Department for Environment and Heritage

A Biological Survey of Mount Willoughby Indigenous Protected Area

South Australia

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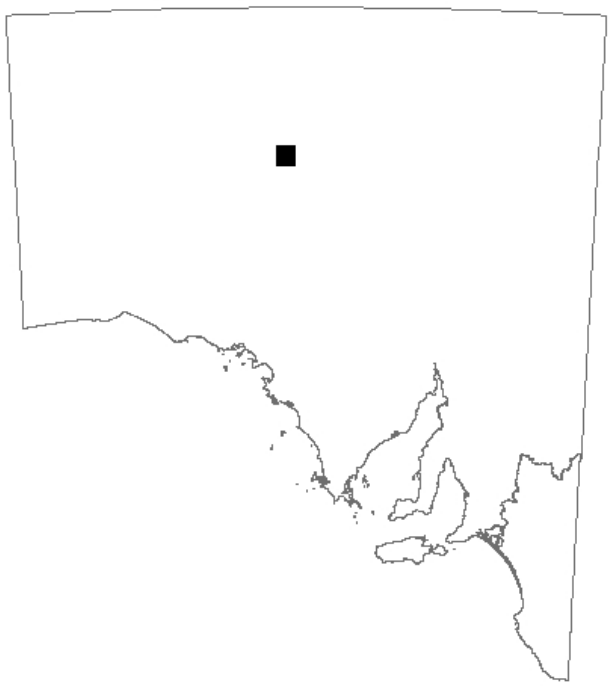
A BIOLOGICAL SURVEY OF THE MT WILLOUGHBY INDIGENOUS PROTECTED AREA, SOUTH AUSTRALIA

OCTOBER 2003



BIOLOGICAL SURVEY
SOUTH AUSTRALIA

by

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Science and Conservation Directorate
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South Australia

2005

The Biological Survey of the Mt Willoughby I. P. A. South Australia was carried out as a consultancy to the Tjirilia Foundation with funds from the Indigenous Protected Areas Fund of the Commonwealth of Australia

The report may be cited as:

R. Brandle, B. Sparrow, J. N. Foulkes and A. C. Robinson (2005). ***A Biological Survey of the Mt Willoughby Indigenous Protected Area, South Australia - October 2003*****. (Department for Environment and Heritage, South Australia).**

Limited hard copies of the report were prepared, but it can also be accessed from the Internet on:

http://www.environment.sa.gov.au/biodiversity/biosurveys

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Cover Photograph
View SW across breakaway hills from above survey site BRU00501 on the Mt Willoughby I. P. A.
Photo AC Robinson

PREFACE

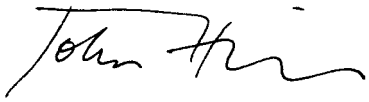
A Biological Survey of the Mt Willoughby Indigenous Protected Area, South Australia is a further product of the Biological Survey of South Australia.

The program of systematic biological surveys to cover the whole of South Australia arose out of a realisation that an effort was needed to increase our knowledge of the remaining vascular plants and vertebrate fauna of South Australia and to encourage its conservation.

Over the last 21 years, there has been a strong commitment to the Biological Survey by Government and an impressive dedication from hundreds of volunteer biologists.

By 2015, it is anticipated that the Biological Survey will achieve complete statewide coverage.

The Biological Survey of South Australia will be an achievement for which we can be very proud. We will have substantially improved our knowledge of the biodiversity of South Australia to enable biologists in the future to measure the direction of long-term ecological change. This will greatly enhance our ability to adequately manage nature conservation into the future.



JOHN HILL
MINISTER FOR ENVIRONMENT AND CONSERVATION

ABSTRACT

Mt Willoughby Indigenous Protected Area (IPA) has a diverse suite of landforms and related physical characteristics. It lies across two biogeographical regions of Australia, the Stony Plains and the Great Victoria Desert. The area is predominantly native vegetation having been modified to various extents by sheep and cattle grazing during its former landuse as a Pastoral Station.

The aims of this biological survey were to identify and sample the habitats and associated plants and animals for the Tjirilia Aboriginal Corporation to assist the management of the area for biodiversity. A vegetation map of the area was produced to enhance the interpretation of this information and assist with management planning.

Twenty-eight quadrats were selected from across the study area to sample the maximum variety of habitat types. A further 221 sites were sampled for dominant vegetation to assist with the mapping which was done using supervised classification of satellite imagery data. Each quadrat was sampled for vegetation, birds, reptiles, mammals and invertebrates using the standard methods adopted for the Biological Survey of South Australia. Extra methods were used to opportunistically sample bats and also to search for signs of Marsupial Moles.

Sites sampled ranged from swamps and drainage lines to breakaway hills and sand dunes. These supported a variety of grasslands, shrublands and low woodlands. Fourteen vegetation types were described and these were mapped into nine mapping classes. Mt Willoughby IPA is now known to support at least 225 plant taxa (3 introduced) from 29 Families. No species with national or South Australian conservation status ratings were recorded at quadrats, however a number of endemic species were recorded or would be expected to occur in the breakaway habitats given suitable rainfall events.

Twelve native and 6 introduced mammal species were recorded during the survey, none are currently rated as rare or threatened. Seventy-four bird species were recorded at the 28 survey quadrats with a further twelve being observed away from sites. Six species with current conservation significance ratings were recorded at quadrats including a rediscovery of the northern population of Slender-billed Thornbill. Forty-five reptile species were recorded during the survey and 47 are now known to inhabit the IPA. The Bronze-back Legless Lizard, the only reptile with an Australian conservation status rating, was recorded at one site. One species of frog was detected after a shower of rain. Invertebrates from 79 Families in 22 Orders were collected during the survey.

As the Mt Willoughby IPA represents the only area of the breakaways region managed with biodiversity protection as an objective, the bulk of cattle should be removed to enable regeneration of the vegetation and fauna communities in this area. Because of the dry conditions during the survey, further surveys targetting specific species are needed to establish the areas' conservation value for some of the rarer and endemic species known to occur in the region.

Figure 1. Residual hills E of Brumby Creek, Mt Willoughby I. P. A. Photo: AC Robinson.

Figure 2. The spectacular wolf spider *Lycosa bicolor* from the mulga sand plains of the Mt Willoughby I. P. A. Photo AC Robinson.

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ACKNOWLEDGEMENTS

The Commonwealth of Australian provided funding for this project through the Tjirilia Aboriginal Corporation from the Indigenous Protected Areas Fund. The Government of South Australia provided assistance with personnel and equipment.

William Lennon Senior assisted with site selection and provided advice on the Aboriginal Heritage significance.

The following people contributed to data collection that made this report possible: Kirrily Blaylock, Jane Cooper, Deb Hopton, Justin Jay, Gavin Kluske, Frank Kutche, John McDonald, Queale.

David Gibson and David Thompson assisted with vegetation map processing, design and production.

David Symon and staff from the Plant Biodiversity Centre provided determinations of vouchered plants.

Mark Hutchinson and David Stemmer provided determinations of vouchered reptiles and mammals.

The Pastoral Management Branch (department for Land, Water and Biodiversity Conservation) provided property information for Mt Willoughby Station.

Tonia Wright assisted with data entry and verification and Nerissa Haby provided assistance with PC-Ord analyses.

INTRODUCTION

PHYSICAL CHARACTERISTICS

Mt Willoughby Indigenous Protected Area (IPA) has a diverse suite of landforms and related physical characteristics. It lies across two biogeographical regions of Australia, the Stony Plains and the Great Victoria Desert (IBRA Version 5 - Thackway & Creswell 1995). Within these regions are sub-regions that were originally described for South Australia as Environmental Associations (Laut *et al.* 1977). Four of these Environmental Associations straddle Mt Willoughby IPA (Figure 3).

The Great Victoria Desert (GVD) biogeographical region is described as: "Arid active sand ridge desert of deep Quaternary aeolian sands overlying Permian and Mesozoic strata of the Officer Basin. Tree steppe of *Eucalyptus gongylocarpa*, Mulga (*Acacia aneura*) and *E. youngiana* over hummock grassland dominated by *Triodia basedowii*. Arid with summer and winter rain" (Thackway and Creswell 1995). This description is more typical of the bulk of the region to the west of Mt Willoughby and not particularly appropriate for Mt Willoughby. Laut *et al.* (1977) was more targeted with the description for the east of the Western Sandplains Environmental Region (8.2): "In the east where drift sands overlie the silcrete plain which further to the east becomes region 8.3, Mulga woodlands with an understorey of kerosene grass (*Aristida contorta* or *A. browniana* on deeper sands), or kerosene grass and blackheads (*Enneapogon* spp.) on shallower sands are dominant…".

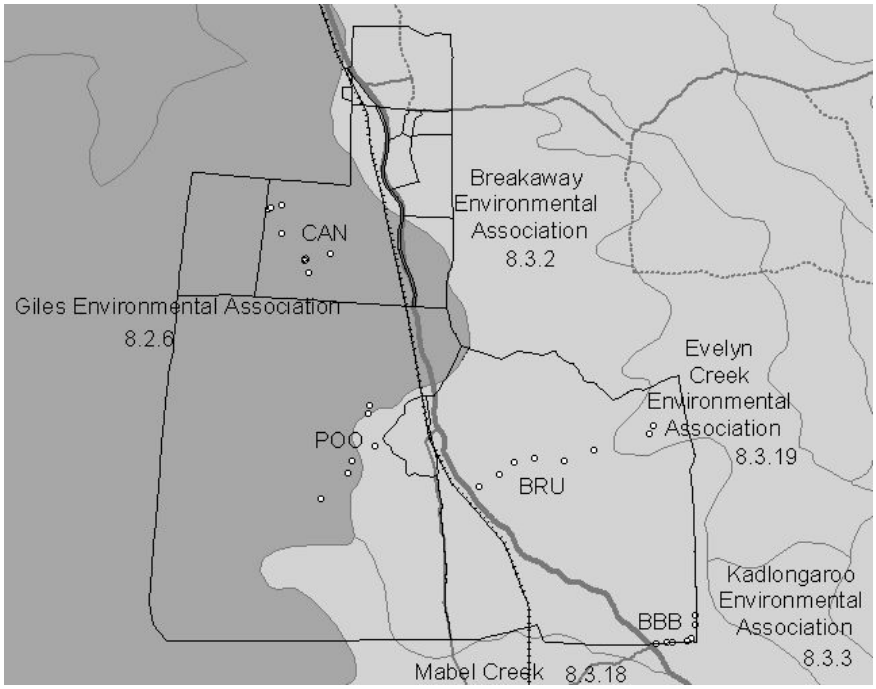


Figure 3. Mt Willoughby Indigenous Protected Area (inside the black thin line) in relation to the two environmental regions (dark and light shaded areas) and their relevant associations. Survey quadrats are indicated by white centred circles and labelled with the three-letter quadrat prefix.

Only the Giles Environmental Association of the GVD region falls within the Mt Willoughby IPA. This area was described as a gently undulating plain with dunes and gibber-covered rises, and a dense relict drainage system. There is a cover of low open woodland with a grass understorey and chenopod shrubland." The dominant land unit is sandy plain often with a surface strew of iron stone gravel supporting a tall shrubland of Mulga over Blackheads, Kerosene Grass and forbs with minor low shrublands of Bladder Saltbush (*Atriplex vesicaria*) over bindyi (*Dissocarpus*/*Sclerolaena* spp.). Rises with iron stone gravel or calcrete are subdominant in this association supporting Low Open Woodlands of Mulga, *Hakea*, *Senna* and *Eremophila*. Sand dunes supporting a shrubland of *Senna, Eremophila* and Mulga over Kerosene Grass are minor features as are depressions that support low shrublands of chenopods such as Bluebush, Samphire and Sandhill Canegrass (*Zygochloa paradoxa*)(Laut *et al.* 1977).

The other three associations are within the Central Tablelands Environmental Region (8.3), which is characterised by two main landform types, "…the stony silcrete tablelands and the lower-lying gibber and gypsum plains with duplex soils or calcareous earths". The Breakaway Environmental Association (8.3.2) is the most dominant across the Mt Willoughby IPA and was described as "a dissected silcrete tableland and mesas, and extensive gibber-covered footslopes on deeply weathered shales. There is a cover of chenopod shrubs and forbs with small areas of low woodland…". The dominant land units are footslopes covered with silcrete gibber/porcelanite stones supporting a low shrubland of Bladder Saltbush, samphires over bindyi and other forbs. The subdominant silcrete covered mesas support similar vegetation to the footslopes with minor areas of Mitchell Grass. Of minor extent are ridges and escarpments with siliceous rocky outcrops supporting chenopod shrubs and floodplains supporting tussock grassland and Low Woodland with Gidgee, Coolibahs and River Red Gums (Laut *et al.* 1977).

The Kadlongaroo Environmental Association does not quite map to the south-eastern tip of Mt Willoughby IPA but its typical undulating plain and low gypcrete escarpments are a feature of this southern part of the IPA. The Mabel Creek Environmental Association extends into the southern part of the IPA and is a gently undulating plain with broad floodplains and occasional low silcrete rises. Rises are sparsely vegetated with Mulga and *Hakea* spp. whilst the depressions and creeks have tall open shrublands and woodlands of Mulga and occasionally eucalypt woodland. The Evelyn Creek Environmental Association juts into the eastern boundary of the IPA and is dominated by shaly gibber plains of Bladder Saltbush and Mitchell Grass feeding into the floodplain of Evelyn Creek which supports a Gidgee and Coolibah Low Woodland (Laut *et al.* 1977).

The Mt Willoughby IPA was previously Pastoral Leasehold land and was therefore subject to assessment/inspection by the Pastoral Management Branch for the South Australian Pastoral Board (Fleming: unpubl. assessment report, Pastoral Board SA ~2001). Each paddock as depicted in Figure 4 has been described through this process and is presented below:

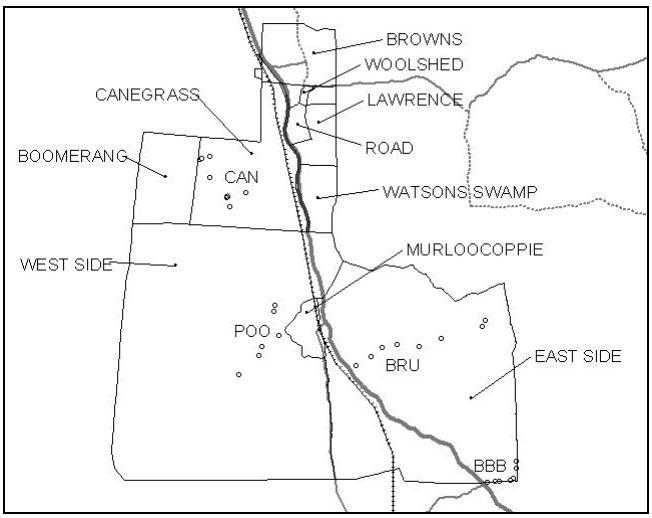


Figure 4. Mt Willoughby paddock fencelines and their names (Pastoral Management Branch SA). Survey quadrats are indicated by white centred circles and labelled with a three letter quadrat prefix.

Boomerang Paddock 226 km^2 - This entire paddock is comprised of the Mulga dominated low red dunes and sandplains of the Great Victoria Desert. Shrubs in the understorey include Green Emubush, 'Y' Cassia (*Senna*) and Desert Cassia. Grasses include Woollybutt, Buck Wanderrie, Bandicoot Grass, Kerosene Grass, Tall Kerosene Grass and Long Grey-beard Grass. The Terminus Creek runs east west through the northern end of the paddock.

Browns Paddock 181 km^2 - The western side of this paddock consists of the hard bare flats, low rises and shallow sand spreads typical of the Mt Willoughby land system. Dense stands of Mulga occur on fertile sandy patches between the flats and in the drainage lines. Woody shrubs are widespread, including numerous species of *Senna* and *Eremophila*. Shallow sand spreads on hard pebbly clay flats and rises support Kerosene Grass. Other grasses and palatable plant species are restricted to the deeper soils in the fertile sandy patches, drainage lines and in shallow gilgais on the gibber tableland. Numerous Mulga watercourses dissect the eastern half of the paddock, which slopes down from open Bladder Saltbush tableland in the north and from Mulga and Myall dominated breakaway country in the south-east. The Evelyn Creek runs through breakaway country in the southern part of the paddock.

Browns Bore is the major stock watering point in the paddock. Stock would also have once watered from the well at the Mount Willoughby homestead, the oldest man-made watering point on the lease. Sheep were run on these older waters in addition to cattle up until 1958. Browns Bank and Liar Waterhole are minor waters and are often dry.

Canegrass Paddock 460km^2 - Mulga dominates this paddock, which lies entirely within the Mount Willoughby land system. Low, confused red-dunes and sand spreads are separated by hard pebbly red clay flats or extensive low stony rises. There are some areas of open gibber tableland on the eastern side but elsewhere the mulga woodland ranges from open to very dense, particularly in the drainage lines. Numerous Nitre Goosefoot swamps occur throughout the paddock, some of which last for several months after filling. The Terminus Creek runs east-west through the centre of the paddock, exiting at Boomerang Bore on the western side.

East Side Paddock 1631 km^2 - This large paddock consists mainly of the low hills, mesas, scarps, outwash slopes and numerous drainage lines of the Breakaway landsystem. A long strip of Paisley land system, which is comprised mainly of Bladder Saltbush tableland on escarpment tops, runs from south to north-west, creating a drainage divide. East of the divide the creeks run east into Mount Barry, west of the divide the creeks run south-east into the Box Hole and Woorong creeks. The breakaway country is dominated by Mulga, Western Myall and Shrubby Myall, with an understorey of Bladder Saltbush. Larger drainage lines support Coolibah and River Red Gum. Patches of Low Bluebush occur frequently through the south-west of the paddock.

Lawrence Paddock 88 km^2 - Undulating gibber tableland with bladder saltbush and numerous gilgais in the west give way to a more uniform gibber clad surface with Rock Emubush and fewer, shallower gilgais nearer to Lawrence Dam. The north and east of the paddock consist of the numerous hills, slopes and mulga dominated drainage lines of the Breakaway landsystem. Patches of Low Bluebush occur on some slopes in the breakaway country. Lawrence Dam is the only waterpoint.

Road Paddock 32 km^2 - The only stock water in this paddock is from several small Nitre Goosefoot swamps along the western perimeter, two of which last for several months after filling. A small portion of the paddock at the northern end is dominated by Mulga and woody shrubs with little ground cover. Most of the remainder consists of open undulating gibber tableland with moderately dense Bladder Saltbush. Numerous deep gilgais support Barley Mitchell Grass and Neverfail.

Watson's Swamp 94 km^2 - Watson's Swamp is located in the centre of the paddock with Matheson's Bore on the southern fence. Matheson's Bore is the only permanent waterpoint. The southern end of the paddock consists of sandy areas and low dunes dominated by dense mulga. Dunes are separated by hard flats that are either bare or supporting woody shrubs, including Bastard Mulga and Dead Finish. Woollybutt, Buck Wanderrie, Bandicoot Grass and Tall Kerosene Grass are the more common grasses on the sandy areas with Neverfail and Kerosene Grass in the understorey of the interdune areas. The northern portion of the paddock consists of open undulating Bladder Saltbush tableland.

West Side Paddock 2234 km^2 - The greater part of the paddock is comprised of the mulga dominated low red dunes and sandplains of the Great Victoria Desert. This western part has no water and the few bores that lie within the mulga scrub are not currently in use. Shrubs in the understorey include Green Emubush, 'Y' Cassia and Desert Cassia. Grasses include Woolybutt, Buck Wanderrie, Bandicoot Grass, Kerosene Grass, Tall Kerosene Grass and Long Grey-beard Grass. All of the dams and most of the other major waters lie in the breakaway country in the south-eastern corner of the paddock. This area is mainly undulating Bladder Saltbush gibber tableland with patches of Low Bluebush and numerous Mulga watercourses. The major creeks are the Woorong and Box Hole Creeks, both of which run south into Mabel Creek Station.

CLIMATE

The climate of the region has been described as warm to hot in summer and cool to cold in winter, with extremely low and unreliable rainfall and very high evaporation throughout the year (Laut *et al.* 1977). Coober Pedy, which is 30km south of the southeastern corner of Mt Willoughby, is the closest long-term weather station. This station has been gathering rainfall data since 1921 and averages 157mm per year, but ranges from a minimum of 30mm (1929) to 427mm (1973). Figure 5 highlights the variability of annual rainfall and Figure 6 demonstrates the lack of seasonallity for this rainfall with uniformly low monthly averages.

Coober Pedy average monthly temperature varies from a 37^0C maximum and 22^0C minimum in February to a 19^0C maximum and 6^0C minimum in July. Daily summer maximum temperatures well over 40^0C are not uncommon, as are winter minimums well below 0^0C (refer to Figure 7).

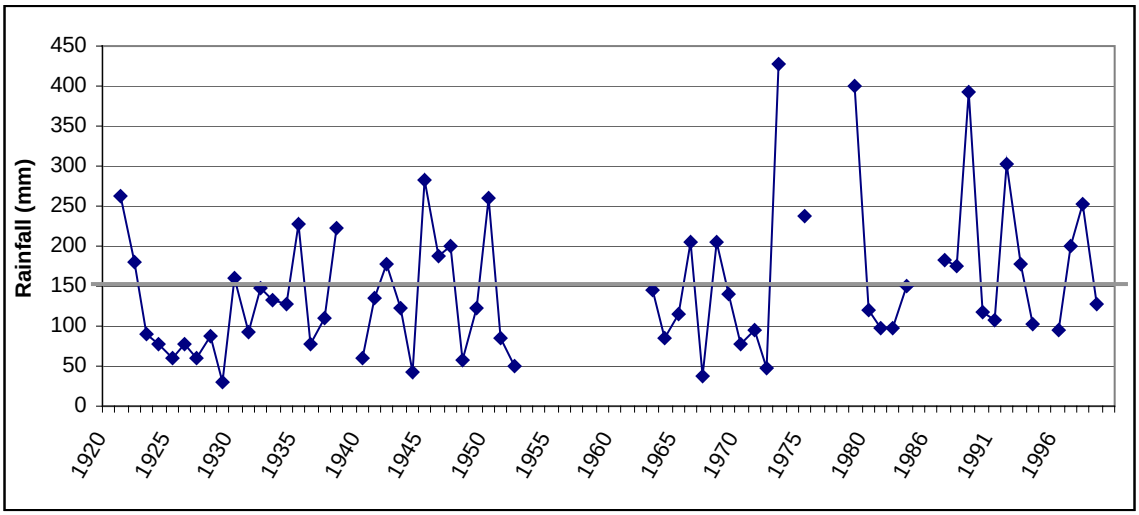


Figure 5. Annual rainfall totals 1921 to 2000 for Coober Pedy (data from Bureau of Meteorology). Horizontal line indicates annual average (157mm).

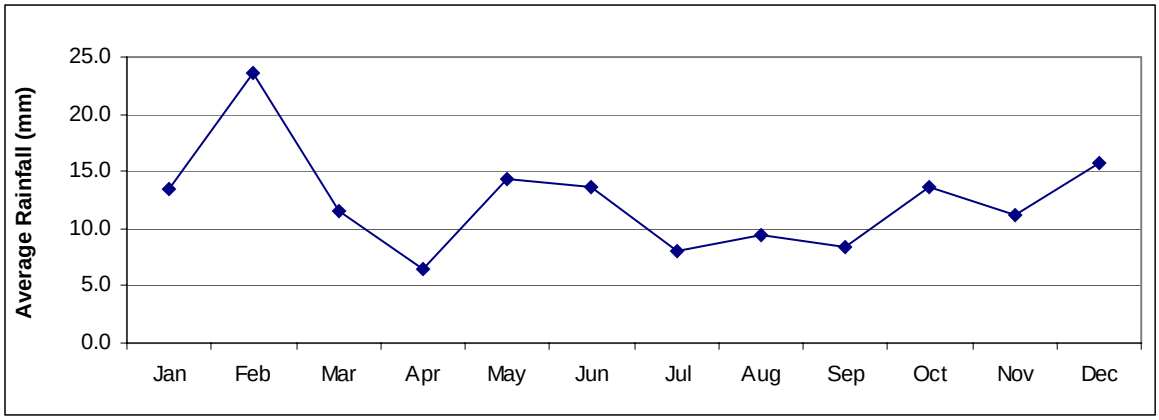


Figure 6. Average monthly rainfall for Coober Pedy since 2001 (data from Bureau of Meteorology).

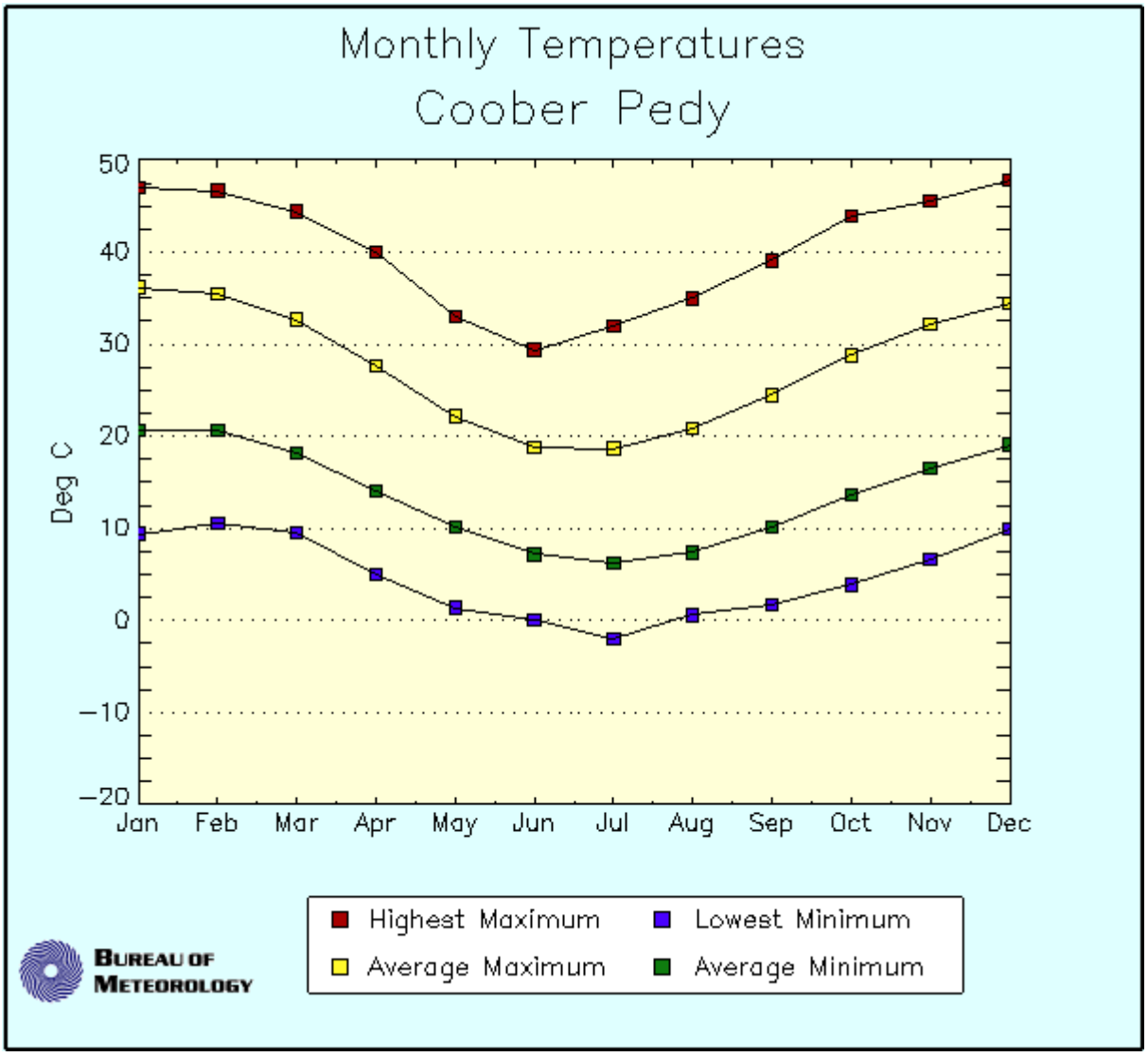


Figure 7. Average monthly temperatures for Coober Pedy since 2001 (data from Bureau of Meteorology).

PREVIOUS BIOLOGICAL SURVEYS

There have been five specific biological surveys in the areas surrounding Mt Willoughby IPA. The earliest was an undergraduate student project in the Breakaways Reserve area to the south (Hobbs 1987). The Department for Environment undertook a survey of the Tallaringa Conservation Park prior to its dedication (Robinson *et al.* 1988) in the sandy areas to the west. The Australian & New Zealand Scientific Exploration Society undertook two surveys in the hills of Arkaringa Station to the north-east (ANZSES 1994, 1995). The stony plains and breakaways to the east and north-east were sampled in 1995 as part of the Biological Survey of the Stony Deserts (Brandle 1998). The Biological Survey of the Anangu-Pitjantjatjara Lands sampled the hard mulga and sand country to the north and north-west in 1996 and 1998 (Robinson *et al.* 2003). A number of quadrats were also sampled in 1992 on Evelyn Downs Station adjacent to the north east of Mt Willoughby as part of a threatened species project, the results of which were included in Biological Survey of the Stony Deserts (Brandle 1998).

METHODS

This survey for the Tjiriliya Aboriginal Corporation of the Mt Willoughby IPA contributes to the Biological Survey of South Australia. The methods used to survey the flora and fauna are consistent with the methodology first developed for the Biological Survey of the Nullarbor and Yellabinna Regions (Copley and Kemper 1992). They were also used for the Biological Survey of the Stony Deserts of SA (Brandle 1998) for which the study area covered the eastern half of Mt Willoughby IPA. The two manuals detailing these methods are available from the South Australian Department for Environment and Heritage web site under Survey Methods:

http://www.environment.sa.gov.au/biodiversity/biosurveys.html (Heard and Channon 1997, Owens 2000).

QUADRAT SELECTION

Vegetation information for the IPA was limited to quadrat information collected at 12 strategic sites for the Pastoral Assessment Program. There was no similar effort for fauna data collection, and the records of the South Australian Museum indicated that very few specimens in their collections came from this area (three mammals, 18 reptiles and three frogs). The original Atlas of Australian Birds (Blakers *et al.* 1984) sampled five quadrats within the IPA boundary. No sites were sampled in this area between 1997-2001, for the most recent Atlas of Australian Birds (Barrett *et al.* 2003). Existing information was therefore not a determining factor in selection of quadrats for this survey.

Satellite imagery, 1:250,000 topographic maps, vegetation mapping from the Biological Survey of the Stony Deserts (Hudspith and Brandle 1998) and information from Laut *et al.* (1977) was used to determine the range of landform types and vegetation communities likely to be encountered, and their likely distribution across the area. This information combined with track information was used to select four key sample areas. Quadrats were selected in these areas during a reconnaissance trip in September 2003. William Lennon Snr acted as guide and highlighted areas of Aboriginal Heritage significance. These were avoided as potential survey quadrats. Potential survey quadrats were recorded using Global Positioning System recorders and written descriptions. Chosen quadrats were marked with two star droppers set 10m apart as photopoint posts and labelled with an aluminium quadrat tag wired to the camera position post.

The extensive chenopod shrublands were deliberately under-represented in the selected quadrats because of the extensive body of information collected for this habitat type during the Biological Survey of the Stony Deserts SA (Brandle 1998).

PLANT AND ANIMAL SAMPLING

Quadrats were sampled for vegetation over a $100m^2$ area. Vertebrate fauna (mammals, birds, reptiles and frogs) and terrestrial macro-invertebrates were sampled within the habitat type sampled for vegetation and within 500m of the photopoint (Owens 2000). Bats were sampled where conditions were suitable using harp traps, mist nets and an Anabat call detector. Two teams sampled the four key study areas over two weeks from the 1st to 11th October 2003 (Figure 3). Each survey team was independent and consisted of six people: a botanist and assistant; a herpetologist; a mammalogist; an ornithologist; and a technical assistant. All survey quadrats data is stored in the Survey Database (South Australian Government Environmental Databases)

Plant and animal records were also collected on an opportunistic basis across the study area. This involved recording particular species, the map grid Australia coordinates using a global positioning device or a map, and written notes about the habitat. Spotlighting results away from survey quadrats were treated as opportunistic records and are stored in the Opportune Database (South Australian Government Environmental Databases).

MARSUPIAL MOLE SAMPLING

Sampling for Marsupial Moles *Notoryctes typhlops* was included in this survey to help determine the eastern extent of this species in sandy country connected to the Anangu-Pitjantjatjara Lands. Mole trench methods developed by Joe Benshemesh were used along two dunes north of the POO Camp. Three trenches were dug at POO00101 and POO00301 and on a dune a further 6 km NNE (54/414023mE/6863192mN). These were checked for evidence of mole burrows five days later and filled in. Refer to Appendix 8 for full details.

DATA ANALYSIS

Vegetation and vertebrate data was analysed for species community similarities between quadrats using PC-ORD 4 (McCune and Mefford 1999). The cluster analysis option was used to define groups of species based on their similarities using the Relative Sorensen Distance Measure and Ward's Linkage Method. The relationship between these clusters was represented on a dendrogram. The NMS Ordination option was used to compare the relationship of clusters to environmental variables to help decide on the number of groups presented in the results. The indicator analysis option was then chosen to determine and display: the relative abundance of a species within each group, the relative frequency of a species within each

group, the indicator values for each species, and a Monto Carlo test of significance (*p*-value) of observed maximum indicator value for species based on 1000 permutations. The indicator value was based on combining the values of relative abundance and relative frequency.

VEGETATION MAPPING

Overview

Mapping vegetation for the Mt Willoughby IPA was conducted using a method similar to that developed for the Biological Survey of the Sandy Deserts of South Australia (Phase one:- Simpson and Tirari Deserts (Sparrow in prep.)). This method utilised image processing methods and available field data to attribute meaning to image variability detected in the Satellite imagery.

Field data were acquired from information collected at full survey sites as well as purpose collected vegetation mapping sites. This field data was analysed using the PCOrd cluster analysis program and combined with image data to determine vegetation mapping groups. The satellite imagery classification was then attributed with these mapping groups and a process of vectorisation and generalisation of the classification was conducted to produce the Mt Willoughby vegetation map.

Image Acquisition

For the Mount Willoughby area, suitable imagery was obtained from a state wide coverage taken in summer 1999-2000. It was necessary to acquire "dry" images from a time when there was little preceding rain in the previous six months to minimise the spectral effect of ephemeral plant growth. Therefore only dominant perennial vegetation has been assessed and mapped as part of this vegetation mapping exercise. In the 12 months preceding the image acquisition there was significantly below average rainfall in the study area (between 40 and 60% of mean (data from Bureau of Meteorology))

The imagery that is available over the Mt Willoughby area has the following attributes:

Sensor: Landsat 7 ETM+
Scene : 101/80
Date Acquired: 31/1/2000

This scene was already rectified to an average RMS of 22.0m meaning that the spatial accuracy was within that of 1:50,000 mapping accuracy standards. The Mount Willoughby area falls entirely on this scene.

This scene was trimmed to an area defined by the Mt Willoughby pastoral lease boundary and a 10 kilometre buffer. The imagery was clipped to the property boundary so that image analysis and classification was confined to the study area. A 10 kilometre buffer was determined to allow for future edge mapping of this dataset to the other mapping datasets both to the east (Stony Deserts mapping) and to the west (Tallaringa mapping).

The resulting image was then classified using standard unsupervised techniques into 50 separate image classes based on spectral differences. This classified image was then split into two separate datasets equating to an image for each of the bioregions within the property. The western section was split off equating to that part of the property that corresponded to the IBRA Great Victoria Desert bioregion and is characterised in the context of the Mt Willoughby survey as that area consisting primarily of dunes, swales and sand plains being generalised as the sandy areas. The eastern section of the property equates to that part of the property that falls within the Stony Plains bioregion which can be broadly described as stony, consisting of gibber tablelands, dissected tablelands and plains. This splitting of the dataset was necessitated by the fact that the division between the two land forms and hence bioregions was in this area fairly distinct. By dividing the dataset into these two halves it significantly reduced erroneous attribution of vegetation classes in widely differing land systems. Each of these two datasets was independently attributed using the results of the clustering technique. Each of these data sets (both the "sandy" and "stony") sections were then attributed individually before recombination into a final dataset.

FIELD VEGETATION MAPPING SURVEY

The full vegetation survey sites collected as part of the Biological survey of the Mt Willoughby IPA were collated and simplified for the vegetation mapping analysis. Any species with a cover abundance code of N or T or 1 (all codes indicating vegetation cover below 5%) were removed for this analysis. This data comprised data from 27 full vegetation survey sites, from 4 distinct areas within the IPA and comprises 159 records that were used in the vegetation mapping analysis.

It was felt that the vegetation mapping would be more accurate (particularly considering the complexity of the landscape in the area) if extra vegetation mapping field data sites were obtained. These were collected on a quad bike to facilitate collection in parts of the property where it was not feasible to collect field data using standard four wheel drive vehicles due to the rugged terrain. This enabled sites to be collected with a good spatial coverage of the property.

These vegetation mapping data collection points were designed to be collected rapidly. Programs on both a laptop computer and palmtop computer that was linked to a GPS were utilised for rapid data collection. At each site a GPS location was recorded along with the species names and cover abundance codes for dominant perennial species (perennial species with an estimated cover greater than 5%) If taxonomy was uncertain a sample of each species was taken and vouchered for later identification at the South Australian Plant Biodiversity Centre by experienced

botanists. A further 221 rapid vegetation sampling sites were utilised using this rapid assessment method. This data included 795 additional species records, of which 272 vouchered for later verification. In total 954 samples were used for the image attribution.

Image attribution.

The image attribution phase of the mapping is where the mapping deviates from standard methodologies. Field data was collated on a spreadsheet with all the appended biological information. This data was then manipulated into the format of site number, Easting, Northing and then as many columns of biological data as needed for the analysis. This data was then loaded as a point coverage into ArcMap.

An add on tool has been developed by the Environmental Information Division of DEH that extracts the information on the positioning of each of the sampling sites and determines the frequency of class values for a certain size matrix of cells from the raster classification that occurs around these field survey sites. The matrix size required is entered by the user when the data is being input. If large areas of homogeneous vegetation occur then a larger matrix size will give a larger number of results to conduct statistics on, however in areas that are heterogeneous then a smaller matrix size is required so that an improper extrapolation from field data does not occur. Due to the complexity of the landscape in the study area, a matrix of 3 x 3 pixels (up to 45 m from the point where the field data is collected from) was utilised.

The results of these frequencies of class occurrence are then attributed to every species record at that site and the major output from the process is a text file that was imported to Excel for sorting and interpretation.

The data is then sorted on image class and a skilled ecologist is utilised to interpret the frequency of species records that occur at the sites where that particular class occurs. This results in the development of ecological classes that the image data is then attributed with. Understandably the method has an increasing robustness with the more field data that can be put into the system. Processing can be done iteratively to determine where more field survey sites are needed. Due to the complexity of the landscape at Mt Willoughby the Sandy and Stony segments were run through this process independently and combined after attribution. Due to the variable nature of this landscape this required that the process be run several times.

Once the attribution was agreed upon the raster data was converted to the correct class codes and filtered to remove class areas with an area less than 10ha. This provided a finalised raster vegetation map. This dataset was further filtered to approximately 100ha and then a raster to vector conversion conducted. The resulting vector dataset was generalised and smoothed before being produced as the completed vector vegetation mapping coverage.

RESULTS

VEGETATION

PHYSICAL ATTRIBUTES

Twenty-eight quadrats were selected from across the study area as depicted in Figure 3 to sample the maximum variety of habitat types in four areas that were chosen to reflect habitat diversity, have reasonable vehicular access, and to avoid areas of Aboriginal Heritage significance (Appendices 1 & 2).

The following physical attributes were sampled in the proportions depicted in Tables 1-3. These included landform pattern types and the more specific elements at each sample quadrat, surface strew/stone size and cover classes, and surface soil textures. Landforms ranged from swamps to breakaway hills, with plains dominating (50% of quadrats). Hill slopes and breakaways are significant landform elements on Mt Willoughby and were represented by 14% of quadrats. Sandy plains and dunes also represented 14% of the sampling effort. Dunes may be under represented in the sampling, as the dunefield on the north-western side of Mt Willoughby was inaccessible for vehicles. Only the four hills and breakaway quadrats had slopes greater than 1% (Table 2). The stony nature of the country is reflected in Table 3. Only four quadrats had no surface stones present and these included a dune crest, sand plain, drainage depression and flood plain. Only two quadrats had cobbles larger than 50mm dominating, and the surface of 64% of quadrats had a strew cover greater than 30%. Surface soil textures ranged from sand to medium clay (Table 4). Mixed soils with sand, clay and loam were the most common surface soils (43% of quadrats) followed by clays (32% of quadrats).

Table 1. Sampling effort across landform elements and types in the survey area.

Landform / Element / Type	swamp	drainage depression	flood out	stream channel	plain (incl undulating plain)	stony plain	sandy plain	dune crest	hill slope	Breakaway	Total No. quadrats
Flood plain	**2**	**1**	**1**	**2**							6
Plain	**1**				**1**	**11**		**1**			14
Sand plain							**3**				3
Rises				**1**					**1**		2
Escarpment										**3**	3
Total No. quadrats	3	1	1	3	1	11	3	1	1	3	28

Table 2. Slopes and aspects of quadrats sampled.

QUADRAT Aspect \ % Slope	0%	1%	5%	10%	20%
0	13				
3		1			
18				1	
20			1		
22		1			
65		1			
90		1			
106		1			
170		1			
180		2	1		
330		1			
360		2			1

Table 3. Surface strew size and cover summary for quadrats sampled.

Strew size \ cover	0%	1 <10%	2 10-30%	3 30-70%	4 > 70%	Total
none apparent	**4**					4
Pebble (5-50 mm)		**5**	**1**	**12**	**4**	22
Cobble (51-250 mm)				**1**	**1**	2
Total	4	5	1	13	5	28

Table 4. Surface soil type and texture classification summary for quadrats sampled.

Soil Type	No. quadrats	Surface texture	No. quadrats
Sand	1	Sand	1
Sand/Loam	3	Loamy Sand	2
		Sandy Loam	1
Loam	1	Loam	1
Sand/Loam/Clay	12	Fine Sandy Clay Loam	4
		Sandy Clay Loam	8
Loam/Clay	1	Silty Clay Loam	1
Sand/Clay	1	Sandy Clay	1
Clay	9	Light Clay	2
		Light Medium Clay	4
		Medium Clay	2
		Silty Clay	1

VEGETATION STRUCTURE

The structural vegetation formations at quadrats ranged from ephemeral tussock grassland on clay gibber plains to Coolibah *Eucalyptus coolabah* and River Red Gum *E. camaldulensis* woodlands in swamps and drainage lines (Table 5). Low Shrublands dominated by chenopod shrubs (25% of quadrats sampled), Mulga Low Woodlands (25% of quadrats sampled) and emubush Shrublands (18% of quadrats sampled) were the dominant vegetation types.

Table 5. Vegetation structure and formation summary for quadrats sampled.

Veg Structure	No. quadrats	Formation	No. quadrats
Grassland	1	Very Open (Tussock) Grassland	1
Low shrubland	8	Low Open Shrubland	2
		Low Shrubland	2
		Low Very Open Shrubland	3
		Very Low Open Shrubland	1
Shrubland	5	Open Shrubland	4
		Shrubland	1
Tall shrubland	1	Tall Open Shrubland	1
Mallee	1	Very Open Mallee	1
Low woodland	9	Low Woodland	4
		Very Low Open Woodland	2
		Very Low Woodland	3
Woodland	3	Low Open Forest	1
		Open Woodland	1
		Woodland	1

TAXONOMIC SUMMARY

The survey recorded 206 plant taxa from 28 Families at survey quadrats. Ninety-nine plant taxa from 21 Families were recorded at twelve Pastoral Assessment Program sites (1997 and 2001) bringing the total known for Mt Willoughby to 225 taxa from 29 Families (Table 6). Chenopodiacae, Graminae and Leguminosae were the dominant families with 32 species each, making up 47% of the total species recorded. Appendix 4 provides a full species list. Of 35 plant species recorded opportunistically away from quadrats, 11 were not recorded at quadrats (Appendix 5).

Table 6. List of plant Family names recorded in Mt Willoughby IPA at Biological Survey of South Australia quadrats (N=28) and Pastoral Assessment Program sites (N=12).

FAMILY	No. species Survey	No. species Pastoral
ADIANTACEAE	1	0
AIZOACEAE	3	2
AMARANTHACEAE	7	4
ASCLEPIADACEAE	3	1
BORAGINACEAE	2	0
CAMPANULACEAE	1	0
CAPPARACEAE	1	0
CHENOPODIACEAE	32	25
COMPOSITAE	23	10
CONVOLVULACEAE	1	1
CRUCIFERAE	2	2
CYPERACEAE	1	0
ELATINACEAE	1	0
EUPHORBIACEAE	3	1
FRANKENIACEAE	1	0
GENTIANACEAE	1	0
GERANIACEAE	1	2
GOODENIACEAE	7	1
GRAMINEAE	32	12
HALORAGACEAE	1	0
LABIATAE	1	0
LEGUMINOSAE	32	12
LORANTHACEAE	3	1
MALVACEAE	10	6
MARSILEACEAE	2	0
MYOPORACEAE	10	7
MYRTACEAE	3	0
PITTOSPORACEAE	1	0
PLANTAGINACEAE	0	1
POLYGALACEAE	1	0
POLYGONACEAE	2	0
PORTULACACEAE	3	2
RANUNCULACEAE	1	0
SANTALACEAE	2	1
SAPINDACEAE	1	0
SCROPHULARIACEAE	1	0
SOLANACEAE	5	5
UMBELLIFERAE	2	1
ZYGOPHYLLACEAE	2	2
TOTALS	**206**	**99**

COMMON SPECIES

Only 19 species were recorded at 25% or more of the quadrats sampled in the survey and only three at more than 50%. This reflects the diversity of landforms and soil types covered by survey quadrats as the three most commonly encountered species are able to grow on a wide variety of landforms and soil types.

Table 7. Frequency of plant species at quadrats and the average of cover abundance estimates. The table is sorted in decreasing quadrat frequency and only species at 25% or more of quadrats are shown.

SPECIES	Common Name	No. quadrats	%	Ave. cover
Acacia tetragonophylla	Dead Finish	21	75	0.49
Acacia aneura	Mulga	18	64	1.02
Salsola kali	Buckbush	15	54	0.50
Atriplex vesicaria ssp.	Bladder Saltbush	14	50	1.22
Eremophila freelingii	Rock Emubush	14	50	0.96
Aristida contorta	Curly Wire-grass	14	50	0.59
Trichanthodium skirrophorum	Woolly Yellow-heads	13	46	0.32
Eremophila paisleyi	Paisley's Emubush	12	43	0.43
Senna artemisioides nothossp. *coriacea*	Broad-leaf Desert Senna	12	43	0.32
Ptilotus obovatus	Silver Mulla Mulla	11	39	0.54
Eragrostis xerophila	Knotty-butt Neverfail	10	36	0.69
Santalum lanceolatum	Plumbush	9	32	0.50
Enneapogon avenaceus	Common Bottle-washers	8	29	0.60
Senna artemisioides nothossp. *artemisioides*	Silver Senna	8	29	0.26
Sclerolaena eriacantha	Silky Bindyi	7	25	0.29
Enneapogon polyphyllus	Leafy Bottle-washers	7	25	0.53
Acacia papyrocarpa	Western Myall	7	25	0.47
Enchylaena tomentosa	Ruby Saltbush	7	25	0.29
Astrebla pectinata	Barley Mitchell-grass	7	25	0.59

SIGNIFICANT SPECIES

No plant species with current threatened Australian and South Australian conservation significance ratings (EPBC Act 2000, SANPW Act 2000) were recorded at survey quadrats. However, a number of species were recorded that are endemic to the region, or are Rare in South Australia. One species collected, *Erigeron sessilifolius*, is the first record of this species in South Australia since 1927 and has only been collected at two other localities, one in NSW and one in NT (Australia's Virtual Herbarium www.anbg.gov.au/cgi-bin/avh.cgi).

ENDEMIC SPECIES

Barker's Mulla Mulla *Ptilotus barkeri* SA R
This hairy, small shrub is known only from shaly, lower breakaway slopes in the west Lake Eyre Basin (Badman 1995). It was collected opportunistically in 1997 west of Evelyn Downs Station and south east of Coober Pedy in the west region, for the Stony Deserts Biological Survey (Brandle 1998). During the Mt Willoughby Survey it was recorded on a bare shaly slope with scattered Bladder Saltbush *Atriplex vesicaria* and Silver Mulla Mulla *Ptilotus obovatus*.

Figure 8. *Ptilotus barkeri.* Photo PJ Lang.

RARE SPECIES

Bergia perennis* ssp. *exigua
This prostrate perennial that sometimes has woody older stems (Jessop & Toelken 1986), has been recorded from the central-east of Western Australia, South West Queensland, and the Lake Eyre herbarium region in South Australia (Hnatiuk 1990). Three previous collections in South Australia and NT are represented on Australia's Virtual Herbarium (www.anbg.gov.au/cgi-bin/avh.cgi). During the survey it was recorded as very sparely present at one quadrat CAN00101. This sandy clay-loam swamp quadrat had a 30-70% soil cover of pebbles and supported a woodland of Coolibah *Eucalyptus coolabah* over Lignum *Muehlenbeckia florulenta*.

Erigeron sessilifolius
A hairy annual herb 10-35cm high that grows on creek and waterhole edges. Known from three SA collections made between 1916-1927 (Jessop & Toelken 1986). It has also been collected in the eastern NT and western NSW (Hnatiuk 1990, Australia's Virtual Herbarium www.anbg.gov.au/cgi-bin/avh.cgi). During the survey it was recorded as sparsely present at quadrat CAN00201. This medium clay swamp quadrat had a <10% soil cover of pebbles and supported a shrubland of Nitre Goosefoot *Chenopodium nitrariaceum* with Swamp Canegrass *Eragrostis australis*.

***Peplidium* "marla" (WR Barker 3535)**
This fleshy leaved perennial with branches to 30cm (Jessop & Toelken 1986 *Peplidium* sp.B) has been recorded at a number of disparate locations in South Australia to the north-east and north-west of Mt Willoughby and in western New South Wales (www.anbg.gov.au/cgi-bin/avh.cgi). During the survey it was recorded as very sparely present at quadrat CAN00101. This sandy clay-loam swamp quadrat had a 30-70% soil cover of pebbles and supported a Coolibah *Eucalyptus coolabah* woodland over Lignum *Muehlenbeckia florulenta*.

Figure 8. *Peplidium* "marla". Photo AC Robinson.

Sand Pea *Muelleranthus stipularis*
A small prostrate herbaceous plant (Jessop & Toelken 1986) that has been recorded in one Western Australian Herbarium region, two in south west Queensland, western New South Wales, Southern Northern Territory and north-west South Australia (Hnatiuk 1990). During the survey it was recorded as sparsely present at quadrat CAN00601. This loamy sand plain quadrat has a soil cover of 30-70% pebbles and supports a very low woodland of Mulga *Acacia aneura* over grasses dominated by Swamp Wanderrie *Eriachne mucronata* and Knotty-butt Neverfail *Eragrostis xerophila*.

Figure 9. *Muelleranthus stipularis.* Photo AC Robinson.

Central Australian Milkwort *Polygala isingii*
This prostrate, sometimes densely branched, herb (Jessop & Toelken 1986) is known from eastern Western Australia, southern Northern Territory, south-west Queensland and the Lake Eyre Basin in South Australia (Hnatiuk 1990). During the survey it was recorded as very sparsely present at quadrat CAN00301. This sandy clay loam, stony plain quadrat had a 30-70% cover of pebbles and supported a Rock Emubush *Eremophila freelingii* shrubland over ephemeral grasses and *Sclerolaena* spp.

SPECIES WITH LIMITED DISTRIBUTIONS NOT RECORDED ON SURVEY BUT MAYBE PRESENT

***Gunniopsis tenuifolia* SA endemic**
This perennial, rounded, glabrous shrub to 1m high (Jessop & Toelken 1986) was known from the Lake Eyre and Gawler Herbarium Regions in South Australia (Hnatiuk 1990). The Australian Virtual Herbarium indicates that this species has been collected from at least three localities on Arkaringa Station to the north-east and a further seven locations south of Lake Eyre to the Willouran Ranges (www.anbg.gov.au/cgi-bin/avh.cgi).

Figure 10. *Gunniopsis tenuifolia.* Photo PJ Lang

***Goodenia chambersii* SA R**
This erect to ascending shrub to 50 cm high was considered endemic to the Lake Eyre Botanical Region (Jessop *et al.* 1986, Hnatiuk 1990). It was recorded during a biological survey of the stony deserts in the Lake Eyre South and West regions in low open woodland/low open shrubland associated with breakaways and hills (floristic groups 1, 2), and Acacia woodland creeks (floristic group 5) in the same landforms (Brandle 1998). Badman (1995) reports the species as generally uncommon in the west region. Records in the Australian Virtual Herbarium indicate that this species has been collected from multiple localities from similar landforms and ranges in the west Lake Eyre Basin and isolated specimens come from the Indulkana, Musgrave and Petermann Ranges to the North West (www.anbg.gov.au/cgi-bin/avh.cgi). The Environmental databases of South Australia indicate that this species may also be present in the northern Flinders Ranges (not verified by a voucher specimen, Neagle 2003).

Figure 11. *Goodenia chambersii.* Photo PD Canty

***Zygophyllum crassissimum* SA R**
A glaucous perennial sub-shrub known from the North-West and Lake Eyre Botanical Regions (Jessop *et al.* 1986, Hnatiuk 1990). The three records of this species (including an interesting orange flowered form) during the biological survey of the stony deserts came from the Lake Eyre South region (Brandle 1998). The species was reported to favour the gypseous breakaway hill slopes that supported *Atriplex vesicaria* low very open shrubland with emergent *Acacia tetragonophylla / Eremophila freelingii* shrubs. It was also recorded in gypseous sandy creeklines supporting Gidgee woodland in the same region. Herbarium collections from gypseous flats and rocky rises are reported for the north-west (Symon 1984b) and the west regions (Badman 1995) of the study area. The Australian Virtual Herbarium indicates that this species is present in the central-southern Northern Territory and in Witjira National Park (www.anbg.gov.au/cgi-bin/avh.cgi).

Figure 12. ***Zygophyllum crassissimum.*** **Photo PD Canty.**

Othonna gypsicola **SA Endemic R**

An annual yellow flowered, purplish leaved herb known only from west of Lake Eyre (Brandle 1998) and was first collected in 1989 (Badman 1995). Also collected by RB Bates and DE Symon on separate trips in 1997 on gypseous cracking clay areas near Coober Pedy and Oodnadatta (Brandle 1998). The Australian Virtual Herbarium indicates that this species is restricted to the breakaways and moon plain areas immediately to the north-east and south-east of Mt Willoughby IPA (www.anbg.gov.au/cgi-bin/avh.cgi). This species was recorded on gypseous lower slopes of breakaways north east of Mt Willoughby on Arkaringa station following heavy autumn rain in 2000 (PJ Lang pers. comm.).

Figure 13. ***Othonna gypsicola.*** **Photo PJ Lang.**

Olearia **sp. 'nov.' "Arkaringa" Arkaringa Daisy**

This daisy was first discovered on a powdery gypseous breakaway slope on Arkaringa Station in May 2000 (PJ Lang Pers. comm.). Whilst this as yet undescribed species appears to be very restricted, similar habitats exist on Mt Willoughby between the Brumby Creek quadrats BRU00501 and BRU00601.

Figure 14. Arkaringa Daisy. **Photo AC Robinson.**

INTRODUCED SPECIES

Only three introduced species (<2% of 206 species sampled) were recorded at six of the 28 study quadrats. No quadrat had more than one species present and all but one quadrat had these species sparsely or very sparsely present. No introduced plant records were collected for the pastoral management program. Buffel Grass *Cenchrus ciliaris* was evident along the Stuart Highway in a number of localities. If sampling was done after substantial rains, particularly during winter, it is likely that many more annual introduced species such as Rosy Dock *Acetosa vesicaria* would be encountered. Most of the 25 alien species recorded for the Biological Survey of the Anangu Pitjantjatjara Lands (Lang *et al.* 2003) and the 17 alien species recorded in the "West Region" of the Stony Deserts (Brandle 1998) are potentially present on Mt Willoughby, particularly in the vicinity of major roads and the railway line (these are listed in Table 9). The position of these transport corridors at the head of the all of the major catchments in the area has significance for the spread of some of these weeds such as Buffel Grass down stream.

Table 8. Introduced species recorded at quadrats (N = very sparse, T = sparse, 2 = 5-25% cover).

SPECIES	Common Name	BRU00701	CAN00101	CAN00201	CAN00601	POO00201	POO00601
Heliotropium europaeum	Common Heliotrope	N					N
Centaurium spicatum	Spike Centaury		N	T	N		
Eragrostis pergracilis	Small Love-grass					2	

Table 9. Alien species recorded in the Ananngu Pitjantjatjara Lands (Lang *et al.* 2003) and the west region of the Stony Deserts (Brandle 1998)

Species	APL	SDS
Acetosa vesicaria Rosy Dock	*	*
Brassica tournefortii Wild Turnip	*	*
Carrichtera annnua Ward's Weed	*	
Cenchrus ciliaris Buffel Grass	*	*
Cenchrus echinatus	*	
Centaurium spicatum Spike Centaury	*	
Chloris virgatus Feathertop Rhodes Grass		*
Citrullus colocynthis Colocynth	*	*
Citrullus lanatus Bitter Melon		*
Cucumis myriocarpus Paddy Melon	*	*
Cynodon dactylum Couch Grass	*	
Cyperus hamulosus	*	
Datura leichhadtii Thorn-apple		*
Echium plantagineum Salvation Jane	*	
Eragrostis barrelieri Lovegrass	*	
Erodium aureum Heron's-bill	*	*
Erodium cicutarium Cut-leaf Heron's-bill		*
Gypsophila tubulosa	*	*
Heliotropium curassavicum Smooth Heliotrope		*
Heliotropium europaeum Common Heliotrope		*
Lactuca serriola	*	
Malva parviflora Small-flower Marshmallow	*	
Melinus repens	*	
Myosurus minimus var. *australis* Mousetail		*
Ricinus communis	*	
Schismus barbatus Arabian Grass	*	
Sisymbrium erysimoides Smooth Mustard		*
Sisymbrium orientalis Oriental Mustard	*	
Solanum nigrum Black Nightshade	*	
Sonchus oleraceus Common Sow-thistle	*	*
Spergularia rubra Red Sand-spurrey		*
Tamarix aphylla Tamarisk	*	
Tribulus terrestris Caltrop	*	*

Figure 14a. Buffel Grass *Cenchrus ciliaris.*

VEGETATION COMMUNITIES

Cluster analysis of the 28 survey quadrats sampled was used to define 14 vegetation communities. Data from 196 vegetation mapping sample sites (where only perennial plant species with cover >5% were recorded) and other data from 12 Pastoral Assessment Program sites was also analysed to help define a comprehensive set of vegetation mapping groups. The relationships between vegetation communities and environmental parameters are summarised in the tables following the community descriptions below. Groups 1 to 9 represent vegetation communities within the Stony Plains Bioregion occurring on the stony plains, tablelands, and escarpments and in drainage lines. Groups 10 to 14 represent communities within the Giles Bioregion and include swamps, stony plains sand plains and dunefields.

Stony Plains Bioregion

Stony Plains

Group 1. *Atriplex holocarpa* (Pop Saltbush), *Iseilema eremaeum* (Flinders Grass) herbland/grassland +/- *Atriplex nummularia* ssp. *omissa* (Oodnadatta Bush) low very open shrubland on stony plains

Group 5. *Atriplex vesicaria* (Bladder Saltbush) Low Shrubland over *Enneapogon avenaceus* (Common Bottlewashers) tussock grass with emergent *Eremophila* spp. (emubushes) and *Senna* spp. (desert sennas) on stony plains

Group 6. *Atriplex vesicaria* (Bladder Saltbush) Low Open Shrubland over herbs and grasses with emergent *Eremophila freelingii* (Rock Emubush), *Acacia tetragonophylla* (Dead Finish) shrubs +/- *Pittosporum angustifolium* (Native Apricot)*/ Acacia aneura* (Mulga) on stony plains.

Group 7. *Atriplex vesicaria* (Bladder Saltbush) Low Open Shrubland over *Enneapogon polyphyllus* (Common Bottlewashers) and herbs with emergent *Acacia tetragonophylla* (Dead Finish), *Senna* spp. (desert sennas) and *Eremophila* spp. (emubushes) on stony plains.

Escarpment

Group 3. *Acacia calcicola* (Northern Myall), *Santalum lanceolatum* (PlumBush) Low Open Woodland over *Eremophila freelingii* (Rock Emubush), *A. tetragonophylla*(Dead Finish), *A. kempeana* (Witchetty Bush) and *Senna artemissiodes* nothosp. a*rtemissioides* (Silver Senna) shrubs, *Atriplex vesicaria* (Bladder Saltbush) and *Ptilotus obovatus* (Silver Mulla Mulla) low shrubs on breakaways.

Group 4. *Acacia tetragonophylla* (Dead Finish) Open Shrubland over sparse *Atriplex vesicaria* (Bladder Saltbush) and *Ptilotus obovatus* (Silver Mulla Mulla) low shrubs +/- *Acacia aneura* (Mulga) Very Low Open Woodland on stony rises.

Group 8. *Acacia stowardii* (Bastard Mulga) / *A. papyrocarpa* (Myall) / *A. aneura* (Mulga) Tall Shrubland over *Eremophila freelingii* (Rock Emubush) and *Senna* spp. (desert sennas) shrubs and *Ptilotus obovatus* (Silver Mulla Mulla) low shrubs on breakaways.

Drainage lines and floodplains

Group 2. *Maireana aphylla* (Cotton-bush), *Atriplex vesicaria* (Bladder Saltbush) Low Open Shrubland over grasses on drainage lines

Group 9. *Eucalyptus coolabah* (Coolibah) / *E. camaldulensis* (River Red Gum) Woodland over *Santalum lanceolatum* (Plumbush), *Senna* spp. (desert sennas), *Rhagodia spinescens* (Spiny Saltbush) shrubs and *Maireana aphylla* (Cotton-bush) low shrubs floodplains.

Giles Bioregion

Stony Plains

Group 12. *Eremophila freelingii* (Rock Emubush) with *Acacia tetragonophylla* (Dead Finish) shrubland +/- *Acacia aneura* (Mulga) / *A. papyrocarpa* (Myall) / *A. stowardii* (Bastard Mulga) low woodland over *Sclerolaena* spp. (Bindyi) on stony plains

Swamps

Group 10. *Eucalyptus coolabah* (Coolibah) Woodland over *Muehlenbeckia florulenta* (Lignum) and *Chenopodium nitrariaceum* (Nitre Goosefoot) shrubs on swamps

Group 11. *Muehlenbeckia florulenta* (Lignum) and *Chenopodium nitrariaceum* (Nitre Goosefoot) shrubland on swamps

Sand Plains and Dune Fields

Group 13. *Acacia aneura* (Mulga) low woodland over *Eriachne mucronata* (Mountain Wanderrie), *E. helmsii* (Woollybut Wanderrie) and *Eragrostis xerophila* (Knotty-but Neverfail) grasses on sandy plains.

Group 14. *Acacia aneura* (Mulga) +/- *A. ramulosa* (Horse Mulga) low woodland over *Rhagodia eremaea* (Desert Saltbush) shrubs on dunes and deep sandy drainage lines.

Detailed descriptions of the 14 vegetation communities are presented in the context of the 9 vegetation mapping groups following the vegetation mapping section.

Table 10. Vegetation community by environmental variables summary table.

		Vegetation Community													
Land form pattern		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Escarpment				2					1						
Flood plain			1							2	1	1			
Plain		2			1	1	3	1				1	4		2
Rises				1	1										
Sand plain														3	
Land form type		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
plain (incl undulating plain)													1		
sandy plain														3	
stony plain		2			1	1	3	1					3		
breakaway				2					1						
drainage depression															1
dune crest															1
hill slope					1										
stream channel			1	1						1					
flood out										1					
swamp											1	2			
Surface Soil Texture		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Sand															1
Loamy Sand														2	
Sandy Loam															1
Loam				1											
Sandy Clay Loam				1		1	1		1	1	1		1	1	
Fine Sandy Clay Loam			1		1		1						1		
Sandy Clay													1		
Silty Clay					1										
Silty Clay Loam				1											
Light Clay		1						1							
Light Medium Clay		1					1					1	1		
Medium Clay										1		1			
Vegetation class		**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
Grassland		1													
Low shrubland		1	1		1	1	2	1					1		
Shrubland				1			1					2	1		
Tall shruband									1						
Mallee				1											
Low woodland				1	1								2	3	2
Woodland										2	1				
STREW SIZE	**COVER**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**
none apparent	0%													1	2
	nil									1					
pebble (5-50 mm)	<10%		1							1		2	1		
	10-30%												1		
	30-70%	2		2	2		1				1		2	2	
	> 70%					1	1	1	1						
cobble (51-250 mm)	30-70%			1											
	> 70%						1								
No. of quadrats in group		**2**	**1**	**3**	**2**	**1**	**3**	**1**	**1**	**2**	**1**	**2**	**4**	**3**	**2**

VEGETATION MAPPING

INTRODUCTION

Previous vegetation mapping work was conducted in adjacent areas by Robinson *et al.* (1988) and Hudspith and Brandle (1998), however a significant part of the study are was not covered by either survey.

The Robinson *et al.* (1988) study covered an area that roughly equates to what is now the Tallaringa Conservation Park. Mapping in this study was performed by visually delineating vegetation communities on clear film overlays of unrectified aerial photography. This study identifies 10 vegetation communities for mapping, and although of a coarser scale and lower spatial accuracy than the current projects provides a valuable indication of vegetation expected in the sandy areas of the Mount Willoughby IPA, in particular those communities found on the western boundary.

Classes mapped by Robinson *et al*.

1. *Acacia aneura/Maireana villosa* Tall Open Shrubland
2. *Acacia aneura/Monocather paradoxa* Tall Open Shrubland
3. *Senna artemisioides/Dodonaea microzyga* Low Open Shrubland
4. *Acacia ramulosa* Tall Open Shrubland
5. *Senna artemisioides* ssp. *petiolaris* Tall Open Shrubland
6. *Scleroleana diacantha/Maireana erioclada* Low Open Shrubland
7. *Eragrostis falcata/Zygophyllum eremaeum* Open Herbland
8. *Halosarcia indica* ssp. *leiostachya* Low Shrubland
9. *Myoporum platycarpum* Low Open Woodland
10. *Acacia papyrocarpa* Low Open Woodland

Hudspith and Brandle (1998) mapped 17 structural vegetation classes throughout the stony deserts of South Australia. This mapping incorporates a segment of the eastern side of the Mount Willoughby IPA. Of these 17 classes only 6 are relevant to this study area. They will be detailed below. This mapping was conducted by delineating visible communities on transparencies over either 1:89 000 scale colour aerial photographs or 1:250 000 scale hardcopy Image Maps derived from Landsat 5 TM data. Mapping was produced at a scale of 1:250 000, and although coarser than this study provides useful additional information on vegetation communities occurring on the stony areas to the east of this study site.

Vegetation Communities relevant to this study mapped by Hudspith and Brandle (1998)

5. Coolibah *Eucalyptus coolabah* +/- River Red Gum *Eucalyptus camaldulensis* / Gidgee *Acacia cambagei* Red Mulga *Acacia cyperophylla*/Mulga *Acacia aneura* Woodland.

7. Cottonbush *Maireana aphylla* +/- Saltbush *Atriplex* spp. Low shrubland +/- emergent trees or tall shrubs.

12. Mixed Mitchell-grass *Astrebla pectinata* Rat-tail Couch *Sporobolous actinocladus* Tussock grassland with chenopod *Scleroleana/Atriplex/ Dissocarpus/Neobassia* spp. Sub-shrubland.

13. Chenopod *Atriplex/Scleroleana/Maireana* spp. Low Open Shrubland over sub-shrubs and grasses.

14. Chenopod *Dissocarpus/Neobassia/Atriplex/Scleroleana* spp. +/- herbs and grasses – on cracking clays.

17. Mulga *Acacia aneura/A. tetragonophylla* Open Woodland over shrubs/grasses.

This current vegetation mapping of the Mount Willoughby IPA provides the most comprehensive Vegetation mapping of this area available. The mapping is nominally at the scale of 1:250 000 however the imagery utilised to obtain the classification has an average spatial accuracy of 15m and pixel sizes of 25m. As a result the filtering and vector generalisation process imparts the greatest spatial error. As such for highly detailed work the reader is urged to utilise the raster classification. Mapping accuracy for this layer exceeds the parameters of 1:100 000 and is getting close to 1:50 000 mapping accuracy standards (+/-12.5m).

MT WILLOUGHBY VEGETATION MAP KEY

Class 1 *Acacia stowardii* (Bastard Mulga) Open Woodland +/- *Acacia aneura* (Mulga) and *Eremophila freelingii* (Rock Emubush)

Class 2 *Chenopodium nitrariaceum* (Nitre Goosefoot) Shrubland

Class 3 *Atriplex vesicaria* (Bladder Saltbush) Low Shrubland +/- *Eremophila rotundifolia* (Round-leaf Emubush) and *Senna artemisioides* (Senna).

Class 4 *Acacia ramulosa* (Horse Mulga) Tall Shrubland +/- *Acacia aneura* (Mulga).

Class 5 *Acacia aneura* complex (Mulga) Shrubland.

Class 6. *Eremophila freelingii* (Rock Emubush) Shrubland +/- Emergent *Acacia aneura* complex (Mulga)

Class 7 *Maireana aphylla* (Cottonbush) Low Shrubland +/- Emergent *Eucalyptus coolabah* (Coolibah) and *E. camaldulensis* (River Red Gum) with *Aristida nitidula* (Curly Wire-grass), *Acacia*

papyrocarpa (Western Myall), *Acacia aneura* (Mulga) and *Alectryon oleifolius* (Bullock Bush)

Class 8 *Atriplex nummularia* ssp. *omissa* (Oodnadatta Bush) Low Shrubland

Class 9 *Acacia calcicola* (Northern Myall) Tall Shrubland +/- *Acacia papyrocarpa* (Western Myall), *Acacia tetragonaphylla* (Dead finish), *Eucalyptus socialis* (Red Mallee) and *Rhagodia eremaea* (Desert Saltbush)

DETAILED DESCRIPTION FOR THE VEGETATION MAPPING AND FLORISTIC ANALYSIS

The following section details each mapping class and floristic group using the set formats described below. They are also presented in Bioregion and Landform order as depicted in the Vegetation Community section:

Mapping Class

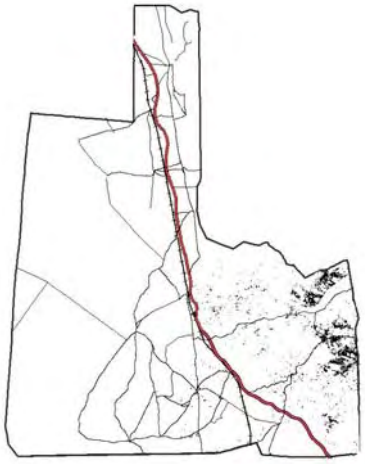
- Class number and dominant vegetation description
- Landform description
- % of area mapped
- Relationship to floristic groups
- Black and white map showing areas mapped

Floristic group

- Group number and description
- Number of quadrats in Group
- Total number of species in the group
- Average number of plant species in group and the range (minimum and maximum)
- Number of introduced species in group
- Landform
- Soil surface texture
- Non vegetative cover
- Vegetation Structure
- Indicator plant Species: define the group because of their abundance and/or their uniqueness to it (in bold)
- Map of Quadrats and Quadrat names
- Table of species in structural and frequency order: PLANT SPECIES; COMMON NAME; % frequency in group (sorted in descending order); % indicator value derived from PCORD based on importance of species in defining group; % frequency across all 14 groups; p * value statistical significance level as an indicators species; average species cover when present - taken from raw data to assist in group interpretation and not used in the group definition analysis; vertebrate species group; quadrat photographs.

Photographs depicting sites within these groups.

STONY PLAINS BIOREGION



STONY PLAINS

Class 8. *Atriplex nummularia* ssp. *omissa* (Oodnadatta Bush) Low Open Shrubland

A minor group on stony plains within the study area, usually associated with cracking clay depressions (gilgais) that are patchily distributed in gibber plains where gypsum occurs in the surface clays. A dominant widespread group of the stony plains of the western lake Eyre Basin

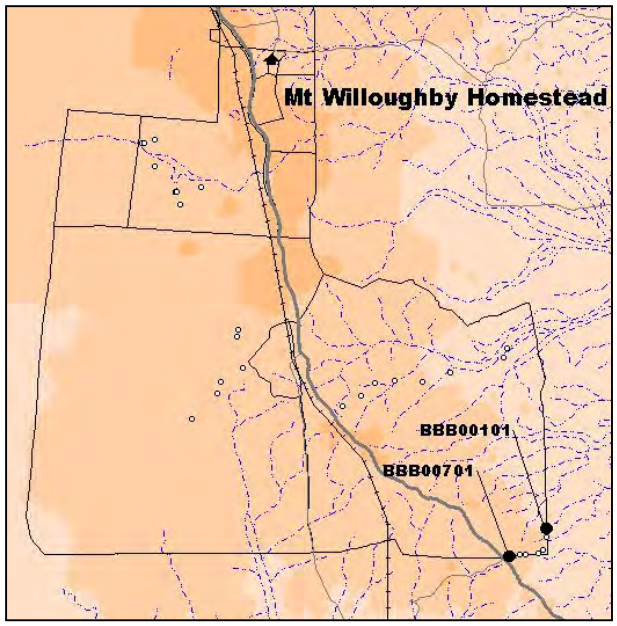
Area mapped as class 8 = 63.9 km^2 (1.3%)

This mapping class closely relates to floristic group 1

Figure 15. Quadrat BBB00701 displays a typical Floristic Group 1 vegetation community in the foreground in association with Oodnadatta Bush.

Figure 16. The low ephemeral vegetation at BBB00101 is characteristic of Floristic Group 1 and is often found in association with the Oodnadatta Bush Low Open Shrublands that are more characteristic of Mapping Class 8.

FLORISTIC GROUP 1



***Atriplex holocarpa* (Pop Saltbush), *Iseilema eremaeum* (Flinders Grass) herbland/grassland +/- *Atriplex nummularia* ssp. *omissa* (Oodnadatta Bush) low very open shrubland**

No. quadrats in Group 2
Total species in group 19
Ave No. sp. in group 13.5 range: 11-16
No. introduced sp. in group 0

Landform: Stony plains with less than 1% slope
Soils: light to light medium clay
Cover: 30-70% cover of pebbles (5-50mm in size) with 5-15% bare earth and 7-20% litter
Vegetation Structure: Very open tussock grassland to low very open shrubland
Indicator species: *Atriplex holocarpa, Sclerolaena intricata, Iseilema eremaeum, Aristida anthoxanthoides, Dactyloctenium radulans*
Comments: Community of the cracking clay plains typical of the Moon Plain and was present only in the eastern section of Mt Willoughby. Often in association with Oodnadatta Bush low shrublands where it occurs on cracking clay areas that periodically break through the gibber mantle. Neither community is common on Mt Willoughby.

Quadrats: BBB00101, BBB00701

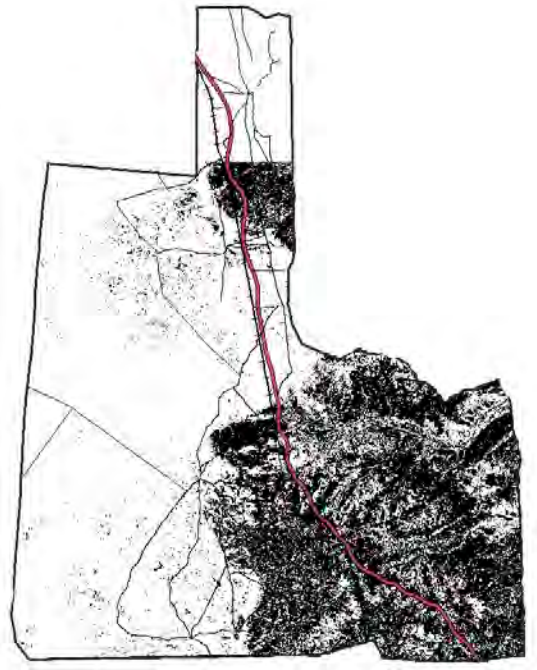
PLANT SPECIES	COMMON NAME	% freq in grp	% indicator value	% freq across 14 grps	p *	ave cover when present
LOW SHRUBS < 0.5m						
Sarcostemma viminale ssp. *australe*	Caustic Bush	50	50	100	0.471	not many
Atriplex nummularia ssp. ***omissa***	Oodnadatta Bush	50	30	60	0.598	5-25%
Atriplex vesicaria ssp.	Bladder Saltbush	50	6	13	0.518	common <5%
FORBS & HERBS						
Atriplex holocarpa	Pop Saltbush	100	100	100	0.013	common <5%
Sclerolaena intricata	Tangled Bindyi	100	67	67	0.073	common <5%
Euphorbia parvicaruncula	Rough-seeded Spurge	50	50	100	0.419	sparse <5%
Minuria sp.	Minuria	50	50	100	0.471	sparse <5%
Euphorbia tannensis ssp. *eremophila*	Desert Spurge	50	30	60	0.553	sparse <5%
Craspedia sp.		50	30	60	0.615	common <5%
Salsola kali	Buckbush	100	21	21	0.056	common <5%
Dissocarpus paradoxus	Ball Bindyi	50	19	38	0.88	sparse <5%
GRASSES						
Iseilema eremaeum		100	100	100	0.013	common <5%
Aristida anthoxanthoides	Yellow Three-awn	100	67	67	0.073	sparse <5%
Dactyloctenium radulans	Button-grass	100	57	57	0.076	sparse <5%
Astrebla pectinata	Barley Mitchell-grass	100	55	55	0.108	common <5%
Tripogon loliiformis	Five-minute Grass	50	19	38	0.874	sparse <5%
Panicum decompositum var. *decompositum*	Native Millet	50	15	30	0.325	not many
Enneapogon avenaceus	Common Bottle-washers	50	9	19	0.295	sparse <5%
FERNS						
Marsilea sp.	Nardoo	50	17	33	0.063	not many

Characteristic Fauna

Bird Group 1: Rufous Fieldwren, Richard's Pipit, Gibberbird, Inland Dotterel
Mammal Group 1: Fat-tailed Dunnart, Forrest's Mouse, Narrow-nosed Planigale
Reptile Group 1: Eyrean Earless Dragon, Tessellated Gecko

STONY PLAINS AND CREEKLINES

Class 3. *Atriplex vesicaria* (Bladder Saltbush) Low Shrubland +- *Eremophila rotundifolia* (Round-leaf Emubush) and *Senna artemisioides* (Senna).



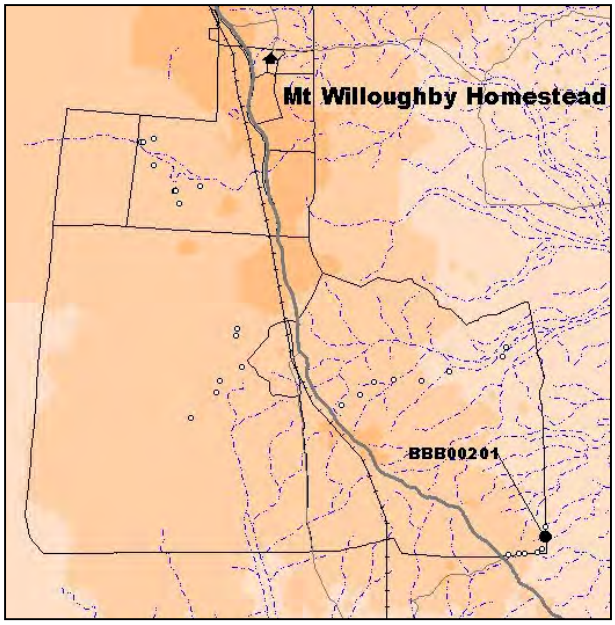
The dominant mapping class for stony plains and tablelands within the study area. Typical of gibber plains without areas of cracking clays stony hill slopes and tablelands throughout the stony plains in South Australia.

Area mapped as class 3 = 1675.8 km^2 (33%)

This mapping class closely relates to the floristic groups 2, 5, 6 and 7

FLORISTIC GROUP 2

***Maireana aphylla* (Cotton-bush), *Atriplex vesicaria* (Bladder Saltbush) Low Open Shrubland over grasses**



No. quadrats in Group 1
Total species in group 22
No. introduced sp. in group 0

Landform: Stream channel floodout in larger Floodplain with 1% slope
Soils: Fine sandy clay loam
Cover: < 10% cover of pebbles (5-50mm in size) with 25% bare earth and 20% litter
Vegetation Structure: Low Open Shrubland
Indicator species: *Maireana aphylla, Senecio cunninghamii* var. *serratus, Atriplex spongiosa, Crotalaria* sp., *Aristida nitidula, Eragrostis setifolia* (present in less than four of the other 13 groups)

Quadrats: BBB00201

PLANT SPECIES	COMMON NAME	ave cover when present
TREES		
Acacia aneura	Mulga	not many
Santalum lanceolatum	Plumbush	not many
SHRUBS > 0.5m		
Senna artemisioides nothossp. *artemisioides*	Silver Senna	not many
LOW SHRUBS < 0.5m		
Atriplex vesicaria ssp.	Bladder Saltbush	5-25%
Maireana aphylla	Cotton-bush	5-25%
Senecio cunninghamii var. *serratus*	Inland Shrubby Groundsel	not many
FORBS & HERBS		
Atriplex holocarpa	Pop Saltbush	common <5%

Atriplex spongiosa	Pop Saltbush	not many
Crotalaria sp.	Rattle-pod/Bird-flower	sparse <5%
Dissocarpus paradoxus	Ball Bindyi	common <5%
Sclerolaena intricata	Tangled Bindyi	sparse <5%
Amaranthus mitchellii	Boggabri Weed	
Malvastrum americanum	Malvastrum	not many
Minuria sp.	Minuria	common <5%
Trichanthodium skirrophorum	Woolly Yellow-heads	sparse <5%
GRASSES		
Aristida nitidula	Brush Three-awn	common <5%
Astrebla pectinata	Barley Mitchell-grass	common <5%
Dactyloctenium radulans	Button-grass	5-25%
Enneapogon avenaceus	Common Bottle-washers	5-25%
Eragrostis setifolia	Bristly Love-grass	sparse <5%
Panicum decompositum var. *decompositum*	Native Millet	not many

Fauna

Bird Group 1: Rufous Fieldwren, Richard's Pipit, Gibberbird, Inland Dotterel

Mammal Group 2: Stripe-faced Dunnart, House Mouse, Giles' Planigale

Reptile Group 2: Broad-banded Sandswimmer, Pink-blotched Gecko, Saltbush Ctenotus, Sand Goanna, Dwarf Three-toed Slider

Figure 17. Quadrat BBB00201 was the only quadrat sampled that was characteristic of Floristic Group 2. Cotton Bush, Bladder Saltbush and emergent Mulga.

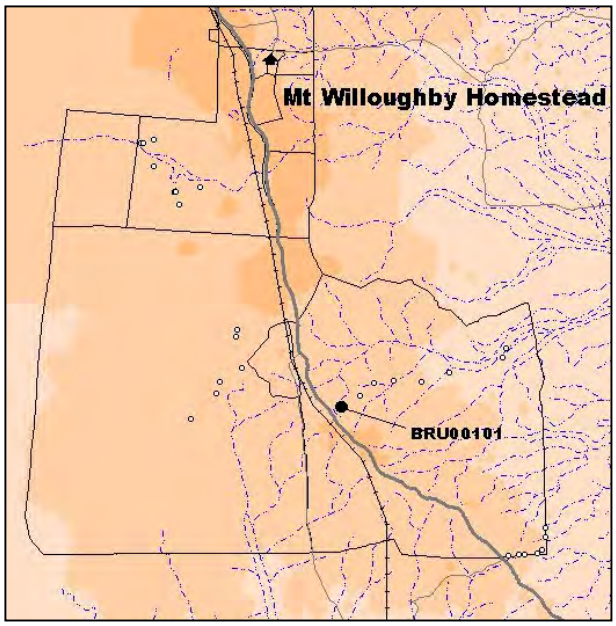
FLORISTIC GROUP 5

***Atriplex vesicaria* (Bladder Saltbush) Low Shrubland over *Enneapogon avenaceus* (Common Bottle-washers) tussock grass with emergent *Eremophila* spp. (emubushes) and *Senna* spp. (desert sennas)**

No. quadrats in Group 1
Total species in group 22
No. introduced sp. in group 0

Landform: Stony plain with 1% slope
Soils: sandy clay loam
Cover: >70% cover of pebbles (5-50mm in size) with 5% bare earth and 25% litter
Vegetation Structure: Low Shrubland
Indicator species: *Sclerolaena brachyptera, Sida corrugata, Cullen patens, Iseilema membranaceum* (species unique to this group).

Quadrats: BRU00101



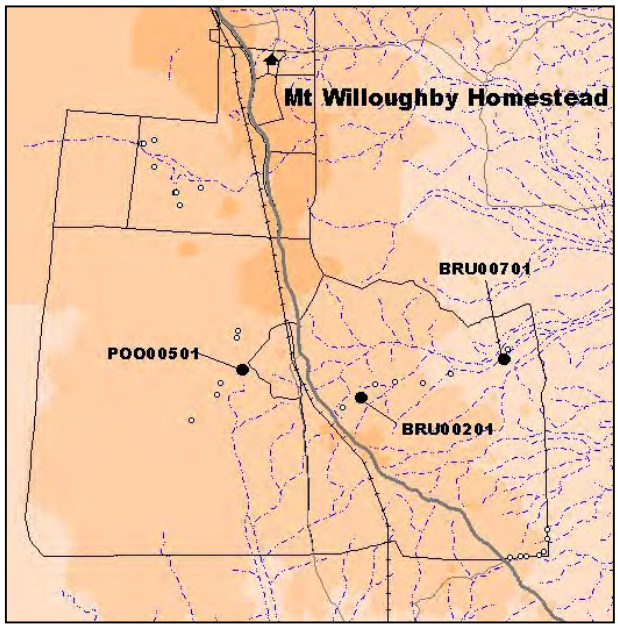
PLANT SPECIES	COMMON NAME	ave cover when present
SHRUBS > 0.5m		
Eremophila freelingii	Rock Emubush	not many
Eremophila paisleyi	Paisley's Emubush	not many
Senna artemisioides ssp. *helmsii*	Blunt-leaf Senna	not many
LOW SHRUBS < 0.5m		
Atriplex vesicaria ssp.	Bladder Saltbush	25-50%
Maireana aphylla	Cotton-bush	not many
Ptilotus exaltatus var.	Pink Mulla Mulla	sparse <5%
FORBS & HERBS		
Sclerolaena brachyptera	Short-wing Bindyi	not many
Sclerolaena longicuspis	Long-spine Bindyi	not many
Sida corrugata var.	Corrugated Sida	not many
Solanum ellipticum	Velvet Potato-bush	not many
Cullen patens	Spreading Scurf-pea	sparse <5%
Euphorbia tannensis ssp. *eremophila*	Desert Spurge	not many
Lotus cruentus	Red-flower Lotus	sparse <5%
Salsola kali	Buckbush	not many
Trichanthodium skirrophorum	Woolly Yellow-heads	sparse <5%
Portulaca oleracea	Common Purslane	not many
GRASSES		
Aristida contorta	Curly Wire-grass	sparse <5%
Astrebla pectinata	Barley Mitchell-grass	sparse <5%
Dactyloctenium radulans	Button-grass	sparse <5%
Enneapogon avenaceus	Common Bottle-washers	common <5%
Eragrostis xerophila	Knotty-butt Neverfail	sparse <5%
Iseilema membranaceum	Small Flinders-grass	not many

Fauna
Bird Group 1: Rufous Fieldwren, Richard's Pipit, Gibberbird, Inland Dotterel
Mammal Group 1: Fat-tailed Dunnart
Reptile Group 1: Eyrean Earless Dragon, Tessellated Gecko

Figure 18. Bladder Saltbush Low Open Shrubland with emergent emubushes at BRU00101 (Floristic Group 5, Map Class 3).

Figure 19. An atypical example of Floristic Group 6 at BRU00201 with a dominant shrub layer of Rock Emubush over a sparse layer of Bladder Saltbush (Map Class 3).

FLORISTIC GROUP 6



***Atriplex vesicaria* (Bladder Saltbush) Low Open Shrubland over herbs and grasses with emergent *Eremophila freelingii* (Rock Emubush), *Acacia tetragonophylla* (Dead Finish) shrubs +/- *Pittosporum angustifolium* (Native Apricot)/ *Acacia aneura* (Mulga).**

No. quadrats in Group 3
Total species in group 31
Ave No. sp in group 16.7 range 14 - 19
No. introduced sp. in group 1

Landform: Stony plains with 1% slope
Soils: sandy clay loams and light medium clay
Cover: 30% to > 70% cover of pebbles (5-50mm in size) or cobbles (50-250mm in size) with 5% bare earth and 2-5% litter
Vegetation Structure: Low Very Open Shrubland to Open Shrubland
Indicator species: *Eremophila freelingii, Atriplex vesicaria, Sclerolaena diacantha, Sida fibulifera, Aristida contorta, Enneapogon polyphyllus, Panicum decompositum* var. *decompositum*

Quadrats: BRU00201, POO00501, BRU00701

PLANT SPECIES	COMMON NAME	% freq in grp	% indicator value	% prop. in group	p *	ave cover when present
TREES						
Pittosporum angustifolium var. *microcarpa*	Native Apricot	33	17	50	1	not many
Acacia aneura complex	Mulga	33	3	8	0.149	sparse <5%
SHRUBS > 0.5m						
Eremophila freelingii	Rock Emubush	100	25	25	0.004	sparse <5%
Acacia tetragonophylla	Dead Finish	100	14	14	0.075	not many
Senna artemisioides nothossp. *sturtii*	Grey Senna	33	12	36	0.931	common <5%
Rhagodia spinescens	Spiny Saltbush	33	6	17	0.071	common <5%
Senna artemisioides nothossp. *coriacea*	Broad-leaf Desert Senna	33	4	12	0.022	not many
Eremophila paisleyi	Paisley's Emubush	33	3	9	0.071	not many
LOW SHRUBS < 0.5m						
Atriplex vesicaria ssp.	Bladder Saltbush	100	25	25	0.518	5-25%
Atriplex nummularia ssp. *omissa*	Oodnadatta Bush	33	13	40	0.598	not many
Enchylaena tomentosa var.	Ruby Saltbush	33	5	14	0.094	not many
Ptilotus obovatus var.	Silver Mulla Mulla	33	3	9	0.056	common <5%
FORBS & HERBS						
Trichanthodium skirrophorum	Woolly Yellow-heads	100	35	35	0.004	sparse <5%
Salsola kali	Buckbush	100	21	21	0.056	sparse <5%
Sclerolaena diacantha	Grey Bindyi	67	38	57	0.168	common <5%
Sida fibulifera	Pin Sida	67	31	47	0.225	sparse <5%
Atriplex angulata	Fan Saltbush	33	33	100	0.816	not many
Sclerolaena longicuspis	Long-spine Bindyi	33	33	100	0.827	sparse <5%
Abutilon malvaefolium	Scrambling Lantern-bush	33	33	100	0.846	not many
Maireana spongiocarpa	Spongy-fruit Bluebush	33	17	50	1	not many
Euphorbia tannensis ssp. *eremophila*	Desert Spurge	33	13	40	0.553	not many
Heliotropium europaeum	Common Heliotrope*	33	13	40	0.573	not many
Malvastrum americanum	Malvastrum	33	13	40	0.599	sparse <5%
Sclerolaena sp.	Bindyi	33	12	36	0.931	sparse <5%
Solanum ellipticum	Velvet Potato-bush	33	10	29	0.377	not many
Sclerolaena eriacantha	Silky Bindyi	33	6	18	0.005	not many
GRASSES						
Aristida contorta	Curly Wire-grass	100	24	24	0.04	sparse <5%
Enneapogon polyphyllus	Leafy Bottle-washers	67	36	53	0.181	common <5%
Panicum decompositum var. ***decompositum***	Native Millet	67	27	40	0.325	not many
Astrebla pectinata	Barley Mitchell-grass	33	6	18	0.108	not many
Enneapogon avenaceus	Common Bottle-washers	33	4	13	0.295	sparse <5%

Fauna

Bird Groups 1, 2 & 3: Little Crow, Richard's Pipit, Galah, Zebra Finch, Crested Bellbird, Cinnamon Quail-thrush

Mammal Groups 1: Fat-tailed Dunnart also Cattle, Red Kangaroo and Rabbit

Reptile Groups 1 & 2: No species in common at the two quadrats with reptiles present, but species of these groups were often found together in similar habitats within the stony deserts (Brandle and Hutchinson 1998).

Figure 20. Very open Bladder Saltbush Shrubland with emergent Dead Finish and emubushes at POO00501 (Floristic Group 6, Map Class 3).

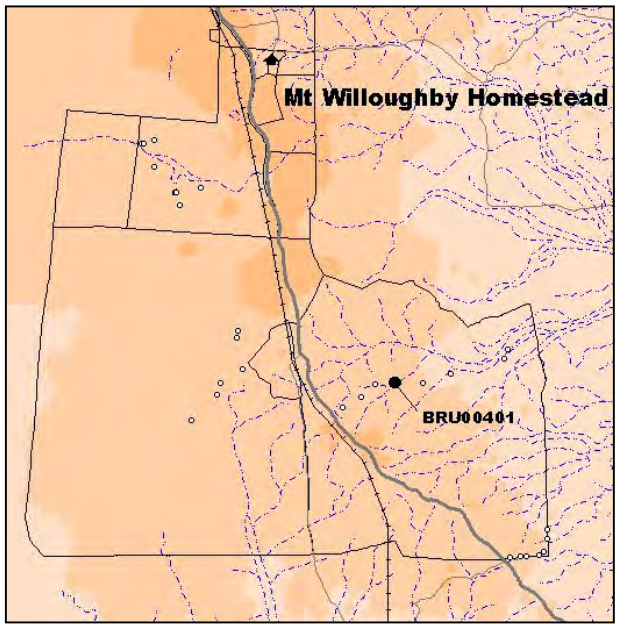
Figure 21. Bladder Saltbush low shrubland with emergent Dead Finish at BRU00701 (Floristic Group 6, Map Class 3).

FLORISTIC GROUP 7

***Atriplex vesicaria* (Bladder Saltbush) Low Open Shrubland over *Enneapogon polyphyllus* (Leafy Bottle-washer) and herbs with emergent *Acacia tetragonophylla* (Dead Finish), *Senna* spp. (desert sennas) and *Eremophila* spp. (emubushes)**

No. quadrats in Group 1
Total species in group 29
No. introduced sp. in group 0

Landform: Stony plain with 1% slope
Soils: light clay
Cover: > 70% cover of pebbles (5-50mm in size) with 5% bare earth and 5% litter
Vegetation Structure: Low Open Shrubland
Indicator species: *Atriplex quinii, Frankenia serpyllifolia, Sida intricata, Solanum esuriale, Convolvulus remotus*



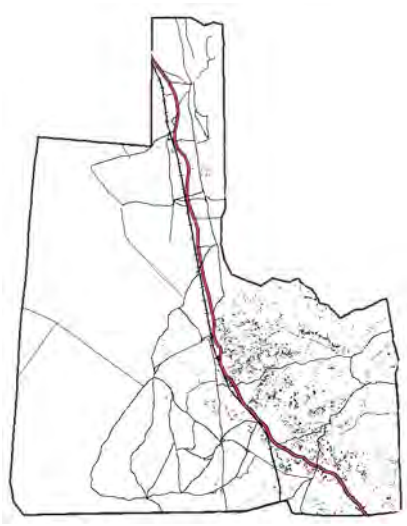
Quadrats: BRU00401

PLANT SPECIES	COMMON NAME	ave cover when present
SHRUBS > 0.5m		
Acacia tetragonophylla	Dead Finish	not many
Eremophila rotundifolia	Round-leaf Emubush	common <5%
Eremophila serrulata	Green Emubush	not many
Senna artemisioides nothossp. *artemisioides*	Silver Senna	not many
Senna artemisioides ssp. *filifolia*	Fine-leaf Desert Senna	common <5%
SHRUBS < 0.5m		
Atriplex vesicaria ssp.	Bladder Saltbush	5-25%
FORBS & HERBS		
Atriplex quinii	Kidney-fruit Saltbush	sparse <5%
Frankenia serpyllifolia	Thyme Sea-heath	not many
Sclerolaena intricata	Tangled Bindyi	sparse <5%
Sclerolaena longicuspis	Long-spine Bindyi	sparse <5%
Sclerolaena sp.	Bindyi	not many
Sclerolaena uniflora	Small-spine Bindyi	sparse <5%
Sida fibulifera	Pin Sida	sparse <5%
Sida intricata	Twiggy Sida	sparse <5%
Solanum esuriale	Quena	not many
Solanum quadriloculatum	Plains Nightshade	sparse <5%
Cullen graveolens	Native Lucerne	not many
Daucus glochidiatus	Native Carrot	not many
Ranunculus pentandrus var.	Smooth Buttercup	not many
Trichanthodium skirrophorum	Woolly Yellow-heads	sparse <5%
GRASSES		
Aristida anthoxanthoides	Yellow Three-awn	sparse <5%
Aristida contorta	Curly Wire-grass	sparse <5%
Astrebla pectinata	Barley Mitchell-grass	sparse <5%
Digitaria brownii	Cotton Panic-grass	not many
Enneapogon polyphyllus	Leafy Bottle-washers	common < 5%
Eragrostis xerophila	Knotty-butt Neverfail	not many
Panicum decompositum var. *decompositum*	Native Millet	sparse <5%
Tripogon loliiformis	Five-minute Grass	not many
VINES		
Convolvulus remotus	Grassy Bindweed	sparse <5%
FERNS		
Marsilea sp.	Nardoo	sparse <5%

Fauna
Bird Group 1: Richard's Pipit, Galah, Zebra Finch, Emu
Mammal Group 2: House Mouse, Stripe-faced Dunnart also Cattle and Rabbit
Reptile Group 1: Eyrean Earless Dragon, Pink-blotched Gecko, Curl Snake

Figure 22. Bladder Saltbush Low Open Shrubland with scattered emubushes and sennas at BRU00401 (Floristic Group 7, Map Class 3).

ESCARPMENT



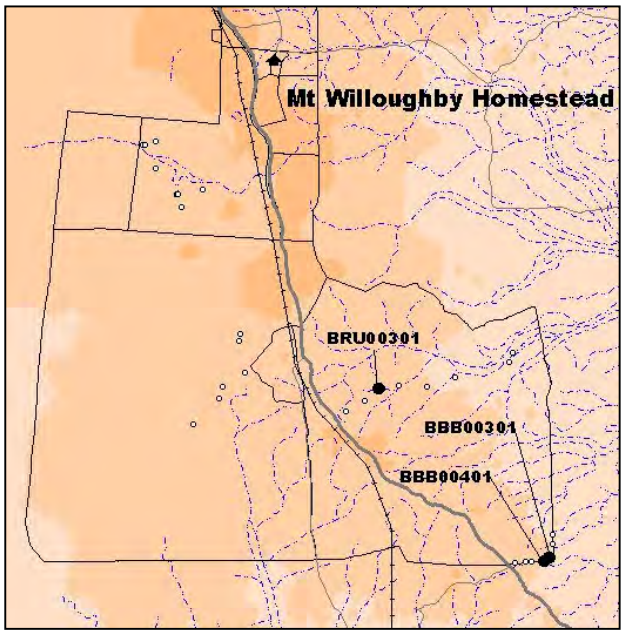
Class 9 ***Acacia calcicola*** **(Northern Myall) Tall Shrubland +/-** ***Acacia papyrocarpa*** **(Western Myall),** ***Acacia tetragonaphylla*** **(Dead Finish),** ***Eucalyptus socialis*** **(Red Mallee) and** ***Rhagodia eremaea*** **(Desert Saltbush)**

Occurring in Stony breakaway areas, this mapping group is restricted to the western Lake Eyre Basin in South Australia

Area mapped as class 9 = 40 km^2 (0.8%)

This mapping class closely relates to the floristic group 3

FLORISTIC GROUP 3



Acacia calcicola **(Northern Myall),** ***Santalum lanceolatum*** **(Plumbush) Low Open Woodland over** ***Eremophila freelingii*** **(Rock Emubush),** ***A. tetragonophylla*** **(Dead Finish),** ***A. kempeana*** **(Witchetty Bush) and** ***Senna artemisiodes*** **nothosp.** ***artemisioides*** **(Silver Senna) shrubs,** ***Atriplex vesicaria*** **(Bladder Saltbush) and** ***Ptilotus obovatus*** **(Silver Mulla Mulla) low shrubs**.

No. quadrats in Group	3		
Total species in group	44		
Ave No. sp in group	26.7	**range**	22-32
No.introduced sp in group	0		

Landform: Breakaway slopes and creek channels in escarpment country with slopes 0-10%
Soils: loam, silty and sandy clay loams
Cover: 30-70% cover of pebbles (5-50mm in size) and cobbles (50-250 mm in size) with 5-15% bare earth and 5-10% litter
Vegetation Structure: Open Shrubland to Very Low Woodland and Open Mallee
Indicator species: *Acacia calcicola, Acacia kempeana, Eremophila neglecta, Exocarpos aphyllus, Rhagodia ulicina, Abutilon leucopetalum, Maireana campanulata, Cheilanthes lasiophylla*

Quadrats: BBB00301, BBB00401, BRU00301

PLANT SPECIES	COMMON NAME	% freq in grp	% indicator value	% freq across 14 grps	p *	ave cover when present
TREES						
Acacia calcicola	Northern Myall	100	100	100	0.002	common <5%
Santalum lanceolatum	Plumbush	100	40	40	0.175	sparse <5%
Acacia salicina	Willow Wattle	33	33	100	0.815	sparse <5%
Pittosporum angustifolium var. *microcarpa*	Native Apricot	33	17	50	1	sparse <5%
Acacia stowardii	Bastard Mulga	33	10	29	0.343	not many
Acacia papyrocarpa	Western Myall	33	8	24	0.513	common <5%
Acacia aneura complex	Mulga	33	3	8	0.149	5-25%
Eucalyptus socialis ✞	Beaked Red Mallee	33	na	100	na	common <5%
SHRUBS > 0.5m						
Acacia kempeana	Witchetty Bush	100	67	67	0.011	sparse <5%
Eremophila neglecta		67	67	100	0.062	sparse <5%
Exocarpos aphyllus	Leafless Cherry	67	67	100	0.065	sparse <5%
Senna artemisioides nothossp.	Silver Senna	100	50	50	0.056	sparse <5%

artemisioides						
Eremophila rotundifolia	Round-leaf Emubush	67	31	47	0.18	sparse <5%
Senna artemisioides ssp. *helmsii*	Blunt-leaf Senna	67	31	47	0.226	not many
Eremophila freelingii	Rock Emubush	100	25	25	0.004	common <5%
Rhagodia spinescens	Spiny Saltbush	67	22	33	0.071	not many
Senna artemisioides nothossp. *coriacea*	Broad-leaf Desert Senna	67	16	24	0.022	sparse <5%
Acacia tetragonophylla	Dead Finish	100	14	14	0.075	sparse <5%
Senna artemisioides ssp. *oligophylla*	Limestone Senna	33	13	40	0.2	sparse <5%
Senna artemisioides nothossp. *sturtii*	Grey Senna	33	12	36	0.931	not many
Senna artemisioides ssp. *filifolia*	Fine-leaf Desert Senna	33	7	21	0.028	not many
Eremophila paisleyi	Paisley's Emubush	33	3	9	0.071	not many
LOW SHRUBS < 0.5m						
Rhagodia ulicina	Intricate Saltbush	67	67	100	0.05	sparse <5%
Ptilotus obovatus var.	Silver Mulla Mulla	100	28	28	0.056	sparse <5%
Atriplex vesicaria ssp.	Bladder Saltbush	100	25	25	0.518	common <5%
Maireana aphylla	Cotton-bush	33	8	25	0.04	not many
FORBS & HERBS						
Abutilon leucopetalum	Desert Lantern-bush	67	67	100	0.065	not many
Maireana campanulata	Bell-fruit Bluebush	100	57	57	0.01	sparse <5%
Sida petrophila	Rock Sida	33	33	100	0.824	not many
Euphorbia australis	Hairy Caustic Weed	33	33	100	0.824	not many
Maireana spongiocarpa	Spongy-fruit Bluebush	33	17	50	1	not many
Anemocarpa saxatilis	Hill Sunray	33	13	40	0.582	sparse <5%
Craspedia sp.		33	13	40	0.615	sparse <5%
Sclerolaena sp.	Bindyi	33	12	36	0.931	not many
Salsola kali	Buckbush	67	10	14	0.056	common <5%
Solanum ellipticum	Velvet Potato-bush	33	10	29	0.377	not many
Dissocarpus paradoxus	Ball Bindyi	33	8	25	0.88	not many
Trichanthodium skirrophorum	Woolly Yellow-heads	33	4	12	0.004	not many
GRASSES						
Aristida strigosa	Rough Three-awn	33	33	100	0.824	not many
Enneapogon polyphyllus	Leafy Bottle-washers	33	9	27	0.181	sparse <5%
Enneapogon avenaceus	Common Bottle-washers	33	4	13	0.295	not many
Aristida contorta	Curly Wire-grass	33	3	8	0.04	not many
MISTLETOE						
Amyema preissii	Wire-leaf Mistletoe	67	27	40	0.058	not many
Amyema maidenii ssp. *maidenii*	Pale-leaf Mistletoe	33	6	17	0.498	not many
FERNS						
Cheilanthes lasiophylla	Woolly Cloak-fern	67	67	100	0.05	sparse <5%

✞ not included in overall analyses as only present at one quadrat.

Fauna

Bird Groups 2 & 3: Cinnamon Quail-thrush, Singing Honeyeater, Black-faced Woodswallow, Zebra Finch, Chestnut-rumped Thornbill, Zebra Finch, Galah

Mammal Groups 3: House Mouse, Euro, Rabbit

Reptile Group 3: Tree Dtella, Mesa Gecko, Ochre Dragon, Binoe's Gecko, Dwarf Three-toed Slider

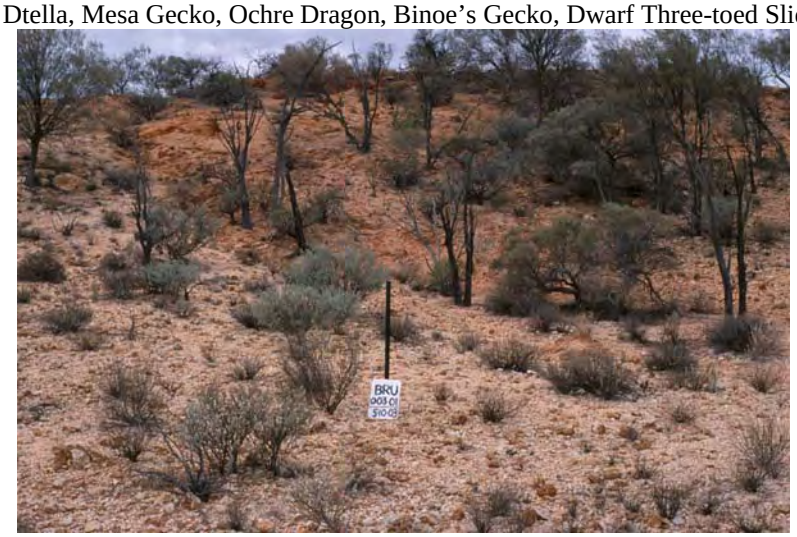
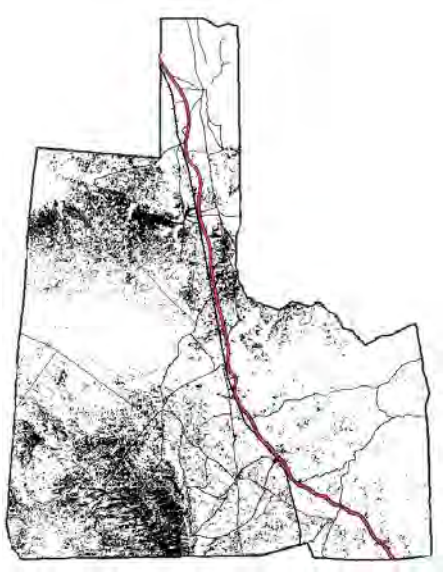


Figure 23. Northern Myall Low Open Woodland on dissected tableland at BRU00301 Floristic Group 3 (Map Class 9).

Figure 24. Beaked Red Mallee, Leafless Cherry and Northern Myall in a creek draining breakaway tableland at BBB00301 Floristic Group 3 (Map Class 9).

Figure 25. Mixed Acacia tall shrubland over emubushes on breakaway slope at BBB00401 Floristic Group 3 (Map Class 9).

Class 6. *Eremophila freelingii* (Rock Emubush) Shrubland +/- Emergent *Acacia aneura* (Mulga)



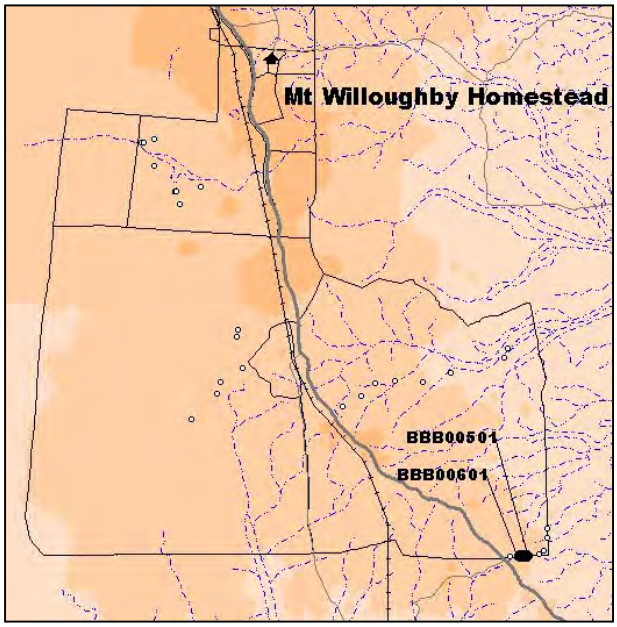
This group is common in the Great Victoria Desert Bioregegion on sandy caly loams and on breakaway tablelands in the Stony Plains Bioregegion..

Area mapped as class 6 = 612.4 km^2 (12.1%)

This mapping class closely relates to the floristic groups 4 and 12

Figure 26. Mulga shrubland dominates the overstorey at BBB00501 in Floristic Group 4 (Map Class 6).

GROUP 4



***Acacia tetragonophylla* (Dead Finish) Open Shrubland over sparse *Atriplex vesicaria* (Bladder Saltbush) and *Ptilotus obovatus* (Silver Mulla Mulla) low shrubs +/- and *Acacia aneura* (Mulga) Very Low Open Woodland.**

No. quadrats in Group 2
Total species in group 24
Ave No. sp in group 15.5 **range** 13 - 18
No. introduced sp. in group 0

Landform: Stony plain and low rise with slopes 0-5%
Soils: silty loam and fine sandy clay loam
Cover: 30-70% cover of pebbles and shale fragments (5-50mm in size) with 5-10% bare earth and 2-3% litter
Vegetation Structure: Low Very Open Shrubland to Very Low Open Woodland
Indicator species: *Senna artemisioides* nothossp. *coriacea, Maireana astrotricha, Ptilotus exaltatus, Ptilotus obovatus, Anemocarpa saxatilis, Enneapogon avenaceus*
Comments: The two quadrats comprising this group are structurally very different. They have been clustered in this analysis due to the commonality of a number of species probably related to their proximity to each other. This diverse assemblage was restricted to the Stony Plains Environmental Region.

Quadrats: BBB00501, BBB00601

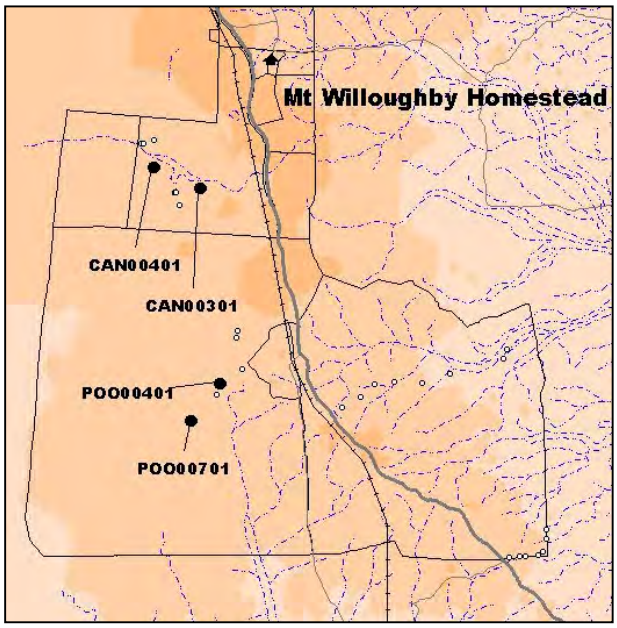
PLANT SPECIES	COMMON NAME	% freq in grp	% indicator value	% freq across 14 grps	p *	ave cover when present
TREES						
Acacia aneura var.	Mulga	50	6	11	0.149	5-25%
SHRUBS > 0.5m						
Senna artemisioides nothossp. *coriacea*	Broad-leaf Desert Senna	100	36	36	0.022	sparse <5%
Eremophila freelingii	Rock Emubush	100	25	25	0.004	sparse <5%
Acacia tetragonophylla	Dead Finish	100	14	14	0.075	common <5%
Eremophila rotundifolia	Round-leaf Emubush	50	18	35	0.18	common <5%
Acacia kempeana	Witchetty Bush	50	17	33	0.011	not many
LOW SHRUBS < 0.5m						
Ptilotus obovatus var.	Silver Mulla Mulla	100	28	28	0.056	sparse <5%
Atriplex vesicaria ssp.	Bladder Saltbush	100	25	25	0.518	sparse <5%
Maireana astrotricha	Low Bluebush	50	50	100	0.448	common <5%
Ptilotus exaltatus var.	Pink Mulla Mulla	50	50	100	0.449	not many
FORBS & HERBS						
Gunniopsis sp.	Pigface	50	50	100	0.448	not many
Anemocarpa saxatilis	Hill Sunray	50	30	60	0.582	sparse <5%
Sclerolaena cuneata	Tangled Bindyi	50	20	40	0.132	common <5%
Sclerolaena intricata	Tangled Bindyi	50	17	33	0.073	sparse <5%
Solanum quadriloculatum	Plains Nightshade	50	17	33	0.532	sparse <5%
Maireana campanulata	Bell-fruit Bluebush	50	14	29	0.01	not many
Salsola kali	Buckbush	50	5	11	0.056	sparse <5%
GRASSES						
Enneapogon avenaceus	Common Bottle-washers	100	38	38	0.295	not many
Aristida contorta	Curly Wire-grass	100	24	24	0.04	common <5%
Tripogon loliiformis	Five-minute Grass	50	19	38	0.874	not many
Aristida anthoxanthoides	Yellow Three-awn	50	17	33	0.073	not many
Panicum decompositum var. *decompositum*	Native Millet	50	15	30	0.325	not many
Astrebla pectinata	Barley Mitchell-grass	50	14	27	0.108	sparse <5%
Enteropogon ramosus	Umbrella Grass	50	10	20	0.196	not many

Fauna

Bird Group 2: Cinnamon Quail-thrush, Singing Honeyeater, Richard's Pipit, Black-faced Woodswallow, Zebra Finch
Mammal Group 0: Echidna recorded at BBB00501
Reptile Group 2 & 3: No species common to both quadrats relating to differences in landform and surface strew.

Figure 27. A low open shrub version of Floristic Group 4 at BBB00601 (Map Class 6).

FLORISTIC GROUP 12



***Eremophila freelingii* (Rock Emubush) with *Acacia tetragonophylla* (Dead Finish) shrubland +/- *Acacia aneura* (Mulga) / *A. papyrocarpa* (Myall) / *A. stowardii* (Bastard Mulga) low woodland over *Sclerolaena* spp. (Bindyi)**

No. quadrats in Group 4
Total species in group 46
Ave No. sp in group 24.3 **range** 19 - 32
No.introduced sp in group 0

Landform: Stony plains with slopes 0%
Soils: Fine Sandy Clay Loam to Light Medium Clay
Cover: < 70% cover of pebbles (5-50mm in size) with 5-20% bare earth and 5-25% litter
Vegetation Structure: Very Low Open Shrubland to Low Woodland
Indicator species: *Eremophila freelingii, Eremophila duttonii, Sclerolaena eriacantha, Trichanthodium skirrophorum*
Comments: This Emubush and Acacia shrubland group typifies very small pebble covered hard soils in the Giles Bioregion and combines with Floristic group 4 as Map Class 6.

Quadrats: CAN00301, CAN00401, POO00401, POO00701

PLANT SPECIES	COMMON NAME	% freq in grp	% indicator value	% prop. in group	p *	ave cover when present
TREES						
Acacia aneura complex	Mulga	75	13	17	0.149	sparse <5%
Acacia stowardii	Bastard Mulga	50	21	43	0.343	common <5%
Acacia papyrocarpa	Western Myall	25	4	18	0.513	sparse <5%
SHRUBS > 0.5m						
Eremophila freelingii	Rock Emubush	100	25	25	0.004	5-25%
Acacia tetragonophylla	Dead Finish	100	14	14	0.075	sparse <5%
Senna artemisioides ssp. ***helmsii***	Blunt-leaf Senna	75	40	53	0.226	sparse <5%
Senna artemisioides nothossp. *coriacea*	Broad-leaf Desert Senna	75	20	27	0.022	not many
Eremophila paisleyi	Paisley's Emubush	75	16	21	0.071	sparse <5%
Eremophila duttonii	Harlequin Emubush	50	50	100	0.091	sparse <5%
Senna artemisioides ssp. *oligophylla*	Limestone Senna	50	30	60	0.2	sparse <5%
Eremophila latrobei ssp.	Crimson Emubush	50	25	50	0.213	not many
Senna "phyllodinea"		25	25	100	1	common <5%
Senna artemisioides nothossp. *sturtii*	Grey Senna	25	7	27	0.931	not many
Senna artemisioides ssp. *filifolia*	Fine-leaf Desert Senna	25	4	16	0.028	not many
Eremophila rotundifolia	Round-leaf Emubush	25	4	18	0.18	not many
SHRUBS < 0.5m						
Ptilotus obovatus var.	Silver Mulla Mulla	75	16	21	0.056	not many
Enchylaena tomentosa var.	Ruby Saltbush	50	11	21	0.094	not many
Ptilotus gaudichaudii var.	Paper Fox-tail	25	25	100	1	not many
Maireana georgei	Satiny Bluebush	25	8	33	0.255	common <5%
Maireana integra	Entire-wing Bluebush	25	7	27	0.085	sparse <5%
FORBS & HERBS						
Sclerolaena eriacantha	Silky Bindyi	100	55	55	0.005	sparse <5%
Trichanthodium skirrophorum	Woolly Yellow-heads	100	35	35	0.004	not many
Salsola kali	Buckbush	100	21	21	0.056	sparse <5%
Sclerolaena cuneata	Tangled Bindyi	75	45	60	0.132	common <5%
Scaevola spinescens	Spiny Fanflower	50	50	100	0.091	sparse <5%
Solanum ellipticum	Velvet Potato-bush	50	21	43	0.377	sparse <5%
Solanum quadriloculatum	Plains Nightshade	50	17	33	0.532	sparse <5%
Abutilon fraseri ssp.		25	25	100	1	not many
Rhodanthe floribunda	White Everlasting	25	25	100	1	sparse <5%
Trianthema triquetra	Red Spinach	25	25	100	1	not many
Nicotiana simulans	Native Tobacco	25	8	33	0.243	not many
Sclerolaena sp.	Bindyi	25	7	27	0.931	sparse <5%
Solanum lasiophyllum	Flannel Bush	25	6	23	0.47	not many
Portulaca oleracea	Common Purslane	25	5	20	0.688	sparse <5%

Maireana campanulata	Bell-fruit Bluebush	25	4	14	0.01	sparse <5%
Sida fibulifera	Pin Sida	25	4	18	0.225	not many
Calandrinia remota	Round-leaf Parakeelya	25	4	14	0.079	not many
GRASSES						
Aristida contorta	Curly Wire-grass	75	13	18	0.04	sparse <5%
Enteropogon ramosus	Umbrella Grass	50	10	20	0.196	not many
Digitaria brownii	Cotton Panic-grass	25	25	100	1	not many
Aristida holathera var. *holathera*	Tall Kerosene Grass	25	8	33	0.232	sparse <5%
Eriachne mucronata	Mountain Wanderrie	25	5	20	0.003	not many
Enneapogon polyphyllus	Leafy Bottle-washers	25	5	20	0.181	not many
Dactyloctenium radulans	Button-grass	25	4	14	0.076	sparse <5%
Eragrostis xerophila	Knotty-butt Neverfail	25	2	9	0.18	not many
VINES						
Einadia nutans ssp.	Climbing Saltbush	25	25	100	1	not many

Fauna

Bird Groups 2 & 3: Crested Bellbird, Little Crow, Wedge-tailed Eagle, Zebra Finch, Cinnamon Quail-thrush, Black-faced Woodswallow, Singing Honeyeater

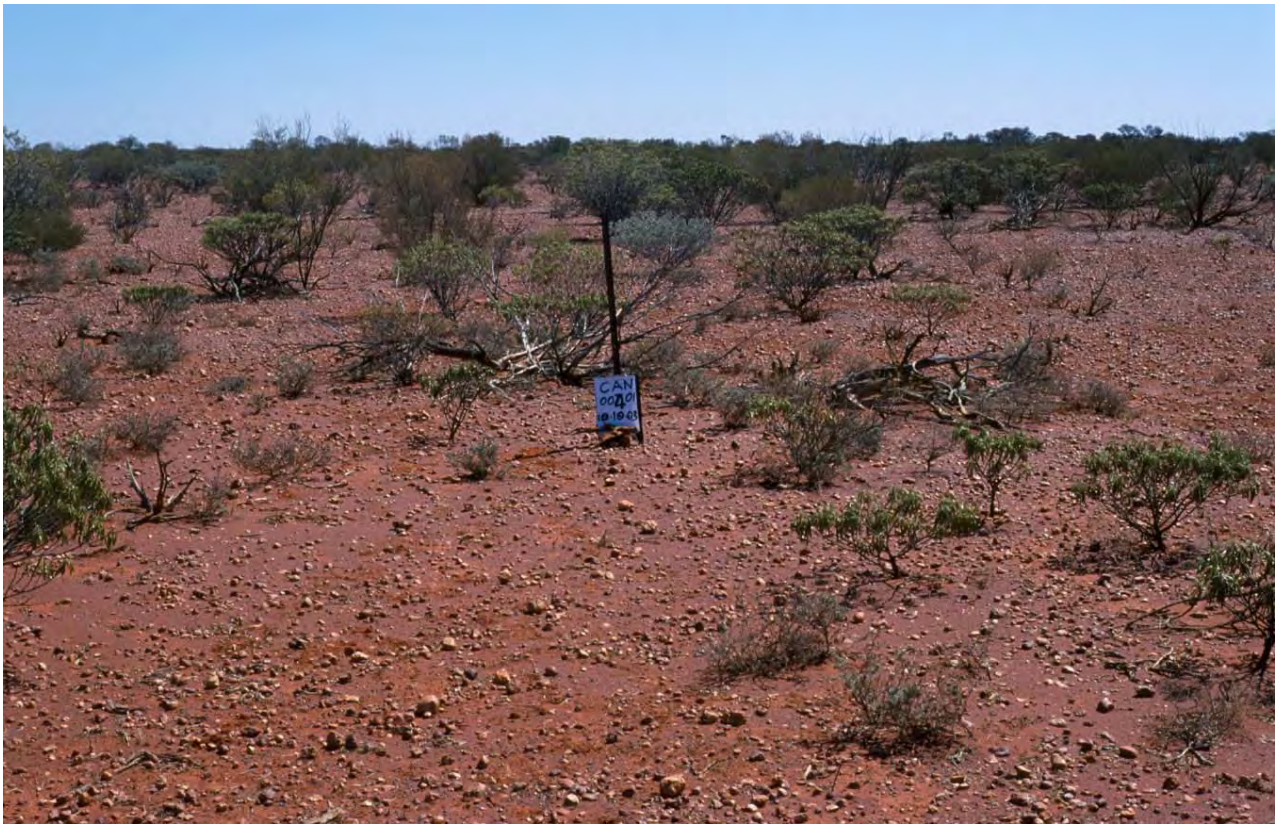
Mammal Groups 3 & 4: no overlap between species at the four quadrats

Reptile Groups 4 & 5: Fat-tailed Gecko, minimal overlap between both groups

Figure 28. Scattered patches of emubush and Dead Finish at POO00401 Floristic Group 12 (Map Class 6).

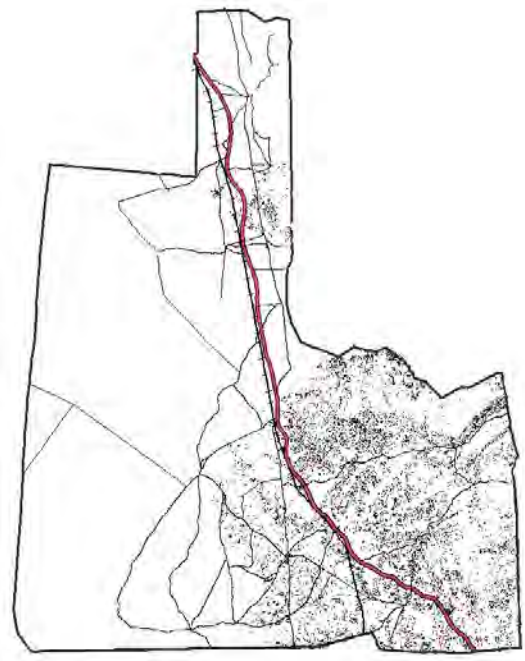
Figure 29. Mulga Shrublands over emubushes at POO00701 Floristic Group 12 (Map Class 6).

Figure 30. Emubush Open Shrubland at CAN00301 Floristic Group 12 (Map Class 6).



Figures 31. Emubush with Acacia shrubland at CAN00401 in Floristic group 12 (Map Class 6)

Class 1 ***Acacia stowardii*** **(Bastard mulga) Open Woodland +-** ***Acacia aneura*** **(Mulga) and** ***Eremophila freelingii*** **(Rock Emubush)**



Predominantly on breakaway tablands in the Stony Plains Bioregion.

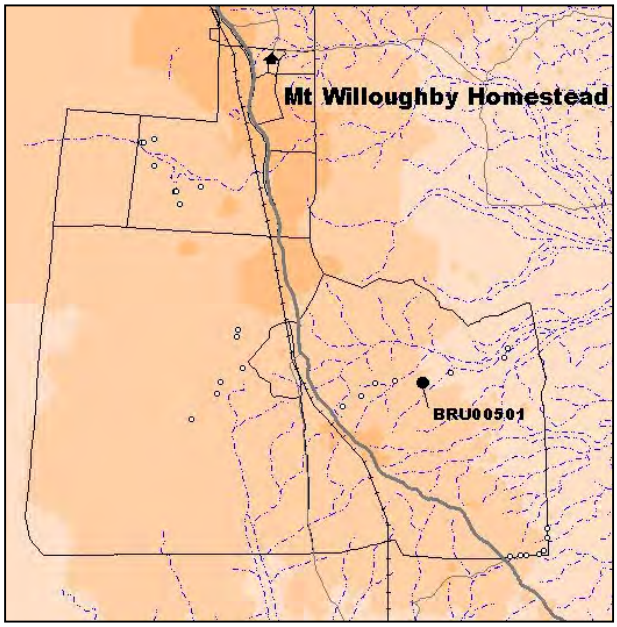
Area mapped as class 1 = 82.8 km^2 (1.6%)

This Mapping class closely relates to floristic group 8.

Figure 32. Bastard Mulga Tall Shrubland at BRU00501 Floristic Group 8 (Map Class 1).

FLORISTIC GROUP 8

***Acacia stowardii* (Bastard Mulga) / *A. papyrocarpa* (Myall) / *A. aneura* (Mulga) Tall Shrubland over *Eremophila freelingii* (Rock Emubush) and *Senna* spp. (desert sennas) shrubs and *Ptilotus obovatus* (Silver Mulla Mulla) low shrubs on breakaways.**



No. quadrats in Group 1
Total species in group 12
No. introduced sp. in group 0

Landform: Escarpment breakaway with slope of 20%
Soils: sandy clay loam
Cover: Shale outcrops 10-20% and > 70% cover of pebbles (5-50mm in size) with 0% bare earth and 5% litter
Vegetation Structure: Tall Open Shrubland
Indicator species: *Acacia stowardii, Maireana campanulata*

Quadrats: BRU00501

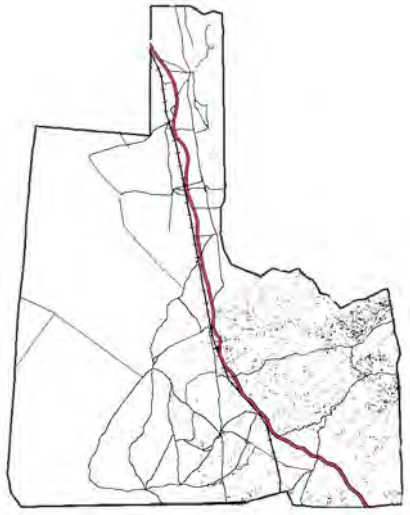
PLANT SPECIES	COMMON NAME	ave cover when present
TREES		
Acacia aff. Papyrocarpa	Myall	not many
Acacia aneura	Mulga	
Acacia stowardii	Bastard Mulga	5-25%
SHRUBS > 0.5m		
Eremophila freelingii	Rock Emubush	common <5%
Eremophila paisleyi	Paisley's Emubush	not many
Senna artemisioides nothossp. *coriacea*	Broad-leaf Desert Senna	common <5%
SHRUBS < 0.5m		
Atriplex vesicaria ssp.	Bladder Saltbush	sparse <5%
Ptilotus obovatus var.	Silver Mulla Mulla	common <5%
FORBS & HERBS		
Anemocarpa saxatilis	Hill Sunray	-
Maireana campanulata	Bell-fruit Bluebush	common <5%
Sclerolaena sp.	Bindyi	not many
GRASSES		
Enneapogon polyphyllus	Leafy Bottle-washers	not many

Fauna

Bird Group 3: Singing Honeyeater, Chestnut-rumped Thornbill, Grey Shrike-thrush
Mammal Group 4: Ooldea Dunnart, Sandy Inland Mouse, also old Stick Nest Rat nests and Echidna sign in caves along breakaways plus Dingo, Rabbit.
Reptile Group 3: Ochre Dragon, Mesa Gecko

FLOODPLAINS

Class 7 *Maireana aphylla* (Cottonbush) Low Shrubland +/- Emergent *Eucalyptus coolabah* (Coolibah) and *E. camaldulensis* (River Red Gum) with *Aristida nitidula* (Brush Three-awn), *Acacia papyrocarpa* (Myall), *Acacia aneura* (Mulga) and *Alectryon oleifolius* (Bullock Bush)



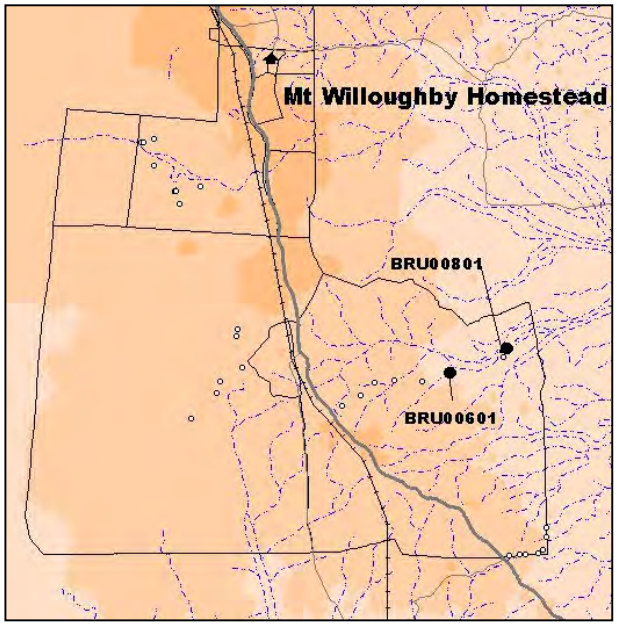
Typical of drainage lines and associated floodouts in the Stony Plains Bioregion.

Area mapped as class 7 = 52.9 km^2 (1%)

This mapping class closely relates to floristic group 9

GROUP 9

***Eucalyptus coolabah* (Coolibah) / *E. camaldulensis* (River Red Gum) Woodland over *Santalum lanceolatum* (Plumbush), *Senna* spp. (desert sennas), *Rhagodia spinescens* (Spiny Saltbush) shrubs and *Maireana aphylla* (Cotton-bush) low shrubs floodplains.**



No. quadrats in Group 2
Total species in group 36
Ave No. sp in group 27.5 **range** 17 - 36
No. introduced sp. in group 0

Landform: Stream channels and floodouts with slopes < 1%
Soils: sandy clay loam to medium clay
Cover: < 10% cover of pebbles (5-50mm in size) with 5-30% bare earth and 10-20% litter
Vegetation Structure: Open Woodland and Woodland
Indicator species: *Alectryon oleifolius* ssp. *canescens*, *Eucalyptus coolabah*, *Eucalyptus camaldulensis*, *Senna artemisioides* ssp. *filifolia*, *Maireana aphylla*, *Aristida nitidula*

Quadrats: BRU00601, BRU00801

PLANT SPECIES	COMMON NAME	% freq in grp	% indicator value	% prop. in group	p *	ave cover when present
TREES						
Alectryon oleifolius ssp. *canescens*	Bullock Bush	100	100	100	0.015	sparse <5%
Santalum lanceolatum	Plumbush	100	40	40	0.175	common <5%
Eucalyptus coolabah ssp. *arida*	Coolibah	50	50	100	0.415	5-25%
Eucalyptus camaldulensis var.	River Red Gum	50	50	100	0.439	5-25%
Acacia papyrocarpa	Western Myall	50	18	35	0.513	not many
Acacia aneura complex	Mulga	50	6	11	0.149	not many
SHRUBS > 0.5m						
Senna artemisioides ssp. ***filifolia***	Fine-leaf Desert Senna	100	63	63	0.028	common <5%
Rhagodia spinescens	Spiny Saltbush	100	50	50	0.071	sparse <5%
Acacia tetragonophylla	Dead Finish	100	14	14	0.075	sparse <5%
Eremophila longifolia	Weeping Emubush	50	50	100	0.415	not many
Petalostylis labicheoides	Butterfly Bush	50	50	100	0.439	not many
Eremophila latrobei ssp.	Crimson Emubush	50	25	50	0.213	common <5%
Muehlenbeckia florulenta	Lignum	50	17	33	0.06	not many
Senna artemisioides nothossp. *artemisioides*	Silver Senna	50	13	25	0.056	sparse <5%
Eremophila paisleyi	Paisley's Emubush	50	7	14	0.071	not many
SHRUBS < 0.5m						
Maireana aphylla	Cotton-bush	100	75	75	0.04	25-50%
Enchylaena tomentosa var.	Ruby Saltbush	100	43	43	0.094	sparse <5%
Atriplex vesicaria ssp.	Bladder Saltbush	50	6	13	0.518	sparse <5%
FORBS & HERBS						
Ptilotus sessilifolius var. *sessilifolius*	Crimson-tails	50	50	100	0.439	sparse <5%
Glycine canescens	Silky Glycine	50	50	100	0.415	not many
Ixiolaena tomentosa	Woolly Plover-daisy	50	50	100	0.439	not many
Malvastrum americanum	Malvastrum	50	30	60	0.599	sparse <5%
Sclerolaena diacantha	Grey Bindyi	50	21	43	0.168	sparse <5%
Dissocarpus paradoxus	Ball Bindyi	50	19	38	0.88	not many
Sida fibulifera	Pin Sida	50	18	35	0.225	not many
Sclerolaena eriacantha	Silky Bindyi	50	14	27	0.005	not many
Salsola kali	Buckbush	50	5	11	0.056	not many
GRASSES						
Aristida nitidula	Brush Three-awn	100	100	100	0.015	common <5%
Enteropogon ramosus	Umbrella Grass	100	40	40	0.196	common <5%
Eriachne ovata	Swamp Wanderrie	50	50	100	0.415	common <5%
Enteropogon acicularis	Umbrella Grass	50	50	100	0.439	common <5%
Dactyloctenium radulans	Button-grass	50	14	29	0.076	common <5%
Eragrostis xerophila	Knotty-butt Neverfail	50	9	18	0.18	sparse <5%
Enneapogon avenaceus	Common Bottle-washers	50	9	19	0.295	sparse <5%
VINES						
Marsdenia australis	Native Pear	50	50	100	0.439	not many
MISTLETOE						
Amyema maidenii ssp. *maidenii*	Pale-leaf Mistletoe	50	13	25	0.498	not many

Fauna

Bird Groups 2 & 4: White-browed Babbler, Black-eared Cuckoo, Weebill

Mammal Group 3: House Mouse and Cattle

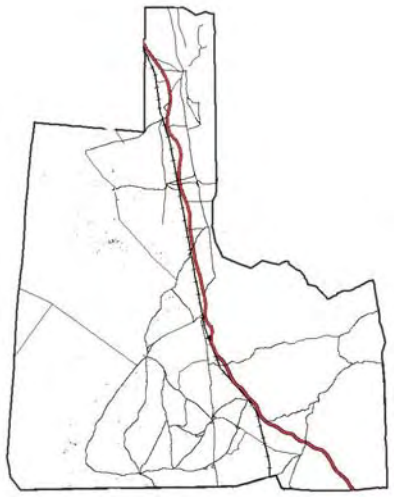
Reptile Group 3: Tree Dtella, Bynoe's Gecko, Long-nosed Dragon, Common Snake-eye, Desert Whipsnake, Western Brown Snake, Purple Dtella, Centralian Striped Skink

Figure 33. River Red Gum and Western Myall Woodland over Lignum at BRU00601 Floristic Group 9 (Map Class 7).

Figure 34. Coolibah and Plumbush Low Open Woodland over Cottonbush at BRU00801 Floristic Group 9 (Map Class 7).

GREAT VICTORIA DESERT BIOREGION

SWAMPS



Class 2 *Chenopodium nitrariaceum* (Nitre Goosefoot) Shrubland +/- emergent *Eucalyptus coolabah* (Coolibah).

A minor mapping restricted to swamps and low-lying drainage areas in the Great Victoria Desert Bioregion.

Area mapped as class 2 = 1.3 km^2 (0.03%)

This mapping class closely relates to the floristic groups 10 and 11

Figure 35. Coolibah Woodland over scattered Lignum at CAN00101 Floristic Group 10 (Map Class 2).

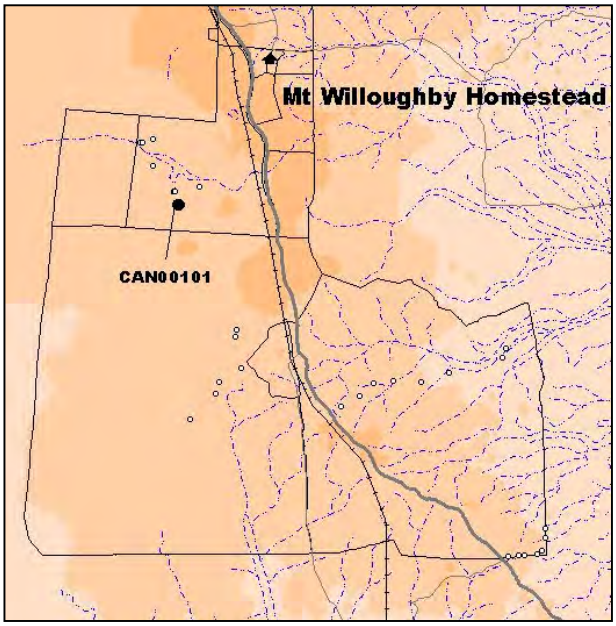
FLORISTIC GROUP 10

***Eucalyptus coolabah* (Coolibah) Woodland over *Muehlenbeckia florulenta* (Lignum) and *Chenopodium nitrariaceum* (Nitre Goosefoot) shrubs on swamps**

No. quadrats in Group 1
Total species in group 38
No. introduced sp. in group 1

Landform: Swamp with slope < 1%
Soils: Sandy Clay Loam
Cover: 30-70% cover of pebbles (5-50mm in size) with 15% bare earth and 20% litter
Vegetation Structure: Low Open Forest
Indicator species: *Eucalyptus coolabah, Chenopodium nitrariaceum, Muehlenbeckia florulenta*

Quadrats: CAN00101



PLANT SPECIES	COMMON NAME	ave cover when present
TREES		
Acacia aneura var.	Mulga	sparse <5%
Acacia papyrocarpa	Western Myall	not many
Acacia stowardii	Bastard Mulga	not many
Eucalyptus coolabah ssp. *arida*	Coolibah	25-50%
Santalum lanceolatum	Plumbush	not many
SHRUBS > 0.5m		
Acacia tetragonophylla	Dead Finish	5-25%
Chenopodium nitrariaceum	Nitre Goosefoot	common <5%
Eremophila longifolia	Weeping Emubush	not many
Muehlenbeckia florulenta	Lignum	5-25%
Senna artemisioides nothossp. *artemisioides*	Silver Senna	not many
Senna artemisioides nothossp. *coriacea*	Broad-leaf Desert Senna	not many
Senna artemisioides ssp. *oligophylla*	Limestone Senna	not many
SHRUBS < 0.5m		
Enchylaena tomentosa var.	Ruby Saltbush	not many
FORBS & HERBS		
Abutilon fraseri ssp.		not many
Solanum quadriloculatum	Plains Nightshade	not many
Teucrium racemosum	Grey Germander	common <5%
Alternanthera denticulata	Lesser Joyweed	common <5%
Bergia perennis ssp. *exigua*	Perennial Water-fire	not many
Calandrinia polyandra var. *polyandra*	Parakeelya	not many
Calotis plumulifera	Woolly-headed Burr-daisy	0.55
Centaurium spicatum	Spike Centaury*	not many
Chenopodium melanocarpum forma	Black-fruit Goosefoot	not many
Goodenia modesta		common <5%
Lepidium muelleri-ferdinandi	Mueller's Peppercress	not many
Leucochrysum fitzgibbonii	Fitzgibbon's Daisy	not many
Myriocephalus rudallii	Small Poached-egg Daisy	common <5%
Nicotiana simulans	Native Tobacco	not many
Peplidium "Marla"(W.R.Barker 3535)		not many
Pterocaulon sphacelatum	Apple-bush	not many
Rhodanthe floribunda	White Everlasting	sparse <5%
Rutidosis helichrysoides	Grey Wrinklewort	not many
Salsola kali	Buckbush	not many
Trichanthodium skirrophorum	Woolly Yellow-heads	not many
Portulaca oleracea	Common Purslane	not many
Tetragonia eremaea	Desert Spinach	not many
GRASSES		
Eragrostis setifolia	Bristly Love-grass	sparse <5%
MISTLETOE		
Amyema maidenii ssp. *maidenii*	Pale-leaf Mistletoe	common <5%
FERNS		
Marsilea drummondii	Common Nardoo	not many

Fauna

Bird Group 4: Mistletoebird, Spiny-cheeked Honeyeater, Rufous Whistler, Mulga Parrot, Red-capped Robin, White-browed Babbler, Grey Shrike-thrush, Willie Wagtail, Black-eared Cuckoo, Bourke's Parrot, Australian Ringneck Parrot

Mammal Group 3: House Mouse also Red Kangaroo and Cattle

Reptile Group 3: Common Snake-eye, Dwarf Skink

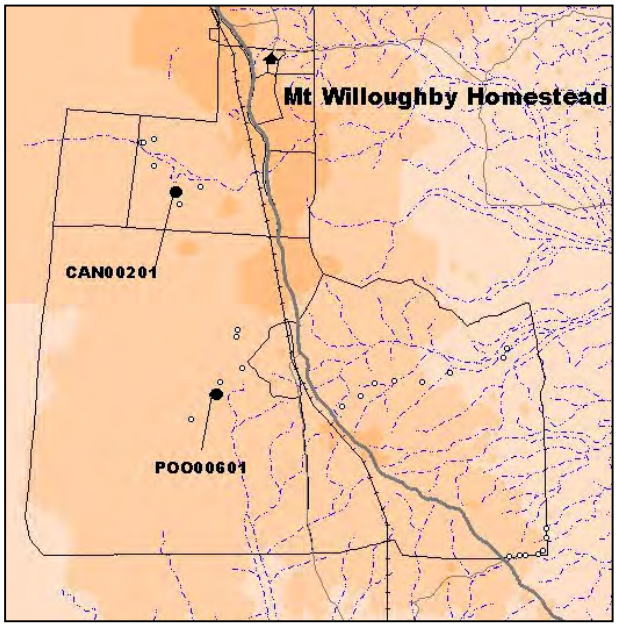
FLORISTIC GROUP 11

***Muehlenbeckia florulenta* (Lignum) and *Chenopodium nitrariaceum* (Nitre Goosefoot) shrubland**

No. quadrats in Group 2
Total species in group 19
Ave No. sp in group 18 range 18 - 18
No. introduced sp. in group 2

Landform: Swamps with slope < 1%
Soils: Light Medium Clay and Medium Clay
Cover: 1-10% cover of pebbles (5-50mm in size) with 25-40% bare earth and 20% litter
Vegetation Structure: Shrubland
Indicator species: *Chenopodium nitrariaceum, Muehlenbeckia florulenta, Teucrium racemosum, Alternanthera denticulata, Eragrostis australasica*

Quadrats: CAN00201, POO00601



PLANT SPECIES	COMMON NAME	% freq in grp	% indicator value	% prop. in group	p *	ave cover when present
SHRUBS > 0.5m						
Chenopodium nitrariaceum	Nitre Goosefoot	100	100	100	0.021	25-50%
Muehlenbeckia florulenta	Lignum	100	67	67	0.06	sparse <5%
Acacia tetragonophylla	Dead Finish	50	3	7	0.075	not many
FORBS & HERBS						
Teucrium racemosum	Grey Germander	100	100	100	0.021	not many
Alternanthera denticulata	Lesser Joyweed	100	100	100	0.021	sparse <5%
Atriplex lobativalvis		50	50	100	0.424	sparse <5%
Ixiolaena brevicompta	Plains Plover-daisy	50	50	100	0.424	not many
Myriocephalus rudallii	Small Poached-egg Daisy	50	50	100	0.48	sparse <5%
Tetragonia eremaea	Desert Spinach	50	50	100	0.424	not many
Heliotropium europaeum	Common Heliotrope*	50	30	60	0.573	not many
Centaurium spicatum	Spike Centaury*	50	30	60	0.604	sparse <5%
Calotis plumulifera	Woolly-headed Burr-daisy	50	30	60	0.633	25-50%
Calotis hispidula	Hairy Burr-daisy	50	25	50	0.719	not many
Portulaca oleracea	Common Purslane	50	20	40	0.688	not many
Calandrinia remota	Round-leaf Parakeelya	50	14	29	0.079	not many
Trichanthodium skirrophorum	Woolly Yellow-heads	50	9	18	0.004	not many
GRASSES						
Eragrostis australasica	Cane-grass	100	100	100	0.021	common <5%
Eragrostis xerophila	Knotty-butt Neverfail	50	9	18	0.18	not many
FERNS						
Marsilea sp.	Nardoo	100	67	67	0.063	not many

Fauna

Bird Group 2 & 3: Zebra Finch, no real overlap between birds at both quadrats related to shrubland dominance at POO00601 and Woodland at CAN00201

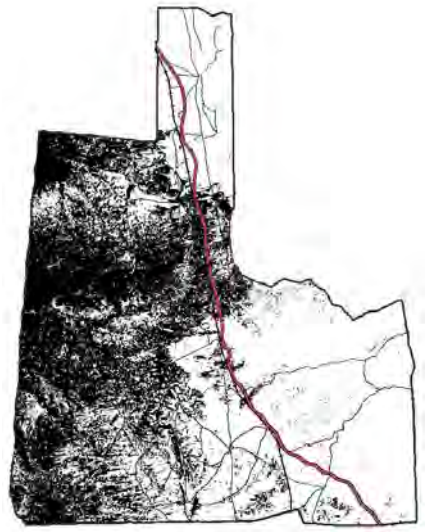
Mammal Group 2 & 3: Giles' Planigale, House Mouse

Reptile Group 5: sand overlying cracking clay dominated the fauna at POO00601, no reptiles from CAN00201.

Figure 36. Nitre Goosefoot Shrubland in Pooramingie Swamp at POO00601 Floristic Group 11 (Map Class 2).

Figure 37. Nitre Goosfoot and Lignum Shrubland at with fringing River Red Gum and Coolibah Woodland at CAN00201 Floristic Group 11 (Map Class 2).

SAND PLAINS



Class 5 *Acacia aneura* complex (Mulga) Shrubland.

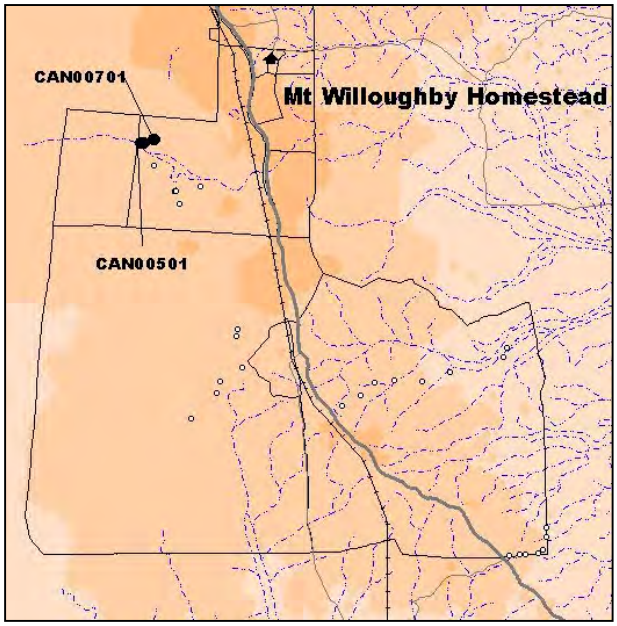
The dominant map group in the Great Victoria Desert Bioregion occurs on sandy plains.

Area mapped as class 5 = 2109.8 km^2 (41.6%)

This mapping class closely relates to the Floristic group 13

FLORISTIC GROUP 13

***Acacia aneura* (Mulga) low woodland over *Eriachne mucronata* (Mountain Wanderrie), *E. helmsii* (Woollybut Wanderrie) and *Eragrostis xerophila* (Knotty-but Neverfail) grasses on sandy plains.**



No. quadrats in Group 2
Total species in group 27
Ave No. sp in group 18.3 **range** 16 - 20
No. introduced sp. in group 1

Landform: Sandy plains with slopes 0%
Soils: Loamy Sand to Sandy Clay Loam
Cover: 0-70% cover of pebbles (5-50mm in size) with 5-25-35% bare earth and 10-15% litter
Vegetation Structure: Very Low Woodland to Low Woodland
Indicator species: *Maireana integra, Eriachne mucronata, Eriachne helmsii, Eragrostis xerophila, Brunonia australis, Leucochrysum stipitatum*

Quadrats: CAN00501, CAN00701

PLANT SPECIES	COMMON NAME	% freq in grp	% indicator value	% prop. in group	p *	ave cover when present
TREES						
Acacia aneura var.	Mulga	100	23	23	0.149	5-25%
Acacia brachybotrya	Grey Mulga-bush	33	33	100	0.824	5-25%
Acacia stowardii	Bastard Mulga	33	10	29	0.343	common <5%
Acacia papyrocarpa	Western Myall	33	8	24	0.513	common <5%
SHRUBS > 0.5m						
Eremophila paisleyi	Paisley's Emubush	67	12	19	0.071	5-25%
Acacia tetragonophylla	Dead Finish	67	6	9	0.075	not many
Eremophila gilesii	Hairy-fruit Emubush	33	33	100	0.824	common <5%
Acacia ramulosa	Horse Mulga	33	13	40	0.598	not many
SHRUBS < 0.5m						
Maireana integra	Entire-wing Bluebush	67	48	73	0.085	not many
FORBS & HERBS						
Brunonia australis	Blue Pincushion	100	100	100	0.003	not many
Leucochrysum stipitatum	Salt-spoon Daisy	67	67	100	0.046	common <5%

Trachymene glaucifolia	Blue Parsnip	67	38	57	0.158	sparse <5%
Ptilotus polystachyus var.	Long-tails	67	27	40	0.062	common <5%
Hibiscus sturtii var.	Sturt's Hibiscus	33	33	100	0.824	sparse <5%
Muelleranthus stipularis	Sand Pea	33	33	100	0.811	sparse <5%
Lotus cruentus	Red-flower Lotus	33	33	100	0.828	common <5%
Rhodanthe charsleyae		33	13	40	0.597	not many
Centaurium spicatum	Spike Centaury*	33	13	40	0.604	not many
Calotis plumulifera	Woolly-headed Burr-daisy	33	13	40	0.633	not many
Solanum lasiophyllum	Flannel Bush	33	10	31	0.47	not many
GRASSES						
Eriachne mucronata	Mountain Wanderrie	100	80	80	0.003	5-25%
Eriachne helmsii	Woollybutt Wanderrie	100	50	50	0.074	common <5%
Eragrostis xerophila	Knotty-butt Neverfail	100	36	36	0.18	common <5%
Monachather paradoxa	Bandicoot Grass	67	27	40	0.048	sparse <5%
Aristida contorta	Curly Wire-grass	67	10	16	0.04	sparse <5%
Tripogon loliiformis	Five-minute Grass	33	8	25	0.874	sparse <5%
MISTLETOES						
Amyema maidenii ssp. *maidenii*	Pale-leaf Mistletoe	67	22	33	0.498	sparse <5%

Fauna

Bird Group 4: Red-capped Robin, Mulga Parrot, Little Crow, Singing Honeyeater, Mistletoebird, Spiny-cheeked Honeyeater, Rufous Whistler, Crested Bellbird

Mammal Group 5: Sandy Inland Mouse aslo Red Kangaroo

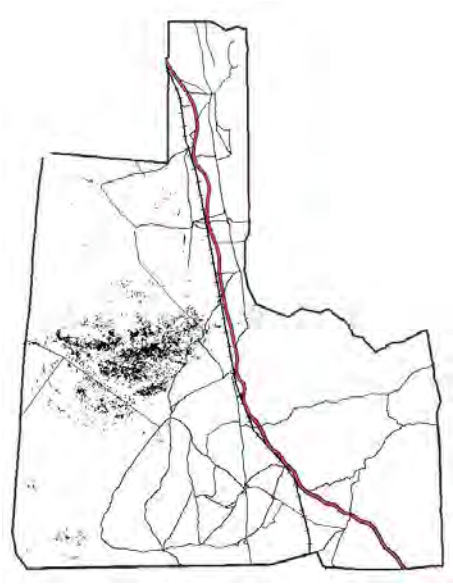
Reptile Group 5: Military Dragon, Sandplain Ctenotus, Common Desert Ctenotus

Figure 38. Open Mulga Woodland at CAN00501 Floristic Group 13 (Map Class 5).

Figure 39. Mulga Tall Shrubland at CAN00701 Floristic Group 13 (Map Class 5).

SAND DUNES AND SANDY DRAINAGE LINES

Class 4 *Acacia ramulosa* (Horse Mulga) Tall Shrubland +/- *Acacia aneura* (Mulga).



Occurs mainly on sand dunes with deep sand in the Great Victoria Desert Bioregion.

Area mapped as class 4 = 86 km^2 (1.7%)

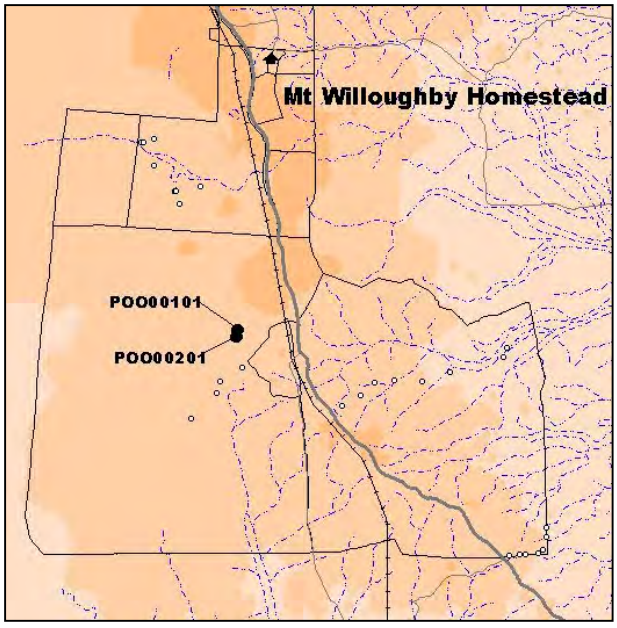
This mapping class closely relates to the floristic group 14

FLORISTIC GROUP 14

***Acacia aneura* (Mulga) +/- *A. ramulosa* (Horse Mulga) low woodland over *Rhagodia eremaea* (Desert Saltbush) shrubs.**

No. quadrats in Group 2
Total species in group 36
Ave No. sp in group 29.5 **range** 22 - 37
No. introduced sp. in group 0

Landform: Dune crest and drainage line with slopes < 1%
Soils: Sand to Sandy Loam
Cover: 0% sterw cover, 15-20% bare earth and 10-15% litter
Vegetation Structure: Low Woodland
Indicator species: *Rhagodia eremaea, Ptilotus polystachyus, Calandrinia remota, Monachather paradoxa, Rhyncharrhena linearis*



Quadrats: POO00101, POO00201

PLANT SPECIES	COMMON NAME	% freq in grp	% indicator value	% prop. in group	p *	ave cover when present
TREES						
Acacia aneura var.	Mulga	100	23	23	0.149	common <5%
Santalum lanceolatum	Plumbush	50	10	20	0.175	sparse <5%
SHRUBS > 0.5m						
Eremophila paisleyi	Paisley's Emubush	100	28	28	0.071	sparse <5%
Acacia tetragonophylla	Dead Finish	100	14	14	0.075	common <5%
Eremophila glabra ssp. *glabra*	Tar Bush	50	50	100	0.406	not many
Eremophila serrulata	Green Emubush	50	50	100	0.431	not many
Acacia ramulosa	Horse Mulga	50	30	60	0.598	5-25%
Senna artemisioides nothossp. *artemisioides*	Silver Senna	50	13	25	0.056	not many
SHRUBS < 0.5m						
Rhagodia eremaea	Desert Saltbush	100	100	100	0.023	common <5%
Maireana georgei	Satiny Bluebush	50	33	67	0.255	not many
Enchylaena tomentosa var.	Ruby Saltbush	50	11	21	0.094	common <5%

Ptilotus obovatus var.	Silver Mulla Mulla	50	7	14	0.056	not many
FORBS & HERBS						
Ptilotus polystachyus var.	Long-tails	100	60	60	0.062	common <5%
Calandrinia remota	Round-leaf Parakeelya	100	57	57	0.079	sparse <5%
Sclerolaena uniflora	Small-spine Bindyi	50	50	100	0.431	sparse <5%
Erodium sp.	Heron's-bill/Crowfoot	50	50	100	0.406	not many
Leucochrysum fitzgibbonii	Fitzgibbon's Daisy	50	50	100	0.431	not many
Nicotiana simulans	Native Tobacco	50	33	67	0.243	not many
Rhodanthe charsleyae		50	30	60	0.597	common <5%
Calotis hispidula	Hairy Burr-daisy	50	25	50	0.719	not many
Solanum lasiophyllum	Flannel Bush	50	23	46	0.47	not many
Trachymene glaucifolia	Blue Parsnip	50	21	43	0.158	sparse <5%
Portulaca oleracea	Common Purslane	50	20	40	0.688	common <5%
Solanum quadriloculatum	Plains Nightshade	50	17	33	0.532	not many
GRASSES						
Monachather paradoxa	Bandicoot Grass	100	60	60	0.048	sparse <5%
Eriachne helmsii	Woollybutt Wanderrie	100	50	50	0.074	not many
Eragrostis eriopoda	Woollybutt	50	50	100	0.406	5-25%
Eragrostis pergracilis	Small Love-grass	50	50	100	0.431	5-25%
Aristida holathera var. *holathera*	Tall Kerosene Grass	50	33	67	0.232	common <5%
Enteropogon ramosus	Umbrella Grass	50	10	20	0.196	common <5%
Eragrostis xerophila	Knotty-butt Neverfail	50	9	18	0.18	sparse <5%
Aristida contorta	Curly Wire-grass	50	6	12	0.04	sparse <5%
VINES						
Rhyncharrhena linearis	Bush Bean	100	100	100	0.023	not many
MISTLETOES						
Amyema preissii	Wire-leaf Mistletoe	100	60	60	0.058	sparse <5%
Lysiana exocarpi ssp. *exocarpi*	Harlequin Mistletoe	50	50	100	0.431	not many
Amyema maidenii ssp. *maidenii*	Pale-leaf Mistletoe	50	13	25	0.498	sparse <5%

Fauna

Bird Group 4: Mistletoebird, Spiny-cheeked Honeyeater, Rufous Whistler, Mulga Parrot, Red-capped Robin, White-browed Babbler, Grey Shrike-thrush, Willie Wagtail, Black-eared Cuckoo, Bourke's Parrot, Australian Ringneck Parrot

Mammal Group 5: Spinifex Hopping-mouse

Reptile Group 5: Military Dragon, Eastern Desert Ctenotus

Figure 40. Horse Mulga Tall Shrubland on dune at POO00101 Floristic Group 14 (Map Class 4)

Figure 41. Mulga Woodland over Dead Finish and grasses in a sandy drainage line at POO00201 Floristic Group 14 (Map Class 4).

FAUNA

MAMMALS

There are no published accounts of the mammals of Mt Willoughby. Prior to the survey the South Australian Museum held three mammal specimens for the area. These represented three species (Fat-tailed Dunnart *Sminthopsis crassicaudata*, Stripe-faced Dunnart *S. macroura* and Kultarr *Antechinomys laniger*). The Biological Survey of the Stony Deserts sampled half of the surrounding area and detected 23 species of which 14 were native, across the west region from 114 quadrats (Brandle 1998, Appendix 7). This survey did not sample habitats similar to those on the western half of Mt Willoughby.

107 records of 18 mammal species of which 12 were natives, were recorded at the 28 survey quadrats. Past use of the area by Stick-nest Rats *Leporillus* spp. was also recorded through old stick nests that have survived in shallow caves along the breakaways at quadrat BRU00301 and BRU00501. Thirty-two opportune records of eight mammal species were collected during the survey. Of these only the three bat species were not recorded at quadrats (refer to Table 11).

The known native mammal fauna for Mt Willoughby is brought to 14 by the inclusion of the extinct Stick-nest Rat and a Kultarr that was collected 1km south of the homestead in 1986 (S. Doyle, South Australian Museum records).

Figure 41. Relict piles of sticks and rat droppings are all that remain of the nests of the extinct Lesser Stick-nest Rat *Leporillus apicalis*. Still commonly found in breakaway caves as at BRU00501. Photos AC Robinson.

Figure 42. The fragile looking Kultarr *Antechinomys laniger* lives on the most open plains. While not captured during the survey one animal was collected in 1986. Photo AC Robinson.

Table 11. Mammal Species recorded at quadrats in Family order.

FAMILY Subfamily *SPECIES*	Common Name	BBB00101	BBB00201	BBB00301	BBB00401	BBB00501	BBB00601	BBB00701	BRU00101	BRU00201	BRU00301	BRU00401	BRU00501	BRU00601	BRU00701	BRU00801	CAN00101	CAN00201	CAN00301	CAN00401	CAN00501	CAN00601	CAN00701	POO00101	POO00201	POO00401	POO00501	POO00601	POO00701	Nuber of quadrats	Number of records	% recording rate
TACHYGLOSSIDAE																																
Tachyglossus aculeatus	Short-beaked Echidna					1					1		1																	3	3	3
DASYURIDAE Planigalinae																																
Planigale gilesi	Giles' Planigale																	1										1		2	2	2
Planigale tenuirostris	Narrow-nosed Planigale	2						1																						2	3	3
DASYURIDAE Sminthopsinae																																
Sminthopsis crassicaudata Opp	Fat-tailed Dunnart	2	2	2				2		1																	1			6	10	10
Sminthopsis macroura	Stripe-faced Dunnart	1	2									1																1		4	5	5
Sminthopsis ooldea	Ooldea Dunnart												1										2			1				3	4	4
MACROPODIDAE																																
Macropus robustus	Euro				1						1		1																	3	3	3
Macropus rufus Opp	Red Kangaroo		1					1	1	1			1		1	1	2			1		1	1							11	12	13
Macropus sp.			1	1	1	1	1																		1	1	1	1	2	10	11	11
CANIDAE																																
Canis lupus dingo Opp	Dingo						1			1			1														1			4	4	4
EQUIDAE																																
*Equus caballus**	Horse																									1			1	2	2	2
CAMELIDAE																																
Camelus dromedarius Opp*	One-humped Camel												1												1	1	1		1	5	5	5
BOVIDAE																																
*Bos taurus**	Cattle					1			1	1	1	1	1	1	1	1	2									1	1	1	2	14	16	17
*Ovis aries**	Sheep							1																						1	1	1
MURIDAE Hydromyinae																																
Leggadina forresti	Forrest's Mouse	1						1	1																					3	3	3
Leporillus apicalis	Lesser Stick-nest Rat **EX**										1		1																	2	2	2
Notomys alexis	Spinifex Hopping-mouse																				2	1		2	2					4	7	7
Pseudomys hermannsburgensis	Sandy Inland Mouse												1		1				1			1	1		1	2		1		8	9	9
MURIDAE Murinae																																
*Mus musculus**	House Mouse		1								1	1		2		1	3	2	3									1		9	15	16
LEPORIDAE																																
Oryctolagus cuniculus Opp*	Rabbit			1	1	1			1	1	1	1	2		1														1	1	11	12	13
12 native + 6 introduced	Number species/quadrat	4	5	2	2	3	2	5	3	4	5	3	9	2	3	3	3	2	2	1	1	3	3	1	4	6	4	7	4		96	
OPPORTUNISTIC RECORDS NOT IN SURVEY SITES																																
VESPERTILIONIDAE																																
Chalinolobus gouldii	Gould's Wattled Bat																															
Nyctophilus geoffroyi	Lesser Long-eared Bat																															
Vespadelus baverstocki	Inland Forest Bat																															

***** introduced mammals

Opp mammals also recorded opportunistically away from survey sites

COMMON SPECIES

Only the Red Kangaroo *Macropus rufus* was detected (observed or from tracks and scats) at more than half the quadrats (21 or 75%) reflecting the diversity of habitat types across the edge of two bioregions. Introduced mammals were the next most frequently detected: Cattle *Bos taurus* 14 quadrats, Rabbits *Oryctolagus cunniculus* 11 quadrats, House Mouse *Mus musculus* 9 quadrats. The Sandy Inland Mouse (8 quadrats 9 individuals) and the Fat-tailed Dunnart (8 quadrats 10 individuals) were the most widespread and commonly captured small mammals trapped (Table 11). The Sandy Inland Mouse is usually associated with sandy soils whilst the Fat-tailed Dunnart prefers clay soils and open areas.

Figure 43. Red Kangaroos are the dominant large native mammals of the plains at Mt Willoughby. Photo S Doyle.

SIGNIFICANT SPECIES

None of the surviving mammal species recorded during the survey are rated as being of conservation concern. However, the Kultarr, collected near Mt Willoughby Homestead in 1986 was considered data deficient for assessment under the 1996 Action Plan for Australian Marsupials and Monotremes (Maxwell *et al.* 1996). It is also likely to occur further south on open stony or grassy flats with or without scattered shrubs or trees. Attempts were made to detect the Nationally and South Australian Endangered Southern Marsupial Mole *Notoryctes typhlops* by looking for tunnels in the sand dunes at, and to the north of POO00101. This technique has proved useful in other areas to the north-west (Benshemesh pers. comm.) and in the Simpson Desert (pers. obs.), but no traces were detected on Mt Willoughby. The greater areas of dunes on the western boundary of the property that is connected to the Great Victoria Desert dunefields should be searched with the methods used during this survey before their presence can be confidently excluded. The Plains Rat *Pseudomys australis* (Vulnerable in Australia and South Australia) may also occur on the southwestern portion of Mt Willoughby, particularly in open cracking clay habitats (Brandle *et al.* 1998).

Figure 44. Trench technique for detecting tunnelling signs of Marsupial Moles. A mole tunnel 70 cm below the surface. Photos S Pillman.

Figure 45. A Marsupial Mole. Photo H Ehmann.

SPECIES WITH RESTRICTED DISTRIBUTIONS

None of the mammals recorded are restricted to the study area, however, the Euro *Macropus robustus* is restricted to hilly and breakaway habitats. It is rare in northern South Australia but abundant on Mt Willoughby. The Echidna *Tachyglossus aculeatus*, while occurring over a wider range of habitats is probably more abundant in the hilly breakaway areas.

The Fat-tailed Antechinus *Pseudantechinus macdonnellensis*, although not recorded at Mt Willoughby is a possible inhabitant of the rocky breakaway areas. It is a central Australian rocky range specialist, more common in the ranges to the northwest. It has been recorded in similar habitat to the north and in Witjira National Park.

Figure 46. The Fat-tailed Antechinus, pictured in Witjira National Park, is likely to be present in some of the rocky breakaway areas common on Mt Willoughby. Photo AC Robinson.

BIOGEOGRAPHIC AFFINITIES

Several species are also at their biogeographical boundaries. The Ooldea Dunnart *Sminthopsis ooldea* is at its eastern limits being associated with the sandplain deserts to the west. The two species of *Planigale* are at the western limit of their distributions being associated with cracking clay habitats more common in the east.

MACROPODS

Two species of Kangaroo were recorded during the survey. The Red Kangaroo *Macropus rufus* was the most widespread mammal recorded across quadrats. The majority of these records were from sign such as tracks and scats. Red Kangaroos were only directly observed at 4 of the 11 quadrats on which they were recorded. Signs were detected at a further 10 quadrats but as identification was uncertain, these were recorded as *Macropus* sp. as Red Kangaroo and Euro tracks and scats can be difficult to distinguish. Euros *Macropus robustus* were only recorded at three quadrats. All of these were breakaway escarpment quadrats and direct observation was only made at one. Past survey efforts have shown that Euros are confined to rocky hills and breakaway habitats in northern South Australia while Red Kangaroos are found throughout, particularly in more open habitats (Brandle 1998, Copley *et al.* 2003).

Figure 47. The Euro is the most common large native mammal in the Breakaways and hills. Photo AC Robinson.

BATS

The three species of bats that were captured at Mt Willoughby are amongst the most widespread and readily captured species across inland Australia (Churchill 1998). A further seven species were recorded in the Anangu Pitjantjatjara Lands survey to the north west of Mt Willoughby (Copley *et al.* 2003) and it is likely that all of these species make use of the habitats on Mt Willoughby (refer to Table 9).

Figure 48. Gould's Wattled Bats are common throughout wooded areas of South Australia. Photo P Bird.

Figure 49. Lesser Long-eared Bat. Photo PD Canty.

INTRODUCED MAMMALS

Six non-native or introduced mammal species were recorded during the survey. Four of these are domestic stock or their wild descendants. One introduced species recorded by its skeletal remains, the sheep, is no longer stocked north of the Dingo Proof Fence which runs along the southern boundary of Mt Willoughby. Horses and Camels are likely to be feral in the areas where they were recorded, whilst the cattle are still being grazed for commercial purposes. Of the smaller introduced species the House Mouse was relatively rare – possibly reflecting the generally dry conditions prior to the survey. Rabbits were similarly scarce and seemed to be surviving best in the breakaway habitats along Brumby Creek. No foxes or cats were recorded during the survey but it is likely that they are sparsely present and would build in numbers if prey such as rabbits reached high numbers or Dingo populations were significantly reduced. Proper introduced herbivore and predator surveys should be undertaken before any decisions to bait or control numbers are instigated.

SMALL MAMMAL COMMUNITIES

The small mammals recorded at quadrats were clustered into five broad mammal communities using the computer program PCORD.

Five groups were chosen to reflect the major mammal communities that are found in the various habitats of the area.

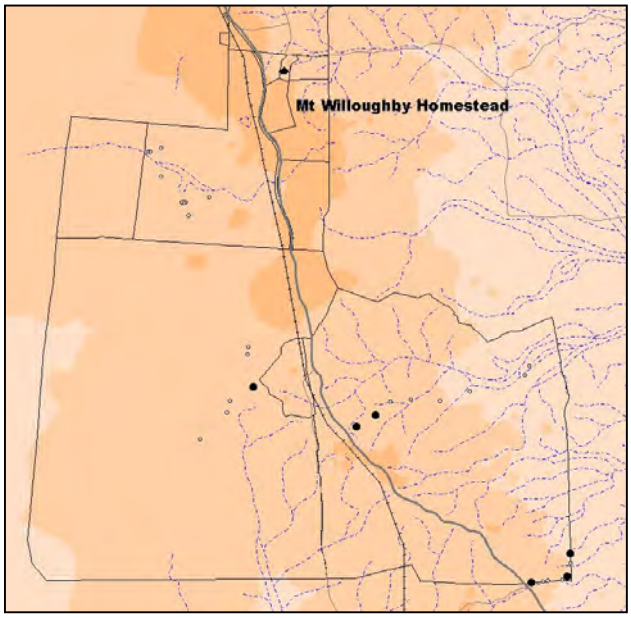
Group 1 represents a Very Low Open Shrubland/Grassland on clay soil mammal community. Group 2 covers a similar swuit of habitats with denser areas of low shrub providing habitat for a slightly wider range of small mammals. Group 3 represents a poorly defined cluster dominated by the introduced House Mouse, incorporating a range of quadrats subject to regular disturbance, such as creeklines, floodplains and swamps. Group 4 represents the small mammal community found on a variety of sandy clay loam soils supporting Open Low Shrublands and Shrublands with predominantly sand plain mammals. Group 5 represents the sandy soil fauna of the Mulga Woodlands of the Giles biogeographical region.

The following section details each Mammal group using the set format described below:

- Group number and description
- Number of quadrats in Group,
- Total number of species in the group,
- Average number of species in the group and the range (minimum and maximum)
- Landforms
- Soil Surface Texture
- Cover
- Vegetation Structure
- Comments
- Indicator Species
- Map of Quadrats and Quadrat names
- Table of species in frequency order: Mammal species; Common Name; % frequency in group (sorted in descending order); % indicator value derived from PCORD based on importance of species in defining group; % frequency across all 14 groups; p * value statistical significance level as an indicators species; vegetation groups; species photographs.

Figure 50. Fat-tailed Dunnarts favour sparsely vegetated grasslands and herblands and are aften associated with craking clay flats. Photo AC Robinson.

MAMMAL GROUP 1.



No. of quadrats 6
No. of species 4
Ave sp./quadrat 1.8 **range** 1 - 4

Landform: Stony plains and stream channel with slopes of less than 1%
Soils: Fine sandy clay loam to light medium clay
Cover: 30-100% cover of pebbles (5-50mm in size) to cobbles (50-250mm) with 5-15% bare earth and 2-25% litter
Vegetation Structure: very low shrublands plus grassland, shrubland and mallee
Comments: *Atriplex vesicaria*, *A. nummularia* ssp. *omissa* low shrublands, ephemeral grassland, *Eremophila freelingii* shrubland and sparse *Eucalyptus socialis* mallee. This assemblage was described by groups 6 and 9, for the stony deserts survey (Brandle 1998) and by group 3 for the Anangu Pitjantjatjara lands survey (Copley *et al.* 2003).

Indicator species: Fat-tailed Dunnart, Forrest's Mouse

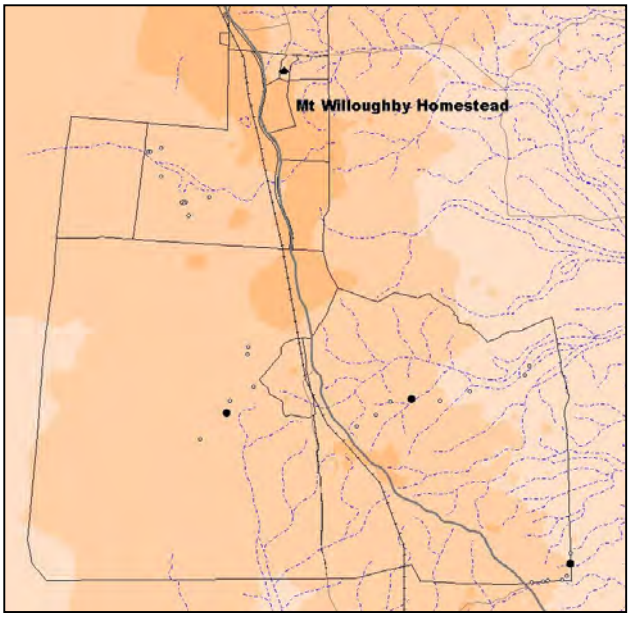
Quadrats: BBB00101, BBB00301, BBB00701, BRU00101, BRU00201, POO00501

SPECIES	Common Name	% indicator sp.	% freq in gp.	% freq across gp.	p*
Sminthopsis crassicaudata	Fat-tailed Dunnart	56	83	67	0.013
Leggadina forresti	Forrest's Mouse	50	50	100	0.056
Planigale tenuirostris	Narrow-nosed Planigale	33	33	100	0.173
Sminthopsis macroura	Stripe-faced Dunnart	2	17	11	0.004

Vegetation groups 1, 3, 5 & 6

Figure 51. Forrest's Mouse inhabits gibber and clay plains. Photo AC Robinson.

MAMMAL GROUP 2.



No. of quadrats 3
No. of species 5
Ave sp./quadrat 3 **range** 2 - 4

Landform: Stream channel, stony plain and swamp with slopes < 1%
Soils: Fine sandy clay loam to light medium clay
Cover: <10% to >70% cover of pebbles with 5-25% bare earth and 5-20% litter
Vegetation Structure: Low open shrublands to open shrubland
Comments: Mixed *Atriplex vesicaria, Maireana aphylla* and *Chenopodium nitrariaceum* shrublands. This assemblage was best described by groups 5 for the stony deserts survey (Brandle 1998), and by group 3 for the Anangu Pitjantjatjara lands survey (Copley *et al.* 2003).

Indicator species: *Sminthopsis macroura,*

Quadrats: BBB00201, BRU00401, POO00601

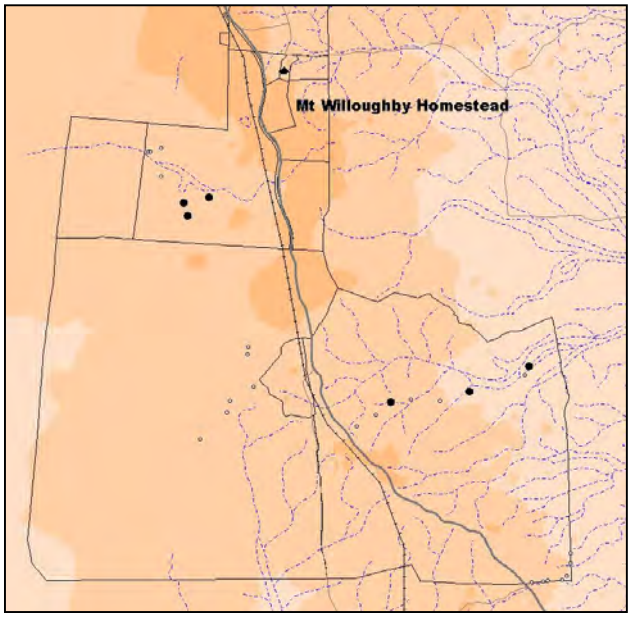
SPECIES	Common Name	% indicator sp.	% freq in gp.	% freq across gp.	p*
Sminthopsis macroura	Stripe-faced Dunnart	89	100	89	0.004
Mus musculus	House Mouse	33	100	33	0.003
Planigale gilesi	Giles' Planigale	22	33	67	0.303
Sminthopsis crassicaudata	Fat-tailed Dunnart	11	33	33	0.013
Pseudomys hermannsburgensis	Sandy Inland Mouse	5	33	15	0.015

Vegetation groups 2, 7 & 11

Figure 52. Stripe-faced Dunnart inhabits chenopod shrublands on gibber plains and tablelands. Photo P Canty.

MAMMAL GROUP 3

No. of quadrats 6
No. of species 3
Ave sp./quadrat 1.5 **range** 1 - 2



Landform: Stream channel, floodout, swamps, stony plain and breakaway with slopes < 1%
Soils: sandy clay loam and medium clay
Cover: 0-10% and 30-70% cover of pebbles with 5-40% bare earth and 10-25% litter
Vegetation Structure: Open shrubland to woodland and low open forest
Comments: Coolibah and River Red Gum woodlands, Chenopod swamps, eremophila and Mulga creeks and breakaways. House mice are often dominant in areas that suffer periodic disturbances such as flooding, and have higher nutrient and moisture levels.

Indicator species: *Mus musculus*

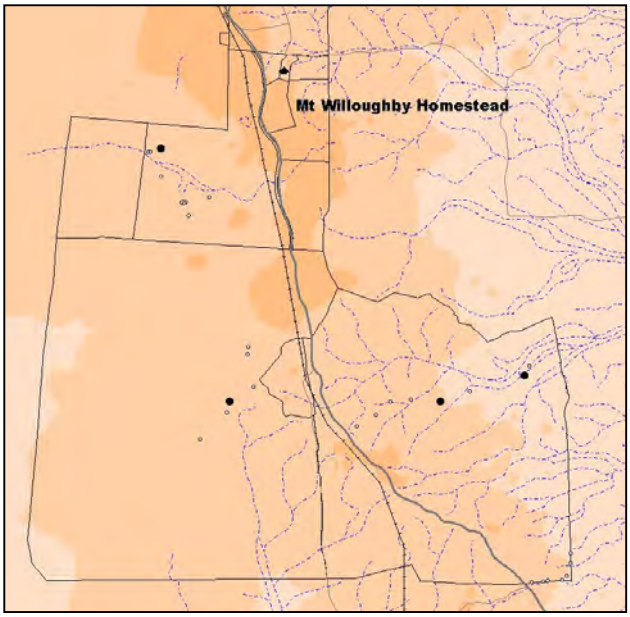
Quadrats: BRU00301, BRU00601, BRU00801, CAN00101, CAN00201, CAN00301

SPECIES	Common Name	% indicator sp.	% freq in gp.	% freq across gp.	p*
Mus musculus	House Mouse	67	100	67	0.003
Planigale gilesi	Giles' Planigale	6	17	33	0.303
Pseudomys hermannsburgensis	Sandy Inland Mouse	1	17	7	0.015

Vegetation groups 3, 9, 10, 11 & 12

Figure 53. Giles' Planigale prefers cracking clay areas, usually found in swamps and gypseous clay depressions. Photo AC Robinson.

MAMMAL GROUP 4.



No. of quadrats 4
No. of species 2
Ave sp./quadrat 2 **range** 1 - 3

Landform: Stream channel, stony plain and swamp with slopes < 1%
Soils: Fine sandy clay loam to light medium clay
Cover: <10% to >70% cover of pebbles with 5-25% bare earth and 5-20% litter
Vegetation Structure: Low open shrublands to open shrubland
Comments: Mixed *Atriplex vesicaria, Maireana aphylla* and *Chenopodium nitrariaceum* shrublands. No stony deserts equivalent assemblages. The poorly defined group 4 for the Anangu Pitjantjatjara lands survey probably incorporates this assemblage (Copley *et al.* 2003).

Indicator species: *Sminthopsis ooldea, Pseudomys hermannsburgensis*

Quadrats: BRU00501, BRU00701, CAN00701, POO00401

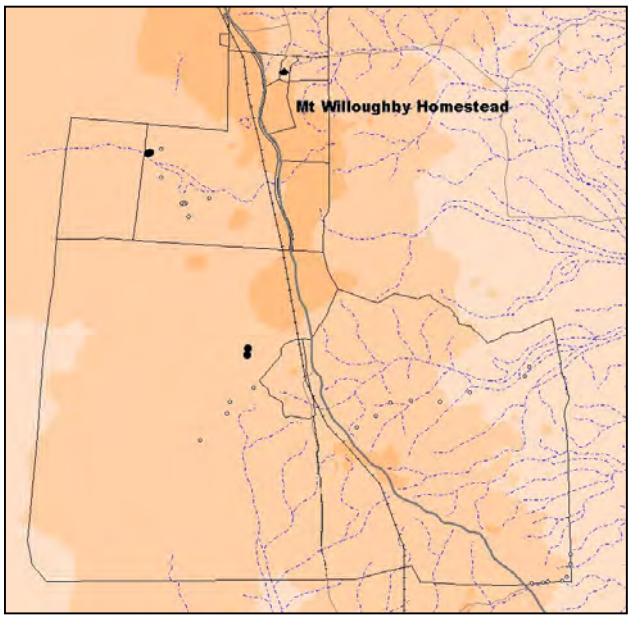
SPECIES	Common Name	% indicator sp.	% freq in gp.	% freq across gp.	p*
Sminthopsis ooldea	Ooldea Dunnart	75	75	100	0.008
Pseudomys hermannsburgensis	Sandy Inland Mouse	56	100	56	0.015

Vegetation groups 6, 8, 12 & 13

Figure 54. The Sandy Inland Mouse is widespread and common in many habitats with surface sand. Photo AC Robinson.

Figure 55. Ooldea Dunnart is at the eastern edge of its range at Mt Willoughby. Photo AC Robinson.

MAMMAL GROUP 5



No. of quadrats 4
No. of species 2
Ave sp./quadrat 1.5 **range** 1 - 2

Landform: Sandy plains, dune and drainage line > 1% slopes
Soils: Sand, loamy sands and sandy loam
Cover: Mostly no surface strew, or pebbles (5-50mm) with 30-70% cover, 15-25% bare earth and 10-15% litter
Vegetation Structure: Very low woodland to low woodland
Comments: Mulga woodlands with grass or *Rhagodia eremaea* shrub understorey. No stony deserts equivalent assemblages. Mammal group 5 for the Anangu Pitjantjatjara lands survey best describes this assemblage, which at Mt Willoughby lacks *Triodia* and the associated Wongai Ningaui (Copley *et al.* 2003).

Indicator species: *Notomys alexis, Pseudomys hermannsburgensis*

Quadrats: CAN00501, CAN00601, POO00101, POO00201

SPECIES	Common	% indicator sp.	% freq in gp.	% freq across gp.	p*
Notomys alexis	Spinifex Hopping-mouse	100	100	100	0.001
Pseudomys hermannsburgensis	Sandy Inland Mouse	11	50	22	0.015

Vegetation groups 13 & 14

Figure 56. The Spinifex Hopping-mouse inhabits areas with deep sand such as dunes and sandplains. Photo AC Robinson.

BIRDS

Previous studies on Mount Willoughby are restricted to seven localities sampled for the Atlas of Australian Birds (Blakers *et al.* 1984). Several visits to these locations between October 1977 and August 1981 recorded 93 species (17 of which were water birds). The Biological Survey of the Stony Deserts sampled half of the surrounding area and detected 91 (10 water birds) species across the west region from 81 quadrats (Brandle & Reid 1998). This survey did not sample habitats similar to those on the western half of Mt Willoughby.

1493 records of 74 bird species were recorded at the 28 survey quadrats. The only water bird recorded at a quadrat was an Australasian Grebe. The 208 opportunistic records collected away from quadrats comprised 68 species. Of these, twelve were not recorded from quadrats (refer to bottom of Table 12).

Table 12. Frequency of bird species recorded at quadrats in Family order.

FAMILY NAME SPECIES	Common Name	BBB00101	BBB00201	BBB00301	BBB00401	BBB00501	BBB00601	BBB00701	BRU00101	BRU00201	BRU00301	BRU00401	BRU00501	BRU00601	BRU00701	BRU00801	CAN00101	CAN00201	CAN00301	CAN00401	CAN00501	CAN00601	CAN00701	POO00101	POO00201	POO00401	POO00501	POO00601	POO00701	Number of quadrats	number of records	% recording rate
CASUARIIDAE																																
*Dromaius novaehollandiae**	Emu	1										1				1	1											1		5	5	0
PODICIPEDIDAE																																
*Tachybaptus novaehollandiae**	Australasian Grebe																			10			3							2	13	1
ACCIPITRIDAE Accipitrinae																																
Accipiter fasciatus	Brown Goshawk																					1								1	1	0
*Aquila audax**	Wedge-tailed Eagle				2				1				2														2		6	5	13	1
Hamirostra melanosternon	Black-breasted Buzzard **R**													1																1	1	0
*Hieraaetus morphnoides**	Little Eagle																			1			1							2	2	0
*Milvus migrans**	Black Kite							1						1																2	2	0
FALCONIDAE																																
*Falco berigora**	Brown Falcon										2			3					1	1	1			1	1					7	10	1
*Falco cenchroides**	Nankeen Kestrel				2										1															2	3	0
OTIDIDAE																																
*Ardeotis australis**	Australian Bustard **V**																				1									1	1	0
TURNICIDAE																																
Turnix velox	Little Button-quail																					3								1	3	0
CHARADRIIDAE																																
Charadrius australis	Inland Dotterel						4	3																						2	7	0
*Vanellus tricolor**	Banded Lapwing																1			3										2	4	0
COLUMBIDAE																																
*Ocyphaps lophotes**	Crested Pigeon			2	3			2								3	4				6				1		1		8	22	1
*Phaps chalcoptera**	Common Bronzewing																3	2					1	1					4	7	0
CACATUIDAE																																
*Cacatua roseicapilla**	Galah			12			3				3	8	4	3	3	5	20				12	4			1		2	90		14	170	11
*Cacatua sanguinea**	Little Corella			9																										1	9	1
*Nymphicus hollandicus**	Cockatiel									4							4							3						3	11	1
PSITTACIDAE																																
*Barnardius zonarius**	Australian Ringneck													3			9				2									3	14	1
*Melopsittacus undulatus**	Budgerigar			54		18											13			6	6	6						1		7	104	7
*Neopsephotus bourkii**	Bourke's Parrot													3										4	9					3	16	1
*Psephotus varius**	Mulga Parrot										2			3			7				4	3	7	2						7	28	2
CUCULIDAE																																
Chrysococcyx basalis	Horsfield's Bronze-cuckoo																							1						1	1	0
Chrysococcyx osculans	Black-eared Cuckoo																1				1	1								3	3	0
*Cuculus pallidus**	Pallid Cuckoo																1													1	1	0
STRIGIDAE																																
*Ninox novaeseelandiae**	Southern Boobook													1																1	1	0
PODARGIDAE																																
Podargus strigoides	Tawny Frogmouth													1																1	1	0

Mt Willoughby I. P. A. Biological Survey

FAMILY NAME *SPECIES*	**Common Name**	**BBB00101**	**BBB00201**	**BBB00301**	**BBB00401**	**BBB00501**	**BBB00601**	**BBB00701**	**BRU00101**	**BRU00201**	**BRU00301**	**BRU00401**	**BRU00501**	**BRU00601**	**BRU00701**	**BRU00801**	**CAN00101**	**CAN00201**	**CAN00301**	**CAN00401**	**CAN00501**	**CAN00601**	**CAN00701**	**POO00101**	**POO00201**	**POO00401**	**POO00501**	**POO00601**	**POO00701**	**Number of quadrats**	**number of records**	**% recording rate**
ALCEDINIDAE Halcyoninae																															
*Todiramphus pyrrhopygia**	Red-backed Kingfisher			2	5	2							2																4	11	1
MEROPIDAE																															
*Merops ornatus**	Rainbow Bee-eater												4															1	2	5	0
CLIMACTERIDAE																															
Climacteris affinis	White-browed Treecreeper **R**																							2					1	2	0
MALURIDAE Malurinae																															
Malurus lamberti	Variegated Fairy-wren				2							3	15			12	6						6		3				7	47	3
Malurus leucopterus	White-winged Fairy-wren		11		4		7	17					10		11											5	54		8	119	8
Malurus sp.																	1												1	1	0
Malurus splendens	Splendid Fairy-wren								4	3		2				5	9		4			10	27	14					9	78	5
PARDALOTIDAE																															
Pardalotus rubricatus	Red-browed Pardalote			1																									1	1	0
Pardalotus striatus	Striated Pardalote														1														1	1	0
ACANTHIZIDAE Acanthizinae																															
*Acanthiza apicalis**	Inland Thornbill									4		3											2	2					4	11	1
Acanthiza iredalei	Slender-billed Thornbill **V VU**												6																1	6	0
*Acanthiza uropygialis**	Chestnut-rumped Thornbill			4	6	2				2	3		3	10					13			7	7	13				3	12	73	5
*Aphelocephala leucopsis**	Southern Whiteface																								2	3		2	3	7	0
Calamanthus campestris	Rufous Fieldwren		2					2							3														3	7	0
*Pyrrholaemus brunneus**	Redthroat **R**								1	2						1		3	9			1	2						7	19	1
*Smicrornis brevirostris**	Weebill												2		2														2	4	0
MELIPHAGIDAE																															
*Acanthagenys rufogularis**	Spiny-cheeked Honeyeater				1		1						4			5				2	2	1	3	2					9	21	1
Certhionyx variegatus	Pied Honeyeater																										1		1	1	0
Lichenostomus ornatus	Yellow-plumed Honeyeater															10													1	10	1
*Lichenostomus penicillatus**	White-plumed Honeyeater												1																1	1	0
*Lichenostomus plumulus**	Grey-fronted Honeyeater															6													1	6	0
*Lichenostomus virescens**	Singing Honeyeater			3	1	4	3			1	2		2	3		1	4		2		2	6	1	2	2	2		1	2	19	44	3
*Manorina flavigula**	Yellow-throated Miner			4													24												2	28	2
Ashbyia lovensis	Gibberbird	2																											1	2	0
PETROICIDAE																															
*Petroica goodenovii**	Red-capped Robin					1				3	2			6			2				2	3	3	2	12				10	36	2
POMATOSTOMIDAE																															
*Pomatostomus superciliosus**	White-browed Babbler												4		3	7					10		6	4				10	7	44	3
EUPETIDAE																															
Cinclosoma castanotus	Chestnut Quail-thrush **R**																						1					1	2	2	0
*Cinclosoma cinnamomeum**	Cinnamon Quail-thrush		1	1	1	1	2											3	3						4	3	2	1	11	22	1
*Psophodes occidentalis**	Chiming Wedgebill																			3			1	2	1			1	5	8	1
PACHYCEPHALIDAE																															
*Colluricincla harmonica**	Grey Shrike-thrush												2	1			2				1	1		1					6	8	1
*Oreoica gutturalis**	Crested Bellbird			1		1	1			2			1				1	1	1	1			1	1	1	1		2	15	17	1
*Pachycephala rufiventris**	Rufous Whistler													1						1	2	1	2	2					6	9	1
DICRURIDAE																															
*Grallina cyanoleuca**	Magpie-lark												2							2									2	4	0
*Rhipidura leucophrys**	Willie Wagtail				1								4			2					2			2					5	11	1
ARTAMIDAE																															
*Artamus cinereus**	Black-faced Woodswallow			2		4					5				3	4									2			1	7	21	1
*Artamus personatus**	Masked Woodswallow				1			11		11																			3	23	2
*Cracticus nigrogularis**	Pied Butcherbird												1			1													2	2	0
*Cracticus torquatus**	Grey Butcherbird								1																				1	1	0
*Gymnorhina tibicen**	Australian Magpie			7		1	1						5																4	14	1
CAMPEPHAGIDAE																															
*Coracina maxima**	Ground Cuckoo-shrike				1	8										3													3	12	1
*Coracina novaehollandiae**	Black-faced Cuckoo-shrike					1							3		3	3													4	10	1
CORVIDAE																															
*Corvus bennetti**	Little Crow	1	4	1		8	4	2		1	4		2	3	4	5			2	3	2	1	1		1		2		1	20	52	3
*Corvus coronoides**	Australian Raven								3	2			3	3			6	1					2						7	20	1

FAMILY NAME SPECIES	Common Name	BBB00101	BBB00201	BBB00301	BBB00401	BBB00501	BBB00601	BBB00701	BRU00101	BRU00201	BRU00301	BRU00401	BRU00501	BRU00601	BRU00701	BRU00801	CAN00101	CAN00201	CAN00301	CAN00401	CAN00501	CAN00601	CAN00701	POO00101	POO00201	POO00401	POO00501	POO00601	POO00701	Number of quadrats	number of records	% recording rate
HIRUNDINIDAE																																
Cheramoeca leucosternus	White-backed Swallow			1							1																			2	2	0
*Petrochelidon nigricans**	Tree Martin														8															1	8	1
DICAEIDAE																																
Dicaeum hirundinaceum	Mistletoebird			1										1			2				4	4	2	1	5				1	9	21	1
MOTACILLIDAE																																
*Anthus novaeseelandiae**	Richard's Pipit			3		6	2	1	7			4		1	6				4							4	2	1		12	41	3
ESTRILDIDAE																																
*Taeniopygia guttata**	Zebra Finch		4	18		10	8		4	12	12	6	6	3		11	6	2	6	4				2		8	9	8	8	20	147	10
74 species	**Total**	3	5	18	13	14	11	8	4	12	13	4	12	33	6	12	31	7	8	12	17	15	15	21	18	10	9	10	14	75	1493	
OPPORTUNE Species not also recorded at quadrats																																
PHALACROCORACIDAE																																
Phalacrocorax sulcirostris	Little Black Cormorant																															
ACCIPITRIDAE Accipitrinae																																
Haliastur sphenurus	Whistling Kite																															
CHARADRIIDAE																																
Charadrius veredus	Oriental Plover																															
Vanellus miles	Masked Lapwing																															
TYTONIDAE																																
Tyto alba	Barn Owl																															
CAPRIMULGIDAE																																
Eurostopodus argus	Spotted Nightjar																															
AEGOTHELIDAE																																
Aegotheles cristatus	Australian Owlet-nightjar																															
MELIPHAGIDAE Epthianurinae																																
Epthianura tricolor	Crimson Chat																															
CAMPEPHAGIDAE																																
Lalage tricolor	White-winged Triller																															
CORVIDAE																																
Corvus orru	Torresian Crow																															
SYLVIIDAE Megalurinae																																
Cincloramphus cruralis	Brown Songlark																															

* species recorded at quadrats and also opportunistically away from quadrats.

COMMON SPECIES

The most widespread species across the quadrats surveyed are listed in Table 13, which shows species recorded at more than 40% of quadrats. While the Little Crow was as commonly encountered as the Zebra Finch, the latter was far more abundant and was only surpassed in number by Galahs, which feed on gibber plains in large flocks. Other abundant species were 119 White-winged Fairy-wrens from 8 quadrats and 109 Budgerigars from 7 quadrats (see Table 12 for full list). The abundant species reflect the mix of tall shrubland (Singing Honeyaeter, Crested Belbird, Chestnut-rumped Thornbill) and low open shrubland (Zebra Finch, Richards Pipit, Galah) quadrats.

Table 13. Most widespread and commonly encountered bird species.

SPECIES	Common name	No. quadrats	number of records
Corvus bennetti	Little Crow	20	52
Taeniopygia guttata	Zebra Finch	20	147
Lichenostomus virescens	Singing Honeyeater	19	44
Oreoica gutturalis	Crested Bellbird	15	17
Cacatua roseicapilla	Galah	14	170
Acanthiza uropygialis	Chestnut-rumped Thornbill	12	73
Anthus novaeseelandiae	Richard's Pipit	12	41

SIGNIFICANT SPECIES

Six species with current conservation significance ratings were recorded at quadrats. Two are considered threatened and have vulnerable ratings in South Australia and four are considered rare in South Australia. These are listed in Table 14.

Table 14. Bird species with conservation ratings under the South Australian National Parks and Wildlife Act (SA Status) and the Federal Environment Protection and Biodiversity Conservation Act (Aus Status). The number of individuals recorded at quadrats are also displayed and summarised.

SPECIES	Common Name	SA STATUS	AUS STATUS	BRU00201	BRU00301	BRU00601	CAN00101	CAN00301	CAN00401	CAN00501	CAN00701	POO00101	POO00201	POO00701	No. quadrats	number of records
Acanthiza iredalei	Slender-billed Thornbill	V	VU			6									1	6
Ardeotis australis	Australian Bustard	V								1					1	1
Cinclosoma castanotus	Chestnut Quail-thrush	R										1		1	2	2
Climacteris affinis	White-browed Treecreeper	R											2		1	2
Hamirostra melanosternon	Black-breasted Buzzard	R				1									1	1
Pyrrholaemus brunneus	Redthroat	R		1	2		1	3	9		1	2			7	19

Slender-billed Thornbill *Acanthiza iredalei*

This species was collected at three locations north of Mt Willoughby in 1913 and 1914 (Mathew 1994, Pavey and Joseph 2004) in a similar range of habitats. The species was not located during other survey work in the region since (Blakers *et al.* 1984, Brandle and Reid 1998). The nearest recent records are from 200 km south of Mt Willoughby in 1978 and another in the Northern Flinders Ranges (Blakers *et al.* 1984). Schodde and Mason (1999) did not recognize a northern population of this species.

During the survey a small group were heard and observed at BRU00601 in a drainage line supporting River Red Gums and Western Myall woodland with an open shrub understorey and Cottonbush low shrubland adjacent. Survey ornithologist, Jane Cooper suggests that her observations should be independently confirmed to establish beyond doubt the authenticity of what would be a highly significant population from a conservation perspective.

Australian Bustard *Ardeotis australis*

Bustards are considered vulnerable in South Australia and the reporting rate for this large obvious species is low indicating its rarity. They were recorded at nine quadrats from 553 in the Stony Deserts (Brandle and Reid 1998). Twenty-one birds were recorded at 15 localities between 1991-2001 in the Anangu Pitjantjatjara Lands (Copley *et al.* 2003) indicating the species may be more common in the Mulga lands than the chenopod shrublands. This species was also recorded at two localities for the Atlas of Australian Birds (Blakers *et al.* 1984), one on the southern boundary in 1979 and the other 17km east of the eastern boundary of Mt Willoughby in 1984. It was also reported at another 7 localities within 150km of Mt Willoughby between 1977 and 1981.

The only record of this species during the Mt Willoughby survey was at quadrat CAN00501 on a Mulga sand-plain.

Chestnut Quail-thrush *Cinclosoma castanotus*

This species has not been previously reported for Mt Willoughby. The nearest records in the Atlas of Australian Birds (Blakers *et al.* 1984) were collected during 1977 to 1981 and were all from south of the 30th parallel more than 200km from Mt Willoughby. The 2002 atlas census had one record 220km SSW of Mt Willoughby. The biological survey of the Anangu Pitjantjatjara lands (Copley *et al.* 2003) recorded 40 individuals at 18 widespread localities to the west north west of Mt Willoughby between 1991-2001. The Chestnut Quail-thrush was targeted for further conservation research in the recommendations listed in the report.

The Chestnut Quail-thrush was recorded at two POO quadrats by Deb Hopton during the survey. POO00101 was on a sand dune dominated by Mulga and Horse Mulga Low woodland over grasses and scattered shrubs. POO00701 was a lightly pebbled light medium clay plain with Bastard Mulga and Mulga over *Eremophila* and *Senna* shrubs.

White-browed Tree-creeper *Climacteris affinis*

The Atlas of Australian Birds reports three localities for the species within 100 km to the south, northwest and northeast of Mt Willoughby 1978-80 (Blakers *et al.* 1984). The 2002 report failed to record the species in the area. White-browed Tree-creepers were not recorded to the north and east in the Stony Deserts Survey (Brandle and Reid 1998). In the Anangu Pitjantjatjara Lands to the north west, 11 birds were recorded at seven localities and it was concluded that

the species had not appeared to decline in the region, but further research with a view to future monitoring was recommended (Copley *et al.* 2003).

Two White-browed Tree-creepers were recorded at quadrat POO00201 in a sandy loam drainage line supporting dense Mulga woodland over shrubs and grasses.

Black-breasted Buzzard *Hamirostra melanosternon*
This species was recorded at four localities within 100 km to the north of Mt Willoughby and one 100 km east for the first Atlas of Australian Birds and none to the south or west (Blakers *et al.* 1984). During the biological survey of the stony deserts it was recorded at two localities to the northeast and two to the south-west but none in the western region adjacent to and including Mt Willoughby (Brandle and Reid 1998). To the north west 13 birds were recorded from 13 localities (Copley *et al.* 2003). No conservation recommendations were made with regard to this nomadic species.

The Black-breasted Buzzard was recorded at only one quadrat BRU00601, a River Red Gum and Coolibah Creekline.

Redthroat *Pyrrholaemus brunneus*
This species was recorded for the Atlas of Australian Birds at three localities less than 100 km to the south of Mt Willoughby and two to the north (Blakers *et al.* 1984). The 1998-2002 census contained only one record 300 km to the south-east of Mt Willoughby. This species was rarely recorded in low shrublands on the Stony Deserts Survey, only 4 of 553 quadrats, one being in the west region nearest to Mt Willoughby (Brandle and Reid 1998). In the Anangu Pitjantjatjara Lands, north west of Mt Willoughby, ten Redthroats were found at six quadrats and targeted surveys were recommended (Copley *et al.* 2003).

Nineteen Redthroats were recorded at seven of the 28 quadrats sampled. These ranged from stony plains with *Eremophila* shrubland +/- Mulga woodland, stony swamps with *Chenopodium* shrubs and Mulga woodland on sandy soils. Given the number of Redthroats recorded during this relatively small survey, Mt Willoughby could be a focus for some of the further study suggested by Copley *et al.* (2003).

Figure 57. Australian Bustard. Photo L Pedler.

BIOGEOGRAPHIC AFFINITIES

Most species recorded in the study area have widespread arid Australian distributions or are more widespread nomads such as the Rainbow Bee-eater *Merops ornatus*, Little Button-quail *Turnix velox* and the Cuckoos. The Australasian Grebe *Tachybaptus novaehollandiae* was the only waterbird recorded at quadrats. Two species recorded at Mt Willoughby are at the limits of their known range, the Gibberbird *Ashbyia lovensis* and the northern subspecies of Cinnamon Quail-thrush *Cinclosoma cinnamomeum* ssp. *cinnamomeum*. Both are restricted to the driest parts of Australia, concentrated in the Stony Plains, Simpson and Channel Country Bioregions (Thackway *et al.* 1995), and were recorded at the western limit of their known range.

BIRD COMMUNITIES

All birds recorded at quadrats were sorted into four, broad bird communities using PCORD.

Four groups were chosen to reflect the major bird communities using the various habitats of the area.

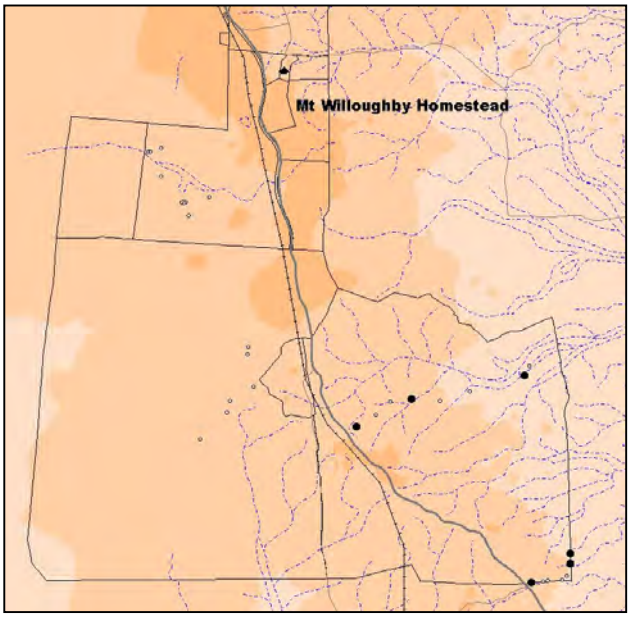
Group 1 encompasses a very low open shrubland grassland bird community that is closely allied to stony plains and typified by highly mobile small passerines species and the Inland Dotterel. Group 2 is a larger more diverse community found in the Emubush dominated open shrublands of the stony tablelands running north south through the middle of Mt Willoughby. As well as low shrub and grassland birds (eg Pipits, Cinnamon Quail-thrush) this community is typified by larger passerines that prefer taller exposed perches in an open shrubland low woodland setting (eg Singing Honeyeater, Black-faced Woodswallow). Group 3 appears to be associated with denser shrublands and low woodlands of the stony tablelands and open swamps and is typified by shrubland species (eg Splendid Fairy-wren, Chestnut-rumped Thornbill, Redthroat). Group four includes the Woodland bird communities of the sandplains, dunes and drainage lines. This is the most diverse community and includes Mistletoe Birds, Whistlers, Honeyeaters, Robins and Parrots.

The following section details each bird group using the set format described below:

- Group number and description
- Number of quadrats in Group,
- Total number of species in the group,
- Average number of species in group and the range (minimum and maximum)
- Landforms
- Soils
- Cover
- Vegetation Structure
- Comments
- Indicator Species
- Map of Quadrats and Quadrat names
- Table of species in frequency order: Bird species; Common Name; % frequency in group (sorted in descending order); % indicator value derived from PCORD based on importance of species in defining group; % frequency across all 14 groups; p * value statistical significance level as an indicators species; vegetation groups; species photographs.

BIRD GROUP 1

Very low open shrubland/grassland stony plains bird community



No. of quadrats 6
No. of species 17
Ave sp./quadrat 5 **range** 3 - 8

Landform: Stony plains with slopes of less than 1%
Soils: Sandy clay loams to light medium clay
Cover: 30-100% cover of pebbles (5-50mm in size) with 5-25% bare earth and 5-25% litter
Vegetation Structure: Very open tussock grassland to low shrubland
Comments: Low shrublands mostly dominated by *Atriplex vesicaria* but also *A. nummularia* ssp. *omissa* and *Maireana aphylla*. One quadrat was a floodout fan with a light <10% cover of pebbles. The dry conditions and low numbers of birds present mean few species are significant indicators. However, the birds listed as indicators are characteristic of low open shrublands as identified for the stony deserts (Brandle and Reid 1988).

Indicator species: Rufous Fieldwren, Richard's Pipit, Gibberbird, Inland Dotterel

Quadrats: BBB00101, BBB00201, BBB00701, BRU00101, BRU00401, BRU00701

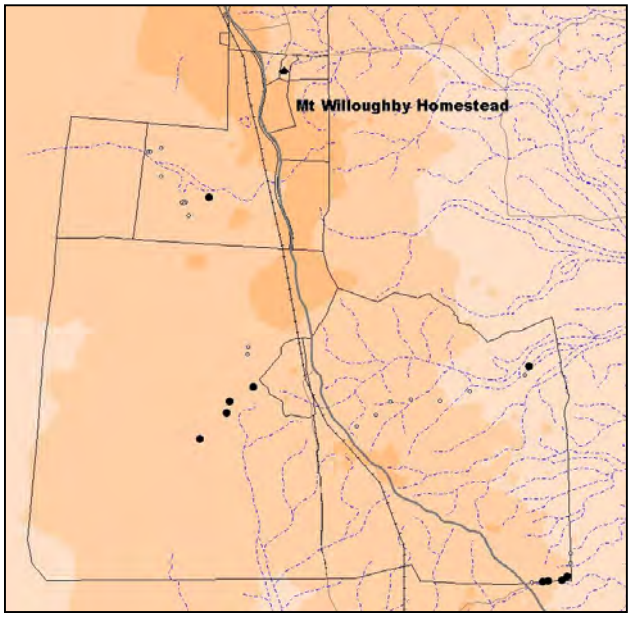
SPECIES	Common Name	% indicator sp.	% freq in gp.	% freq across gp.	p*
Calamanthus campestris	Rufous Fieldwren	50	50	100	0.011
Anthus novaeseelandiae	Richard's Pipit	29	67	44	0.17
Petrochelidon nigricans	Tree Martin	17	17	100	0.384
Ashbyia lovensis	Gibberbird	17	17	100	0.378
Dromaius novaehollandiae	Emu	16	33	49	0.459
Corvus bennetti	Little Crow	15	67	23	1
Malurus leucopterus	White-winged Fairy-wren	11	33	34	0.246
Falco cenchroides	Nankeen Kestrel	10	17	63	0.682
Charadrius australis	Inland Dotterel	10	17	63	0.709
Taeniopygia guttata	Zebra Finch	9	50	18	0.056
Milvus migrans	Black Kite	9	17	54	0.84
Cacatua roseicapilla	Galah	6	33	17	0.385
Artamus personatus	Masked Woodswallow	6	17	36	0.834
Aquila audax	Wedge-tailed Eagle	4	17	25	0.74
Ocyphaps lophotes	Crested Pigeon	3	17	18	0.258
Cinclosoma cinnamomeum	Cinnamon Quail-thrush	2	17	13	0.001
Corvus coronoides	Australian Raven	2	17	14	0.132

Vegetation Groups: 1, 2, 5, 6, 7

Figure 58. The Gibber Bird inhabits open gibber and cracking clay herblands/grasslands and is on the western edge of its distribution at Mt Willoughby. Photo HM Owens.

BIRD GROUP 2

Open shrublands on stony tablelands bird community



No. of quadrats 10
No. of species 40
Ave sp./quadrat 12 **range** 8 - 18

Landform: Predominantly flat stony plains but includes swamps, drainage lines and breakaway hill slopes with slopes up to 5%

Soils: Sandy clay loams to medium clay with one loam quadrat

Cover: Mostly 30-70% cover of pebbles (5-50mm in size) but includes lightly covered plains and swamps, 5-25% bare earth and 2-25% litter

Vegetation Structure: Low open shrublands with emergent taller shrubs and open shrublands to open woodland and mallee

Comments: Mixed open *Eremophila* and chenopod shrublands with emergent trees. This assemblage incorporates elements from stony deserts bird groups 6 to 9 (Brandle and Reid 1998).

Indicator species: Cinnamon Quail-thrush, Singing Honeyeater, Richard's Pipit, Black-faced Woodswallow, Southern Whiteface, Zebra Finch

Quadrats: BBB00301, BBB00401, BBB00501, BBB00601, BRU00801, CAN00301, POO00401, POO00501, POO00601, POO00701

SPECIES	Common Name	% indicator sp.	% freq in gp.	% freq across gp.	p*
Cinclosoma cinnamomeum	Cinnamon Quail-thrush	64	90	71	0.001
Lichenostomus virescens	Singing Honeyeater	32	90	36	0.005
Anthus novaeseelandiae	Richard's Pipit	32	70	46	0.17
Artamus cinereus	Black-faced Woodswallow	30	50	59	0.173
Aphelocephala leucopsis	Southern Whiteface	30	30	100	0.088
Taeniopygia guttata	Zebra Finch	29	90	32	0.056
Ocyphaps lophotes	Crested Pigeon	26	50	52	0.258
Malurus leucopterus	White-winged Fairy-wren	26	50	51	0.246
Oreoica gutturalis	Crested Bellbird	24	70	34	0.217
Gymnorhina tibicen	Australian Magpie	20	30	68	0.29
Todiramphus pyrrhopygia	Red-backed Kingfisher	20	30	68	0.28
Corvus bennetti	Little Crow	17	70	24	1
Aquila audax	Wedge-tailed Eagle	14	30	45	0.74
Cacatua roseicapilla	Galah	13	50	26	0.385
Coracina maxima	Ground Cuckoo-shrike	12	20	58	0.451
Melopsittacus undulatus	Budgerigar	10	30	32	0.352
Pardalotus striatus	Striated Pardalote	10	10	100	1
Pardalotus rubricatus	Red-browed Pardalote	10	10	100	1
Certhionyx variegatus	Pied Honeyeater	10	10	100	1
Cacatua sanguinea	Little Corella	10	10	100	1
Acanthiza uropygialis	Chestnut-rumped Thornbill	9	40	23	0.089
Coracina novaehollandiae	Black-faced Cuckoo-shrike	8	20	41	0.51
Dromaius novaehollandiae	Emu	6	20	30	0.459
Psophodes occidentalis	Chiming Wedgebill	6	20	32	0.113
Pomatostomus superciliosus	White-browed Babbler	4	20	22	0.003
Malurus lamberti	Variegated Fairy-wren	4	20	19	0.476
Cinclosoma castanotus	Chestnut Quail-thrush SA:R	4	10	41	1
Manorina flavigula	Yellow-throated Miner	4	10	41	1
Merops ornatus	Rainbow Bee-eater	4	10	41	1
Smicrornis brevirostris	Weebill	4	10	41	1
Charadrius australis	Inland Dotterel	4	10	38	0.709
Falco cenchroides	Nankeen Kestrel	4	10	38	0.682
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	3	20	17	0.001
Dicaeum hirundinaceum	Mistletoebird	3	20	17	0.001
Cheramoeca leucosternus	White-backed Swallow	3	10	33	0.372
Artamus personatus	Masked Woodswallow	2	10	21	0.834
Pyrrholaemus brunneus	Redthroat SA:R	1	10	9	0.098
Falco berigora	Brown Falcon	1	10	9	0.172
Rhipidura leucophrys	Willie Wagtail	1	10	15	0.018
Petroica goodenovii	Red-capped Robin	1	10	7	0.001

Vegetation groups 3, 4, 6, 9, 11 & 12

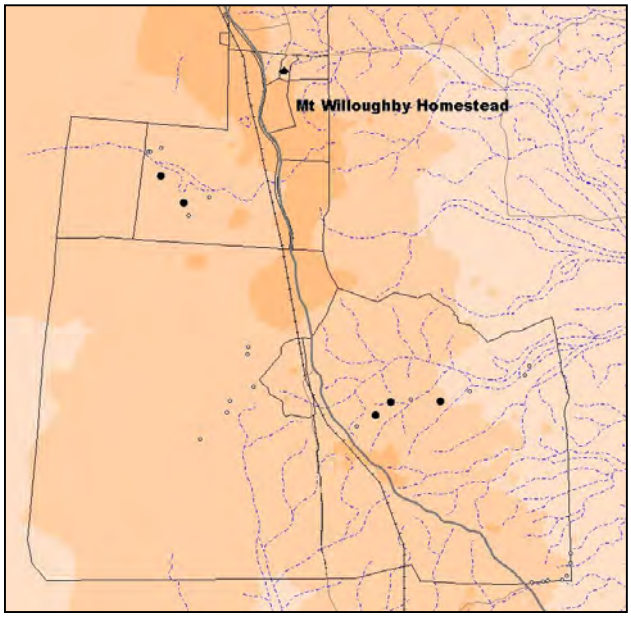
Figure 59. The Masked Woodswallow is most often seen in very open shrublands where it hawks for insects. Photo AC Robinson.

Figure 60. The widespread and common Richards Pipit is most often seen in low shrublands and open areas after favourable rainfall. Photo R Brandle.

BIRD GROUP 3

Low woodland/shrubland tableland and swamp bird community

No. of quadrats 5
No. of species 28
Ave sp./quadrat 11 **range** 7 - 13



Landform: Variable group of breakaway, stony plains and a swamp with slopes up to 20%
Soils: Sandy clay loams to medium clay
Cover: Mostly 30-70% cover of pebbles (5-50mm in size) but includes cobbles on a breakaway and <10% cover in the swamp, 0-40% bare earth and 0-20% litter
Vegetation Structure: Shrublands to low woodland
Comments: *Eremophila* shrubland with or without *Acacia* low woodland overstorey. Swamp dominated by Chenopodium shrubs. This assemblage is described by stony deserts bird group 2 (Brandle and Reid 1998).

Indicator species: Splendid Fairy-wren, Chestnut-rumped Thornbill, Zebra Finch, Redthroat, Crested Bellbird,

Quadrats: BRU00201, BRU00301, BRU00501, CAN00201, CAN00401

SPECIES	Common Name	% indicator sp.	% freq in gp.	% freq across gp.	p*
Malurus splendens	Splendid Fairy-wren	64	100	64	0.004
Acanthiza uropygialis	Chestnut-rumped Thornbill	36	80	45	0.089
Taeniopygia guttata	Zebra Finch	35	100	35	0.056
Pyrrholaemus brunneus	Redthroat SA:R	32	60	53	0.098
Oreoica gutturalis	Crested Bellbird	31	80	39	0.217
Corvus coronoides	Australian Raven	30	60	50	0.132
Acanthiza apicalis	Inland Thornbill	23	40	58	0.182
Corvus bennetti	Little Crow	22	80	28	1
Cracticus torquatus	Grey Butcherbird	20	20	100	0.187
Malurus lamberti	Variegated Fairy-wren	16	40	39	0.476
Falco berigora	Brown Falcon	15	40	37	0.172
Lichenostomus virescens	Singing Honeyeater	14	60	24	0.005
Cheramoeca leucosternus	White-backed Swallow	13	20	67	0.372
Hieraaetus morphnoides	Little Eagle	12	20	58	0.478
Tachybaptus novaehollandiae	Australasian Grebe, (Little Grebe)	12	20	58	0.478
Vanellus tricolor	Banded Lapwing	12	20	58	0.472
Petroica goodenovii	Red-capped Robin	11	40	27	0.001
Artamus personatus	Masked Woodswallow	9	20	43	0.834
Cacatua roseicapilla	Galah	8	40	21	0.385
Nymphicus hollandicus	Cockatiel	8	20	41	0.352
Aquila audax	Wedge-tailed Eagle	6	20	30	0.74
Phaps chalcoptera	Common Bronzewing	6	20	32	0.089
Artamus cinereus	Black-faced Woodswallow	5	20	24	0.173
Psephotus varius	Mulga Parrot	4	20	19	0.001
Melopsittacus undulatus	Budgerigar	4	20	22	0.352
Colluricincla harmonica	Grey Shrike-thrush	4	20	22	0.007
Cinclosoma cinnamomeum	Cinnamon Quail-thrush	3	20	16	0.001

Vegeation Groups 3, 6, 8, 11 & 12

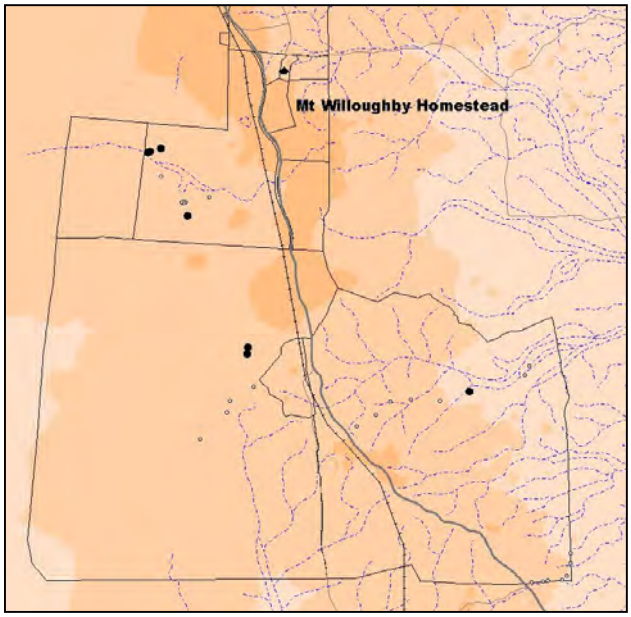
Figure 61. The Splendid Fairywren is common on the western half of Mt Willoughby and almost absent on the east. Photo L. Pedler.

Figure 62. Zebra Finches are common across Mt Willoughby but usually require some taller shrubs for roosting and nesting. Photo S Doyle.

BIRD GROUP 4

Eucalypt and Mulga woodland on sandy soils bird community

No. of quadrats 7
No. of species 60
Ave sp./quadrat 21 range 15 - 33



Landform: Sandy plains, swamps and drainage lines with > 1% slopes
Soils: Sand, loamy sands and sandy clay loams
Cover: Mostly no surface strew, or pebbles (5-50mm) with up to 70% cover, 15-35% bare earth and 10-20% litter
Vegetation Structure: Low woodland to woodland
Comments: Mulga and Coolibah woodlands with mixed open understorey on sandy soils. Stony deserts groups 1, 3 and 4 (Brandle and Reid 1998) are described by this assemblage. It also has similarities with Anangu Pitjantjatjara lands bird groups 1b and 2 (Copley *et al.* 2003).

Indicator species: Mistletoebird, Spiny-cheeked Honeyeater, Rufous Whistler, Mulga Parrot, Red-capped Robin, White-browed Babbler, Grey Shrike-thrush, Willie Wagtail, Black-eared Cuckoo, Bourke's Parrot, Australian Ringneck Parrot

Quadrats: BRU00601, CAN00101, CAN00501, CAN00601, CAN00701, POO00101, POO00201

SPECIES	Common Name	% indicator sp.	% freq in gp.	% freq across gp.	p*
Dicaeum hirundinaceum	Mistletoebird	83	100	83	0.001
Acanthagenys rufogularis	Spiny-cheeked Honeyeater	83	100	83	0.001
Pachycephala rufiventris	Rufous Whistler	71	71	100	0.001
Psephotus varius	Mulga Parrot	69	86	81	0.001
Petroica goodenovii	Red-capped Robin	67	100	67	0.001
Pomatostomus superciliosus	White-browed Babbler	56	71	78	0.003
Colluricincla harmonica	Grey Shrike-thrush	56	71	78	0.007
Rhipidura leucophrys	Willie Wagtail	49	57	85	0.018
Chrysococcyx osculans	Black-eared Cuckoo	43	43	100	0.024
Neopsephotus bourkii	Bourke's Parrot	43	43	100	0.017
Barnardius zonarius	Australian Ringneck, (Ring-necked Parrot)	43	43	100	0.018
Lichenostomus virescens	Singing Honeyeater	40	100	40	0.005
Falco berigora	Brown Falcon	30	57	53	0.172
Psophodes occidentalis	Chiming Wedgebill	29	43	68	0.113
Phaps chalcoptera	Common Bronzewing	29	43	68	0.089
Cracticus nigrogularis	Pied Butcherbird	29	29	100	0.119
Grallina cyanoleuca	Magpie-lark	29	29	100	0.117
Cacatua roseicapilla	Galah	26	71	37	0.385
Malurus splendens	Splendid Fairy-wren	21	57	36	0.004
Melopsittacus undulatus	Budgerigar	20	43	46	0.352
Corvus bennetti	Little Crow	18	71	25	1
Acanthiza uropygialis	Chestnut-rumped Thornbill	18	57	32	0.089
Malurus lamberti	Variegated Fairy-wren	18	43	42	0.476
Nymphicus hollandicus	Cockatiel	17	29	59	0.352
Coracina novaehollandiae	Black-faced Cuckoo-shrike	17	29	59	0.51
Oreoica gutturalis	Crested Bellbird	16	57	28	0.217
Pyrrholaemus brunneus	Redthroat SA:R	16	43	38	0.098
Corvus coronoides	Australian Raven	15	43	36	0.132
Accipiter fasciatus	Brown Goshawk	14	14	100	0.656
Podargus strigoides	Tawny Frogmouth	14	14	100	0.639
Pachycephala rufogularis	Red-lored Whistler AUS:VU	14	14	100	0.639
Ninox novaeseelandiae	Southern Boobook	14	14	100	0.639
Lichenostomus plumulus	Grey-fronted Honeyeater)	14	14	100	0.651
Lichenostomus penicillatus	White-plumed Honeyeater	14	14	100	0.639
Lichenostomus ornatus	Yellow-plumed Honeyeater	14	14	100	0.651
Hamirostra melanosternon	Black-breasted Buzzard SA:R	14	14	100	0.639
Cuculus pallidus	Pallid Cuckoo	14	14	100	0.651
Climacteris affinis	White-browed Treecreeper SA:R	14	14	100	0.648
Chrysococcyx basalis	Horsfield's Bronze-cuckoo	14	14	100	0.621

Ardeotis australis	Australian Bustard SA:V	14	14	100	0.628
Turnix velox	Little Button-quail	14	14	100	0.656
Acanthiza iredalei	Slender-billed Thornbill AUS:VU	14	14	100	0.639
Acanthiza apicalis	Inland Thornbill	12	29	42	0.182
Ocyphaps lophotes	Crested Pigeon	9	29	30	0.258
Cinclosoma castanotus	Chestnut Quail-thrush SA:R	8	14	59	1
Smicrornis brevirostris	Weebill	8	14	59	1
Manorina flavigula	Yellow-throated Miner	8	14	59	1
Merops ornatus	Rainbow Bee-eater	8	14	59	1
Milvus migrans	Black Kite	7	14	46	0.84
Taeniopygia guttata	Zebra Finch	6	43	15	0.056
Vanellus tricolor	Banded Lapwing	6	14	42	0.472
Tachybaptus novaehollandiae	Australasian Grebe, (Little Grebe)	6	14	42	0.478
Hieraaetus morphnoides	Little Eagle	6	14	42	0.478
Coracina maxima	Ground Cuckoo-shrike	6	14	42	0.451
Todiramphus pyrrhopygia	Red-backed Kingfisher	5	14	32	0.28
Gymnorhina tibicen	Australian Magpie	5	14	32	0.29
Dromaius novaehollandiae	Emu	3	14	21	0.459
Malurus leucopterus	White-winged Fairy-wren	2	14	15	0.246
Artamus cinereus	Black-faced Woodswallow	2	14	17	0.173
Anthus novaeseelandiae	Richard's Pipit	1	14	9	0.17

Vegeation Groups 9, 10, 13 & 14

Figure 63. Spiny-cheeked Honeyeaters are most commonly found in the woodland sites particularly where eucalypts are present. Photo B Prime.

Figure 64. Rufous Whistlers were only found along major drainage lines on the eastern side of Mt Willoughby. Photo SAOA.

REPTILES

There are no published accounts of the reptiles of Mt Willoughby. Prior to the survey the South Australian Museum held 19 reptile and 3 frog specimens for the area. These represented 10 reptile and 2 frog species (Appendix 3). The Biological Survey of the Stony Deserts sampled half of the surrounding area and detected 50 species across the west region from 101 quadrats (Brandle & Hutchinson 1998 Appendix 6). This survey did not sample habitats similar to those on the western half of Mt Willoughby.

153 records of 44 reptile species were recorded at the 28 survey quadrats. The 19 opportune records of 7 species recorded one extra species (*Ctenophorus pictus* Painted Dragon) not recorded at quadrats. This plus two species held at the SA Museum (*Neprurus millii* Thick-tailed Gecko, *Antaresia stimpsoni* Stimpsons Python) bring the total number of species recorded on Mt Willoughby to 47.

Table 15. Reptile species recorded at quadrats in Family order.

FAMILY Sub-family *Species*	**Common Name**	**BBB00101**	**BBB00201**	**BBB00301**	**BBB00401**	**BBB00501**	**BBB00601**	**BBB00701**	**BRU00101**	**BRU00201**	**BRU00301**	**BRU00401**	**BRU00501**	**BRU00601**	**BRU00701**	**BRU00801**	**CAN00101**	**CAN00201**	**CAN00301**	**CAN00401**	**CAN00501**	**CAN00601**	**CAN00701**	**POO00101**	**POO00201**	**POO00401**	**POO00501**	**POO00601**	**POO00701**	**Number of quadrats**	**Number of records**	**% recording rate**
AGAMIDAE																															
Amphibolurus longirostris	Long-nosed Dragon													2															1	2	1
*Ctenophorus isolepis**	Military Dragon																				4	2	2	2	1			1	6	12	8
Ctenophorus nuchalis	Central Netted Dragon																											1	1	1	1
*Ctenophorus reticulatus**	Western Netted Dragon																							1				1	2	2	1
Ctenophorus tjantjalka	Ochre Dragon				1	1					1		2																4	5	3
*Pogona vitticeps**	Central Bearded Dragon					1													1		1				1		1		5	5	3
Tympanocryptis cephalus	Pebble Dragon					2													3	1									3	6	4
*Tympanocryptis tetraporophora**	Eyrean Earless Dragon	1						1	2			2														1			5	7	5
GEKKONIDAE Diplodactylinae																															
Diplodactylus byrnei	Pink-blotched Gecko						1					1			1														3	3	2
Diplodactylus conspicillatus	Fat-tailed Gecko																		1						2			1	3	4	3
Diplodactylus galeatus	Mesa Gecko				2	1					2		1																4	6	4
Diplodactylus tessellatus	Tessellated Gecko							1	1																	1			3	3	2
Nephrurus levis	Smooth Knob-tailed Gecko																					1							1	1	1
Rhynchoedura ornata	Beaked Gecko					1	1															2		1				1	5	6	4
Strophurus intermedius	Southern Spiny-tailed Gecko																					1		1					2	2	1
GEKKONIDAE Gekkoninae																															
Gehyra purpurascens	Purple Dtella													1															1	1	1
*Gehyra variegata**	Tree Dtella			1	1	2					1			1		1													6	7	5
Heteronotia binoei	Bynoe's Gecko			1	1						1			2															4	5	3
GEKKONIDAE Pygopodinae																															
Ophidiocephalus taeniatus	Bronzeback Legless Lizard			1																									1	1	1
SCINCIDAE																															
Ctenotus brooksi	Sandhill Ctenotus										1																		1	1	1
Ctenotus leonhardii	Common Desert Ctenotus																				1	1	1		2	2		1	6	8	5
Ctenotus olympicus	Saltbush Ctenotus		1					1							2														3	4	3
Ctenotus quattuordecimlineatus	Many-lined Ctenotus																				1	1							2	2	1
Ctenotus regius	Eastern Desert Ctenotus																				1			2	3			1	4	7	5
Ctenotus saxatilis	Centralian Striped Skink													1															1	1	1
Ctenotus schomburgkii	Sandplain Ctenotus																				3	3	2					2	2	5	12	8
Ctenotus septenarius	Gibber Ctenotus				1																								1	1	1
Ctenotus sp.																					1		1						2	2	1
Ctenotus strauchii	Short-legged Ctenotus																		1							2			2	3	2
Egernia inornata	Desert Skink																								1				1	1	1
*Eremiascincus richardsonii**	Broad-banded Sandswimmer						1								1														2	2	1
Lerista desertorum	Great Desert Slider																											1	1	1	1

FAMILY Sub-family *Species*	Common Name	BBB00101	BBB00201	BBB00301	BBB00401	BBB00501	BBB00601	BBB00701	BRU00101	BRU00201	BRU00301	BRU00401	BRU00501	BRU00601	BRU00701	BRU00801	CAN00101	CAN00201	CAN00301	CAN00401	CAN00501	CAN00601	CAN00701	POO00101	POO00201	POO00401	POO00501	POO00601	POO00701	Number of quadrats	Number of records	% recording rate
Lerista labialis	Eastern Two-toed Slider																				1			2						2	3	2
Lerista muelleri	Dwarf Three-toed Slider		1	2		1					1				1															5	6	4
Lerista sp.																													1	1	1	1
SCINCIDAE (continued)																																
Menetia greyii	Dwarf Skink																1													1	1	1
Morethia boulengeri	Common Snake-eye													1			3													2	4	3
VARANIDAE																																
Varanus giganteus	Perentie										1																			1	1	1
Varanus gilleni	Pygmy Mulga Goanna																												1	1	1	1
*Varanus gouldii**	Sand Goanna		1				1																1						1	4	4	3
TYPHLOPIDAE																																
Ramphotyphlops australis	Southern Blind Snake																							1						1	1	1
Ramphotyphlops endoterus	Centralian Blind Snake																							1						1	1	1
Ramphotyphlops sp.															1															1	1	1
ELAPIDAE																																
Demansia reticulata	Desert Whipsnake													1																1	1	1
Pseudonaja nuchalis	Western Brown Snake													1																1	1	1
Simoselaps fasciolatus	Narrow-banded Snake																							2						1	2	1
Suta suta	Curl Snake											1																		1	1	1
45 species	**Number of species/quadrat**	1	3	4	5	7	4	3	2	0	7	3	2	8	5	1	2	0	4	1	8	7	5	9	4	3	3	5	9		153	

* species also recorded opportunistically away from quadrats.

COMMON SPECIES

The three most common species occurred at only 6 (21%) of 28 quadrats reflecting the diversity of habitat types across the edge of two bioregions.

Table 14. Most commonly encountered reptile species (present >15% of quadrats and total numbers recorded).

FAMILY	SPECIES	COMMON NAME	Total	No. records
AGAMIDAE Dragons	*Ctenophorus isolepis*	Military Dragon	6	12
GEKKONIDAE Geckos	*Gehyra variegata*	Tree Dtella	6	7
SCINCIDAE Skinks	*Ctenotus leonhardii*	Common Desert Ctenotus	6	8
AGAMIDAE Dragons	*Pogona vitticeps*	Central Bearded Dragon	5	5
AGAMIDAE Dragons	*Tympanocryptis tetraporophora*	Eyrean Earless Dragon	5	7
GEKKONIDAE Geckos	*Rhynchoedura ornata*	Beaked Gecko	5	6
SCINCIDAE Skinks	*Ctenotus schomburgkii*	Sandplain Ctenotus	5	12
SCINCIDAE Skinks	*Lerista muelleri*	Dwarf Three-toed Slider	5	6

Figure 65. Tree Dtellas are common in shrubs, trees and rocky areas. Photo AC Robinson.

SIGNIFICANT SPECIES

Only one species recorded during the survey is rated for its conservation status. The Bronze-back Legless Lizard is considered Vulnerable to extinction under South Australian and Australian legislation (NPWSA 2002, EPBC 2000). This species was rated as Endangered in the 1990's prior to the increase in survey activity during this decade resulting in records of this species at a number of locations along the breakaway country north of Coober Pedy (Brandle & Hutchinson 1998, Matejic 2003). Two members of this species were found at one quadrat on the floodplain of a drainage line running out of the breakaways near the southeastern boundary (quadrat BBB00301). Both animals were raked up under thin but well matted and undisturbed leaf-litter of a large Leafless Cherry *Exocarpus aphyllus*.

Figure 66. The Bronze-back Legless Lizard captured at BBB00301 is endemic to the breakaway habitats of the western Lake Eyre Basin and are rated as Vulnerable to extinction. Photo AC Robinson

SPECIES WITH RESTRICTED DISTRIBUTIONS

Two other species recorded on the survey are also restricted to the breakaway habitats of northern central South Australia that are well represented on Mt Willoughby. The IPA is therefore likely to be the only area of the range under formal protected area management in South Australia. These are the Mesa Gecko *Diplodactylus galeatus* that also occurs in the central Australian Ranges to Alice Springs, and the Pebble Dragon *Tympanocryptis cephalus*. The breakaway tablelands of Mt Willoughby are also likely to represent an important protected area of habitat in South Australia for Australia's largest lizard the Perentie *Varanus giganteus*, the Ochre Dragon *Ctenophorus tjantjalka*, and the Gibber Ctenotus *Ctenotus septanarius* (Brandle 1998). The Gibber Ctenotus record at quadrat BBB00401, 30km north of Coober Pedy represents a significant extension of its known range 100 km south.

Figure 67. The Mesa Gecko is a species restricted to central northern South Australia and is well represented in the tableland habitats at Mt Willoughby. Photo AC Robinson.

Figure 68. The Pebble Dragon also has a restricted central northern South Australian distribution. Photo AC Robinson.

BIOGEOGRAPHIC AFFINITIES

Several species are at the western or eastern limits of their distributions that are bounded by the Giles (western) and Stony Plains (eastern) biogeographical regions.

Species with western limits: Western Netted Dragon *Ctenophorus reticulatus*, Many-lined Ctenotus *Ctenotus quattuordecimlineatus* (60 km sw of previous known range).

Species with eastern limits: Central Bearded Dragon *Pogona vitticeps*, Tessellated Gecko *Diplodactylus tessellatus*, Pink-blotched Gecko *D. byrnei*, Saltbush Ctenotus *Ctenotus olympicus*, Short-legged Ctenotus *Ctenotus strauchii.*

Figure 69. The Many-lined Ctenotus at CAN00601 was at its south-eastern limits. Photo AC Robinson.

Figure 70. The Pink Blotched Gecko is at its western limits at Mt Willoughby. Photo AC Robinson.

REPTILE COMMUNITIES

All reptiles recorded at quadrats were clustered into five, broad reptile communities using the agglomerative clustering program, PCORD.

Five groups were chosen to reflect the major reptile communities that are found in the various habitats of the area.

Group 1 encompasses a low shrubland grassland reptile community that is closely allied to stony plains and typified by very low open shrubland clay soil specialist reptiles. Group 2 is a more complex variant of group one incorporating loamy soil species (such as the Beaked Gecko) commonly associated with floodplain environments in the stony deserts (Brandle and Hutchinson 1998). Group 3 describes the reptile community of the breakaway and drainage lines of the escarpment country and includes the local endemic Tjantjalka Dragon, Pebble Dragon and Mesa Gecko. Group 4 describes a community that occurs on sandy clay gibber shrublands of the Giles biogeographical region. Reptile species present are a mix of clay, sandy loam and stony species not usually present in the same areas. Group 5 is characterised by sandy soil and woodland specialist species and is confined to the Giles biogeographical region.

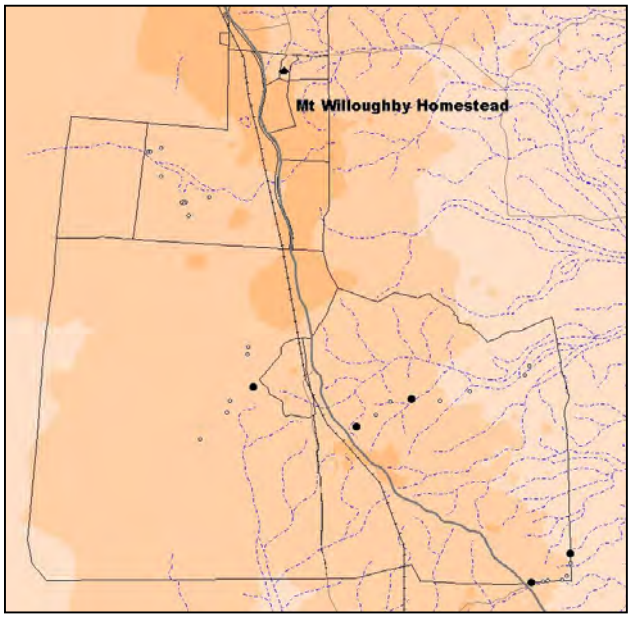
Figure 71. The Pygmy Mulga Goanna lives in mulga hollows. Photo AC Robinson.

The following section details each Reptile group using the set format described below:

- Group number and description
- Number of quadrats in Group,
- Total number of species in the group,
- Average number of species in the group and the range (minimum and maximum)
- Landforms
- Soils
- Cover
- Vegetation Structure
- Comments
- Indicator Species
- Map of Quadrats and Quadrat names
- Table of species in frequency order: Reptile species; Common Name; % frequency in group (sorted in descending order); % indicator value derived from PCORD based on importance of species in defining group; % frequency across all 14 groups; p * value statistical significance level as an indicators species; vegetation groups; species photographs.

REPTILE GROUP 1

No. of quadrats 5
No. of species 6
Ave sp./quadrat 2.4 **range** 1 - 3



Landform: Stony plains with slopes of less than 1%
Soils: Fine sandy clay loam to light medium clay
Cover: 30-100% cover of pebbles (5-50mm in size) with 5-15% bare earth and 2-25% litter
Vegetation Structure: Grassland to low shrublands
Comments: *Atriplex vesicaria*, *A. nummularia* ssp. *omissa* low shrublands and ephemeral grassland. This assemblage was described by reptile groups 17 and 18 in the Biological Survey of the Stony Deserts (Brandle & Hutchinson 1998).

Indicator species: Eyrean Earless Dragon, Tessellated Gecko

Quadrats: BBB00101, BBB00701, BRU00101, BRU00401, POO00501

SPECIES	Common Name	% indicator sp.	% freq in gp.	% freq across gp.	p*
Tympanocryptis tetraporophora	Eyrean Earless Dragon	100	100	100	0.001
Diplodactylus tessellatus	Tessellated Gecko	60	60	100	0.005
Suta suta	Curl Snake	20	20	100	0.4
Ctenotus strauchii	Short-legged Ctenotus	8	20	38	0.568
Diplodactylus byrnei	Pink-blotched Gecko	5	20	23	0.049
Ctenotus olympicus	Saltbush Ctenotus	5	20	23	0.059

Vegetation groups 1, 5, 6 & 7

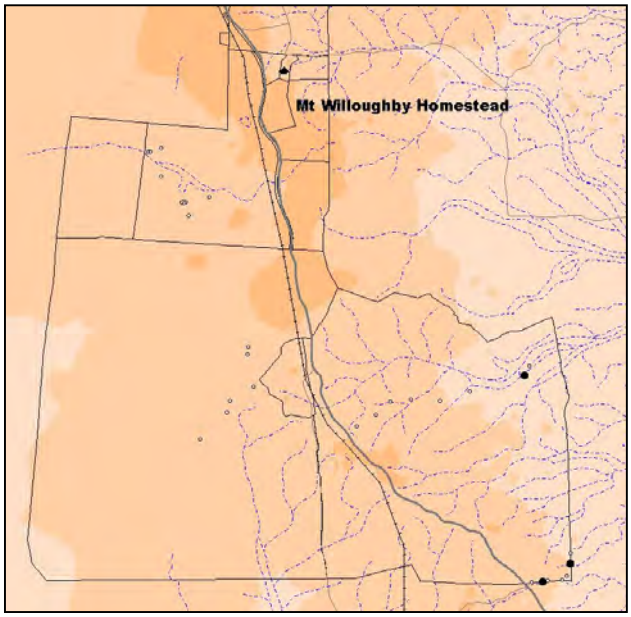
Figure 72. The Eyrean Earless Dragon is one of the most common reptiles in chenopod shrublands. Photo AC Robinson.

Figure 73. The variable Tessellated Geckos are one of the most common geckos on the stony plains. Photo R Brandle.

Figure 74. The Short-legged Ctenotus is the typical small skink on stony plains. Photo R Brandle.

REPTILE GROUP 2

No. of quadrats 3
No. of species 7
Ave sp./quadrat 4 **range** 3 - 5



Landform: Alluvial to stony plains with slopes < 1%
Soils: Fine to sandy clay loams
Cover: <10% to >70% cover of pebbles with 5-25% bare earth and 3-20% litter
Vegetation Structure: Low shrublands
Comments: Mixed *Atriplex vesicaria* shrublands. Brandle and Hutchinson (1998) did not describe this loose assemblage.

Indicator species: Broad-banded Sandswimmer, Pink-blotched Gecko, Saltbush Ctenotus, Sand Goanna, Dwarf Three-toed Slider

Quadrats: BBB00201, BBB00601, BRU00701

SPECIES	Common Name	% indicator sp.	% freq in gp.	% freq across gp.	p*
Eremiascincus richardsonii	Broad-banded Sandswimmer	67	67	100	0.019
Diplodactylus byrnei	Pink-blotched Gecko	51	67	77	0.049
Ctenotus olympicus	Saltbush Ctenotus	51	67	77	0.059
Varanus gouldii	Sand Goanna	47	67	70	0.067
Lerista muelleri	Dwarf Three-toed Slider	43	67	64	0.023
Ramphotyphlops sp.		33	33	100	0.248
Rhynchoedura ornata	Beaked Gecko	13	33	38	0.314

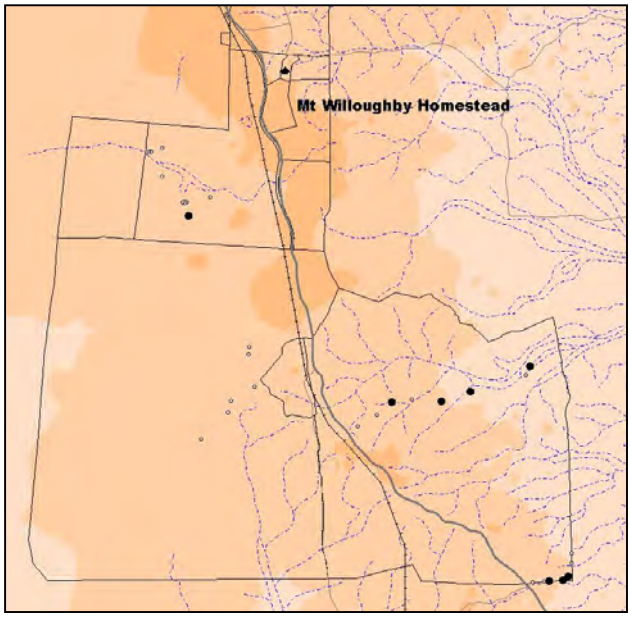
Vegetation groups 2, 4 & 6

Figure 75. The Broad-banded Sandswimmer is widespread across South Australia's hard soil areas and is rarely found near sand. Photo B Miller.

Figure 76. The Saltbush Ctenotus is the most common mid-sized skink on the stony plains. Photo AC Robinson.

REPTILE GROUP 3

No. of quadrats 8
No. of species 19
Ave sp./quadrat 4.5 **range** 1 - 8



Landform: Mostly escarpments and stream channels but includes one swamp
Soils: Mostly sandy clay loams but includes a loam and medium clay quadrat
Cover: 30-70% cover of pebbles with 0-30% bare earth and 2-20% litter
Vegetation Structure: Mostly Woodlands but includes mallee and shrublands
Comments: Mixed *Acacia* spp., *Eucalyptus socialis*, *E. coolabah* and *E. camaldulensis*. The biological survey of the stony deserts (Brandle and Hutchinson 1998) under-sampled the breakaway country of the western Lake Eyre basin and did not adequately define this assemblage.

Indicator species: *Gehyra variegata*, *Diplodactylus galeatus*, *Ctenophorus tjantjalka*, *Heteronotia binoei*, *Lerista muelleri*

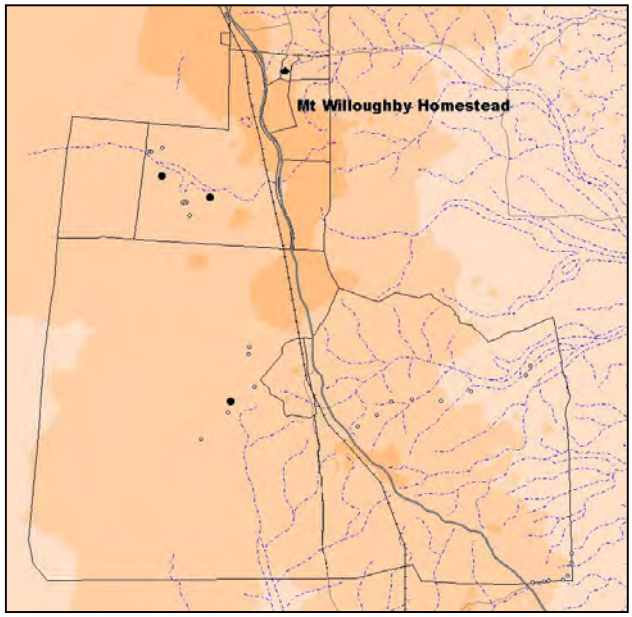
Quadrats: BBB00301, BBB00401, BBB00501, BRU00301, BRU00501, BRU00601, BRU00801, CAN00101

SPECIES	Common Name	% indicator sp.	% freq in gp.	% freq across gp.	p*
Gehyra variegata	Tree Dtella	75	75	100	0.002
Diplodactylus galeatus	Mesa Gecko	50	50	100	0.008
Ctenophorus tjantjalka	Ochre Dragon	50	50	100	0.008
Heteronotia binoei	Bynoe's Gecko	50	50	100	0.013
Morethia boulengeri	Common Snake-eye	25	25	100	0.225
Lerista muelleri	Dwarf Three-toed Slider	13	38	36	0.023
Ctenotus septenarius	Gibber Ctenotus	13	13	100	1
Menetia greyii	Dwarf Skink	13	13	100	1
Ctenotus brooksi	Sandhill Ctenotus	13	13	100	1
Varanus giganteus	Perentie	13	13	100	1
Ophidiocephalus taeniatus	Bronzeback Legless Lizard	13	13	100	1
Demansia reticulata	Desert Whipsnake	13	13	100	1
Pseudonaja nuchalis	Western Brown Snake	13	13	100	1
Gehyra purpurascens	Purple Dtella	13	13	100	1
Ctenotus saxatilis	Centralian Striped Skink	13	13	100	1
Amphibolurus longirostris	Long-nosed Dragon	13	13	100	1
Tympanocryptis cephalus	Pebble Dragon	2	13	16	0.024
Rhynchoedura ornata	Beaked Gecko	2	13	14	0.314
Pogona vitticeps	Central Bearded Dragon	1	13	12	0.066

Vegetation groups 3, 4, 8, 9 & 10

Figure 77. The Tjantjalka Dragon was found at the rockiest breakaway habitats such as BRU00301, and is restricted to central northern South Australia. Photo AC Robinson.

REPTILE GROUP 4



No. of quadrats 3
No. of species 5
Ave sp./quadrat 2.7 **range** 1 - 4

Landform: Stony plains with 0% slopes
Soils: Fine sandy clays to sandy clay
Cover: 10-70% cover of pebbles with 10-20% bare earth and 5-25% litter
Vegetation Structure: Shrubland to very low woodland
Comments: Sparse *Acacia aneura* over *Eremophila freelingii*. No stony deserts or Anangu Pitjantjatjara equivalent assemblages.

Indicator species: Pebble Dragon, Fat-tailed Gecko

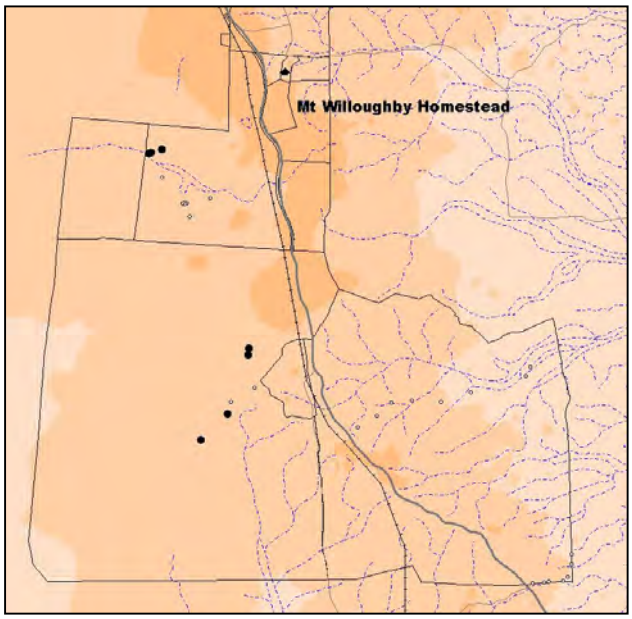
Quadrats: CAN00301, CAN00401, POO00401

SPECIES	Common Name	% indicator sp.	% freq in gp.	% freq across gp.	p*
Tympanocryptis cephalus	Pebble Dragon	56	67	84	0.024
Diplodactylus conspicillatus	Fat-tailed Gecko	55	67	82	0.033
Pogona vitticeps	Central Bearded Dragon	41	67	62	0.066
Ctenotus strauchii	Short-legged Ctenotus	21	33	63	0.568
Ctenotus leonhardii	Common Desert Ctenotus	11	33	32	0.025

Vegetation groups 12

Figure 78. Fat-tailed Geckos were only found on the western half of Mt Willoughby in sandier soils. Photo R Brandle.

REPTILE GROUP 5



No. of quadrats **7**
No. of species **20**
Ave sp./quadrat **6.7** **range 4 - 9**

Landform: Sandy plains, dune and drainage line > 1% slopes
Soils: Sand, loamy sands and sandy clay loams, light medium clays on a plain and swamp quadrat
Cover: Mostly no surface strew, or pebbles (5-50mm) with up to 70% cover, 5-35% bare earth and 5-20% litter
Vegetation Structure: Low woodland to woodland
Comments: Mulga woodlands with grass understorey on sandy soils, except for one *Eremophila* shrub with Mulga quadrat with some shallow sand spreads and one *Chenopodium* swamp overlain at the edges with sandy soil. No stony deserts equivalent assemblages. Some similar elements to Anangu Pitjantjatjara Lands reptile group 1 (Robinson *et al.* 2003).

Indicator species: Military Dragon, Sandplain Ctenotus, Eastern Desert Ctenotus, Common Desert Ctenotus,

Quadrats: CAN00501, CAN00601, CAN00701, POO00101, POO00201, POO00601, POO00701,

SPECIES	Common Name	% indicator sp.	% freq in gp.	% freq across gp.	p*
Ctenophorus isolepis	Military Dragon	86	86	100	0.001
Ctenotus schomburgkii	Sandplain Ctenotus	71	71	100	0.005
Ctenotus regius	Eastern Desert Ctenotus	57	57	100	0.007
Ctenotus leonhardii	Common Desert Ctenotus	49	71	68	0.025
Strophurus intermedius	Southern Spiny-tailed Gecko	29	29	100	0.107
Ctenophorus reticulatus	Western Netted Dragon	29	29	100	0.104
Ctenotus quattuordecimlineatus	Many-lined Ctenotus	29	29	100	0.116
Lerista labialis	Eastern Two-toed Slider	29	29	100	0.106
Rhynchoedura ornata	Beaked Gecko	21	43	48	0.314
Simoselaps fasciolatus	Narrow-banded Snake	14	14	100	0.707
Ctenophorus nuchalis	Central Netted Dragon	14	14	100	0.718
Varanus gilleni	Pygmy Mulga Goanna	14	14	100	0.718
Nephrurus levis	Smooth Knob-tailed Gecko	14	14	100	0.697
Egernia inornata	Desert Skink	14	14	100	0.699
Lerista desertorum	Great Desert Slider	14	14	100	0.718
Ramphotyphlops australis	Southern Blind Snake	14	14	100	0.707
Ramphotyphlops endoterus	Centralian Blind Snake	14	14	100	0.707
Varanus gouldii	Sand Goanna	9	29	30	0.067
Pogona vitticeps	Central Bearded Dragon	8	29	27	0.066
Diplodactylus conspicillatus	Fat-tailed Gecko	3	14	18	0.033

Vegetation groups 11, 12, 13 & 14

Figure 79. The Eastern Desert Ctenotus is widespread and common in sandy areas of South Australia. Photo R Brandle.

Figure 80. The Military Dragon is only found in areas with deep sand. Photo R Brandle.

Figure 81. The Sandplain Ctenotus at CAN00601 replaces the Short-legged Ctenotus in non-stony plain habitats. Photo AC Robinson.

INVERTEBRATES

LF Queale[1]

The abundance and variety of insect species found in this area reflects a high diversity of habitats at the boundary of two major bioregions (the Sandy Deserts and the Stony Deserts). 680 specimens were identified from 75 families, over 28 quadrats. The apparent abundance and diversity of insects over the two weeks of the survey was impressive given the generally dry conditions prior to the survey (refer to the Climate chapter).

15 silverfish (Lepismatids) were collected which suggests that the conditions were likely to be favourable for a diversity of other species, as they are are normally not so commonly encountered using standard survey techniques in dry habitats. Table 15 illustrates a high diversity of families and taxa at Mt Willoughby for a relatively low level of sites/trapping effort in camparison with other surveys.

Table 15. Comparison of invertebrate richness found for 5 biological surveys

Survey	#sites	# Families	# taxa	taxa/sites	taxa/ Family
Mt Willoughby	28	80	221	7.89	2.76
Midnorth-Yorke Pen.	85	115	268	3.15	2.33
Murray Valley	81	99	222	2.74	2.24
Sandy Deserts	164	131	491	2.99	3.75
Eyre Pen.	108	142	432	4	3.04

INVERTEBRATE GROUP SUMMARY

Centipedes: (Chilopoda)
8 were collected and 3 identified to family. A Scutigera was found, which is not often seen on desert field trips. These centipedes have very long legs and a short body. There are 15 pairs of legs and 8 segments.

Springtails: (Collembola)
Only 37 specimens were collected, reflecting the dry conditions (this group tends to be found in wetter places). Site POO00101 was an exception with 19 Sminthurids in one micropit trap. Sminthruids have been rarely collected on other aridzone surveys and reflects their preference for wetter conditions. This sand dune quadrat received localised rainfall at the beginning of the survey and was surrounded by temporary pools of water over the five days of the survey. Quadrats with the highest number of Entomobryidae were in sandy soil under low Acacia woodland.

Web-spinners: (Embioptera)
This rarely observed insect taxa was collected during the survey.

Cockroaches: (Blattodea)
Of the three families recorded during the survey the Blattidae were the most numerous. *Calolampra* spp. were collected in leaf litter, whilst the *Anamesia* spp. and *Euzosteria* spp. appeared to prefer open habitats, often with Spinifex. The *Platyzosteria* species were dominant in woodlands. Thirteen morphospecies were identified, which was unexpected during a short survey in dry conditions. Sites with the highest number of Blattidae were in Plant group 1 (low open chenopod shrublands on cracking clay soils).

Mantids: (Mantodea)
Thirteen specimens were collected representing two families: Mantidae and Amorphoscelidae. The preference of Amorphoscelids for dry conditions, was reflected by the number found during the survey.

Grasshoppers and Crickets: (Orthoptera)
Seven families were found with a strong representation from the short horned grasshoppers (154) and crickets (56). Among the raspy crickets (*Hadrogryllacris sp*.: Gryllacrididae) many large orange specimens were encountered at the Broken Bit Bore (BBB) sites. Large numbers of dead and dried out bodies of acridids were also observed, indicating that there had been a population boom in the months before the survey. Two species were noted – *Buforania* and *Monistria* both of which are common in stony deserts. Live *Monistria pustulifera* were present at some sites.

The most abundant grasshopper genera were *Buforania* sp., *Coryphistes* sp., *Beplessia* sp. And *Urnisa* sp. Other genera also collected were easily located.

Sites with the highest numbers of crickets were in plant group 1 (low open chenopod shrublands on cracking clay soils). Acridids were found in highest numbers in quadrats of plant group 3 (Northern Myall low open woodland over shrubs on breakaway slopes and drainage lines).

Stick insects: (Phasmatodea)
Four specimens of the genus Acrophylla were collected. The females often fly towards light. The males are much smaller and wingless. One phasmid was collected at each set of sites.

Bugs: (Hemiptera)
These were represented by 11 families, the most abundant being the pentatomids (Stink Bugs). The Pentatomids were mainly found on stony sites.

Lacewings: (Neuroptera)
One Chrysopa (a small green lacewing) at the CAN campsite and 3 antlion adults were collected at POO and BBB camps.

Beetles: (Coleoptera)
A broad range of families was collected. Carabids were the most numerous, which is consistent with other South Australian surveys. This family is usually widespread across the drier parts of the state. Thirteen species were identified within this group, including the primitive *Arthropterus* sp., one of the oldest known beetle genera. The piedish beetles (Tenebrionidea) yielded 7 species. Scarabs were collected at only three sites on this survey, while weevils were collected at six sites.

Flies: (Diptera)
Ten families were collected. Usually, significant numbers of representativesof the families Phoridae and Chloropidae are collected on surveys in pitfalls. Here the sarcophagids also yielded a high number of specimens. Phoridae and Chloropidae are small flies and are found commonly across the state in leaf litter. Sarcophagids are carrion feeders and much larger.

Butterflies: (Lepidoptera)
Butterflies were scarce during the survey, with only one caterpillar collected. One yellow *Eurema* sp. butterfly was recorded in the Pooraminga area.

Wasps: (Hymenoptera)
Nine families were collected. The 27 specimens were not identified to species at time of writing. Ten digger wasps (Sphex) were collected – these capture and paralyse other insects and spiders and store them in sealed burrows to feed the wasp larvae until they develop into adults.

Two lists of insect taxa indicating the numbers collected in the variety of landform elements and structural vegetation types sampled are presented in Appendices 9 and 10.

Table 16. The number of species in each insect Order and Family detected at Mt Willoughby

ORDER	Family	164
Acarina	Anystidae	15
Acarina	Erythraeidae	20
Acarina	Family	8
Acarina	Oribatidae	1
BLATTODEA	Blaberidae	4
BLATTODEA	Blattellidae	4
BLATTODEA	Blattidae	16
CHILOPODA	Family	5
CHILOPODA	Scolopendridae	2
CHILOPODA	Scutigeridae	1
COLEOPTERA	Brentidae	1
COLEOPTERA	Carabidae	33
COLEOPTERA	Cerambycidae	3
COLEOPTERA	Chrysomelidae	7
COLEOPTERA	Cleridae	2
COLEOPTERA	Curculionidae	13
COLEOPTERA	Elateridae	2
COLEOPTERA	Family	12
COLEOPTERA	Mordellidae	6
COLEOPTERA	Scarabaeidae	2
COLEOPTERA	Staphylinidae	3
COLEOPTERA	Tenebrionidae	11
COLEOPTERA	Trogidae	1
COLLEMBOLA	Entomobryidae	10
COLLEMBOLA	Family	3
COLLEMBOLA	Poduroidea	1
COLLEMBOLA	Sminthuridae	23
DERMAPTERA	Labiduridae	1
DIPTERA	Asilidae	2
DIPTERA	Calliphoridae	2
DIPTERA	Cecidomyidae	2
DIPTERA	Chironomidae	1
DIPTERA	Chloropidae	10
DIPTERA	Phoridae	25
DIPTERA	Sarcophagidae	17
DIPTERA	Sciaridae	1
DIPTERA	Syrphidae	1
DIPTERA	Tachinidae	1
EMBIOPTERA	Family	1
HEMIPTERA	Cicadellidae	1
HEMIPTERA	Cicadidae	2
HEMIPTERA	Coreidae	1
HEMIPTERA	Cydnidae	2
HEMIPTERA	Eurymelidae	1
HEMIPTERA	Family	9
HEMIPTERA	Jassidae	9
HEMIPTERA	Lycaenidae	1
HEMIPTERA	Lygaeidae	2
HEMIPTERA	Pentatomidae	11
HEMIPTERA	Reduviidae	4
HYMENOPTERA	?Pompillidae	1
HYMENOPTERA	Anthophoridae	1
HYMENOPTERA	Apidae	2
HYMENOPTERA	Family	27
HYMENOPTERA	Formicidae	5
HYMENOPTERA	Mutillidae	9
HYMENOPTERA	Pompilidae	3
HYMENOPTERA	Sphecidae	10
HYMENOPTERA	Sphecidae near	3
ISOPODA	Family	5
ISOPTERA	Family	5
LEPIDOPTERA	Family	1
MANTODEA	Amorphoscellidae	3
MANTODEA	Mantidae	10
NEUROPTERA	Chrysopidae	1
NEUROPTERA	Myrmeleontidae	3
ORTHOPTERA	Acrididae	150
ORTHOPTERA	Eumastacidae	14
ORTHOPTERA	Gryllacrididae	5
ORTHOPTERA	Gryllidae	56
ORTHOPTERA	Pyrgomorphidae	8
ORTHOPTERA	Tetrigidae	2
ORTHOPTERA	Tettigoniidae	6
PHASMATODEA	Phasmatidae	4
PSEUDOSCORPIONIDA	Family	5
PSOCOPTERA	Family	2
SCORPIONIDA	Family	2
THYSANOPTERA	Family	6
THYSANURA	Lepismatidae	15
	Total 80	844

SUMMARY

INTRODUCTION

The biodiversity of the Mount Willoughby Indigenous Protected Area reflects three major biogeographical influences: the western sandy deserts, the stony deserts of the Lake Eyre Basin and the Stuart Range breakaway tableland which divides the catchments of the two major regions. As a protected area, Mt Willoughby's importance to biodiversity conservation is most significant for breakaway tablelands, as these areas support distinctive local vegetation communities, plants and animals.

PLANT COMMUNITIES

The chenopod low shrublands, emubush shrublands, acacia tall shrublands and eucalypt woodlands of the Mt Willoughby IPA represented fourteen distinct floristic communities at 28 quadrats sampled. These were depicted as nine vegetation map classes for the vegetation mapping. The Stony Plains Bioregion supported four saltbush low shrubland communities on the stony plains on the south eastern side of the IPA, three acacia shrubland to woodland communities along the escarpments of the Stuart Range breakaway tableland, and two drainage line communities including a low shrub cottonbush and Coolibah / River Red Gum woodland groups. The Giles Bioregion incorporating the western deserts included one emubush with acacias shrubland community on stony plains, two swamp communities including Coolibah woodlands and Lignum shrublands and a sandplain Mulga low woodland plus a sand dune Horse Mulga low woodland community.

Mulga Low Woodlands on sand plains, and Northern Myall, Plumbush Low Woodland on calcareous soils of breakaway tablelands are rated as Vulnerable in 'An Inventory of the Biological Resources of the Rangelands of South Australia' (Neagle 2003) for the Stony Plains Bioregion. Both Coolibah Woodlands and River Red Gum Woodlands have been rated as "of concern" for the Stony Plains and other rangelands Bioregions (Neagle 2003). The communities of the Giles Bioregion have not yet been assessed for conservation status.

PLANT SPECIES

The survey recorded 206 species of plants during the survey. Conditions were generally dry and many more ephemeral species are likely to be present after significant rainfall events. Data from the Pastoral Assessment Program from 1997 and 2001 contributed another 19 species to the total list known to the IPA. The most commonly encountered perennial plants across the area were Mulga, Dead Finish, Bladder Saltbush and Rock Emubush, which were present at more than 50% of sites. Whilst no plants with threatened species status (EPBC Act 2000) were recorded during the survey, one species endemic to the breakaway habitats and five other rare species were recorded. Two South Australian endemic species rated as Rare under South Australian legislation (NPWS Act 1972) are found in breakaway habitat to the north west of Mt Willoughby, and two rare species with limited distributions in breakaway areas further south and north into the Northern Territory are also likely to be present with more extensive searching. A yet to be described daisy that has only been found on powdery gypseous slopes at Arkaringa Station may also be present in similar habitat on Mt Willoughby. Only three introduced plant species were recorded at sites but it is likely that up to 30 species may be present. Some such as Buffel Grass, which was present along the Stuart Highway, have the potential to spread down waterways.

BIRDS

Of the 86 species of bird recorded during the survey, 74 were found at sites. Bird communities associated with four broad habitat types were described. A low open shrub/grasslands on stony plains group characterised by the Rufous Fieldwren, Richard's Pipit, Gibberbird and Inland Dotterel. An open shrubland on stony tablelands group characterised by Cinnamon Quail-thrush, Singing Honeyeater, Black-faced Woodswallow, Southern Whiteface and Zebra Finch. A low woodland/shrublands on stony tableland and swamps group characterised by Splendid Fairy-wren, Chestnut-rumped Thornbill, Redthroat and Crested Bellbird, and a eucalypt and mulga woodlands on sandy soils group characterised by a number of species including Spiny-cheeked Honeyeater, Rufous Whistler, Red-capped Robin and several parrots. One species, the Slender-billed Thorn-bill has is rated as Vulnerable across Australia (EPBC Act) and the survey detected the only records for this region since 1914. Five other species (Australian Bustard, Chestnut Quail-thrush, White-browed Treecreeper, Black-breasted Buzzard and Redthroat) have South Australian conservation status (NPWS Act). No introduced species were detected.

REPTILES

A diverse assemblage of 47 reptile species is now known to inhabit Mt Willoughby. Of these, 44 were recorded at sites with one being only recorded opportunistically and two were previously collected for the SA Museum. Reptile communities associated with five habitat types were described. A low open shrub/grassland on stony plains group characterised by the Eyrean Earless Dragon ad the Tessellated Gecko. A low open shrubland of stony flats and floodouts group characterised by the Pink-blotched Gecko, Broad-banded Sandswimmer, Saltbush Ctenotus and Dwarf Three-toed Slider. A low woodland to shrubland on breakaways and drainage line group characterised by

the Tree Dtella, Mesa Gecko, Ochre Dragon and Bynoe's Gecko. A shrubland to low woodland on the western tablelands group characterised by the Pebble Dragon and Fat-tailed Gecko, and a woodland/low woodland sandy soils group characterised by the Military Dragon, Sandplain Ctenotus, Eastern Desert Ctenotus and Common Desert Ctenotus. The Bronze-backed Legless Lizard was recorded at one site and has an Australian and South Australian conservation status of Vulnerable. Two other species (Mesa Gecko and Pebble Dragon) have distributions restricted to breakaway and tableland habitats. The record of a Gibber Ctenotus at Mt Willoughby represents a significant southern extension of this species range (~100 km).

MAMMALS

The 12 native mammal species recorded on the survey added 10 species to the three that had previously been collected and lodged with the SA Museum. However, the records of the Lesser Stick-nest Rat from stick nests and scats found in caves are remnants of a species that has been extinct for 50+ years. Six introduced species were also recorded. Mammal communities associated with five habitat types were described. A very low open shrub/grassland on stony plains group characterised by the Fat-tailed Dunnart and Forrest's Mouse. A shrubland/low shrubland on clay floodouts and swamps group characterised by the Stripe-faced Dunnart. A low woodland to shrubland on breakaways and drainage lines and swamps group characterised by the introduced house mouse. A second shrubland/low shrubland on clay floodouts and swamps group with sandier soils characterised by the Ooldea Dunnart and Sandy Inland Mouse. A low woodland on sandy soils group characterised by the Spinifex Hopping-mouse and Sandy Inland Mouse. Euros were common in the hilly areas and Red Kangaroos were present throughout the IPA. No extant species with conservation status were recorded during the survey. The Kultarr, which is rated as being of conservation concern, was collected at Mt Willoughby in 1986. Introduced animal numbers were generally low reflecting the dry conditions prior to the survey. Cattle were still having obvious impacts in parts of the study area, particularly to the south of the Pooramingie (or POO) sites.

INVERTEBRATES

The abundance and variety of insect species found in this area reflects a high diversity of habitats at the boundary of two major bioregions (the Giles Sandy Deserts and the Stony Deserts). 680 specimens were identified from 75 families, over 28 quadrats. The apparent abundance and diversity of insects over the two weeks of the survey was impressive given the generally dry conditions prior to the survey

RECOMMENDATIONS

- As the Mt Willoughby IPA represents the only area of the breakaways region managed with biodiversity protection as an objective, the bulk of cattle should be removed to enable regeneration of the vegetation and fauna communities in this area.
- An ongoing program to survey for and remove weeds that represent an environmental threat, such as Buffel Grass, from roadsides and other infestation points before they become a major problem should be instigated as a priority.
- Dingoes play an important role in the natural ecology of this region and should not be controlled as they help to suppress feral predator populations such as foxes and cats.
- Opportunistic plant surveys of the breakaway country should be done two months following the next exceptional period of rainfall during winter and summer to look for the rare and endemic plants mentioned in the vegetation chapter plus new species.
- Targeted bird survey by expert ornithologists are recommended to confirm presence of the Slender-billed Thornbill at site BRU00601 and then to determine range and estimate size of local populations.
- Targeted reptile survey of breakaway drainage lines by expert herpetologists to determine the status of the Bronze-backed Legless Lizard on Mt Willoughby.
- Opportunistic small mammal surveys of the stony grassland areas to target the Kultarr (using Elliott Traps with dogfood and fishoil bait) to enable assessment of its status in the area. The survey should be done in late spring/early summer following better than average winter rainfall.
- Opportunistic small mammal surveys of the rockiest breakaway areas to target the Fat-tailed Antechinus to enable assessment of its status in the area (using Elliott Traps with combined dog-biscuit fish-oil and peanut paste oat bait). The survey should be done in late spring/early summer following better than average winter rainfall.
- Opportunistic small mammal surveys of the cracking clay plains on the south eastern boundary (vicinity of BBB00101) to determine presence/absence of the Plains Rat on Mt Willoughby (using combination of Elliott traps baited with peanut paste and oats, and pitfall traps). The survey should be done in late spring/early summer following better than average winter rainfall.
- Targetted Marsupial Mole trenches in dunefields in the north-western corner of Mt Willoughby.

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APPENDIX 1.

Site description details.

For overstory, understorey and emergent plant species the cover abundance class estimates are included in brackets N=<10 plants and cover <5%, T= sparsely present cover<5%, 1=numerous cover<5%, 2=cover 5-25%

SITE ID	Id NO.	LAND FORM PATTERN	LANDFORM TYPE	SOIL TEXTURE CLASS CODE	% SITE SLOPE	SITE ASPECT deg N	OUTCROP % COVER	OUTCROP LITHOLOGY	SURFACE STREW SIZE (mm)	SURFACE STREW % COVER	LAST FIRE YEAR	% BARE EARTH	% LITTER	VEGETATION STRUCTURE	STRUCTURAL VEGETATION FORMATION DESCRIPTION	OVER STOREY SPECIES	UNDER STOREY SPECIES	EMERGENT SPECIES
BBB00101	19576	Plain	stony plain	Light Med. Clay	1	65	nil		pebble 5-50	30-70		5	7	Grassland	Very Open (Tussock) Grassland	Iseilema eremaeum (1)		
BBB00201	19577	Flood plain	stream channel	Fine Sandy Clay Loam	1	90	nil		pebble 5-50	<10		25	20	Low shrubland	Low Open Shrubland	Maireana aphylla (2)	Atriplex vesicaria ssp. (2), Astrebla pectinata (1), Aristida nitidula (1)	Acacia aneura (N), Santalum lanceolatum (N)
BBB00301	19578	RIS Rises	stream channel	Loam	0	0	nil		pebble 5-50	30-70		15	10	Mallee	Very Open Mallee	Eucalyptus socialis (1)	Acacia calcicola (1), Atriplex vesicaria ssp. (1)	
BBB00401	19580	Escarpment	breakaway	Silty Clay Loam	5	20	10-50	not identified	cobble 51-250	30-70		5	5	Shrubland	Open Shrubland	Acacia calcicola (2)	Eremophila freelingii (2), Senna artemisioides nothossp. coriacea (1), Ptilotus obovatus (1)	
BBB00501	19581	Rises	hill slope	Silty Clay	5	180	10-50	Sand-stone	pebble 5-50	30-70		10	2	Low woodland	Very Low Open Woodland	Acacia aneura (2)	Eremophila freelingii (1), Ptilotus obovatus (1)	
BBB00601	19582	Plain	stony plain	Fine Sandy Clay Loam	0		nil		pebble 5-50	30-70		5	3	Low shrubland	Low Very Open Shrubland	Eremophila rotundifolia (1)	Atriplex vesicaria ssp. (1), Sclerolaena cuneata (1)	Acacia tetragonophylla (T)
BBB00701	19583	Plain	stony plain	Light Clay	1	170	nil		pebble 5-50	30-70		15	20	Low shrubland	Low Very Open Shrubland	Atriplex nummularia ssp. omissa (2)	Sclerolaena intricata (2), Astrebla pectinata (1)	
BRU00101	19584	Plain	stony plain	Sandy clay loam	1	180	nil		pebble 5-50	> 70		5	25	Low shrubland	Low Shrubland		Atriplex vesicaria ssp. (3), Enneapogon avenaceus (1)	
BRU00201	19585	Plain	stony plain	Light Med. Clay			<10		cobble 51-250	> 70		5		Shrubland	Open Shrubland	Eremophila freelingii (2)	Sclerolaena diacantha (T), Enneapogon avenaceus (T), Trichanthodium skirrophorum (T), Aristida contorta (T), Sclerolaena sp. (T)	Senna artemisioides nothossp. sturtii (1), Acacia aneura (T)

APPENDIX 1. (cont.)

Mt Willoughby I. P. A. Biological Survey

SITEID	Id NO.	LAND FORM PATTERN	LANDFORM TYPE	SOIL TEX CLASS CODE	% SITE SLOPE	SITE ASPECT deg N	OUTCROP % COVER	OUTCROP LITHOLOGY	SURFACE STREW SIZE (mm)	SURFACE STREW % COVER	LAST FIRE YEAR	% BARE EARTH	% LITTER	VEGETATION STRUCTURE	STRUCTURAL VEGETATION FORMATION DESCRIPTION	OVER STOREY SPECIES	UNDER STOREY SPECIES	EMERGENT SPECIES
BRU00301	19586	Escarpment	breakaway	Sandy Clay Loam	10	18	10-50	laterite iron-stone	pebble 5-50	30-70		5	10	Low woodland	Very Low Woodland	Acacia aneura (2)	Eremophila freelingii (1), Ptilotus obovatus (T)	Acacia calcicola (1)
BRU00401	19587	Plain	stony plain	Loamy Clay	1	360	nil		pebble 5-50	> 70		5	5	Low shrubland	Low Open Shrubland	Atriplex vesicaria ssp. (2)	Enneapogon polyphyllus (1), Sida intricata (T), Astrebla pectinata (T), Sclerolaena intricata (T), Sida fibulifera (T)	Eremophila rotundifolia (1), Eremophila serrulata (N)
BRU00501	19588	Escarpment	breakaway	Sandy Clay Loam	20	360	10-50	shale	pebble 5-50	> 70		0	5	Tall shruband	Tall Open Shrubland	Acacia stowardii (2)	Eremophila freelingii (1), Ptilotus obovatus (1), Senna artemisioides nothossp. coriacea (1), Maireana campanulata (1)	Acacia aneura (T)
BRU00601	19589	Flood plain	stream channel	Sandy Clay Loam	1	180	nil		pebble 5-50	<10		30	10	Woodland	Woodland	Eucalyptus camaldulensis (2), Acacia papyrocarpa (N)	Maireana aphylla (3), Enteropogon ramosus (1), Aristida nitidula (1), Eulalia aurea (T), Aristida sp. (T)	Alectryon oleifolius ssp. Canescens (1), Alectryon oleifolius ssp. Canescens (N)
BRU00701	19590	Plain	stony plain	Sandy Clay Loam	1	360	nil		pebble 5-50	> 70		5	5	Low shrubland	Low Shrubland	Atriplex vesicaria ssp. (3), Rhagodia spinescens (1)	Ptilotus obovatus (1), Enneapogon polyphyllus (T), Trichanthodium skirrophorum (T)	Pittosporum angustifolium var. microcarpa (N)
BRU00801	19591	Flood plain	flood out	Med. Clay	0		nil		none apparent	nil		5	20	Woodland	Open Woodland	Eucalyptus coolabah ssp. arida (2)	Maireana aphylla (3), Aristida nitidula (1), Eriachne ovata (1), Enteropogon ramosus (1)	
CAN00101	19592	Flood plain	swamp	Sandy Clay Loam	1	3	nil		pebble 5-50	30-70	1975	15	20	Woodland	Low Open Forest	Eucalyptus coolabah ssp. arida (3)	Muehlenbeckia florulenta (2), Myriocephalus rudallii (1), Alternanthera denticulata (1), Teucrium racemosum (1)	

APPENDIX 1. (cont.)

SITEID	Id NO.	LAND FORM PATTERN	LANDFORM TYPE	SOIL TEX CLASS CODE	% SITE SLOPE	SITE ASPECT deg N	OUTCROP % COVER	OUTCROP LITHOLOGY	SURFACE STREW SIZE (mm)	SURFACE STREW % COVER	LAST FIRE YEAR	% BARE EARTH	% LITTER	VEGETATION STRUCTURE	STRUCTURAL VEGETATION FORMATION DESCRIPTION	OVER STOREY SPECIES	UNDER STOREY SPECIES	EMERGENT SPECIES
CAN00201	19593	Flood plain	swamp	Med. Clay			nil		pebble 5-50	<10		40	20	Shrubland	Shrubland	Chenopodium nitrariaceum (3), Eragrostis australasica (2)	Calotis plumulifera (3), Ixiolaena chloroleuca (1)	
CAN00301	19594	Plain	stony plain	Sandy Clay Loam	0		nil		pebble 5-50	30-70		15	25	Shrubland	Open Shrubland	Eremophila freelingii (2)	Enneapogon cylindricus (1), Aristida contorta (1), Sclerolaena eriacantha (1)	Senna “phyllodinea” (1)
CAN00401	19595	Plain	stony plain	SandyClay	0		nil		pebble 5-50	30-70		10	7	Low woodland	Low Woodland	Eremophila freelingii (2), Eremophila duttonii (1)	Maireana georgei (1), Sclerolaena cuneata (T)	Scaevola spinescens (1), Acacia papyrocarpa (T), Acacia aneura (T)
CAN00501	19596	Sand plain	sandy plain	LoamySand	0		nil		none apparent	0	2002	25	15	Low woodland	Very Low Woodland	Acacia aneura (2)	Eriachne mucronata (3), Eragrostis xerophila (2), Eremophila paisleyi (1)	Acacia aneura (1)
CAN00601	19597	Sand plain	sandy plain	LoamySand	0		nil		pebble 5-50	30-70	1975	25	10	Low woodland	Very Low Woodland	Acacia aneura (2)	Eriachne mucronata (2), Eragrostis xerophila (1)	Acacia papyrocarpa (1)
CAN00701	19598	Sand plain	sandy plain	Sandy Clay Loam	0		nil		pebble 5-50	30-70		35	15	Low woodland	Low Woodland			
POO00101	19570	Plain	dune crest	Sand	1	22	nil		none apparent	0		20	15	Low woodland	Low Woodland	Acacia aneura (2), Acacia ramulosa (2), Acacia aneura complex (T)	Eragrostis eriopoda (2), Rhagodia eremaea (1)	
POO00201	19571	Plain	drainage depression	SandyLoam	0	0	nil		none apparent	0		15	10	Low woodland	Low Woodland	Acacia aneura complex(2)	Acacia tetragonophylla (2), Rhagodia eremaea (1)	
POO00401	19572	Plain	stony plain	Fine Sandy Clay Loam	0	0	nil		pebble 5-50	10-30		20	5	Low shrubland	Very Low Open Shrubland	Acacia tetragonophylla (1)	Sclerolaena cuneata (2), Eremophila freelingii (1)	Acacia aneura var. aneura (N)

APPENDIX 1. (cont.)

SITEID	Id NO.	LAND FORM PATTERN	LANDFORM TYPE	SOIL TEX CLASS CODE	% SITE SLOPE	SITE ASPECT deg N	OUTCROP % COVER	OUTCROP LITHOLOGY	SURFACE STREW SIZE (mm)	SURFACE STREW % COVER	LAST FIRE YEAR	% BARE EARTH	% LITTER	VEGETATION STRUCTURE	STRUCTURAL VEGETATION FORMATION DESCRIPTION	OVER STOREY SPECIES	UNDER STOREY SPECIES	EMERGENT SPECIES
POO00501	19573	Plain	stony plain	Fine Sandy Clay Loam	1	106	nil		pebble 5-50	30-70		5	2	Low shrubland	Low Very Open Shrubland	Atriplex vesicaria ssp. (1)	Sclerolaena diacantha (1)	Eremophila freelingii (N), Senna artemisioides nothossp. coriacea (N), Acacia tetragonophylla (N)
POO00601	19574	Plain	swamp	Light Med. Clay	1	330	nil		pebble 5-50	1 <10		25	20	Shrubland	Open Shrubland	Chenopodium nitrariaceum (2)	Trigonella suavissima (2)	
POO00701	19575	Plain	plain (incl undulating plain)	Light Med. Clay	0	0	nil		pebble 5-50	1 <10		5	5	Low woodland	Very Low Open Woodland	Acacia stowardii (2), Acacia aneura (1)	Senna artemisioides ssp. helmsii (1), Eremophila freelingii (1)	

APPENDIX 2.

Site location details

SITE ID	Dist. & Dir. from nearest Named Place	MGA zone	Easting	Northing	Latitude Dec.	Longitude Dec.	Latitude Deg.	Longitude Deg.
BBB00101	16.7 km NW of Pile Hill	53	458296	6824103	-28.7097	134.573	-28o 42' 34.88"	134o 34' 22.87"
BBB00201	15.6 km WNW of Pile Hill	53	458334	6822467	-28.7245	134.5734	-28o 43' 28.06"	134o 34' 24.06"
BBB00301	14.7 km WNW of Pile Hill	53	457810	6820303	-28.744	134.5679	-28o 44' 38.29"	134o 34' 4.44"
BBB00401	15.0 km WNW of Pile Hill	53	457085	6819682	-28.7496	134.5605	-28o 44' 58.38"	134o 33' 37.62"
BBB00501	16.7 km WNW of Pile Hill	53	455017	6819573	-28.7505	134.5393	-28o 45' 1.69"	134o 32' 21.37"
BBB00601	17.3 km WNW of Pile Hill	53	454274	6819429	-28.7517	134.5317	-28o 45' 6.26"	134o 31' 53.94"
BBB00701	27.9 km NNE of Manguri	53	452600	6819295	-28.7529	134.5145	-28o 45' 10.4"	134o 30' 52.2"
BRU00101	24.6 km SSW of Ely Hill	53	426820	6845048	-28.5192	134.2521	-28o 31' 9.26"	134o 15' 7.6"
BRU00201	21.5 km SSW of Ely Hill	53	429611	6846980	-28.502	134.2808	-28o 30' 7.06"	134o 16' 50.7"
BRU00301	18.5 km SSW of Ely Hill	53	431744	6849172	-28.4823	134.3027	-28o 28' 56.24"	134o 18' 9.61"
BRU00401	16.9 km SSW of Ely Hill	53	434773	6849657	-28.4781	134.3337	-28o 28' 41.05"	134o 20' 1.14"
BRU00501	16.4 km SSW of Ely Hill	53	439046	6849372	-28.4809	134.3773	-28o 28' 51.06"	134o 22' 38.21"
BRU00601	13.9 km WNW of Ant Hill	53	443334	6851046	-28.4659	134.4212	-28o 27' 57.35"	134o 25' 16.21"
BRU00701	7.1 km WNW of Ant Hill	53	451481	6853777	-28.4416	134.5045	-28o 26' 29.8"	134o 30' 16.2"
BRU00801	7.7 km NNW of Ant Hill	53	452073	6855282	-28.428	134.5106	-28o 25' 40.94"	134o 30' 38.2"
CAN00101	21.8 km WSW of England Hill	53	401698	6880012	-28.202	133.9984	-28o 12' 7.27"	133o 59' 54.1"
CAN00201	31.6 km SSW of Cadney Park	53	401060	6882130	-28.1829	133.992	-28o 10' 58.3"	133o 59' 31.34"
CAN00301	18.3 km WSW of England Hill	53	404807	6883102	-28.1744	134.0303	-28o 10' 27.7"	134o 1' 49.04"
CAN00401	28.2 km SSW of Cadney Park	53	397613	6886521	-28.143	133.9573	-28o 8' 34.69"	133o 57' 26.32"
CAN00501	25.3 km SSW of Cadney Park	53	395694	6890555	-28.1064	133.9381	-28o 6' 23.08"	133o 56' 17.27"
CAN00601	25.1 km SSW of Cadney Park	53	396071	6890608	-28.106	133.942	-28o 6' 21.46"	133o 56' 31.13"
CAN00701	23.9 km SSW of Cadney Park	53	397595	6891208	-28.1007	133.9575	-28o 6' 2.38"	133o 57' 27.14"
POO00101	29.1 km SSW of England Hill	53	410694	6858259	-28.399	134.0883	-28o 23' 56.4"	134o 5' 18.02"
POO00201	30.3 km SSW of England Hill	53	410581	6857011	-28.4103	134.0871	-28o 24' 36.94"	134o 5' 13.52"
POO00401	35.9 km WSW of Ely Hill	53	408133	6849159	-28.481	134.0615	-28o 28' 51.46"	134o 3' 41.33"
POO00501	31.8 km WSW of Ely Hill	53	411573	6851582	-28.4593	134.0968	-28o 27' 33.55"	134o 5' 48.52"
POO00601	37.3 km WSW of Ely Hill	53	407605	6847202	-28.4986	134.0559	-28o 29' 54.89"	134o 3' 21.35"
POO00701	59.7 km NNW of Manguri	53	403800	6842825	-28.5378	134.0167	-28o 32' 16.12"	134o 1' 0.08"

APPENDIX 3.

Species recorded for Mt Willoughby and held as specimens in the South Australian Museum Natural Sciences collections.

Mammals

Collection Number	Species	Collection Date	Distance and Direction from Nearest Names Place
m09978	*Sminthopsis macroura*	7-Sept-1975	3 km N Mount Willoughby Homestead
m13179	*Antechinomys laniger*	14-Dec-1986	1 km S Mount Willoughby
m09354	*Sminthopsis crassicaudata*	Sept-1974	80 mi N Coober Pedy

Reptiles

Collection Number	Species	Collection Date	Distance and Direction from Nearest Names Place
R34773	*Antaresia stimsoni*	21 10 1989	57 KM S OF MARLA
R51043	*Antaresia stimsoni*	25 04 1998	STUART H/WAY,44.8 KM SSW EVELYN DOWNS H/S
R32926	*Ctenophorus reticulatus*	03 04 1988	150 KM N COOBER PEDY, ON STUART HWY
R45494	*Ctenophorus reticulatus*	13 03 1995	1.6 KM E OF STUART H/WAY,ON COPPER HILL ROAD
R45493	*Ctenophorus reticulatus*	14 03 1995	1.6 KM E OF STUART H/WAY,ON COPPER HILL ROAD
R53971	*Ctenophorus reticulatus*	09 05 2000	3 KM (AIR) SE OF CADNEY PARK
R37115	*Ctenophorus tjantjalka*	15 10 1990	83 KM N OF COOBER PEDY
R38863	*Ctenotus strauchii*	13 11 1991	MT WILLOUGHBY H/S
R57250	*Ctenotus leonhardii*	22 04 2002	approx 2km W of Gorrie Bore, Wintinna Station
R57251	*Ctenotus leonhardii*	22 04 2002	approx 2km W of Gorrie Bore, Wintinna Station
R10369	*Gehyra variegata*	04 04 1968	2MI N MOUNT WILLOUGHBY H/S
R11872	*Gehyra variegata*	04 04 1968	2MI.N.MOUNT WILLOUGHBY H/S
R38971	*Gehyra variegata*	03 04 1988	150 KM N OF COOBER PEDY ON STUART H/WAY
R32691	*Heteronotia binoei*	11 1998	MT WILLOUGHBY STN
R54645	*Heteronotia binoei*	09 2000	CADNEY H/S, 84 KM S OF MARLA
R38864	*Lerista muelleri*	13 11 1991	MT WILLOUGHBY H/S
R13867 A	*Litoria rubella*	19 04 1973	BOXHOLE CK 47 MILES N W COOBER PEDY
R13867 B	*Litoria rubella*	19 04 1973	BOXHOLE CK 47 MILES N W COOBER PEDY
R54646	*Morethia boulengeri*	09 2000	CADNEY H/S, 84 KM S OF MARLA
R13278	*Neobatrachus centralis*	12 10 1972	BOX HOLE CK, 48 MILES NW OF COOBER PEDY
R32972	*Nephrurus milii*	28 10 1987	MT WILLOUGHBY HS

APPENDIX 4.

Plant species recorded at Mt Willoughby from Survey sites and the Pastoral Management Program

FAMILY NAME	Species	Common Name	Survey	Pastoral Program
ADIANTACEAE	*Cheilanthes lasiophylla*	Woolly Cloak-fern	2	
AIZOACEAE	*Gunniopsis sp.*	Pigface	1	
	Tetragonia eremaea	Desert Spinach	2	
	Tetragonia tetragonioides	New Zealand Spinach		1
	Trianthema triquetra	Red Spinach	1	1
AMARANTHACEAE	*Alternanthera denticulata*	Lesser Joyweed	3	
	Amaranthus mitchellii	Boggabri Weed	1	
	Ptilotus exaltatus var.	Pink Mulla Mulla	2	
	Ptilotus gaudichaudii var.	Paper Fox-tail	1	4
	Ptilotus nobilis var.	Yellow-tails		5
	Ptilotus obovatus var.	Silver Mulla Mulla	11	7
	Ptilotus polystachyus var.	Long-tails	4	
	Ptilotus sessilifolius var. sessilifolius	Crimson-tails	1	
	Marsdenia australis	Native Pear	1	2
	Rhyncharrhena linearis	Bush Bean	2	
	Sarcostemma viminale ssp. Australe	Caustic Bush	1	
BORAGINACEAE	*Heliotropium europaeum* *	Common Heliotrope	2	
	Heliotropium tenuifolium	Bushy Heliotrope	1	
CAMPANULACEAE	*Wahlenbergia aridicola*	Dryland Bluebell	1	
CAPPARACEAE	*Cleome viscosa*	Tickweed	1	
CHENOPODIACEAE	*Atriplex angulata*	Fan Saltbush	1	
	Atriplex holocarpa	Pop Saltbush	3	2
	Atriplex lobativalvis		1	
	Atriplex nummularia ssp. Omissa	Old-man Saltbush	2	
	Atriplex quinii	Kidney-fruit Saltbush	1	
	Atriplex spongiosa	Pop Saltbush	1	
	Atriplex stipitata	Bitter Saltbush		2
	Atriplex vesicaria ssp.	Bladder Saltbush	14	11
	Chenopodium melanocarpum forma	Black-fruit Goosefoot	1	
	Chenopodium nitrariaceum	Nitre Goosefoot	3	
	Dissocarpus paradoxus	Ball Bindyi	4	2
	Einadia nutans ssp.	Climbing Saltbush	1	
	Enchylaena tomentosa var.	Ruby Saltbush	7	
	Maireana aphylla	Cotton-bush	5	2
	Maireana appressa	Pale-fruit Bluebush		1
	Maireana astrotricha	Low Bluebush	1	1
	Maireana campanulata	Bell-fruit Bluebush	6	
	Maireana georgei	Satiny Bluebush	2	5
	Maireana integra	Entire-wing Bluebush	3	
	Maireana schistocarpa	Split-fruit Bluebush		1
	Maireana sp.	Bluebush/Fissure-plant	5	
	Maireana spongiocarpa	Spongy-fruit Bluebush	2	2
	Maireana triptera	Three-wing Bluebush		3
	Neobassia proceriflora	Desert Glasswort		2
	Osteocarpum dipterocarpum	Two-wing Bonefruit		1
	Rhagodia eremaea	Desert Saltbush	2	
	Rhagodia spinescens	Spiny Saltbush	6	7
	Rhagodia ulicina	Intricate Saltbush	2	
	Salsola kali	Buckbush	15	7
	Sclerolaena brachyptera	Short-wing Bindyi	1	1
	Sclerolaena cuneata	Tangled Bindyi	4	
	Sclerolaena diacantha	Grey Bindyi	3	
	Sclerolaena divaricata	Tangled Bindyi		2
	Sclerolaena eriacantha	Silky Bindyi	7	4
	Sclerolaena glabra	Smooth Bindyi		4
	Sclerolaena intricata	Tangled Bindyi	5	
	Sclerolaena lanicuspis	Spinach Bindyi		4
	Sclerolaena longicuspis	Long-spine Bindyi	3	4
	Sclerolaena parallelicuspis	Western Bindyi		3
	Sclerolaena patenticuspis	Spear-fruit Bindyi		1
	Sclerolaena tricuspis	Three-spine Bindyi		3
	Sclerolaena uniflora	Small-spine Bindyi	2	
	Sclerostegia disarticulata			1

Appendix 4. (cont.)

FAMILY NAME	Species	Common Name	Survey	Pastoral Program
COMPOSITAE	*Anemocarpa podolepidium*	Rock Everlasting		1
	Anemocarpa saxatilis	Hill Sunray	3	
	Calotis hispidula	Hairy Burr-daisy	2	4
	Calotis multicaulis	Woolly-headed Burr-daisy		2
	Calotis plumulifera	Woolly-headed Burr-daisy	4	
	Centipeda cunninghamii	Common Sneezeweed	2	
	Centipeda thespidioides	Desert Sneezeweed	1	
	Craspedia sp.		2	
	Erigeron sessilifolius		1	
	Gnephosis arachnoidea	Spidery Button-flower		8
	Ixiochlamys filicifolia			1
	Ixiolaena brevicompta	Plains Plover-daisy	1	
	Ixiolaena chloroleuca	Pale Plover-daisy	2	2
	Ixiolaena leptolepis	Narrow Plover-daisy		1
	Ixiolaena tomentosa	Woolly Plover-daisy	1	
	Lawrencella davenportii	Davenport Daisy	1	
	Leucochrysum fitzgibbonii	Fitzgibbon's Daisy	2	
	Leucochrysum stipitatum	Salt-spoon Daisy	2	
	Minuria leptophylla	Minnie Daisy		1
	Minuria sp.	Minuria	2	
	Myriocephalus rudallii	Small Poached-egg Daisy	2	
	Pterocaulon sphacelatum	Apple-bush	1	
	Rhodanthe charsleyae		2	
	Rhodanthe floribunda	White Everlasting	2	4
	Rutidosis helichrysoides	Grey Wrinklewort	2	
	Schoenia cassiniana	Pink Everlasting	1	
	Senecio cunninghamii var. serratus	Inland Shrubby Groundsel	1	
	Streptoglossa liatroides	Wertaloona Daisy		1
	Trichanthodium skirrophorum	Woolly Yellow-heads	13	
CONVOLVULACEAE	*Convolvulus erubescens*	Australian Bindweed		4
	Convolvulus remotus	Grassy Bindweed	1	
CRUCIFERAE	*Lepidium muelleri-ferdinandi*	Mueller's Peppercress	1	
	Lepidium papillosum	Warty Peppercress	1	
	Lepidium phlebopetalum	Veined Peppercress		1
	Stenopetalum lineare	Narrow Thread-petal		1
CYPERACEAE	*Cyperaceae sp.*	Sedge Family	1	
ELATINACEAE	*Bergia perennis ssp. exigua*	Perennial Water-fire	1	
EUPHORBIACEAE	*Euphorbia australis*	Hairy Caustic Weed	1	
	Euphorbia drummondii	Caustic Weed		1
	Euphorbia parvicaruncula	Rough-seeded Spurge	1	
	Euphorbia tannensis ssp. eremophila	Desert Spurge	3	
FRANKENIACEAE	*Frankenia serpyllifolia*	Thyme Sea-heath	1	
GENTIANACEAE	*Centaurium spicatum **	Spike Centaury	3	
GERANIACEAE	*Erodium crinitum*	Blue Heron's-bill		1
	Erodium sp.	Heron's-bill/Crowfoot	1	1
GOODENIACEAE	*Brunonia australis*	Blue Pincushion	3	
	Goodenia berardiana	Split-end Goodenia	1	
	Goodenia cycloptera	Serrated Goodenia	1	
	Goodenia fascicularis	Silky Goodenia		1
	Goodenia modesta		1	
	Scaevola spinescens	Spiny Fanflower	2	
	Velleia sp.	Velleia	1	
GRAMINEAE	*Aristida anthoxanthoides*	Yellow Three-awn	4	1
	Aristida contorta	Curly Wire-grass	14	4
	Aristida holathera var. holathera	Tall Kerosene Grass	2	
	Aristida latifolia	Feather-top Wire-grass		2
	Aristida nitidula	Brush Three-awn	3	
	Aristida strigosa	Rough Three-awn	1	
	Astrebla pectinata	Barley Mitchell-grass	7	4
	Chloris truncata	Windmill Grass		4
	Dactyloctenium radulans	Button-grass	6	
	Digitaria brownii	Cotton Panic-grass	2	1
	Enneapogon avenaceus	Common Bottle-washers	8	5
	Enneapogon cylindricus	Jointed Bottle-washers	1	
	Enneapogon polyphyllus	Leafy Bottle-washers	7	
	Enteropogon acicularis	Umbrella Grass	1	

Appendix 4. (cont.)

FAMILY NAME	Species	Common Name	Survey	Pastoral Program
GRAMINEAE	*Enteropogon ramosus*	Umbrella Grass	6	
	Eragrostis australasica	Cane-grass	2	
	Eragrostis eriopoda	Woollybutt	1	
	Eragrostis pergracilis *	Small Love-grass	1	
	Eragrostis setifolia	Bristly Love-grass	2	2
	Eragrostis xerophila	Knotty-butt Neverfail	10	
	Eriachne helmsii	Woollybutt Wanderrie	5	
	Eriachne mucronata	Mountain Wanderrie	4	
	Eriachne ovata	Swamp Wanderrie	1	
	Iseilema eremaeum		2	
	Iseilema membranaceum	Small Flinders-grass	1	1
	Monachather paradoxa	Bandicoot Grass	4	
	Panicum decompositum var. decompositum	Native Millet	6	2
	Stipa sp.	Spear-grass		1
	Themeda triandra	Kangaroo Grass	1	
	Tripogon loliiformis	Five-minute Grass	4	8
HALORAGACEAE	*Haloragis odontocarpa forma*	Mulga Nettle	3	
LABIATAE	*Teucrium racemosum*	Grey Germander	3	
LEGUMINOSAE	*Acacia aff. papyrocarpa*	Myall	1	
	Acacia aneura complex	Mulga	2	
	Acacia aneura var.	Mulga	18	5
	Acacia aneura var. aneura	Mulga	2	
	Acacia brachybotrya	Grey Mulga-bush	1	
	Acacia calcicola	Northern Myall	3	1
	Acacia kempeana	Witchetty Bush	4	
	Acacia ligulata	Umbrella Bush	1	
	Acacia minyura	Desert Mulga	1	
	Acacia papyrocarpa	Western Myall	7	2
	Acacia ramulosa	Horse Mulga	2	
	Acacia salicina	Willow Wattle	1	
	Acacia stowardii	Bastard Mulga	6	1
	Acacia tetragonophylla	Dead Finish	21	6
	Acacia victoriae ssp.	Elegant Wattle		1
	Crotalaria sp.	Rattle-pod/Bird-flower	1	
	Cullen cinereum	Annual Scurf-pea		2
	Cullen graveolens	Native Lucerne	1	
	Cullen patens	Spreading Scurf-pea	1	
	Glycine canescens	Silky Glycine	1	
	Lotus cruentus	Red-flower Lotus	2	2
	Muelleranthus stipularis	Sand Pea	1	
	Petalostylis labicheoides	Butterfly Bush	1	
	Senna "phyllodinea"		1	
	Senna artemisioides nothossp. artemisioides	Silver Senna	8	4
	Senna artemisioides nothossp. coriacea	Broad-leaf Desert Senna	12	3
	Senna artemisioides nothossp. sturtii	Grey Senna	3	
	Senna artemisioides ssp. filifolia	Fine-leaf Desert Senna	5	
	Senna artemisioides ssp. helmsii	Blunt-leaf Senna	6	1
	Senna artemisioides ssp. oligophylla	Limestone Senna	5	
	Senna artemisioides ssp. petiolaris	Flat-stalk Senna	1	
	Senna artemisioides ssp. quadrifolia	Four-leaf Desert Senna	1	
	Senna cardiosperma ssp. gawlerensis	Gawler Ranges Senna		1
	Swainsona canescens	Grey Swainson-pea	1	
	Trigonella suavissima	Sweet Fenugreek	1	
LORANTHACEAE	*Amyema maidenii ssp. maidenii*	Pale-leaf Mistletoe	6	
	Amyema preissii	Wire-leaf Mistletoe	4	
	Lysiana exocarpi ssp. exocarpi	Harlequin Mistletoe	1	1
MALVACEAE	*Abutilon cryptopetalum*	Hill Lantern-bush		1
	Abutilon fraseri ssp.		2	
	Abutilon leucopetalum	Desert Lantern-bush	2	
	Abutilon malvaefolium	Scrambling Lantern-bush	1	2
	Hibiscus sturtii var.	Sturt's Hibiscus	1	
	Malvastrum americanum	Malvastrum	3	2
	Sida corrugata var.	Corrugated Sida	1	3
	Sida fibulifera	Pin Sida	5	3
	Sida intricata	Twiggy Sida	1	2
	Sida petrophila	Rock Sida	1	

Appendix 4. (cont.)

FAMILY NAME	Species	Common Name	Survey	Pastoral Program
MARSILEACEAE	*Marsilea drummondii*	Common Nardoo	4	
MYOPORACEAE	*Eremophila duttonii*	Harlequin Emubush	2	2
	Eremophila freelingii	Rock Emubush	14	6
	Eremophila gilesii	Hairy-fruit Emubush	1	1
	Eremophila glabra ssp. glabra	Tar Bush	1	
	Eremophila latrobei ssp.	Crimson Emubush	3	1
	Eremophila latrobei ssp. glabra	Crimson Emubush		2
	Eremophila latrobei ssp. latrobei	Grey-leaf Crimson Emubush		1
	Eremophila longifolia	Weeping Emubush	2	
	Eremophila neglecta		2	
	Eremophila paisleyi	Paisley's Emubush	12	
	Eremophila rotundifolia	Round-leaf Emubush	5	3
	Eremophila serrulata	Green Emubush	2	
MYRTACEAE	*Eucalyptus camaldulensis var.*	River Red Gum	1	
	Eucalyptus coolabah ssp. arida	Coolibah	2	
	Eucalyptus socialis	Beaked Red Mallee	1	
PITTOSPORACEAE	*Pittosporum angustifolium var. microcarpa*	Native Apricot	2	
PLANTAGINACEAE	*Plantago drummondii*	Dark Plantain		2
POLYGALACEAE	*Polygala isingii*	Central Australian Milkwort	1	
	Muehlenbeckia florulenta	Lignum	4	
	Polygonum plebeium	Small Knotweed	2	
PORTULACACEAE	*Calandrinia polyandra var. polyandra*	Parakeelya	1	
	Calandrinia remota	Round-leaf Parakeelya	4	
	Calandrinia reticulata			4
	Portulaca oleracea	Common Purslane	5	7
RANUNCULACEAE	*Ranunculus pentandrus var.*	Smooth Buttercup	1	
SANTALACEAE	*Exocarpos aphyllus*	Leafless Cherry	2	
	Santalum lanceolatum	Plumbush	9	2
SAPINDACEAE	*Alectryon oleifolius ssp. canescens*	Bullock Bush	3	
SCROPHULARIACEAE	*Peplidium "Marla"(W.R.Barker 3535)*		1	
SOLANACEAE	*Nicotiana simulans*	Native Tobacco	3	
	Solanum cleistogamum	Shy Nightshade		2
	Solanum ellipticum	Velvet Potato-bush	5	3
	Solanum esuriale	Quena	1	
	Solanum lasiophyllum	Flannel Bush	3	
	Solanum petrophilum	Rock Nightshade		1
	Solanum quadriloculatum	Plains Nightshade	6	1
THYMELAEACEAE	*Pimelea simplex ssp. continua*	Desert Riceflower		1
UMBELLIFERAE	*Daucus glochidiatus*	Native Carrot	1	1
	Trachymene glaucifolia	Blue Parsnip	3	
ZYGOPHYLLACEAE	*Tribulus astrocarpus*	Star-fruit Caltrop		1
	Zygophyllum ammophilum	Sand Twinleaf	1	2

APPENDIX 5.

Alphabetically sorted plant species list by sites and showing estimated cover abundance classes.
N=<10 plants and cover <5%, T=sparsely present cover <5%, 1=numerous but cover <5%, 2=cover 5-25%, 3=cover 25-50%, 4=cover 50-75%, 5=cover >75%.

SPECIES	COMMON NAME	BBB00101	BBB00201	BBB00301	BBB00401	BBB00501	BBB00601	BBB00701	BRU00101	BRU00201	BRU00301	BRU00401	BRU00501	BRU00601	BRU00701	BRU00801	CAN00101	CAN00201	CAN00301	CAN00401	CAN00501	CAN00601	CAN00701	POO00101	POO00201	POO00401	POO00501	POO00601	POO00701	# sites
Abutilon fraseri ssp.																	N									N				2
Abutilon leucopetalum	Desert Lantern-bush			N	N																									2
Abutilon malvaefolium	Scrambling Lantern-bush																										N			1
Acacia aff. papyrocarpa	Myall												N																	1
Acacia aneura complex	Mulga																							T	T					2
Acacia aneura var.	Mulga		N			2				T				N			T			T	1	2	1	2	1	N			1	13
Acacia aneura var. aneura	Mulga																								2	N				2
Acacia brachybotrya	Grey Mulga-bush																						2							1
Acacia calcicola	Northern Myall			1							1																			2
Acacia kempeana	Witchetty Bush			N		N					N																			3
Acacia ligulata	Umbrella Bush																													0
Acacia minyura	Desert Mulga																						N							1
Acacia papyrocarpa	Western Myall										1			N			N			T		1								5
Acacia ramulosa	Horse Mulga																					N		2						2
Acacia salicina	Willow Wattle			T																										1
Acacia stowardii	Bastard Mulga										N		2				N			T		1						2	6
Acacia tetragonophylla	Dead Finish			N	T	1	T			N	1	N		N	N	1	2		N	N	N		N	N	2	1	N	N	N	21
Alectryon oleifolius ssp. canescens	Bullock Bush													1		T														2
Alternanthera denticulata	Lesser Joyweed																1	T										N		3
Amaranthus mitchellii	Boggabri Weed																													0
Amyema maidenii ssp. maidenii	Pale-leaf Mistletoe										N			N			1				1	N			T					6
Amyema preissii	Wire-leaf Mistletoe			N							N													N	T					4
Anemocarpa saxatilis	Hill Sunray				T	T																								2
Aristida anthoxanthoides	Yellow Three-awn	N					N	T				T																		4
Aristida contorta	Curly Wire-grass					1	1		T	T	N	T			T				1	N		T	T		T	T	1			14
Aristida holathera var. holathera	Tall Kerosene Grass																							1					T	2
Aristida nitidula	Brush Three-awn		1											1		1														3
Aristida sp.	Three-awn/Wire-grass													T																1
Aristida strigosa	Rough Three-awn				N																									1
Astrebla pectinata	Barley Mitchell-grass	T	1				T	1	T			T															N			7
Atriplex angulata	Fan Saltbush														N															1
Atriplex holocarpa	Pop Saltbush	1	1					T																						3
Atriplex lobativalvis																												T		1
Atriplex nummularia ssp. omissa	Old-man Saltbush							2							N															2
Atriplex quinii	Kidney-fruit Saltbush											T																		1
Atriplex sp.	Saltbush											T														T				2
Atriplex spongiosa	Pop Saltbush		N																											1
Atriplex vesicaria ssp.	Bladder Saltbush		2	1	T	N	1	1	3	T	1	2	T	T	3											1				14
Bergia perennis ssp. exigua	Perennial Water-fire																N													1
Brunonia australis	Blue Pincushion																				N	T	N							3
Calandrinia polyandra var. polyandra	Parakeelya																2													1
Calandrinia remota	Round-leaf Parakeelya																	N						1	N				N	4
Calotis hispidula	Hairy Burr-daisy																							N				N		2
Calotis plumulifera	Woolly-headed Burr-daisy																1	3			N									3
*Centaurium spicatum **	Spike Centaury																N	T				N								3
Centipeda cunninghamii	Common Sneezeweed																	T										N		2
Centipeda thespidioides	Desert Sneezeweed							N																						1
Cheilanthes lasiophylla	Woolly Cloak-fern				N						T																			2
Chenopodium melanocarpum	Black-fruit Goosefoot																N													1
Chenopodium nitrariaceum	Nitre Goosefoot																1	3										2		3
Cleome viscosa	Tickweed																								N					1
Compositae sp.	Daisy Family																												N	1
Convolvulus remotus	Grassy Bindweed											T																		1
Craspedia sp.				T				1																						2
Crotalaria sp.	Rattle-pod/Bird-flower		T																											1
Cullen graveolens	Native Lucerne											N																		1
Cullen patens	Spreading Scurf-pea								T																					1
Cyperaceae sp.	Sedge Family																	T												1
Dactyloctenium radulans	Button-grass	T	2					T	T					1												T				6
Daucus glochidiatus	Native Carrot											N																		1
Digitaria brownii	Cotton Panic-grass											N														N				2
Dissocarpus paradoxus	Ball Bindyi	T	1	N										N																4
Einadia nutans ssp.	Climbing Saltbush																									N				1
Enchylaena tomentosa var.	Ruby Saltbush													T		N	N								1	N	N		N	7
Enneapogon avenaceus	Common Bottle-washers	T	2	N		N	N		1	T				T																8

Appendix 5. (cont.)

SPECIES	COMMON NAME	BBB00101	BBB00201	BBB00301	BBB00401	BBB00501	BBB00601	BBB00701	BRU00101	BRU00201	BRU00301	BRU00401	BRU00501	BRU00601	BRU00701	BRU00801	CAN00101	CAN00201	CAN00301	CAN00401	CAN00501	CAN00601	CAN00701	POO00101	POO00201	POO00401	POO00501	POO00601	POO00701	# sites
Enneapogon cylindricus	Jointed Bottle-washers																		1											1
Enneapogon polyphyllus	Leafy Bottle-washers				T							T	N		T				N								1			6
Enteropogon acicularis	Umbrella Grass													1																1
Enteropogon ramosus	Umbrella Grass						N							1		1								1	N			N		6
Eragrostis australasica	Cane-grass																	2									N			2
Eragrostis eriopoda	Woollybutt																							2						1
Eragrostis pergracilis *	Small Love-grass																								2					1
Eragrostis setifolia	Bristly Love-grass		T														T													2
Eragrostis sp.	Love-grass															N														1
Eragrostis xerophila	Knotty-butt Neverfail								T			N		T				N		N	N	1	2		T					9
Eremophila duttonii	Harlequin Emubush																		N	1										2
Eremophila freelingii	Rock Emubush			N	2	1	N		N	2	1		1		N				2	2					1	N		1		14
Eremophila gilesii	Hairy-fruit Emubush																						1							1
Eremophila glabra ssp. glabra	Tar Bush																							N						1
Eremophila latrobei ssp.	Crimson Emubush													1					N							N				3
Eremophila longifolia	Weeping Emubush															N	N													2
Eremophila neglecta				N							T																			2
Eremophila paisleyi	Paisley's Emubush								N	N	N		N	N						T	1	2		T	N	N			T	12
Eremophila rotundifolia	Round-leaf Emubush				N		1				1	1													N					5
Eremophila serrulata	Green Emubush											N													N					2
Eriachne helmsii	Woollybutt Wanderrie																				N	2	T	N	N					5
Eriachne mucronata	Mountain Wanderrie																			N	3	2	2							4
Eriachne ovata	Swamp Wanderrie															1														1
Erigeron sessilifolius																		T												1
Erodium sp.	Heron's-bill/Crowfoot																							N						1
Eucalyptus camaldulensis var.	River Red Gum													2																1
Eucalyptus coolabah ssp. arida	Coolibah															2	3													2
Eucalyptus socialis	Beaked Red Mallee			1																										1
Eulalia aurea	Silky Brown-top													T																1
Euphorbia australis	Hairy Caustic Weed				N																									1
Euphorbia parvicaruncula	Rough-seeded Spurge	T																												1
Euphorbia tannensis ssp. eremophila	Desert Spurge	T							N																	N				3
Exocarpos aphyllus	Leafless Cherry			N	T																									2
Frankenia serpyllifolia	Thyme Sea-heath											N																		1
Glycine canescens	Silky Glycine															N														1
Goodenia berardiana	Split-end Goodenia																								N					1
Goodenia cycloptera	Serrated Goodenia																							T						1
Goodenia modesta																	1													1
Goodenia sp.	Goodenia																							N						1
Gramineae sp.	Grass Family										1																			1
Gunniopsis sp.	Pigface					N																								1
Haloragis odontocarpa forma	Mulga Nettle																				T	T	T							3
Heliotropium europaeum *	Common Heliotrope														N													N		2
Heliotropium tenuifolium	Bushy Heliotrope																							N						1
Hibiscus sturtii var.	Sturt's Hibiscus																						T							1
Iseilema eremaeum		1						1																						2
Iseilema membranaceum	Small Flinders-grass								N																					1
Ixiolaena brevicompta	Plains Plover-daisy																										N			1
Ixiolaena chloroleuca	Pale Plover-daisy																	1									N			2
Ixiolaena tomentosa	Woolly Plover-daisy													N																1
Lawrencella davenportii	Davenport Daisy																							N						1
Lepidium muelleri-ferdinandi	Mueller's Peppercress																N													1
Lepidium papillosum	Warty Peppercress																								N					1
Leucochrysum fitzgibbonii	Fitzgibbon's Daisy																N							N					2
Leucochrysum stipitatum	Salt-spoon Daisy																				T	1								2
Lotus cruentus	Red-flower Lotus								T												1									2
Lysiana exocarpi ssp. exocarpi	Harlequin Mistletoe																							N						1
Maireana aphylla	Cotton-bush		2	N					N					3		3														5
Maireana astrotricha	Low Bluebush					1																								1
Maireana campanulata	Bell-fruit Bluebush			N	1	N					1		1						T											6
Maireana georgei	Satiny Bluebush																			1				N						2
Maireana integra	Entire-wing Bluebush																		T		N		N							3
Maireana sp.	Bluebush/Fissure-plant										N					T									1			T	4
Maireana spongiocarpa	Spongy-fruit Bluebush										N															N			2
Malvastrum americanum	Malvastrum		N												T	T														3
Marsdenia australis	Native Pear													N																1
Marsilea drummondii	Common Nardoo							N									N	N									N			4
Marsilea sp.	Nardoo											T															N			2
Minuria sp.	Minuria		1					T																						2
Monachather paradoxa	Bandicoot Grass																				N		T	T	N					4

Appendix 5. (cont.)

SPECIES	COMMON NAME	BBB00101	BBB00201	BBB00301	BBB00401	BBB00501	BBB00601	BBB00701	BRU00101	BRU00201	BRU00301	BRU00401	BRU00501	BRU00601	BRU00701	BRU00801	CAN00101	CAN00201	CAN00301	CAN00401	CAN00501	CAN00601	CAN00701	POO00101	POO00201	POO00401	POO00501	POO00601	POO00701	# sites
Muehlenbeckia florulenta	Lignum															N		T										T		3
Muelleranthus stipularis	Sand Pea																					T								1
Myriocephalus rudallii	Small Poached-egg Daisy																1	T												2
Nicotiana simulans	Native Tobacco																N								N	N				3
Panicum decompositum var. decompositum	Native Millet		N				N	N		N		T															N			6
Panicum sp.	Panic/Millet											T			N															2
Peplidium "Marla"(W.R.Barker 3535)																	N													1
Petalostylis labicheoides	Butterfly Bush													N																1
Pittosporum angustifolium var. microcarpa	Native Apricot			T											N															2
Polygala isingii	Central Australian Milkwort																		N											1
Polygonum plebeium	Small Knotweed																	N										N		2
Portulaca oleracea	Common Purslane								N								N							1	T			N		5
Pterocaulon sphacelatum	Apple-bush																N													1
Ptilotus exaltatus var.	Pink Mulla Mulla						N		T																					2
Ptilotus gaudichaudii var.	Paper Fox-tail																									N				1
Ptilotus obovatus var.	Silver Mulla Mulla			T	1	1	N				T		1		1					N				N	T			N	11
Ptilotus polystachyus var.	Long-tails																				T	1		T	1					4
Ptilotus sessilifolius var. sessilifolius	Crimson-tails													T																1
Ranunculus pentandrus var.	Smooth Buttercup											N																		1
Rhagodia eremaea	Desert Saltbush																							1	1					2
Rhagodia spinescens	Spiny Saltbush			N							N			N	1	N														5
Rhagodia ulicina	Intricate Saltbush				T						N																			2
Rhodanthe charsleyae																					N				1					2
Rhodanthe floribunda	White Everlasting																T									T				2
Rhyncharrhena linearis	Bush Bean																							N	N					2
Rutidosis helichrysoides	Grey Wrinklewort																N								N					2
Salsola kali	Buckbush	1		1	T		T	1	N	T				N	T		N		N	T					T	1		N	15
Santalum lanceolatum	Plumbush		N	N	1						N			T		2	N								T					8
Sarcostemma viminale ssp. australe	Caustic Bush							N																						1
Scaevola spinescens	Spiny Fanflower																		N	1										2
Schoenia cassiniana	Pink Everlasting																								1					1
Sclerolaena brachyptera	Short-wing Bindyi								N																					1
Sclerolaena cuneata	Tangled Bindyi						1												1	T						2				4
Sclerolaena diacantha	Grey Bindyi									T				T													1			3
Sclerolaena eriacantha	Silky Bindyi													N	N				1	T						N			N	6
Sclerolaena intricata	Tangled Bindyi	T	T				T	2				T																		5
Sclerolaena longicuspis	Long-spine Bindyi								N	T		T																		3
Sclerolaena sp.	Bindyi									T	N	N	N							T										5
Sclerolaena uniflora	Small-spine Bindyi											T													T					2
Senecio cunninghamii var. serratus	Inland Shrubby Groundsel		N																											1
Senna "phyllodinea"																			1											1
Senna artemisioides nothossp. artemisioides	Silver Senna		N	N	1						N	N		T			N								N					8
Senna artemisioides nothossp. coriacea	Broad-leaf Desert Senna			N	1	T	N						1				N		N	N							N		N	10
Senna artemisioides nothossp. sturtii	Grey Senna			N						1																			N	3
Senna artemisioides ssp. filifolia	Fine-leaf Desert Senna			N								1		1		T										N				5
Senna artemisioides ssp. helmsii	Blunt-leaf Senna				N				N		N								N	N									1	6
Senna artemisioides ssp. oligophylla	Limestone Senna										T						N		T							N				4
Senna artemisioides ssp. petiolaris	Flat-stalk Senna																							N						1
Senna artemisioides ssp. quadrifolia	Four-leaf Desert Senna																			N										1
Sida corrugata var.	Corrugated Sida								N																					1
Sida fibulifera	Pin Sida											T		N	N											N	T			5
Sida intricata	Twiggy Sida											T																		1
Sida petrophila	Rock Sida				N																									1
Sida sp.	Sida		N																		N	N		N						4
Solanum ellipticum	Velvet Potato-bush								N		N								T	N							N			5
Solanum esuriale	Quena											N																		1
Solanum lasiophyllum	Flannel Bush																			N			N		N					3
Solanum quadriloculatum	Plains Nightshade						T					T					N							N		1			N	6
Swainsona canescens	Grey Swainson-pea																								1					1
Tetragonia eremaea	Desert Spinach																N											N		2
Teucrium racemosum	Grey Germander																1	N										N		3

Appendix 5. (cont.)

SPECIES	COMMON NAME	BBB00101	BBB00201	BBB00301	BBB00401	BBB00501	BBB00601	BBB00701	BRU00101	BRU00201	BRU00301	BRU00401	BRU00501	BRU00601	BRU00701	BRU00801	CAN00101	CAN00201	CAN00301	CAN00401	CAN00501	CAN00601	CAN00701	POO00101	POO00201	POO00401	POO00501	POO00601	POO00701	# sites
Themeda triandra	Kangaroo Grass													T																1
Trachymene glaucifolia	Blue Parsnip																				T	T		T						3
Trianthema triquetra	Red Spinach																									N				1
Trichanthodium skirrophorum	Woolly Yellow-heads		T						T	T	N	T			T		N	N	N	N						N	1		N	13
Trigonella suavissima	Sweet Fenugreek																											2		1
Tripogon loliiformis	Five-minute Grass						N	T				N											T							4
Velleia sp.	Velleia																					N								1
Wahlenbergia aridicola	Dryland Bluebell																	N												1
Zygophyllum ammophilum	Sand Twinleaf																									N				1
Zygophyllum sp.	Twinleaf			T													N													2
	number of species	11	21	26	20	13	18	16	22	14	28	32	10	33	17	17	38	18	20	23	18	19	16	22	37	32	18	18	19	204

APPENDIX 6.

Reptile list for the west region as defined in the Biological Survey of the Stony Deserts SA (Brandle 1998) which encompases the western half of Mt Willoughby.

Only one (*Diporiphora winneckei* Canegrass Dragon) of the 49 species recorded are likely to occur on Mt Willoughby IPA.

SPECIES	COMMON NAME	# sites at which species recorded in west region
Amphibolurus longirostris	Long-nosed Dragon	4
Antaresia stimsoni	Stimson's Python	1
Ctenophorus gibba	Gibber Dragon	4
Ctenophorus nuchalis	Central Netted Dragon	2
Ctenophorus pictus	Painted Dragon	13
Ctenophorus tjantjalka	Tjantjalka Dragon	1
Ctenotus brooksi	Sandhill Ctenotus	9
Ctenotus leae	Centralian Coppertail	1
Ctenotus leonhardii	Common Desert Ctenotus	1
Ctenotus regius	Eastern Desert Ctenotus	13
Ctenotus saxatilis	Centralian Striped Skink	3
Ctenotus schomburgkii	Sandplain Ctenotus	5
Ctenotus septenarius	Gibber Ctenotus	1
Ctenotus olympicus	"Saltbush Ctenotus"	33
Ctenotus strauchii	Short-legged Ctenotus	12
Cyclodomorphus venustus	Saltbush Slender Bluetongue	7
Delma australis	Barred Snake-lizard	6
Diplodactylus byrnei	Pink-blotched Gecko	12
Diplodactylus conspicillatus	Fat-tailed Gecko	1
Diplodactylus damaeus	Beaded Gecko	6
Diplodactylus galeatus	Mesa Gecko	5
Diplodactylus stenodactylus	Sandplain Gecko	11
Diplodactylus tessellatus	Tessellated Gecko	16
Diporiphora winneckei	Canegrass Dragon	1
Eremiascincus fasciolatus	Narrow-banded Sandswimmer	4
Eremiascincus richardsonii	Broad-banded Sandswimmer	10
Gehyra variegata	Tree Dtella	14
Heteronotia binoei	Bynoe's Gecko	17
Lerista desertorum	Great Desert Slider	2
Lerista elongata	Woomera Slider	2
Lerista muelleri	Dwarf Three-toed Slider	8
Menetia greyii	Dwarf Skink	49
Morethia adelaidensis	Adelaide Snake-eye	5
Morethia boulengeri	Common Snake-eye	9
Nephrurus levis	Smooth Knob-tailed Gecko	3
Nephrurus milii	Thick-tailed Gecko	19
Ophidiocephalus taeniatus	Bronzeback Legless Lizard	2
Pogona vitticeps	Central Bearded Dragon	17
Pseudechis australis	Mulga Snake	1
Pygopus nigriceps	Hooded Scaly-foot	1
Ramphotyphlops bituberculatus	Rough-nosed Blind Snake	4
Rhynchoedura ornata	Beaked Gecko	24
Suta suta	Curl Snake	5
Tympanocryptis intima	Smooth-snouted Earless Dragon	9
Tympanocryptis lineata	Five-lined Earless Dragon	2
Tympanocryptis tetraporophora	Centralian Earless Dragon	30
Varanus giganteus	Perentie	1
Varanus gilleni	Pygmy Mulga Goanna	1
Varanus gouldii	Sand Goanna	1

APPENDIX 7.

Mammal list for the west region as defined in the Biological Survey of the Stony Deserts SA (Brandle 1998) which encompases the western half of Mt Willoughby.

Of the 14 native species recorded two (the Ampurta and Long-haired Rat) are unlikely to be found in the Mt Willoughby IPA.

SPECIES	Common Name	# sites in West Region
Antechinomys laniger	Kultarr	3
Bos taurus	Cattle *	34
Camelus dromedarius	Arabian Camel *	8
Canis lupus	Dingo	12
Dasycercus sp. (*hillieri*)	Ampurta	1
Equus asinus	Donkey *	13
Equus caballus	Horse *	7
Felis catus	Cat *	1
Leggadina forresti	Forrest's Mouse	18
Macropus robustus	Common Wallaroo (Euro)	2
Macropus rufus	Red Kangaroo	9
Mus domesticus	House Mouse *	11
Oryctolagus cuniculus	(European) Rabbit *	30
Planigale gilesi	Paucident Planigale (Giles' Planigale)	18
Planigale tenuirostris	Narrow-nosed Planigale	9
Pseudomys australis	Plains Mouse (Plains Rat)	4
Pseudomys desertor	Desert Mouse (Brown Desert Mouse)	1
Pseudomys hermannsburgensis	Sandy Inland Mouse	3
Rattus villosissimus	Long-haired Rat (Plague Rat)	1
Sminthopsis crassicaudata	Fat-tailed Dunnart	51
Sminthopsis macroura	Stripe-faced Dunnart	49
Vulpes vulpes	Fox (Red Fox) *	14

Appendix 8.

Methodology used to detect burrowing signs of Itjaritjari (marsupial mole) – notes from Joe Benshemesh pers. com. 2003.

1) Find some dunes or deep aeolian sand. If there is a choice, go for areas where the deep sand (ie dunes) is continuous with lots of other areas. For example, jumbled dunes or where swales are narrow are probably better areas than where swales are hundreds of metres wide.
2) Do at least 3 - 6 trenches at a site and get as many sites as possible!
3) Dig trenches on the north side of dunes to maximise sunshine, anywhere on the upper slopes is preferable.
4) Orient the trench so that the long axis is about E-W. It helps to draw it in the sand first, and pick a spot where the S edge is undisturbed (no fresh prints etc) and protect it as much as possible while digging etc. This is the edge you will search for moleholes, and it helps if it is undisturbed.
5) Dig the trench to expose the South side (North facing) to about 80cm deep, 100 cm long, and about 40cm wide. Then take of 30cm or so of the N side to get a bit more sun onto the all important S side (N facing).
6) Smooth the wall to make it near vertical and Smooth like plaster.
7) Place a branch in the trench to let animals out (unless you are checking every morning and evening)
8) Leave the trench for as long as possible before returning to read it. 5 days is preferable, but if this is not practical at least 3 days to let them dry (even if they feel dry they are not, and if they feel wet then they will probably need more than 3 days)
9) Reading a trench is a process of gently smoothing it again and carefully looking for the (usually) 40mm diameter backfilled tunnels of Itjaritjari (in cross section). Only look at the N facing wall because it will be the driest.
10) Itjaritjari tunnels are recognised by their size and symmetry. The most important measures are the long and short dimensions of the cross-section, and its depth from the surface. Also, make a note of whether the hole is symmetrical or not, and if not be suspicious. If Itjaritjari are about, you will probably see several faded old holes for every fresh or very distinct mhole; it's a matter of getting ones eye in to see the more indistinct mholes. It's often very useful to have one or two people looking from outside the trench as one searches for mholes and they will often see mholes before you do.
11) Other things to keep in mind are that mholes are continuous and invariably softer in the centre than the surrounding sand. If a mhole is indistinct, it may be clearer if you rub the sand back a bit…or it may disappear completely! Indeed, once you hit damp sand its all over, so work gently. That the sand is softer in the centre can easily be confirmed by tapping lightly inside and outside the mhole. Typically, more sand falls out of the mhole, sometimes revealing the entire tunnel.
12) Most mholes have been found from 30-50 cm down, but they range from just under the surface to below 2m. They tend to be more horizontal than vertical, but can be any direction/orientation.
13) Its probably a good idea to take some scaled photos of likely candidates.
14) Finally, measure the area of the wall that was inspected (length and depth).

Appendix 9.

The number of each insect taxa collected (at the levels identified) for the variety of landform elememts sampled at sites during the survey.

Order	Family	Genus species	Total collected	plain	sandy plain	stony plain	breakaway	drainage depression	dune crest	hill slope	stream channel	flood out	swamp
Acarina	Anystidae	*Tarsotomus sp.*	13		3	2	1	1	1	1	1		3
Acarina	Caeculidae	*black leg*	3	1	1	1							
Acarina	Erythraeidae	*Gn sp*	17	1	2	4	1	1	1	1	3		3
Acarina	Family	*Gn sp*	5	1		1		1	1				1
Acarina	Oribatidae	*Gn sp*	1								1		
BLATTODEA	Blaberidae	*Calolampra sp.*	3					1	1		1		
BLATTODEA	Blattellidae	*Gn sp*	1			1							
BLATTODEA	Blattellidae	*Robshelfordia sp.*	1					1					
BLATTODEA	Blattidae	*Anamesia sp.*	1			1							
BLATTODEA	Blattidae	*Euzosteria sp.*	1				1						
BLATTODEA	Blattidae	*orange*	1						1				
BLATTODEA	Blattidae	*Periplaneta sp. near*	1			1							
BLATTODEA	Blattidae	*Platyzosteria blk*	1			1							
BLATTODEA	Blattidae	*Platyzosteria blk-smooth*	1								1		
BLATTODEA	Blattidae	*Platyzosteria orange*	3	1		1					1		
BLATTODEA	Blattidae	*Platyzosteria sp.*	2		1	1							
BLATTODEA	Blattidae	*Platyzosteria sp. brw*	1							1			
BLATTODEA	Blattidae	*Platyzosteria sp. lg blk*	2			1					1		
CHILOPODA	Family	*Gn sp*	5		1	2					2		
CHILOPODA	Scolopendridae	*Gn sp*	2			1			1				
CHILOPODA	Scutigeridae	*Scutigera sp.*	1									1	
COLEOPTERA	Anthicidae	*Formicomus sp.*	1					1					
COLEOPTERA	Brentidae	*Gn sp*	1			1							
COLEOPTERA	Carabidae	*Arthropterus sp.*	1			1							
COLEOPTERA	Carabidae	*Carenum sp black*	2					1	1				
COLEOPTERA	Carabidae	*Chlaenius australis*	1										1
COLEOPTERA	Carabidae	*Geoscaptus sp*	2										2
COLEOPTERA	Carabidae	*Gigadema small*	2			2							
COLEOPTERA	Carabidae	*Gn sp. tiny*	1										1
COLEOPTERA	Carabidae	*larva*	4			1					2	1	
COLEOPTERA	Carabidae	*Megacephala cylindricus*	1			1							
COLEOPTERA	Carabidae	*Neocarenum sp.*	1						1				
COLEOPTERA	Carabidae	*Notagonum sp.*	3			2						1	
COLEOPTERA	Carabidae	*Phorticosomus sp*	2			1			1				
COLEOPTERA	Carabidae	*Phorticosomus sp blaklarg*	1					1					
COLEOPTERA	Carabidae	*Phorticosomus sp brwmed*	2					1	1				
COLEOPTERA	Carabidae	*Phorticosomus sp brwsm*	1					1					
COLEOPTERA	Carabidae	*Phorticosomus sp. near*	1			1							
COLEOPTERA	Carabidae	*Promecoderus sp.*	1			1							
COLEOPTERA	Carabidae	*Pteroheleus sp.*	1										1
COLEOPTERA	Carabidae	*tiny*	1				1						
COLEOPTERA	Cerambycidae	*Corrhenes ?picta*	1			1							
COLEOPTERA	Chrysomelidae	*Gn sp*	1										1
COLEOPTERA	Chrysomelidae	*larva*	1					1					
COLEOPTERA	Chrysomelidae	*Paropsis brown sp.*	2	1					1				
COLEOPTERA	Chrysomelidae	*Paropsis sp.*	1					1					
COLEOPTERA	Cleridae	*?Phlogistus sp.*	1			1							
COLEOPTERA	Cleridae	*Gn sp*	1								1		
COLEOPTERA	Curculionidae	*Amycterinae Gn. sp.*	1									1	
COLEOPTERA	Curculionidae	*Cubicorhynchus sp.*	1			1							
COLEOPTERA	Curculionidae	*Eleagyna humeralis near*	2			1					1		

Order	Family	Genus species	Total collected	plain	sandy plain	stony plain	breakaway	drainage depression	dune crest	hill slope	stream channel	flood out	swamp
COLEOPTERA	Curculionidae	*Gn sp*	3	1	1	1							
COLEOPTERA	Curculionidae	*Molochtus sp.*	1					1					
COLEOPTERA	Curculionidae	*Sitona sp. near*	1			1							
COLEOPTERA	Family	*Gn sp*	2								1	1	
COLEOPTERA	Family	*larva*	2			1			1				
COLEOPTERA	Family	*tiny*	6		1	3					1		1
COLEOPTERA	Mordellidae	*Gn sp*	6			3	1			1	1		
COLEOPTERA	Scarabaeidae	*?Byrromorpha sp.*	1					1					
COLEOPTERA	Scarabaeidae	*Heteronyx sp.*	1						1				
COLEOPTERA	Staphylinidae	*Gn sp*	3								2		1
COLEOPTERA	Tenebrionidae	*Brises caraboides*	2			1						1	
COLEOPTERA	Tenebrionidae	*Caedius sp.*	2					1					1
COLEOPTERA	Tenebrionidae	*Caedius sphaeroides*	1					1					
COLEOPTERA	Tenebrionidae	*Celibe small*	1		1								
COLEOPTERA	Tenebrionidae	*Chalcopteroides purpureus*	1					1					
COLEOPTERA	Tenebrionidae	*Helea castor*	2							1	1		
COLEOPTERA	Tenebrionidae	*Helea monilifera*	1				1						
COLEOPTERA	Tenebrionidae	*Hypaulax sp.*	1					1					
COLEOPTERA	Tenebrionidae	*Pteroheleus granulatus*	1			1							
COLLEMBOLA	Entomobryidae	*Gn sp*	10	1	3	2	1	1	1				1
COLLEMBOLA	Family	*Gn sp*	3			2		1					
COLLEMBOLA	Poduroidea	*Gn sp*	1	1									
COLLEMBOLA	Sminthuridae	*Gn sp*	22	1	3	7	1	1	1	1	3	1	3
DERMAPTERA	Labiduridae	*Gn sp*	1										1
DIPTERA	Asilidae	*Gn sp*	2			2							
DIPTERA	Calliphoridae	*Calliphora sp.*	1			1							
DIPTERA	Calliphoridae	*Gn sp*	1							1			
DIPTERA	Cecidomyidae	*Gn sp*	2								1		1
DIPTERA	Chironomidae	*Gn sp*	1				1						
DIPTERA	Chloropidae	*Gn sp*	8	1	2	1		1	1		1		1
DIPTERA	Phoridae	*Gn sp*	25	1	3	10	2	1	1	1	3	1	2
DIPTERA	Sarcophagidae	*Gn sp*	1			1							
DIPTERA	Sarcophagidae	*larva*	1							1			
DIPTERA	Sarcophagidae	*Sarcophaga sp*	12			5	1		1	1	2		2
DIPTERA	Sciaridae	*Gn sp*	1	1									
DIPTERA	Syrphidae	*Melangyna sp*	1			1							
DIPTERA	Tachinidae	*Gn sp*	1										1
EMBIOPTERA	Family	*Gn sp*	1								1		
HEMIPTERA	Cicadidae	*Gn sp*	2	1		1							
HEMIPTERA	Coreidae	*Leptocoris sp.*	1				1						
HEMIPTERA	Cydnidae	*Adrisa sp.*	2					1			1		
HEMIPTERA	Family	*Cuprascula sp. near*	1		1								
HEMIPTERA	Family	*Gn sp*	2	1		1							
HEMIPTERA	Family	*juvenile*	4	1	1		1						1
HEMIPTERA	Jassidae	*Gn sp*	6		2	1	1	1					1
HEMIPTERA	Lygaeidae	*Dieuches sp.*	3			1					1		1
HEMIPTERA	Pentatomidae	*Boocoris rufiformis*	1			1							
HEMIPTERA	Pentatomidae	*Boocoris sp.*	6			4	2						
HEMIPTERA	Pentatomidae	*Gn sp*	1			1							
HEMIPTERA	Pentatomidae	*juvenile*	1						1				
HEMIPTERA	Pentatomidae	*Morbora schoutedeni*	1										1
HEMIPTERA	Pentatomidae	*Oechalia sp.*	1			1							
HEMIPTERA	Reduviidae	*?Coranus sp.*	1					1					
HEMIPTERA	Reduviidae	*Coranus sp.*	2			1						1	
HEMIPTERA	Reduviidae	*Peirates sp.*	1										1

Order	Family	Genus species	Total collected	plain	sandy plain	stony plain	breakaway	drainage depression	dune crest	hill slope	stream channel	flood out	swamp
HYMENOPTERA	Anthophoridae	*Amegilla sp.*	1			1							
HYMENOPTERA	Apidae	*Amegilla sp.*	1					1					
HYMENOPTERA	Apidae	*Apis mellifera*	1									1	
HYMENOPTERA	Apoidea	*Native bee*	7			3	1				2		1
HYMENOPTERA	Eumenidae	*Gn sp*	1			1							
HYMENOPTERA	Family	*Gn sp*	15	1	3	4		1			2	1	3
HYMENOPTERA	Family	*tiny*	1			1							
HYMENOPTERA	Formicidae	*Camponotus sp.*	1	1									
HYMENOPTERA	Formicidae	*Myrmecia sp.*	1										1
HYMENOPTERA	Mutillidae	*Ephutomorpha black*	3	1			1	1					
HYMENOPTERA	Mutillidae	*Ephutomorpha smbrw*	1										1
HYMENOPTERA	Mutillidae	*Ephutomorpha sp.*	1			1							
HYMENOPTERA	Mutillidae	*Gn sp*	2			2							
HYMENOPTERA	Pompilidae	*Gn sp*	2			1							1
HYMENOPTERA	Sphecidae	*Gn sp*	1					1					
HYMENOPTERA	Sphecidae	*Prionyx sp.*	1			1							
HYMENOPTERA	Sphecidae	*Sphex sp.*	5			1				1	2	1	
HYMENOPTERA	Sphecidae	*Sphex sp. near*	3								1		2
HYMENOPTERA	Sphecidae near	*Gn sp*	1					1					
ISOPODA	Family	*Gn sp*	5		1	1					1	1	1
ISOPTERA	Family	*Gn sp*	5			3	1	1					
LEPIDOPTERA	Family	*larva*	1			1							
MANTODEA	Amorphoscellidae	*Paraoxypilinae Gn sp*	1								1		
MANTODEA	Amorphoscellidae	*Paraoxypilus sp.*	2				1						1
MANTODEA	Mantidae	*Gn sp*	2			1					1		
MANTODEA	Mantidae	*juvenile*	2			2							
ORTHOPTERA	Acrididae	*Apotropis sp.*	1				1						
ORTHOPTERA	Acrididae	*Austroicetes frater*	2			1		1					
ORTHOPTERA	Acrididae	*Beplessia sp.*	7			4	2				1		
ORTHOPTERA	Acrididae	*Buforania sp.*	11	1		7	2				1		
ORTHOPTERA	Acrididae	*Buforania sp. near Peakesia*	1			1							
ORTHOPTERA	Acrididae	*Buforania sp. Small*	1			1							
ORTHOPTERA	Acrididae	*Caledia captiva*	2			1							1
ORTHOPTERA	Acrididae	*Capraxa near*	1				1						
ORTHOPTERA	Acrididae	*Chortiocetes terminifera*	3			3							
ORTHOPTERA	Acrididae	*Cirphula sp.*	1			1							
ORTHOPTERA	Acrididae	*Cirphula sp. near*	2			1					1		
ORTHOPTERA	Acrididae	*Collitera sp. near*	1					1					
ORTHOPTERA	Acrididae	*Coryphistes sp*	4				1	1	1		1		
ORTHOPTERA	Acrididae	*Cratilopus sp.*	3			2					1		
ORTHOPTERA	Acrididae	*Cuprascula sp. near*	1	1									
ORTHOPTERA	Acrididae	*Desertaria sp. near*	1				1						
ORTHOPTERA	Acrididae	*dried*	1								1		
ORTHOPTERA	Acrididae	*Ecphantus quadrilobus*	3			1	1				1		
ORTHOPTERA	Acrididae	*Epallia sp.*	1				1						
ORTHOPTERA	Acrididae	*Froggattina australis*	1			1							
ORTHOPTERA	Acrididae	*Genus Nov 60 sp3*	1			1							
ORTHOPTERA	Acrididae	*Goniaea gumleaf*	2			1					1		
ORTHOPTERA	Acrididae	*Goniaea opomaloides*	2			1					1		
ORTHOPTERA	Acrididae	*Goniaea sp.*	2								1		1
ORTHOPTERA	Acrididae	*Goniaea sp. Pointed pronotum*	1	1									
ORTHOPTERA	Acrididae	*Goniaeoidea sp. near*	1			1							
ORTHOPTERA	Acrididae	*juvenile*	11	1	1	5	1	1			1		1
ORTHOPTERA	Acrididae	*Locusta migratoria*	1			1							
ORTHOPTERA	Acrididae	*Minyacris sp.*	3			2	1						

Order	Family	Genus species	Total collected	plain	sandy plain	stony plain	breakaway	drainage depression	dune crest	hill slope	stream channel	flood out	swamp
ORTHOPTERA	Acrididae	*Monistria sp.*	2			1				1			
ORTHOPTERA	Acrididae	*Peakesia hospita*	4			2			1				1
ORTHOPTERA	Acrididae	*Peakesia sp.*	3			2		1					
ORTHOPTERA	Acrididae	*Peakesia sp. near*	1						1				
ORTHOPTERA	Acrididae	*Peakesia straminea*	2			1					1		
ORTHOPTERA	Acrididae	*Peakesia vitripennis near*	1										1
ORTHOPTERA	Acrididae	*Perbellia near*	4	1		1					1		1
ORTHOPTERA	Acrididae	*Qualetta maculata*	3			2			1				
ORTHOPTERA	Acrididae	*Raniliella sp.*	6			5					1		
ORTHOPTERA	Acrididae	*Rhitzala near*	3			3							
ORTHOPTERA	Acrididae	*Stropis sp*	4			2	1			1			
ORTHOPTERA	Acrididae	*Tapesta sp.*	2			1							1
ORTHOPTERA	Acrididae	*Urnisa sp.*	6			3	1	1			1		
ORTHOPTERA	Acrididae	*Urnisa sp. near*	1						1				
ORTHOPTERA	Acrididae	*Urnisella sp.*	3	1		1			1				
ORTHOPTERA	Eumastacidae	*Gn sp*	6			4	1		1				
ORTHOPTERA	Eumastacidae	*large*	1		1								
ORTHOPTERA	Gryllacrididae	*Hadrogryllacris sp.*	2			1	1						
ORTHOPTERA	Gryllacrididae	*Hadrogryllacris sp. Orange*	1			1							
ORTHOPTERA	Gryllacrididae	*large orange*	2			2							
ORTHOPTERA	Gryllacrididae	*Paragryllacris sp.*	1				1						
ORTHOPTERA	Gryllidae	*Acheta sp.*	5			3					1		1
ORTHOPTERA	Gryllidae	*Artiella sp.*	1								1		
ORTHOPTERA	Gryllidae	*Birubia sp.*	9			4		1		1	1		2
ORTHOPTERA	Gryllidae	*Comidogryllus sp.*	2			2							
ORTHOPTERA	Gryllidae	*Endacusta sp.*	5		1	2					1		1
ORTHOPTERA	Gryllidae	*Eurygryllodes ?wilrindri*	1			1							
ORTHOPTERA	Gryllidae	*Eurygryllodes sp.*	2	1									1
ORTHOPTERA	Gryllidae	*juvenile*	12		1	5	2			1	1	1	1
ORTHOPTERA	Gryllidae	*Lebinthus sp.*	1				1						
ORTHOPTERA	Gryllidae	*Lepidogryllus sp.*	2										2
ORTHOPTERA	Pyrgomorphidae	*Monistria sp.*	5			3	2						
ORTHOPTERA	Tetrigidae	*Gn sp*	1										1
ORTHOPTERA	Tettigoniidae	*Caedicia sp.*	1						1				
ORTHOPTERA	Tettigoniidae	*Hemisaga sp.*	1			1							
PHASMATODEA	Phasmatidae	*Acrophylla sp.*	1							1			
PHASMATODEA	Phasmatidae	*Gn sp*	1		1								
PHASMATODEA	Phasmatidae	*juvenile*	1			1							
PSEUDOSCORPIONIDA	Family	*Gn sp*	5			3					2		
PSOCOPTERA	Family	*Gn sp*	2	1							1		
SCORPIONIDA	Family	*Gn sp*	2			1					1		
THYSANOPTERA	Family	*black*	1			1							
THYSANOPTERA	Family	*Gn sp*	5		1	1		1		1			1
THYSANURA	Lepismatidae	*Gn sp*	14		2	7	1			1	1	1	1

Appendix 10.

The number of each insect taxa collected (at the levels identified) for the variety of structural vegetation types at sites sampled during the survey.

Order	Family	Genus species	Total collected	Low Open Forest	Low Open Shrubland	Low Shrubland	Low Very Open Shrubland	Low Woodland	Open Shrubland	Open Woodland	Shrubland	Tall Open Shrubland	Very Low Open Woodland	Very Low Woodland	Very Open (Tussock) Grassland	Very Open Mallee	Woodland
Acarina	Anystidae	*Tarsotomus sp.*	13	1	1		2	3	2		1		1	2			
Acarina	Caeculidae	*black leg*	3					2					1				
Acarina	Erythraeidae	*Gn sp*	17	1	1	1	1	4	2		1		2	1		1	1
Acarina	Family	*Gn sp*	5				1	2	1				1				
Acarina	Oribatidae	*Gn sp*	1		1												
BLATTODEA	Blaberidae	*Calolampra sp.*	3					2									1
BLATTODEA	Blattellidae	*Gn sp*	1					1									
BLATTODEA	Blattellidae	*Robshelfordia sp.*	1					1									
BLATTODEA	Blattidae	*Anamesia sp.*	1			1											
BLATTODEA	Blattidae	*Euzosteria sp.*	1						1								
BLATTODEA	Blattidae	*orange*	1					1									
BLATTODEA	Blattidae	*Periplaneta sp. near*	1												1		
BLATTODEA	Blattidae	*Platyzosteria blk*	1				1										
BLATTODEA	Blattidae	*Platyzosteria blk-smooth*	1		1												
BLATTODEA	Blattidae	*Platyzosteria orange*	3		1								1				
BLATTODEA	Blattidae	*Platyzosteria sp.*	2						1					1			
BLATTODEA	Blattidae	*Platyzosteria sp. brw*	1										1				
BLATTODEA	Blattidae	*Platyzosteria sp. lg blk*	2												1	1	
CHILOPODA	Family	*Gn sp*	5			1		1	1							1	1
CHILOPODA	Scolopendridae	*Gn sp*	2				1	1									
CHILOPODA	Scutigeridae	*Scutigera sp.*	1							1							
COLEOPTERA	Anthicidae	*Formicomus sp.*	1					1									
COLEOPTERA	Brentidae	*Gn sp*	1														
COLEOPTERA	Carabidae	*Arthropterus sp.*	1			1											
COLEOPTERA	Carabidae	*Carenum sp black*	2					2									
COLEOPTERA	Carabidae	*Chlaenius australis*	1	1													
COLEOPTERA	Carabidae	*Geoscaptus sp*	2						1		1						
COLEOPTERA	Carabidae	*Gigadema small*	2				1										
COLEOPTERA	Carabidae	*Gn sp. tiny*	1	1													
COLEOPTERA	Carabidae	*larva*	4		1					1					1	1	
COLEOPTERA	Carabidae	*Megacephala cylindricus*	1				1										
COLEOPTERA	Carabidae	*Neocarenum sp.*	1					1									
COLEOPTERA	Carabidae	*Notagonum sp.*	3			1	1			1							
COLEOPTERA	Carabidae	*Phorticosomus sp*	2					1							1		
COLEOPTERA	Carabidae	*Phorticosomus sp blaklarg*	1					1									
COLEOPTERA	Carabidae	*Phorticosomus sp brwmed*	2					2									
COLEOPTERA	Carabidae	*Phorticosomus sp brwsm*	1					1									
COLEOPTERA	Carabidae	*Phorticosomus sp. near*	1														
COLEOPTERA	Carabidae	*Promecoderus sp.*	1														
COLEOPTERA	Carabidae	*Pteroheleus sp.*	1						1								
COLEOPTERA	Carabidae	*tiny*	1											1			
COLEOPTERA	Cerambycidae	*Corrhenes ?picta*	1				1										
COLEOPTERA	Chrysomelidae	*Gn sp*	1	1													
COLEOPTERA	Chrysomelidae	*larva*	1					1									
COLEOPTERA	Chrysomelidae	*Paropsis brown sp.*	2					1					1				
COLEOPTERA	Chrysomelidae	*Paropsis sp.*	1					1									
COLEOPTERA	Cleridae	*?Phlogistus sp.*	1			1											
COLEOPTERA	Cleridae	*Gn sp*	1		1												
COLEOPTERA	Curculionidae	*Amycterinae Gn. sp.*	1							1							
COLEOPTERA	Curculionidae	*Cubicorhynchus sp.*	1				1										
COLEOPTERA	Curculionidae	*Eleagyna humeralis near*	2														1
COLEOPTERA	Curculionidae	*Gn sp*	3				1						1	1			
COLEOPTERA	Curculionidae	*Molochtus sp.*	1					1									
COLEOPTERA	Curculionidae	*Sitona sp. near*	1				1										
COLEOPTERA	Family	*Gn sp*	2							1						1	
COLEOPTERA	Family	*larva*	2				1	1									
COLEOPTERA	Family	*tiny*	6			1	1	1	1								1
COLEOPTERA	Mordellidae	*Gn sp*	6		1		2		2				1				

Order	Family	Genus species	Total collected	Low Open Forest	Low Open Shrubland	Low Shrubland	Low Very Open Shrubland	Low Woodland	Open Shrubland	Open Woodland	Shrubland	Tall Open Shrubland	Very Low Open Woodland	Very Low Woodland	Very Open (Tussock) Grassland	Very Open Mallee	Woodland
COLEOPTERA	Scarabaeidae	*?Byrromorpha sp.*	1					1									
COLEOPTERA	Scarabaeidae	*Heteronyx sp.*	1					1									
COLEOPTERA	Staphylinidae	*Gn sp*	3		1						1					1	
COLEOPTERA	Tenebrionidae	*Brises caraboides*	2				1			1							
COLEOPTERA	Tenebrionidae	*Caedius sp.*	2					1	1								
COLEOPTERA	Tenebrionidae	*Caedius sphaeroides*	1					1									
COLEOPTERA	Tenebrionidae	*Celibe small*	1											1			
COLEOPTERA	Tenebrionidae	*Chalcopteroides purpureus*	1					1									
COLEOPTERA	Tenebrionidae	*Helea castor*	2										1			1	
COLEOPTERA	Tenebrionidae	*Helea monilifera*	1									1					
COLEOPTERA	Tenebrionidae	*Hypaulax sp.*	1					1									
COLEOPTERA	Tenebrionidae	*Pteroheleus granulatus*	1			1											
COLLEMBOLA	Entomobryidae	*Gn sp*	10				1	3	2				1	2			
COLLEMBOLA	Family	*Gn sp*	3				1	1									
COLLEMBOLA	Poduroidea	*Gn sp*	1										1				
COLLEMBOLA	Sminthuridae	*Gn sp*	22	1	2	1	3	3	2	1	1		2	2	1	1	1
DERMAPTERA	Labiduridae	*Gn sp*	1	1													
DIPTERA	Asilidae	*Gn sp*	2		1				1								
DIPTERA	Calliphoridae	*Calliphora sp.*	1			1											
DIPTERA	Calliphoridae	*Gn sp*	1										1				
DIPTERA	Cecidomyidae	*Gn sp*	2								1						1
DIPTERA	Chironomidae	*Gn sp*	1									1					
DIPTERA	Chloropidae	*Gn sp*	8	1		1		2					1	2			1
DIPTERA	Phoridae	*Gn sp*	25	1	2	2	2	4	4	1			2	3	1	1	1
DIPTERA	Sarcophagidae	*Gn sp*	1														
DIPTERA	Sarcophagidae	*larva*	1										1				
DIPTERA	Sarcophagidae	*Sarcophaga sp*	12	1	1	1	1	2	3				1		1		1
DIPTERA	Sciaridae	*Gn sp*	1										1				
DIPTERA	Syrphidae	*Melangyna sp*	1					1									
DIPTERA	Tachinidae	*Gn sp*	1	1													
EMBIOPTERA	Family	*Gn sp*	1		1												
HEMIPTERA	Cicadidae	*Gn sp*	2				1						1				
HEMIPTERA	Coreidae	*Leptocoris sp.*	1									1					
HEMIPTERA	Cydnidae	*Adrisa sp.*	2					1								1	
HEMIPTERA	Family	*Cuprascula sp. near*	1					1									
HEMIPTERA	Family	*Gn sp*	2		1								1				
HEMIPTERA	Family	*juvenile*	4	1					1				1	1			
HEMIPTERA	Jassidae	*Gn sp*	6					1	2					3			
HEMIPTERA	Lygaeidae	*Dieuches sp.*	3	1													1
HEMIPTERA	Pentatomidae	*Boocoris rufiformis*	1				1										
HEMIPTERA	Pentatomidae	*Boocoris sp.*	6			1	1		2					1			
HEMIPTERA	Pentatomidae	*Gn sp*	1				1										
HEMIPTERA	Pentatomidae	*juvenile*	1					1									
HEMIPTERA	Pentatomidae	*Morbora schoutedeni*	1	1													
HEMIPTERA	Pentatomidae	*Oechalia sp.*	1					1									
HEMIPTERA	Reduviidae	*?Coranus sp.*	1					1									
HEMIPTERA	Reduviidae	*Coranus sp.*	2				1			1							
HEMIPTERA	Reduviidae	*Peirates sp.*	1	1													
HYMENOPTERA	Anthophoridae	*Amegilla sp.*	1			1											
HYMENOPTERA	Apidae	*Amegilla sp.*	1					1									
HYMENOPTERA	Apidae	*Apis mellifera*	1							1							
HYMENOPTERA	Apoidea	*Native bee*	7	1	1	2			1						1	1	
HYMENOPTERA	Eumenidae	*Gn sp*	1			1											
HYMENOPTERA	Family	*Gn sp*	15	1	1	2		2	2	1	1		1	2	1	1	
HYMENOPTERA	Family	*tiny*	1					1									
HYMENOPTERA	Formicidae	*Camponotus sp.*	1										1				
HYMENOPTERA	Formicidae	*Myrmecia sp.*	1	1													
HYMENOPTERA	Mutillidae	*Ephutomorpha black*	3					1				1	1				
HYMENOPTERA	Mutillidae	*Ephutomorpha smbrw*	1	1													
HYMENOPTERA	Mutillidae	*Ephutomorpha sp.*	1				1										
HYMENOPTERA	Mutillidae	*Gn sp*	2			1									1		
HYMENOPTERA	Pompilidae	*Gn sp*	2								1						

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HYMENOPTERA	Sphecidae	*Gn sp*	1					1								
HYMENOPTERA	Sphecidae	*Prionyx sp.*	1													
HYMENOPTERA	Sphecidae	*Sphex sp.*	5		1	1				1			1			1
HYMENOPTERA	Sphecidae	*Sphex sp. near*	3	1							1					1
HYMENOPTERA	Sphecidae near	*Gn sp*	1					1								
ISOPODA	Family	*Gn sp*	5	1				1		1					1	1
ISOPTERA	Family	*Gn sp*	5			2		1	1							
LEPIDOPTERA	Family	*larva*	1			1										
MANTODEA	Amorphoscellidae	*Paraoxypilinae Gn sp*	1													1
MANTODEA	Amorphoscellidae	*Paraoxypilus sp.*	2						2							
MANTODEA	Mantidae	*Gn sp*	2		1										1	
MANTODEA	Mantidae	*juvenile*	2			1		1								
ORTHOPTERA	Acrididae	*Apotropis sp.*	1									1				
ORTHOPTERA	Acrididae	*Austroicetes frater*	2			1		1								
ORTHOPTERA	Acrididae	*Beplessia sp.*	7		1	1	3		1					1		
ORTHOPTERA	Acrididae	*Buforania sp.*	11		2	1	2	1	2				1	1		
ORTHOPTERA	Acrididae	*Buforania sp. near Peakesia*	1			1										
ORTHOPTERA	Acrididae	*Buforania sp. Small*	1				1									
ORTHOPTERA	Acrididae	*Caledia captiva*	2	1			1									
ORTHOPTERA	Acrididae	*Capraxa near*	1						1							
ORTHOPTERA	Acrididae	*Chortiocetes terminifera*	3				2									
ORTHOPTERA	Acrididae	*Cirphula sp.*	1				1									
ORTHOPTERA	Acrididae	*Cirphula sp. near*	2		1		1									
ORTHOPTERA	Acrididae	*Collitera sp. near*	1					1								
ORTHOPTERA	Acrididae	*Coryphistes sp*	4					2	1							1
ORTHOPTERA	Acrididae	*Cratilopus sp.*	3		1										1	1
ORTHOPTERA	Acrididae	*Cuprascula sp. near*	1										1			
ORTHOPTERA	Acrididae	*Desertaria sp. near*	1									1				
ORTHOPTERA	Acrididae	*dried*	1													1
ORTHOPTERA	Acrididae	*Ecphantus quadrilobus*	3		1		1					1				
ORTHOPTERA	Acrididae	*Epallia sp.*	1						1							
ORTHOPTERA	Acrididae	*Froggattina australis*	1													
ORTHOPTERA	Acrididae	*Genus Nov 60 sp3*	1													
ORTHOPTERA	Acrididae	*Goniaea gumleaf*	2			1										1
ORTHOPTERA	Acrididae	*Goniaea opomaloides*	2				1									1
ORTHOPTERA	Acrididae	*Goniaea sp.*	2						1							1
ORTHOPTERA	Acrididae	*Goniaea sp. Pointed pronotum*	1										1			
ORTHOPTERA	Acrididae	*Goniaeoidea sp. near*	1				1									
ORTHOPTERA	Acrididae	*juvenile*	11	1		1	1	2	2				1		1	1
ORTHOPTERA	Acrididae	*Locusta migratoria*	1													
ORTHOPTERA	Acrididae	*Minyacris sp.*	3				1		1						1	
ORTHOPTERA	Acrididae	*Monistria sp.*	2				1						1			
ORTHOPTERA	Acrididae	*Peakesia hospita*	4			1	1	1	1							
ORTHOPTERA	Acrididae	*Peakesia sp.*	3			1	1	1								
ORTHOPTERA	Acrididae	*Peakesia sp. near*	1					1								
ORTHOPTERA	Acrididae	*Peakesia straminea*	2		1	1										
ORTHOPTERA	Acrididae	*Peakesia vitripennis near*	1						1							
ORTHOPTERA	Acrididae	*Perbellia near*	4	1	1				1				1			
ORTHOPTERA	Acrididae	*Qualetta maculata*	3		1		1	1								
ORTHOPTERA	Acrididae	*Raniliella sp.*	6		2	2	1		1							
ORTHOPTERA	Acrididae	*Rhitzala near*	3			1	1								1	
ORTHOPTERA	Acrididae	*Stropis sp*	4				1		1				1			
ORTHOPTERA	Acrididae	*Tapesta sp.*	2						1							
ORTHOPTERA	Acrididae	*Urnisa sp.*	6				1	2	1							1
ORTHOPTERA	Acrididae	*Urnisa sp. near*	1					1								
ORTHOPTERA	Acrididae	*Urnisella sp.*	3					1					1			
ORTHOPTERA	Eumastacidae	*Gn sp*	6			1	1	2						1		
ORTHOPTERA	Eumastacidae	*large*	1											1		
ORTHOPTERA	Gryllacrididae	*Hadrogryllacris sp.*	2						1					1		
ORTHOPTERA	Gryllacrididae	*Hadrogryllacris sp. Orange*	1												1	
ORTHOPTERA	Gryllacrididae	*large orange*	2		1										1	
ORTHOPTERA	Gryllacrididae	*Paragryllacris sp.*	1						1							

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ORTHOPTERA	Gryllidae	*Acheta sp.*	5		1		1		1						1	1
ORTHOPTERA	Gryllidae	*Artiella sp.*	1		1											
ORTHOPTERA	Gryllidae	*Birubia sp.*	9		1	1	2	1	1		1		1		1	
ORTHOPTERA	Gryllidae	*Comidogryllus sp.*	2				1								1	
ORTHOPTERA	Gryllidae	*Endacusta sp.*	5	1	1		1	2								
ORTHOPTERA	Gryllidae	*Eurygryllodes ?wilrindri*	1													
ORTHOPTERA	Gryllidae	*Eurygryllodes sp.*	2						1				1			
ORTHOPTERA	Gryllidae	*juvenile*	12		1	2			2	1	1		1	2	1	1
ORTHOPTERA	Gryllidae	*Lebinthus sp.*	1						1							
ORTHOPTERA	Gryllidae	*Lepidogryllus sp.*	2	1							1					
ORTHOPTERA	Pyrgomorphidae	*Monistria sp.*	5		1		1		1			1		1		
ORTHOPTERA	Tetrigidae	*Gn sp*	1	1												
ORTHOPTERA	Tettigoniidae	*Caedicia sp.*	1					1								
ORTHOPTERA	Tettigoniidae	*Hemisaga sp.*	1					1								
PHASMATODEA	Phasmatidae	*Acrophylla sp.*	1										1			
PHASMATODEA	Phasmatidae	*Gn sp*	1											1		
PHASMATODEA	Phasmatidae	*juvenile*	1			1										
PSEUDOSCORPIONIDA	Family	*Gn sp*	5		1	1	2									1
PSOCOPTERA	Family	*Gn sp*	2										1			
SCORPIONIDA	Family	*Gn sp*	2			1										
THYSANOPTERA	Family	*black*	1						1							
THYSANOPTERA	Family	*Gn sp*	5				1	1	1				1	1		
THYSANURA	Lepismatidae	*Gn sp*	14	1	2		3	1	2	1			1	1	1	