APPENDIX

1 Botanical Significance Ratings used for Natural Temperate Grassland Sites

The botanical significance ratings are based on a qualitative assessment of the naturalness of the vegetation community in grassland sites. They have been modified by Environment ACT (Wildlife Research and Monitoring) from Stuwe (1986) to assist with the identification of conservation values of sites. A further modification of the ratings as applied in Action Plan 1 (ACT Government 1997a) has been undertaken using a more thorough knowledge of the response of species of plants to disturbance. The ratings reflect the diversity of native and exotic plant species and the occurrence of species that are indicative of disturbance levels. Diversity is a measure of species richness measured over a specified area, such as species per hectare.

Botanical significance rating has been applied to polygons, which are the smallest units surveyed in 2003–04 and are identified as homogeneous areas in terms of vegetation structure and composition. The species identified in the polygons were used to enable interpretation of the extent to which sites are likely to have been modified. This was based on the diversity and abundance of species that have been identified as sensitive to disturbance. Studies undertaken by Prober and Thiele (1995) and Dorrough (Dorrough *et al.* 2004) have described which species occur more frequently in grazed and ungrazed areas. Plant ecologists from Environment ACT and the NSW National Parks and Wildlife Service have been analysing the frequency with which native species have been encountered during grassland and woodland surveys in over 700 sites in the ACT and NSW Southern Tablelands since 1991. These studies have provided information on those species that are less common, and those that appear to have declined as a result of site disturbance. The following table lists examples of these species.

Because annual exotic species fluctuate in their cover and diversity between seasons and years, they are not used in the evaluation of botanical significance rating, although generally there is a greater cover of annual exotic species in the more disturbed sites. However, grasslands almost invariably now contain perennial and annual plant species.

Within a site there may be multiple polygons, which may differ in terms of their botanical significance. This may be due to differing disturbance levels or differences in natural site conditions such as drainage, soil depth or nutrient levels. Where the BSR varies in a site, the botanical significance of the minor areas is indicated in brackets.

Botanical significance rating does not include other assessments of conservation value, including the occurrence of threatened species, the occurrence of particular floristic associations, site size, threats from surrounding land uses and assessments of viability. These assessments, together with the botanical significance, are used to determine appropriate protection and management requirements (see s. 3.4).

The attributes of each botanical significance rating are expressed in tabular form in Table 3.1 (Chapter 3).

Botanical Significance Rating 1 (Very High)

Sites with this rating contain a very high diversity and cover of native plant species, especially native forbs and including uncommon species and several to many disturbance sensitive species, and a low cover of exotic species. These sites contain species indicative of minimal disturbance and generally include the most natural examples of the ecological community. They are amongst the best available sites of their type, and are often one of only a small number of sites with similar conservation values remaining in Australia. These sites are categorised as **partially modified natural temperate grassland**.

Botanical Significance Rating 2 (High)

Sites with this rating have a high to very high diversity of native plants. They generally have fewer species indicative of minimal disturbance than areas classed as BSR 1, but contain uncommon species and several disturbance sensitive species. They have a low cover of perennial exotic species. These sites are categorised as **partially modified natural temperate grassland**.

Botanical Significance Rating 3 (Moderate)

Sites with this rating have usually been moderately altered by disturbance or land uses. They have moderate to high native species diversity, but only those species that are tolerant of disturbance. There is low to moderate exotic species cover. These sites are categorised as **moderately modified natural temperate grassland**.

Botanical Significance Rating 4 (Low)

Sites with this rating contain a very low diversity of native species, particularly native forbs, but contain a high cover of native grasses. They contain a low to moderate cover, but may have a high diversity of perennial exotic plants. They include no species that are indicative of low levels of disturbance. They are unlikely to have a diverse native seed bank, and therefore may not be able to naturally regenerate to increase diversity. The maintenance of these sites as natural temperate grassland generally requires considerable management input. However, they may be valuable for fauna habitat, for wildlife corridors or buffers to areas of higher conservation value, and as potential sites for rehabilitation. These sites are categorised as **highly modified natural temperate grassland**.

Botanical Significance Rating 5 (Very Low)

Sites with this rating have a high cover of native grasses, but native forb cover and diversity is very low to zero. They contain only native species tolerant of high levels of disturbance (such as previous cropping, regular fertiliser input or continuous intensive grazing). Exotic species cover is moderate to low but diversity may be high. However, they may be valuable for fauna habitat, for wildlife corridors or buffers to areas of higher conservation value, and as potential sites for rehabilitation. These sites are categorised as **substantially modified native grassland (native pasture)** and are not regarded as the natural temperate grassland endangered ecological community.

Botanical Significance Rating E (Exotic)

These sites are dominated by perennial exotic species. They may contain low to very low cover of disturbance tolerant native species, mainly grasses or may be entirely exotic (such as sown pasture).

SPECIES TYPICAL OF DIFFERENT LEVELS OF DISTURBANCE

Species typical of different levels of disturbance in lowland grassy ecosystems are shown in the following table.

Degree of Disturbance	Ground Layer Species	Examples of Characteristic Species	Typical Flora of the Ground Layer	BSR Rating
Very low	Disturbance sensitive species	*Diuris* spp., *Caladenia* spp., *Thelymitra* spp.	Native species include orchids, lilies and other highly sensitive species, as well as more tolerant species.	**1**
Low	Moderately disturbance tolerant species	*Dichopogon* spp., *Bulbine bulbosa*, *Craspedia variabilis*, *Cryptandra amara*, *Themeda triandra*, *Pimelia* spp., *Wurmbea dioica*	Species present include those moderately tolerant of disturbance, as well as disturbance tolerant species.	**2**
Moderate	Disturbance tolerant species	*Chrysocephalum apiculatum*, *Convolvulus erubescens*, *Plantago varia*, *Asperula conferta*, *Glycine* spp., *Hibbertia obtusifolia*	Native species include those commonly found in a range of sites that have been subject to moderate disturbance; sensitive species are rarely present.	**3,4**
High	Disturbance tolerant native grasses	*Poa* spp., *Austrodanthonia* spp., *Austrostipa* spp., *Bothriochloa macra*, *Microlaena stipoides*	Site may contain a variety of native grass species but few or no native forbs are present.	**5**
Very high	Exotic species	Perennial and annual* weeds, introduced or adventitious species.	Either dominated by perennial exotic species species or a low cover and diversity of native species, of which most are native grasses.	**E**

* Because annual exotic species fluctuate in cover and diversity between seasons and years, they are not used in the evaluation of the degree of disturbance although generally there is a greater cover of annual exotic species in the more disturbed sites.

APPENDIX

2 Changes in Areas of Lowland Native Grassland and Threatened Species Habitat in the ACT Since 1997

1. Increase in Area of Natural Temperate Grassland since 1997

(a) New Sites Identified as Containing Natural Temperate Grassland

Area/Site Name	Floristic Association—2005	BSR—2005	Area (ha)
Canberra Central			
St Johns Church, Reid, CC03	*Austrodanthonia* grassland	BSR 4	0.9
Kintore St, Yarralumla, CC09	Dry *Themeda* grassland	BSR 3	0.8
Jerrabomberra Valley			
Tennant St, Fyshwick, JE10	Dry *Themeda* grassland	BSR 3	0.3
Gungahlin			
Nicholls, GU08	*Austrostipa* grassland	BSR 4	0.3
Wells Station Road, GU07	*Austrostipa* grassland	BSR 4	0.2
TOTAL (additional area of Natural Temperate Grassland)			**2.5**

(b) Sites Described as Being Natural Temperate Grassland Due to Improvements in Survey and Condition Assessment Techniques

Area/Site Name	Floristic Association—1997	BSR—2005	Area (ha)
Belconnen			
Dunlop Nature Reserve, BE02	*Austrostipa grassland*, native pasture	BSR 3, 4	51.1
Umbagong Park, BE04	*Austrodanthonia*, dry *Themeda* grassland, native pasture, exotic vegetation	BSR 4, 5	4.0
Glenloch Interchange, BE11	Dry *Themeda* grassland, native pasture	BSR 2	0.7
Gungahlin			
Gungaderra Grassland Reserve, GU02	*Austrostipa* grassland, native pasture	BSR 4	12.3
Crace Grassland Reserve, GU03	*Themeda* grassland, native pasture	BSR 3	8.2
Jerrabomberra Valley			
Mugga Mugga, JE01	*Austrostipa* grassland, native pasture	BSR 4	12.0
Woods Lane (Tharwa Road), JE04	Dry *Themeda* grassland, exotic, native pasture	BSR 3	8.3
Canberra Central			
Dudley St, Yarralumla, CC08	*Austrodanthonia* grassland, exotic vegetation	BSR 3	0.6
TOTAL (area reassessed as Natural Temperate Grassland)			**97.2**

2. Reduction in Area of Natural Temperate Grassland Since 1997

(a) Sites Developed in Whole or Part Since 1997

Area/Site Name	Floristic Association—1997	Status 2005	Decrease in Area (ha)
Gungahlin			
'Stray Leaf' Property, GAP 4	*Austrostipa* grassland, BSR 4	Loss of all of site	4.8
Majura Valley			
Canberra International Airport, MA03	*Austrodanthonia* grassland, BSR 3, 4	Loss of part of site	2.0
Canberra Central			
ACCC, Barton, CC04	Dry *Themeda* grassland, BSR 1	Loss of part of site	1.2
TOTAL (decrease in area of Natural Temperate Grassland)			**8.0**

(b) Sites that Have Deteriorated Since 1997

Area/Site Name	Floristic Association, Change in BSR	Cause of Reduction in Area	Decrease in Area (ha)
Canberra Central			
Yarramundi Reach, CC06	Dry *Themeda*, Wet *Themeda*, *Poa* grasslands, BSR 3 to 4	Weed invasion	10.8
Lady Denman Drive, CC07	*Austrodanthonia* grassland, BSR 3 to exotic	Weed invasion	2.1
Belconnen			
Evatt Powerlines, BE05	*Austrodanthonia* grassland, BSR 4 to exotic	Weed invasion	1.1
Gungahlin			
Mitchell, GU05	Dry *Themeda* grassland, BSR 3 to 5 (native pasture)	Site disturbance	0.3
Total area (decreased BSR)			**14.3**

(c) Sites Described in 2005 as Native Pasture or Exotic Grassland and not Natural Temperate Grassland, Based on Improvements in Survey and Condition Assessment Techniques

Area/Site Name	Floristic Association—1997	2005 Classification	Decrease in Area (ha)
Belconnen			
Lawson Territory, BE07	*Austrostipa* grassland, BSR 3	Native pasture, BSR 5	46.9
Kaleen East, BE09	*Austrodanthonia* grassland, BSR 3	Native pasture, BSR 5	24.6
Lake Ginninderra, BE06	*Austrodanthonia* grassland, BSR 4	Exotic	0.4
Majura Valley			
Canberra International Airport, MA03	*Austrodanthonia* grassland, BSR 2, 3	Native pasture, BSR 5	44.2
Jerrabomberra Valley			
Amtech, JE09	*Austrodanthonia* grassland, BSR 4	Exotic	6.2
Canberra Central			
Constitution Avenue, Reid, CC02	Dry *Themeda* grassland, BSR 3	Exotic	2.3
Lady Denman Drive, CC07	*Austrodanthonia* grassland, BSR 3	Exotic	2.1

(Continued) ▶

2. (c) *(Continued)*

Area/Site Name	Floristic Association—1997	2005 Classification	Decrease in Area (ha)
Gungahlin			
Belconnen Pony Club, GU06	*Austrodanthonia* grassland, BSR 3	Exotic	1.2
Kenny North, GAP 11	*Austrostipa* grassland, BSR 4	Exotic	11.4
Gundaroo Road South, GAP 8	*Austrostipa* grassland, BSR 4	Exotic	4.2
Kenny, GAP 12	*Austrostipa* grassland, BSR 4	Exotic	1.7
TOTAL (reduction in area of Natural Temperate Grassland)			**145.2**

Note that all these sites retain some native grassland.

3. Sites Formerly Described as Natural Temperate Grassland, but Re-assessed as Secondary Grassland or Woodland and Now Included in the *ACT Lowland Woodland Conservation Strategy* (ACT Government 2004a)

Area/Site Name	Floristic Association—1997	Area (ha)
Gungahlin		
Horse Park Entrance, GAP 1	Wet *Themeda*, *Austrodanthonia* grassland, BSR 3, 4	32.1
Mulanggari Grassland Reserve, GU01	*Austrodanthonia* grassland, BSR 3	23.5
Kosciusko Ave., Palmerston, GAP 7	Dry *Themeda* and *Austrostipa* grassland, BSR 3, 4 (developed)	14.2
Harrison, GAP 5	*Austrostipa* grassland, BSR 4	4.7
Majura Valley		
Majura Training Area, MA01	*Austrodanthonia* grassland, BSR 2	15.6
Jerrabomberra Valley		
'Woden Station', JE03	*Austrodanthonia* grassland, BSR 2	10.9
Belconnen		
Caswell Drive, BE10	Dry *Themeda* grassland, BSR 3	1.0
TOTAL (included in Lowland Woodland Conservation Strategy)		**102.0**

Note:

1. **GAP** (Grassland Action Plan) location numbers are from Action Plan 1 (ACT Government 1997a).
2. **BSR**: Botanical Significance Rating (see Appendix 1).
3. **Site numbers (e.g. MA01)**: A complete list is contained in Table 3.2

APPENDIX

3 Specific and Common Names of Species in this Strategy

NATIVE GRASSES

Bothriochloa macra	Red Grass
Chloris truncata	Windmill Grass
Danthonia spp.	Wallaby Grasses
D. caespitosa	Ringed Wallaby Grass
D. carphoides	Short Wallaby Grass
D. laevis	Wallaby Grass
Elymus scaber	Common Wheat Grass
Enneapogon nigricans	Niggerheads
Poa spp.	Tussock Grasses
Poa labillardieri	Tussock Grass
P. sieberiana ssp. *sieberiana*	Tussock Grass
Panicum effusum	Hairy Panic
Stipa spp.	Spear grasses
S. scabra ssp. *falcata*	Spear grass
S. bigeniculata	Spear grass
Themeda triandra	Kangaroo Grass

NATIVE FORBS

Asperula conferta	Common Woodruff
Bulbine bulbosa	Golden Lily
Carex appressa	Sedge
C. inversa	Common Sedge
Chrysocephalum apiculatum	Common Everlasting
Goodenia pinnatifida	Scrambled Eggs
Haloragis heterophylla	Perennial Raspweed
Hydrocotyle laxiflora	Stinking Pennywort
Juncus spp.	Rushes
Leptorhynchos squamatus	Scaly Buttons
Microseris lanceolata	Yam Daisy
Oxalis perennans	Wood Sorrel
Plantago varia sens. lat.	Variable Plantain
Psoralea tenax	Emu Foot
Rutidosis leptorrhynchoides	Button Wrinklewort
Solenogyne dominii	Solenogyne
Stackhousia monogyna	Creamy Candles
Swainsona monticola	Purple Pea
S. sericea	Purple Pea
S. recta	Purple Pea
Thesium australe	Toadflax
Triptilodiscus pygmaeus	Common Sunray
Vittadinia muelleri	Narrow-leaf New Holland Daisy
Wahlenbergia spp.	Native bluebells
Wurmbia dioica	Early Nancy

EXOTIC GRASSES

Aira caryophyllea	Silvery Hairgrass
Aira elegantissima	Delicate Hairgrass
Avena spp.	Wild Oats
Bromus hordaceous	Brome
Dactylis glomerata	Cocksfoot
Holcus lanatus	Yorkshire Fog
Phalaris aquatica	Phalaris
Poa pratensis	Kentucky Bluegrass
Vulpia myuros	Rat's Tail Fescue

EXOTIC FORBS

Arctotheca calendula	Cape Weed
Carthamus lanatus	Saffron Thistle
Centaurium erythraea	Common Centaury
Cerastium glomeratum	Chick weed
Cirsium vulgare	Spear Thistle
Hypochaeris glabra	Smooth Catsear
Hypochaeris radicata	Flatweed
Paronchyia brasiliana	Chilean Whitlow
Rumex crispus	Curled Dock
Tolpis umbellata	Tolpis
Tragopogon porrifolius	Salsify
Tragopogon dubius	Salsify
Trifolium spp.	Clovers
T. arvense	Haresfoot Clover
T. campestre	Hop Clover
T. dubium	Yellow Suckling Clover
T. glomeratum	Clover
T. repens	White Clover

INVERTEBRATES

Cooraboorama canberrae	Canberra Raspy Cricket
Keyacris scurra	Key's Matchstick
Perunga ochracea	Perunga Grasshopper
Synemon plana	Golden Sun Moth

REPTILES

Aprasia parapulchella	Pink-tailed Worm Lizard
Delma impar	Striped Legless Lizard
Lampropholis delicata	Delicate Skink
Tympanocryptis pinguicolla	Grassland Earless Dragon

AMPHIBIANS

Lymnodynastes dumerilii	Eastern Banjo Frog
Neobatrachus sudelli	Spotted Burrowing Frog
Uperoleia laevigata	Orange-groined Toadlet

BIRDS

Ardeotis australis	Australian Bustard
Coturnix australis	Brown Quail
Coturnix novaezeelandiae	Stubble Quail
Ephthianura albifrons	White-fronted Chat
Gallinago hardwickii	Latham's Snipe
Gymnorhina tibicen	Australian Magpie
Pedionomus torquatus	Plains Wanderer
Rhipidura leucophrys	Willy Wagtail

APPENDIX

4 Threatened Plant Species in Natural Temperate Grassland in the ACT (declared under the *Nature Conservation Act 1980* (ACT))

Appendix 4.1

Button Wrinklewort (*Rutidosis leptorrhynchoides*)

(Illustration: John Pratt)

In accordance with section 21 of the *Nature Conservation Act 1980*, the **Button Wrinklewort (*Rutidosis leptorrhynchoides*)** was declared an **endangere**d species on 15 April 1996 (formerly Determination No. 29 of 1996 and currently Determination No. 7 of 1998). Section 23 of the Act requires the Conservator of Flora and Fauna to prepare an Action Plan in response to each declaration. The Action Plan requirements are incorporated into this *Lowland Native Grassland Conservation Strategy*.

Conservation Status (ACT) Endangered

Criteria satisfied (ACT Flora and Fauna Committee 1995)

The species is known or suspected to occur in the ACT region and is already recognised as endangered in an authoritative international or national listing.

The species is observed, estimated, inferred or suspected to be at risk of premature extinction in the ACT region in the near future, as demonstrated by the following:

- Current severe decline in population or distribution, from evidence based on:
  - —direct observation, including comparison of historical and current records; and
  - —severe decline in quality or quantity of habitat.
- Imminent risk of severe decline in population or distribution from evidence based on severe decline in quality or quantity of habitat.
- Severely fragmented distribution for a species currently occurring over a small range or having a small area of occupancy within its range.

DESCRIPTION

The Button Wrinklewort (*Rutidosis leptorrhynchoides*) is a slender perennial forb, 25–35 cm tall with up to 30 leafy stems, branching mainly at the base. The leaves are narrow, dark green, ageing to yellow–green and up to 3.5 cm long and 1.5 mm wide, with rolled edges concealing the undersides. The stems usually die back in late summer or autumn, and the new basal leaves appear by early winter. The species has bright yellow button flowers (2 cm wide) from December to April.

DISTRIBUTION AND ABUNDANCE

R. leptorrhynchoides appears to have been formerly widespread in south-eastern New South Wales and across the western plains of Victoria. The species has a disjunct distribution and is known from 17 populations in the ACT region (ten within the ACT, six near

Queanbeyan and one near Goulburn (NSW)) and nine in Victoria. Current populations range in size from five to approximately 95,000 plants. These are often restricted to small, scattered refugia that have escaped grazing, ploughing and the application of fertilisers, for example, road margins, railway easements and cemeteries (Young 1997).

Of the nine sites occurring within the ACT, two have large populations. The larger is within Stirling Park, Yarralumla, where up to 70 000 plants have been recorded (A. Young and F. Zich unpublished data). The other, comprising about 30 000 plants, occurs on the Majura Training Area, although this is confined to a small area and is therefore vulnerable to damage (Crawford and Rowell 1996). Smaller populations occur on Red Hill, at Barton, on the edge of Capital Hill, near West Block, the Campbell Park Offices and near HMAS Harman, in the Jerrabomberra Valley.

In NSW, the species is known to occur naturally at six sites within the Queanbeyan area, with the largest population (10 000 plants in February 1995) being found within the Queanbeyan Nature Reserve (A. Young and F. Zich unpubl. data). Other sites occur at 'The Poplars' near Jerrabomberra, Letchworth, along the slopes of Mt. Jerrabomberra, and along a roadside by the Queanbeyan–Captains Flat Road.

The largest known NSW population is at Gundary Reserve, a Travelling Stock Reserve and Arboretum, 5 km SSE of Goulburn, NSW and contains 95 000 plants (A. Young unpubl. data).

HABITAT

In the ACT, *R. leptorrhynchoides* occurs on the margins of open stands of Yellow Box–Red Gum Grassy Woodland with a ground layer of various native grasses and other forbs, and extends into Natural Temperate Grassland. Soils are usually shallow stony red–brown clay loams. Occasionally, Apple Box (*Eucalyptus bridgesiana*) is also present.

Rutidosis leptorrhynchoides prefers an open habitat and is a poor competitor amongst tall, dense sward-forming grasses. It is found where the soil is too shallow to support the growth of plants that may rapidly overtop it, or on deeper soils where the vegetation is kept short by regular disturbance (Scarlett and Parsons 1990). It may also be adapted to the sparser *Themeda* growth found under trees in woodlands (Morgan 1995a).

BIOLOGY

The population density of the species affects seed production, with sparsely distributed individuals producing fewer seeds per inflorescence than plants from denser colonies. This suggests that the species is dependent on the maintenance of the standing population for recruitment (Morgan 1995a).

In Victoria, recruitment may be limited by high summer mortality of seedlings in open microsites and by deep shading in dense, unburnt grasslands (Morgan 1995b).

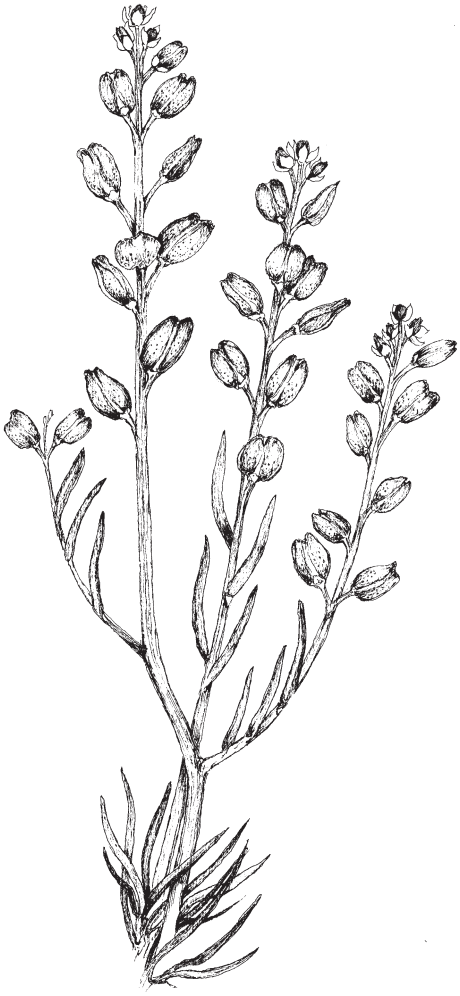
The reproductive potential and viability of small remnant populations may also be limited by inbreeding and related reductions in fitness (inbreeding depression). Research using genetic markers to characterise the mating patterns of *R. leptorrhynchoides* shows evidence of increased potential for mating among relatives in populations of less than 200 plants, especially when these are isolated by more than 5 km from other populations. The demographic consequences of this are as yet unknown, but could be significant.

Reproductive capability of populations also depends on their chromosome number. Chromosome counts of *R. leptorrhynchoides* show the species to be cytologically complex. Northern populations in the ACT and NSW are diploid (2n=26), while in the south of the range, Victorian populations are either wholly diploid, or primarily tetraploid (2n=44), with a mix of anueploids and even some hexaploids. Diploids produce more seed per head than tetraploids and any mating between the two ploidy levels produces few seed, all of which are triploids with low pollen fertility (Young 1997).

R. leptorrhynchoides has been the subject of considerable ecological and genetic research aimed at understanding the factors that limit population viability. Most of this is reviewed in Young *et al.* (2000). Issues and options for the genetic conservation of the species are contained in Young (2001).

Appendix 4.2

Ginninderra Peppercress (*Lepidium ginninderrense*)



(Illustration: Kim Neubauer)

In accordance with section 21 of the *Nature Conservation Act 1980*, the **Ginninderra Peppercress (*Lepidium ginninderrense*)** was declared an **endangered** species on 4 September 2001 (Instrument No. 192 of 2001). Section 23 of the Act requires the Conservator of Flora and Fauna to prepare an Action Plan in response to each declaration. The Action Plan requirements are incorporated into this *Lowland Native Grassland Conservation Strategy*.

Conservation Status (ACT) Endangered

Criteria satisfied (ACT Flora and Fauna Committee 1995)

The species is observed, estimated, inferred or suspected to be at risk of premature extinction in the ACT region in the medium-term future, as demonstrated by:

- Severely fragmented distribution for a species currently occurring over a small range or having a small area of occupancy within its range.

DESCRIPTION

The Ginninderra Peppercress *Lepidium ginninderrense* N. H. Scarlett is a perennial herb to a maximum height of about 20 cm, with one to six branched stems arising from a rootstock. Stems are striate and moderately papillose. Leaves are thick and fleshy, glabrous and shiny on the upper surface. Rosette leaves are widely spaced and very narrow (1.5 to 2.0 mm wide) and 15–55 mm long. The inflorescence is an elongating raceme with a maximum length of 15 cm. Flowers are small, 2 mm wide and 1.5 mm long. Sepals are less than 1 mm long and about 0.5 mm wide, green and with scarious margins. Petals are absent (Scarlett 2001). *Lepidium ginninderrense* flowers in late spring. It sets seed mainly in December and the majority of seed is dispersed before August (Avis 2000).

DISTRIBUTION AND ABUNDANCE

The only known population of *Lepidium ginninderrense* occurs in the north-west corner of Belconnen Naval Transmission Station in the suburb of Lawson in the Australian Capital Territory (which is the type locality). The population is currently about 2000 plants, occupying an area of 90 x 30 metres (Avis 2000).

A second record of *L. ginninderrense* is from 1952 in the ACT suburb of Reid, however, a recent search failed to locate the species in this area (M. Gray pers. comm. cited in Scarlett 2001).

L. ginninderrense has been recorded only from these two cited localities in the ACT and is not known from outside the ACT. The species is remarkably disjunct from all other members of the allied *Lepidium* section *Papillosa* in south-eastern Australia, which are mainly confined to the inland plains west and north of the Eastern Highlands (Scarlett 2001).

HABITAT

At the type locality *Lepidium ginninderrense* grows on the flood plain of Ginninderra Creek, in Natural Temperate Grassland dominated by *Austrodanthonia* spp. and *Bothriochloa macra*. Associated herbaceous species include *Plantago gaudichaudii*, *Juncus filicaulis*, *Triptilodiscus pygmaeus*, *Parentucellia latifolia* and *Calocephalus citreus* (Scarlett 2001).

Avis (2000) has shown that *L. ginninderrense* grows in areas with relatively low perennial grass cover, often with indications of past soil disturbance.

The soil type over most of the site is a shallow red earth, with patches of colluvium on the footslopes (Crawford and Rowell 1995a cited in Lowe 1996, p. 41). The population occurs at an altitude of approximately 580 metres.

BIOLOGY

Almost nothing is known about the general biology of the species but fecundity (seed set) appears to be good. The species may still contain significant genetic variation that could form the basis for a conservation strategy (Young 2001).

APPENDIX

5 Threatened Animal Species in Natural Temperate Grassland in the ACT (declared under the *Nature Conservation Act 1980* (ACT))

Appendix 5.1

Striped Legless Lizard (*Delma impar*)

In accordance with section 21 of the *Nature Conservation Act 1980*, the **Striped Legless Lizard (*Delma impar*)** was declared a **vulnerable** species on 15 April 1996 (formerly Determination No. 29 of 1996 and currently Determination No. 89 of 1997). Section 23 of the Act requires the Conservator of Flora and Fauna to prepare an Action Plan in response to each declaration. The Action Plan requirements are incorporated into this *Lowland Native Grassland Conservation Strategy*.

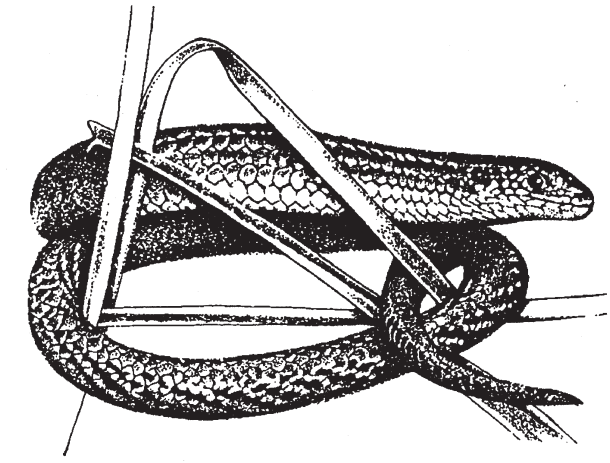


Figure 1: Striped Legless Lizard (*Delma impar*)

(Illustration: Marjorie Crosby-Fairall)

Conservation Status (ACT) Vulnerable

Criteria satisfied (ACT Flora and Fauna Committee 1995)

The species is known to occur in the ACT region and is already recognised as vulnerable in an authoritative international or national listing.

Species is observed, estimated, inferred or suspected to be at risk of premature extinction in the ACT region in the medium-term future, as demonstrated by the following:

- Current serious decline in population or distribution from evidence based on:
  - —serious decline in quality and quantity of habitat;
  - —high actual or potential levels of exploitation or persecution; and
  - —serious threats from herbivores, predators, parasites, pathogens or competitors.
- Imminent risk of serious decline in population or distribution from evidence based on the above.
- Seriously fragmented distribution for a species currently occurring over a moderately small range or having a moderately small area of occupancy within its range.

DESCRIPTION

The Striped Legless Lizard *Delma impar* (Fischer 1882) (Figure 1) is a reptile of the family Pygopodidae. The average snout-vent length of adults is 90 mm (Cogger 2000), with a maximum total length of about 300 mm and an average body weight of 4.1 grams (Coulson 1990). Sexes are externally similar.

The species is variable in colour but is most commonly pale grey-brown above, with a series of dark brown or blackish longitudinal stripes along the length of the body and tail, commencing at the neck (Cogger 2000). A large amount of variation exists between individuals in colour and intensity of the striping, and in some animals (particularly in the young), striping is indistinct or absent. The colour of the head is darker than that of

the body, being dark brown to dark slate grey in adults and black in young individuals. The ventral surface has been described as whitish (Cogger 2000), however some individuals have salmon-pink coloration on the flanks that may extend to the undersurface. Most individuals have yellow coloration on the infralabial and adjacent gular scales, extending back to the tympanum (Coulson 1990). The Striped Legless Lizard can usually be distinguished from the Inornate Legless Lizard *Delma inornata*, a closely related species that also occurs in the ACT region, by the presence of stripes.

Legless lizards superficially resemble small snakes, however, they can be readily distinguished from snakes by having a visible ear opening, fleshy broad tongue, the presence of remnant hindlimbs (which are reduced to two scaly flaps near the vent) and a tail that is longer than the body, which can be voluntarily shed.

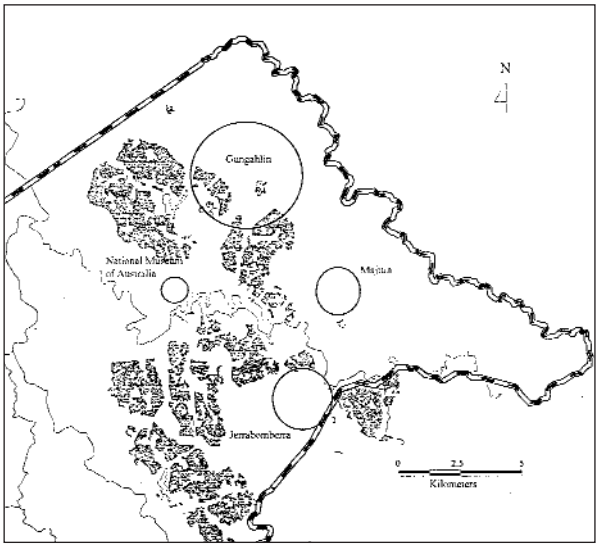


Figure 2: Four Areas Known to Support *Delma impar* in the ACT

DISTRIBUTION AND ABUNDANCE

ACT Distribution

In the ACT, the potential range of the species prior to European settlement is likely to have been within the more or less continuous area of treeless plains covering over 20 000 hectares. However, most of this area has been developed for urban and related purposes and the current distribution of the Striped Legless Lizard in the ACT is a fragmented one, with four disjunct populations recognised (Figure 2): Gungahlin, Yarramundi Reach, Majura Valley and the Jerrabomberra Valley (Rauhala *et al.* 1995). Unsuitable habitat, roads and urban development separate these sites.

Gungahlin

Three grassland reserves (Mulanggari, Gungaderra and Crace) have been established in the Gungahlin area to protect the species. It has also been found in the Kenny area and in some relatively small and isolated patches of habitat (ACT Government 1997b).

Yarramundi Reach

This small area of grassland was surveyed in 1993 and low numbers recorded (Kukolic 1994). The *Delma impar* population on the site appears to be in decline and may have become extinct.

Majura Valley

This is a large area of habitat with surveys showing the species to be present in moderate densities. To the east of the Majura Road, the habitat comprises part of the Majura Training Area and the Airservices Australia navigational beacon enclosure. To the west of Majura Road, the species has been found in the Campbell Park area but has not been fully surveyed.

Jerrabomberra Valley

The species is currently known only in the grassland to the east of Jerrabomberra Avenue on the Woden, Bonshaw and Wendover properties, as well as on HMAS Harman. In the Jerrabomberra Valley, *Delma impar* has been found in relatively low densities and is more scattered in distribution compared with the Gungahlin area.

Distribution in South-eastern Australia

The geographic range of *Delma impar* is confined to south-eastern Australia. Throughout its range, the species is considered to have suffered a substantial contraction in its distribution since European settlement.

It has been recorded from south-eastern South Australia but the area now appears unlikely to support a population (Coulson 1990; Hadden 1995). It is currently known from scattered locations in Victoria, mainly on the basalt plains to the north and west of Melbourne and in the western district of the state (Department of Conservation and Environment 1992). Surveys by the NSW National Parks and Wildlife Service in 1998–9 identified populations near Yass and Goulburn. Other records are for Cooma (1995) (Biosis Research Pty Ltd 1995) and Batlow (1977) (Cogger *et al.* 1993

HABITAT

The Striped Legless Lizard is found primarily in lowland native grasslands (Coulson 1990; Osborne, Kukolic and Williams 1993). This habitat type occurs on flat or gently undulating plains (Coulson 1990; Hadden 1995),

and is dominated by perennial, tussock-forming grasses such as Kangaroo Grass *Themeda triandra*, spear grasses *Austrostipa* spp. and wallaby grasses *Austrodanthonia* spp. (Coulson 1990; Hadden 1995). The species is also found in some areas dominated by exotic grasses (Coulson 1990; Williams and Kukolic 1991; Kukolic *et. al.* 1994; Rauhala *et. al.* 1995; Hadden 1995). A tussock structure in grassland appears to be an important habitat characteristic (Wildlife Research Unit 1994; Hadden 1995), although little is known about the way in which the vegetation is utilised. There is evidence that lizards over-winter at the base of grass tussocks or just below the soil surface (Wildlife Research Unit 1994). Soils that have a moderate to high clay content and often produce cracks in summer are another habitat feature. In Victoria, most sites supporting the species have a cover of lightly embedded rocks, although this is not a feature of its habitat in the ACT (Hadden 1995).

Although the Striped Legless Lizard is found in both primary and secondary grasslands, Dorrough (1995) found that it inhabited secondary grasslands only within two kilometres of primary grasslands.

Most areas where the species persists, are thought to have had low to moderate levels of agricultural disturbance in the past (Coulson 1990; Hadden 1995; Dorrough 1995). It has been suggested (Coulson 1990; Dorrough 1995) that ploughing in particular may be incompatible with the survival of the species.

BEHAVIOUR AND BIOLOGY

The Striped Legless Lizard is known to feed on a variety of insects and arthropods including spiders, crickets, cockroaches and caterpillars (Coulson 1990; Wainer 1992; Nunan 1995). The species may display some selectivity in its diet, with *Lepidoptera* larvae (caterpillars) being implicated as a particularly important food resource (Nunan 1995).

The species is diurnal and active on the ground surface from late spring to early autumn, with a peak in activity in November and December (Kukolic 1994). Gravid individuals are commonly caught in these months, with two eggs being laid in December. There is some evidence for communal oviposition and that sometimes; eggs may be laid under rocks or other substrate (Mills 1992; Rauhala 1996). Incubation periods of between 35 and 60 days have been observed in captivity under ideal conditions; however, the incubation period is likely to be longer in the field.

The longevity of the species is not known but a maximum of ten years has been estimated (Webster *et al.* 1991; Dorrough 1995).

Appendix 5.2

Grassland Earless Dragon (*Tympanocryptis pinguicolla*)

In accordance with section 21 of the *Nature Conservation Act 1980*, the Grassland Earless Dragon (Tympanocryptis pinguicolla) was declared an endangered species on 15 April 1996 (formerly Determination No. 29 of 1996 and currently Determination No. 89 of 1997). Section 23 of the Act requires the Conservator of Flora and Fauna to prepare an Action Plan in response to each declaration. The Action Plan requirements are incorporated into this *Lowland Native Grassland Conservation Strategy*.

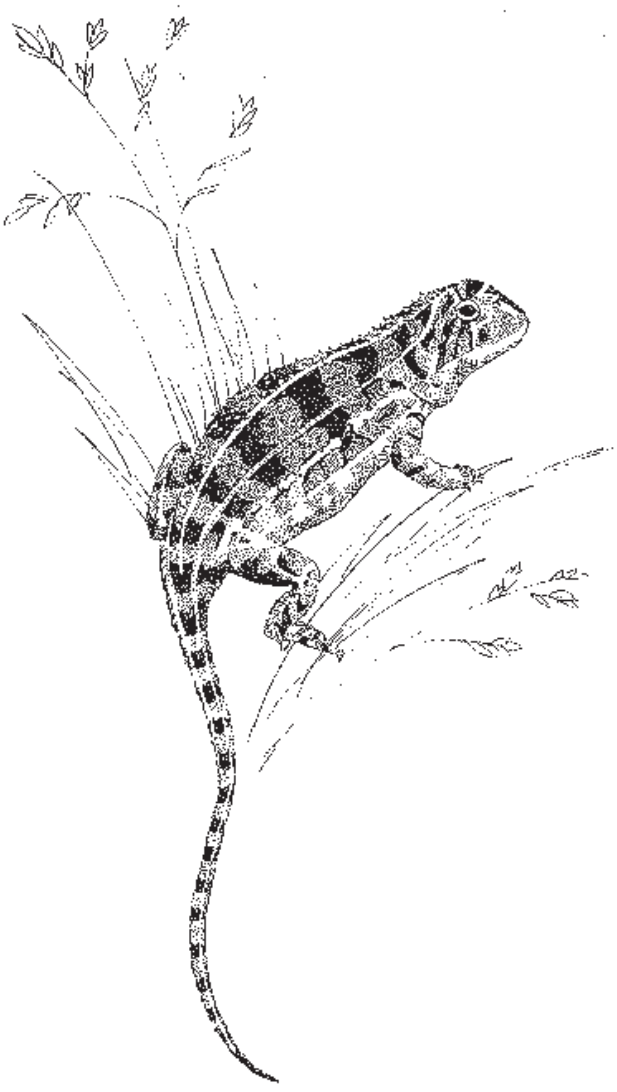


Figure 1: Grassland Earless Dragon (*Tympanocryptis pinguicolla*)

(Illustration: Liz Faull)

Conservation Status (ACT) Endangered

Criteria satisfied (ACT Flora and Fauna Committee 1995)

Species is observed, estimated, inferred or suspected to be at risk of premature extinction in the ACT region in the near future, as demonstrated by:

- Current severe decline in population or distribution from evidence based on:
  - —severe decline in quality or quantity of habitat; and
  - —severe threats from herbivores, predators, parasites, pathogens or competitors.
- Severely fragmented distribution for a species currently occurring over a small range or having a small area of occupancy within its range.
- Extremely small population.

DESCRIPTION

This species was originally considered to be a sub-species of *Tympanocryptis lineata* and named *Tympanocryptis lineata pinguicolla* (Mitchell 1948). Smith *et al.* (1999) reviewed the systematic status of *Tympanocryptis* in south-eastern Australia and determined that *T. l. pinguicolla* should be raised to specific status and thus be renamed *Tympanocryptis pinguicolla*. The common name has been changed from Eastern Lined Earless Dragon to Grassland Earless Dragon.

The Grassland Earless Dragon (*Tympanocryptis pinguicolla*) is a member of the family Agamidae, the dragon lizards. Most members of the genus *Tympanocryptis*, including *T. pinguicolla*, lack an external ear opening (Greer 1989) and a functional tympanum (ear drum) (Witten 1993).

T. pinguicolla is a small lizard with a stout body and short robust limbs (Figure 1). Total adult body length is between 180 and 210 mm (Smith 1994). These lizards have three longitudinal light stripes on the dorsal surface and the ventral surface is either intricately patterned with dark brown or grey markings or immaculate white or cream. They are diurnal and are cryptic in their grassland habitat. When captured, individuals can be identified from distinct grey and dark brown dorsal surface markings (Nelson *et al.* 1996) that usually form thick irregular transverse bars across the body and down the tail. Many individuals exhibit yellow or orange flushing of the throat that sometimes extends to the sides of the head and down the dorsal stripes and flanks (Smith 1994). Differentiation of these markings occurs between sexes and age classes (Langston 1996). Specimens usually have a narrow

pale bar on their head between the anterior corners of the eyes (Cogger 2000).

T. pinguicolla is distinguished from other *Tympanocryptis* in south-eastern Australia by its greater number of mid-body dorsal scales and greater number of scattered dorsal spinous scales which are also higher than their basal width (Mitchell 1948; Smith 1994; Smith *et al.* 1999).

DISTRIBUTION AND ABUNDANCE

Former Distribution

In 1938 Pryor described the species as more common than the Brown Snake (*Pseudonaja textilis*) in the ACT, and animals were captured adjacent to Northbourne Avenue in the 1950s (Pryor 1938; Young 1992).

NSW records show that the species occurred near Cooma in the Southern Tablelands (Mitchell 1948) and at Bathurst (Osborne, Kukolic *et al.* 1993).

Most former records of *T. pinguicolla* in Victoria are from the basalt plains in the south of the state (Brereton and Backhouse 1993). There are also records from Maryborough and Rutherglen in central Victoria (Lucas and Frost 1894).

Present Distribution

T. pinguicolla has shown a dramatic decrease in its geographical range. The species is found in small and seasonally variable numbers in seven sites with suitable native grassland habitat in the Majura and Jerrabomberra valleys in the ACT and at 'Letchworth' near Queanbeyan in NSW (Figure 2). The lizards have also been recorded at several sites near Cooma (Osborne, Kukolic and Williams 1993; Biosis Research Pty Ltd 1995).

From the early 1990s considerable survey and research effort has been directed towards the species. The Action Plan for the species (ACT Government 1997c) identified survey and monitoring as important components of the conservation management of the species. Surveys have been undertaken of areas of potential habitat and a monitoring program of known populations is in place (e.g. Dunford et al. 2001; Evans and Ormay 2002).

Surveys of potentially suitable habitat at the Belconnen Naval Station, in areas outside of Public Land Nature Reserve, and in the Crace and Mulanggari grassland reserves at Gungahlin have failed to locate the species (Kukolic 1992; Nelson et al. 1996; Dunford et al. 2001; Evans and Ormay 2002). Similarly, Langston (1996) surveyed for the species in the Gundaroo, Bungendore and Hoskingtown areas without success. In 2000, the NSW National Parks and Wildlife Service conducted surveys for the species in the Bungendore and Goulburn areas but none were found.

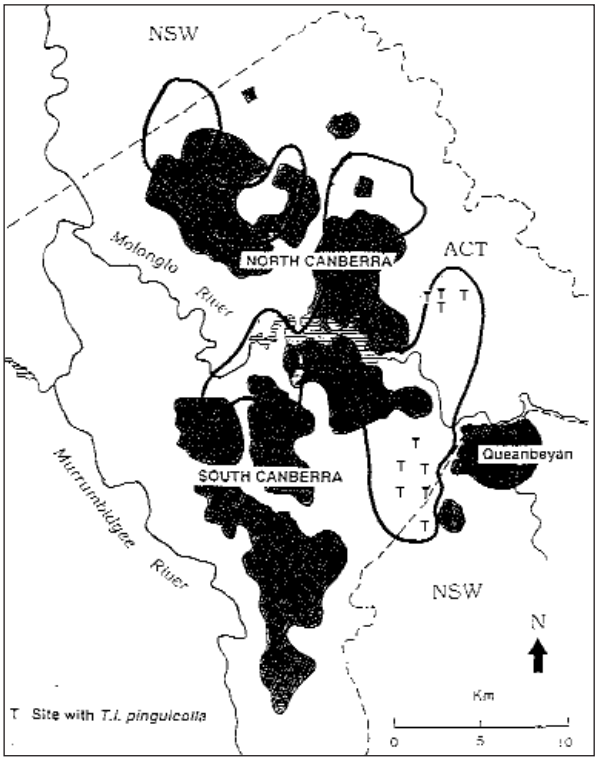


Figure 2: Distribution (T) of *Tympanocryptis pinguicolla* in the ACT and adjacent region. Former extent of natural temperate grassland outlined.

HABITAT

Observations in the ACT and region indicate that *T. pinguicolla* is found in Natural Temperate Grassland dominated by wallaby grasses (*Austrodanthonia* spp.), spear grasses (*Austrostipa* spp.), Kangaroo Grass (*Themeda triandra*) and tussock grasses (*Poa* spp.) (ACT Government 1997c; Robertson and Cooper 2000). Capture locations in the ACT suggest that the animals prefer well-drained Natural Temperate Grasslands that are relatively undisturbed and minimally pasture-improved. Nelson *et al.* (1998) also recorded the species in *Austrostipa* dominated grassland with low diversity, which had been modified by pasture improvement and weed invasion. There appears to be a preference for shorter grassland with an open structure or with open areas, however, the patchy occurrence of *T. pinguicolla* within such areas may indicate a more subtle relationship of the species to its grassland habitat (Robertson and Cooper 2000).

T. pinguicolla makes use of arthropod burrows and may retreat into these when alarmed. It also shelters beneath rocks (Victoria, Monaro region NSW) and within *Austrostipa* tussocks (ACT) (Robertson and Cooper 2000).

BEHAVIOUR AND BIOLOGY

Most of what is known about the biology and ecology of *T. pinguicolla* is derived from university research and project work in the last decade (Smith 1994; Langston 1996; Nelson 2004) and survey and monitoring by Environment ACT. Field observation is difficult because *T. pinguicolla* avoids detection by remaining still and uses its cryptic coloration to blend in with its grassland environment (Smith 1994).

Capture data is characterised by a dominance of young animals and low recaptures of previous-year adults (Smith 1994; Langston 1996; Nelson *et al.* 1996) indicating a predominantly annual turnover of adults. This turnover suggests that females breed once and gravid females have been recorded in the field from September to January (Langston 1996). However, some females survive to their second year and may produce a second clutch (Langston 1996).

T. pinguicolla is oviparous (Witten 1993). The only two known records of egg laying are for late November and early December (Langston 1996). Both records comprised a clutch of five eggs, one in a shallow scrape that was covered with soil and small stones to disguise its presence, and the other was unintentionally disturbed with the eggs successfully incubated in the laboratory. Field incubation time has been recorded at 11 weeks and two days (Langston 1996).

Hatching occurs from January to March and hatchlings show rapid growth (mean 0.3 mm/day) approaching adult size by the end of March (Smith 1994). Adult growth rates are much slower with a mean of 0.08 mm/day (Langston 1996). The young may disperse soon after hatching as small lizards have been caught in pitfall traps.

Fat storage in the neck, body and tail is thought to be an adaptation to a cooler climate (Mitchell 1948). Animals in the *T. lineata* group have been found during winter in a torpid state under rocks (Jenkins and Bartell 1980) and in arthropod burrows (Langston 1996). However, active individuals have been observed above-ground in June and trapped in August, suggesting that individuals can be active anytime weather conditions are suitable (Robertson and Cooper 2000).

Although the sizes of home ranges of *T. pinguicolla* are unknown, individuals are highly mobile. Individual adult animals have been shown to move 40 m in a day (Langston 1996) with some movements of more than 230 m between yearly trapping seasons.

Population density may be influenced by social interactions, as aggressive encounters between individuals, involving vocalisation (using a soft hiss) and displays, have been observed in captive animals and in the field (Robertson and Cooper 2000). There appears to be a dominance hierarchy based on the size of individuals (Smith 1994).

T. pinguicolla feeds on a variety of insects, banana and apple in captivity (Robson 1968; Smith 1994). In the field, animals have been observed consuming spiders and insects, however precise field dietary requirements are yet to be determined.

Appendix 5.3

Golden Sun Moth (*Synemon plana*)

In accordance with section 21 of the *Nature Conservation Act 1980*, the **Golden Sun Moth (*Synemon plana*)** was declared an **endangered** species on 15 April 1996 (formerly Determination No. 29 of 1996 and currently Determination No. 7 of 1998). Section 23 of the Act requires the Conservator of Flora and Fauna to prepare an Action Plan in response to each declaration. The Action Plan requirements are incorporated into this *Lowland Native Grassland Conservation Strategy*.

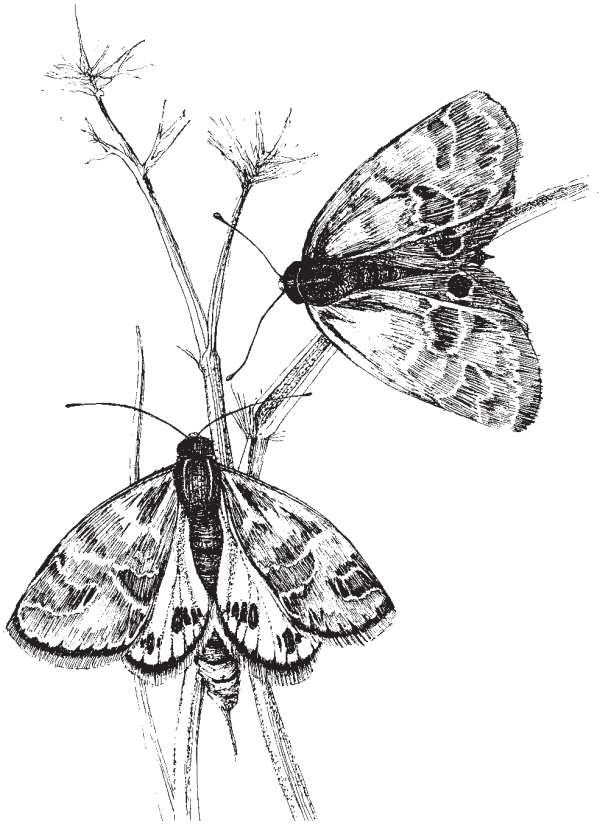


Figure 1: Golden Sun Moth (*Synemon plana*) (female—bottom left; male—top right)

(Illustration: Sarah Reglar)

Conservation Status (ACT) Endangered

Criteria satisfied (ACT Flora and Fauna Committee 1995)

The species is observed, estimated, inferred or suspected to be at risk of premature extinction in the ACT region in the near future, as demonstrated by:

- Current severe decline in population or distribution, from evidence based on:
  - —direct observation, including comparison of historical and current records; and
  - —severe decline in quality or quantity of habitat.
- Continuing decline or severe fragmentation in population, for species with a small current population.

DESCRIPTION

The Golden Sun Moth (*Synemon plana*) is a medium sized moth belonging to the family Castniidae, which is thought to be of Gondwanan origin (Edwards, 1990). The male has a wingspan of about 34 mm, the female about 31 mm. This larger male wingspan is unique in the Australian Castniidae. The upperside of the forewing of the male is dark brown with patterns of pale grey scales and the hind wing is dark bronzy brown with dark brown patches. The underside of both wings of the male is mostly pale grey with dark brown spots. The upperside forewing of the female is very dark grey with patterns of pale grey scales and the hind wing is bright orange with black submarginal spots. The underside of both wings of the female is silky white with small black submarginal spots. The adults have no functional mouthparts. They have strongly clubbed antennae and the female has a long extensible ovipositor. Coloured illustrations may be found in Common (1990) and Fraser and McJannett (1996).

DISTRIBUTION AND ABUNDANCE

At the time of European settlement, *S. plana* was widespread in south-eastern Australia and relatively continuous throughout its range, showing a close correlation with the distribution of native grasslands dominated by *Austrodanthonia* spp. (O'Dwyer and Attiwill 1999a). Museum records show that *S. plana* was still common and widespread prior to 1950, before the advent of extensive pasture improvement and other land use changes that have reduced native grasslands to scattered fragments.

The known distribution of the species from museum specimens extended from Bathurst, NSW, through the

Southern Tablelands of NSW and central Victoria to the South Australian border (Edwards 1993). There are about 30 localities in Victoria represented by museum specimens.

Currently, the species is known from 27 sites in the ACT of various sizes, 42 sites in NSW, and nine sites in Victoria. In the ACT, the species occurs in lowland areas adjacent to the city of Canberra and within the city. There are extensive populations within the Majura Training Area, 'Malcolm Vale', Canberra International Airport and the Belconnen Naval Station. Less extensive populations occur within large grassland sites at 'Woden' property in the Jerrabomberra Valley and in the Mulanggari and Crace Grassland Reserves in Gungahlin. Together, these make up the eight sites of high conservation value. Smaller sites at Campbell Park, York Park in Barton, Mulligans Flat (North and South), North Mitchell, Black Street and Stirling Ridge in Yarralumla and the Dunlop Hills Grassland Reserve in Belconnen contain populations of high to moderate density (Edwards 1994). A further eleven sites contain very small populations, which may not be viable in the short to medium term.

The 42 NSW sites are found within grassland and grassy woodlands near Yass, Boorowa, Binalong, Rye Park, Sutton, Gundaroo, areas immediately north of the ACT, and at Queanbeyan and Tumut (Clarke and Dear 1998). All sites are below 700 m (with the exception of one site south of Queanbeyan recorded at 790 m), suggesting that *S. plana* is a western species at the limit of its range. The survey by Clarke and Dear (1998) did not locate any populations in the Goulburn, Tarago and Bungendore areas, or on the Monaro (Bredbo, Cooma, Adaminaby and Dalgety).

Population estimates for *S. plana* at ACT and NSW sites vary from a few hundred to more than 100 000 individuals (Ginninderra Road and Letchworth, NSW)(Clarke and Dear 1998; ACT Government 1998a). One population estimate based on monitoring is from the small (0.4 ha) site at York Park, Barton, ACT. Population size estimates of males at York Park were 520 (1992–3), 456 (1993–4) and 736 (1994–5) or a mean for the three years of 571 (Harwood *et al.* 1995). This gives a crude population of 1700 males per hectare. There is no information about the sex ratio in adult S. plana, and the females are much more inconspicuous than the males, therefore no female population estimates were attempted at York Park. A 1:1 sex ratio would give a population density of 3500 per hectare. A two-year life cycle would mean that double the number of adults observed is potentially present, but the genetic interchange between the odd and even cohorts may be low.

Population estimates are crude and refer to the number of adults in the population (census size) not the actual number of individuals contributing to the next generation (effective size). Based on census data from a single ACT site, it is estimated that up to 99% of female fecundity is unrealised, through either adult or immature immortality (Clarke and O'Dwyer 2000). Small sites may be less viable than the observed population size would indicate. It is the effective population size that is critical in assessing the extinction risk of a population.

HABITAT

The habitat of *S. plana* is native grassland dominated by wallaby grasses *Austrodanthonia* spp., in particular, *A. carphoides*, *A. auriculata*, *A. setacea* and *A. eriantha*. In a study of eight ACT sites and six Victorian sites (four current, two historical), O'Dwyer and Attiwill (1999a) found that the percentage cover of *Austrodanthonia* at currently inhabited sites was 40% and soils were low in available phosphorus. Weed invasion is a major threat to *Austrodanthonia* on these sites (O'Dwyer and Attiwill 1999b).

In the ACT, *S. plana* usually occurs in Natural Temperate Grassland dominated by *Austrodanthonia carphoides*. Some populations of the moth at Mulligans Flat occur in grassy areas within open woodland, but all other sites are believed to have been treeless grassland prior to European settlement. In the ACT, these grasslands are not found at an altitude above 630 m. Areas dominated by *A. carphoides* occur in grasslands containing *Austrodanthonia* or *Austrostipa* associations, and may occur in patches in Dry *Themeda* grasslands. Wallaby grass is very low growing with tussocks usually separated by bare ground. These grasslands normally contain several species of *Austrodanthonia* and the species actually fed on by the moth larvae are uncertain.

In NSW, *S. plana* is also found in grasslands dominated by *Austrodanthonia setacea* and *A. auriculata* as well as *D. carphoides* (Clarke and Dear 1998)

In Victoria, *S. plana* may be found in grassland dominated by *Austrodanthonia setacea* (Douglas 1993), *A. pilosa* (Britten *et al.* 1995) and *A. eriantha* (O'Dwyer and Attiwill 1999a, 1999b). Field studies at Mt Piper, where a large *S. plana* population remains, indicate that the habitat of *S. plana* is native grassland dominated by *Austrodanthonia eriantha*, with a smaller cover of *A. auriculata*, *A. carphoides* and *A. racemosa* (O'Dwyer and Attiwill 1999b). A 40% cover of

Austrodanthonia has been shown to be the minimum density required to sustain a *S. plana* in Victoria (Dear 1997; O'Dwyer and Attiwill 1999a).

BEHAVIOUR AND BIOLOGY

The life history of *S. plana* is not fully understood. Common and Edwards (1981) described the life history of *S. magnifica* and the life history of *S. plana* is probably similar (E.D. Edwards, pers. comm. 1996 in O'Dwyer and Attiwill 1999a). The following summary of the life history of the species is drawn mainly from ACT Government (1998a) and Clarke and O'Dwyer (2000).

Most of the life cycle of *S. plana* is in the pre-adult stage. Adults are short lived (1–4 days) and do not feed, having no functional mouthparts. Five days is the longest recorded life span for the male but 1–2 days is normal (Cook and Edwards 1993). Males spend their entire adult life patrolling grassland for females, and females, once mated, spend their time laying eggs within clumps of *Austrodanthonia*. Females are reluctant to fly, even when disturbed, and walk between grass tussocks. Males are capable of active and prolonged flight, usually about one metre above the ground, but will not fly long distances (more than 100 m) from areas of suitable habitat. Thus populations separated by more than 200 m can be considered effectively isolated, and sites from which the moth has gone extinct, or vacant patches of suitable habitat are highly unlikely to be (re)colonised.

S. plana is a day flying moth, active in the warmest part of the day (1000–1400 h) and only under sunny conditions. The flying season is relatively short (6–8 weeks) mainly in November and December, but to early January in the ACT. Warm dry spring weather may result in earlier emergence while cool moist conditions may delay emergence until late November (Cook and Edwards 1993). Adult emergence continues throughout the flying season.

Females are estimated to lay 100–150 eggs (Edwards 1994). It is not known if they are laid singly or in clusters on grass clumps. Eggs are laid between the tillers of an *Austrodanthonia* tussock or between the tillers and the soil. They are inserted into the crevices by the long ovipositor of the female. The larvae feed on the underground parts of the *Austrodanthonia*. Whether the larva needs a single tussock for development or must move between tussocks to complete its development is unknown. The length of the life cycle is unknown, but may vary between one and three years. As noted above, up to 99% of total potential fecundity is unrealised, through either adult or immature mortality but levels of these are not known. Predation of adults has been observed at York Park, Barton, by several species of birds including the Willie Wagtail (*Rhipidura leucophrys*), the Magpie Lark (*Grallina cyanoleuca*), the Starling (*Sturnus vulgaris*) as well as robber flies (*Colepia abludo* and *Brachypogon* sp.) (Cook and Edwards 1993, 1994). Some reptiles may also be predators. No parasites or predators of the early stages have been recorded.

Clarke and O'Dwyer (1998, 2000) assessed the levels of genetic variation and diversity, and investigated patterns of population structure, in a sample of 20 populations of *S. plana* throughout its geographic range (Victoria, ACT, NSW). Genetically, the populations clustered into five distinct groupings corresponding to geographic locations of the populations. The Victorian group (two populations) is significantly different genetically from the other four groupings, and the two Victorian populations, 220 km apart, are significantly different from one another. These results conform to an isolation by distance model, in which genetic distance is correlated with geographical distance.

The level of genetic differentiation among groups may be sufficient for each group to be subject to separate conservation management in an effort to conserve as much genetic diversity as possible for the species. The average genetic differences between the Victorian group and the other four groups can be considered quite high and typical of values that distinguish sub-species or races. Given the limited mobility of the species, the lack of differentiation between closely located populations may indicate that these were all historically connected and have only recently undergone fragmentation.

Appendix 5.4

Perguna Grasshopper (*Perunga ochracea*)

In accordance with section 21 of the *Nature Conservation Act 1980*, the **Perunga Grasshopper (*Perunga ochracea*)** was declared a **vulnerable** species on 19 May 1997 (formerly Instrument No. 89 of 1997 and currently Instrument No. 192 of 1998). Section 23 of the Act requires the Conservator of Flora and Fauna to prepare an Action Plan in response to each declaration. The Action Plan requirements are incorporated into this *Lowland Native Grassland Conservation Strategy*.

Figure 1: Perunga Grasshopper (*Perunga ochracea*) (Female (above) and male (below))

(Illustration: Fiona Sivyer)

Conservation Status (ACT) Vulnerable

Criteria satisfied (ACT Flora and Fauna Committee 1995)

The species is observed, estimated, inferred or suspected to be at risk of premature extinction in the ACT region in the medium-term future, as demonstrated by:

- Current serious decline in population or distribution, from evidence based on:
  - —direct observation, including comparison of historical and current records; and
  - —serious decline in quality or quantity of habitat.
- Seriously fragmented distribution for a species currently occurring over a moderately small area of occupancy within its range.

DESCRIPTION

The Perunga Grasshopper, *Perunga ochracea* is the only described species in the genus (Orthoptera: Acrididae: Catantopinae). The Australian National Insect Collection (ANIC), Canberra, has specimens also of an undescribed species (designated as *Perunga* sp. 1), known only from South Australia. *Perunga* belongs to the sub-tribe Apotropina of the tribe Catantopini (Rentz 1996). Members of the sub-tribe are characterised principally by the stout femur of the hind leg and the presence of an auditory tympanum on the anterior abdomen under the wings. In males, there is a furcula (a forked structure) near the tip of the abdomen. Both sexes of *P. ochracea* are short-winged and flightless (Figure 1).

The species is distinctive in having the pronotum (the dorsal surface of the first thoracic segment) wrinkled and slightly extended caudally. In the Canberra region, the species is distinguished further by the appearance on the pronotum of a pale 'X' (D. Rentz pers. comm.), which is the most useful field identification characteristic. The wings are shorter than the length of the pronotum and possess many raised longitudinal veins. Adult females range in length from 26–35 mm and adult males from 15–20 mm. Males possess short, rounded furculae and simple, elongate cerci (the pair of appendages at the apex of the abdomen), each with a blunt, rounded tip which is slightly deflexed. Females bear very short, stout cerci and the dorsal ovipositor valves are strongly recurved. Adults are variable in colour, ranging from brown to grey and often with green. Colour can vary from year to year with a tendency toward grey-brown in dry years and greenish in wet years (R.C. Lewis pers. comm.). A colour photograph is found in Rentz (1996).

DISTRIBUTION AND ABUNDANCE

Perunga ochracea has been collected mainly as individuals or in low numbers, though population

densities may vary among years and sites (ACT Government 1999).

The species was first described from Wagga Wagga in NSW. Until the collection of individuals in surveys in 1997–1998, and one individual taken at Mt Majura in 1992, all specimens in the ANIC were collected prior to 1970. They came from near Wagga Wagga (at Uranquinty), Boorowa or nearby Galong, or from the ACT and adjacent areas of NSW, including Jeir, Murrumbateman and Queanbeyan. Localities in the ACT where ANIC specimens of *P. ochracea* had been collected include Black Mountain, Gungahlin, 1.6 km SW of Hall, 3.2 km NE of Kambah Pool, at the foot of Mt Stromlo, at Reid and near Weetangera.

In 1975–76 *P. ochracea* was recorded from specific localities in Tuggeranong (now the suburbs of Calwell and Gordon) and the lower slopes of Mt Jerrabomberra (in areas that are now housing estates). There are also records from sites on the edge of Naas Road north of the junction of the Gudgenby and Naas rivers and near the cork oak plantation adjacent to William Hovell Drive (R.C. Lewis pers. comm.).

In 1997–8 *P. ochracea* was found in Natural Temperate Grassland in the Mulanggari, Gungaderra and Crace Nature Reserves at Gungahlin, in the Majura Valley (Majura Training Area, Air Services Australia Beacon site and the Campbell Park paddocks), in the Jerrabomberra Valley ('Woden' property) and in Belconnen Naval Station (Stephens 1998, Dunford pers. comm.). In addition, a female specimen was collected in the grassland at Letchworth Housing Estate near Queanbeyan in December 1997 (Stephens 1998). More recently, new sites have been found in Natural Temperate Grassland in the Jerrabomberra Valley (2001–2) and a single specimen at East O'Malley (2002). A new population has also been located in NSW.

On the basis of ANIC and other records, it is suggested that the species has a small range stretching 180 km east-west and 150 km north-south. However, the area of occupancy within this range is likely to be low because of the reduction in size or extinction of populations through habitat alteration and fragmentation. The ANIC records and recent collections suggest that the species was once quite widespread across the ACT.

No population studies have been undertaken, therefore it is impossible to estimate population sizes.

HABITAT

In the ACT, *P. ochracea* has been found in both Natural Temperate Grassland dominated by *Danthonia* spp., *Stipa* spp. or *Themeda triandra*, and in native pasture (Stephens 1998, M. Dunford pers. comm.). The species may also occur in open woodland areas with a grassy understorey, including the endangered Yellow Box–Red Gum Grassy Woodland community, as suggested by earlier collections from the Black Mountain and Mt Majura areas. Field observations suggest that the species uses grass tussocks as shelter spaces. Stephens (1998) recorded several individuals in heavily grazed habitats, where the availability of dense grass tussocks was low. Despite this, these individuals were found in or near grass tussocks, suggesting they are an essential habitat requirement.

BEHAVIOUR AND BIOLOGY

P. ochracea is a cryptic grasshopper which is difficult to see unless first disturbed. When disturbed, the species appears to actively seek shelter, jumping once or twice before burying itself into a grass tussock. It is a powerful jumper, covering distances of a metre or more.

Nymphs hatch in late summer and autumn, and develop over the winter and early spring (Rentz 1996). This is unusual compared with most other ACT grasshopper species that overwinter as eggs rather than nymphs. Adults of *P. ochracea* have been collected from late October to mid February (ANIC specimens). The life cycle is a single year.

It has been suggested that *P. ochracea* has a dietary relationship with *Chrysocephalum* spp. (Rentz 1996), largely due to collection of the species at sites containing these forb species, particularly Common Everlasting (*Chrysocephalum apiculatum*). Dietary analysis undertaken by Stephens (1998) found that all six individuals of *P. ochracea* examined had consumed forb species. *Perunga* sp. 1, from South Australia, has been recorded eating several species of forbs, both flowerheads and leaves. In feeding trials, *Perunga* sp. 1 readily fed on the petals and flowers of Capeweed (*Arctotheca calendula*) and less so on wild geranium (*Erodium* spp.) and *C. apiculatum* (P. Birks pers. comm.). Although Stephens (1998) ultimately made no attempt to determine the exact forb species that *P. ochracea* was eating, there was no evidence from crop contents that the individuals collected had consumed *C. apiculatum*, despite this forb species being present where the individuals were collected.

Although no work has been done to identify predators of *P. ochracea*, parasitic wasps (*Scelio* spp.) in south-eastern Australia have been shown to regulate some populations of other acridid grasshoppers (Baker *et al.* 1996). Vertebrate predators such as birds may reduce population numbers, as shown in other studies of grasshopper assemblages (e.g. Belovsky and Slade 1993).