



Technical Report

A Native Vegetation Survey of the Burra Hills Region of South Australia

November
1995



Front cover photograph: View east to Porcupine Range, 1994

**A Native Vegetation Survey
of the
Burra Hills Region
of
South Australia**

R M Playfair

L M B Heard

November 1995

Geographic Analysis and Research Unit
Information & Data Analysis Branch
Planning Division

ISBN 0 7308 4908 2



DEPARTMENT OF HOUSING
AND URBAN DEVELOPMENT



CONTENTS	Page No.
LIST OF FIGURES	v
LIST OF TABLES	v
APPENDICES	v
SUMMARY	1
ACKNOWLEDGMENTS	3
1. INTRODUCTION	5
2. BACKGROUND	7
2.1 Background on Native Vegetation	8
2.2 Aims and Objectives	11
3. PROJECT METHODOLOGY	13
3.1 Pre Survey	13
3.1.1 Digital Topographic and Landcover Database Compilation	13
3.1.2 Site Selection	14
3.1.3 Landholder Contact	16
3.2 Field Survey	16
3.2.1 Field Data Collected	16
3.2.2 Survey Logistics	18
3.3 Post Survey	19
3.3.1 Plant Species Verification, Data Validation, Entry and Editing	19
4. SURVEY RESULTS	21
4.1 General	21
4.2 Plant Species of Conservation Significance	21
4.3 Floristic Communities	25
4.3.1 Mallee Communities	25
4.3.2 Woodland Communities	25
4.3.3 Shrublands	25
4.3.4 Grassland and Sedgeland Communities	26
4.4 Introduced Plants and Disturbance Indicators	26

5. CONCLUSIONS AND RECOMMENDATIONS	29
5.1 Further Work	29
5.2 Significant Species	29
REFERENCES	31

LIST OF FIGURES

Figure 1: Burra Hills Native Vegetation Survey Study Area.....	6
Figure 2: Burra Hills Native Vegetation Survey Sites.....	22

LIST OF TABLES

Table 1: Areas of the Different Landcover Types in the Study Area.....	14
Table 2: Data Collected During Field Survey.....	16
Table 3: Plant Species with Regional Conservation Significance Recorded on this Survey.....	23

APPENDICES

Appendix 1: Summary of Survey Sites with Percentage of Introduced Species Indicated.....	33
Appendix 2: List of Introduced Plant Species Recorded during the Burra Hills Vegetation Survey.....	39

SUMMARY

During October 1994 a native vegetation survey was conducted of the Burra Hills area using standard systematic and repeatable sampling techniques. This survey, partially funded by the National Estate Grants Program, is one in series of vegetation surveys being conducted across South Australia's Agricultural Regions to provide background data on the native vegetation as an integral part of the Biological Survey of South Australia and the Environmental Data Base of South Australia (EDBSA).

Baseline vegetation and physical data was collected from 145 sites across the 643,200 hectares of the study area extending from Eudunda to Terowie. A total of 4,138 plant species records were entered into the database of which 463 were unique plant species. Of the 463 unique species, 98 species were recorded as having regional conservation significance according to Lang & Kraehenbuehl (1994), 1 species was recorded as having national conservation significance (*Swainsona tephrotricha*) and 18 as having a state rating. It was also noted that 112 of the 463 plant species were introduced. A total of 1,754 individual plant specimens were collected, processed and lodged with the State Herbarium.

All spatial data, such as the digitised landcover boundaries, are stored and maintained on a geographical information system (Environmental Systems Research Institutes' [ESRI] ARC/INFO) while the textual (survey) data are stored and maintained in a relational database (ORACLE). Both the spatial and textual data, incorporated as part of the EDBSA, are maintained by the Information & Data Analysis Branch, Department of Housing and Urban Development.

ACKNOWLEDGMENTS

The Burra Hills Native Vegetation Survey was carried out with the assistance of funds made available by the Commonwealth of Australia under the National Estate Grants Program.

Involved in any large scale regional vegetation surveys are a large number of people who provide a variety of expertise and assistance. The Burra Hills Remnant Vegetation Survey is no exception. Thanks go to the survey teams whose diligent efforts produced an extensive dataset, and to a number of GAR Unit staff, particularly Bronwen Channon, Kate Graham and Sue Kenny for pre-survey and post-survey assistance. Special thanks also to Denzel Murfet, Rosemary Taplin, Peter Lang and Mike Hyde for their taxonomic expertise, botanical knowledge and patience. Sandy Kinnear and Jake Gillen, also deserve thanks as their previous documentation provided the basis of this report. Others who have greatly assisted include Doug Love for providing digitising support, Sally Wheldrake for assistance with the survey system database, Glenys Maeder and Mimma Voulgarakis for report formatting and Greg Wilkins for the figure production.

Thanks must also go to the National Estate Grants Program whose funding assistance made the project possible.

1. INTRODUCTION

The Burra Hills Native Vegetation Survey is one in a series of vegetation surveys being conducted in South Australia's Agricultural Regions to provide background inventory data on the native vegetation of each region. These surveys are an integral part of the Biological Survey of South Australia and the ongoing development of the South Australian Environmental Database, administered by the Department of Housing and Urban Development.

In 1993 funding was sought from the National Estate Grants Program (NEGP) for a native vegetation survey in the Burra Hills region of South Australia (SA) with the aim of providing some baseline data on the vegetation of the area. A secondary aim, following the recent rediscovery of Pygmy Bluetongue Lizards (*Tiliqua adelaidensis*) in the grasslands near Burra, was to collect more information about their habitat and distribution to assist the implementation of the recovery plan for this species.

Funding was received in mid 1994 and additional support was gained from the GAR Unit under the umbrella of consolidation of the Environmental Database of SA.

This survey contributes towards a comprehensive database of flora for the agricultural regions of South Australia and eventually the whole of the State. It links with the Mid-North Survey (1992), the South Olary Plains (1991) and Western Murray Flats Survey (1992).

As this survey follows on from other similar surveys (Mid North, South Olary Plains, Murray Mallee, South East, Yorke Peninsula & Western Murray Flats), the survey design was formulated so that data remains consistent and compatible with these surveys.

The survey area extends from Eudunda in the south to Yongala in the north, Riverton in the west to Ketchowla and Caroonna in the Olary Plains to the east (see Figure 1). The total area covered was 643,200 hectares (6,432 square km) across the Mid-North of South Australia and involved approximately ten 1:50,000 standard mapsheets (refer to Figure 1). The survey was undertaken in October 1994.

This report provides details of the survey.

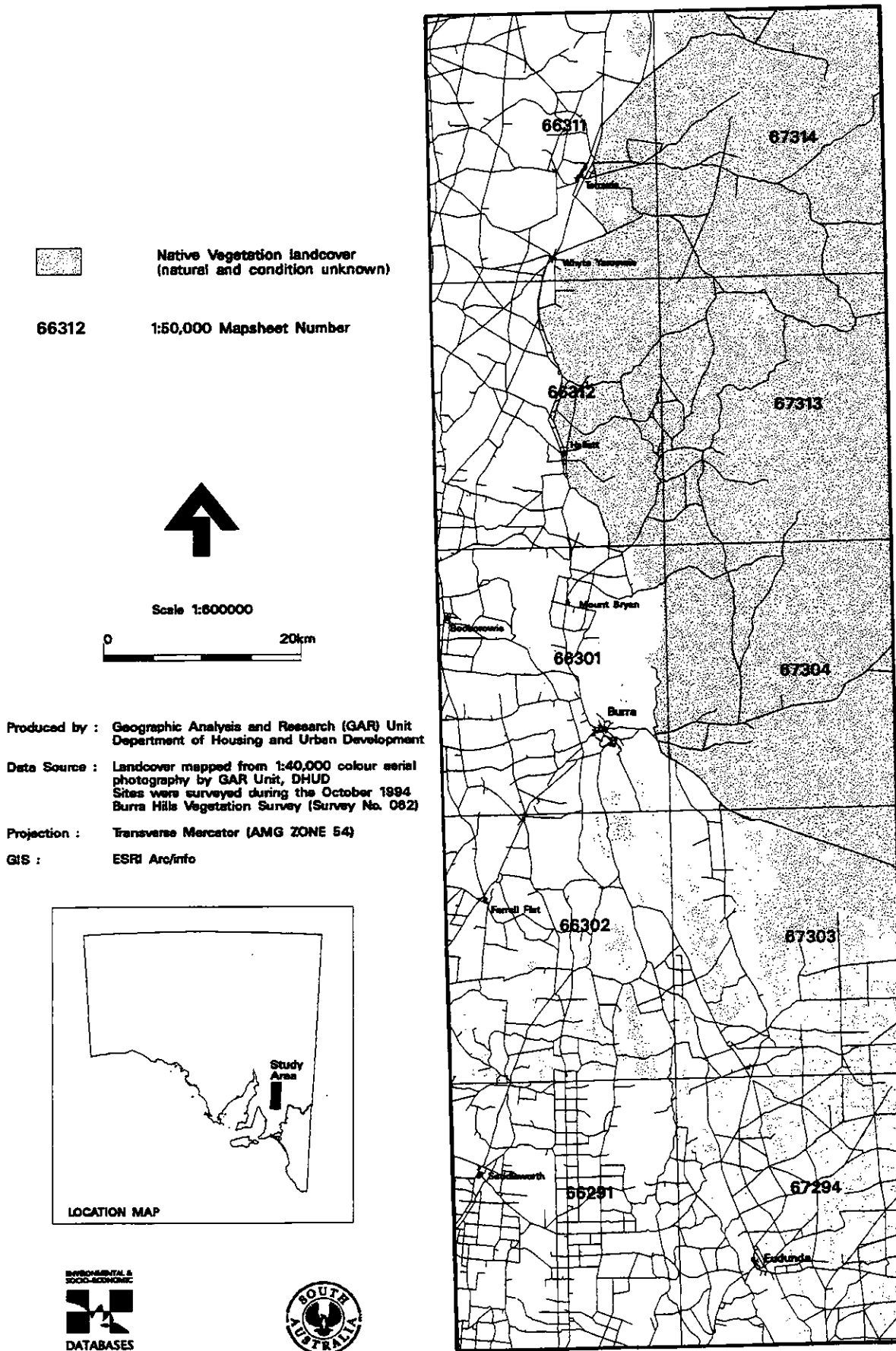


Figure 1: Burra Hills Native Vegetation Survey Study Area

2. BACKGROUND

The Department of Housing and Urban Development (DHUD), in conjunction with the Department of Environment and Natural Resources (DENR), has developed a vegetation mapping programme to assess and classify remnant native vegetation in the State's agricultural region. These surveys, which come under the umbrella of the Biological Survey of SA, have been carried out by the Biological Survey and Research Unit of DENR and the Geographic Analysis and Research Unit (GAR), of the Information & Data Analysis Branch of DHUD, with extensive support from other areas in these Departments.

The agricultural region is defined as the portion of South Australia not under Pastoral Lease. This region is characterised by a higher rainfall, more intensive agriculture and a fragmented landscape of easily recognisable areas of remaining native vegetation.

Assessment and classification of vegetation in the pastoral region is being conducted by the Pastoral Management Branch and the Biological Survey and Research Unit of DENR. These sections are systematically investigating the impacts of pastoral activities on the environment and conducting vegetation and vertebrate surveys in environmental provinces within the region.

Both vegetation assessment and mapping programmes are devised and coordinated by the Biological Survey Coordinating Committee (BSCC). The role of the BSCC is to ensure support is available to conduct a survey, enforce data collection standards, identify gaps in existing knowledge and to seek State and Federal government funds.

Data on native vegetation is fundamental to many of the Department's activities ranging from clearance assessment (under the Native Vegetation Act 1991), biological and environmental research for land management, conservation and wilderness assessment, environmental impact assessment, fire and weed control, land degradation and coastal management. All of these areas require, on an ongoing basis, varying degrees of information on the extent, quality and relative importance of remnant native vegetation.

The interest in native vegetation also extends widely outside DHUD and DENR. Many organisations require detailed information about native vegetation. These include:

- Landcare Groups, Trees for Life and Greening Australia, interested in seed sources, corridor establishment and optimising revegetation schemes to take advantage of existing remnants;
- organisations advising on catchment management schemes and salinity mitigation programmes;
- Primary Industries South Australia, investigating land rehabilitation options and links between soil types and native vegetation communities;
- Mines and Energy South Australia in assessing mining lease applications and suitable seed sources for rehabilitation;
- the Country Fire Service, in determining bushfire hazard and the associated ecological values of native vegetation; and
- corridor assessment being carried out by agencies including the Department of Transport, Telstra, Optus and ETSA.

In addition, many research and academic institutions require detailed information on remnant vegetation to conduct research into its management and the associated benefits. The value of such research is often intangible and rarely accounted for when surveys are costed.

The need to systematically collect quantitative and qualitative data on the remaining native vegetation was identified prior to the creation of the Native Vegetation Heritage Scheme (1980). Many attempts had been made to conduct such surveys, but the lack of available tools to store and process this information limited their usefulness.

The purchase of a geographic information system [GIS] in 1984 by the Environmental Survey Branch (now the Geographic Analysis and Research [GAR] Unit) changed this situation. This system enabled the storage and manipulation of data about locations, and provided a set of tools that could describe and plot relationships about features on the Earth's surface. This is essential for analysing the distribution of species and areas.

Since this time the GAR Unit, in conjunction with the Biological Survey and Research Unit (DENR), and under the auspices of the Biological Survey Coordinating Committee, have established data collection methods, data storage standards and data analysis techniques with an emphasis on preserving the original field data in digital form. This is to ensure that all the data are available for a range of different analysis techniques for any interested organisation. In addition, the survey data has facilitated the floristic mapping of remnant vegetation which now occurs using GIS techniques, resulting in a vegetation data layer.

The GAR Unit also represents the Environmental Node of South Australia's Land Information System. This role enables the collection and collation of many different data sets which relate to environmental and planning issues. The benefits of storing these data along with natural resource information means that it can be directly associated and plotted to reveal conflicts in land use, management policy and proposed developments.

2.1 Background on Native Vegetation

Historical Vegetation Records

The vegetation of the study area is determined largely by geographical features - topography, soil type, geology and climate. The nine major vegetation types in the region described in Jessup (1948) are:

***Eucalyptus leucoxylon* savannah woodlands**

This association occurs in the higher rainfall part of the survey area on the undulating to hilly parts between Burra and Riverton. Soil type is usually red-brown earth, sometimes shallow enough to be called skeletal. *Callitris preissii* occurs on the skeletal soils in the drier limits of this community. Shrubs and undershrubs are not generally a conspicuous feature. They may include *Bursaria spinosa*, *Acacia pycnantha*, *A. paradoxa*, *Pimelea glauca*, *Cryptandra amara*, *Acacia brachybotrya*, *Maireana brevifolia* and *Enchylaena tomentosa*, and are found in the drier parts. The ground layer contains many volunteer medics and clovers with the grasses. Native grasses are mainly *Stipa* spp. and *Danthonia* spp. with a variety of the introduced *Critesion* spp., *Bromus* spp. and *Avena* spp. Grasses.

***Eucalyptus oleosa* - *E. gracilis* woodlands**

This habitat is characterised by level to gently undulating low angle slopes on the depositional soil types in the north-eastern parts of the survey area. The density of the co-dominants varies considerably, and *Callitris preissii*, *C. glaucophylla*, *Pittosporum phylliraeoides* and *Alectryon oleifolius* are found occasionally in the tree layer. *Atriplex vesicaria*, *Maireana sedifolia*, *Zygophyllum* spp. and other chenopods are common in the low shrub layer. In low-lying parts where occasional inundation occurs, *Muehlenbeckia florulenta*, *Maireana aphylla* and *Chenopodium nitrariaceum* can be found. In the herbaceous layer, *Sclerolaena decurrens*, *Eriochiton sclerolaenoides*, *Zygophyllum ammophilum* and *Stipa* spp. are common. A wide range of herbaceous weed species are also found.

***Eucalyptus odorata* woodlands**

This association has limited distribution within the survey area and is restricted to the shaley hills running from Eudunda to the area just north of Robertstown. It occurs on brown solonised soils on the foothill plains and skeletal soils in the hills. Shrubs are quite prominent in this community, including *Acacia paradoxa*, *A. brachybotrya*, *A. pycnantha*, *Maireana brevifolia*, *Enchylaena tomentosa*, *Senna* spp. and *Bursaria spinosa*. *Stipa* spp. and *Danthonia* spp. dominate the sward, and in the drier areas, the spear grass is more prominent. Associated herbaceous species include *Erodium* spp., *Vittadinia* spp., *Critesion* spp. and *Avena* spp.

***Eucalyptus oleosa* - *E. brachycalyx* woodlands**

This association is found in the flat to undulating low hills in the south eastern part of the survey area south of Mount Bryan East on brown solonised soils. *E. gracilis* is commonly present as a co-dominant. Shrubs and undershrubs are conspicuous in portions of the habitat and practically absent elsewhere, depending on the density of the dominance. *Atriplex vesicaria* and *A. stipitata* are common. Other common shrub species are *Sclerolaena uniflora*, *Maireana brevifolia*, *M. tomentosa*, *Enchylaena tomentosa* and *Zygophyllum aurantiacum*. Dominant herbaceous plants are *Stipa variabilis*, *Schismus barbatus*, *Eriochiton sclerolaenoides*, *Atriplex campanulatum* and *Zygophyllum ammophilum*.

***Eucalyptus anceps* - *E. dumosa* woodlands**

Only a few remnants of this association remain, the majority having been cleared for cereal cropping. Even where the dominants have not been destroyed, intensive grazing has removed the associated species. The habitat is characterised by brown solonised soils on siltstone/greywacke low hills between Eudunda and Sutherlands. Occasional trees of *Myoporum platycarpum*, *Callitris preissii*, *Santalum* sp., *Pittosporum phylliraeoides* and *Alectryon oleifolius* occur. A wide variety of shrubs are found, including *Rhagodia parabolica*, *Acacia brachybotrya*, *Enchylaena tomentosa*, *Senna* spp., *Sclerolaena uniflora*, *Maireana brevifolia* and *Westringia rigida*. Dominant herbaceous species *Stipa variabilis* and *Schismus barbatus*. Other herbaceous species include *Medicago* spp., *Danthonia caespitosa*, *Erodium* spp. and numerous introduced weeds.

***Allocasuarina verticillata* open woodlands**

This association is restricted to the tillite hills near Eudunda in the south western part of the survey area. The habitat is characterised by rough hills with skeletal soils and resembles a grassland community with only scattered trees. Shrubs therefore are rare and less important ecologically. *Stipa variabilis* and *Danthonia caespitosa* dominate the sward. Associated species include *Erodium* spp., *Vittadinia* spp., *Critesion* spp. and *Avena* spp. A variety of medics also commonly occur.

***Eremophila* - *Dodonaea* - *Acacia* open shrublands**

This community is associated with the *E. oleosa* - *E. gracilis* community. The mallees are only found on the lower slopes of the hills and the valleys between the ridges. The hills themselves are almost entirely devoid of mallee, but carry shrublands in which the dominants are species of *Eremophila*, *Dodonaea* and *Acacia*. *Dodonaea lobulata*, *D. viscosa*, *Eremophila serrulata*, *E. alternifolia*, *Acacia calamifolia*, and *A. acinacea* are the dominant species. *Rhagodia parabolica* is also prominent. Commonly associated shrubs and undershrubs include *Sclerolaena uniflora*, *Ptilotus obovatus*, *Maireana brevifolia*, *Zygophyllum* sp. and *Acacia pycnantha*. Rocky outcrops are common, and in soil pockets, a wide variety of herbaceous species occur, including *Stipa variabilis*, *Erodium cygnorum*, *Danthonia caespitosa* and *Atriplex* sp.

***Myoporum platycarpum* - *Maireana sedifolia*/*Atriplex vesicaria* low shrublands**

This association occurs in the low rainfall plains on the north eastern boundary of the survey area. *M. platycarpum* occurs very sparsely as an emergent over an understorey of *Atriplex vesicaria* and *Maireana sedifolia*. *M. sedifolia* which replaces *A. vesicaria* in soils with neutral pH is more often the dominant. *M. pyramidata* also dominates some areas. Major ground cover species are *Stipa nitida* and *Sclerolaena patentiscuspis*. Drainage patterns in these plains have produced a complex mixture of erosional and depositional zones which appear to be the major factor determining plant distributions. Pastoral practices have also selectively altered plant densities and distributions in favour of less palatable species.

***Lomandra multiflora* ssp. *dura* grasslands**

This association has a conspicuous absence of trees, however historical evidence (Auhl & Marfleet 1975) does suggest that there were scattered trees over these grasslands on the skeletal shaley hills in the northern and western parts of the survey area. *L. multiflora* is more prominent on the hills than in the valleys, and historically this may also have been the case, with Wood (1937) commenting that *Lomandra* tussocks were generally quite sparse on the valley floors. It also appears that *Lomandra* is unable to regenerate at all after cultivation, and consequently the majority of the remnants are confined to the outcropping low hills which are too rocky for cereal cropping. The *Lomandra* is replaced by *Triodia* sp. and *Xanthorrhoea quadrangulata* on some hills south of Burra, and intensive pastoral use and attempts at cereal cropping in the 1800s has probably significantly altered the botanical composition. Shrubs and undershrubs are not a prominent feature, and the grasses *Stipa variabilis* and *Danthonia caespitosa* often dominate the sward.

2.2 Aims and Objectives

The Burra Hills Native Vegetation Survey, partially funded by the NEGP, the GAR Unit and supported by the Biological Survey Coordinating Committee had the following main aims :

- produce a digital coverage of the remnant vegetation patches coded according to the landcover type, which complies with established mapping standards;
- provide more information about Pygmy Bluetongue Lizard (*Tiliqua adelaidensis*) habitat and distribution in the grasslands near Burra to assist the implementation of the recovery plan for this species;
- provide site-based plant species lists along with supporting physical environmental information at a density suitable for cluster analysis into meaningful floristic groupings; and
- enable production of plant species distribution maps within and surrounding the region.

The overall aim of the remnant native vegetation survey programme in South Australia is to provide a baseline dataset on the composition, structure, relative importance, area, perimeter, tenure and degree of disturbance of all remnants in the agricultural region of South Australia within the framework of South Australia's Land Information System. After further analysis, this will subsequently allow the following objectives to be achieved:

- objectively classify vegetation communities and their status with respect to the reserve system and past clearance activities;
- objectively advise on the proclamation of reserves and wilderness areas;
- produce maps of potential seed sources for revegetation schemes;
- predict the distribution of rare and endangered species and associated communities;
- produce maps showing the most likely vegetation communities to have occurred prior to land clearance for revegetation schemes;
- produce maps showing remnants, drainage lines, road reserves and tenure for identifying optimum paths for establishing habitat corridors; and
- produce maps showing areas of high fire danger and those of ecological importance in terms of fire management.

3. PROJECT METHODOLOGY

The Burra Hills Survey followed the standards and survey methodology developed by previous surveys, which have been carried out under the auspices of the BSCC. The process falls into 3 major parts :

- Pre Survey Planning Organisation
- Field Survey
- Post Survey Database work and feedback

Statistical floristic analysis and vegetation mapping which usually occurs following regional surveys were not part of this project. This will be undertaken in the future when the datasets from this and adjoining areas have been amalgamated and a regional analysis can be done.

Specific details on project planning procedures, particularly for the survey process, can be found in the **Burra Hills Vegetation Survey Manual** compiled by DHUD for the survey.

3.1 Pre Survey

3.1.1 Digital Topographic and Landcover Database Compilation

Prior to the commencement of such a vegetation survey, it is necessary to compile a digital topographic and landcover database. This then provides the foundation for location of survey sites and accurate vegetation maps, based on colour aerial photography. To achieve this, a planimetric base must be produced, on which site localities and aerial photo interpretations will be recorded and digitised to establish appropriate digital coverages.

The planimetric base was produced with line features such as roads, railways, utility services (such as pipelines and transmission lines) and administrative boundaries digitised from Lands SA 1:50,000 standard mapping, with point features such as houses/sheds, quarries and watering points also digitised. Drainage details were also accessed. Landcover information, polygons, showing hardwood and softwood plantations, lakes and land subject to inundation, bare sand dunes and built-up areas were also digitised from Lands SA 1:50,000 maps where they were greater than one hectare in area. All the data were transformed to Australian Map Grid (AMG's) coordinates and plotted onto transparent mylar sheets at 1:40,000 scale, similar to the colour aerial photography. Using the aerial photography, natural vegetation landcover was then mapped manually onto the mylar bases. In cases where mapping already existed, changes or additions were completed onto these bases also. This mapping or updates were then digitised.

All topographical information was entered and coded using the Environmental Systems Research Institute's (ESRI) geographic information systems (GIS) software package ARC/INFO.

Table 1 provides a summary of the landcover types, area and percentage of the study area under each type.

Table 1: Areas Of The Different Landcover Types In The Study Area

Landcover Classification	Area (km²)	% Study Area
Vegetation		
- natural	317.637	4.938
- condition unknown (possibly modified)	511.399	7.950
- pastoral	1,830.678	28.459
Total	2,659.714	41.347
Wetlands		
- swamps	10.683	0.166
- perennial lakes	6.542	0.102
Total	17.225	0.268
Softwood Plantation	0.167	0.002
Hardwood Plantation	1.052	0.016
Built-up Area	0.995	0.015
Cleared Land	3,753.437	58.352
	6,432.591	100.00

3.1.2 Site Selection

In conjunction with the landcover mapping, a site based vegetation survey is necessary to provide accurate on-ground attribute data which can then be used to describe the variety of vegetation communities which occur across the region. As the native vegetation in the region has become fragmented, it was necessary to employ a stratified sampling strategy to select appropriate sites from which data could be collected and extrapolated.

Prior to site selection, a search and collation of literature was undertaken to assist in the various stages of the project. At the site selection stage the search targeted literature that provided an overview of the regional vegetation. References of particular assistance, at this stage, were Davies (1982), Specht (1972), Jessup (1948) and Laut et al. (1977). Data recorded for Heritage Agreements was also useful.

A further stratification technique referred to as "Gradsect" sampling by Gillison (1984) was also applied to provide as great a representation of the various vegetation types across the regional soil and land types. Prior to commencing the selection process, plots were produced indicating the locations of sites visited during other surveys (to avoid duplication of survey effort), and of environmental associations in the region. The environmental associations acted as a guide so that sites could be selected to represent the widest possible range of different land types.

Based on previous survey work, where 5 - 7 sites were surveyed per day per team, approximate calculations were made to estimate the number of sites to be selected per mapsheet, providing representative coverage within a physically possible time frame for the allotted survey period of one week. As a result, it was estimated that between 10-12 sites could be selected per mapsheet, hence a total of 180 - 200.

Site selection was carried out using 1:40,000 scale colour aerial photography. Individual blocks of remnant vegetation were examined under a stereoscope, then sites (quadrats) were selected across the mapsheet to reflect north - south and east - west variations, and provide replication of vegetation types. A selection preference was made to choose sites that appeared to be in good condition (minimal disturbance), as perceived from the summer captured aerial photography, and that attempted to reflect the range of textural and tonal vegetation signatures that were observed. There appeared to be a human bias to select sites in the darker coloured tones, as these were perceived to be less disturbed. It was important to overcome this tendency, to avoid missing open woodland areas with native grassland understoreys which were characterised by a sparser overstorey and lighter colour tones. An effort was also made to sample areas of native grassland, the boundaries of which were often indistinct. On the aerial photography, these showed as even, mid-grey areas, and as subsequent survey work found, were sometimes confused with pastures and onion weed or thistle infested areas.

A site code system was designed to provide a unique and meaningful way to identify each site (quadrat), indicating the mapsheet it was on, the number of the remnant vegetation block to be visited on that sheet and the quadrat (site) within that particular block to be surveyed. For example, MON0202 indicated that the site was on the Mongolata mapsheet, it was in the second block of remnant vegetation to visit on that mapsheet, and it was the second site (quadrat) within that block to be surveyed. To make new sites, created in the course of the survey readily identifiable, a slight variation to the site selection naming system was used. The prefix by mapsheet name was still used and the team number and field sequence in which the site was recorded, made the numeric part of the code. For example BUR1A12, indicates the site is on the Burra mapsheet, surveyed by team 1A (survey week 1 and team A) and was the 12th site Team A had surveyed for that week.

During site selection, notes were made on the aerial photographs beside selected sites indicating the site code and what the site selector was attempting to direct the survey team to. This allowed essential communication between the site selector and survey team, giving the survey team the ability to make on-ground decisions regarding the best location to reflect the vegetation types, while also allowing the survey team the opportunity to add in further sites if necessary. This flexibility was essential.

Following the selection of sites, details associated with the site such as site code, hundred name and section number and comments about the sites were entered into INFO, the relational database associated with ARC/INFO. This tool was used to interrogate the data and to organise the logistics such as site allocation to survey teams, as well as to aid the landholder contact process.

A total of 185 sites were selected representing approximately 1 site per 34 square kilometres.

3.1.3 Landholder Contact

Using Hundred name and Section number, details on each site's ownership, such as landholder name, address and telephone number, were collated with the assistance of Local Councils, accessing their ratepayers' records, and the use of the Department of Environment and Natural Resources' LOTS system. These details were then used to send letters to landholders, providing details about the survey and requesting permission to survey sites on their land. The letter contact was followed by telephone contact with each landholder, where permission for access and access logistics were discussed. Telephone contact was also used extensively in the field to contact landholders to clarify access details. Public relations was handled through contact with the local media and interested parties such as Landcare Groups and Soil Conservation Boards. This initial information did elicit some calls from people wishing to have their patches of scrub surveyed. Wherever possible, these requests were met during site selection.

3.2 Field Survey

3.2.1 Field Data Collected

Each site (quadrat) consisted of a 30 x 30 m quadrat from which details of the vegetation and physical attributes were recorded. The dimensions of the quadrat could be altered to accommodate the vegetation type, such as a ridgeline or a swamp edge, however, it was important to attempt to maintain the quadrat area (ie. 90 x 10 m). Surveyors were asked to locate sites well within representative vegetation types so as to avoid ecotonal or disturbance effects from boundaries and to avoid gradations. In the pastoral areas in the eastern part of the study area, 50m X 50m quadrats were used because of the generally lower plant densities. The information collected at each site is listed below in Table 2.

Table 2: Data Collected During Field Survey

FIELD DATA COLLECTED		
1.	*	Site number
2.	*	Observer(s)
3.	*	Survey date
4.	*	Field sequence (week, group, sequence of site surveyed in the field)
5.		Hundred
6.		Section
7.		Property
8.		Owners
9.		Mapsheet number
10.		Mapsheet name
11.	*	Amg zone
12.	*	Easting
13.	*	Northing
14.	*	Altitude
15.	*	Reliability (accuracy of location)
16.	*	Quadrat size (if not 30 x 30 m)
17.		Environmental association
18.	*	Aerial survey/ photo number/ date
19.		East (measurement to pin prick in photo [mm] from western photo edge)
20.		North (measurement to pin prick in photo in [mm] from southern photo edge)

FIELD DATA COLLECTED	
21.	Site photo number
22.	Direction of photo (degrees)
23.	Location map (sketch of location) locations comments (directions to the site from local major features)
24.	* General landscape description
25.	Site landform pattern
26.	* Site landform element (type)
27.	* Site slope (degrees)
28.	* Site aspect (degrees)
29.	Outcrop cover and lithology
30.	* Surface strew form
31.	* Surface strew cover
32.	* Surface strew lithology
33.	Fire scars (y/n) last fire (year)
34.	Bare earth/litter estimate %
35.	Presence of erosion and comments
36.	Disturbance factors - for items of interest Power lines/bee hives/water points/fire breaks Remnant adjoins roadside vegetation/fence lines / rubbish dump/quarry pits/access tracks
37.	Vertebrate presence (presence/absence) Rabbits/kangaroos/goats/sheep/cattle/donkey/wombat/fox/emu/cat/horse/other
38.	* Surface soil texture class
39.	Climatic condition
40.	* Plant species name
41..	* Voucher number
42.	Lifeform(using Muir's' table)
43.	* Cover/abundance (adapted Braun-Blanquet measure)
44.	Life stages (flowering fruiting budding etc.)/comments
45.	Upper stratum age class (presence/absence of seedling, saplings, mature, senescent trees for dominant/codominant overstorey tree species)
46.	* Overstorey height (five estimates)
47.	* Crown depth (five estimates)
48.	* Canopy diameter (five estimates)
49.	* Gap (five estimates)
50.	* Canopy type %
51.	Structural summary of the vegetation
52.	* Vegetation association description (overstorey dominant species, structural description (using Muir's' table), emergents (if relevant) dominant shrub & ground species)
53.	Overall vegetation comments

* Considered to be essential for mapping and analysis and thus comprise the minimum data set.

Datasheets, incorporating the data attributes indicated above, were designed to reflect the logical flow of the information as best recorded in the field, to ease the survey effort while maintaining the highest degree of accuracy. To explain the datasheet layout and survey methodology/techniques, a survey manual was produced. The manual also provided definitions relating to aspects such as landform or cover/abundance categories as well as organisational aspects such as survey teams, accommodation details and overall survey schedules. Details of the survey methodology were also explained at a meeting of survey team members to clarify specifics. As a significant number of technique related problems only arise after a day in the field when each region's differences become apparent, some allowance was made for evening discussions to resolve these during the actual survey.

The general flow of data collection at a site is as follows. Initial observations of the general area in which the site has been selected are used to determine the most appropriate position for the site to be located while avoiding edge effects, gradations and physical disturbances. Generally the team then divides the tasks, with the most common way being one member concentrating on the location and physical aspects, while the other begins the botanically related aspects. Voucher specimens were required for each species encountered for the first time, and subsequently for any species which required clarification. The team member completing the physical aspects would usually take the site photograph and mark the site location on the aerial photograph. Once the physical data were collected, this team member would also take five estimates of each of the dominant and co-dominant overstorey attributes of height, canopy depth, canopy diameter, gap and canopy type. A two metre range pole was used as a guide for these estimations.

After this stage, the team members would join forces to complete the remaining plant species collection, vouchering and floristic assessment. The combination of both team members searching the quadrats for species resulted in a more complete assessment of the vegetation, as well as better efficiency in processing vouchered specimens. The collection of floristic data, in addition to a complete list of vascular plants included recording the plants' lifeform/height class according to the Muir's Table, a cover/abundance score (adapted from the Braun-Blanquet system) and an indication of the life stage of the plant.

To provide data relating to habitat assessment, an overall vegetation structural summary was completed working from the highest to lowest stratum. Canopy cover was estimated according to Muir's canopy cover categories for each lifeform/height class that was observed as a dominant strata. To complete the vegetation assessment, an overall qualitative vegetation description of the site was provided by the observers indicating the dominant/codominant overstorey species, the corresponding dominant lifeform and canopy cover, and the dominant understorey species. This subjective assessment, being particularly useful in the analysis stages, providing a generalised summary of each site's vegetation types, hence an overview of the regional vegetation types.

Any observations made regarding the state or condition of the vegetation, noting details of disturbance were recorded in the *Overall Comments* section of the vegetation datasheet.

3.2.2 Survey Logistics

The project area was only 150 km by 50 km, which made a single central base camp the most efficient way of minimising travelling time for the surveyors. The main purpose of centralising the group, was to enable all teams access to the survey plant taxonomists who provided advice on plant species identifications at the conclusion of each days surveying. This enhanced the accuracy and efficiency of the field work, as well as helping to maintain consistency in data collection.

Each team was allocated 1-2 x 1:50,000 mapsheets to survey depending on the number of selected sites per mapsheet and the travel distances.

The survey teams were equipped with full field kits containing all the necessary equipment for the survey, including an appropriate set of the allocated mapsheets and 1:40,000 colour aerial photographs with sites marked. Consumable items in the kits could be replenished from supplies at the base camp.

Each team's daily schedule involved surveying sites and checking blocks of vegetation, as allocated, from 7.30 am till approximately 6.00 pm (depending on daylight), followed by the evening tasks of clarifying plant identifications with the plant taxonomist, pressing voucher specimens, editing datasheets and planning the next days schedule. Telephone contact was made with landholders to clarify access and any other details required at this time.

3.3 Post Survey

3.3.1 Plant Species Verification, Data Validation, Entry and Editing

During the course of the survey, a plant taxonomist was present each evening to clarify plant identifications for all vouchered specimens. At the completion of the survey, these identifications were then verified by a taxonomist who was able to view the all the survey collections together and check any suspect identifications thoroughly. Final identifications could then be resolved and datasheets updated accordingly.

Following this intensive post survey plant verification process, datasheets were also checked for completeness and correctness of location and physical data, as well as vegetation information. A considerable effort was spent tracing through plant identifications via voucher numbers to correct identification inconsistencies. At this stage taxonomic and identification problems were recognised with some species. Discussions were held with Dr P Lang, the Flora System Manager, to resolve these difficulties before data entry. Vouchered specimens were all lodged at the State Herbarium.

Data collected from the survey were then entered into the Department's relational data base, Interbase, which was accessed via customised Powerhouse screens. The Powerhouse system contains a number of validation routines, to ensure that data is checked against valid lists electronically prior to being incorporated in the data base. This is essential for ensuring all species names are current and typed correctly. Codes used for many of the attributes collected, were similarly checked electronically by use of 'look up' tables.

To speed aspects of the data entry process and more importantly avoid typing errors, site codes, hundred and section numbers, mapsheets numbers, location details (AMG's & Lats/Longs) and environmental associations were globally loaded into the system at various stages. The majority of these data were available in INFO following the initial site selection. Following the survey, this data was corrected in INFO, where necessary. Location details were produced from points digitised from mylar overlays, the points having been marked onto the mylar from the pin pricked aerial photos.

On completion of the data entry phase, reports were produced detailing each sites data, in field datasheet order, to be checked against the original field copies. To aid this labour intensive, but essential editing process, frequencies were produced for all species, the number of species at a site and for species and lifeforms. Checks could be readily conducted to see that values were in the expected ranges, and if not, global updates performed to avoid typing errors.

Following the completion of all the data checks and editing, individual reports for each site were compiled consisting of details on locations, landform, vegetation association description and plants list with common name and cover abundance. Presence of vertebrates at the site was also listed. These reports were sent to all landholders where sites were surveyed thus providing feedback to all landholders. The site reports were accompanied by a letter detailing the limitations of the data collected. For example, that the data only reflects the species at one location during a specific season and is not a comprehensive listing for a whole block of native vegetation.

4. SURVEY RESULTS

4.1 General

At the conclusion of the Burra Hills Native Vegetation Survey, October 1994, 145 sites had been comprehensively surveyed throughout 643,200 ha in the study area. As result one survey site occurred on average every 4,370 ha across the whole region. Figure 2 indicates the location of sites across the study area.

This survey resulted in 4,138 plant species records being entered into the survey database, providing distribution and abundance data on 463 unique plant species recorded throughout that survey area. Of the total number of plant species records, 1,754 individual specimens were collected, which were examined during the plant species verification process and then lodged with the State Herbarium.

Overall, the field survey involved 6 days work for 6 teams of 2 people working approximately 12 hours per day. This equates to a survey effort of 860 hours, equivalent to one person working full time in the field for 72 days.

4.2 Plant Species of Conservation Significance

From the 463 unique plant species recorded by the survey, 98 species were recorded to have regional conservation significance ratings according to Lang & Kraehenbuehl (1994) *Plants of Particular Conservation Significance in SA's Agricultural Regions*, database version September 1994. This is only a very small percentage of the species which Lang & Kraehenbuehl (1994) record with conservation significance in the Northern Lofty and Murray Mallee regions, however, given that the survey was not targeting rare plant associations or areas where these may occur, this is not unexpected. Of the species recorded in this survey of regional significance, 1 species also has a national conservation significance rating (*Swainsona tephrotricha*) while 18 have a rating at the South Australian level. Table 3 lists the species of conservation significance, their ratings at the Regional and South Australian levels, and the frequency with which the species was recorded in the survey. The collection of *Swainsona tephrotricha*, recorded as rare at the Australian level, occurred at one location near Eudunda.

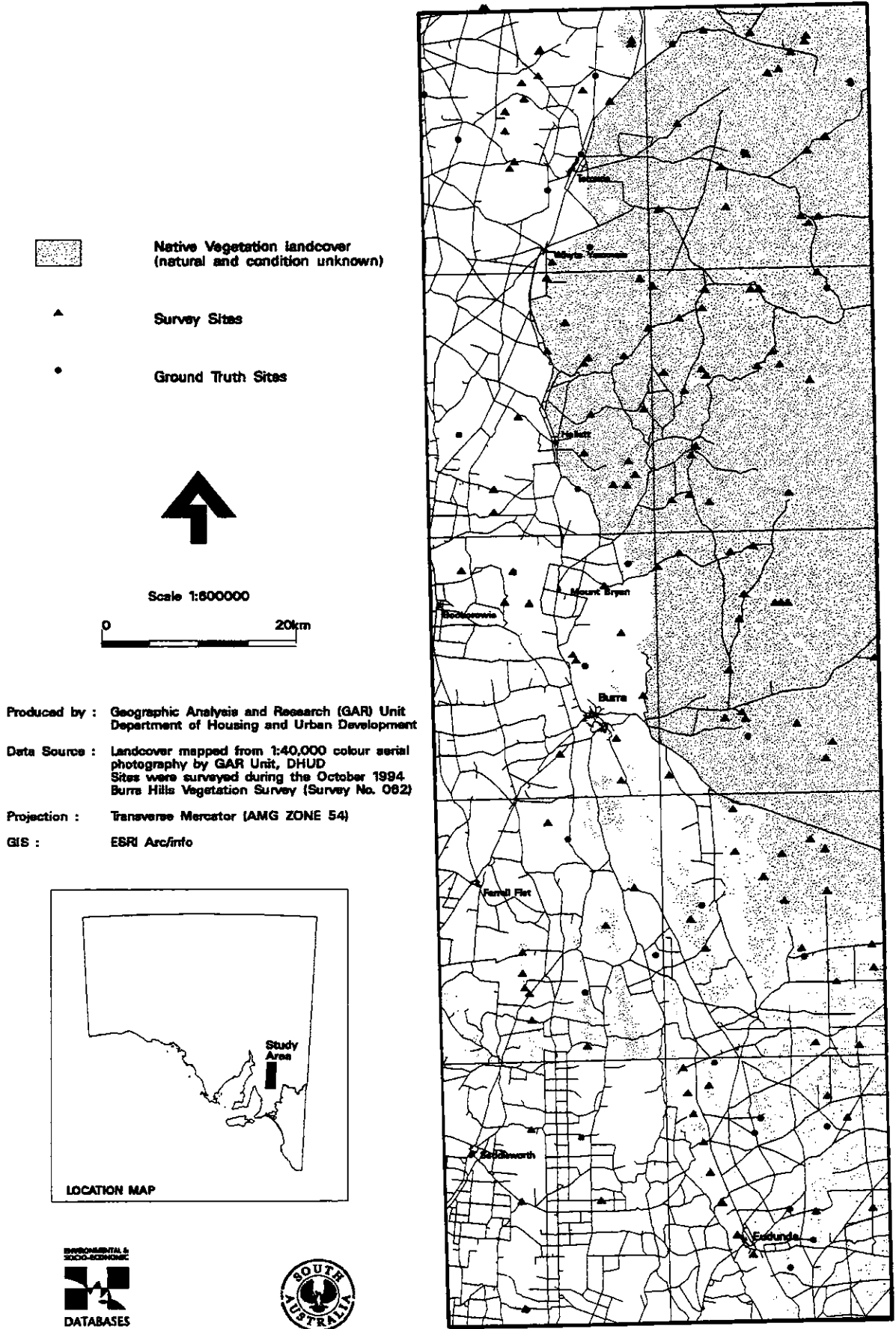


Figure 2: Burra Hills Native Vegetation Survey Sites

Table 3: Plant Species with Regional Conservation Significance Recorded on this Survey

Species	South Aust. Status	Murray Mallee Regional Status	Northern Lofty Regional Status	Number of Records from this Survey
<i>Abutilon fraseri</i>	N	K		2
<i>Acacia argyrophylla</i>	N		R	1
<i>Acacia victoriae</i> ssp.	N	R		3
<i>Alectryon oleifolius</i> ssp. <i>canescens</i>	N		U	8
<i>Apium prostratum</i> ssp. <i>prostratum</i> var. <i>prostratum</i>	N	K	K	1
<i>Aristida behriana</i>	N	R		37
<i>Arthropodium minus</i>	N	R	V	2
<i>Asplenium flabellifolium</i>	N	R	R	2
<i>Astroloma humifusum</i>	N		#	3
<i>Atriplex lindleyi</i> ssp. <i>inflata</i>	#		K	5
<i>Atriplex pumilio</i>	N	#	V	1
<i>Banksia marginata</i>	N	U	V	1
<i>Brachycome ciliaris</i> var. <i>lanuginosa</i>	N		X	1
<i>Brachycome ciliaris</i> var. <i>subintegrifolia</i>	N		K	2
<i>Brachycome exilis</i>	N	R	E	1
<i>Bromus arenarius</i>	N		X	1
<i>Bulbine bulbosa</i>	N	R		6
<i>Calandrinia volubilis</i>	U	K		1
<i>Calocephalus citreus</i>	U	V	U	11
<i>Cheilanthes distans</i>	N		R	1
<i>Cheilanthes lasiophylla</i>	N	U		1
<i>Cheilanthes sieberi</i> ssp. <i>sieberi</i>	N	K		1
<i>Chenopodium curvispicatum</i>	N		E	11
<i>Correa glabra</i>	N		R	1
<i>Craspedia glauca</i>	N	R	R	2
<i>Craspedia globosa</i>	V	E	E	2
<i>Cratystylis conocephala</i>	N		E	1
<i>Cryptandra amara</i> var. <i>longiflora</i>	R	K	R	7
<i>Cymbonotus preissianus</i>	U	K	R	3
<i>Cynoglossum suaveolens</i>	N	V	R	1
<i>Danthonia auriculata</i>	N	R	R	8
<i>Danthonia carphoides</i> var.	K	K	K	11
<i>Danthonia eriantha</i>	R	K	R	16
<i>Danthonia pilosa</i> var.	#	K	#	5
<i>Danthonia racemosa</i> var. <i>racemosa</i>	N	K	U	2
<i>Dichelachne crinita</i>	N	K	R	1
<i>Dissocarpus biflorus</i> var.	N	K	K	1
<i>Distichlis distichophylla</i>	N	U	K	1
<i>Dodonaea lobulata</i>	N	U	R	9
<i>Echinopogon ovatus</i> var. <i>ovatus</i>	R		R	1
<i>Elachanthus pusillus</i>	U	U	R	2
<i>Elymus scabrus</i> var. <i>scabrus</i>	N	R	U	12
<i>Enneapogon nigricans</i>	N		U	19
<i>Eremophila serrulata</i>	N			1
<i>Eriostemon angustifolius</i> ssp. <i>angustifolius</i>	R	R	R	1
<i>Euphorbia tannensis</i> ssp. <i>eremophila</i>	N		K	1
<i>Exocarpos cupressiformis</i>	N	K	U	1
<i>Goodenia blackiana</i>	N	R	R	2
<i>Goodenia pinnatifida</i>	#	U	#	37
<i>Hydrocotyle laxiflora</i>	N	K	U	3
<i>Hymenanchera dentata</i>	U	R	R	4
<i>Isolepis cernua</i>	N		R	1
<i>Kennedia prostrata</i>	N	U		2
<i>Lagenifera huegelii</i>	N	R	N	4
<i>Lepidium papillosum</i>	#	#	#	7
<i>Leptorhynchos squamatus</i>	N	R		15
<i>Leptorhynchos tetrachaetus</i>	U	K	U	4

Table 3: Continued

Species	South Aust. Status	Murray Mallee Regional Status	Northern Lofty Regional Status	Number of Records from this Survey
<i>Leptorhynchos waitzia</i>	N	K	E	1
<i>Linum marginale</i>	N	U	U	1
<i>Lomandra densiflora</i>	N	R		14
<i>Lomandra micrantha</i> ssp. <i>micrantha</i>	N	U	T	2
<i>Lomandra nana</i>	U	T	K	1
<i>Maireana aphylla</i>	N	R	V	13
<i>Maireana appressa</i>	N	U	V	1
<i>Maireana enchylaenoides</i>	N		U	47
<i>Maireana excavata</i>	K		E	8
<i>Maireana radiata</i>	N		#	8
<i>Maireana rohrlachii</i>	R	R	V	3
<i>Mimulus repens</i>	N		T	1
<i>Myoporum montanum</i>	N	N	#	4
<i>Myoporum platycarpum</i> ssp. <i>platycarpum</i>	N		#	9
<i>Olearia calcaria</i>	U	R	E	4
<i>Pleurosorus rutifolius</i>	N	R	U	3
<i>Poa crassicaudex</i>	N	U		9
<i>Podolepis tepperi</i>	N		R	2
<i>Prostanthera striatiflora</i>	N	R	X	2
<i>Pultenaea largiflorens</i>	N	K		1
<i>Rumex dumosus</i> var.	K	E	K	11
<i>Santalum acuminatum</i>	N	N	U	1
<i>Schoenoplectus pungens</i>	N	U	R	1
<i>Senecio odoratus</i> var. <i>odoratus</i>	N	T	U	1
<i>Spyridium parvifolium</i>	N	K	#	1
<i>Stenopetalum lineare</i>	N		R	5
<i>Stipa acrociliata</i>	N		K	9
<i>Stipa blackii</i>	N	T	N	38
<i>Stipa breviglumis</i>	R	E	R	1
<i>Stipa gibbosa</i>	T		T	4
<i>Stipa platychaeta</i>	N		R	5
<i>Stipa setacea</i>	R	K	R	5
<i>Swainsona tephrotricha</i>	R	E	T	1
<i>Teucrium racemosum</i>	N	U		2
<i>Teucrium sessiliflorum</i>	N	R		2
<i>Thysanotus baueri</i>	N		T	2
<i>Thysanotus tenellus</i>	R		R	1
<i>Triptilodiscus pygmaeus</i>	#	#	#	23
<i>Velleia paradoxa</i>	#	#	#	8
<i>Vittadinia blackii</i>	N	U	N	9
<i>Wilsonia rotundifolia</i>	N		E	1

Conservation Status Codes :

- X - Extinct - extinct or presumed extinct
E - Endangered - rare and in danger of becoming extinct
V - Vulnerable - rare and at risk of becoming endangered
T - Threatened - likely to be E or V but insufficient data is available
R - Rare - low overall frequency/confined to a restricted area/sparse
K - Uncertain - likely to be T or R but insufficient data is available
U - Uncommon - less common species of interest, but not rare enough to warrant special protection
N - Not Significant - common
- not yet assessed, but flagged as being of possible significance

Codes are defined in full in Lang & Kraehenbuehl (1994).

4.3 Floristic Communities

Appendix 1 lists the overstorey dominants and understorey at the surveyed sites. These data correlate fairly closely with the historical descriptions from Jessup (1948) described earlier in *Background on Native Vegetation* (Section 2.1). The following comments, highlighted by a minor examination of the raw data relate to these vegetation types.

4.3.1 Mallee Communities

- Most of the mallee communities surveyed (46 sites of the total 61 where *Eucalyptus* spp. were present) are dominated by *Eucalyptus brachycalyx* / *E. oleosa* / *E. gracilis* and *E. socialis* or any combination of these. Understorey usually contains chenopods, particularly *Atriplex vesicaria*, *A. stipitata*, *Maireana brevifolia*, *M. pyramidata*, *M. pentatropis* and *Enchylaena tomentosa*. *Zygophyllum aurantiacum* and *Stipa* spp. grasses are also quite common.
- *Eucalyptus porosa* was listed at 6 sites, quite widely spread, with an extremely variable understorey often containing larger shrubs such as *Acacia pycnantha*, *A. calamifolia*, *Senna* spp. as well as a range of chenopods and numerous grasses and herbs.
- Though during this survey, *Eucalyptus 'anceps'* and *E. dumosa* were not specifically sought, no sites visited contained either. In view of Jessup's comments in 1948, it may be that the few then remaining examples of this association no longer exist. A comprehensive search would be required to clarify this.

4.3.2 Woodland Communities

- *Allocasuarina verticillata* open woodlands were sampled at 8 sites, 7 of which were in the south western section, and most had a very sparse understorey, in concurrence with Jessup's description. However, at odds with this early description, this understorey contained *Xanthorrhoea quadrangulata* at 3 sites and *Lomandra* spp. at 3 sites, and 2 sites, EUD2501 and HAL1701 had very rich and diverse species lists (70 and 73 respectively).
- *Eucalyptus odorata* was listed at only 4 out of the 61 *Eucalyptus* dominated sites and had an understorey dominated by grasses, notably *Stipa blackii*, *Danthonia* spp. and a variety of introduced grasses.
- *Eucalyptus leucoxydon* dominated woodlands (at 1 site in association with *Allocasuarina verticillata*) were sampled at 5 locations in the south west and central west of the area with highly modified and variable understorey, often containing *Acacia pycnantha*, *A. paradoxa*, *Stipa* spp and *Lomandra* spp., numerous introduced grasses and herbs.

4.3.3 Shrublands

- Shrublands dominated by *Dodonaea lobulata*, *D. viscosa* often in association with *Senna artemisioides* spp. over *Stipa* spp. Onion weed, Ward's weed and Salvation Jane occur in the low hills and rises of the north eastern part of the survey area (5 sites).
- 4 types of Chenopod shrublands occur in the north and east of the region; *Maireana sedifolia* over *Stipa* spp., *Maireana pyramidata* ± *Atriplex vesicaria* over *Stipa* spp and *Medicago* spp. (sometimes with *Nitraria billardierei*), *Atriplex vesicaria* over *Stipa* spp. on low rises and plains, and *M. aphylla* over introduced grasses in slight depressions and areas subject to more run-on.

No examples of the *Myoporum platycarpum* - *Maireana sedifolia* / *Atriplex vesicaria* low shrublands were found during this survey, possibly because of the loose geographical boundaries described in Jessup (1948). An association containing these species has been described in the adjacent South Olary Plains regional survey (Forward unpublished).

4.3.4 Grassland and Sedgeland Communities

- *Lomandra multiflora* ssp. *dura* and *Lomandra effusa* often occur together in these remnant sedgelands, which did not contain *X. quadrangulata* at any of the surveyed sites. No examples of *Triodia* spp. were encountered at any site either. This suggests that there may have been a diversity decline over time in this vegetation type. Comprehensive grasslands studies are currently being undertaken in the region, which when read in conjunction with the available historical botanical information may clarify this.
- *Stipa nitida*, *S. nodosa*, *S. setacea* and *S. blackii* were listed as dominants at a number of sites and often in association with the *Lomandra* spp., suggesting that a *Stipa* sp. dominated grassland association may also exist in the region. These grasslands also contain high percentages of introduced species, indicating significant modification from the pre-European vegetation. This is likely to confuse the floristic analysis, particularly as the sample size for this vegetation type is small.
- 2 sites in the central west of the study area on low-lying areas with poor drainage, were dominated by *Juncus* spp. in association with *Cyperaceae* spp. and high percentages of introduced grasses and herbs.

4.4 Introduced Plants and Disturbance Indicators

Of the 463 unique plant species recorded by the survey, 112 species (24%) are introduced species. A list of the introduced species recorded during the survey is included as Appendix 2.

A cursory examination of the distribution of introduced species reveals some interesting statistics relating to the distribution of some weeds of agricultural significance.

- Brome grasses (*Bromus rubens*, *B. diandrus*, *B. hordeaceus*) - 61 sites, mostly in the southern half of the study area.
- Onion Weed (*Asphodelus fistulosus*) - 19 sites, all in the northern third of the study area.
- Barley Grass (*Critesion murinum* ssp.) - 13 sites, well spread over the entire area.
- Wild Oats (*Avena* sp.) - 55 sites, none on the 2 north-eastern mapsheets in the pastoral region.
- Ward's Weed (*Carrichtera annua*) - 12 sites, all in the eastern half (pastoral region).
- African Boxthorn (*Lycium ferrocissimum*) - 2 sites on the Carroona mapsheet in the central east of the area.
- *Zygophyllum aurantiacum*, a native perennial shrub, often an indicator of historical degradation in pastoral areas and an early colonising species in chenopod shrublands - 9 sites, all in the south east of the area.

- *Maireana pyramidata*, a native perennial chenopod shrub, often colonises areas historically covered by *M. astrotricha* and *Atriplex vesicaria* due to preferential sheep grazing - 12 sites, all in the central east of the area. (Redbanks Reserve, west of Burra was the junction of 4 major travelling stock routes, and has borne extremely high stock grazing pressures in the past).

Appendix 1 presents a list of the surveyed sites ranked in order of the percentage of introduced plants on their species list.

Care must be taken not to read too much into these numbers, however it is interesting to note the following:

- no introduced species were listed at 15 of the 145 sites visited;
- all sites (except one Samphire saltmarsh) where no introduced species were found were Mallee communities, mostly with a sparse chenopod understorey and an average plant list of 12 species;
- 27 out of the total 61 sites with *Eucalyptus* spp. overstorey (Mallee and Woodland) had 2 or less introduced species listed;
- an average of 29.9% introduced species per site was recorded over the whole 145 sites visited; and
- grassland and sedgeland sites, generally with species lists of 20 - 40 plants tended to have 40% or greater introduced species present.

5. CONCLUSIONS AND RECOMMENDATIONS

The vegetation of the region is determined largely by geographical features - topography, soil type, geology and climate. This survey provides more data with which to define the currently described main vegetation types in the region, however this will not become clear until an analysis has been performed using data from the adjoining areas to augment that collected during this project. At that time, some refinement should be possible on the historical descriptions of the region.

Data from this survey have already been supplied to grasslands researchers to supplement their knowledge of native grasslands in the region, and to Pygmy Bluetongue Lizard researchers to assist with their understanding of historical and potential habitats, and general ecology of this species. It should be made available to any future projects related to nature conservation in the region.

5.1 Further Work

Data from this survey should be appended to that from adjoining areas with a floristic analysis completed on a bioregional basis, to refine the existing knowledge of native vegetation in the region. This should then be followed with floristic mapping across the region. Both the analysis and mapping will assist in obtaining a clearer picture of the regional significance of species, including those which are currently of unknown or threatened status.

Due to the difficulties of differentiating grasslands and pastures using aerial photography, it is recommended that further investigation be made into use of remote sensing to assist the mapping of such communities.

A detailed survey should be undertaken investigating fauna (including invertebrates), particularly in the grassland and grassy woodland communities.

5.2 Significant Species

The majority of sites of remnant native vegetation in this study area are very highly affected by human activities, which have occurred over a long period of time. As a result, the original botanical composition has been substantially altered, in some cases to the extent that very few of the historical understorey species still exist, regeneration of the overstorey has been all but halted, and botanical diversity severely depleted. Consequently, the only new record of any species of conservation significance was *Swainsona tephrotricha*, a nationally and regionally rare species, listed as being plentiful but of small cover on site EUD2501, an undeveloped Road Reserve just north of Eudunda. Whilst current management of this site, which had a total of 70 species listed, appears to be appropriate for the preservation of the rich and diverse habitat, it would be desirable to ensure that this management regime or similar, were able to be guaranteed in the future. Consideration should also be given to registering this location on the Register of the National Estate.

REFERENCES

- Allaby, A. and M. (1990) *The Concise Oxford Dictionary of Earth Sciences*.
Oxford University Press, Oxford.
- American Geological Institute (1976) *Dictionary of Geological Terms*. Revised Ed.
Anchor Books USA.
- Auhl, I. and Marfleet, D. (1975) *Australia's Earliest Mining Era, South Australia 1841-1851: Paintings*
by S.T. Gill Lynton Publishers, South Australia
- Davies, R.J-P. (1982) *The Conservation of Major Plant Associations in South Australia*. Conservation
Council of S.A. Incorporated.
- Gillison, A.N. (1984) Gradient oriented Sampling for Resource Surveys : the Gradsect Method. In:
Myers, K., Margules, C. and Musto, I. (eds) *Survey Methods for Nature Conservation Proceedings*
of workshop, Adelaide. pp. 349-374.
- Jessup, R.W. (1948) A Vegetation and Pasture Survey of Counties Eyre, Burra and Kimberley, South
Australia *Trans. Royal Society South Australia*. 72 (1) pp. 33 - 71, 23 Aug 1948.
- Laut, P., Heyligers, P.C., Keig, G., Loffler, E., Margules, C., Scott, R.M. and Sullivan, M.E. (1977)
Environments of South Australia. Provinces 2,3 & 5 C.S.I.R.O. Canberra.
- McDonald, R.C., Isbell, R.F., Speight, J.G., Walker, J. and Hopkins, M.S. (1990) *Australian Soil and*
Land Survey Field Handbook. Inkata Press Pty Ltd, Sydney.
- Muir, B.G. (1977) Biological Survey of Western Australian Wheatbelt. Part 2. Vegetation and Habitat
of Bendering Reserve. Records of the Western Australian Museum, Supplement No. 3. Perth.
- Specht, R.L. (1972) *The Vegetation of South Australia*. Government Printer, Adelaide
- Wood, J.G. (1937) *Vegetation of South Australia*. Government Printer, Adelaide

Appendix 1: Summary of Survey Sites with Percentage of Introduced Species Indicated

Site No.	Overstorey species	Vegetation Structure	Understorey species	Total	% Introduced
MON0801	Eucalyptus gracilis Eucalyptus oleosa Eucalyptus brachycalyx	Open Tree Mallee	Enchylaena tomentosa Maireana radiata Maireana pyramidata	12	0.0
WOR1701	Eucalyptus oleosa	Tree Mallee	Sclerolaena spp. Maireana pentatropis	15	0.0
WOR1601	Eucalyptus brachycalyx Eucalyptus gracilis	Open Tree Mallee	dwarf shrub D Olearia muelleri Westringia rigida	14	0.0
FRA1401	Eucalyptus brachycalyx Eucalyptus socialis Eucalyptus gracilis	Tree Mallee	Atriplex vesicaria	16	0.0
MON1003	Eucalyptus gracilis Eucalyptus oleosa	Open Tree Mallee	Atriplex vesicaria Maireana turbinata & Sclerolaena species	15	0.0
CAR2001	Eucalyptus oleosa Eucalyptus gracilis	Tree Mallee		7	0.0
MON1201	Eucalyptus brachycalyx	Open Tree Mallee	Atriplex vesicaria	8	0.0
EUD1801	Eucalyptus oleosa	Tree Mallee	Zygophyllum aurantiacum Sclerolaena spp	13	0.0
MON0501	Eucalyptus brachycalyx Eucalyptus oleosa	Open Tree Mallee	Atr stipitata & vesicaria Rhag parabolica Zyg aurantiacum	13	0.0
WOR0701	Eucalyptus brachycalyx	Tree Mallee	Atriplex vesicaria	11	0.0
CAR2201	Eucalyptus oleosa Eucalyptus gracilis Eucalyptus brachycalyx	Tree Mallee	Very sparse Olearia muelleri	7	0.0
WOR0501	Eucalyptus gracilis Eucalyptus oleosa	Tree Mallee	Atriplex vesicaria	13	0.0
WOR0401	Halosarcia indica ssp. leiostachya Halosarcia pergranulata ssp. pergranulata	Low Heath D	Disphyma crassifolia	5	0.0
EUD2601	Eucalyptus oleosa	Tree Mallee	Maireana spp Atriplex sp. Zygophyllum	13	0.0
CAR0401	Eucalyptus gracilis Eucalyptus oleosa	Very Open Tree Mallee	Atriplex vesicaria Maireana brevifolia	12	0.0
FRA1701	Eucalyptus socialis Eucalyptus gracilis	Tree Mallee	Olearia calcarea	19	5.3
CAR1201	Eucalyptus socialis Eucalyptus gracilis	Tree Mallee	very sparse Maireana aphylla	18	5.6
WOR0301	Eucalyptus oleosa Eucalyptus brachycalyx	Tree Mallee	Zygophyllum aurantiacum Maireana pentatropis	17	5.9
PET0101	Callitris preissii	Low Forest B	Lomandra effusa Stipa nodosa Chrysocephalum apiculatum	33	6.1
WOR0801	Eucalyptus oleosa Eucalyptus brachycalyx	Tree Mallee	Atriplex vesicaria Rhagodia crassifolia	16	6.3
WOR1101	Eucalyptus oleosa	Tree Mallee	Maireana pentatropis M.radiata Zygophyllum aurantiacum	15	6.7
MON1001	Eucalyptus gracilis Eucalyptus oleosa Eucalyptus brachycalyx	Open Tree Mallee	Atriplex vesicaria	14	7.1
MON0301	Eucalyptus oleosa Eucalyptus brachycalyx	Open Tree Mallee	Maireana pyramidata	14	7.1

Appendix 1: Continued

Site No.	Overstorey species	Vegetation Structure	Understorey species	Total	% Introduced
EUD0201	<i>Eucalyptus oleosa</i>	Tree Mallee	<i>Enchylaena tomentosa</i> <i>Maireana</i> spp.	12	8.3
WOR0601	<i>Eucalyptus brachycalyx</i> <i>Eucalyptus socialis</i>	Tree Mallee	low grazed grass <i>Stipa scabra</i>	12	8.3
CAR0301	<i>Eucalyptus brachycalyx</i> <i>Eucalyptus socialis</i> <i>Eucalyptus gracilis</i>	Open Tree Mallee	<i>Rhag. parabolica</i> <i>Atr stipitata</i> <i>Enc tomentosa</i> <i>Mai brevifolia</i>	10	10.0
FRA0101	<i>Eucalyptus gracilis</i> <i>Eucalyptus brachycalyx</i> <i>Eucalyptus oleosa</i>	Open Tree Mallee	<i>Enchylaena tomentosa</i> <i>Rhagodia ulicina</i> <i>Atriplex</i> spp.	29	10.3
FRA0401	<i>Eucalyptus oleosa</i> <i>Eucalyptus gracilis</i> <i>Eucalyptus brachycalyx</i>	Tree Mallee	<i>Atriplex</i> sp	18	11.1
WOR1201	<i>Eucalyptus oleosa</i>	Tree Mallee	<i>Maireana pentatropis</i> <i>Zygophyllum aurantiacum</i>	16	12.5
TER1C12	<i>Acacia pycnantha</i>	Low Forest B	<i>Dianella rev.var.rev.</i> <i>Stipa scabra</i> ssp <i>falcata</i> <i>S.blackii</i>	30	13.3
FRA1601	<i>Dodonaea lobulata</i> <i>Senna artemisioides</i> nothosp. <i>artemisioides</i>	Dwarf Scrub C	<i>Chrysocephalum semipapposum</i>	37	13.5
MON0601	<i>Eucalyptus oleosa</i>	Tree Mallee	<i>Maireana pyramidata/eriodclada</i> <i>Rhagodia parabolica</i>	14	14.3
WOR0901	<i>Maireana sedifolia</i>	Open Dwarf Scrub C	<i>Stipa eremophila</i> <i>S.lanata</i> <i>Goodenia pusilliflora</i>	21	14.3
FRA0501	<i>Rhagodia spinescens</i> <i>Sida petrophila</i> <i>Ptilotus obovatus</i> var.	Dwarf Scrub D	<i>Asphodelus fistulosus</i> <i>Stipa scabra</i>	39	15.4
FRA1501	<i>Callitris glaucophylla</i>	Low Woodland A	<i>Rhagodia parabolica</i>	32	15.6
APO2201	<i>Allocasuarina verticillata</i>	Low Woodland B	<i>Correa glabra</i> <i>Xanth quadrangulata</i> . herbs and grasses	31	16.1
CAR0801	<i>Eucalyptus brachycalyx</i> <i>Eucalyptus gracilis</i>	Tree Mallee	shrub <i>Beyeria</i> and <i>Eriostemon</i> herbs and grasses	55	16.4
CAR1701	<i>Eucalyptus socialis</i> <i>Eucalyptus gracilis</i> <i>Eucalyptus brachycalyx</i>	Tree Mallee	<i>Atriplex stipitata</i> <i>Maireana brevifolia</i>	18	16.7
HAL1601	<i>Eucalyptus leucoxylon</i> ssp. <i>pruinosa</i>	Open Low Woodland A	<i>Lomandra</i> and <i>Stipa</i> spp and <i>Avena</i>	53	17.0
CAR1101	<i>Eucalyptus porosa</i>	Tree Mallee	<i>Acacia calamifolia</i> <i>Bromus rubens</i> <i>Asphodelus fistulosus</i>	41	17.1
FRA0201	<i>Atriplex vesicaria</i> ssp. <i>Rhagodia ulicina</i>	Low Heath C	<i>Sclerolaena</i> spp <i>Stipa nitida</i> <i>Carrichtera annua</i> <i>Medicago</i> spp	34	17.6
MON1002	<i>Dodonaea lobulata</i> <i>Atriplex vesicaria</i> <i>Rhagodia ulicina</i> <i>Eremophila alternifolia</i>	Open Dwarf Scrub C	<i>Carrichtera annua</i>	17	17.6
HAL1401	<i>Eucalyptus porosa</i> <i>Eucalyptus gracilis</i>	Tree Mallee	<i>Vittadinia</i> low grasses and scattered shrubs	61	18.0
FRA0102	<i>Eucalyptus oleosa</i> <i>Eucalyptus gracilis</i>	Open Tree Mallee	<i>Atriplex vesicaria</i> <i>Maireana pyramidata</i> <i>Asphodelus fistulosus</i>	27	18.5
WOR0201	<i>Eucalyptus oleosa</i>	Tree Mallee	very sparse <i>Zygophyllum</i> spp.	21	19.0
BUR1401	<i>Lomandra multiflora</i> ssp. <i>dura</i>	Very Open Low Sedges	<i>Dant.carphoides</i> <i>Av.barbata</i> <i>Cot.australis</i>	26	19.2
CAR1401	<i>Maireana pyramidata</i> <i>Atriplex vesicaria</i> ssp.	Dwarf Scrub C	<i>Maireana sedifolia</i> <i>Stipa eremophila</i> <i>Danthonia caespitosa</i>	20	20.0
TER1301	<i>Lomandra multiflora</i> ssp. <i>dura</i>	Very Open Low Sedges	<i>Chrysocephalum apiculatum</i> <i>Calocephalus citreus</i>	50	20.0
BUR0801	<i>Lomandra multiflora</i> ssp. <i>dura</i>	Open Low Sedges	mixed grass and herbs.	44	20.5

Appendix 1: Continued

Site No.	Overstorey species	Vegetation Structure	Understorey species	Total	% Introduced
	<i>Lomandra effusa</i>				
APO1801	<i>Allocasuarina verticillata</i>	Open Low Woodland B	<i>Lepid viscidum</i> <i>Hake rostrata</i> <i>Cryptandra amara</i>	29	20.7
TER2002	<i>Eucalyptus socialis</i>	Tree Mallee	<i>E.aphylla</i> <i>O.decurrens</i> <i>O.pimellioides</i> <i>S.nitida</i> <i>C.annua</i>	43	20.9
PET0202	<i>Callitris preissii</i>	Low Woodland B	<i>Senna art.petiolaris</i> <i>Dodonaea baueri</i> <i>Stipa nitida</i> <i>Lomand.eff</i>	37	21.6
BUR1501	<i>Allocasuarina verticillata</i>	Open Low Woodland A	<i>Bursaria spinosa</i> mixed grasses native and exotic.	27	22.2
TER0502	<i>Lomandra multiflora</i> ssp. <i>dura</i>	Open Low Sedges	<i>Stipa setacea</i> <i>S.nitida</i> <i>Leptorhynchos tetrachaetus</i> <i>Trip pygma</i>	31	22.6
BUR1701	<i>Lomandra multiflora</i> ssp. <i>dura</i> <i>Cryptandra amara</i> var. <i>longiflora</i>	Very Open Low Sedges	<i>Stipa blackii/eremophila/scabra.Vel paradoxa.</i> <i>Vit cuneata</i>	26	23.1
APO1401	<i>Lomandra multiflora</i> ssp. <i>dura</i> <i>Cryptandra amara</i> var. <i>amara</i>	Open Low Sedges	<i>Danthonia</i> spp. <i>Stipa</i> spp. <i>Vittadinia</i> spp.	39	23.1
TER1701	<i>Cryptandra amara</i> var. <i>amara</i>	Low Heath D	<i>Lomandra multiflora dura</i> <i>Stipa nodosa</i> <i>Leptorhynchos squamatu</i>	39	23.1
MON1301	<i>Eucalyptus brachycalyx</i>	Open Tree Mallee	<i>Enchylaena tomentosa</i> <i>Atriplex vesicaria</i>	26	23.1
FRA0901	<i>Dodonaea lobulata</i> <i>Acacia wilhelmiana</i>	Heath B	various herbs	34	23.5
CAR1601	<i>Atriplex vesicaria</i> ssp. <i>Maireana pyramidata</i>	Low Heath C	<i>Asphodelus fistulosus</i> <i>Medicago</i> spp <i>Stipa nitida</i>	21	23.8
MON1603	<i>Maireana pyramidata</i> <i>Nitraria billardierei</i>	Dwarf Scrub C	<i>Crit murinum</i> ssp <i>glauca</i> <i>Carrictera annua</i> <i>Medicago polymorpha</i>	16	25.0
FRA1901	<i>Acacia wilhelmiana</i> <i>Dodonaea lobulata</i> <i>Dodonaea viscosa</i> ssp. <i>spatulata</i>	Heath A	<i>Chrysocephalum semipapposum</i>	36	25.0
WOR1501	<i>Eucalyptus brachycalyx</i>	Tree Mallee	<i>Maireana pentatropis</i> <i>Enchylaena tomentosa</i>	20	25.0
HAL1701	<i>Allocasuarina verticillata</i>	Open Low Woodland A	<i>Gonocarpus elatus</i> <i>Lomandra densiflora</i> herbs and low sedges	73	26.0
MON0901	<i>Senna artemisioides</i> nothosp. <i>coriacea</i>	Low Scrub A	<i>Medicago minima</i> <i>Carrichtera annua</i>	15	26.7
TER1101	<i>Stipa blackii</i> <i>Lomandra multiflora</i> ssp. <i>dura</i> <i>Cryptandra amara</i> var. <i>amara</i>	Tall Grass	<i>Stipa scabra</i> <i>Danthonia eriantha</i> <i>Aristida behriana</i>	33	27.3
CAR0101	<i>Eucalyptus gracilis</i> <i>Eucalyptus socialis</i>	Open Tree Mallee	<i>Rhagodia parabolica.</i> <i>Stipa</i> spp.	18	27.8
HAL0801	<i>Eucalyptus odorata</i>	Low Woodland A	<i>Stipa blackii</i> and low grasses and herbs	50	28.0
MON1101	<i>Maireana pyramidata</i> <i>Maireana brevifolia</i>	Dwarf Scrub C	<i>Danthonia caespitosa</i> <i>Stipa nitida</i> <i>Medicago</i> sp.	21	28.6
WOR1401	<i>Eucalyptus oleosa</i> <i>Eucalyptus gracilis</i>	Tree Mallee	<i>Maireana pentatropis</i>	14	28.6
TER1401	<i>Lomandra multiflora</i> ssp. <i>dura</i> <i>Lomandra effusa</i> <i>Cryptandra amara</i> var. <i>amara</i>	Low Sedges	<i>Aristida behrianna</i> <i>Stipa nitida</i> <i>Avena barbata</i> <i>Danthonia eria</i>	35	28.6
CAR0601	<i>Eucalyptus brachycalyx</i>	Tree Mallee	very sparse low grass	31	29.0
CAR2101	<i>Eucalyptus socialis</i> <i>Eucalyptus gracilis</i> <i>Eucalyptus brachycalyx</i>	Open Tree Mallee	<i>Enchylaena tomentosa</i> <i>Maireana brevifolia</i> <i>Atriplex lin</i> ssp in	31	29.0
TER0101	<i>Atriplex vesicaria</i> ssp. <i>Stipa blackii</i>	Dwarf Scrub D	<i>Vittadinia cuneata</i> <i>Lomandra multi.dura</i> <i>Stipa nitida</i> <i>Avena ba</i>	41	29.3

Appendix 1: Continued

Site No.	Overstorey species	Vegetation Structure	Understorey species	Total	% introduced
FRA1301	<i>Senna artemisioides</i> nothosp. <i>artemisioides</i> <i>Dodonaea lobulata</i>	Dwarf Scrub C	<i>Asphodelus fistulosus</i> <i>Echium plantagineum</i>	34	29.4
APO1802	<i>Lepidosperma viscidum</i>	Low Sedges	<i>Stipa elegantissima/scabra/blackii</i> and herbs.	27	29.6
PET0201	<i>Senna artemisioides</i> nothosp. <i>coriacea</i> <i>Dodonaea viscosa</i> ssp. <i>angustissima</i>	Heath B	<i>E.tomentosa</i> <i>C.annua</i> <i>S.nitida</i> <i>A.barbata</i> <i>M.minima</i>	37	29.7
HAL2201	<i>Eucalyptus socialis</i> <i>Eucalyptus gracilis</i>	Open Tree Mallee	<i>Asphodelus fistulosus</i> and herbs	30	30.0
HAL0501	<i>Avena barbata</i>	Low Grass	small herbs	43	30.2
APO1101	<i>Eucalyptus odorata</i> <i>Allocasuarina verticillata</i>	Low Woodland A	<i>Bursaria spinosa</i> . <i>Stipa</i> spp. <i>Avena barbata</i> .	23	30.4
BUR0401	<i>Lomandra multiflora</i> ssp. <i>dura</i>	Open Low Sedges	<i>Avena</i> . <i>Stipa scabra</i> <i>Dant caespitosa</i> <i>Vittadinia gracilis</i>	26	30.8
CAR1901	<i>Dodonaea lobulata</i>	Heath B	no real understorey	26	30.8
HAL1801	<i>Maireana rohrlachii</i>	Low Heath D	<i>Lomandra effusa</i> <i>L.multiflora</i> ssp <i>dura</i> and low grass	45	31.1
TER1001	<i>Lomandra effusa</i> <i>Maireana turbinata</i> <i>Asphodelus fistulosus</i>	Low Sedges	<i>Avena barbata</i> <i>Stipa nitida</i> <i>Carthamus lanatus</i> <i>Neatostema apul</i>	32	31.3
CAR0201	<i>Eucalyptus porosa</i>	Open Tree Mallee	<i>Lyc ferocissium</i> <i>At semibaccata</i> <i>Av barbata</i> <i>Bro rubens</i>	19	31.6
MON0101	<i>Eucalyptus porosa</i>	Open Tree Mallee	<i>Maireana brevifolia</i> <i>Critesion murinum</i> ssp <i>glaucum</i>	22	31.8
CAR0701	<i>Callitris preissii</i>	Open Low Woodland B	<i>Rhag parabolica</i> <i>Lom effusa</i> <i>Sti scabra</i> <i>Lep tetrachaetus</i>	31	32.3
HAL1001	<i>Lomandra multiflora</i> ssp. <i>dura</i> <i>Stipa blackii</i>	Open Tall Sedges	low grass <i>Avena barbata</i>	55	32.7
FRA1201	<i>Dodonaea viscosa</i> ssp. <i>angustissima</i>	Low Scrub A	<i>Asphodelus fistulosus</i> <i>Neatostema apulum</i>	30	33.3
CAR1801	<i>Eucalyptus socialis</i> <i>Eucalyptus gracilis</i> <i>Eucalyptus oleosa</i>	Tree Mallee	<i>Maireana aphylla</i>	24	33.3
HAL0301	<i>Eucalyptus leucoxylon</i> ssp. <i>pruinosa</i>	Low Woodland A	grasses and herbs low	69	33.3
APO1701	<i>Stipa setacea</i>	Open Low Grass	<i>Lom mul</i> ssp <i>dura</i> <i>Dan caespitosa</i> / <i>carphoides</i> <i>Vitt gracilis</i>	26	34.6
TER0801	<i>Maireana aphylla</i>	Low Heath C	<i>Vittadinia cuneata</i> <i>Avena barbata</i> <i>Medicago truncatula</i>	23	34.8
MON1401	<i>Eucalyptus gracilis</i>	Open Tree Mallee	<i>Enchlyaena tomentosa</i> <i>Stipa nitida</i> <i>Zygophyllum aurantiacum</i>	31	35.5
WOR0101	<i>Eucalyptus gracilis</i>	Tree Mallee	chenopods - <i>Rhagodia parabolica</i> low heath B	31	35.5
EUD0301	<i>Eucalyptus porosa</i>	Open Tree Mallee	<i>Senna</i> <i>Acacia calamifolia</i> <i>Rhagodia parabolica</i>	50	36.0
TER0501	<i>Lomandra multiflora</i> ssp. <i>dura</i>	Open Low Sedges	<i>Sclerolaena pungens</i> <i>Ptilotus spathalatus</i> <i>Avena barbata</i>	33	36.4
MON0201	<i>Maireana sedifolia</i>	Dwarf Scrub C	<i>Rhagodia parabolica</i> <i>Stipa nitida</i> <i>Danthonia caespitosa</i>	22	36.4
HAL0701	<i>Hymenathera dentata</i>	Dwarf Scrub C	grass and herbs	62	37.1
CAR1001	<i>Dodonaea viscosa</i> ssp. <i>angustissima</i>	Dwarf Scrub C	<i>Avena barbata</i> <i>Echium plantagineum</i> <i>Stipa nitida</i>	16	37.5
HAL0601	<i>Lomandra multiflora</i> ssp. <i>dura</i> <i>Avena barbata</i>	Low Sedges	grasses and herbs	40	37.5
RIV1B36	<i>Eucalyptus leucoxylon</i> ssp.	Low Forest A	<i>Acacia pycnantha</i> <i>Stipa blackii</i> <i>Danthonia setacea</i>	30	40.0
APO1901	<i>Allocasuarina verticillata</i>	Low Woodland A	<i>Xanth quadrangulata</i> <i>Lom multiflora</i> ssp <i>dura</i>	25	40.0
EUD2101	<i>Lomandra effusa</i>	Very Open Low Sedges	<i>Chrysocephalum apiculatum</i> <i>Vittadinia</i> spp <i>Danthonia pilosa</i>	35	40.0

Appendix 1: Continued

Site No.	Overstorey species	Vegetation Structure	Understorey species	Total	% Introduced
BUR0701	<i>Dianella revoluta</i> var.	Open Low Sedges	mixed grasses <i>Lomandra</i> <i>Salvia</i>	25	40.0
HAL1101	<i>Stipa blackii</i>	Tall Grass	introduced grasses <i>Bromus</i> <i>Vulpia</i> <i>Avena</i>	49	40.8
EUD2501	<i>Allocasuarina verticillata</i> <i>Acacia pycnantha</i>	Open Low Woodland B	<i>Dianella revoluta</i> <i>Lomandra effusa</i> <i>Lomandra densiflora</i>	70	41.4
HAL0201	<i>Avena barbata</i> <i>Enneapogon nigricans</i>	Dense Low Grass	scattered herbs and <i>Aristida</i> scattered - open herb	36	41.7
WOR1801	<i>Sclerolaena obliquicuspis</i>	Low Heath D	<i>Critesion murinum</i> spp <i>glaucum</i> <i>Zygophyllum aurantiacum</i>	12	41.7
RIV1301	<i>Eucalyptus leucoxylo</i> ssp. <i>Allocasuarina verticillata</i> <i>Eucalyptus odorata</i>	Low Woodland A	<i>Acacia paradoxa</i> <i>Stipa</i> spp. <i>Danthonia</i> spp.	31	41.9
MON1501	<i>Lomandra effusa</i>	Open Low Sedges	<i>Stipa nitida</i> <i>Avena barbata</i> <i>Danthonia auriculata</i>	19	42.1
RIV1401	<i>Eucalyptus odorata</i>	Low Forest A	<i>Lolium</i> <i>Bromus</i> <i>Danthonia</i> spp.	30	43.3
BUR1001	<i>Stipa nitida</i> <i>Stipa blackii</i>	Open Low Grass	<i>Vit cuneata</i> <i>Vit gracilis</i> <i>Hypo glabra</i> <i>Pti spathu</i>	30	43.3
EUD1601	<i>Eucalyptus socialis</i>	Low Woodland A	<i>Melaleuca lanceolata</i> <i>Stipa scabra</i>	31	45.2
EUD1901	<i>Lomandra effusa</i>	Open Low Sedges	<i>Danthonia Wahlenbergia</i>	48	45.8
EUD1B33	<i>Lomandra effusa</i>	Open Low Sedges	<i>Danthonia</i> spp. <i>Stipa</i> spp.	37	45.9
HAL0901	<i>Eucalyptus leucoxylo</i> ssp. <i>pruinosa</i>	Low Woodland A	<i>Avena</i> and <i>Bromus</i> grasses	43	46.5
HAL1301	<i>Eucalyptus brachycalyx</i>	Tree Mallee	<i>Olearia</i> sparse and low very sparse grasses	17	47.1
BUR0601	<i>Lomandra effusa</i>	Very Open Low Sedges	<i>Av barbata</i> <i>S eremophila/blackii</i> <i>Vit gracilis</i>	21	47.6
CAR0501	<i>Eucalyptus gracilis</i>	Open Tree Mallee	<i>Lyc ferocis</i> <i>Brom rubens</i>	25	48.0
EUD1201	<i>Lomandra effusa</i>	Open Low Sedges	<i>Stipa blackii</i> <i>Danthonia</i>	52	48.1
RIV1701	<i>Eucalyptus odorata</i>	Low Woodland A	<i>Stipa blackii</i>	16	50.0
BUR1D04	<i>Lomandra multiflora</i> ssp. <i>dura</i>	Open Low Sedges	<i>Avena barbata</i> <i>Echium plantagineum</i> <i>Erodium botrys</i>	24	50.0
TER0201	<i>Maireana aphylla</i>	Dwarf Scrub C	<i>Bromus diandrus</i> <i>Stipa blackii</i> <i>Avena barbata</i>	29	51.7
TER1702	<i>Stipa nitida</i> <i>Stipa blackii</i>	Tall Grass	<i>Danthonia eriantha</i> <i>Bromus rubens</i> <i>Vulpia myuros myu.</i> <i>Avena ba</i>	27	51.9
EUD2001	<i>Lomandra effusa</i>	Open Low Sedges	<i>Danthonia</i> spp. <i>Stipa</i> spp. <i>Romulea minutiflora</i>	30	53.3
BUR1201	<i>Stipa blackii</i>	Low Grass	mixed grasses and herbs (<i>Avena.</i> <i>Aristida.</i> <i>Bromus</i>).	16	56.3
AP01803	<i>Juncus kraussii</i>	Tall Sedges	<i>Cyperacea</i> spp. grasses and herbs.	25	60.0
HAL0101	<i>Avena barbata</i> <i>Bromus rubens</i>	Dense Low Grass	introduced herbs <i>Medicago</i>	28	60.7
MON0701	<i>Maireana pyramidata</i>	Dwarf Scrub C	<i>Asphodelus fistulosus</i> <i>Schismus barbatus</i> <i>Medicago minima</i>	8	62.5
MON1601	<i>Phragmites australis</i>	Tall Grass	<i>Cynodon dactylon</i>	32	62.5
CAR1301	<i>Asphodelus fistulosus</i> <i>Critesion murinum</i> ssp. <i>glaucum</i>	Low Grass		8	62.5
EUD2401	<i>Lomandra effusa</i>	Tall Sedges	<i>Stipa</i> spp. <i>Danthonia caespitosa</i> herbs	27	63.0
FRA0701	<i>Maireana aphylla</i>	Dwarf Scrub C	<i>Critesian murinum</i> ssp <i>glaucum</i>	20	65.0
HAL2001	<i>Maireana aphylla</i>	Low Heath C	<i>Avena</i> <i>Bromus dense</i> grass	12	66.7
BUR1301	<i>Juncus subsecundus</i>	Open Low Sedges	low grasses and herbs - all exotic.	16	68.8
EUD2301	<i>Lomandra effusa</i>	Open Tall Sedges	<i>Enneapogon nigrans</i> <i>Stipa</i> spp. <i>Danthonia</i> spp.	36	69.4
BUR0902	<i>Lomandra effusa</i>	Very Open Low Sedges	mixed grasses and herbs see COM for list.	18	72.2

Appendix 2: List of Introduced Plant Species Recorded during the Burra Hills Native Vegetation Survey

Scientific Name	Common Name
* <i>Aira cupaniana</i>	small hair-grass
* <i>Aira elegantissima</i> ssp. <i>elegantissima</i>	delicate hair-grass
* <i>Alyssum linifolium</i>	flax-leaf alyssum
* <i>Anagallis arvensis</i>	pimpernel
* <i>Arctotheca calendula</i>	Cape weed
* <i>Asphodelus fistulosus</i>	onion weed
* <i>Aster subulatus</i>	aster-weed
* <i>Avellinia michelii</i>	avellinia
* <i>Avena barbata</i>	bearded oat
* <i>Avena sativa</i>	cultivated oat
* <i>Brachypodium distachyon</i>	false brome
* <i>Briza maxima</i>	large quaking-grass
* <i>Bromus diandrus</i>	great brome
* <i>Bromus hordeaceus</i> ssp. <i>hordeaceus</i>	soft brome
* <i>Bromus madritensis</i>	compact brome
* <i>Bromus rigidus</i>	rigid brome
* <i>Bromus rubens</i>	red brome
* <i>Buglossoides arvensis</i>	sheepweed
* <i>Bupleurum semicompositum</i>	hare's ear
* <i>Carduus tenuiflorus</i>	slender thistle
* <i>Carrichtera annua</i>	Ward's weed
* <i>Carthamus lanatus</i>	saffron thistle
* <i>Centaurea melitensis</i>	Malta thistle
* <i>Cerastium glomeratum</i>	common mouse-ear chickweed
* <i>Cirsium vulgare</i>	spear thistle
* <i>Cotula coronopifolia</i>	water buttons
* <i>Critesion murinum</i> ssp.	barley-grass
* <i>Critesion murinum</i> ssp. <i>glaucum</i>	blue barley-grass
* <i>Cynara cardunculus</i>	artichoke thistle
* <i>Cynodon dactylon</i>	couch
* <i>Desmazeria rigida</i>	rigid fescue
* <i>Echium plantagineum</i>	Salvation Jane
* <i>Erodium botrys</i>	long heron's-bill
* <i>Erodium cicutarium</i>	cut-leaf heron's-bill
* <i>Fumaria densiflora</i>	dense fumitory
* <i>Galium divaricatum</i>	slender bedstraw
* <i>Galium murale</i>	small bedstraw
* <i>Galium spurium</i> ssp. <i>ibicinum</i>	bedstraw
* <i>Gynandris setifolia</i>	thread iris
* <i>Hedypnois rhagadioloides</i>	Cretan weed

Scientific Name	Common Name
* <i>Herniaria cinerea</i>	rupturewort
* <i>Hypochaeris radicata</i>	rough cat's ear
* <i>Lactuca serriola</i>	prickly lettuce
* <i>Lepidium africanum</i>	common peppergrass
* <i>Limonium companyonis</i>	sea-lavender
* <i>Limonium lobatum</i>	winged sea-lavender
* <i>Lolium perenne</i>	perennial ryegrass
* <i>Lolium rigidum</i>	Wimmera ryegrass
* <i>Lycium ferocissimum</i>	African boxthorn
* <i>Malva parviflora</i>	small-flower marshmallow
* <i>Marrubium vulgare</i>	horehound
* <i>Medicago minima</i> var. <i>minima</i>	little medic
* <i>Medicago polymorpha</i> var. <i>polymorpha</i>	burr-medic
* <i>Medicago truncatula</i>	barrel medic
* <i>Mesembryanthemum crystallinum</i>	common iceplant
* <i>Mesembryanthemum nodiflorum</i>	slender iceplant
* <i>Moenchia erecta</i>	erect chickweed
* <i>Neotostema apulum</i>	hairy sheepweed
* <i>Onopordum acaulon</i>	horse thistle
* <i>Opuntia robusta</i>	wheel pear
* <i>Osteospermum clandestinum</i>	tripteris
* <i>Oxalis pes-caprae</i>	soursob
* <i>Papaver aculeatum</i>	bristle poppy
* <i>Papaver hybridum</i>	rough poppy
* <i>Parapholis incurva</i>	curly ryegrass
* <i>Pentaschistis airoides</i>	false hair-grass
* <i>Petrorhagia velutina</i>	velvet pink
* <i>Phalaris minor</i>	lesser canary-grass
* <i>Poa bulbosa</i>	bulbous meadow-grass
* <i>Polypogon monspeliensis</i>	annual beard-grass
* <i>Polypogon viridis</i>	water bent
* <i>Psilurus incurvus</i>	bristle-tail grass
* <i>Reichardia tingitana</i>	false sowthistle
* <i>Reseda luteola</i>	wild mignonette
* <i>Romulea minutiflora</i>	lesser Guildford grass
* <i>Rosa canina</i>	dog rose
* <i>Rostraria cristata</i>	annual cat's-tail
* <i>Rostraria pumila</i>	tiny bristle-grass

Scientific Name	Common Name
* <i>Salvia verbenaca form</i>	wild sage
* <i>Salvia verbenaca form</i> A	wild sage
* <i>Schismus barbatus</i>	Arabian grass
* <i>Scorzonera laciniata</i>	
* <i>Silene nocturna</i>	Mediterranean catchfly
* <i>Silene tridentata</i>	
* <i>Sisymbrium</i> <i>erysimoides</i>	smooth mustard
* <i>Sisymbrium irio</i>	London rocket
* <i>Sisymbrium officinale</i>	hedge mustard
* <i>Sisymbrium orientale</i>	wild mustard
* <i>Sisymbrium sp.</i>	
* <i>Solanum nigrum</i>	black nightshade
* <i>Sonchus asper ssp.</i> <i>glaucescens</i>	
* <i>Sonchus oleraceus</i>	common sow- thistle
* <i>Sonchus tenerrimus</i>	clammy sow- thistle
* <i>Spergularia diandra</i>	lesser sand- spurrey
* <i>Spergularia sp.</i>	
* <i>Stellaria media</i>	chickweed
* <i>Trifolium angustifolium</i>	narrow-leaf clover
* <i>Trifolium arvense var.</i> <i>arvense</i>	hare's-foot clover
* <i>Trifolium campestre</i>	hop clover
* <i>Trifolium dubium</i>	suckling clover
* <i>Trifolium glomeratum</i>	cluster clover
* <i>Trifolium scabrum</i>	rough clover
* <i>Trifolium subterraneum</i>	subterranean clover
* <i>Trifolium tomentosum</i>	woolly clover
* <i>Urospermum picroides</i>	false hawkbit
* <i>Valerianella discoidea</i>	lesser cornsalad
* <i>Vulpia bromoides</i>	squirrel-tail fescue
* <i>Vulpia myuros forma</i>	
* <i>Vulpia myuros forma</i> <i>myuros</i>	rat's-tail fescue