunflower		2					8
	Hyalosperma demissum	pygmy sunray	1						8
	Hyalosperma glutinosum ssp. *glutinosum*	golden sunray							8
	Hyalosperma glutinosum/semisterile	sunray							8
	Hyalosperma semisterile	orange sunray	1	2					8
	Hyalosperma sp.	sunray							8
	* *Hypochaeris glabra*	smooth cat's ear	1	2					8
	* *Hypochaeris radicata*	dandelion	1						8
	Isoetopsis graminifolia	grass cushion	1	2				7	8
	Ixiochlamys cuneifolia		1						8
	Ixiochlamys nana	small fuzzweed		2				7	8
	Ixiolaena chloroleuca	pale plover-daisy	1	2					8
	Ixiolaena leptolepis	stalked plover-daisy	1	2	3	4		7	8
	Ixiolaena leptolepis/tomentosa	plover-daisy							8
	Ixiolaena tomentosa	woolly plover-daisy	1	2	3				8
	Kippistia suaedifolia	fleshy minuria							8
	* *Lactuca serriola*	prickly lettuce		2					8
	Lemooria burkittii	wires-and-wool	1	2		4		7	8
	Leptorhynchos baileyi		1	2					8
	Leucochrysum molle	hoary sunray	1			4			8
	Microseris lanceolata	yam daisy							8
	Millotia greevesii ssp. *greevesii*	creeping millotia	1	2					8
	Millotia macrocarpa	large-fruit millotia				4		7	8
	Millotia myosotidifolia	broad-leaf millotia		2				7	8
	Millotia perpusilla	tiny bow-flower		2					8
	Millotia sp.	millotia/bow-flower							8
	Minuria annua	annual minuria	1			4			8
	Minuria cunninghamii	bush minuria	1	2	3	4		7	8
	Minuria denticulata	woolly minuria	1	2		4			8
	Minuria integerrima	smooth minuria	1						8
	Minuria leptophylla	minnie daisy	1	2	3				8
	Myriocephalus pluriflorus	inland woolly-heads							8
	Myriocephalus rhizocephalus var. *rhizocephalus*	woolly-heads				4			8
	Olearia ciliata var. *ciliata*	fringed daisy-bush							8
	Olearia decurrens	clammy daisy-bush	+	2	3				8
	Olearia floribunda var. *floribunda*	heath daisy-bush							8
	Olearia muelleri	Mueller's daisy-bush		2	3				8
	Olearia passerinoides ssp. *passerinoides*	feather daisy-bush							8
	Olearia picridifolia	rasp daisy-bush							8
	Olearia pimeleoides ssp. *pimeleoides*	showy daisy-bush	1	2	3	4		7	8

Family	Scientific Name	Common Name	Source						
	Olearia sp.	daisy-bush							8
	Olearia subspicata	shrubby daisy-bush		2					8
	* *Onopordum acaulon*	stemless thistle	1	2					8
	Othonna gregorii	fleshy groundsel	1	2	3	4		7	8
	Ozothamnus scaber	rough bush-everlasting							8
	* *Pentzia incana*	African sheep bush							8
	Picris angustifolia ssp. *angustifolia* **QKN**	hawkweed							8
	Pluchea dentex	bowl daisy			1				8
	Podolepis arachnoidea	clustered copper-wire daisy	1						8
	Podolepis canescens	large copper-wire daisy		2					8
	Podolepis capillaris	invisible plant	1	2					8
	Podolepis muelleri	small copper-wire daisy	1						8
	Polycalymma stuartii	poached-egg daisy	1	2	3	4			8
	Pseudognaphalium luteoalbum	Jersey cudweed		2	3			7	8
	Pterocaulon sphacelatum	apple-bush	1	2	3	4		7	8
	* *Reichardia tingitana*	false sowthistle		2					8
	Rhodanthe corymbiflora	grey sunray	1	2		4			8
	Rhodanthe floribunda	white everlasting	1	2				7	8
	Rhodanthe microglossa	clustered everlasting	1	2	3	4			8
	Rhodanthe moschata	musk sunray	1	2	3	4	6	7	8
	Rhodanthe polygalifolia	brilliant sunray	1	2		4			8
	Rhodanthe pygmaea	pigmy sunray	1	2	3	3			8
	Rhodanthe sp.	everlasting							8
	Rhodanthe sp.	sunray							8
	Rhodanthe stricta	slender sunray	1	2	3			7	8
	Rhodanthe stuartiana	clay sunray				4			8
	Rhodanthe troedelii	small paper-everlasting		2	3	4			8
	Rhodanthe uniflora	woolly sunray		2					8
	Rutidosis helichrysoides	grey wrinklewort		2					8
	Rutidosis multiflora	small wrinklewort						7	8
	Schoenia ramosissima	dainty everlasting	1						8
	Senecio anethifolius	feathery groundsel	1	2	3	4		7	8
	Senecio cunninghamii var. *cunninghamii*	bushy groundsel							8
	Senecio cunninghamii var. *serratus*	shrubby groudsel	1	2					8
	Senecio cunninghamii var.	shrubby groundsel	1						8
	Senecio glomeratus	annual fireweed	1						8
	Senecio glossanthus	slender groundsel	1	2	3	4			8
	Senecio lautus	variable groundsel	1	2	3	4			8
	Senecio magnificus	showy groundsel	1	2	3	4		7	8
	Senecio quadridentatus	cotton fireweed	1	2		4		7	8
	Senecio runcinifolius	tall groundsel		2					8
	Senecio sp.	groundsel							8
	Sigesbeckia australiensis	Australian sigesbeckia			3				8
	* *Silybum marianum*	variegated thistle							8
	* *Sonchus asper* ssp. *glaucescens*	rough sow-thistle							8
	* *Sonchus oleraceus*	common sow-thistle	1	2	3	4		7	8
	Sonchus sp.	sow-thistle							8
	Streptoglossa adscendens	desert daisy	1						8
	Streptoglossa liatroides	Wertaloona daisy			3				8
	Stuartina hamata	prickly cudweed	1						8
	Stuartina muelleri	spoon cudweed				4			8
	Trichanthodium skirrophorum	woolly yellow-heads	1	2	3				8
	Triptilodiscus pygmaeus	common sunray							8
	Vittadinia blackii	narrow-leaf New Holland daisy							8
	Vittadinia cervicularis var. *cervicularis*	waisted New Holland daisy		2					8
	Vittadinia cuneata var.	fuzzy New Holland daisy	1						8
	Vittadinia cuneata var. *cuneata*	fuzzweed							8
	Vittadinia cuneata var. *morrisii*	New Holland daisy							8
	Vittadinia dissecta var. *hirta*	dissected New Holland daisy		2	3	4			8
	Vittadinia eremaea	desert New Holland daisy	1	2	3			7	8
	Vittadinia gracilis	woolly New Holland daisy		2					8
	Vittadinia pterochaeta	fuzzweed	1	2					8
	Vittadinia sp.	New Holland daisy	1					7	8
	Vittadinia sulcata	furrowed New Holland daisy	1	2					8
	Waitzia acuminata var. *acuminata*	orange immortelle		2					8
	* *Xanthium occidentale*	Noogoora burr							8
	* *Xanthium* sp.	burr							8
	* *Xanthium spinosum*	Bathurst burr	1	2	3			7	8
JUNCAGINACEAE									
	Triglochin calcitrapum	spurred arrowgrass							8
	Triglochin centrocarpum	dwarf arrowgrass							8
	Triglochin sp.	arrowgrass/water-ribbons							8
POTAMOGETONACEAE									
	Potamogeton ochreatus	blunt pondweed							8
LILIACEAE									

Family	Scientific Name	Common Name	Source						
	Arthropodium minus	small vanilla-lily	1						8
	Arthropodium sp.		1						
	Arthropodium strictum	vanilla-lily	1		3				8
	* *Asphodelus fistulosus*	onion weed	1	2				7	8
	Bulbine alata	winged leek-lily			3				8
	Bulbine bulbosa.	leek-lily	1						8
	Bulbine semibarbata	annual leek-lily	1	2					8
	Bulbine sp.	bulbine-lily							8
	Dianella longifolia var. *porracea*	pale flax-lily	1						8
	Dianella longifolia var. *?*	yellow-anther flax-lily							8
	Dianella revoluta var. *revoluta*	black-anther flax-lily			3				8
	Liliaceae sp.	lily family							8
	Lomandra effusa	scented iron-grass		2					8
	Lomandra leucocephala ssp. *robusta*	woolly mat-rush		2					8
	Lomandra multiflora ssp. *dura*	iron-grass			3				8
	Thysanotus baueri	mallee fringe-lily		2	3				8
	Thysanotus sp.	fringe-lily							8
	Wurmbea centralis	inland star-lily		2					8
	Wurmbea dioica ssp. *"citrina"*	green early Nancy							8
	Wurmbea dioica ssp. *dioica*	early Nancy	1	2					8
	Wurmbea sp.	early Nancy							8
	Xanthorrhoea quadrangulata	Mount Lofty grass-tree		2	3				8
AGAVACEAE									
	* *Agave americana* var. *americana*	American aloe		2					8
AMARYLLIDACEAE									
	Calostemma purpureum	purple bells	1						8
	Crinum flaccidum	Darling lily		2					8
HYPOXIDACEAE									
	Hypoxis glabella var. *glabella*	tiny star							8
JUNCACEAE									
	Juncus aridicola	tussock rush	1		3				8
	Juncus bufonius	toad rush			3				8
	Juncus sp.	rush	1		3				8
	Juncus subsecundus	finger rush			3				8
CENTROLEPIDACEAE									
	Centrolepis drummondiana	Drummond's centrolepis							8
	Centrolepis eremica	dryland centrolepis							8
GRAMINEAE									
	Agrostis avenacea var.	common blown-grass			3				8
	Agrostis avenacea var. *avenacea*	common blown-grass							8
	Agrostis avenacea var. *perennis*	perennial blown-grass							8
	* *Alopecurus geniculatus*	marsh fox-tail				4			8
	Aristida anthoxanthoides	pale wire-grass							8
	Aristida behriana	brush wire-grass							8
	Aristida contorta	mulga grass	1	2	3		5		8
	Aristida holathera var. *holathera*	tall kerosene grass	1			4	5		8
	Aristida latifolia	feathertop wiregrass							8
	Aristida nitidula	brush threeawn	1	2	3				8
	Aristida personata		1						8
	Aristida sp.	threeawn/wire-grass	1				5		8
	Aristida strigosa	rough wire-grass							8
	* *Arundo donax*	giant reed		2					8
	Astrebla lappacea	curly Mitchell-grass		2		4			8
	Astrebla pectinata	barley Mitchell-grass	1		3		5		8
	Astrebla sp.	Mitchell-grass							8
	* *Avena barbata/fatua*	wild oat		2					8
	* *Avena fatua*	wild oat							8
	Bothriochloa macra	red-leg grass							8
	Bromus arenarius	sand brome	1	2		4			8
	* *Bromus catharticus*	prairie grass		2					8
	* *Bromus rubens*	red brome	1	2					8
	Bromus sp.	brome							8
	* *Cenchrus ciliaris*	buffel grass	1						8
	Chloris pectinata	comb windmill grass		2		4			8
	Chloris sp.	windmill grass/chloris							8
	Chloris truncata	windmill grass	1			4			8
	* *Critesion murinum* ssp.	barley-grass		2					8
	* *Critesion murinum* ssp. *glaucum*	northern barley-grass	1			4			8
	* *Critesion murinum* ssp. *leporinum*	barley-grass			3				8
	Cymbopogon ambiguus	lemon-grass	1	2	3	4		7	8
	Cymbopogon obtectus	silky-heads							8
	* *Cynodon dactylon*	couch-grass	+		3				8
	Dactyloctenium radulans	button-grass	1	2		4		7	8
	Danthonia caespitosa	common wallaby-grass	1	2					8
	Danthonia setacea var. *setacea*	bristly wallaby-grass			3				8
	Danthonia sp.	wallaby-grass	1						8

Family	Scientific Name	Common Name	Source						
	Dichanthium sericeum ssp.	silky blue-grass	1	2		4			8
	Dichanthium sericeum ssp. *humilius*	dwarf blue-grass							8
	Dichanthium sericeum ssp. *sericeum*	silky blue-grass							8
	Digitaria ammophila	spider grass							8
	Digitaria brownii	cotton panic-grass	1	2	3				8
	Digitaria coenicola	spider grass							8
	Digitaria sanguinalis	crab grass	1						8
	Digitaria sp.	summer-grass	1						8
	Diplachne fusca	brown beetle-grass				4			8
	* *Echinochloa crus-galli*	barnyard grass							8
	* *Echinochloa utilis*	Japanese millet							8
	Elymus scabrus var. *scabrus*	native wheat-grass		2	3				8
	Enneapogon avenaceus	common bottle-washers	1	2	3	4		7	8
	Enneapogon caerulescens var. *caerulescens*	blue nineawn		2	3				8
	Enneapogon cylindricus	jointed bottle-washers	1	2	3			7	8
	Enneapogon intermedius		+						8
	Enneapogon nigricans	black-heads	1	2					8
	Enneapogon polyphyllus	limestone bottle-washers	1		3	4		7	8
	Enneapogon sp.	bottle-washers/nineawn	1				5		8
	Enteropogon acicularis	umbrella grass	1	2	3				8
	Enteropogon ramosus	umbrella grass							8
	Enteropogon sp.	windmill grass							8
	Eragrostis australasica	cane-grass	1	2		4	5		8
	* *Eragrostis barrelieri*	pitted love-grass		2					8
	* *Eragrostis cilianensis*	stink grass							8
	Eragrostis dielsii var. *dielsii*	mulka grass	1	2	3	4		7	8
	Eragrostis eriopoda	woollybutt	1	2					8
	Eragrostis falcata	sickle love-grass	1	2	3				8
	Eragrostis lacunaria	neverfail		2					8
	Eragrostis laniflora	hairy-flower woollybutt							8
	Eragrostis leptocarpa	slender love-grass		2					8
	* *Eragrostis minor*	smaller stinkgrass							8
	Eragrostis parviflora	weeping love-grass		2					8
	* *Eragrostis pergracilis*	small love-grass							8
	Eragrostis setifolia	narrow-leaf neverfail		2	3	4			8
	Eragrostis sp.	love-grass	1						8
	* *Eragrostis tenellula*	delicate love-grass	+						8
	Eragrostis xerophila	knotty-butt neverfail	1		3	4			8
	Eriachne aristidea	three-awned wanderrie	1						8
	Eriachne mucronata	mountain wanderrie grass							8
	Eriachne pulchella	pretty wanderrie grass							8
	Eriachne sp.	wanderrie grass							8
	Eriochloa australiensis	Australian cupgrass		2					8
	Eriochloa pseudoacrotricha	perennial cupgrass							8
	Eriochloa sp.	cupgrass							8
	Eulalia aurea	silky browntop	+						8
	Gramineae sp.	grass family	1						8
	* *Hyparrhenia hirta*	Tambookie grass							8
	Iseilema membranaceum	small Flinders-grass							8
	* *Lamarckia aurea*	golden-top	1	2					8
	Leptochloa digitata	umbrella cane-grass							8
	* *Lolium rigidum*	Wimmera ryegrass							8
	Monachather paradoxa	bandicoot grass							8
	Neurachne alopecuroidea	fox-tail mulga-grass							8
	Panicum decompositum var. *decompositum*	native millet	1	2		4			8
	Panicum effusum var. *effusum*	hairy panic							8
	Panicum laevinode		1						8
	* *Panicum miliaceum*	common millet							8
	Panicum sp.	panic/millet	1						8
	Paractaenum novae-hollandiae ssp. *reversum*	barbed-wire grass	1		3				8
	Paspalidium clementii	Clement's paspalidium							8
	Paspalidium constrictum	knotty-butt paspalidium	1		3				8
	Paspalidium sp.	summer-grass	1						8
	* *Phalaris minor*	annual canary grass							8
	* *Phalaris paradoxa*	paradoxical canary-grass							8
	* *Phalaris* sp.	canary grass							8
	Phragmites australis	common reed							8
	Poa fordeana	Forde's poa							8
	* *Polypogon maritimus*	coast beard-grass							8
	* *Polypogon monspeliensis*	annual beard-grass			3				8
	* *Polypogon viridis*	water bent			3				8
	* *Rostraria cristata*	annual cat's-tail	1			4			8
	* *Rostraria pumila*	tiny bristle-grass	1	2				7	8
	* *Schismus barbatus*	mulga grass	1	2	3	4	6	7	8
	Setaria dielsii	Diel's pigeon-grass							8

Family	Scientific Name	Common Name	Source							
	** Setaria italica*	foxtail millet								8
	** Setaria* sp.	pigeon-grass								8
	** Sorghum halepense*	Johnson grass								8
	Sporobolus actinocladus	ray grass	1	2						8
	Sporobolus caroli	yakka grass								8
	Stipa acrociliata	graceful spear-grass	1	2						8
	Stipa blackii	crested spear-grass								8
	Stipa densiflora	foxtail spear-grass								8
	Stipa drummondii	cottony spear-grass		2						8
	Stipa elegantissima	elegant spear-grass		2	3					8
	Stipa eremophila	desert spear-grass	1	2	3					8
	Stipa flavescens	spear-grass	1							8
	Stipa nitida	Balcarra spear-grass	1	2	3	4	5	6	7	8
	Stipa nodosa	tall spear-grass	1	2	3					8
	Stipa platychaeta	flat-awn spear-grass	1	2					7	8
	Stipa scabra ssp. *scabra*	rough spear-grass								8
	Stipa scabra group	falcate-awn spear-grass	1	2						8
	Stipa sp.	spear-grass	1							8
	Stipa tuckeri	Tucker's spear-grass								8
	Themeda triandra	kangaroo grass	1							8
	Thyridolepis mitchelliana	window mulga-grass								8
	Tragus australianus	bur grass	1	2		4		6		8
	Triodia irritans complex	porcupine grass					5		7	8
	Triodia scariosa ssp. *scariosa*	porcupine grass	1	2	3					8
	Tripogon loliiformis	five-minute grass	1	2		4				8
	Triraphis mollis	purple heads	1	2		4			7	8
	Urochloa gilesii ssp. *gilesii*	hairy-edged arm-grass								8
	Urochloa praetervisa	large arm-grass								8
	Urochloa sp.	arm-grass								8
	Vulpia muralis	wall fescue	1	2						8
	** Vulpia myuros forma myuros*	silver grass		2						8
	Zygochloa paradoxa	sandhill cane-grass	1		3		5			8
TYPHACEAE										
	Typha domingensis	bullrush	1	2	3					8
CYPERACEAE										
	Bolboschoenus caldwellii	sea club-rush	1							8
	Cyperaceae sp.	sedge family								8
	Cyperus alterniflorus	umbrella flat-sedge								8
	Cyperus bulbosus	bulbous flat-sedge								8
	Cyperus difformis	rice sedge								8
	Cyperus gilesii **KN**	Gile's flat-sedge								8
	Cyperus gymnocaulos	spiny flat-sedge		2	3					8
	Cyperus laevigatus	bore-drain sedge	1							8
	Cyperus rigidellus	dwarf flat-sedge								8
	Cyperus sp.	flat-sedge								8
	Cyperus squarrosus	bearded flat-sedge		2						8
	Eleocharis pallens	pale spike-rush		2						8
	Eleocharis sp.	spike-rush								8
	Fimbristylis dichotoma	common fringe-rush		2						8
	Isolepis australiensis	southern club-rush								8
	Isolepis congrua	slender club-rush								8
	Isolepis sp.	club-rush								8
	Schoenoplectus dissachanthus	inland club-rush								8
	Schoenoplectus litoralis	shore club-rush								8
	Schoenoplectus litoralis/validus	club-rush								8
ORCHIDACEAE										
	Caladenia sp.	spider-orchid								8
	Caladenia toxochila	dryland spider-orchid								8
	Microtis unifolia	common onion-orchid								8
	Prasophyllum odoratum	scented leek-orchid								8
	Pterostylis aff. excelsa	dryland greenhood								8
	Pterostylis biseta	rusty-hood								8
	Pterostylis "Mt Victoria Uranium Mine"(R.Bates 16740) **KN**									8
	Pterostylis mutica	midget greenhood								8
	Pterostylis "Oraton Rock"(R.Bates 16756) **KN**									8
	Pterostylis robusta	large striped greenhood								8
	Pterostylis rufa group	rusty-hood								8
	Pterostylis sp.	greenhood								8

Appendix VI

BIRD SPECIES RECORDED FROM THE NORTH OLARY PLAINS SURVEY AREA

Species are listed by common name in taxonomic order of Family using the nomenclature of Parker and Horton (1990). Subspecies are not listed unless they are morphologically distinct enough to be accurately identified in the field.

* Introduced species

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 .

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 columns indicate the source of bird species records as follows:

1 Playfair & Robinson (1997), site data (this survey)
2 Playfair & Robinson (1997), opportunistic data (this survey)
3 Royal Australasian Ornithologists Union records from the RAOU S.A. Database and RAOU Atlas (Blakers *et al*., 1984)
4 South Australian Museum records from the survey area
5 Birds listed in the Honeymoon Uranium Mine EIS (Gutteridge, Haskins & Davey, 1981)
6 Birds listed near Lakes Frome and Callabonna by Pedler and Ragless (1978)
7 Birds listed in the Lake Frome District by McGilp (1923)
8 Birds listed in the Beverley Uranium Mine EIS (Close & Williams, 1979)

Common Name	Scientific Name	Source
CASUARIIDAE		
Emu	*Dromaius novaehollandiae*	1 2 3 5 6 7 8
PHASIANIDAE		
Stubble Quail	*Coturnix novaezelandiae*	1 2 3 4 5 6 7
Brown Quail	*Coturnix ypsilophorus*	7
ANATIDAE		
Chestnut Teal	*Anas castanea*	3 7
Australasian Grey Teal	*Anas gracilis*	1 2 3 7 8
* Mallard	*Anas platyrhynchos*	3 7
Australasian Shoveler **-RR**	*Anas rhynchotis*	2 3 6 7
Pacific Black Duck	*Anas superciliosa*	1 2 3 5 6 7 8
Magpie Goose	*Anseranas semipalmata*	7 8
Hardhead **-R**	*Aythya australis*	2 3 6 7 8
Musk Duck **-VU**	*Biziura lobata*	3 5 7 8
Wood Duck	*Chenonetta jubata*	2 3 5 7 8
Black Swan	*Cygnus atratus*	2 3 4 6 7 8
Plumed Whistling-Duck **-R**	*Dendrocygna eytoni*	7
Pink-eared Duck	*Malacorhynchus membranaceus*	2 3 4 7 8
Blue-billed Duck **-R**	*Oxyura australis*	3 7
Freckled Duck **RVV**	*Stictonetta naevosa*	7
Common Name	**Scientific Name**	**Source**

Australian Shelduck	*Tadorna tadornoides*	1		3				7	8
TURNICIDAE									
Little Button-quail	*Turnix velox*	1	2	3	4			7	8
DACELONIDAE									
Red-backed Kingfisher	*Halcyon pyrrhopygia*	1	2	3	4		6	7	8
Sacred Kingfisher	*Halcyon sancta*			3				7	
MEROPIDAE									
Rainbow Bee-eater	*Merops ornatus*	1	2	3	4		6	7	8
CUCULIDAE									
Fan-tailed Cuckoo	*Cacomantis flabelliformis*			3					
Horsfield's Bronze-cuckoo	*Chrysococcyx basalis*	1	2	3	4	5	6	7	8
Black-eared Cuckoo	*Chrysococcyx osculans*			3				7	8
Pallid Cuckoo	*Cuculus pallidus*	1	2	3	4		6	7	8
PSITTACIDAE									
Red-winged Parrot	*Aprosmictus erythropterus*						6	7	
Ringneck Parrot	*Barnardius zonarius*	1	2	3	4	5	6	7	8
Major Mitchell Cockatoo **-VV**	*Cacatua leadbeateri*			3					
Little Corella	*Cacatua sanguinea*	1	2	3	4		6	7	8
Galah	*Eolophus roseicapilla*	1	2	3	4	5	6	7	8
Budgerigah	*Melopsittacus undulatus*	1	2	3	4		6	7	8
Blue-winged Parrot**-VV**	*Neophema chrysostoma*		2	3			6		
Elegant Parrot **--I**	*Neophema elegans*			3				7	8
Scarlet-chested Parrot **RRR**	*Neophema splendida*				4			7	
Blue Bonnet	*Northiella haematogaster*	1	2	3	4	5	6		8
Cockatiel	*Nymphicus hollandicus*	1	2	3	4			7	8
Red-rumped Parrot	*Psephotus haematonotus*			3				7	
Mulga Parrot	*Psephotus varius*	1	2	3	4			7	8
APODIDAE									
Fork-tailed Swift	*Apus pacificus*			3				7	8
TYTONIDAE									
Barn Owl	*Tyto alba*		2	3	4		6	7	8
STRIGIDAE									
Barking Owl **-V**	*Ninox connivens*								8
Boobook Owl	*Ninox novaeseelandiae*		2	3	4			7	8
EUROSTOPODIDAE									
Spotted Nightjar	*Eurostopodus argus*	1	2	3				7	8
AEGOTHELIDAE									
Australian Owlet-nightjar	*Aegotheles cristatus*		2	3	4			7	8
PODARGIDAE									
Tawny Frogmouth	*Podargus strigoides*		2	3	4		6	7	8
COLUMBIDAE									
* Feral Pigeon	*Columba livia*		2	3					
Diamond Dove	*Geopelia cuneata*		2	3	4			7	8
Peaceful Dove	*Geopelia placida*	1	2	3					8
Crested Pigeon	*Ocyphaps lophotes*	1	2	3	4	5	6	7	8
Common Bronzewing	*Phaps chalcoptera*	1	2	3	4	5	6	7	8
OTIDIDAE									
Australian Bustard **-VV**	*Ardeotis australis*			3	4			7	8
RALLIDAE									
Eurasian Coot	*Fulica atra*		2	3		5	6	7	8
Common Name	**Scientific Name**	**Source**							
Dusky Moorhen	*Gallinula tenebrosa*			3					
Black-tailed Native-hen	*Gallinula ventralis*		2	3	4	5	6	7	8

Purple Swamphen	*Porphyrio porphyrio*			3			6	7		
Australian Crake	*Porzana fluminea*		2	3				7		
GRUIDAE										
Brolga **-V**	*Grus rubicundus*			3				7		
PEDIONOMIDAE										
Plains-wanderer	*Pedionomus torquatus*							*7*		
SCOLOPACIDAE										
Sharp-tailed Sandpiper	*Calidris acuminata*		2	3			6	7		
Latham's Snipe	*Gallinago hardwickii*						6			
Greenshank	*Tringa nebularia*			3						8
BURHINIDAE										
Southern Stone Curlew (Bush Thick-knee) **--E**	*Burhinus grallarius (B. magnirostris)*			3	4			7		
RECURVIROSTRIDAE										
Banded Stilt	*Cladorhynchus leucocephalus*				4					
White-headed Stilt	*Himantopus leucocephalus*				4		6	7		
Black-winged Stilt	*Himantopus himantopus*		2	3						
Red-necked Avocet	*Recurvirostra novaehollandiae*		2	3	4		6	7		
CHARADRIIDAE										
Red-capped Dotterel	*Charadrius ruficapillus*		2		4		6	7		8
Black-fronted Dotterel	*Elseyornis melanops*	1	2	3	4	5	6	7		8
Red-kneed Dotterel	*Erythrogenys cinctus*		2	3	4			7		
Masked Lapwing	*Hoplopterus miles*	1	2	3	4		6	7		8
Banded Lapwing	*Hoplopterus tricolor*	1	2	3	4			7		8
Inland Dotterel	*Peltohyas australis*	1	2	3				7		8
GLAREOLIDAE										
Australian Pratincole	*Stiltia isabella*			3	4			7		8
LARIDAE										
Whiskered Tern	*Chlidonias hybridus*		2	3	4		6	7		
Gull-billed Tern	*Gelochelidon nilotica*		2		4		6	7		
Caspian Tern	*Hydroprogne caspia*						6	7		
Silver Gull	*Larus novaehollandiae*			3	4		6	7		
ACCIPITRIDAE										
Collared Sparrowhawk	*Accipiter cirrhocephalus*	1	2	3	4			7		8
Brown Goshawk	*Accipiter fasciatus*	1	2	3	4		6	7		8
Wedge-tailed Eagle	*Aquila audax*	1	2	3	4		6	7		8
Swamp Harrier	*Circus aeruginosus*			3				7		
Spotted Harrier	*Circus assimilus*	1	2	3	4		6	7		8
Black-shouldered Kite	*Elanus caeruleus*			3			6			8
Letter-winged Kite **-R**	*Elanus scriptus*		2	3	4					
Little Eagle	*Hieraaetus morphnoides*	1	2	3	4		6	7		8
Whistling Kite	*Haliastur sphenurus*			3	4		6	7		8
Black-breasted Kite	*Hamirostra melanosternon*			3	4		6	7		8
Black Kite	*Milvus migrans*	1	2	3	4		6	7		8
FALCONIDAE										
Brown Falcon	*Falco berigora*	1	2	3	4		6	7		8
Australian Kestrel	*Falco cenchroides*	1	2	3	4		6	7		8
Grey Falcon **-V**	*Falco hypoleucos*				4			7		8
Little Falcon	*Falco longipennis*		2	3	4		6	7		8
Peregrine Falcon (**-RR** if ssp. *macropus*)	*Falco peregrinus*		2	3				7		
Black Falcon	*Falco subniger*		2	3	4		6	7		8
PODICIPEDIDAE										
Great Crested Grebe	*Podiceps cristatus*			3						
Common Name	**Scientific Name**	**Source**								
Hoary-headed Grebe	*Poliocephalus poliocephalus*			3	4	5		7		
Australasian Grebe	*Tachybaptus novaehollandiae*	1	2	3		5	6			
ANHINGIDAE										

Darter	*Anhinga melanogaster*			3				7	
PHALACROCORACIDAE									
Black Cormorant	*Phalacrocorax carbo*			3			6		8
Little Pied Cormorant	*Phalacrocorax melanoleucos*			3		5		7	8
Little Black Cormorant	*Phalacrocorax sulcirostris*			3				7	8
Pied Cormorant	*Phalacrocorax varius*			3			6		
ARDEIDAE									
Great Egret	*Ardea alba*			3					8
White-faced Heron	*Ardea novaehollandiae*		2	3		5	6	7	8
Pacific Heron	*Ardea pacifica*			3				7	8
Nankeen Night Heron	*Nycticorax caledonicus*			3			6	7	8
THRESKIORNITHIDAE (PLATALEIDAE)									
Yellow-billed Spoonbill	*Platalea flavipes*			3			6	7	8
Royal Spoonbill	*Platalea regia*			3				7	8
Glossy Ibis **--R**	*Plegadis falcinellus*			3				7	
Sacred Ibis	*Threskiornis aethiopicus*			3				7	8
Straw-necked Ibis	*Threskiornis spinicollis*			3			6	7	
PELECANIDAE									
Australian Pelican	*Pelecanus conspicillatus*			3			6	7	
CLIMACTERIDAE									
White-browed Treecreeper	*Climacteris affinis*	1		3	4				
Brown Treecreeper	*Climacteris picumnus*			3				7	
MALURIDAE									
Variegated Wren	*Malurus lamberti*	1	2	3					8
Purple-backed Wren	*Malurus lamberti assimilis*				4		6	7	
White-winged Wren	*Malurus leucopterus*	1	2	3	4	5	6	7	8
Splendid Blue Wren	*Malurus splendens*			3					
Black-backed Wren	*Malurus splendens melanotus*				4				
AMYTORNITHIDAE									
Striated Grasswren **IVV**	*Amytornis striatus*						6		
MELIPHAGIDAE									
Spiny-cheeked Honeyeater	*Acanthogenys rufogularis*	1	2	3	4	5	6	7	8
Gibberbird	*Ashbyia lovensis*	1	2	3	4		6	7	8
Pied Honeyeater **--R**	*Certhionyx variegatus*	1	2		4			7	8
White-fronted Chat	*Ephthianura albifrons*	1	2	3				7	
Orange Chat	*Ephthianura aurifrons*	1	2	3	4	5	6	7	8
Crimson Chat	*Ephthianura tricolor*	1	2	3	4			7	8
Yellow-throated Miner	*Manorina flavigula*	1	2	3	4	5	6	7	8
White-eared Honeyeater	*Meliphaga leucotis*			3					
Yellow-plumed Honeyeater	*Meliphaga ornata*			3				7	
White-plumed Honeyeater	*Meliphaga penicillata*	1	2	3	4	5	6	7	8
Grey-fronted Honeyeater	*Meliphaga plumula*			3			6	7	8
Singing Honeyeater	*Meliphaga virescens*	1	2	3	4		6	7	8
Brown-headed Honeyeater	*Melithreptus brevirostris*	1		3					
White-fronted Honeyeater	*Phylidonyris albifrons*	1		3	4		6	7	8
New Holland Honeyeater	*Phylidonyris novaehollandiae*							7	
Striped Honeyeater **-VV**	*Plectorhyncha lanceolata*							*7*	
Black Honeyeater **-R**	*Sugomel niger*	1		3				7	
PARDALOTIDAE									
Spotted Pardalote	*Pardalotus punctatus*	1							
Striated Pardalote	*Pardalotus striatus*	1	2	3	4		6	7	8
Common Name	**Scientific Name**		**Source**						
Red-browed Pardalote	*Pardalotus rubricatus*	1	2	3	4		6	7	8
ACANTHIZIDAE									
Inland Thornbill	*Acanthiza apicalis*	1		3	4		6		8
Yellow-rumped Thornbill	*Acanthiza chrysorrhoa*	1	2	3	4	5		7	8
Brown Thornbill	*Acanthiza pusilla*							7	

Chestnut-rumped Thornbill	*Acanthiza uropygialis*	1	2	3	4		6	7	8
Southern Whiteface	*Aphelocephala leucopsis*	1	2	3	4		6	7	8
Banded Whiteface **-R**	*Aphelocephala nigricincta*		2		4			7	
Western Fieldwren	*Calamanthus campestris*	1	2		4			7	
Shy Hylacola **-VV**	*Hylacola cauta*							*7*	
Redthroat	*Pyrrholaemus brunneus*	1	2	3				7	8
Fieldwren (Calamanthus)	*Sericornis fuliginosus*			3					8
Weebill	*Smicrornis brevirostris*	1	2	3	4		6	7	8
EOPSALTRIIDAE									
Varied Sittella	*Daphoenositta chrysoptera*			3				7	8
Southern Scrub-robin	*Drymodes brunneopygia*			3					
Hooded Robin	*Melanodryas cucullata*	1		3				7	
Jacky Winter	*Microeca leucophaea*		2	3					
Red-capped Robin	*Petroica goodenovii*	1	2	3	4		6	7	8
POMATOSTOMIDAE									
Chestnut-crowned Babbler	*Pomatostomus ruficeps*	1	2	3	4	5	6	7	
White-browed Babbler	*Pomatostomus superciliosa*	1		3	4		6	7	8
CINCLOSOMATIDAE									
Chestnut Quail-thrush **-VV**	*Cinclosoma castanotum*							7	
Cinnamon Quail-thrush	*Cinclosoma cinnamomeum*	1	2	3	4		6	7	8
Chirruping Wedgebill	*Psophodes cristatus*	1	2	3	4	5	6	7	8
CORCORACIDAE									
Apostlebird **--R**	*Struthidea cinerea*	1	2	3		5			
PACHYCEPHALIDAE									
Grey Shrike-thrush	*Colluricincla harmonica*	1	2	3			6	7	8
Crested Bellbird	*Oreoica gutturalis*	1	2	3	4			7	8
Rufous Whistler	*Pachycephala rufiventris*	1	2	3	4		6	7	8
CORVIDAE									
Black-faced Woodswallow	*Artamus cinereus*	1	2	3	4	5	6	7	8
Dusky Woodswallow	*Artamus cyanopterus*			3				7	
White-breasted Woodswallow	*Artamus leucorhynchus*	1	2	3			6	7	
Little Woodswallow **--R**	*Artamus minor*			3	4				
Masked Woodswallow	*Artamus personatus*		2	3	4			7	
White-browed Woodswallow	*Artamus superciliosus*		2	3				7	
Ground Cuckoo-shrike	*Coracina maxima*			3			6		
Black-faced Cuckoo-shrike	*Coracina novaehollandiae*	1	2	3			6	7	8
Little Crow	*Corvus bennetti*	1	2	3	4			7	8
Australian Raven	*Corvus coronoides*	1	2	3	4		6	7	8
Little Raven	*Corvus mellori*						6		
Pied Butcherbird	*Cracticus nigrogularis*	1						7	
Grey Butcherbird	*Cracticus torquatus*	1	2	3		5		7	8
Australian Magpie	*Gymnorhina tibicen*	1	2	3	4	5	6	7	8
White-winged Triller	*Lalage sueurii*	1	2	3	4		6	7	8
Grey Currawong	*Strepera versicolor*			3					
DICRURIDAE									
Magpie-lark	*Grallina cyanoleuca*	1	2	3	4	5	6	7	8
Restless Flycatcher	*Myiagra inquieta*			3				7	
Grey Fantail	*Rhipidura fuliginosa*		2	3			6	7	8
Willie Wagtail	*Rhipidura leucophrys*	1	2	3		5	6	7	8
STURNIDAE									
* European Starling	*Sturnus vulgaris*			3				7	8
Common Name	**Scientific Name**	**Source**							
HIRUNDINIDAE									
White-backed Swallow	*Chermoeca leucosternum*	1	2	3	4	5	6	7	8
Fairy Martin	*Hirundo ariel*	1	2	3			6	7	8
Welcome Swallow	*Hirundo neoxena*	1	2	3	4		6	7	8
Tree Martin	*Hirundo nigricans*	1	2	3	4		6	7	8
ZOSTEROPIDAE									
Silvereye	*Zosterops lateralis*	1		3			6	7	

SYLVIDAE									
Clamorous Reed-warbler	*Acrocephalus stentoreus*			3				7	8
Brown Songlark	*Cinclorhamphus cruralis*	1	2	3	4		6	7	8
Rufous Songlark	*Cinclorhamphus mathewsi*	1	2	3	4				
Little Grassbird	*Megalurus gramineus*	1	2	3					8
ALAUDIDAE									
Singing Bushlark	*Mirafra javanica*	1							
NECTARINIIDAE									
Mistletoe Bird	*Dicaeum hirundinaceum*	1	2	3	4		6	7	8
PASSERIDAE									
* House Sparrow	*Passer domesticus*	1	2	3	4			7	8
MOTACILLIDAE									
Richard's Pipit	*Anthus novaeseelandiae*	1	2	3	4	5	6	7	8
ESTRILDIDAE									
Zebra Finch	*Poephila guttata*	1	2	3	4	5	6	7	8

Appendix VII

MAMMAL SPECIES RECORDED FROM THE NORTH 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). 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.

Conservation status code definitions are:

X **Extinct** - species not definitely located in the wild during the past 50 years.

pX **Presumed 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 columns indicate the source of mammals species records as follows:

1 Playfair & Robinson (1997), site data (this survey)
2 Playfair & Robinson (1997), opportunistic data
3 South Australian Museum Mammal Section records up to 1997.
F Sub-fossil material of locally extinct species (i.e. could be up to several thousand years old), found by Forward & Robinson 1996 at Anabama Hill or by others at Chambers Gorge, Moro Gorge and Old Quinyambie. Material identified by G. Medlin at the SA Museum.

Scientific Name	Common Name	Source
TACHYGLOSSIDAE		
Tachyglossus aculeatus	Short-beaked Echidna	1 3 F
DASYURIDAE		
Antechinomys laniger **pVR**	Kultarr	3 F
Dasycercus cristicauda **VE**	Mulgara	F
Dasycercus byrnei **RR**	Kowari	F
Dasyurus geoffroii **EX**	Western Quoll	F
Phascogale calura **EX**	Red-tailed Phascogale	F
Planigale gilesi **-U**	Giles' Planigale	1 3
Planigale tenuirostris **-U**	Narrow-nosed Planigale	1 3 F
Sminthopsis crassicaudata	Fat-tailed Dunnart	1 3 F
Sminthopsis macroura	Stripe-faced Dunnart	1 3 F
MACROPODIDAE		
Macropus fuliginosus	Western Grey Kangaroo	1 2 3
Macropus giganteus **-V**	Eastern Grey Kangaroo	1 2 3
Macropus robustus	Euro	1 2 3
Scientific Name	**Common Name**	**Source**

Macropus rufus	Red Kangaroo	1	2	3	
Onychogalea lunata **XX**	Crescent Nailtail Wallaby				F
Petrogale xanthopus **pVR**	Yellow-footed Rock-wallaby			3	F
PERAMELIDAE					
Chaeropus ecaudatus **XX**	Pig-footed Bandicoot				F
Isoodon cf. *auratus* **EX**	Golden Bandicoot				F
Macrotis lagotis **VX**	Greater Bilby			3	F
Perameles bougainville **EX**	Western Barred Bandicoot				F
PHALANAGERIDAE					
Trichosurus vulpecula	Common Brushtail				F
POTORIDAE					
Bettongia lesueur **EX**	Burrowing Bettong				F
Caloprymnus campestris **XX**	Desert Rat-kangaroo				F
MURIDAE					
Leggadina forresti **-R**	Forrest's Mouse	1		3	F
Leporillus apicalis **XX**	Lesser Stick-nest Rat				F
Leporillus conditor **VE**	Greater Stick-nest Rat				F
Mus domesticus	House Mouse	1	2	3	F
Notomys cervinus	Fawn Hopping Mouse				F
Notomys cf. *fuscus*[1] **VE**	Dusky-Hopping Mouse	1		3	F
Notomys longicaudatus **XX**	Long-tailed Hopping-mouse				F
Notomys amplus **XX**	Short-tailed Hopping-mouse				F
Pseudomys australis **VR**	Plains Rat				F
Pseudomys bolami	Bolam's Mouse	1		3	F
Pseudomys desertor **IR**	Desert Mouse				F
Pseudomys gouldii **XX**	Gould's Mouse				F
Rattus villosissimus	Long-haired (Plague) Rat			3	F
MEGADERMATIDAE					
Macroderma gigas **RX**	Ghost Bat			3	F
MOLOSSIDAE					
Mormopterus planiceps	Little Mastiff-bat			3	
Nyctinomus australis	White-striped Mastiff-bat			3	
VESPERTILIONIDAE					
Chalinolobus gouldii	Gould's Wattled Bat			3	
Chalinolobus picatus **RR**	Little Pied Bat				
Vespadelus baverstocki	Inland Eptesicus			3	
Vespadelus finlaysoni	Little Brown Bat				
Nyctophilus geoffroyi	Lesser Long-eared Bat		2	3	
Scotorepens balstoni	Western Broad-nosed Bat			3	
Scotorepens greyii	Little Broad-nosed Bat			3	
LEPORIDAE					
* *Oryctolagus cuniculus*	European Rabbit	1	2		
CANIDAE					
* *Canis familiaris dingo*	Dingo	1	2	3	
* *Vulpes vulpes*	Fox	1	2	3	
FELIDAE					
* *Felis catus*	Cat	1	2	3	
Scientific Name	**Common Name**	**Source**			
BOVIDAE					
* *Bos taurus*	Cattle	1	2		

[1] Sub-fossil material is probably this species as too small for *N. mitchelli* (pers. comm. G. Medlin).

*	*Capra hircus*	Goat	1	2 3
*	*Ovis aries*	Sheep	1	

EQUIDAE

*	*Equus caballus*	Horse	2

Appendix VIII

REPTILE AND AMPHIBIAN SPECIES RECORDED FROM THE NORTH OLARY PLAINS SURVEY AREA

Species are listed by scientific name in taxonomic 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 four columns indicate the source of reptile species records as follows:

1 Playfair & Robinson (1997), site data (this survey)
2 Playfair & Robinson (1997), opportunistic data
3 Herbert (1997), opportunistic data
4 South Australian Museum Herpetology Section records prior to 1996 (whole area)

Scientific Name	Common Name	Source
REPTILES		
AGAMIDAE		
Ctenophorus fordi	Mallee Dragon	1 4
Ctenophorus pictus	Painted Dragon	1 4
Ctenophorus nuchalis	Central Netted Ground Dragon	1 4
Diporiphora winneckei	Canegrass Two-lined Dragon	4
Pogona vitticeps	Central Bearded Dragon	1 2 4
Tympanocryptis intima	Gibber Earless Dragon	2 4
Tympanocryptis lineata	Five-lined Earless Dragon	1 2 4
Tympanocryptis tetraporophora	Eyrean Earless Dragon	1 3 4
GEKKONINAE		
**Gehyra* '2N=44'	Southern Rock Dtella	1 2 4
Gehyra variegata	Tree Dtella	1 2 3 4
Heteronotia binoei	Bynoe's Gecko	1 2 4
DIPLODACTYLINAE		
Diplodactylus byrnei	Pink-blotched Gecko	1 2 4
Diplodactylus damaeus	Beaded Gecko	1 4
Diplodactylus tessellatus	Tessellated Gecko	1 3 4
Diplodactylus vittatus	Eastern Stone (Wood) Gecko	1 2 4
Nephrurus levis	Smooth Knob-tailed Gecko	2 4
Nephurus milii	Barking (Thick-tailed) Gecko	2 4
Scientific Name	**Common Name**	**Source**

Oedura marmorata	Marbled Velvet Gecko				4
Rhynchoedura ornata	Beaked Gecko	1	2	3	4
Strophurus ciliaris	Northern Spiny-tailed Gecko	1		3	4
Strophurus elderi	Jewelled Gecko				4
Strophurus williamsi	Eastern Spiny-tailed Gecko		2		4
Strophurus intermedius	Southern Spiny-tailed Gecko				4
PYGOPODINAE					
Delma australis	Barred Snake-lizard				4
Delma butleri	Spinifex Snake-lizard	1			4
Delma tincta	Excitable Snake-lizard				4
Lialis burtonis	Burton's LeglessLizard				4
Pygopus nigriceps	Black-headed Scaly-foot	1			4
SCINCIDAE					
SPHENOMORPHOUS GROUP					
Ctenotus brachyonyx	Eastern Ctenotus				4
Ctenotus brooksi	Sandhill Ctenotus	1			4
Ctenotus leae	Orange-tailed Finesnout Ctenotus				4
Ctenotus leonhardii	Leonhardi's Ctenotus	1		3	4
***Ctenotus "olympicus"*	Spotted Ctenotus	1	2	3	4
Ctenotus pantherinus	Leopard Skink			3	
Ctenotus regius	Eastern Desert Ctenotus	1	2	3	4
Ctenotus robustus	Eastern Striped Skink	1	2		4
Ctenotus schomburgkii	Sandplain Ctenotus	1	2	3	4
Ctenotus strauchii	Short-legged Ctenotus	1	2	3	4
Ctenotus uber	Spotted Ctenotus	1	2	3	4
Eremiascincus fasciolatus	Narrow-banded Sand Swimmer	1			4
Eremiascincus richardsonii	Broad-banded Sand Swimmer		2		4
Lerista labialis	Eastern Two-toed Slider	1	2	3	4
Lerista muelleri	Dwarf Three-toed Slider	1	2		4
Lerista punctatovittata	Spotted Slider		2	3	4
Lerista xanthura	Yellow-tailed Slider	1			4
EGERNIA GROUP					
Egernia inornata	Desert Skink				4
Egernia margatetae	Masked Rock Skink		2		4
Egernia stokesii	Gidgee (Spiny-tailed) Skink				4
Egernia striolata	Tree Skink	1	2		4
Tiliqua occipitalis	Western Bluetongue				4
Tiliqua rugosa	Sleepy Lizard / Shingle Back	1	2		4
EUGONGYLUS GROUP					
Cryptoblepharus carnabyi	Speckled Wall Skink		2		4
Cryptoblepharus plagiocephalus	Desert Wall Skink	1	2	3	4
Menetia greyii	Dwarf Skink	1	2	3	4
Morethia adelaidensis	Adelaide Snake-eye	1	2		4
Morethia boulengeri	Common Snake-eye	1	2	3	4
VARANIDAE					
Varanus gouldii	Sand (Gould's) Goanna	1			4
TYPHLOPIDAE					
Ramphotyphlops australis	Southern Blind Snake				4
Ramphotyphlops bituberculatus	Rough-nosed Blind Snake				4
Ramphotyphlops endoterus	Interior Blind Snake				4
BOIDAE					
Morelia spilota **-(V)R**	Carpet (Diamond) Python				4
Scientific Name	**Common Name**	**Source**			
Antaresia stimsoni	Large-blotched Python				4

ELAPIDAE					
Pseudechis australis	Mulga (King Brown) Snake				4
Pseudonaja modesta	Five-ringed Snake	1			4
Pseudonaja nuchalis	Western Brown Snake (Gwardar)	1	2		4
Pseudonaja textilis	Eastern Brown Snake				4
Simoselaps australis	Coral Snake				4
Simoselaps fasciolatus	Narrow-banded Shovel-nosed Snake	1			4
Suta nigriceps	Mitchell's Short-tailed Snake				4
Suta spectabilis	Mallee Black-headed Snake		2		4
Suta suta	Curl Snake		2		4
AMPHIBIANS					
HYLIDAE					
Cyclorana platycephala	Water-holding Frog				4
Litoria rubella	Red Tree Frog			3	4
LEPTODACTYLIDAE					
Limnodynastes tasmaniensis	Spotted Grass Frog	1			4
Neobatrachus centralis	Trilling Frog	1			4
Neobatrachus pictus	Painted Frog				4

* *Gehyra* '2N=44' is a new as yet unpublished species, closely related to *Gehyra variegata.* Voucher specimens of both *G. variegata* and the new species collected in this area have been lodged with the S A Museum.

** *Ctenotus "olympicus"* is a new species (Hutchinson & Donellan in press) which in this region will replace the current records of *Ctenotus uber*. All previously collected specimens of *C. uber* in this area have been assigned to the new species of *Ctenotus "olympicus"*.

Appendix IX

WEATHER CONDITIONS DURING THE NORTH OLARY PLAINS VERTEBRATE SURVEY PERIOD

CAMP	DATE	SUN		SHADE		COMMENTS
		MIN	MAX	MIN	MAX	
Cockburn	28 Aug 96	10	23	10	18	Westerly in morning, scattered high cloud.
	29 Aug 96	5	32	6	27	Scattered cloud throughout day.
	30 Aug 96	3	29	4	27	SE breeze in pm, scattered cloud, mainly fine.
	31 Aug 96	5	29	6	22	Still, cloudless morning.
Bimbowrie	28 Aug 96	8	28	10	16	Overcast.
	29 Aug 96	6	30	9	19	Clear, cool.
	30 Aug 96	5	29	8	17	Cold, strong breeze.
	31 Aug 96	5	29	8	19	
Wooltana	28 Aug 96	10	26	11	26	
	29 Aug 96	9	27	12	27	
	30 Aug 96	5	31	9	24	
	31 Aug 96	8	30	10	23	
Coonee	1 Sept 96	2	38	4	24	Fine & warm, light breeze.
	2 Sept 96	9	39	10	18	Very light rain overnight, south wind all day.
	3 Sept 96	2	48	4	22	Fine & warm, very light breeze.
	4 Sept 96	5	38	7	25	Cloudless, gusty westerly all pm, fine & warm.
Koonamore	1 Sept 96	5	29	7	24	Mostly overcast, cool & windy. Light rain in evening.
	2 Sept 96	3	26	8	22	Mostly overcast, cool & windy.
	3 Sept 96	0	27	6	22	Clear, fine, mild. Overcast later.
	4 Sept 96	13	35	11	24	Partly overcast then clearing, windy, warm.
	5 Sept 96	0	28	8	22	Clear, warm to mild, light breeze.
Billeroo West	2 Sept 96	4	39	6	37	Light rain during night, overcast all night - no moon.
	3 Sept 96	1	25	6	30	Cold wind all day, clear still night.
	4 Sept 96	9	37	8	33	Fine, still, warm day, cold, clear night.
	5 Sept 96	0	31	5	29	Early overcast & cold wind clearing to fine clear cold night.

Appendix X

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 XI

GLOSSARY OF GEOLOGICAL TERMS

Definitions are taken largely from Bates and Jackson (1980)

aeolian	pertaining to the wind
alluvial	pertaining to or composed of sediments deposited by rivers
anastomosing	net-like pattern
barchan dune	crescent-shaped dune lying transverse to the direction of prevailing wind
calcrete	sediment or rock cemented by calcium carbonate
conformable	said of sedimentary strata deposited with no major time breaks
craton	part of the Earth's crust that has been stable for a prolonged period
duricrust	hard or indurated crust that is part or all of a soil
etch surface	erosional surface formed by downward removal of weathered rock
geosyncline	a basin or complex succession of basins formed by a mobile downwarping of the Earth's crust in which sediments accumulate
gilgai	surface relief of the order of centimetres to metres in a vertical sense
hiatus	a break in deposition of sediments ie a time interval of non-deposition
intermontane	located between mountain ranges
lacustrine	of or pertaining to a lake
lunette	low, wind-built mound on the lee-side of a lake
metamorphism	change that occurs in rocks (below the influence of weathering) under conditions (eg temperature) that differ from those in which they first formed
monadrock	a hill that rises above the general plain level, that is an isolated remnant of an earlier cycle of erosion
orogeny	event or process of mountain building
palaeo-	old or fossil
playa	dried up lake
regression	the retreat of the sea thereby exposing more land
silcrete	siliceous duricrust
stratigraphy	science of rock strata
tectonic	pertaining to the forces involved in forming the broad architecture of the Earth's crust
tor	usually granitic rocky peak or rocks with rounded form
transgression	the spread or extension of the sea over land