

# The vegetation of the Scotia 1: 100 000 map sheet, western New South Wales

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*Westbrooke, M.E., Miller, J.D. and Kerr, M.K.C. (Centre for Environmental Management, University of Ballarat, PO Box 663 Ballarat, Victoria, Australia 3353) 1998. The vegetation of the Scotia 1: 100 000 map sheet, western New South Wales. Cunninghamia 5(3): 665–684.* The vegetation of the Scotia 1: 100 000 map sheet 7131 (latitude 33°43'S, longitude 143°02'E) in south western New South Wales was assessed through analysis of 498 quadrats and mapped using ground truthing, aerial photograph interpretation and Landsat Thematic Mapper satellite image analysis. Three hundred and eighty species of vascular plants including 62 (16%) exotic species were recorded from 66 families. Four species were new records for New South Wales and a further five species are of conservation significance. Seventeen vegetation communities were identified, of which the most widespread were *Eucalyptus* spp. open shrubland and *Casuarina pauper* woodland/open woodland. The area contains significant communities that are not included in conservation reserves and examples of communities which are amongst the most intact in NSW.

## Introduction

The Scotia 1: 100 000 map sheet covers an area of 258 800 ha in far south western New South Wales, 150 km north-west of Wentworth and adjacent to the South Australian border, latitude 33°43'S, longitude 143°02'E (Fig. 1). The southern section is located within the Wentworth Shire and the remainder is unincorporated. The Scotia comprises all of four and part of seven other western division pastoral leases. It is bounded by pastoral leases to the north, south and east and Danggali Conservation Park in South Australia to the west. It is within the Murray Darling Depression bioregion (Thackway & Cresswell 1995).

## History of the area

The Scotia has one of the shortest stock grazing histories of western NSW, the majority of the constituent properties having been created as pastoral leases in the 1920s. Previously the area was part of the large Lake Victoria lease and stock grazing occurred only in wet years (Withers 1989). During the 1980s a number of the leases were purchased as extensions of other district properties but in the 1990s this trend was reversed (P. Clark, NSW Dept. Land & Water Conservation, pers. comm.). In 1994 the Tarawi lease was purchased by the NSW National Parks & Wildlife Service as a nature reserve and the Ennisvale and Tarrara leases were purchased to be managed jointly as a private nature reserve. Stocking rates in the Scotia have always been low due to the difficulty in providing water and the unpalatable nature of the dominant mallee vegetation (Stanley & Lawrie 1980). This situation is now changing through more efficient reticulation of water through PVC pipe leading to higher and more widespread stocking rates.

### Climate

The climate is classified as cool semi-arid (Dick 1975), the area being within climatic zone 1B for New South Wales (Edwards 1979): temperatures are high in summer and mild in winter with average daily maxima of 32°C in February and 15°C in July respectively and average daily minima of 16°C in February and 5°C in July. The mean annual rainfall is approximately 250 mm; the seasonal distribution of rainfall is fairly even but annual variation is high.

### Geology and geomorphology

The study area lies within the Murray Basin geological province and consists of Quaternary material, with little rock outcropping (Lawrie & Stanley 1980).

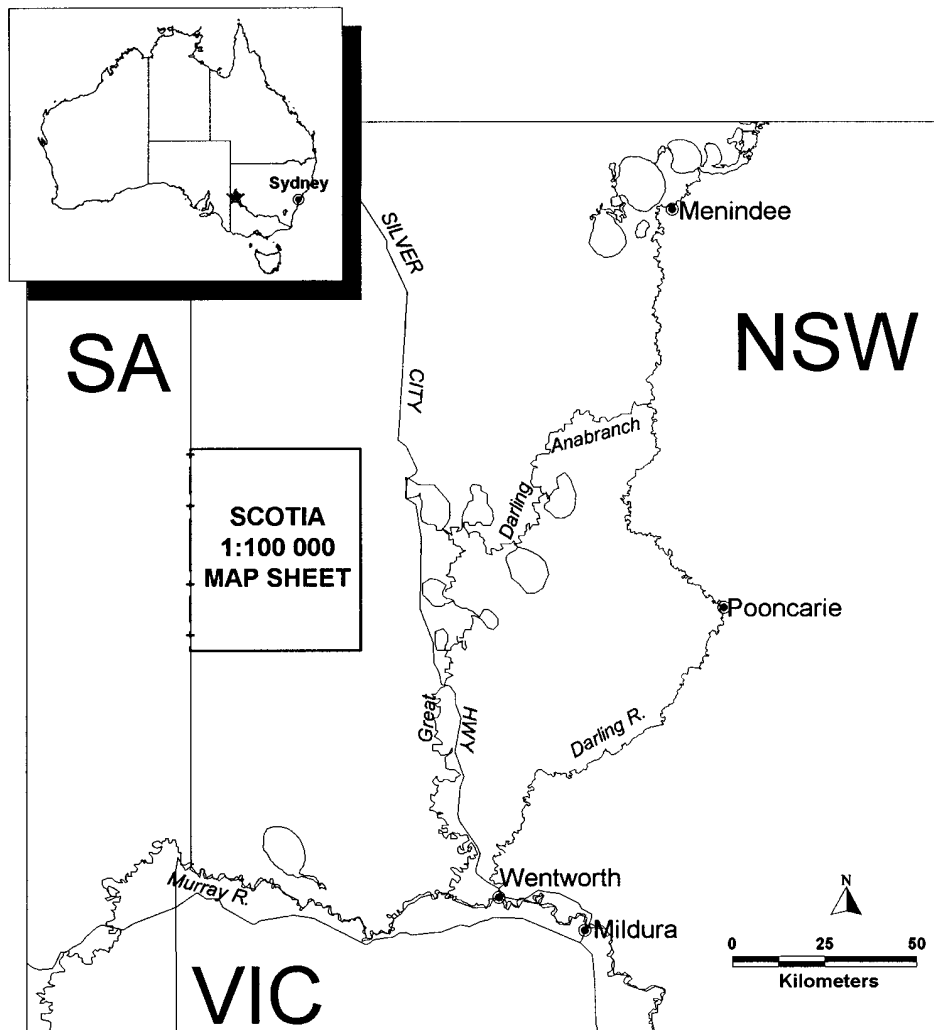


Fig. 1. Location of Scotia 1: 100 000 map sheet, western New South Wales.

Two broad land systems dominate the landscape: dunefields consisting of low parallel ridges running east–west composed of red earthy sands and sandy solonised brown soils overlying sandy clays; and calcareous sandplains of loam or sandy loam solonised brown soils often with limestone nodules at the surface (Walker 1991). A number of salt lakes occur within the area. The largest complex of salt lakes, referred to as the Scotia Discharge Complex, has been the subject of a detailed hydrological study by Ferguson et al. (1995).

### Previous studies

The most complete study of the vegetation of far western New South Wales is that by Beadle (1945, 1948) who included the study area as *Eucalyptus dumosa*–*Eucalyptus oleosa* association. Noy-Meir (1971) carried out a quantitative analysis of the large area of *Eucalyptus* shrubland in south western New South Wales and north-west Victoria. More recently the National Herbarium of NSW, Sydney, has mapped the vegetation of the Ana Branch–Mildura (Fox 1991), Balranald–Swan Hill (Scott 1992) and Pooncarie (Porteners et al. 1997) 1: 250 000 map sheets. Detailed survey and mapping of vegetation in Mallee Cliffs National Park (Morcom & Westbrooke 1990) and Mungo National Park (Westbrooke & Miller 1996), to the south-east of the area, has also been undertaken. Mapping the area at 1: 100 000 scale revealed communities not previously recognised, particularly around the salt lakes, and enabled greater definition of the mosaics presented at 1: 250 000 scale.

### Methods

Following preliminary survey, 498 × 0.09 ha (30 m × 30 m) quadrats were sampled and all vascular plant species occurring were recorded. Also recorded was a cover abundance value, modified from Braun–Blanquet (1928) for each species. Quadrats were subjectively located following the method of Gullan (1978). This method ensured that all communities were sampled and provided data on floristic variability within the communities. Communities were in general sampled in proportion to the area they covered however, since many quadrats were located along transects wherever community type was observed to change, those with a discontinuous distribution may have been over-sampled. Sampling was undertaken between February 1993 and October 1995. Data from the quadrats were analysed via a computer-based numerical classification procedure coupled with a hand sorting procedure of the type outlined in Gullan (1978). A species list was compiled incorporating all vascular plant species recorded from sampled quadrats and following opportunistic collection. Further restricted communities recorded during the field work but not evident from the numeric classification were added to the final classification to provide 16 vegetation communities. For each community mean species richness, total species richness and number of exotic species as a proportion of the total number of species were calculated (Table 1).

During surveys, ground truthing was undertaken by driven and walked transects. Information from these transects was used in conjunction with study of colour aerial

photographs and Landsat Thematic Mapper satellite image data (Scene 96–83) to produce a vegetation map at 1: 100 000 scale. The mapped vegetation communities were defined by floristic and structural characteristics (Specht 1970). All processing and manipulation of the digital satellite data was conducted using ER Mapper 5.2 (Earth Resource Mapping Pty. Ltd.). A supervised classification of the image, based on training sets derived from the vegetation classification, was undertaken. Eight communities from the vegetation classification were able to be mapped at this scale. Additional vegetation types of restricted occurrence, e.g. those dominated by *Acacia aneura*, *Acacia loderi*, and *Callitris glaucophylla*, were located as points on the map. The classified image was transferred to the MapInfo Geographic Information System (Mapinfo Corporation, Troy, New York) database for final production of the vegetation map.

**Table 1. Relative area, sampling intensity, species richness and weediness of plant communities of the Scotia map sheet**

Community	Area %	No. Quadrats	Mean Species Richness/ quadrat	Mean % Weediness	Total Species Richness
1a <i>Casuarina pauper</i> woodland/ open-woodland	15	133	18	6	206
1b <i>Eucalyptus largiflorens</i> open-woodland	< 1	1	18	42	18
1c <i>Callitris glaucophylla</i> open-woodland	< 1	4	22	11	57
1d <i>Hakea leucoptera</i> low open-woodland	< 1	15	23	5	104
1e <i>Hakea tephrosperma</i> low open-woodland	< 1	6	34	13	88
2a <i>Eucalyptus</i> spp. open-shrubland with shrub understorey	25	59	21	3	151
2b <i>Eucalyptus gracilis</i> / <i>Melaleuca lanceolata</i> , open-shrubland	< 1	25	14	1	75
2c <i>Eucalyptus</i> spp. open-shrubland with <i>Triodia</i> understorey	50	216	19	1	207
2d <i>Eucalyptus porosa</i> low open-woodland	< 1	1	24	25	25
3a <i>Acacia aneura</i> open-shrubland	< 1	5	23	9	103
3b <i>Acacia loderi</i> tall open-shrubland	< 1	1	24	13	24
4a <i>Dodonaea</i> / <i>Eremophila</i> shrubland	5	46	22	14	215
4b <i>Atriplex vesicaria</i> low open-shrubland	2	10	11	5	53
4c <i>Halosarcia</i> / <i>Frankenia</i> / <i>Osteocarpum</i> low open-shrubland	2	32	8	2	96
4d <i>Halosarcia lylei</i> low open-shrubland	< 1	3	3	0	2
5a <i>Eragrostis australasica</i> tussock grassland	< 1	1	12	25	12
5b Herbland	< 1	2	2	41	37

## Results

### Vegetation

The vegetation of the study area consists predominantly of *Eucalyptus gracilis*/*Eucalyptus dumosa*/*Eucalyptus socialis* open shrubland and *Casuarina pauper* open woodland but 16 distinct communities were recognised (Table 1). While several of the communities are of limited distribution they add significantly to the conservation values of the area. The approximate percentage area occupied by each community, the sampling intensity, mean species richness, total species richness and mean percentage weediness of these communities are given in Table 1.

All vegetation communities are described below, grouped according to structural and floristic attributes.

#### 1. Woodlands

##### 1a *Casuarina pauper* woodland/open-woodland

*Casuarina pauper*, growing to 10–12 m, occurs as a dominant species on the brown loamy sands of interdune areas. It is frequently associated with *Alectryon oleifolius* subsp. *canescens* and/or *Myoporum platycarpum* and *Geijera parviflora*. Commonly associated understorey shrubs are *Enchylaena tomentosa*, *Chenopodium curvispicatum*,

*Maireana pentatropis*, *Maireana georgei*, *Sclerolaena obliquicuspis*, *Eremophila sturtii*, *Olearia muelleri*, *Senna artemisioides* nothosp. *filiformis*, *Senna artemisioides* nothosp. *petiolaris* and *Senna artemisioides* nothosp. *coriacea*. Frequently-occurring grasses and herbs include *Stipa* spp., *Vittadinia cuneata* and *Dissocarpus paradoxus*.

Five sub-communities can be recognised although these may relate to past land use rather than edaphic factors:



**Fig. 2.** A feature of much of the *Casuarina pauper* woodlands is the rich shrubby understorey.

- *Casuarina pauper*/*Alectryon oleifolius* subsp. *canescens* open-woodland with a diverse shrubby understorey (Fig.2).
- *Casuarina pauper* occurring as dense monospecific woodland.
- *Alectryon oleifolius* subsp. *canescens* occurring as dense groves.
- *Myoporum platycarpum* open-woodland.
- *Geijera parviflora* open-woodland.

#### 1b *Eucalyptus largiflorens* open-woodland

A single stand of *Eucalyptus largiflorens* open-woodland to 10 m occurs near the old Moskeg woolshed in the south of the area. The understorey is dominated by exotic herbs and grasses.

#### 1c *Callitris glaucophylla* open-woodland

*Callitris glaucophylla* (10 m tall) occurs as the dominant tree on a few sandy ridges. The community carries an open understorey of herbs and grasses including the native species *Actinobole uliginosum*, *Calandrinia eremaea*, *Calotis hispidula*, *Crassula colorata*, *Rhodanthe moschata*, *Tetragonia tetragonioides* and *Zygophyllum ammophilum* with a very high occurrence of exotic weeds including *Brassica tournefortii*, *Bromus rubens*, *Erodium*

*cicutarium*, *Hypochoeris glabra*, *Medicago polymorpha* and *Sisymbrium irio*.

#### 1d/1e *Hakea leucoptera*/*Hakea tephrosperma* low open woodland

In a number of locations a low open-woodland with a near monospecific overstorey of *Hakea leucoptera* or *Hakea tephrosperma* to 7 m occurs with an understorey of grasses and herbs.

## 2. Eucalypt shrublands (mallee)

#### 2a *Eucalyptus oleosa*/*Eucalyptus gracilis*/*Eucalyptus dumosa* open-shrubland

*Eucalyptus* open-shrubland dominated by *Eucalyptus oleosa*, *Eucalyptus gracilis*, and *Eucalyptus dumosa* to 8 m occurs on interdune plains of sandy-loam solonised soils. Associated understorey shrubs include *Enchylaena tomentosa*, *Chenopodium curvispicatum*, *Chenopodium desertorum*, *Atriplex stipitata*, *Maireana pentatropis*, *Maireana georgei*, *Sclerolaena obliquicuspis*, *Eremophila sturtii*, *Olearia muelleri*, *Senna artemisioides* subspecies, *Myoporum platycarpum*, *Dodonaea viscosa* subsp. *angustissima* and *Acacia colletioides*. Frequently-occurring grasses



**Fig 3.** *Eucalyptus* shrubland with *Triodia scariosa* understorey is the most widespread community of the Scotia.

and herbs include *Stipa* spp., *Vittadinia cuneata*, *Dissocarpus paradoxus* and *Chenopodium cristatum*. There are few exotic species in this community.

**2b *Eucalyptus gracilis*/Melaleuca lanceolata open-shrubland**

In a narrow fringe around the salt lakes a mallee community to 8 m occurs in which *Melaleuca lanceolata* is a prominent component. Associated shrubs confined to this community include *Leptospermum coriaceum*, *Acacia rigens* and *Hibbertia virgata*. *Disphyma crassifolium* subsp. *clavellatum* is a common component of the ground layer.

**2c *Eucalyptus* open-shrubland with *Triodia* understorey**

On low dune ridges *Eucalyptus* open-shrubland to 8 m occurs and is characterised by the presence of *Triodia scariosa* as the dominant component of the understorey. The most frequent dominants are *Eucalyptus socialis*, *Eucalyptus dumosa* and *Eucalyptus gracilis* with *Eucalyptus oleosa*, *Eucalyptus costata* and *Eucalyptus leptophylla* as more occasional associates. Commonly associated shrubs include *Dodonaea viscosa* subsp. *angustissima*, *Maireana pentatropis*, *Eremophila*

*glabra* and *Grevillea huegelii*. Associated grasses and herbs include *Stipa* spp., *Podolepis capillaris* and *Vittadinia cuneata*. There are few exotic species in this community (Fig.3).

**2d *Eucalyptus porosa* low open-woodland**

Adjacent to Canegrass tank on Tarawi is an area of *Eucalyptus porosa* low open-woodland growing to 8 m. The understorey includes the native species *Eremophila sturtii*, *Sclerolaena bicornis*, *Chenopodium cristatum* and *Zygophyllum ammophilum* with a number of exotics including *Brassica tournefortii*, *Solanum nigrum* and *Cucumis myriocarpus*.

**3. Acacia shrublands**

**3a *Acacia aneura* open-shrubland**

Small areas of *Acacia aneura* open shrubland to 8 m occur at a number of sites. They are generally surrounded by *Casuarina pauper* woodland. The understorey is dominated by herbs and grasses.

**3b *Acacia loderi* open-shrubland**

Several small areas of *Acacia loderi* open shrubland to 6 m occur, with an understorey dominated by herbs and grasses.



**Fig. 4.** The *Halosarcia*/*Frankenia*/*Osteopcarpum* low open shrubland occurring around a number of salt lakes includes *Hemichroa diandra*, not previously recorded from NSW.

#### 4. Low open shrublands

##### 4a *Dodonaea viscosa* subsp. *angustissima*/ *Eremophila sturtii* shrubland/open-shrubland

In a number of areas *Dodonaea viscosa* subsp. *angustissima* and/or *Eremophila sturtii* form stands of varying density to approximately 2 metres. The understorey consists of a variety of grasses and herbs. This community is regarded as resulting from clearing of eucalypt open-shrubland or *Casuarina pauper* woodland.

##### 4b *Maireana sedifolia* low open-shrubland

Occurring throughout the Scotia are areas of low open-shrubland dominated by *Maireana sedifolia*, with or without a sparse overstorey of *Casuarina pauper* or *Eucalyptus* spp. Low shrub associates include *Enchylaena tomentosa* var. *tomentosa* and *Sclerolaena obliquicuspis*. The ground layer includes *Vittadinia cuneata* and *Stipa* spp.

##### 4c *Atriplex vesicaria* low open-shrubland

An open-shrub community dominated by *Atriplex vesicaria* is extensive around the salt lakes. Frequently associated species include *Lycium australe*, *Disphyma crassifolium* subsp. *clavellatum*, *Maireana pentatropis*, *Sclerolaena obliquicuspis* and *Stipa* spp.

##### 4d *Halosarcia*/*Frankenia*/*Osteocarpum* low open-shrubland

Around the perimeter of many salt lakes is a community dominated by varying proportions of

*Halosarcia pergranulata*, *Halosarcia indica*, *Halosarcia halocnemoides* subsp. *halocnemoides*, *Frankenia* sp. and *Osteocarpum acropterum* subsp. *diminutum* (Fig. 4).

##### 4e *Halosarcia lylei* low open-shrubland

A near monospecific community of *Halosarcia lylei* occurs across the bed of smaller salt lakes and around the perimeter of larger lakes (Fig.5).

#### 5. Grasslands/Herblands

##### 5a *Eragrostis australasica* tussock grassland

Small patches of *Eragrostis australasica* grassland occur on isolated clay pans in the area. From the number of tanks carrying the Canegrass name it seems likely that this was once more widespread. Because sites supporting this community are suitable for the location of groundwater tanks, heavy grazing pressure has occurred leading to local elimination.

##### 5b Herbland

An artificial community consisting of largely exotic grasses and herbs with no associated shrubs generally occurs around the more reliable groundwater tanks.



Fig. 5. *Halosarcia lylei* not previously recorded from NSW occurs as a near monospecific community around the larger salt lakes.



### Distribution of communities

The distribution of communities is shown on the Scotia vegetation map.

### Species

Three hundred and eighty vascular plant species from 66 families were recorded from the area including 62 (16%) exotics (Appendix 1). The weediness and species richness of each community is given in Table 1. A full listing of species is given as Appendix 1. Reference specimens are held at the University of Ballarat.

### Discussion

The distribution of plant communities within the Scotia is largely determined by minor changes in topography and associated soil type. *Eucalyptus* open-shrubland with *Triodia scariosa* understorey occurs in sandy soils on the low dunes. *Eucalyptus* shrubland with a shrub understorey occurs in the swales. *Casuarina pauper* woodland occurs on calcareous plains of loamy solonised brown soils. *Atriplex vesicaria* low open shrubland is associated with the areas around the salt lake systems and on islands within the salt lakes, while *Halosarcia/Osteocarpum/Frankenia* and *Halosarcia lylei* low open-shrublands occur on the bed and around the fringes of salt lakes.

### Conservation values

#### Significant communities

*Halosarcia lylei* low open-shrubland has not previously been recorded from NSW (Harden 1990–1993). Whilst the species is not listed as endangered for Australia (Briggs & Leigh 1995) this is the only site in NSW from which it has been recorded. *Halosarcia/Frankenia/Osteocarpum* low open-shrubland frequently includes *Hemichroa diandra* which also has not previously been recorded from NSW. This species is not listed as endangered for Australia (Briggs & Leigh 1995) but is endangered in Victoria (Gullan et al. 1990). Its widespread occurrence in this area is significant. *Eucalyptus porosa* is regarded as infrequent in NSW (Cunningham et al. 1981) and the presence of an extensive stand at Canegrass bore is significant. *Eragrostis australasicus* tussock grassland is at risk as long as high grazing pressure continues. Examples of this community in Hattah–Kulkyne National Park, north-west Victoria, did not recover following the removal of stock in 1980 and have only recovered following the reduction of kangaroo populations in the 1990s (D. Major, Dept. Natural Resources & Environment, pers. comm.).

#### Species richness of plant communities

Far more species were recorded in these surveys from both the *Casuarina pauper* open-woodland and the *Eucalyptus* shrubland communities than during studies of examples of the communities at Mungo National Park (Westbrooke & Miller 1996) and Mallee Cliffs National Park (Morcom & Westbrooke 1990). Whilst this may be due to variation in sampling effort and seasonal variation in herb species, it is likely to be a reflection

of the relatively short grazing history of the Scotia. Comparative data are presented in Table 2. Also of note is the high total species richness (215) of the *Dodonaea viscosa* subsp. *angustissima*/*Eremophila sturtii* shrubland/open-shrubland (community 4a). This may reflect its derivation from more than one naturally occurring community.

### Significant plant species

None of the species recorded is rare or threatened Australia-wide (Briggs & Leigh 1995) but nine have either not previously been recorded, or have restricted distribution in western NSW (Harden 1990–93). *Halosarcia lylei*, *Hemichroa diandra*, *Podotheca angustifolia* and *Elachanthus glaber* have not been recorded for NSW; *Bergia trimera* and *Ptilotus atriplicifolius* have not been recorded for the south far western province; *Cratystylis conocephala*, *Acacia acanthoclada* and *Kippistia suaedifolia* were previously known only from a few sites in NSW and were listed by Pressey (1993) as at risk. Beckers (1997) records *Cratystylis conocephala*, *Kippistia suaedifolia* and *Acacia acanthoclada* on Schedule 1, Part 1 endangered species for the Western Zone of NSW but does not list the other six species since they were not previously recorded for New South Wales. With the exception of *Acacia acanthoclada*, which is only found on low dune ridges within *Eucalyptus* open-shrubland with *Triodia* understorey, and *Cratystylis conocephala* and *Podotheca angustifolia*, which only occur within eucalypt shrublands, these species are associated with the salt lakes.

**Table 2. Total species richness and mean percentage weediness of communities in the Scotia compared to Mungo and Mallee Cliffs National Parks**

Location	Total species richness			Mean % weediness		
	1a	2a	2c	1a	2a	2c
Scotia	206	151	207	6	3	1
Mungo National Park	88	82	140	26	18	2
Mallee Cliffs National Park	62	62	74	11	3	5

### Disturbance

Despite the relatively short grazing history of the area, direct and indirect impacts of pastoral activity are evident. Chaining (the clearing of overstorey trees by dragging a heavy chain between two bulldozers) was used extensively in the 1970s to improve pasture growth. Many of the areas of *Casuarina pauper* open-woodland treated in this way now carry *Dodonaea/Eremophila* shrubland (K. Borgholm, Ennisvale Station, pers. comm.). A large number of 'shot lines' were bulldozed in the 1980s during geological survey and are now notable for species such as *Halganea cyanea* and *Haloragis odontocarpa* which appear to be associated with fire and/or disturbance.

*Eucalyptus* shrubland is highly flammable and large areas were burnt in the wildfires of 1975/6 (Rodda 1978). Fire-promoted species such as *Codonocarpus cotonifolius* are now declining in these areas. Further areas on Tarawi and Nagalea leases were burnt experimentally during the 1980s to investigate the effects of burning on pasture (Noble

1989). In December 1996 three areas burned in wildfires including an area of a 1985 experimental burn. Areas of *Casuarina pauper* woodland, having a relatively non-flammable understorey, did not burn in these fires.

### Exotic species

Sixty-two exotic species were recorded from the survey of which only two, *Nicotiana glauca* and *Lycium ferocissimum*, are woody perennials and only the latter is listed as a noxious weed (NSW Government 1997). The most frequently occurring exotic species are the grasses, *Schismus barbatus*, *Critesion murinum* subsp. *leporinum* and *Bromus rubens*. Exotic species recorded in 2% or more of quadrats are listed in Table 3. Weediness in all communities is significantly lower than that reported for Mungo National Park (Westbrooke & Miller 1996) and Mallee Cliffs National Park (Morcom & Westbrooke 1990) as shown in Table 2.

**Table 3. Most frequently occurring exotic species in the Scotia.**

Species	% occurrence
<i>Schismus barbatus</i>	11
<i>Critesion murinum</i> subsp. <i>leporinum</i>	7
<i>Bromus rubens</i>	5
<i>Hypochoeris radicata</i>	4
<i>Medicago minima</i>	4
<i>Medicago polymorpha</i>	3
<i>Sonchus oleraceus</i>	3
<i>Centaurea melitensis</i>	2
<i>Dittrichia graveolens</i>	2
<i>Erodium cicutarium</i>	2
<i>Hypochoeris glabra</i>	2
<i>Onopordum acaulon</i>	2
<i>Reichardia tingitana</i>	2
<i>Solanum nigrum</i>	2
<i>Spergularia rubra</i>	2

### Conclusion

The Scotia contains highly significant plant communities not represented in conservation reserves, as well as some of the most intact examples of *Eucalyptus* spp. open-shrubland and *Casuarina pauper* woodland in New South Wales. The vegetation communities of south western NSW have until recently been poorly conserved and the communities associated with the Scotia are of particular significance due to their species richness, low weediness and occurrence of significant species. There has been some improvement to reservation with the purchase of the Tarawi lease to be gazetted as a Nature Reserve, which has provided some protection for large areas of *Eucalyptus*

shrubland and *Casuarina pauper* woodland. The conservation reserves of south western NSW are shown in Fig. 6. Data on reservation of relevant vegetation types based on Freudenberger et al. (1997) is given in Table 4. It can be seen that even the more widely occurring communities are well below the target of 20% reservation proposed by Freudenberger et al. (1997) and a number of localised communities are unreserved.

Data from this survey suggest that, even without specific management strategies, pastoral properties with low stocking intensities are capable of providing refugia for biological diversity. It should however be noted in this case that the Scotia area has a relatively short grazing history and, due to the presence of large areas of mallee with a *Triodia* understorey and, until recently, restricted water supplies, stocking rates have been low. The advent of PVC pipe enabling cheap reticulation of water may change this and lead to elimination of such refugia through increased and more widespread stocking rates. This study highlights the need for detailed biological surveys, including the establishment of monitoring plots, to establish baselines against which change may be measured and to identify species and communities requiring reservation.

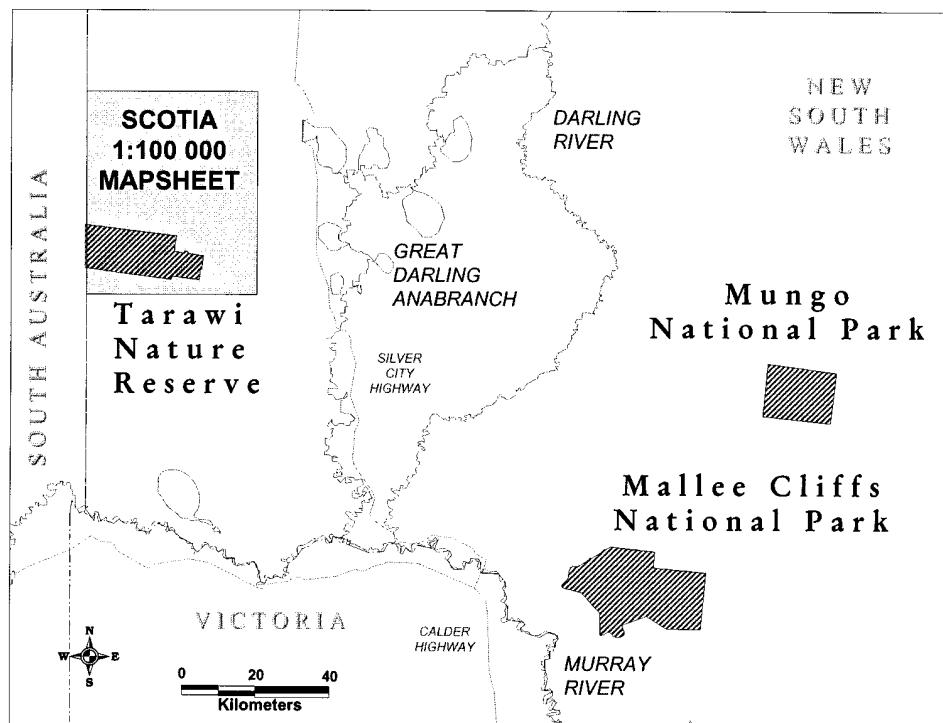


Fig. 6. Conservation reserves in south western NSW.

**Table 4. Extent of reservation of Scotia vegetation types in south western NSW**  
(includes proposed extensions to Mungo National Park)

Vegetation type	Area (km <sup>2</sup> )	% total area	% in reserves
1a <i>Casuarina pauper</i> woodland/open-woodland	9863	21	4
1b <i>Eucalyptus largiflorens</i> open-woodland	2298	5	< 1
1c <i>Callitris glaucophylla</i> open-woodland		Data not available	
1d <i>Hakea leucoptera</i> low open-woodland		Data not available	
1e <i>Hakea tephrosperma</i> low open-woodland		Data not available	
2a <i>Eucalyptus</i> spp. open-shrubland with shrub understorey (mosaic)	2389	5	12
2b <i>Eucalyptus gracilis</i> / <i>Melaleuca lanceolata</i> , open-shrubland	< 1	<1	0
2c <i>Eucalyptus</i> spp. open-shrubland with <i>Triodia</i> understorey	8082	17	10
2d <i>Eucalyptus porosa</i> low open-woodland	< 1	<1	0
3a <i>Acacia aneura</i> open-shrubland	< 1	<1	< 1
3b <i>Acacia loderi</i> open-shrubland		Data not available	
4a <i>Dodonaea/Eremophila</i> shrubland		Data not available	
4b <i>Atriplex vesicaria</i> low open-shrubland		Data not available	
4c <i>Halosarcia/Frankenia/Osteocarpum</i> low open-shrubland	< 1	<1	0
4d <i>Halosarcia lylei</i> low open-shrubland	< 1	<1	0
5a <i>Eragrostis australasica</i> tussock grassland	104	<1	0

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**APPENDIX 1****Vascular plant species recorded from the Scotia 1: 100 000 mapsheet. Nomenclature according to Harden (1990–1993)**

Exotic species denoted thus \*

**ADIANTACEAE***Cheilanthes austrotenuifolia***AIZOACEAE***Disphyma crassifolium* subsp. *clavellatum*\**Mesembryanthemum crystallinum*\**Psilocaulon tenue**Tetragonia tetragonioides***ALSTROMERIACEAE***Dicrastylis verticillata***AMARANTHACEAE***Hemichroa diandra**Ptilotus sessifolius**Ptilotus erubescens**Ptilotus exaltatus**Ptilotus gaudichaudii**Ptilotus nobilis**Ptilotus obovatus**Ptilotus polystachyus**Ptilotus seminudus**Ptilotus atriplicifolius* var. *atriplicifolius**Ptilotus spathulatus***APIACEAE***Daucus glochidiatus***ASCLEPIADACEAE***Leichhardtia australis**Rhyncharhena linearis***ASTERACEAE***Actinobole uliginosum**Angianthus* spp.*Angianthus tomentosus*\**Arctotheca calendula**Brachyscome ciliaris**Brachyscome exilis**Brachyscome lineariloba**Brachyscome trachycarpa**Bracteantha bracteata**Calotis cymbacantha**Calotis erinacea**Calotis hispidula*\**Carthamus lanatus*\**Centaurea melitensis**Centipeda cunninghamii**Centipeda minima**Centipeda thespidioides*\**Chondrilla juncea**Chrysocephalum apiculatum* s.l.*Chthonocephalus pseudevax*\**Cirsium vulgare*\**Conyza bonariensis**Cratystylis conocephala*\**Dittrichia graveolens**Elachanthus glaber**Eriochlamys behrii**Euchiton sphaericus**Gnephosis arachnoidea**Gnephosis tenuissima*\**Hedypnois cretica**Hyalosperma demissum**Hyalosperma stoveae*\**Hypochoeris glabra*\**Hypochoeris radicata**Isoetopsis graminifolia**Ixiolaena leptolepis**Kippistia suaedifolia*\**Lactuca serriola**Lemorea burkittii**Millotia greevesii**Millotia myosotidifolia*

**ASTERACEAE cont.**

*Minuria cunninghamii*  
*Minuria intergerrima*  
*Myriocephalus rhizocephalus*  
*Myriocephalus stuartii*  
*Olearia muelleri*  
*Olearia pimeleoides*  
*Olearia subspicata*  
 \**Onopordum acaulon*  
*Podolepis capillaris*  
*Podotroche angustifolia*  
*Pogonolepis muelleriana*  
*Pseudognaphalium luteoalbum*  
*Pycnosorus pleiocephalus*  
 \**Reichardia tingitana*  
*Rhodanthe corymbiflora*  
*Rhodanthe microglossa*  
*Rhodanthe moschata*  
*Rhodanthe pygmaea*  
*Rhodanthe stuartiana*  
*Rhodanthe tietkensis*  
*Senecio glossanthus*  
*Senecio minimus*  
*Senecio pinnatifolius*  
*Senecio quadridentatus*  
*Senecio runcinifolius*  
 \**Sonchus asper* s.l.  
 \**Sonchus oleraceus*  
*Stuartina muelleri*  
*Triptilodiscus pygmaeus*  
*Vittadinia cuneata*  
*Vittadinia dissecta*  
*Waitzia acuminata* var. *acuminata*  
 \**Xanthium spinosum*

**BORAGINACEAE**

\**Echium plantagineum*  
*Halgania cyanea*  
*Heliotropium curassavicum*  
 \**Heliotropium europaeum*

\**Heliotropium supinum*  
*Omphalolappula concava*  
*Plagiobothrys plurisepalus*

**BRASSICACEAE**

\**Alyssum linifolium*  
*Arabidella trisecta*  
 \**Brassica tournefortii*  
 \**Carrichtera annua*  
*Geococcus pusillus*  
*Harmsiodoxa blennodioides*  
*Harmsiodoxa brevipes* var. *brevipes*  
*Lepidium leptopetalum*  
*Lepidium papillosum*  
*Lepidium phlebopetalum*  
*Menkea australis*  
 \**Sisymbrium erysimoides*  
 \**Sisymbrium irio*  
 \**Sisymbrium orientale*  
*Stenopetalum lineare*  
*Stenopetalum sphaerocarpum*

**CACTACEAE**

\**Opuntia vulgaris*

**CAESALIPINACEAE**

*Senna artemisioides* notho subsp. *coriacea*  
*Senna artemisioides* subsp. *filifolia*  
*Senna artemisioides* subsp. *petiolaris*

**CAMPANULACEAE**

*Wahlenbergia communis* s.l.  
*Wahlenbergia gracilentata* s.l.  
*Wahlenbergia gracilis* s.l.

**CARYOPHYLLACEAE**

*Gypsophila tubulosa*  
 \**Herniaria cinerea*  
*Scleranthus minusculus*  
 \**Silene apetala*

\**Spergularia diandra*

\**Spergularia rubra*

**CASUARINACEAE**

\**Casuarina pauper*



**CHENOPODIACEAE**

*Atriplex acutibractea*  
*Atriplex eardleyae*  
*Atriplex holocarpa*  
*Atriplex lindleyi* subsp. *inflata*  
*Atriplex nummularia*  
*Atriplex stipitata*  
*Atriplex suberecta*  
*Atriplex vesicaria*  
 \**Chenopodium album*  
*Chenopodium cristatum*  
*Chenopodium curvispicatum*  
*Chenopodium desertorum*  
*Chenopodium melanocarpum*  
 \**Chenopodium murale*  
*Chenopodium nitrariaceum*  
*Chenopodium* spp.  
*Chenopodium ulicinum*  
*Dissocarpus paradoxus*  
*Einadia nutans*  
*Enchylaena tomentosa* var. *tomentosa*  
*Eriochiton sclerolaenoides*  
*Halosarcia halocnemoides* subsp. *halocnemoides*  
*Halosarcia indica*  
*Halosarcia lylei*  
*Halosarcia pergranulata*  
*Halosarcia pterygosperma* subsp. *pterygosperma*  
*Maireana appressa*  
*Maireana brevifolia*  
*Maireana ciliata*  
*Maireana decalvans*  
*Maireana erioclada*  
*Maireana georgei*  
*Maireana integra*  
*Maireana lobiflora*  
*Maireana pentatropis*  
*Maireana pyramidata*  
*Maireana radiata*  
*Maireana sedifolia*  
*Maireana trichoptera*

*Maireana triptera*  
*Maireana turbinata*  
*Malacocera tricornis*  
*Neobassia* spp.  
*Osteocarpum acropterum* var. *deminutum*  
*Rhagodia spinescens*  
*Rhagodia ulicina*  
*Salsola kali*  
*Sclerolaena bicornis*  
*Sclerolaena decurrens*  
*Sclerolaena diacantha*  
*Sclerolaena divaricata*  
*Sclerolaena muricata*  
*Sclerolaena obliquicuspis*  
*Sclerolaena parviflora*  
*Sclerolaena patentiscuspis*  
*Sclerolaena tricuspis*  
*Sclerostegia tenuis*

**CONVOLVULACEAE**

*Convolvulus erubescens*

**CRASSULACEAE**

*Crassula colorata*

**CUCURBITACEAE**

\**Citrullus colocynthis*  
 \**Cucumis myriocarpus*

**CUPRESSACEAE**

*Callitris glaucophylla*  
*Callitris verrucosa*

**CYPERACEAE**

*Schoenus subaphyllus*

**DILLENIACEAE**

*Hibbertia virgata*

**ELATINACEAE**

*Bergia trimera*

**EUPHORBIACEAE**

*Beyeria opaca*

**EUPHORBIACEAE**

*Chamaesyce drummondii*  
*Poranthera microphylla*

**FABACEAE**

*Daviesia ulicifolia*  
*Eutaxia diffusa/microphylla*  
*Indigophora australis*  
*Lotus cruentus*  
 \**Medicago laciniata*  
 \**Medicago minima*  
 \**Medicago polymorpha*  
 \**Melilotus indicus*  
*Swainsona purpurea*  
*Templetonia egena*

**FRANKENIACEAE**

*Frankenia connata*  
*Frankenia foliosa*  
*Frankenia pauciflora* subsp. *pauciflora*  
*Frankenia serpyllifolia*

**GENTIANACEAE**

\**Centaurium spicatum*  
 \**Centaurium tenuiflorum*

**GERANIACEAE**

\**Erodium botrys*  
 \**Erodium cicutarium*  
*Erodium crinitum*

**GOODENIACEAE**

*Goodenia fascicularis*  
*Goodenia pinnatifida*  
*Goodenia pusilliflora*  
*Scaevola depauperata*  
*Scaevola spinescens*

**GYROSTEMONACEAE**

*Codonocarpus cotinifolius*

**HALORAGACEAE**

*Glischrocaryon behrii*  
*Haloragis aspera*  
*Haloragis odontocarpa*  
*Myriophyllum verrucosum*  
*Myriophyllum* sp.

**JUNCAGINACEAE**

*Triglochin calcitrapum*

**LAMIACEAE**

\**Marrubium vulgare*  
 \**Salvia verbenaca*  
*Teucrium racemosum* var. *racemosum*  
*Westringia rigida*

**LAURACEAE**

*Cassytha melantha*

**LILIACEAE**

*Bulbine bulbosa*  
*Dianella revoluta*  
*Thysanotus baueri*

**LOGANIACEAE**

*Logania nuda*

**LORANTHACEAE**

*Amyema linophyllum* subsp. *orientale*  
*Amyema miquelii*  
*Amyema miraculosum* subsp. *boormanii*  
*Amyema preissii*  
*Lysiana exocarpi* subsp. *exocarpi*

**MALVACEAE**

*Abutilon fraseri*  
*Lawrencia glomerata*  
*Lawrencia squamata*  
 \**Malva parviflora*  
 \**Modiola caroliniana*  
*Radyera farragei*  
*Sida corrugata* var. *corrugata*  
*Sida intricata*

**MARSILEACEAE**

*Marsilea angustifolia*  
*Marsilea costulifera*  
*Marsilea drummondii*

**MIMOSACEAE**

*Acacia acanthoclada*  
*Acacia aneura*  
*Acacia brachybotrya*  
*Acacia burkittii*  
*Acacia colletioides*  
*Acacia ligulata*

**MIMOSACEAE cont.***Acacia loderi**Acacia oswaldii**Acacia rigens**Acacia sclerophylla**Acacia wilhelmiana***MYOPORACEAE***Eremophila deserti**Eremophila divaricata* subsp. *divaricata**Eremophila glabra**Eremophila glabra* subsp. *murrayana**Eremophila longifolia**Eremophila maculata* var. *maculata**Eremophila oppositifolia* subsp. *oppositifolia**Eremophila scoparia**Eremophila sturtii**Myoporum platycarpum**Myoporum viscosum***MYRTACEAE***Baeckea crassifolia**Eucalyptus costata/incrassata**Eucalyptus dumosa**Eucalyptus gracilis**Eucalyptus leptophylla**Eucalyptus oleosa**Eucalyptus porosa**Eucalyptus socialis**Leptospermum coriaceum**Melaleuca lanceolata***NYCTAGINACEAE***Boerhavia dominii***OLEACEAE***Jasminum didymum* subsp. *lineare***ORCHIDACEAE***Pterostylis biseta* s.l.**OXALIDACEAE***Oxalis perennans*\**Oxalis pes-caprae***PITTOSPORACEAE***Billardiera cymosa**Pittosporum phylliraeoides***PLANTAGINACEAE***Plantago cunninghamii**Plantago drummondii**Plantago varia***POACEAE***Agrostis avenacea**Amphipogon caricinus* var. *caricinus**Aristida contorta**Aristida* spp.*Bromus arenarius*\**Bromus rubens**Chloris truncata*\**Critesion murinum* subsp. *leporinum**Cynodon dactylon**Danthonia eriantha**Danthonia setacea**Enneopogon intermedius**Eragrostis australasica**Eragrostis dielsii**Eragrostis eriopoda**Eragrostis falcata**Eragrostis setifolia*\**Holcus lanatus*\**Panicum capillare**Paspalidium gracile*\**Rostraria pumila*\**Schismus barbatus**Stipa drummondii**Stipa elegantissima**Stipa scabra* subsp. *scabra**Stipa* spp.*Triodia scariosa* subsp. *scariosa*\**Vulpia myuros***POLYGONACEAE**\**Emex australis**Muehlenbeckia diclina*

**POLYGONACEAE cont.***Muehlenbeckia florulenta**Polygonum plebeium*\**Rumex crispus**Rumex tenax***PORTULACACEAE***Calandrinia eremaea***PRIMULACEAE**\**Anagallis arvensis***PROTEACEAE***Grevillea huegelii**Grevillea pterosperma**Hakea leucoptera**Hakea tephrosperma***RANUNCULACEAE***Ranunculus pumilio***RHAMNACEAE***Cryptandra propinqua***RUBIACEAE***Asperula conferta**Synaptantha tillaeaceae***RUTACEAE***Geijera parviflora***SANTALACEAE***Exocarpos aphyllus**Exocarpos sparteus**Santalum acuminatum***SAPINDACEAE***Alectryon oleifolius* subsp. *canescens**Dodonaea bursariifolia**Dodonaea viscosa* subsp. *angustissima***SCROPHULARIACEAE***Limosella australis**Morgania floribunda***SOLANACEAE***Duboisia hopwoodii**Lycium australe*\**Lycium ferocissimum*\**Nicotiana glauca**Nicotiana goodspeedii**Nicotiana occidentalis**Nicotiana simulans**Nicotiana velutina**Solanum coactiliferum**Solanum esuriale*\**Solanum nigrum***THYMELAEACEAE***Pimelea microcephala* subsp. *microcephala**Pimelea simplex* subsp. *simplex**Pimelea trichostachya***TYPHACEAE***Typha domingensis***URTICACEAE***Parietaria debilis***VERBENACEAE**\**Verbena supina***XANTHORRHOACEAE***Lomandra effusa**Lomandra leucocephala* subsp. *robusta***ZYGOPHYLLACEAE***Nitraria billardieri**Tribulus terrestris**Zygophyllum ammophilum**Zygophyllum apiculatum**Zygophyllum aurantiacum**Zygophyllum billardieri**Zygophyllum crenatum**Zygophyllum eremaeum**Zygophyllum glaucum**Zygophyllum iodocarpum**Zygophyllum ovatum*