

DRAFT June 2010

**National Recovery Plan for the  
STRIPED LEGLESS LIZARD**  
*Delma impar*

Peter Robertson and Warwick Smith



  
Australian Government  
Department of the Environment,  
Water, Heritage and the Arts



 Government of South Australia  
Department for Environment  
and Heritage

 NSW  
GOVERNMENT | Environment,  
Climate Change  
& Water

 State Government  
**Victoria** Department of  
Sustainability  
and Environment

Prepared by Peter Robertson (Wildlife Profiles Pty Ltd) and Warwick Smith

Published by the Victorian Government Department of Sustainability and Environment (DSE) Melbourne, 2010.

© The State of Victoria, Department of Sustainability and Environment 2010

This publication is copyright. No part may be reproduced by any process except in accordance with the provisions of the *Copyright Act 1968*.

Authorised by the Victorian Government, 8 Nicholson Street, East Melbourne.

ISBN 978-1-74242-367-8 (online)

This is a Recovery Plan prepared under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*, with the assistance of funding provided by the Australian Government.

This Recovery Plan has been developed with the involvement and cooperation of a range of stakeholders, but individual stakeholders have not necessarily committed to undertaking specific actions. The attainment of objectives and the provision of funds may be subject to budgetary and other constraints affecting the parties involved. Proposed actions may be subject to modification over the life of the plan due to changes in knowledge.

#### **Disclaimer**

This publication may be of assistance to you but the State of Victoria and its employees do not guarantee that the publication is without flaw of any kind or is wholly appropriate for your particular purposes and therefore disclaims all liability for any error, loss or other consequence that may arise from you relying on any information in this publication.

An electronic version of this document is available on the Department of the Environment, Water, Heritage and the Arts website [www.environment.gov.au](http://www.environment.gov.au)

For more information contact the DSE Customer Service Centre 136 186

Citation: Robertson, P. and Smith, W. 2010. National Recovery Plan for the Striped Legless Lizard, *Delma impar*. Department of Sustainability and Environment, Melbourne.

Cover photograph: *Delma impar*. © Peter Robertson

## SUMMARY

*Delma impar* (Fischer 1882), the Striped Legless Lizard, is a member of the family Pygopodidae, the legless or flap-footed lizards (Cogger, 2000). As with other members of the legless lizard family, *D. impar* lacks forelimbs and has only very reduced vestigial hind limbs.

*Delma impar* is patchily distributed in grasslands of south-eastern NSW, the ACT, north-eastern, central and south-western Victoria, and south-eastern South Australia. It is believed to have declined throughout its distribution and is known to have disappeared from many sites. *Delma impar* is a grassland specialist, being found only in areas of native grassland or grassy woodland and nearby exotic pasture.

The main threat to *D. impar* across its entire range is habitat degradation and destruction, with a broad range of potentially threatening processes likely to be acting upon populations of the species.

The Striped Legless Lizard is recognised as threatened in all jurisdictions within its distribution.

The primary conservation goal of this Recovery Plan is to ensure the long-term survival of *D. impar* and maintain its potential for evolutionary development in the wild across its natural geographic range.

This primary objective is broken down into ten specific conservation objectives, as below, each of which is associated with a number of specific recovery actions.

1. Establish and maintain national forums for the discussion and organisation of the conservation of *D. impar* across its natural distribution.
2. Determine the distribution of potential *D. impar* habitat.
3. Determine the current distribution and abundance of *D. impar* in Victoria, New South Wales, the Australian Capital Territory and South Australia.
4. Establish a series of reserves and other managed areas such that viable populations are maintained across the known distribution of the species.
5. Determine the habitat use and ecological requirements of *D. impar*.
6. Identify the nature and extent of the threatening processes affecting *D. impar*.
7. Undertake a program of monitoring to provide a basis for adaptive management of *D. impar*.
8. Increase community awareness and involve the community in aspects of the recovery program.
9. Assess the need for translocation, determine feasibility, develop protocols and undertake a trial translocation if appropriate.
10. Ensure that any captive population(s) are used to support education and research elements of the Recovery Plan.

## **Abbreviations**

ACT – Australian Capital Territory

ANZECC – Australian and New Zealand Environment and Conservation Council

CSIRO – Commonwealth Scientific and Industrial Research Organisation

DECCW – NSW Department of Environment, Climate Change and Water

DEH – South Australian Department of Environment and Heritage

DEWHA – Australian Government Department of the Environment, Water, Heritage and the Arts

DSE – Victorian Department of Sustainability and Environment

PCL – ACT Parks, Conservation and Lands

EPBC – Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*

FFG – Victorian *Flora and Fauna Guarantee Act 1988*

IUCN – International Union for the Conservation of Nature

NSW – New South Wales

NRT – Striped Legless Lizard National Recovery Team

PV – Parks Victoria

SLLRWG – ACT and NSW Striped Legless Lizard Regional Working Group

TSC – New South Wales *Threatened Species Conservation Act 1995*

VSLLWG – Victorian Striped Legless Lizard Working Group.

ZV – Zoos Victoria

## TABLE OF CONTENTS

A	SPECIES INFORMATION.....	7
A.1	Name.....	7
A.2	Description .....	7
A.3	Distribution .....	7
A.3.1	Former and current geographical distribution.....	7
A.3.2	Tenure of land supporting <i>D. impar</i> .....	8
A.4	Life history and ecology .....	9
A.5	Habitat.....	10
A.6	Critical habitat .....	10
A.7	Threats .....	10
A.8	Conservation status .....	11
A.9	Important populations .....	11
B	GENERAL REQUIREMENTS .....	12
B.1	Objectives of the <i>Environment Protection and Biodiversity Conservation Act 1999</i> .. <b>Error! Bookmark not defined.</b>	
B.2	International obligations .....	<b>Error! Bookmark not defined.</b>
B.3	Affected interests .....	12
B.4	Role and interests of indigenous people.....	13
B.5	Social and economic impacts .....	14
B.6	Benefits to other species/ecological communities .....	15
C	RECOVERY OBJECTIVES, CRITERIA AND ACTIONS .....	16
C.1	Previous conservation measures.....	16
C.1.1	Coordination and communication of research and recovery actions .....	16
C.1.2	Population and habitat viability analysis.....	16
C.1.3	Surveys and monitoring.....	16
C.1.4	Research .....	18
C.1.5	Ex situ programs.....	19
C.1.6	Reservation and Management .....	19
C.2	Species ability to recover .....	20
C.3	Further research overview .....	20
C.4	Management practices.....	21
C.5	Community involvement.....	21

C.6	Recovery objectives, performance criteria and actions .....	22
C.6.1	Primary objective .....	22
C.6.2	Specific objectives .....	22
C.6.3	Specific Recovery Objective – Recovery Coordination.....	22
C.6.4	Specific Conservation Objective – Habitat Determination.....	24
C.6.5	Specific Conservation Objective – Distribution and Abundance .....	25
C.6.6	Specific Conservation Objective – Management. ....	27
C.6.7	Specific Conservation Objective – Ecology.....	29
C.6.8	Specific Conservation Objective – Threats. ....	30
C.6.9	Specific Conservation Objective – Monitoring.....	32
C.6.10	Specific Conservation Objective – Community Participation. ....	32
C.6.11	Specific Conservation Objective – Translocation.....	34
C.6.12	Specific Conservation Objective – Captive Management. ....	35
C.6.13	Evaluation of success or failure.....	36
D	RECOVERY COSTS .....	37
E	ACKNOWLEDGEMENTS.....	39
F	BIBLIOGRAPHY .....	40
	Appendix I:Population cluster approach to <i>D. impar</i> conservation .....	44
	Appendix II:Legislation relevant to the management and conservation of <i>D. impar</i> .....	48
	Appendix III.Relationship to other plans.....	49
	Appendix IV:Composition of the National and Regional Recovery Teams.....	50
	Appendix V:Interim directory of relevant past, current and proposed research.....	52
	Appendix VI:Interim management guidelines recommended by the National Recovery Team.....	54

## TABLE OF FIGURES

Figure 1.	Map of south-eastern Australia indicating broad distribution of <i>D. impar</i> and cluster boundaries .....	8
-----------	--	---

## A SPECIES INFORMATION

---

### A.1 Name

The Striped Legless Lizard, *Delma impar*, is a well-defined species within a well-defined genus containing 17 species (Cogger, 2000).

### A.2 Description

*Delma impar* (Fischer 1882) is a member of the family Pygopodidae, the legless or flap-footed lizards (Cogger, 2000). As with other members of the legless lizard family, *D. impar* lacks forelimbs and has only very reduced vestigial hind limbs. These hind limbs are apparent only as small flaps on either side of the vent. *Delma impar* has a long, thin body. The tail, when unbroken, is about twice the length of the body. *Delma impar* reaches a maximum total length of about 300 mm, with a maximum snout-vent length (SVL) of about 120 mm and a weight of about 8 g. While it shows considerable variation in colour and pattern, *D. impar* is usually pale grey-brown above and cream on the ventral surface, with a series of lateral and dorso-lateral stripes along the length of the body, becoming diagonal bands on the tail (Cogger, 2000; Wilson and Knowles, 1988). However, in some individuals, particularly juveniles, these stripes may be very faint or absent. The head is generally darker than the body, tending to black in juveniles. A pale to bright yellow patch is present from the tympanum to the posterior infralabial scales (Coulson, 1990).

Superficially, these animals resemble snakes, but can be readily distinguished from the latter by the presence of external ear openings, a fleshy undivided tongue and a tail which, when unbroken, is longer than the body. These are characters not exhibited by snakes (Cogger, 2000). *Delma impar* can be readily distinguished from other pygopodids by body colouration, body size and head scalation. The species which most closely resembles *D. impar*, and which overlaps in distribution, is the Olive Legless Lizard, *Delma inornata*. The published morphological difference between these taxa is the fusion or partial fusion of the nasal and first supra-labial scale in *D. impar*, and the clear separation of these scales in *D. inornata* (Cogger, 2000; Kluge, 1974). However, this character has been found to be inconsistent, with some specimens of *D. impar* having clearly separated nasal and first supra-labial scales (Coulson, 1990; Jenkins and Bartell, 1980). Despite these difficulties, experienced workers can usually identify specimens of either species.

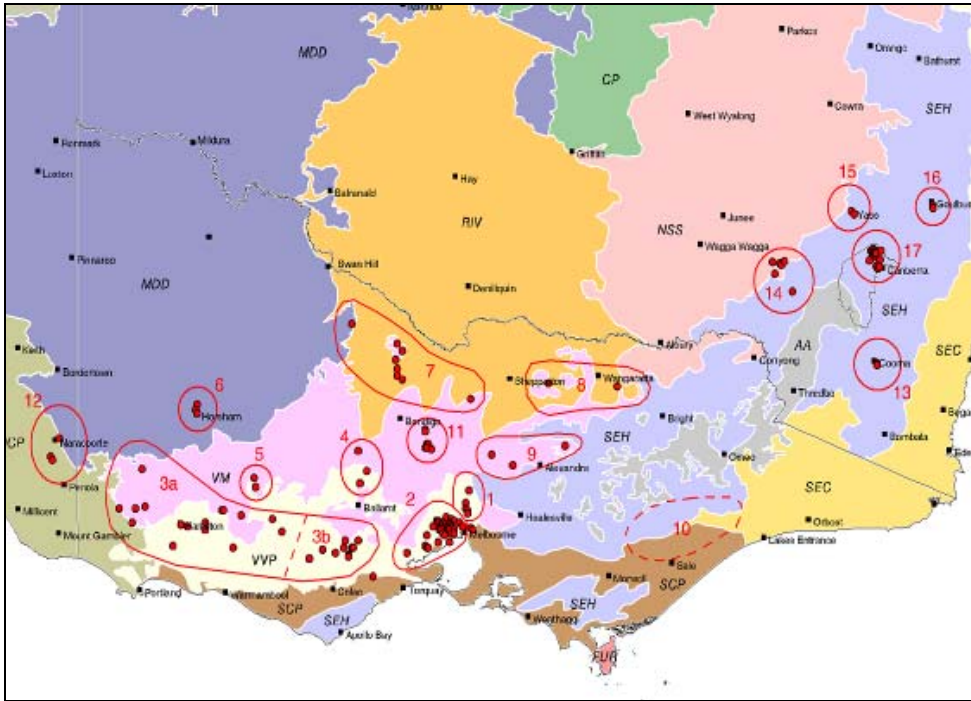
The sexes of *D. impar* appear very similar externally. However, adult males may be distinguished by the presence of a small rounded 'spur' under each hind limb flap (pers obs, Rauhala, 1998).

### A.3 Distribution

#### A.3.1 Former and current geographical distribution

*Delma impar* is patchily distributed in grasslands of south-eastern NSW, the ACT, north-eastern, central and south-western Victoria, and south-eastern South Australia. It is believed to have declined throughout its distribution and is known to have disappeared from many sites.

The broad distribution of *D. impar* is shown in Figure 1.



**Figure 1.** Map of south-eastern Australia indicating broad distribution of *D. impar* (red dots). Cluster boundaries (see Appendix I) are shown in red. Mapping courtesy of DEWHA.

### A.3.2 Tenure of land supporting *D. impar*.

*Delma impar* is currently known from only 10 conservation reserves across its entire distribution; the Terrick Terrick National Park, Derrimut and Craigieburn Grassland Reserves, Rossbridge, Blacks Creek, and Boonderoo Nature Conservation Reserves, Back Creek and Cressy Flora Reserves, Rokewood Common and Corangamite Lake Reserve in Victoria; Mulangari NR, Gungaharra NR and Crace NR in the north of the ACT (known collectively as the Gungahlin Grasslands Reserves); Kuma Nature Reserve near Cooma in NSW; and Bool Lagoon Game Reserve and Hacks Lagoon Conservation Park in South Australia (these are adjacent reserves and together only represent one population).

Comment [SLW1]: C.1.6. says 16 conservation reserves.

Of the seven sites currently known to support the species in NSW, two are on private land, one on private rural-residential land, one on council-owned land, two on land managed by the Rural Lands Protection Board (RLPB), and one on land owned by the Department of Environment and Climate Change (NSW).

Of the sites in Victoria, 48% (35 sites) are on road reserves, 20% (15) on private land and 32% (23) in reserves (this includes conservation reserves, cemeteries, water reserves etc).

The sites outside the Gungahlin Reserves in the ACT are on a mix of private leasehold, military, ACT government and Commonwealth government land – several sites on Commonwealth land (in the Majura and Jerrabomberra valleys) are subject to a Memorandum of Understanding between the ACT Government and the responsible Commonwealth agencies (Defence Department, National Capital Authority, CSIRO, and Department of Environment, Water, Heritage and the Arts).

Comment [DEWHA2]: check

In SA, there are just three areas where *D. impar* is known to occur. The first consists of two adjacent conservation reserves, Bool Lagoon Game Reserve and Hacks Lagoon Conservation Park. The site which has apparently the largest population known in South Australia is Lake Ormerod which is a state Drainage Reserve. The species also occurs in roadside verges along



the Riddoch Highway north of Naracoorte which is state-owned land and falls under the jurisdiction of Naracoorte-Lucindale District Council.

#### A.4 Life history and ecology

The life history of *D. impar* is largely unknown. Adults have been recaptured in the wild almost seven years after first capture (Rauhala, 1997). Adults have also been held in captivity for twelve years (C. Banks pers. comm.). Estimates of lifespan by researchers (ARAZPA, 1996) start at about 10 years, but individuals may live significantly longer. Age at first reproduction is thought to be 2-3 years for males and 3-4 years for females (ARAZPA, 1996). However, this is based only on estimates of growth rates and expected life history patterns. Each female lays two eggs, and it is believed most adult females are capable of breeding every year. Communal clutches of up to 36 eggs have been recorded (G. Peterson pers. comm.). Eggs are laid in December/January and hatch in January/February. Hatchlings measure about 40-45 mm snout-vent length and weigh about 0.5-0.75 g (Banks *et al.*, 1999). In the ACT, adults are more active during November and December than at any other time of the year. In Victoria the most active period may be September and October. This activity is thought to be related to mating and egg laying, requiring increased movements of both sexes.

Very little is known about the movements and micro-habitat use of *D. impar*, although some information has been gained from recapture data and from fluoro-dye tracking (Kukolic *et al.*, 1994; Kutt, 1993; Rauhala, 1996). Animals have been recorded moving at least 20 m in one day (Kutt, 1993), and up to 50 m over several weeks (K. Kukolic pers. comm.). This implies that these animals may be relatively wide-ranging, supporting the belief that they are active hunters, at least some of the time (Nunan, 1995). Most of the movement records, apart from those reported by Kutt (1993), have been recorded during the November/December high activity period, and may be due to reproductive activity rather than normal home range movements. Kukolic *et al.* (1994) found an animal moved 60 m over a two day period. Whilst individual animals are apparently capable of moving this distance (and probably greater) recapture data from Victoria using tiles rather than pitfall traps suggests a very small home range (conservatively within 10 m<sup>2</sup>). Larger movements probably relate to reproductive activity, otherwise the animals seems quite sedentary.

Studies of the diet of *D. impar* indicate that the species feeds primarily on spiders, crickets, Lepidopteran larvae and cockroaches (Coulson, 1990; Nunan, 1995; Wainer, 1992). Despite their availability, Isopoda (slaters), Hemiptera (true bugs) and Formicidae (ants) were not found to be part of the diet of *D. impar*, indicating some degree of specialisation (Nunan, 1995). However, these relatively unpalatable arthropods are often avoided by reptiles (Greer, 1989). Prey availability was not found to be a limiting factor in terms of the distribution of *D. impar* in native or non-native grasslands in the ACT (Nunan, 1995) or in south western Victoria (Goonan, 2008). The diet of these lizards suggests that they are active foragers, although they may also catch prey using a sit-and-wait ambush style of feeding (Nunan, 1995).

It is assumed that *D. impar* shelters mainly in grass tussocks and other thick ground cover. They are also known to utilise soil cracks in Victoria, shelter beneath rocks at numerous sites in Victoria and near Cooma in NSW, and individuals have been found in spider burrows or artificial burrows (used to survey for other lizard species) in the ACT (M. Evans pers comm.). Other ground debris such as timber and asphalt is occasionally utilised (Coulson, 1990; Kukolic *et al.* 1994; Rauhala, 1996).

*Delma impar* enters a state of torpor for the winter months, although the exact timing of this and the torpor sites are mostly unknown. It has been found that animals in Victoria overwinter mostly in soil cracks, under/beside rocks and in tussock bases. In the ACT, however, most sites have little or no rock cover or soil cracking, and it is therefore assumed that grass tussocks provide the primary overwinter refuges. Individuals have been found underground in cracks formed beside pitfall traps in the ACT, indicating that *D. impar* will shelter beneath the surface where opportunity allows.

Due to inherent difficulties when attempting to monitor populations of this species, it has not been possible yet to compile information on the size of any population.

## A.5 Habitat

Until recently, *D. impar* was thought to inhabit only native grasslands dominated by species such as Spear Grass *Austrostipa bigeniculata* and Kangaroo Grass *Themeda triandra*. In recent years, surveys have revealed *D. impar* in many sites dominated by exotic grasses such as *Phalaris aquatica*, *Nasella trichotoma* and *Hypochaeris radicata* (Corrigan *et al.*, 1996; Coulson, 1990; Hadden, 1995; Harley *et al.*, 2005; Kukolic *et al.*, 1994; O'Shea, 1996; Rauhala, 1996; Rauhala *et al.*, 1995). They have also been found in several secondary grassland sites (i.e. sites which were not historically grassland, but which have been cleared for grazing or agriculture). The presence of a relatively dense and continuous structure, rather than the floristic composition of the grasslands, may be important in influencing the persistence of *D. impar*.

It appears that while *D. impar* are restricted to grasslands (and grassy woodland in the ACT and north-eastern Victoria), they are not restricted to native or primary grassland. The key to their survival in rural areas may be the availability of shelter during disturbance events (such as heavy grazing or perhaps even ploughing), from which they may be able to recolonise disturbed sites after the cessation of the disturbance (Dorrrough, 1995; Dorrrough and Ash, 1999). This shelter may take the form of plant species which are relatively unpalatable to stock, such as Serrated Tussock or *Juncus* sp., road easements, less disturbed neighbouring land or even soil cracks and arthropod burrows in the short-term. It is not known if grassland dominated by introduced species can support *D. impar* populations in the long-term, but there is evidence that they do reproduce in these habitats (Corrigan *et al.*, 1996; Harley *et al.*, 2005; Rauhala *et al.*, 1995; SA DEH, 2007).

In south east South Australia the distribution of *D. impar* appears to be limited to heavier clay-based soils rather than those with high sand content (Stratman, 2007). The species also seems to be associated with soils characterised by high clay content in south western Victoria (Koehler, 2004; Candy, 2008).

## A.6 Habitat critical to survival

At this stage it is not possible to determine the extent or location of habitat that is critical to the survival of *D. impar*. One of the actions of this Recovery Plan is to gain a greater understanding of the critical components of this species' habitat (see Section C9). However, to aid conservation management and priority setting, 'clusters' of sites have been identified across the distribution of the species (see Appendix I), with the aim of maintaining viable populations in each cluster. Recent genetic studies (Maldonado, 2009) have contributed to a refinement of the cluster approach and also validated its general principles.

## A.7 Threats

### Habitat modification and fragmentation

*Delma impar* is a grassland specialist, being found only in areas of native grassland or grassy woodland and nearby exotic pasture. Natural temperate grassland is one of Australia's most threatened ecological communities. The main threat to *D. impar* across its entire range is habitat degradation and destruction. Approximately 99.5% of natural temperate grassland has been destroyed or drastically altered since European settlement (Kirkpatrick *et al.*, 1995). While *D. impar* may persist for some time in modified grasslands, it can be eliminated from an area by extended intense grazing, pasture improvement, ploughing, drought or other heavy disturbance. Such areas may be recolonised by the species, but this is probably dependent on the availability of nearby undisturbed refuge areas.

Developments have occurred or are imminent at a number of known sites. These include: railway expansion, pipelines, wind farms, new roads, a freeway, landfill extension, and urban and industrial development. No development threats are currently known in SA.

### **Inappropriate fire regimes**

Fire has been recorded as causing mortality in the species (Coulson, 1995; Walton, 1995), but the extent to which populations are affected is unknown. Extensive fires over large areas are thought to cause direct mortality, as well as reducing cover for the species and its prey and exposing animals to increased predation. Little is known about the behavioural reaction of *D. impar* to fire. O'Shea (2005) recorded more captures in areas that had been burnt compared to unburnt sites and those with an intermediate fire history. This may mean that the animals are more easily trapped in this environment, rather than being a reflection of the density. However, the work did demonstrate that the animals continued to persist in small (0.5 ha) areas of grassland that had been burnt in both the short and medium terms.

### **Predation**

Predation as a threatening process has not yet been quantified. It is assumed that a range of native predators including snakes, other lizards, raptors, magpies and other predatory birds, and possibly the Fat-tailed Dunnart *Sminthopsis crassicaudata*, will prey on *D. impar*, but the extent of this predation and its effect on populations is unknown. There has been speculation about the potential for an increase in raptor presence, and thereby impact, on *D. impar* resulting from the provision of perching sites such as telegraph poles in grasslands. Introduced predators may be more of a concern, as urban development surrounds many *D. impar* populations. There is some anecdotal evidence which suggests that foxes may prey upon *D. impar* (e.g. S. Walton pers. comm.), and domestic cats could have a large impact on local populations where suburban housing abuts grasslands.

## **A.8 Conservation status**

The Striped Legless Lizard, *Delma impar*, is listed as threatened under the following international, commonwealth, state and territory legislation and documentation:

### **International**

IUCN (1996): *Vulnerable*

ANZECC (1991, 1995): *Vulnerable*

### **National**

*Environment Protection and Biodiversity Conservation Act 1999*: *Vulnerable*

### **Australian Capital Territory**

*Nature Conservation Act 1980*: *Vulnerable*

### **New South Wales**

*Threatened Species Conservation Act 1995*: *Vulnerable*

### **Victoria**

*Flora and Fauna Guarantee Act 1988*: *Threatened*

*Advisory List of Threatened Vertebrate Fauna in Victoria – 2007* (DSE 2007).  
*Endangered*

### **South Australia**

*National Parks and Wildlife Act 1972*: *Endangered*

## **A.9 Important populations**

The apparent extent of decline of *D. impar* and its grassland habitat indicates that all extant populations are potentially important for the survival of the taxon.

## B GENERAL REQUIREMENTS

### B.1 Affected interests

**Comment [DEWHA3]:** Need to summarise this section down to a para eg state/territory agencies, local government, land managers, private land holders, CMAs, conservation organisations etc....

Several organisations have legislative responsibilities to *D. impar*, and will be involved in all stages of this Recovery Plan. At a national level, the species is listed on the EPBC Act, administered by the federal Department of Environment, Water, Heritage and the Arts. Any action that will have, or is likely to have, a significant impact on a taxon listed on this legislation will trigger the EPBC Act, necessitating approval from the Commonwealth Environment Minister. Critical habitat may be listed for any nationally listed taxon or ecological community under the EPBC Act.

Within New South Wales (NSW), *D. impar* is listed on the TSC Act. This Act, along with the *Threatened Species Legislation Amendment Act 2004*, outlines the duties of the Department of Environment, Climate Change and Water (DECCW) in protecting threatened species, ecological communities and critical habitat in NSW. An independent Scientific Committee has been set up under the Act to determine which species, populations and ecological communities should be listed as endangered, vulnerable or extinct under the Act, and also to determine key threatening processes. The TSC Act provides an exemption for the carrying out of “*routine agricultural activities*”. As such there not likely to be economic implications for primary producers in NSW under the TSC Act – however, the Commonwealth EPBC Act offers no such exemption for agricultural activities. In accordance with the Priority Action Statement requirements of the *Threatened Species Legislation Amendment Act 2004*, a list of sixteen priority recovery strategies has been developed for *D. impar* with a priority of Low, Medium or High given to each action. All of these strategies relate directly to actions outlined in the previous version of this National Recovery Plan and also included in this updated version.

In the ACT *D. impar* is listed as Vulnerable under the NC Act. The Act was amended in 1994 to establish the Flora and Fauna Committee and a process for listing threatened species, ecological communities and threatening processes. The Committee may recommend to the Minister for the Environment declaration of threatened species and ecological communities and advises on nature conservation matters generally. An Action Plan is required in response to each declaration. It must include proposed actions for the protection and survival of a threatened species or ecological community, or, in the case of a threatening process, proposals to minimise its effect. An Action Plan for *D. impar* was first published in 1997 (ACT Government, 1997), but this has been replaced as part of a multispecies Action Plan for endangered natural temperate grasslands and component species (ACT Government, 2005). There is currently a Memorandum of Understanding between the Defence Department and the ACT Government for management of the Majura Training Area in the ACT.

In Victoria, *D. impar* is listed on the *Advisory List of Threatened Vertebrate Fauna in Victoria* (DSE 2007) as well as the FFG Act. This Act provides the main legal framework for the protection of Victoria's biodiversity. When a listing occurs, an ‘Action Statement’ must be prepared; this is a document that identifies actions that have been or will be taken to conserve the taxon. An Action Statement for *D. impar* has been prepared (DSE, 2003) and is currently in review. The Department of Sustainability and Environment (DSE) has ultimate responsibility for the management of threatened species in Victoria, and is the primary agency involved in management on public and private land, with the exception of the parks and reserves system, which are managed by Parks Victoria (PV). As a proportion of the species' former Victorian distribution occurs in the parks system, PV has management responsibilities to this taxon within their estate and management actions are undertaken in consultation with DSE and directed via actions from the Actions for Biodiversity Conservation database.

*Delma impar* occurs on freehold land at many sites, necessitating the involvement of private individuals. Under the EPBC Act, these individuals have a responsibility to ensure that any development on their properties does not harm *D. impar*. Any such developments commencing since the inception of the EPBC Act will trigger a referral. Private landowners can facilitate monitoring and recovery actions for *D. impar* by permitting access to habitat on their land,

consulting with agencies and individuals involved in these activities, and ensuring that their own activities do not negatively impact the species or its habitat on or near their properties.

The following agencies have legislative responsibility for *D. impar*:

National

- *Department of Environment, Water, Heritage and the Arts*
- *Department of Defence*
- *Department of Transport and Regional Services*
- *National Capital Authority*

ACT

- *Parks, Conservation and Lands*
- *Canberra International Airport*
- *Housing Industry Association*
- *ACT Planning and Land Authority*

NSW

- *DECC (NPWS)*
- *Department of Water and Energy*
- *Department of Lands*
- *Catchment Management Authorities*
- *Local Governments*
- *Rural Land Protection Boards*

Victoria

- *Department of Sustainability and Environment*
- *Parks Victoria*
- *Catchment Management Authorities*
- *VicRoads*
- *Local Governments*

South Australia

- *Department of Water, Land and Biodiversity Conservation*
- *Naracoorte-Lucindale District Council*

## **B.2 Role and interests of indigenous people**

In the ACT and region, the Ngunnawal people are the traditional users of the native grasslands that are habitat for Striped Legless Lizard. The Ngunnawal are a diverse people composed of several subgroups.

In NSW, the indigenous communities involved in the regions affected by this plan have not yet been identified. Implementation of recovery actions under this plan will include consideration of the role and interests of indigenous communities in the region.

In Victoria, the Wurundjeri people are the traditional occupiers of the Port Phillip region, with the Woiwurrung subgroup occupying the northern plains and the Wathaurong subgroup occupying the western area. The Victorian Government has developed an Indigenous Partnership Strategy and is preparing Regional Indigenous Action Plans (RIAP). The DSE Port Phillip Region RIAP

includes actions to consult with indigenous communities on land management and threatened species programs.

### B.3 Social and economic impacts

Conservation of the habitat of *D. impar* may affect activities that conflict with objectives of this Recovery Plan. Examples of this include restrictions on developments on private property, or restrictions on particular land-uses. Development of urban land and infrastructure such as roads can conflict with efforts to conserve habitat for *D. impar*, particularly adjacent to Canberra, Queanbeyan and Melbourne. Similarly, management of the species in rural areas may affect development of infrastructure, or the type of land use.

Where conflict occurs between actions outlined in this Recovery Plan and the interests of others, consultation between the appropriate land management agency and the affected individuals shall occur with the aim of negotiating a desirable outcome for all parties.

There are considerable positive benefits in protecting *D. impar* habitats. The protection of these areas will augment intrinsic natural values enjoyed by visitors to such areas. These benefits complement the management aims of national parks and other reserved land where this species occurs. Visitors to these areas provide economic benefits for the local districts. The major benefit is fulfilment of a community expectation for maintenance of biodiversity, and the long-term protection of both *D. impar* and grassland habitat for the enjoyment of present and future Australians. Involving the community and private landholders in recovery efforts can foster a sense of pride in contributing to conservation programs.

Because much of the remaining *D. impar* habitat is on privately-owned land, the opportunity exists for landholders to make substantial contributions towards the conservation of this species. It will be important to develop management agreements with landholders which attempt to integrate conservation management practices with everyday rural land management, and to maintain a harmonious relationship between the various land managers responsible for *D. impar* populations.

Comment [DEWHA4]: Delete rest of this section from here.

The alteration or rejection of development proposals on land containing *D. impar* populations can have adverse social impacts. Where services are to be supplied by the development, the alteration or denial of these services may have a substantial social impact. The extent of this impact will vary from site to site and will depend upon the type of proposed development.

Surveys for *D. impar* are expensive and time-consuming, and access to private lands for this purpose is sometimes problematic. Therefore, it may not be practical to survey all potential habitat within the time frame of this Recovery Plan. Conservation agencies should therefore use all other means at their disposal for obtaining this information. Many records of this and other threatened species come from work undertaken by consultants and students for other purposes. Conservation agencies should encourage consultants to undertake targeted surveys for *D. impar* whenever they are working in potential habitat, and recommended methodologies should be developed by the NRT. It is extremely important that these records are incorporated by conservation agencies into their databases. In this way, even without targeted surveys, increasing knowledge of distribution can be obtained.

Nevertheless, in comparison to the costs associated with major infrastructure works, *D. impar* surveys are an insignificant cost and should be undertaken in the early planning phases of such works. Such surveys will provide certainty in the planning process and permit implementation of developments thus saving development costs. A recent promising method for surveying *D. impar* uses tiles or wood blocks, which act as artificial shelters.

Similarly, land acquisition to establish a system of grassland reserves is extremely expensive, and must be viewed as a long-term and on-going process, to be achieved in concert with sympathetic management of private and other lands via various agreements. Planning of such a system will rely upon a thorough understanding of the distribution and habitat requirements of *D. impar*, as well as insights into the size and management of areas required to support long-term viable populations.

## B.4 Benefits to other species/ecological communities

The Recovery Plan includes a number of potential biodiversity benefits for other species and vegetation communities throughout the range of *D. impar*. Principally, this will be through the protection and management of habitat.

There is a broad range of potentially threatening processes that are likely to be acting upon populations of *D. impar*. Mitigation of these processes will have wide-ranging benefits for maintenance of ecological processes and biodiversity conservation. The distribution of *D. impar* overlaps with habitat critical for the conservation of other threatened species and communities. For example, this species occurs in and adjacent to endangered natural temperate grasslands fringing Canberra – these grasslands provide habitat for threatened or rare fauna such as the Grassland Earless Dragon *Tympanocryptis pinguicolla*, Golden Sun Moth *Synemon plana*, Perunga Grasshopper *Perunga ochracea* and Canberra Raspy Cricket *Cooraboorama canberrae*, as well as a suite of threatened plant species. Conservation measures, particularly habitat protection, for *D. impar* in these areas are likely to benefit these other species and the overall community.

The conservation of *D. impar* and its habitat will assist in the conservation of natural temperate grasslands, which are among Australia's most threatened ecological communities (ANZCCBDAC, 2001). Natural temperate grasslands have been reduced to just 0.5% of their extent at the time of European settlement (Kirkpatrick *et al.*, 1995). The broad habitat of *D. impar* is natural temperate grassland and in some instances grassy woodland. Consequently, the conservation of *D. impar* involves conservation of such grassland areas and the suite of threatened species associated with them. Natural Temperate Grassland of the Southern Tablelands (NSW and ACT) is listed as an endangered ecological community (EACT, 2003) while Natural Temperate Grassland of the Victorian Volcanic Plain were recently listed as a critically endangered ecological community under the EBPC Act. *Delma impar* has, in some instances, acted as a 'flagship' species in the conservation of natural temperate grasslands, because conservation activities attracted considerable attention, based upon the 'novelty' of the species. The promotion of grassland conservation is problematic, however, because grasslands do not have the broad public appreciation of forests, rivers or wetlands. Because of this, having a species such as *D. impar* as a well-known 'flagship' can be invaluable in the overall conservation of natural temperate grasslands.

The *D. impar* Recovery Plan has strong links to other State and Territory plans. These are listed in Appendix III.

Comment [DEWHA5]: Delete App III

## **C RECOVERY OBJECTIVES, CRITERIA AND ACTIONS**

---

### **C.1 Previous conservation measures**

#### **C.1.1 Coordination and communication of research and recovery actions**

An Action Statement for *D. impar* has been prepared in Victoria (Webster *et al.* 1992 – revised 2003), in accordance with the *Flora and Fauna Guarantee Act 1988*. This Action Statement documents the range of actions previously undertaken and lists actions required for the conservation of the species in that State. Actions from the Action Statement have been included within a statewide database of “Actions for Biodiversity Conservation” (ABC) managed by DSE, for implementation by DSE and other authorities.

An Action Plan for *D. impar* in the ACT was finalised and adopted in 1997 (ACT Government 1997a), in accordance with Section 23 of the *Nature Conservation Act 1980*. It has been updated as part of a multi-species/ecological community Action Plan (No. 28) (ACT Government 2005).

A National Recovery Team (NRT or SLLNRT) for *D. impar* was established in December 1995. This team has been coordinating national survey and research efforts since its establishment. However, the NRT has not met since 2004. Survey and research directions are planned and acted upon primarily by two regional working groups: the Victorian Striped Legless Lizard Working Group (VSLLWG), and the ACT and NSW Striped Legless Lizard Regional Working Group (SLLRWG). The VSLLWG was established in December 1990, and is the body recommended in the Action Statement to coordinate management actions in Victoria (Banks, 1992; Kutt *et al.*, 1995; Webster *et al.*, 1992). These two regional working groups deal with the specific issues faced by their regions and report back to the NRT regarding progress on recovery actions. Regional and national groups are in communication on an as need basis with other relevant working groups and recovery teams, such as the Grassland Earless Dragon National Recovery Team and various grassland recovery groups. The work coordinated by the working groups has provided most of the current knowledge of *D. impar* distribution and biology.

Organisations represented on the three groups are provided in Appendix IV.

#### **C.1.2 Population and habitat viability analysis**

A Population and Habitat Viability Analysis (PHVA) workshop was conducted in Canberra in July-August 1996 by the Conservation Breeding Specialist Group of the IUCN's Species Survival Commission, in collaboration with the NRT, the Australasian Regional Association of Zoological Parks and Aquaria Inc. (ARAZPA), and the ACT Parks & Conservation Service (ARAZPA, 1996). Most members of the Recovery Team, as well as other interested groups and individuals, participated in this exercise. This workshop provided insights into the factors that are important in the population dynamics of *D. impar* and this information has been used to direct research and conservation efforts.

#### **C.1.3 Surveys and monitoring**

##### **ACT**

In the ACT there are no extensive areas of potential habitat remaining which have not been surveyed, and the focus of surveys in the ACT have been to better understand the geographic extent of known populations and confirming persistence of the species at sites. Due to the potential impact of pitfall trapping to sites, since 2001 PCL have moved to other methods for surveying the species, such as the use of tiles. Recently PCL have been investigating how to improve the detection probabilities of tiles, including comparing tiles made of different materials (concrete, wood), colours and designs, in terms of detection of the species and tile thermal



properties. This research is continuing, with trials in three reserves in the ACT. The species has recently been recorded in grassland on Defence land in Belconnen, where it was not known to occur.

### **Victoria**

In Victoria, past survey efforts concentrated in the Melbourne region and some areas in the west of the State. Since winter 2004, targeted surveys to determine the current distribution and status of *D. impar* at 330 remnant grassland/grassy woodland sites across south-western Victoria using a passive survey technique have been undertaken. At each site a grid consisting of 50 roofing tiles, set out in a 20 x 45 m formation, has been established. Each grid has been monitored at least once each season, with approximately 200,000 tiles checked (as of autumn 2008). To date *D. impar* has been detected at 73 sites with approximately half of these sites found on road reserves even though road reserves only represent one third of land tenure being surveyed. Ongoing population monitoring via a capture-mark-recapture program is being conducted in conjunction with the tile surveys. Monitoring and capture-recapture data on *D. impar* is helping to determine population demographics such as population abundances, recruitment, survivorship, growth rates and sex and age ratios. The data also provide direct evidence that monitoring and research of elusive and cryptic vertebrates such as *D. impar* requires resources over an extended period of time in order to make informed decisions about presence/absence, population fluctuations and declines, and habitat management. Temperature data loggers were installed across 60 survey grids to monitor the temperatures underneath the roof tiles in order to provide information on temperature fluctuations in association with catchability of animals and to provide scientifically established guidelines for species monitoring. A data matrix was developed incorporating the *D. impar* monitoring data from all grids in south-western Victoria as well as grids in north central Victoria and south-eastern South Australia from the past four years. This matrix will form the basis for a survey and monitoring protocol for *D. impar*. The data matrix is currently being analysed to determine detection probabilities for *D. impar* and also assessing potential covariates (season, temperature, time of day, etc) that may influence detectability. These results will contribute to forming a survey and monitoring protocol for *D. impar* that will be utilised by both government agencies and environmental consultancies (to be formulated by the NRT and used in conjunction with this Recovery Plan).

### **New South Wales**

Few targeted surveys have been undertaken in NSW, the most recent successfully locating the species near Goulburn (J. Dawson pers. comm.). Recent surveys by ecological consultants have found *D. impar* at two sites in the Monaro region (Dorrough *et al.*, 1996; Frankenberg and Frankenberg, 1998). As the distribution of *D. impar* is poorly understood in NSW, extensive targeted reptile surveys are planned for areas of potential habitat, including the Yass region. Further vegetation surveys are planned in order to identify new areas of potential habitat for later targeted surveys.

### **South Australia**

Brief surveys at Bool (or Hacks) Lagoon in 1995 and 1998 failed to detect *D. impar*. A Wildlife Conservation Fund grant enabled the South Australian Herpetology Group to conduct a targeted survey for the lizard in the South East between 1999 and 2002. This work included a review of historical collection sites, identification of potential habitat, pit-fall trapping, tile surveys, active searches for the species and a media campaign involving local radio, newspapers and the production of a brochure requesting possible sightings to be reported (Milne, 2002). The field surveys consisted of 14 trips to the South East between August 1999 and April 2002 (Milne, 2002).

As part of the Department for Environment and Heritage's threatened species recovery program in the South East, surveys are currently underway to clarify the species' distribution and abundance. The method involves placing 50 roof tiles on rectangular grids of 45 x 20 m, with a 5 m spacing between each adjacent tile. The suitability of more than 250 km of roadside vegetation has been assessed, including sections of the Riddoch Highway between Tarpeena and Padthaway, the Wimmera Highway east of Naracoorte, the Frances-Hynam Road and the Naracoorte-Lucindale Road. The survey targets areas that support well-formed grass tussocks in which the lizards can shelter. Such sites are usually undisturbed (e.g. not slashed, grazed or burnt). The majority of these survey sites are dominated by exotic grasses, such as *P. aquatica*, although a few support small patches of *T. triandra*.

Approximately 3000 roof tiles have been laid with the assistance of Greencorp groups in the quest to locate additional populations. The tiles are monitored at 2-4 week intervals between September and December. The objective of these surveys is to establish the lizard's presence or absence at designated sites.

Annual population monitoring at Lake Ormerod, Hacks Lagoon and Bool Lagoon, using the same roof tile methodology as that described above for the surveys, commenced in spring 2004 (D. Harley pers. comm.). The objective of this work is to clarify the species' distribution and abundance at sites where it is known to occur and collect demographic data (from Harley *et al.*, 2005).

### **C.1.4 Research**

Research into various aspects of the biology of *D. impar* has been instigated and is continuing (see Appendix V for a list of projects.) Habitat relationships have been the focus of much attention, to attempt to identify management requirements (Dorrough, 1995; Hadden, 1995; O'Shea, 1996; O'Shea, 2005; O'Shea and Hocking, 1997), and the effects of fire (Walton, 1995). Movements have been examined (Kutt, 1993; O'Shea, 2005), and the diet has been determined (Wainer, 1992; Nunan, 1995). Recent studies have investigated alternative trapping or detection techniques for the species (Nielsen and Underwood, 1997; O'Shea and Hocking, 1998) and have resulted in the widespread adoption of roof tiles as an alternative to pitfall trapping. Basic demographic parameters, such as mortality, recruitment, growth and life-span remain largely unknown, as do the effects of various habitat disturbance factors (e.g. fire, grazing and weed invasion).

Within Victoria, several recent studies have examined:

- The influence of fire history and frequency at the south-western Victoria monitoring sites to determine fire regimes that are conducive to *D. impar*: (G. Peterson pers. comm.);
- The impacts of fire on *D. impar* prey items (O'Bryan, 2008);
- The use of head scale patterns to identify individual *D. impar*. The examination and recording of head scale patterns is effective enough to replace branding as a way of recognising recaptures (O'Shea, 2005);
- The current distribution, status and habitat preferences of the *D. impar* in far south-western Victoria, based on the survey results from the first year of monitoring in the Glenelg Hopkins Catchment (Koehler, 2004);
- The use of artificial refuges to census populations of *D. impar* in western Victoria. Habitat and microhabitat characteristics, environmental conditions, time of day, and other taxa influencing tile occupation by *D. impar* were examined. Morphometrics of *D. impar* were also investigated, and the relationship of tile occupancy rate to abundance was considered. Refuge preference of *D. impar* was also determined in a laboratory experiment (Thompson, 2006);
- The influence of landscape and habitat variables on the presence and absence of *D. impar* in the Glenelg Hopkins and Corangamite Catchments. The project was largely based on both spatial data and the data that had been collected over three years at tile survey grids. The resulting models will be used to map potential habitat as well as help determine the best management for existing populations (Candy, 2008);
- The potential impact of pesticides on *D. impar* prey availability on linear reserves (generally roadsides) adjacent to crops. Any impact of pesticide drift on *D. impar* prey could be significant in light of both the recent significant change in land-use in south western Victoria from broad acre grazing to cropping, and also the fact that over 50% of *D. impar* sites in this area are on roadsides (Goonan, 2008);
- The current "cluster" management groups by molecular based analyses assessing how these cluster groups actually relate to *D. impar*'s phylogeography. In particular, the project identifies specific molecular "Evolutionary Significant Units" and/or "Management Units". This project also examined current patterns of gene flow and the effects of

anthropogenic fragmentation on the species using microsatellite DNA. (Maldonado, 2009);

- The use of skeletochronology for aging museum specimens was examined. The technique has the potential for correlating morphometric data with age, resulting in a method for determining the approximate age of live *D. impar* specimens (Carpenter, 2008).

### **C.1.5 Ex situ programs**

A captive group of *D. impar* is held by Zoos Victoria. It originated mostly from salvage operations performed prior to destruction of grassland sites for development. Another captive group was maintained at the Animal House at VUT (Werribee), based on animals salvaged from the Albion grasslands. These animals have since been released at Organ Pipes National Park (plus some at Laverton North Grassland) as part of the trial release project. Monitoring of these trials is being conducted by Parks Victoria.

Captive breeding of *D. impar* has been achieved at Zoos Victoria, commencing in 1998 (Banks *et al.* 1999). Additional eggs laid in captivity by wild-caught gravid females have been hatched and the juveniles raised (Kukolic *et al.*, 1994, C. Banks, M. Rauhala, H. Osmond pers. comm.).

Some individuals derived from salvage at doomed sites in Victoria have been released at a trial translocation site(s), after interim housing at Zoos Victoria.

### **C.1.6 Reservation and Management**

*Delma impar* is present in sixteen conservation reserves, ten in Victoria, three in the ACT, two in South Australia and one in NSW. The Victorian reserves (Derrimut (150 ha) and Craigieburn Grassland Reserves (342 ha), Terrick Terrick National Park (3880 ha), Rossbridge (59.5 ha), Back Creek (1.4 ha), Rokewood Common (105 ha) and Iramoo Wildlife Reserve (37.5 ha)). The ACT reserve (Gungahlin Grassland Reserve) is actually three separate, but abutting areas with a total of 564 ha. The NSW reserve (Kuma Nature Reserve) near Cooma is 180 ha. The planned addition to the reserve system of Commonwealth land at Albion in Victoria is an extremely important conservation measure.

ACT Action Plan 28 (ACT Government 2005) gives details of the reserves set aside for the protection of threatened grasslands and grassland fauna. Recently, new grassland reserves have been established in the Jerrabomberra Valley (totalling 470 ha) primarily to protect populations of the Grassland Earless Dragon, but these include some habitat known to be occupied by *D. impar*. There is currently a Memorandum of Understanding with the Defence Department for management of the Majura Field Firing Range, and habitat outside of protected areas in the Jerrabomberra Valley are subject to a Direction to Landowners from the Conservator of Flora and Fauna to prevent land management practices that are likely to have an adverse effect on grassland reptile populations.

These reserves, provide the start of a core of essential areas for the conservation of *D. impar*, as will be identified by the 'cluster' planning approach detailed in Appendix I.

In south-western Victoria, ongoing collaboration with the CFA is occurring in regards to awareness raising and management of roadside grasslands. This has involved the production and distribution of information sheets outlining the project and the preferred burn timing and frequency for roadside grasslands. On-ground works, in particular *Phalaris* control has been undertaken at a number of sites and these works will continue over time. At all extant sites appropriate management is being implemented or determined through negotiations with land managers. Threats have been identified and where applicable mitigation is being implemented. Vegetation assessment has been undertaken at all grids and repeated monitoring had been undertaken at all extant *D. impar* sites. Monitoring involves taking 20 random photo plots (1 m<sup>2</sup> quadrat) per grid to give an overall estimate of the habitat variables, in particular vegetation cover. Community awareness raising has been undertaken through field days, presentations, school involvement, grassland signs, involvement of community groups and volunteers. Fact sheets relating to the project in the south-west have been developed and an

up-dated version of the Striped Legless Lizard fact sheet and related web based documentation has been completed.

## C.2 Species ability to recover

Because populations of *D. impar* are now severely fragmented, it is unknown whether the species will persist in the long-term in reserved or managed areas, or what active management will be required. This will depend upon the size of the reserves, on the threats present, and on the management regimes implemented. Gene flow between many populations may be compromised. Appropriate management with regard to many threatening processes is yet to be determined.

There is circumstantial evidence to suggest that *D. impar* may recover after certain short-term disturbances, for example grazing, fire and drought (Dorrough, 1995; Kukolic *et al.*, 1994; Rauhala *et al.*, 1995; Rauhala, 1996), but the frequency and duration of these threats are undoubtedly important in determining recovery. The effect of introduced predators is not well understood, and may be significantly detrimental in grasslands adjacent to urban areas (such as the Gungahlin Grassland Reserves). When population sizes are reduced by catastrophes, the ability of the species to recover will be limited by its low fecundity. However, recent discoveries of *D. impar* populations inhabiting predominantly exotic grasslands (Harley *et al.*, 2005), do indicate some resilience to disturbance, at least in the short-term.

When appropriate reservation and conservation management has been determined and implemented in each cluster across the range of the species, it should be possible for conservation of the species to be secured.

## C.3 Further research overview

This Recovery Plan advocates strategies to improve our knowledge of the species and its ecology. These include an understanding of the mechanisms limiting population growth, use of habitat, and rates of movement between habitat fragments (partly addressed by Maldonado, 2009). Successful *in situ* population management will be founded on understanding the relationships between *D. impar* and its habitat, movement between habitats, how to appropriately manage habitat and the species' response to environmental processes. These are directly linked to biological function and are thus vital to recovery. Information on abundance, demography and/or other life history information will be necessary to monitor the success of particular management actions. Additionally, *ex situ* research may provide information of the species' biology that is not easily obtained from field studies.

Searches of known and potential habitat should continue in order to better understand the current distribution and extent of populations.

### Critical Gaps in Knowledge

Research to date has facilitated the identification of the broad distribution and habitat use of *D. impar*, and has provided some insights into the basic biology of the species. However, a better understanding of some important areas is required to enable informed management guidelines for the species and its habitat to be formulated. Further research is required into:

- Reliable and effective detection/tracking/monitoring techniques;
- Distribution (detail of areas where information is lacking for targeted surveys);
- Habitat (types of grassland utilised, where and when - include introduced) and what the minimal patch size is that can sustain a viable population;
- Effects of disturbance factors and land management practices (including the influence of adjacent land-use), on habitat and populations – fire, grazing regime, soil disturbance, weeds, predators, etc;
- Demography – abundance, life-span, reproductive age, size-class distribution, mortality, recruitment, etc;

- Seasonal behaviour/movements/microhabitat use/dispersal ability.

#### C.4 Management practices

The philosophy of the strategy for recovery is habitat conservation, restoration and management combined with an understanding of the ecological and biological requirements of *D. impar*. The framework for information acquisition is based on the approach outlined by the Australian and New Zealand Environment and Conservation Council and Biological Diversity Advisory Committee (2001). The emphasis is on using knowledge to better implement *in situ* management techniques that protect populations and promote breeding and recruitment. To achieve this, recovery actions are primarily structured to (i) acquire baseline data, (ii) assess habitat condition including ecological and biological function, (iii) protect populations to maintain or improve population growth, and (iv) to engage the community in recovery actions. On-ground site management will aim to mitigate threatening processes and thereby insure against extinction.

Broad scale protection measures applicable to all populations include legal protection of sites (where possible – it will not be possible to provide this protection on some private land), habitat retention and liaison with land managers including private land holders to secure sympathetic management of the species on their land. Management agreements with non-government landholders will play a crucial role in the conservation of *D. impar*. It is clear that *D. impar* populations can persist in the long-term on rural grazing land that is appropriately managed. Consequently, reserves are not the only solution to conserving the species, and should be viewed as only part of the management strategy for this species (see Appendix I – population cluster approach to *D. impar* management). ACT Action Plan 28 gives details of reservation and agreement strategies for the ACT grasslands or their component species (ACT Government, 2005). Other tools for securing sympathetic management on land in the ACT include 'Memoranda of Understanding', 'Directions of the Conservator of Flora and Fauna', and 'Land Management Agreements' negotiated during leasing of rural lands. In NSW, Joint Management Agreements for several Travelling Stock Reserves (TSR) on the Monaro are being negotiated with the Cooma RLPB. These agreements may be applied more widely across the Monaro to include sites known to support *D. impar*. Similar arrangements may be appropriate for other government lands and private lands in NSW, and for areas of habitat in Victoria.

#### C.5 Community involvement

There is great potential for community involvement in the conservation of *D. impar* and natural temperate grasslands, including the population cluster approach referred to above. For example, active support for and involvement in field studies by a farming family in western Victoria has provided valuable information about the species. Because many of the remaining patches of natural temperate grasslands are on private land, or in close proximity to suburban areas, the involvement of the community will be critical to the successful recovery of both *D. impar* and its grassland habitat. Landowner participation in conservation programs will be crucial.

There are already several community groups which have made great contributions to both grassland and lizard conservation. In the ACT and surrounding locales, the Friends of Grasslands community group is dedicated to the conservation and recovery of native grasslands and their associated fauna. The Friends of Iramoo (previously Friends of the Striped Legless Lizard) is a Victorian community group which has been involved in several conservation-oriented programs, including salvage operations.

The Victorian National Parks Association, the ACT Herpetological Association, the Conservation Council of the South-East Region and Canberra, and Landcare may be pivotal in co-ordinating community efforts. All of these organisations, other similar groups, and individuals will be instrumental in the implementation of this Recovery Plan, and will be included in many actions. Organising more such groups will be a high priority as the Recovery Plan is implemented.

## **C.6 Recovery objectives, performance criteria and actions**

### **C.6.1 Primary objective**

The primary conservation goal is to ensure the long-term survival of *D. impar* and maintain its potential for evolutionary development in the wild across its natural geographic range.

While down-listing of threatened status may be achieved in one or more jurisdictions, the nature of the known threats to the survival of *D. impar* are such that this may not be realistic throughout its distribution.

### **C.6.2 Specific objectives**

This primary objective is broken down into ten specific conservation objectives aimed at focusing resources on achieving the primary objective.

1. Establish and maintain national forums for the discussion and organisation of the conservation of *D. impar* across its natural distribution.
2. Determine the distribution of potential *D. impar* habitat.
3. Determine the current distribution and abundance of *D. impar* in Victoria, New South Wales, the Australian Capital Territory and South Australia.
4. Establish a series of reserves and other managed areas such that viable populations are maintained across the known distribution of the species.
5. Determine the habitat use and ecological requirements of *D. impar*.
6. Identify the nature and extent of the threatening processes affecting *D. impar*.
7. Undertake a program of monitoring to provide a basis for adaptive management of *D. impar*.
8. Increase community awareness and involve the community in aspects of the recovery program.
9. Assess the need for translocation, determine feasibility, develop protocols and undertake a trial translocation if appropriate.
10. Ensure that any captive population(s) are used to support education and research elements of the Recovery Plan.

### **C.6.3 Specific Recovery Objective – Recovery Coordination**

<p><i>Objective 1 – Establish and maintain national forums for the discussion and organisation of the conservation of <i>D. impar</i> across its natural distribution.</i></p>
--

The NRT and regional working groups have been instrumental in the organising of work completed to date and in disseminating information. This high level of organisation and communication must continue if this Recovery Plan is to be implemented successfully. Landowner participation in the recovery process is to be encouraged.

There is a need to further define the role of the NRT, to establish a mechanism that ensures timely implementation of recovery actions, and to regularly review this implementation. This could be facilitated by a coordinator (to be appointed) to schedule regular meetings, to establish agenda that examine all actions, and to promote, facilitate and monitor implementation of recovery actions. This coordinator role may provide similar benefit for the suite of grassland fauna listed as threatened throughout south-eastern Australia. The potential benefits of combining recovery teams for a number of threatened grassland vertebrates should be explored.

**Performance criteria:**

All agencies, institutions, community groups and individuals which have an interest in the conservation of *D. impar* and its grassland habitats have opportunities to be involved in the regional working groups which are represented on the NRT.

The working groups and the NRT continue to coordinate implementation of recovery and action plans, coordinate projects, organise workshops, and disseminate information at the high level which has been achieved to date. In particular, the NRT will:

- Establish strategic objectives and research and management priorities for the conservation of *D. impar* throughout its distribution;
- Facilitate preparation of the National Recovery Plan and the co-ordination of the National and State/Territory management strategies, oversee their implementation, and participate in their review;
- Monitor and evaluate success of research and management programs;
- Assist with seeking resources for conservation programs and advise on their effective use;
- Provide for exchange of information on the conservation of *D. impar* and provide authoritative advice as required;
- Foster community awareness of and the establishment of extension programs for the conservation of *D. impar*;
- Integrate *D. impar* research and management with wider grassland conservation efforts (and organisations).

**Actions required to achieve objective:**

**C.6.3.1 ACTION: Maintain the National Recovery Team and regional working groups.**

A national coordinator dedicated to facilitating the National Recovery Team(s) and recovery programs for a range of threatened grassland fauna, including *D. impar*, is required.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** DEWHA, PCL, DECCW, DSE, ZV, SA DEH.

**C.6.3.2 ACTION: Review performance of Recovery Plan annually.**

The NRT will annually review implementation of all actions listed under this Recovery Plan, will review progress of implemented actions, and will initiate further actions as required.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** DEWHA, PCL, DECCW, DSE, ZV, SA DEH.

**C.6.3.3 ACTION: Establish coordinated databases for each State or Territory agency.**

Distributional databases of *D. impar* records will be maintained by each State or Territory agency, in formats that will facilitate ready exchange of information.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** NRT to oversee.

**C.6.3.4 ACTION: Encourage tertiary institutions to participate in a coordinated research effort for *D. impar*.**

The contributions made to *D. impar* conservation and research by tertiary institutions have been significant. There are several institutions which have shown a continuing interest in this field and these are encouraged and assisted by the working groups and

NRT. These associations will continue and student research should continue to provide valuable contributions to the recovery of the species. Appendix V includes a list of potential research projects. The list will be updated and maintained by the NRT.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** NRT.

**C.6.3.5 ACTION: Determine interim management guidelines for *D. impar* habitat.**

The NRT will determine and periodically update recommended interim guidelines for management of the habitat of *D. impar*, to enable appropriate management for areas where specific habitat management requirements may not have been determined. Preliminary interim guidelines are provided in Appendix VI.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** NRT.

**C.6.3.6 ACTION: Determine minimum survey requirements for *D. impar*.**

The NRT will determine standardised minimum survey methodologies for *D. impar*, for use in surveys where presence/absence information is required. With the cooperation of State and Territory agencies, the NRT will ensure that these minimum survey requirements are adhered to during surveys. When developed, these survey methodologies are to be used in conjunction with this Recovery Plan.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** NRT.

**C.6.4 Specific Conservation Objective – Habitat Determination**

<i>Objective 2 – Determine the distribution of potential <i>D. impar</i> habitat.</i>
---

**Performance criterion:**

Key habitat requirements are known and are used to establish the extent and use of potential native and non-native habitat.

**Actions required to achieve objective:**

**C.6.4.1 ACTION: Determine whether *D. impar* can persist in the long-term in exotic grassland isolated from native grasslands.**

It is important to determine the extent of potential habitat for *D. impar*. It is known that *D. impar* is found in exotic grasslands, but it is still unclear whether these sites act only as temporary refuges, populations sinks, or are actually capable of sustaining populations. In the ACT, breeding populations of *D. impar* have been found in two exotic-dominated sites which had been isolated from other areas of grassland for over eight years (Corrigan *et al.*, 1996; Kukolic *et al.*, 1994). Unfortunately, one of these sites has since been destroyed and can provide no further information. The other site (Kaleen) has been monitored to examine the viability of the population. Similar sites in Victoria, such as the Albion Explosives Factory site, must also be monitored. All of the sites in South Australia are dominated by exotic grasses (D. Harley pers. comm.). Monitoring has been in place since 2004 and *D. impar* appears to be doing well in at least one of these sites (Lake Ormorod).

**Priority:** 2

**Agency(s) responsible for implementation of action:** NRT and the regional working groups will be responsible for coordinating this work with state and territory conservation agencies.



**C.6.4.2 ACTION: Undertake research to determine the relationship between the structure and floristics of grasslands and their utilisation by *D. impar*.**

This research would focus on known populations of *D. impar* to determine what local vegetation characteristics affect habitat utilisation by the species.

**Priority:** 2

**Agency(s) responsible for implementation of action:** Initially, at least, this work should be conducted in the ACT, Victoria and South Australia where there are well known populations which have been the subject of previous research. Therefore, it falls upon PCL, DSE or SA DEH to either conduct this work or coordinate and promote appropriate student projects.

**C.6.4.3 ACTION: Conduct vegetation surveys of grasslands, particularly in New South Wales, to determine the extent of potential habitat for *D. impar*.**

Once the key habitat requirements of the species have been determined in NSW, this information should be used to conduct vegetation surveys with the aim of targeting areas for *D. impar* survey.

**Priority:** 1

**Agency(s) responsible for implementation of action:** Relevant state, territory and commonwealth agencies and regional working groups should be responsible for coordinating and conducting this work in their areas.

### **C.6.5 Specific Conservation Objective – Distribution and Abundance**

*Objective 3 – Determine the current distribution and abundance of *D. impar* in Victoria, New South Wales, the Australian Capital Territory and South Australia.*

**Performance criteria:**

Improved and more effective techniques for surveying, estimating population sizes and monitoring *D. impar* populations have been developed.

A research program for establishing the above is completed within the life of this Recovery Plan.

Surveys have been completed across all potential *D. impar* habitat.

**Actions required to achieve objective:**

**C.6.5.1 ACTION: Develop an improved detection technique.**

Pitfall trapping is very labour intensive to install, may not be as effective and reliable as desired and causes significant disturbance to the grasslands in which it is used. The use of artificial shelter sites (primarily roof tiles) has proven to be a much less labour intensive method of detecting the presence of *D. impar*. However, it appears that the numbers of captures are still too low to effectively estimate population sizes or densities using mark-recapture methods. Development of an improved capture technique is essential if we are to better understand the demographics of *D. impar*.

**Priority:** 2

**Agency(s) responsible for implementation of action:** NRT to co-ordinate.

**C.6.5.2 ACTION: Develop an improved marking technique.**

Research into animal marking techniques suitable for this species is required. Heat branding has had partial success (C. Banks pers. comm.). The alternative freeze branding was trialled by PCL on captive animals at Tidbinbilla Nature Reserve without success. The use of PIT tags may also be investigated as technology improves. O'Shea (2005) describes a technique for recognition of individual *D. impar* using their unique pattern and arrangement of head scales – this technique has been trialled

successfully in several recent studies (O'Shea 2005).

**Priority:** 1

**Agency(s) responsible for implementation of action:** The NRT to co-ordinate further trials.

**C.6.5.3 ACTION: Complete *D. impar* surveys within potential habitat in Victoria.**

Extensive surveys have already been conducted in the Melbourne region, across south-western Victoria and the Wimmera Plain. Surveys undertaken for several years by community groups in the Goulburn Valley area of north-eastern Victoria have proven useful for locating populations. Less survey work has been conducted in central northern Victoria, and more is required. Sites which historically contained *D. impar* should be revisited in order to determine whether or not the species is still present.

**Priority:** 1

**Agency(s) responsible for implementation of action:** DSE.

**C.6.5.4 ACTION: Commence surveys of potential habitat within NSW and survey the extent of the known populations.**

At this time, all of the currently known populations in NSW have been found during general survey and consultancy work. There have been few specific targeted surveys for *D. impar* in NSW aimed at establishing either the distribution or abundance of this species in the state, although an extensive targeted survey of the Yass region will begin to address this lack of information. This work will enable a national perspective on the conservation of *D. impar*. Sites that historically supported *D. impar* should be revisited in order to determine if the species is still present.

**Priority:** 1

**Agency(s) responsible for implementation of action:** The NSW DECCW has applied for funding to undertake extensive grassland surveys, and will be responsible for conducting and organising this work in collaboration with the ACT & NSW Striped Legless Lizard Regional Working Group.

**C.6.5.5 ACTION: Survey remaining potential habitat in south-eastern South Australia.**

It is likely that there is further potential habitat in this region, and soils/vegetation assessments should be undertaken to direct survey work to determine the western extremity of the species distribution. Other grassland areas in south-eastern South Australia should be investigated.

**Priority:** 1

**Agency(s) responsible for implementation of action:** The South Australian Department of Environment and Heritage or the South Australian Museum will be responsible for this action, with assistance/advice from the NRT.

**C.6.5.6 ACTION: Ensure surveys are conducted in accord with guidelines recommended by the NRT.**

The NRT will determine minimum survey requirements for presence/absence surveys. All surveys should adhere at least to these standards. NRT will periodically review and update these guidelines after examining all survey data.

**Priority:** 1

**Agency(s) responsible for implementation of action:** NRT to coordinate. State government agencies to ensure appropriate implementation.

### **C.6.6 Specific Conservation Objective – Management.**

*Objective 4 – Establish a series of reserves and other managed areas such that viable populations are maintained across the known distribution of the species.*

This is the most critical of the actions outlined in this Recovery Plan. Due to the nature of the threats to *D. impar*, the best way to conserve the species is to permanently protect its habitat and to manage these protected sites appropriately.

#### **Performance criteria:**

Within the life of this Recovery Plan, viable populations are under secure management in reserves and other managed areas across the natural distribution of the species.

All personnel involved in managing *D. impar* habitat have been adequately trained in the requirements of the species and in the implementation of actions from this Recovery Plan.

#### **Actions required to achieve objective:**

##### **C.6.6.1 ACTION: Undertake Population and Habitat Viability Assessments.**

A Population and Habitat Viability Assessment (PHVA) has been undertaken (ARAZPA 1996). While components of this PHVA focussed on the then newly established Gungahlin Grassland Reserve in the ACT, the methodology can be applied to other populations throughout the species distribution, as population size, mortality and other biological information is determined for the species and for each site. There was insufficient information on demographics, behaviour and life history for these analyses to be very reliable at the time. As this information accumulates, further PHVA analyses will become more useful in directing management decisions.

**Priority:** 3 to undertake further analyses when adequate data are available.

**Agency(s) responsible for implementation of action:** DEWHA, NRT.

##### **C.6.6.2 ACTION: Develop a national system of managed sites which will ensure the survival of the species across its geographic range.**

A national strategy for a system of managed sites is being developed by members of the NRT. This system focuses on the concept of ecologically or geographically distinct clusters of populations being permanently protected (either within reserves or by secure long-term management agreements). Further research is required before the cluster approach is fully developed and all units are identified and accepted, but preliminary work suggests that about 17 clusters could be required across the range of the species through Victoria, NSW, the ACT and in South Australia. These cluster boundaries are shown in Figure 1. Further explanation of the cluster approach is contained in Appendix I. Cluster boundaries may be refined in the light of findings from genetics studies.

As part of this system, as already noted, *D. impar* is present in fifteen designated reserves across its distribution. Managing the species in these sites, as well as the proposed Albion site and other proposed grassland reserves, will be vital to its long-term survival.

Many of the known sites that contain *D. impar* in Victoria and NSW are on private rural land. In the majority of cases the landowners have no obligation to manage the land sympathetically for *D. impar*, and they have the ability to exterminate *D. impar* populations through land-use practices which are inappropriate for the lizard and its habitat. Land management agreements must be made with these landowners, or land must be acquired for reserves in order to adequately conserve the species across its current range. This is particularly important in regions where *D. impar* populations are not included in reserves. Landowners must be informed about *D. impar* conservation and assured that the presence of *D. impar* on their properties does not mean that they will lose their land, or incur significant loss in productivity if currently land use is maintained. It is generally true that significant changes in land management practices are not required in areas that contain *D. impar*, because their very presence indicates at least a base level of appropriate land-use history. It should be noted that some

landowners are very supportive of grassland and *D. impar* conservation. Voluntary Conservation Agreements (NSW), Public Authority Management Agreements (Vic.), Land for Wildlife (Vic.), market based incentive schemes and Conservation Covenants are other potential formal arrangements whereby cooperative conservation management may be achieved.

Several of the known sites which contain *D. impar* in the ACT are occupied by Commonwealth Government agencies and presently used for a variety of purposes. Other sites are on rural land or are in the Gunghalin Grassland Reserve. In the ACT, Action Plan 28 for Natural Temperate Grasslands give details of protection measures for *D. impar* (ACT Government 1997a & b, 2005). These measures include reservation of the most significant areas, Property Management Agreements and Directions from the Conservator of Flora and Fauna for privately leased land and Memoranda of Agreement for land which is owned or occupied by the Commonwealth Government. Memoranda of Understanding between the Commonwealth and ACT Governments sets out conservation objectives for the land and the management practices required to maintain populations of threatened grassland species.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** This action will be coordinated by the NRT, but relevant state, territory and commonwealth agencies and regional working groups will be responsible for refining the composition of the clusters in their respective areas and for coordinating their protection. Establishment of reserves and liaison with landowners regarding management agreements for private land is the responsibility of the relevant state, territory or commonwealth conservation agency. The identification of sites for development of management agreements is the combined responsibility of the working groups and the NRT.

**C.6.6.3 ACTION: Formulate interim management guidelines for management of *D. impar* habitat. Implement interim management within reserves and, where possible, in other areas of habitat identified as most important in the cluster strategy.**

Information on the habitat requirements of *D. impar*, and on the optimal management of its habitat (including restoration of degraded habitat), is incomplete and requires substantial research. However, there is now an urgent need to manage areas of *D. impar* habitat with respect to fire, grazing, mowing, weed control, recreation, pest animals and other threats, such that further deterioration can be minimised. Consequently, decisions must be made, based upon best available knowledge, on the interim management of many areas – this has been undertaken at some sites in the ACT, NSW, SA and VIC. Management requirements of other coincident conservation values will be considered. Guidelines for the restoration of degraded native grassland areas should also be considered. Interim management guidelines recommended by the NRT are included in Appendix VI, and will be revised by the NRT.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** This action will be coordinated by the NRT, but relevant state, territory and commonwealth agencies and regional working groups will be responsible for formulating and implementing interim management guidelines.

**C.6.6.4 ACTION: Investigate the balanced management of grassland habitats, recognising the potential for conflicting management requirements of other conservation values.**

Other conservation values present within important native grassland areas may have conservation management requirements which differ from those of *D. impar* (e.g. with regard to burning regimes or structure of the vegetation). The importance of these values and the extent to which they may be compromised by optimal *D. impar* management must be assessed, and the best possible balance of management strategies formulated. In the ACT there is some evidence to suggest that *D. impar* and *Tympanocryptis pinguicolla* differ to some extent in their preferences for grassland structure.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** This action will be coordinated by the NRT, but relevant state, territory and commonwealth agencies and regional working groups will be responsible for liaison with all interested parties and for formulating appropriate balanced management guidelines.

**C.6.6.5 ACTION: Investigate the need for active translocation between isolated populations to avoid inbreeding.**

The first stage in determining the need for assisting genetic flow between populations is determining population sizes, mating system, genetic make-up of various populations, animal movements and natural genetic exchange between populations. The next step is to use this information to determine the likelihood of inbreeding having a negative impact on the survival of populations. If it is determined that inbreeding is a problem, experiments with translocation could be conducted to discover whether or not it is an effective remedy and, if so, what rates of translocation are appropriate for what populations.

**Priority:** 3

**Agency(s) responsible for implementation of action:** The NRT will examine the issue and decide upon the delegation of actions.

**C.6.6.6 ACTION: Provide training for personnel involved in activities which may affect *D. impar* and its habitat.**

All agency field staff and other personnel who are responsible for the management of grassland areas, or who undertake activities that may affect grassland conservation values, will be trained in the understanding and implementation of appropriate grassland management.

**Priority:** 1 ongoing

**Agency(s) responsible for implementation of action:** State and Territory conservation agencies.

**C.6.7 Specific Conservation Objective – Ecology.**

*Objective 5 – Determine the habitat use and ecological requirements of *D. impar*.*

**Performance criterion:**

A detailed understanding of the spatial and ecological requirements of *D. impar* is established and the consequences for management are understood.

A research program for establishing the above is completed within the life of this Recovery Plan.

**Actions required to achieve objective:**

**C.6.7.1 ACTION: Develop an effective method for tracking *D. impar*.**

Many questions about habitat use, activity periods and territoriality could be answered if an adequate tracking technique could be established. Thread spool and fluorescent powder tracking has been attempted (Kutt, 1993). The Victorian Striped Legless Lizard Working Group unsuccessfully trialed a harmonic radar diode implanted in a *D. inornata* in 1997 and is continuing to explore this and other systems, including the use of microwave transponders and radioactive isotopes. Tracking of individuals is vital if we are to determine daily and seasonal movement patterns for the species.

**Priority:** 1

**Agency(s) responsible for implementation of action:** NRT to coordinate.

**C.6.7.2 ACTION: Determine the life history of *D. impar*.**

Some of this work has already been conducted by PCL, DSE, Zoos Victoria and through several student projects. Despite the work already conducted, there are still large gaps in our knowledge of the life history of this species. These gaps include factors such as animal movements, egg deposition sites and age at reproductive maturity. Knowledge of life history will enable more informed management decisions to be made.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** All members of the NRT and working groups should be involved in this action.

**C.6.7.3 ACTION: Undertake studies of the demography of *D. impar*.**

Knowledge of factors such as age-related mortality and reproductive life span are vital in understanding and managing this species. When this information is reliably determined, it can be used in PHVA analyses, making them significantly more useful in aiding management decisions. Methods to reliably sex individuals have been developed at ZV and by PCL. These data may be collected during routine monitoring.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** All members of the NRT and working groups should be involved in this action.

**C.6.7.4 ACTION: Determine the daily and seasonal habitat use of *D. impar*.**

Knowledge of the patterns of seasonal and daily habitat use is important to assist in determining optimal management of the habitat.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** All of the member agencies of the NRT are currently making contributions to the general knowledge of the biology of the species.

**C.6.7.5 ACTION: Undertake studies into diet of *D. impar* and food availability in different grassland types.**

Detailed studies of the diet of *D. impar* in the ACT have been conducted by Nunan (1995) and in Victoria by Coulson (1990) and Wainer (1992) (see also Kutt *et al.*, 1998). Further work may be required in the Monaro region of NSW and in South Australia because of the different habitats occupied by the species in these areas.

**Priority:** 2

**Agency(s) responsible for implementation of action:** Further dietary work, if undertaken, would probably form part of a student project.

**C.6.8 Specific Conservation Objective – Threats.**

<i>Objective 6 – Identify the nature and extent of the threatening processes affecting <i>D. impar</i>.</i>
---

**Performance criterion:**

The nature and extent of threats to *D. impar* are well understood and a program for ameliorating the effects of critical threatening processes is established.

A research program for establishing the above is completed within the life of this Recovery Plan.

**Actions required to achieve objective:**

**C.6.8.1 ACTION: Identify threats to *D. impar* and its habitat at known sites and determine the relative severity of these threats.**

Apart from establishing reserves and managed areas (Objective 4), this is probably the most critical action required for the conservation of *D. impar*. All threats, including development proposals, must be identified and their potential effects assessed. This has been, or is in the process of being, done for all extant populations in Victoria through DSE's Actions for Biodiversity Conservation (ABC) database. Known and suspected threatening processes include:

- grassy ecosystem habitat destruction, fragmentation and degradation;
- soil disturbance, i.e. ploughing, road making, etc.;
- weed invasion and tree planting on native grasslands;
- inappropriate burning regimes;
- removal of rocks;
- feral animals such as cats, dogs and foxes.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** NRT to coordinate, with participation from relevant state, territory or commonwealth conservation agencies.

**C.6.8.2 ACTION: Undertake research on the impact of predators on *D. impar*.**

In order to conduct effective research into the effect of predators on *D. impar* it will first be necessary to develop an adequate monitoring technique. Current methods are insufficient to accurately detect all but gross changes in population density of *D. impar*. Acknowledging this situation, there are still some methods which may prove useful. Diet analysis of predators found in grasslands supporting *D. impar* populations would at least indicate which predators take *D. impar* and how often. However, without good monitoring techniques the actual impact of this predation on *D. impar* populations will be difficult to determine.

**Priority:** 2

**Agency(s) responsible for implementation of action:** The NRT will be responsible for organising and coordinating this action, but it will probably be implemented by the state and territory conservation agencies, with possibilities for assistance from student projects.

**C.6.8.3 ACTION: Undertake research on the effects of fire and grazing on the demography of *D. impar*, particularly with respect to grassland types and season.**

Determining the impact of various management practices on *D. impar* populations is going to rely once again on the development of an effective monitoring technique. Without this, it will only be possible to detect very dramatic effects. Trials of different burning and grazing regimes need to be conducted on sites supporting known population densities. This may be difficult to achieve and to justify, in which case monitoring sites must be set up in areas with different and/or changing management practices in order to study their effects. Careful consideration of experimental design will be essential for the interpretation of the results of such research.

**Priority:** 1

**Agency(s) responsible for implementation of action:** The NRT will be responsible for coordinating this action. It would probably be implemented best through postgraduate studies in conjunction with conservation agencies.

### **C.6.9 Specific Conservation Objective – Monitoring.**

*Objective 7 – Undertake a program of monitoring to provide a basis for adaptive management of D. impar.*

#### **Performance criteria:**

A monitoring system which is efficient and causes minimal habitat disturbance is established across the distribution of the species during the life of this Recovery Plan. Results can be related to past survey and monitoring efforts.

Optimum management of *D. impar* habitat has been determined and is being implemented with regard to fire, grazing, predators and conservation of other site attributes.

#### **Actions required to achieve objective:**

##### **C.6.9.1 ACTION: Implement a minimum disturbance monitoring strategy at a representative series of sites.**

Some previous attempts to monitor populations of *D. impar* (e.g. in Derrimut Grassland Reserve) have suffered from extremely low, but variable capture rates and have used inconsistent techniques; they consequently have provided little useful information. An effective, minimum disturbance monitoring technique must be developed (see actions 9.3.1 and 9.5.1) which will provide long-term population trend data. Work currently being conducted by members of the NRT may indicate suitable techniques. In the meantime, sites for monitoring can be selected. Both *D. impar* and various climatic and habitat parameters should be monitored. Sites selected for long-term monitoring should include representatives from all of the site clusters (see Appendix I). Monitoring of many sites using 'tile grids' in a standardized methodology has been implemented at many sites in the ACT, Victoria and SA (Thompson, 2006; Candy, 2008), and should be extended to representative sites from all clusters.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** Members of the NRT will coordinate selection of the monitoring sites. Once a reliable monitoring technique is established and universally accepted, a national monitoring program will be developed and implemented.

##### **C.6.9.2 ACTION: Establish and implement appropriate management strategies for sites supporting D. impar.**

As the effects of fire, grazing and predators are progressively assessed, detailed and informed management guidelines will be established and updated to ensure the persistence of *D. impar* populations in all managed areas. This is best done on a site by site basis, as well as by overall guidelines for grasslands (see Appendix VI). The establishment of management and mitigation protocols to minimise the impact of infrastructure developments is also a priority for many sites.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** The Recovery Team members have developed general management guidelines and will be responsible for reviewing and updating them when new information becomes available. Relevant state and territory conservation agencies will be responsible for implementing these guidelines.

### **C.6.10 Specific Conservation Objective – Community Participation.**

*Objective 8 – Increase community awareness and involve the community in aspects of the recovery program.*

#### **Performance criteria:**



The community is aware of, and involved in, recovery actions and management of *D. impar* and its habitat.

Landowners participate in off-reserve management.

**Actions required to achieve objective:**

**C.6.10.1 ACTION: Provide opportunities for interested community groups and individuals to participate in recovery actions.**

There are already several community groups and individuals with strong involvement in grassland and *D. impar* conservation in the ACT and Victoria. Further involvement will be sought from a wider variety of groups within these areas. The establishment of links with similar community groups in NSW is seen as a high priority action and will be pursued as soon as actions are identified in which community involvement would be beneficial.

**Priority:** 2 ongoing

**Agency(s) responsible for implementation of action:** The regional working groups will be responsible for the identification of target community groups and individual landowners, to be contacted by the relevant agencies.

**C.6.10.2 ACTION: Produce interpretative materials on grasslands and *D. impar* conservation and management for use with school and community groups, landholders, and private and government organisations.**

The production of interpretive material which is easily accessed by land managers, and gives clear summaries of current knowledge of conservation and management of *D. impar* and its grassland habitat, is essential in promoting sympathetic land management practices outside reserves. These materials are important in training conservation agency field staff and keeping all concerned up-to-date on grassland conservation issues. The members of the regional working groups and NRT have an excellent exchange of information and all members are kept apprised of recent work.

**Priority:** 2 ongoing.

**Agency(s) responsible for implementation of action:** The NRT will coordinate this action, continue to encourage production of educational materials and determine the agencies to produce them. Contributions will be made from all members and other grassland interest groups, but particularly the state and territory conservation agencies.

**C.6.10.3 ACTION: Liaise with grassland managers and develop management guidelines for landholders responsible for off-reserve land which supports *D. impar*.**

All landholders with land supporting *D. impar* will be contacted by the relevant government conservation agency. Workshops will be held where landholders will be provided with information about *D. impar* conservation, and where open discussion of the issues relevant to the landholders can lead to appropriate conservation agreements. The exact nature of the implementation of this action will vary from state to state and site to site. Establishment of guidelines for management of native grassland on private properties has been identified as a priority of the Grassy Ecosystems Reference Group and such a field guide was produced by the VNPA in 1998 with funding from the GERG (Lunt *et al.*, 1998). Schemes such as PlainsTender, Bushbroker, Landcare and Land for Wildlife may be appropriate vehicles for promoting and implementing appropriate conservation management of grasslands (Platt, 1998). All ACT lessees have land management agreements including *D. impar* management guidelines (see Appendix VI).

Interim guidelines on appropriate management practices for *D. impar* populations which are not in reserves have been suggested (see Appendix VI), but comprehensive guidelines will not be available until research on the long-term effects of fire and grazing on these populations is complete.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** State and territory conservation agencies will be responsible for continuing to implement this action in their jurisdictions, but the approach will be coordinated by the NRT, with assistance from other organisations such as Catchment Management Authorities in Victoria.

**C.6.10.4 ACTION: Seek sponsorship for community involvement in projects directed to the conservation of *D. impar* and native grasslands, and where possible provide support to community groups undertaking approved projects.**

Given the large number and potentially high expense of the actions identified in this Recovery Plan and the relatively low level of government agency funding available for implementing Recovery Plans, corporate sponsorship may be crucial in achieving the conservation objectives of this Recovery Plan.

**Priority:** 2

**Agency(s) responsible for implementation of action:** The NRT, in conjunction with involved community groups, will be responsible for organising and coordinating these applications.

**C.6.11 Specific Conservation Objective – Translocation.**

*Objective 9 – Assess the need for translocation, determine its feasibility, develop protocols and undertake a trial translocation if appropriate.*

Note that *D. impar* has been salvaged from a number of doomed sites in Victoria under a protocol agreed by the VSLLWG in 1994, and from one site in the ACT under interim salvage protocols. Salvaged animals in Victoria are/were housed in a purpose-built captive facility at Zoos Victoria, and after some years a number of individuals were re-introduced into new habitat as a trial translocation (see C.9.9.3 below). Currently, the NRT believes that removal of lizards from doomed sites cannot make a meaningful contribution to the conservation of the species, and should not be viewed as an action that in any way compensates or mitigates loss of habitat – conservation efforts must concentrate upon *in situ* measures. Consequently, the NRT does not support salvage activity as a form of compensation or offset to loss of habitat. Animals recovered from doomed sites may still be of value for interpretation purposes or research.

**Performance criteria:**

The need for translocation for both re-establishment of populations and for genetic exchange between populations has been examined and, if necessary, protocols developed and a trial(s) conducted.

**Actions required to achieve objective:**

**C.6.11.1 ACTION: Determine the feasibility and appropriateness of translocation.**

Translocation of animals for genetic purposes or for reintroduction is a potentially valuable tool in wildlife management. However, it is a complex and long-term undertaking, for which rigorous protocols must be in place, in accordance with international, commonwealth and state and territory guidelines. In the case of *D. impar*, a clear need must be established before translocation(s) are contemplated. For re-introductions, it will then be necessary firstly to identify sites where *D. impar* populations were once present but have since disappeared, and secondly to understand the cause of the local extinction, and then eliminate or minimize the threat. Currently, there is a higher priority placed on adequately conserving existing populations than on restoring or creating others.

**Priority:** 2

**Agency(s) responsible for implementation of action:** Further investigation into the need for this work and the likelihood of success is required before substantial effort is committed to it. NRT to coordinate.

**C.6.11.2 ACTION: If translocation is appropriate, develop an agreed protocol.**

If translocation is considered appropriate, either for genetic reasons or for re-establishing populations, an agreed protocol is required, developed according to current international, commonwealth and state guidelines (see Coulson, 1995). The key to this research is the development of effective trapping and tracking techniques (see Objective 3.3), without which it will be impossible to monitor translocated animals and determine success or failure of the translocation.

**Priority:** dependent on C.9.9.1.

**Agency(s) responsible for implementation of action:** The NRT and regional working groups will be responsible for considering reintroduction guidelines and deriving an agreed protocol.

**C.6.11.3 ACTION: Undertake a trial translocation using the agreed protocol.**

If translocation is considered desirable for genetic purposes or re-establishment, and once protocols have been established (including site selection), a trial translocation should be undertaken. Monitoring of released animals is essential to ascertain the success or otherwise of the trial. The technique and protocols would be reviewed during and after the trial. Note that a preliminary trial has been conducted in Victoria, using captive animals derived from salvages at doomed sites, with initial monitoring of released individuals indicating some persistence at the release site.

**Priority:** dependent on C.9.9.2.

**Agency(s) responsible for implementation of action:** Regional working groups and the NRT will be responsible for coordinating this research. The possibility for a strong experimental approach and rigorous hypothesis testing appears to lend itself well to postgraduate studies.

**C.6.12 Specific Conservation Objective – Captive Management.**

<p><i>Objective 10 – Ensure that any captive population(s) are used to support education and research elements of the Recovery Plan.</i></p>
--

**Performance criteria:**

The roles of captive populations of *D. impar* have been defined and goals set. Any captive animals are utilised in research programs.

**Actions required to achieve objective:**

**C.6.12.1 ACTION: Use captive animals to heighten community understanding of the conservation of *D. impar* and its grassland habitat.**

Well-interpreted displays of threatened species is an acknowledged role of zoos in conservation, with the aim of increasing visitor understanding of the respective threats and solutions. The Victorian Action Statement recommended establishment of a public display and this is now in place at Zoos Victoria, using animals rescued from doomed grassland sites under an agreed salvage protocol (Hawkes, 1997). There is also a permanent public display of two animals at the Iramoo Sustainable Living Centre at Victoria University (M. O'Shea pers. comm.).

**Priority:** 2 ongoing.

**Agency(s) responsible for implementation of action:** Zoos Victoria is responsible for the ongoing maintenance of captive lizards in Victoria, under the guidance of the VSLLWG.

**C.6.12.2 ACTION: Use captive populations to conduct biological studies.**

The extent to which captive populations could be used for behavioural studies to date has been very limited because of the difficulty of simulating natural environmental conditions. However, captive animals proved useful in an investigation of refuge site preference (Thompson, 2006). Zoos Victoria has constructed larger outdoor enclosures which may provide better conditions for both breeding and the study of behaviour for the animals.

**Priority:** 1 ongoing.

**Agency(s) responsible for implementation of action:** Staff at Zoos Victoria are recording incidental observations and should establish a formal observation program. Encouragement will be given to tertiary institutions to be involved in captive studies. The NRT will coordinate and direct actions in consultation with relevant agencies.

**C.6.12.3 ACTION: Undertake research leading to successful captive breeding.**

This goal was achieved at Zoos Victoria in 1998 and further captive breeding is being pursued (Banks *et al.*, 1999).

**Priority:** 2 ongoing.

**Agency(s) responsible for implementation of action:** Zoos Victoria, with guidance from the VSLLWG.

**C.6.13 Evaluation of success or failure**

The Recovery Plan will run for five years from the time of adoption and will be managed by the Department of Environment, Water, Heritage and the Arts. The Striped Legless Lizard Recovery Team will oversee the research and management of the species. An evaluation of the success or failure of this Recovery Plan will be conducted by the Recovery Team. The team shall meet on an annual basis to review objectives and performance, and to (re)direct recovery actions.

An evaluation of the success or failure of this Recovery Plan will be conducted by the Recovery Team – broad factors to examine, in addition to the detailed lists of criteria for each objective, include:

- The area of land currently managed for the conservation of *D. impar*, especially in relation to the area of known occupancy;
- The number and security of new populations identified;
- Research questions resolved, particularly in relation to the key areas of knowledge required for management, as identified in section C.9.
- The overall Recovery Plan will be reviewed five years after its adoption.

## D RECOVERY COSTS

Recovery and management of threatened fauna is heavily reliant on sound information utilised by a strong and communicative network of organisations and individuals from within government, universities, private consultants and other nature conservation interests. Implementation of this Recovery Plan will involve an integrated approach using a team of committed scientists, students, consultants and on-ground natural resource managers to ensure the most efficient and effective use of resources.

This Recovery Plan complements the ACT, NSW and Victorian conservation plans for *D. impar*, and other threatened grassland species and communities. Recovery actions identified in each of these plans are complementary, and coordination by the Recovery Team will ensure that resources are used efficiently and unnecessary duplications are avoided. This cross species coordination would be best achieved by the appointment of a single national coordinator to assist the operation of the recovery team(s).

The benefits of constituting a single recovery team for threatened grassland vertebrates, for example *D. impar* and *Tympanocryptis pinguicolla*, should be examined.

The table below outlines the estimated costs for the five year Recovery Plan.

Action No.	Action Description	Estimated Cost Year 1-5 (\$1000)
<b>C.9.1</b>	<b>Specific Recovery Objective – Recovery Coordination</b>	
C.9.1.1	Maintain the National Recovery Team and regional working groups.	150
C.9.1.2	Review performance of Recovery Plan annually.	10
C.9.1.3	Establish coordinated databases for each State or Territory agency.	15
C.9.1.4	Encourage tertiary institutions to participate in a coordinated research effort for <i>D. impar</i> .	5
C.9.1.5	Determine interim management guidelines for <i>D. impar</i> habitat.	-
C.9.1.6	Determine minimum survey requirements for <i>D. impar</i> .	-
<b>C.9.2</b>	<b>Specific Conservation Objective – Habitat Determination</b>	
C.9.2.1	Determine whether <i>D. impar</i> can persist in the long-term in exotic grassland isolated from native grasslands.	50
C.9.2.2	Undertake research to determine the relationship between the structure and floristics of grasslands and their utilisation by <i>D. impar</i> .	50
C.9.2.3	Conduct vegetation surveys of grasslands, particularly in New South Wales, to determine the extent of potential habitat for <i>D. impar</i> .	100
<b>C.9.3</b>	<b>Specific Conservation Objective – Distribution and Abundance</b>	
C.9.3.1	Develop an improved detection technique.	20
C.9.3.2	Develop an improved marking technique.	5
C.9.3.3	Complete <i>D. impar</i> surveys within potential habitat in Victoria.	100
C.9.3.4	Commence surveys of potential habitat within NSW and survey the extent of the known populations.	150
C.9.3.5	Survey remaining potential habitat in south-eastern South Australia.	20
C.9.3.6	Ensure surveys are conducted in accord with guidelines recommended by the NRT.	-
<b>C.9.4</b>	<b>Specific Conservation Objective – Management.</b>	
C.9.4.1	Undertake Population and Habitat Viability Assessments.	15
C.9.4.2	Develop a national system of managed sites which will ensure the survival of the species across its geographic range.	250

C.9.4.3	Formulate interim management guidelines for management of <i>D. impar</i> habitat. Implement interim management within reserves areas and, where possible, in other areas of habitat identified as most important in the cluster strategy.	200
C.9.4.4	Investigate the balanced management of grassland habitats, recognising the potential for conflicting management requirements of other conservation values.	20
C.9.4.5	Investigate the need for active translocation between isolated populations to avoid inbreeding.	30
C.9.4.6	Provide training for personnel involved in activities which may affect <i>D. impar</i> and its habitat.	15
<b>C.9.5</b>	<b>Specific Conservation Objective – Ecology.</b>	
C.9.5.1	Develop an effective method for tracking <i>D. impar</i> .	10
C.9.5.2	Determine the life history of <i>D. impar</i> .	20
C.9.5.3	Undertake studies of the demography of <i>D. impar</i> .	20
C.9.5.4	Determine the daily and seasonal habitat use of <i>D. impar</i> .	20
C.9.5.5	Undertake studies into diet of <i>D. impar</i> and food availability in different grassland types.	2
<b>C.9.6</b>	<b>Specific Conservation Objective – Threats.</b>	
C.9.6.1	Identify threats to <i>D. impar</i> and its habitat at known sites and determine the relative severity of these threats.	25
C.9.6.2	Undertake research on the impact of predators on <i>D. impar</i> .	10
C.9.6.3	Undertake research on the effects of fire and grazing on the demography of <i>D. impar</i> , particularly with respect to grassland types and season.	30
<b>C.9.7</b>	<b>Specific Conservation Objective – Monitoring.</b>	
C.9.7.1	Implement a minimum disturbance monitoring strategy at a representative series of sites.	100
C.9.7.2	Establish and implement appropriate management strategies for sites supporting <i>D. impar</i> .	50
<b>C.9.8</b>	<b>Specific Conservation Objective – Community Participation.</b>	
C.9.8.1	Provide opportunities for interested community groups and individuals to participate in recovery actions.	2
C.9.8.2	Produce interpretative materials on grasslands and <i>D. impar</i> conservation and management for use with school and community groups, landholders, and private and government organisations.	15
C.9.8.3	Liaise with grassland managers and develop management guidelines for landholders responsible for off-reserve land which supports <i>D. impar</i> .	15
C.9.8.4	Seek sponsorship for community involvement in projects directed to the conservation of <i>D. impar</i> and native grasslands, and where possible provide support to community groups undertaking approved projects.	2
<b>C.9.9</b>	<b>Specific Conservation Objective – Translocation.</b>	
C.9.9.1	Determine the feasibility and appropriateness of translocation.	2
C.9.9.2	If translocation is appropriate, develop an agreed protocol.	3
C.9.9.3	Undertake a trial translocation using the agreed protocol.	20
<b>C.9.10</b>	<b>Specific Conservation Objective – Captive Management.</b>	
C.9.10.1	Use captive animals to heighten community understanding of the conservation of <i>D. impar</i> and its grassland habitat.	15
C.9.10.2	Use captive populations to conduct biological studies.	10
C.9.10.3	Undertake research leading to successful captive breeding.	1
	<b>Total</b>	<b>1575</b>

## E ACKNOWLEDGEMENTS

---

The following people assisted in the production of this Recovery Plan:

<b>Name</b>	<b>Organisation</b>
Chris Banks	Zoos Victoria
Geoff Brown	Vic. Dept. of Sustainability and Environment
John Birkett	Zoos Victoria
Nick Clemann	Vic. Dept. of Sustainability and Environment
John Coventry	Emeritus Curator, Museum Victoria
James Dawson	NSW Department of Environment and Climate Change
Mark Dunford	Geosciences Australia (formerly PCL)
Murray Evans	ACT Parks, Conservation and Lands
Cath Grant	Vic. Dept. of Sustainability and Environment
Sue Hadden	Vic. Dept. of Sustainability and Environment
Daniel Harley	SA Dept. for Environment and Heritage
Geoff Heard	LaTrobe University, Victoria
Colin Hocking	Victoria University
David Hunter	NSW Department of Environment and Climate Change
Mark Hutchinson	South Australian Museum
Peter Johnson	Vic. Dept. of Sustainability and Environment
Randall Johnson	SA Dept. for Environment and Heritage
Michelle Le Duff	SA Dept. for Environment and Heritage
Will Osborne	University of Canberra
Megan O'Shea	Victoria University
Garry Peterson	Vic. Dept. of Sustainability and Environment
Marjo Rahaula	Environment ACT
Rainer Rehwinkel	NSW Department of Environment and Climate Change
Ross Sadlier	Australian Museum, Sydney
David Shorthouse	Environment ACT
Fiona Smith	Parks Victoria
Steve Smith	Vic. Dept. of Sustainability and Environment
Mike Swan	Zoos Victoria
Alan Webster	Vic. Dept. of Sustainability and Environment
Jason Van Weenen	SA Dept. for Environment and Heritage

## F BIBLIOGRAPHY

---

- ACT Government (1997a). *Striped Legless Lizard (Delma impar): A vulnerable species*. Action Plan No. 2. Environment ACT, Canberra.
- ACT Government (1997b). *Natural temperate grassland: An endangered ecological community*. Action Plan No. 1. Environment ACT, Canberra.
- ACT Government (1997c). *Eastern Lined Earless Dragon (Tymanocryptis pinguicolla): An endangered species*. Action Plan No. 3. Environment ACT, Canberra.
- ACT Government (2005). *ACT Lowland Native Grassland Conservation Strategy*. Action Plan No. 28. ACT Government, Canberra.
- ANZECC (1991). *Australian and New Zealand Environment Conservation Council. List of Endangered Vertebrate Fauna*. ANCA, Canberra.
- ANZECC (1995). *Australian and New Zealand Environment Conservation Council. List of Endangered Vertebrate Fauna*. ANCA, Canberra.
- ARAZPA (1996). *Population and Habitat Viability Assessment (PHVA) for the Striped Legless Lizard (Delma impar)*. Based on a workshop held in Canberra, Australia. 30 July - 2 August 1996. Published by the Australasian Regional Association of Zoological Parks & Aquaria, ACT Parks & Conservation Service, Striped Legless Lizard Working Group, and Conservation Breeding Specialist Group (SSC/IUCN).
- Australian and New Zealand Conservation Council and Biological Diversity Advisory Committee (2001). *Biodiversity Conservation Research: Australia's Priorities*. Environment Australia, Canberra.
- Banks, C.B. (1992). The Striped Legless Lizard Working Group: an interagency initiative to save *Delma impar*, an endangered reptile. *International Zoo Yearbook* **31**: 45-49.
- Banks, C., Hawkes, T., Birkett, J. and Vincent, M. (1999). Captive management and breeding of the Striped Legless Lizard, *Delma impar*, at Melbourne Zoo. *Herpetofauna* **29** (2):18-30.
- Candy, G. (2008). The current distribution of the Striped Legless Lizard, *Delma impar*, in southwestern Victoria: predicting habitat associations at a landscape scale. Unpublished honours thesis. University of Ballarat, Ballarat.
- Carpenter, E.L. (2008). A preliminary investigation into age determination of *Delma impar* (Striped Legless Lizard) using skeletochronology. Unpublished undergraduate research project, Victoria University.
- Cogger, H.G. (2000). *Reptiles and Amphibians of Australia*. 6<sup>th</sup> Edition. Reed Books, Australia.
- Cogger, H.G., Cameron, E.E., Saddler, R.A. and Egger, P. (1993). *The Action Plan for Australian Reptiles*. Endangered Species Program, Project Number 124. Australian Nature Conservation Agency, Canberra.
- Corrigan, A., Nelson, L.S., Shorthouse, D. and Smith, W.J.S. (1996). *Survey of section 107 Symonston for two vulnerable lizard species and salvage of the Striped Legless Lizard (Delma impar) population during the summer of 1995-96*. Internal Report 96/4, Wildlife Research Unit, ACT Parks and Conservation Service.
- Coulson, G. (1990). *Conservation biology of the Striped Legless Lizard (Delma impar): an initial investigation*. Arthur Rylah Institute for Environmental Research Technical Report Series No. 106, Department of Conservation and Environment, Melbourne.
- Coulson, G. (1995). *Management directions for the Striped Legless Lizard (Delma impar) in the Australian Capital Territory*. Technical Report 12. Wildlife Research Unit, ACT Parks and Conservation Service.
- DSE (2003). *Action Statement #17: Striped Legless Lizard, Delma impar*. Department of Sustainability and Environment, Victoria.



- Dorrough, J. (1995). *Past and present habitat of the Striped Legless Lizard, Delma impar (Pygopodidae), in the Australian Capital Territory*. An unpublished report to the Wildlife Research Unit, ACT Parks and Conservation Service.
- Dorrough, J. and Ash, J.E. (1999). Using past and present habitat to predict the current distribution and abundance of a rare cryptic lizard, *Delma impar* (Pygopodidae). *Australian Journal of Ecology* **24**: 614-24.
- Dorrough, J.W., Close, P. and Williams, L. (1996). Rediscovery of the striped legless lizard, *Delma impar* (Pygopodidae), on the Monaro plains of NSW. *Herpetofauna* **26**: 52-53.
- DSE (2007). *Advisory list of threatened vertebrate fauna in Victoria – 2007*. Department of Sustainability and Environment, East Melbourne, Victoria.
- EACT (2003). *National Recovery Plan for Natural Temperate Grassland of the Southern Tablelands (NSW and ACT): an endangered ecological community*. Environment ACT, Canberra.
- Frankenberg, R. and Frankenberg, J. (1998). *Flora and fauna report – proposed Cooma landfill*. Unpublished report to Fisher Stewart Pty. Ltd., Queensland.
- Goonan, R. (2008). Short-term spatial and temporal affects of adjacent land use on the invertebrate prey species of *Delma impar* within linear remnant habitats. Unpublished honours thesis. University of Ballarat, Ballarat.
- Greer, A.E. (1989). *The Biology and Evolution of Australian Lizards*. Surrey Beatty & Sons Pty. Ltd., Chipping Norton, NSW, Australia.
- Hadden, S. (1995). *Distribution, population habitat estimates and habitat requirements for the Striped Legless Lizard Delma impar (Kluge)*. Report to the Australian Nature Conservation Agency. Department of Conservation & Natural Resources, Melbourne.
- Harley et al. (2005). *Regional Action Plans for the recovery of threatened fauna in the south east of South Australia*. South Australian Department for Environment and Heritage, Mount Gambier.
- Hawkes, T. (1997). *Captive management of the Striped Legless Lizard and Melbourne Zoo's role in conserving native grassland*. Unpublished report.
- IUCN (1996). *1996 IUCN Red List of Threatened Animals*. IUCN, Gland, Switzerland.
- Jenkins, R. and Bartell, R. (1980). *A Field Guide to the Reptiles of the Australian High Country*. Inkata Press, Melbourne.
- Kirkpatrick, J., McDougall, K. and Hyde, M. (1995). *Australia's Most Threatened Ecosystems the Southeastern Lowland Native Grasslands*. Surrey Beatty & Sons Pty. Ltd. Chipping Norton, NSW, Australia.
- Kluge, A.G. (1974). *A taxonomic revision of the lizard family Pygopodidae*. Misc. Publ. 147, Museum of Zoology, University of Michigan.
- Koehler, L.E. (2004). The current distribution, status and habitat preferences of the Striped Legless Lizard (*Delma impar*) in far southwestern Victoria. Unpublished Honours thesis, RMIT University, Melbourne.
- Kukolic, K., McElhinney, N. and Osborne, W.S. (1994). *Survey for the Striped Legless Lizard Delma impar during 1993 in the proposed development area E1 comprising sites for the Gungahlin Town Centre and the suburb of Franklin*. Internal Report 94/3. Wildlife Research Unit, ACT Parks and Conservation Service.
- Kutt, A. (1993). A preliminary evaluation of the use of fluorescent pigments to track the movements of the Striped Legless Lizard, *Delma impar* (Reptilia: Pygopodidae). In, Lunney, D. and Ayers, D. (eds.) *Herpetology in Australia: A Diverse Discipline*. Royal Zoological Society of NSW and Surrey Beatty & Sons, Chipping Norton. Pp. 170-83.
- Kutt, A., Ross, J., Banks, C., Coulson, G. and Webster, A. (1995) Conservation of an endangered species: the Striped Legless Lizard Working Group as a successful interagency initiative. In, Saunders, D.A., Craig, G.L. and Matiske, E.M. (eds.) *Nature*

- Conservation 4. The Role of Networks*. Surrey Beatty & Sons, Chipping Norton. Pp. 451-59.
- Kutt, A.S., Coulson, G. and Wainer, J. (1998). Diet of the Striped Legless Lizard *Delma impar* (Squamata: Pygopodidae) in a western (basalt) plains grassland, Victoria. *Australian Zoologist* **30**(4): 412-18.
- Lawler, I.R., Stapley, J., Dennis, S. and Cooper, P. (1999). Survey for *Delma impar* and *Tympanocryptis lineata pinguicollis* in the Yass region. Report to NSW National Parks and Wildlife Service, Queanbeyan.
- Lunt, I., Barlow, T. and Ross, J. (1998). *The Grassy Plains of South-Eastern Australia*. Trust for Nature and Victorian National Parks Association, East Melbourne.
- Maldonado, S. (2009). Human-induced vs. historical habitat shifts: Identifying the processes that shaped the genetic structure of the Striped Legless Lizard, *Delma impar*. Honours thesis, Department of Zoology, University of Melbourne.
- Milne, S. (2002). *Population and habitat survey of the Striped Legless Lizard (Delma impar), in the south east of South Australia*. Wildlife Conservation Fund Report (DRAFT), South Australia Herpetology Group.
- Muir, A. (1995). *Western Basalt Plains Grassland Community – FFG Action Statement No. 5*. Department of Natural Resources and Environment, Melbourne.
- Nielsen, N.K. and Underwood, G.H. (1997). *Trialing of attractants and alternative trap designs on a colony of Striped Legless Lizard, Delma impar at Tidbinbilla Nature Reserve*. ACT Parks and Conservation Service Internal Report 97/2.
- Nunan, D. (1995). *Diet and feeding ecology of the Striped Legless Lizard Delma impar (Fischer, 1882) within the Australian Capital Territory*. Unpublished report to the ACT Parks & Conservation Service, Canberra.
- O'Bryan, M. (2008). The impact of biomass reduction burns on *Delma impar* prey. Unpublished Honours thesis, Victoria University.
- O'Shea, M. (1996). *An ecological study of the population of Striped Legless Lizards Delma impar (Fischer 1882) inhabiting native and exotic grasslands in the north-east corner of the Albion Explosives Factory site (St. Albans, Victoria)*. Unpublished B.Sc. Honours thesis, Department of Environmental Management, Victoria University of Technology.
- O'Shea, M. (2005). Methods for assessment and techniques for management of Striped Legless Lizard *Delma impar* populations in south-eastern Australia. Unpublished PhD thesis, Sustainability Group, Victoria University.
- O'Shea, M. and Hocking, C. (1997). *The distribution of the Striped Legless Lizard (Delma impar) population inhabiting the north-east corner of the Albion Explosives Factory Site (St. Albans, Victoria)*. Unpublished report to the Department of Defence and Victoria University. Department of Biological & Food Sciences, Victoria University.
- O'Shea, M. and Hocking, C. (1998). *Field trials of alternative detection techniques for the Striped Legless Lizard (Delma impar) at the Albion Explosives Factory*. Unpublished report to the Striped Legless Lizard (Victorian) Working Group. Department of Biological & Food Sciences, Victoria University.
- Platt, S. (1998). Native grassland of the basalt plain – an introduction to management for landholders. *Land for Wildlife Note* No. 41.
- Rauhala, M.A. (1996). *1995 survey and monitoring program for the Striped Legless Lizard Delma impar*. Internal Report 96/1. Wildlife Research Unit, ACT Parks and Conservation Service, Canberra.
- Rauhala, M. (1997). *1996 Monitoring program for the Striped Legless Lizard, Delma impar*. Internal Report 97/1. Wildlife Research Unit, ACT Parks & Conservation Service.
- Rauhala, M.A. (1998). *External sexing of the Striped Legless Lizard, Delma impar, using cloacal spurs*. Internal Report 98/4. Wildlife Research & Monitoring Unit, Environment ACT.

- Rauhala, M.A., Shorthouse, D.J., and Ingwersen, F. (1995). *The Striped Legless Lizard Delma impar in the Gungahlin, Majura and Jerrabomberra valleys. Incorporating: A report of the 1994 survey for Delma impar and options for the protection and conservation of Delma impar in the ACT.* Internal Report 95/2. Wildlife Research Unit, ACT Parks and Conservation Service.
- SA DEH (2007). *Department for Environment and Heritage Fact Sheet: Striped Legless Lizard Delma impar.* Government of South Australia. FIS 2779.07
- Stratman, B.K. (2007). *A survey for the Striped Legless Lizard (Delma impar) in the Mosquito Creek Catchment, south-eastern Australia.* Department for Environment and Heritage, Mount Gambier, SA.
- Thompson, M.J. (2006). The use of artificial refuges to census populations of the 'threatened' Striped Legless Lizard, *Delma impar* in Western Victoria. Unpublished B.Sc. (Hons.) thesis, La Trobe University, Melbourne.
- Wainer, J.W. (1992). *Diet of the Striped Legless Lizard, Delma impar, at the Derrimut Grassland Reserve, to the west of Melbourne.* Unpublished report for the Department of Conservation and Environment, Melbourne, Australia.
- Walton, S. (1995). The effects of fire on grassland herpetofauna and habitat structure. Unpublished B.Sc. (Hons.) thesis, Deakin University, Melbourne.
- Webster, A., Fallu, R. and Preece, K. (1992, 2003) *Flora and Fauna Guarantee Action Statement No. 17. Striped Legless Lizard Delma impar.* Department of Conservation & Environment, Victoria.
- Wilson, S.K. and Knowles, D.G.. (1988). *Australia's Reptiles; A Photographic Reference to the Terrestrial Reptiles of Australia.* Collins, Sydney.

## Appendix I: Population cluster approach to *D. impar* conservation

---

Extracted from: ARAZPA (1996). *Population and Habitat Viability Assessment (PHVA) for the Striped Legless Lizard (Delma impar)*. Based on a workshop held in Canberra, Australia. 30 July - 2 August 1996. Published by the Australasian Regional Association of Zoological Parks and Aquaria, ACT Parks and Conservation Service, Striped Legless Lizard Working Group, and Conservation Breeding Specialist Group (SSC/IUCN).

### Goal

To guarantee that *Delma impar* can survive, flourish and retain its potential for evolutionary development in the wild.

To prevent loss of genetic variation throughout the geographic range of the species.

### Objective

Develop a conservation strategy for conservation of *D. impar*, based on conservation of groups of populations throughout its geographic range.

### Justification of Objective

Primary principles of conservation biology, both endorsed here for *D. impar*, are:

- i. specific habitat adaptations throughout the geographic range, as reflected in genetic differentiation between areas, should be preserved to ensure the evolutionary viability of the species;
- ii. where a species has been fragmented into disconnected populations across its geographic range, populations should be protected across that range to guard against unpredicted events that eliminate populations in a region.

We need to ensure we maintain/do not lose genetic variation across the range of the species. This may be achieved by identifying relative homogeneous groups of populations and ensuring that these entities are maintained throughout time. The approach adopted in this document is to identify groups of populations, each here termed a "metapopulation" or "cluster", which are deemed to be adapted to the habitat characteristics of a region, and will contain the unique genetic material characteristic of that region. (Previous genetic studies suggest that there is little genetic variation between populations within a geographic region.) A cluster may contain a single population, but more commonly will consist of two or more populations. Each cluster needs to be conserved, primarily as an evolutionary important unit, but also as a guard against large-scale catastrophe. This approach satisfies both conservation principles above.

These tenets have been incorporated in an operational objective to ensure conservation of *D. impar*: "to ensure survival of all metapopulations with less than 1% risk of extinction of each metapopulation in 100 years." The premise is that the maintenance of a viable metapopulation for each defined geographic region will conserve the species and its incumbent genetic variation within that region, and metapopulations together will conserve the species.

### Steps To Achieve Objective

1. Delineate clusters of *D. impar* populations across its geographic range.
2. Describe the populations comprising each cluster; their biological and management status.
3. Investigate the viability of each individual cluster, and of populations within clusters, using the Population Viability Assessment modelling approach.
4. Generate a series of explicit recommendations detailing the actions needed to conserve *D. impar*.

## **SECTION 1 Clusters**

### **Criteria for formation of clusters**

Clusters have been tentatively defined using geographic and environmental criteria to represent areas of similar habitat. Of the seventeen potential clusters, we have information about the genetic composition of only three. There is a need to further investigate genetic variation between populations to ensure complete representation of the range of differentiation within the species. To complement this research, multivariate analysis of habitat variables should be employed to identify similar populations and to review the composition of clusters.

### **Potential Clusters**

#### *Victoria*

1. North Melbourne, Cragieburn Volcanic Plains
2. West Melbourne, Keilor, Werribee Plains'
- 3 a) Western Victorian, West Volcanic plains  
b) Western Victorian, East Volcanic plains
4. North Ballarat, isolated volcanic areas in central Victoria
5. East Grampians (potential link to western volcanic plains cluster)
6. Horsham, Wimmera grey cracking clays
7. Northern alluvial plains
8. North eastern slopes, Benalla (not volcanic)
9. North eastern slopes, Alexandra (not volcanic)
10. Gippsland Plains (BIOCLIM prediction, no *D. impar* records)
11. South-east Bendigo, Mitiamo volcanic belt

#### *South Australia*

12. Naracoorte region, SA, grey cracking clays

#### *NSW*

13. Cooma-Monaro Plains Treeless basalt plains (*Stipa-Poa* community, under stones)
14. Gilmore (geographically isolated), Batlow (close to Gilmore, old record), Tumut
15. Yass, Young? (grassy White Box woodland)
16. Goulburn (most northern population), Windellama Road (34 47S 149 44E, found in *Phalaris*, although native habitat is close by)

#### *ACT*

17. ACT (3 main sites), Gungahlin, Majura Valley, Jerrabomberra Valley and Yarramundi Reach and new site at Sutton (close to ACT, but in NSW)

## **SECTION 2 Populations**

A population is defined for the purposes herein as a group of individuals capable of interbreeding naturally.

The modelling approach used to assess the viability of the core conservation entities, the clusters, requires detailed information on all *D. impar* populations. This detail includes population size, area of habitat, land tenure, and current management. The spatial location of populations is shown on Figure 1, and the information on each population can be found in Table 4.1 and Table 4.2. In many instances this information is incomplete, and further research or monitoring is required to fill these gaps. Particularly important are improved detection

techniques for the species, allowing more accurate population estimates of the species. This and other explicit recommendations can be found in Section 4.

In the absence of complete information for each population, certain population characteristics were estimated to permit the PHVA process to continue. Where this has been done, the logic followed and the underlying assumptions have been included to provide a full explanation of the process. Two population characteristics of crucial importance to the modelling process were not known; population sizes and carrying capacity of individual areas of habitat. The rationale used to estimate these parameters is detailed below.

### Population Estimates

Estimates of population size in entire patches were based on the numbers of individuals caught in traps within a patch. Consequently it was necessary to determine the area surrounding a standard trapline from which the trapped animals came, i.e. the trap catchment area. With this information, trap numbers could be converted to a density for the trap catchment area, and thence to a patch density by combining information from all traps in the patch. Two approaches were used to determine trap catchment areas;

- extrapolation from trapping records
- extrapolation from animal movement characteristics

a. Trapline Catch Records. An initial assumption was that a cross-pattern trapline (as used in ACT) had a minimum catchment area of 0.25 ha. Data from the repeat trapping of the 20ha AGSO site was used to estimate the maximum size. The first trapping of the site with two traplines yielded 5 animals per trapline. Trapping effort was subsequently increased to 11 traplines. If the catchment area for a trapline were significantly larger than 0.25 ha, perhaps up to 10 ha, then the number of animals yielded per trapline by the second trapping effort would have been much less than 5, as animals from the new trapline areas would already have been removed by the first two traplines. Numbers of animals caught per trapline in the second trapping were similar to those in the first, suggesting that the trapline catchment area was not much bigger than the extent of the trap, 0.25 ha. From this information trapline catchment area was taken to be 0.5ha allowing a degree of conservatism.

b. Animal Movement Characteristics. Again the initial assumption was that a trapline had a minimum catchment area of 0.25 ha. Then information on the extent that *D. impar* move was used to estimate from how far outside the trapline area animals may move to encounter a trap. Records show that *D. impar* are relatively active small reptiles, with 20m the approximate mean distance which individuals have been recorded moving. Consequently, because only half of the potential animals may move towards the trapline, an extra 10m was added around the trapline area, giving a trapline catchment area of 0.5 ha.

### Patch densities from trap catchment densities

The concordance of these two approaches in their estimates of the trapline catchment area give confidence that it is a reasonable approximation of the true catchment area. It should also be noted that both these approaches are based on the assumption that the trapline catches 100% of animals within its catchment area. This is unlikely to be correct, making all density estimates conservative.

Density estimates were obtained for each trapline within a patch, using the maximum number of individuals caught at each trap in any trapping period. Records for traps which caught no animals were also included. A mean was taken of these density estimates and applied to the total area of the patch; the traplines locations being assumed to be representative of conditions in the patch. In many instances traplines were located randomly through the patch and so the representative assumption is valid. In other cases, where there has been trapline positioning in selected areas, this may not be valid and populations may be overestimated.

### Carrying capacity estimates

Carrying capacity (K) has not been measured for any *D. impar* population. This demographic characteristic is necessary for the PHVA process and so it had to be estimated. Two pieces of

information provide some insight into K for the group of populations within a cluster; the maximum population density, and the variability of population densities.

#### Minimum K

One of the assumptions underlying the grouping of populations within a cluster is that there is a degree of similarity in environmental and habitat conditions within that cluster. Consequently, although some populations may have low densities perhaps as a result of more intense predation or disturbance, all populations have the potential of matching the K of the densest population in the cluster, given appropriate management. So the highest population density in a cluster has been used to calculate a K value for each population. This was deemed to be the minimum K value because density estimates were based largely on adult captures, with the survey method not sampling the whole population.

#### Maximum K

The variability of population densities in a cluster, and the relationship of this variability to habitat condition, can tell us how resource limited populations may be. If there is a strong correlation between density and habitat quality, this suggests that populations in the best quality habitat may be resource limited and close to K. If, conversely, there is no such relationship, the populations may be predation or disturbance limited, and not close to K. Inspection of this information for the ACT cluster revealed a weak relationship between population density and habitat quality, and on this basis the maximum value for K was taken at twice minimum K.

### **Techniques for managing small populations**

We have introduced this topic because of the very nature of *D. impar* populations which are small, fragmented and often close to urban situations. They are therefore more likely to be suffering from loss of populations through urban expansion or from other pressures which act on small populations. It is likely that management for long-term viability will involve some form of interventionist management. This may include translocations, supplementation (movement of individuals between populations), habitat restoration or head starting to reduce juvenile mortality.

Our recommendation to carry out a trial translocation is based on the benefits it may bring (providing information on the potential success or other wise of translocations) and the likely possibility that populations will be lost and animals may need to be salvaged from sites prior to habitat loss. Habitat loss may be due to causes including development, fire, flood or other significant catastrophe. This situation has already occurred at a number of sites. We do not advocate the haphazard movement of animals without initial investigation.

Two justifications of trialling this technique are:

- Too many translocations occur under pressure, as last ditch efforts. Refinement of these techniques before crisis situations arise may increase the chance of success.
- A lot of knowledge can be gained by attempting translocations, particularly on habitat requirements, especially if the translocation is set up as an experiment.

### **SECTION 3. Assessment of the viability of clusters and populations**

Further modelling, via PHVA analyses, needs to be completed to assess the viability of clusters and refine management within them. However, we consider that the population and life-history data presently available are inadequate to enable any such analyses to be reliable indicators, and urge that these data are collected as a matter of priority.

## **Appendix II: Legislation relevant to the management and conservation of *D. impar*.**

---

### Commonwealth

- *Native Title Act 1993*
- *Environment Protection and Biodiversity Conservation Act 1999*
- *the Wildlife Protection Act 1982*
- *the National Parks and Wildlife Conservation Act 1975*
- *the Quarantine Act 1908*
- *the Customs Act 1901*

### ACT

- *Nature Conservation Act 1980*

### New South Wales

- *National Parks and Wildlife Act 1974*
- *Environmental Planning and Assessment Act 1979*
- *Wilderness Act 1987*
- *Fisheries Management Act 1994*
- *Threatened Species Conservation Act 1995*
- *Rural Fires Act 1997*
- *Rural Lands Protection Act 1998*
- *Native Vegetation Act 2003*
- *Threatened Species Legislation Amendment Act 2004*

### Victoria

- *Country Fire Authority Act 1958*
- *Soil Conservation and Land Utilisation Act 1958*
- *Forests Act 1958*
- *Land Conservation Act 1970*
- *Environment Protection Act 1970*
- *National Parks Act 1975*
- *Wildlife Act 1975*
- *Environmental Effects Act 1978*
- *Conservation, Forests and Lands Act 1987*
- *Flora and Fauna Guarantee Act 1988*
- *Water Act 1989*
- *Catchment and Land Protection Act 1994*

### South Australia

- *National Parks and Wildlife Act 1972*
- *Pastoral Land Management and Conservation Act 1989*
- *Natural Resources Management Act 2004*
- *Fires and Emergency Services Act 2005*
- *Native Vegetation Act 1991*



## **Appendix III: Relationship to other plans.**

---

### ACT

- ACT Government (1997a). *Striped Legless Lizard (Delma impar): A vulnerable species*. Action Plan No. 2. Environment ACT, Canberra.
- ACT Government (1997b). *Natural temperate grassland: An endangered ecological community*. Action Plan No. 1. Environment ACT, Canberra.
- ACT Government (1997c). *Eastern Lined Earless Dragon (Tympanocryptis pinguicolla): An endangered species*. Action Plan No. 3. Environment ACT, Canberra.
- ACT Government (2003). National Recovery Plan for Natural Temperate Grassland of the Southern Tablelands (NSW and ACT): an endangered ecological community. Environment ACT, Canberra.
- ACT Government (2005). Action Plan 28: ACT Lowland Native Grassland Conservation Strategy. Action Plan No. 28. Environment ACT Government, Canberra.

### NSW

- NSW Draft Threatened Species Priorities Action Statement (2006). Department of Environment and Conservation (NSW). Sydney.

### Victoria

- Corangamite Catchment Management Authority (2003). Corangamite Regional Catchment Strategy 2003-2008. CCMA, Colac, Victoria.
- Department of Sustainability and Environment (2003). Action Statement No. 17: Striped Legless Lizard, *D. impar.*, DSE Victoria.
- Department of Sustainability and Environment (2004). Donnybrook Biodiversity Local Area Plan. DSE, Port Phillip Region, Melbourne.
- Department of Sustainability and Environment (2005). Blacks Creek Nature Conservation Reserve – Management Statement. DSE, Melbourne.
- Department of Sustainability and Environment (2005). Boonderoo Nature Conservation Reserve – Management Statement. DSE, Melbourne.
- Glenelg Hopkins Catchment Management Authority (2003). Glenelg Hopkins Regional Catchment Strategy 2003-2007. GHCMA, Hamilton, Victoria.
- Muir, A. (1995). *Western Basalt Plains Grassland Community* – FFG Action Statement No. 5. Department of Natural Resources and Environment, Melbourne.
- Parks Victoria (2004). Craigieburn Grasslands Flora & Fauna Reserve – Management Guidelines. Parks Victoria, Melbourne.
- Parks Victoria (2005). Merri Creek Regional Park – Draft Management Plan. Parks Victoria, Melbourne.
- Parks Victoria (2005). Holden Flora & Fauna Reserve – Management Guidelines. Parks Victoria, Melbourne.
- Port Phillip and Westernport Catchment Management Authority (2005). Regional Catchment Strategy. PPWCMA, Frankston, Vic.

### SA

- Harley *et al.* (2005). *Regional Action Plans for the Recovery of Threatened Fauna in the South East of South Australia*, South Australian Department for Environment and Heritage, Mount Gambier.

## **Appendix IV: Composition of the National and Regional Recovery Teams.**

---

### **Striped Legless Lizard National Recovery Team (SLLNRT or NRT)**

Australian National University (ANU)  
Department of Sustainability and Environment, Victoria (DSE)  
Department of Environment and Climate Change, NSW (DECCW)  
Department of the Environment, Water, Heritage and the Arts, Federal Government (DEWHA)  
Department of Environment and Heritage, South Australia (DEH)  
ACT Parks, Conservation and Lands (PCL)  
Parks Victoria (PV)  
University of Canberra (UC)  
University of Melbourne (UM)  
Victorian National Parks Association (VNPA)  
Zoos Victoria (ZV)

### **ACT and NSW Striped Legless Lizard Regional Working Group (SLLRWG)**

Australian National University (ANU)  
ACT Parks, Conservation and Lands (PCL)  
Department of Environment and Climate Change, NSW (DECCW)  
Friends of Grasslands  
University of Canberra (UC)

### **Victorian Striped Legless Lizard Working Group (VSLWVG)**

Biosis Research Pty. Ltd.\*  
Department of Sustainability and Environment, Victoria (DSE)  
Parks Victoria (PV)  
Department for Environment and Heritage, South Australia (DEH)  
University of Melbourne\* (UM)  
RMIT University\*  
Victorian National Parks Association (VNPA)  
Victorian University\* (VU)  
Wildlife Profiles Pty. Ltd.\*  
Zoos Victoria (ZV)

\* advisory and observer role

The terms of reference of the Striped Legless Lizard National Recovery Team are:

- To establish strategic objectives and research and management priorities for the conservation of *D. impar* throughout its distribution.
- To facilitate preparation of the National Recovery Plan and the co-ordination of the National and State/Territory management strategies, to oversee their implementation, and to participate in their review.

- To monitor and evaluate success of research and management programs.
- To assist with seeking resources for conservation programs and to advise on their effective use.
- To provide for exchange of information on the conservation of *D. impar* and provide authoritative advice as required.
- To foster community awareness of, and the establishment of extension programs for the conservation of *D. impar*.
- To integrate *D. impar* research and management with wider grassland conservation efforts (and organisations).

## Appendix V: Interim directory of relevant past, current and proposed research.

---

### ACT

- ARAZPA (1996). *Population and Habitat Viability Assessment (PHVA) for the Striped Legless Lizard (Delma impar)*. Based on a workshop held in Canberra, Australia. 30 July - 2 August 1996. Published by the Australasian Regional Association of Zoological Parks & Aquaria, ACT Parks & Conservation Service, Striped Legless Lizard Working Group, and Conservation Breeding Specialist Group (SSC/IUCN).
- Dorrough, J. (1995). *Past and present habitat of the Striped Legless Lizard, Delma impar (Pygopodidae), in the Australian Capital Territory*. An unpublished report to the Wildlife Research Unit, ACT Parks and Conservation Service.
- Dunford, M.A., Nelson, L.S., Jekabsons, M.J., Ormay, P. and Webb, N. (2001). *2000-2001 survey and monitoring program for the Striped Legless Lizard (Delma impar) and the Grassland Earless Dragon (Tymanocryptis pinguicollis) in the ACT*. Internal Report 2001/03. Wildlife Research and Monitoring, Environment ACT.
- Fletcher, D.B., Corrigan, T., Shorthouse, D., Smith, W., Sharp, S. and Dunford, M. (1995). *Survey of part Block 4 Section 102, Symonston for the presence of Lined Earless Dragons and Striped legless Lizards*. Internal Report 95/1. ACT Parks and Conservation Service, Canberra.
- Nelson, L.S., Dunford, M.A., Jekabsons, M.J. and Ormay, P. (2000). *1999-2000 monitoring and survey program for the Striped Legless Lizard (Delma impar) and the Grassland Earless Dragon (Tymanocryptis pinguicollis)*. Internal Report 2002/02. Wildlife Research and Monitoring, Environment ACT.
- Nielsen, N.K. and Underwood, G.H. (1997). *Trialing of attractants and alternative trap designs on a colony of Striped Legless Lizard, Delma impar at Tidbinbilla Nature Reserve*. ACT Parks & Conservation Service Internal Report 97/2.
- Nunan, D. (1995). *Diet and feeding ecology of the Striped Legless Lizard Delma impar (Fischer, 1882) within the Australian Capital Territory*. Unpublished report to the ACT Parks & Conservation Service, Canberra.
- Osborne, W.S., Kukolic, K. and Williams, K.D. (1993). Conservation of reptiles in the Southern Tablelands of New South Wales and the Australian Capital Territory. pp. 151-158 In: Lunney, D and Ayers, D. (eds.). *Herpetology in Australia: A Diverse Discipline*. Transactions of the Royal Society of New South Wales, Surrey Beatty & Sons Pty. Ltd. Chipping Norton, NSW.
- Osmond, H. (1994). *Habitat specialisation and the isolation of remnant populations of the Striped Legless Lizard, Delma impar (Pygopodidae). Temperature preference, metabolic and allozyme correlates of activity in lizards, with particular reference to fossorial habit*. Unpublished report to ACT Parks & Conservation Service.
- Rauhala, M.A. (1998). *External sexing of the Striped Legless Lizard, Delma impar, using cloacal spurs*. Internal Report 98/4. Wildlife Research & Monitoring Unit, Environment ACT.

### VIC

- Anon. (2001). *Trial Field release for Striped Legless Lizard – Draft Proposal*. Unpublished report by SLLWG, Victoria.
- Candy, G. (2008). Influence of landscape and habitat variables on the distribution of *D. impar* in south western Victoria using habitat models. University of Ballarat.
- Goonan, R. (2008). Spatial and temporal affects of adjacent land use on the invertebrate prey species of *Delma impar* within linear remnant habitats. University of Ballarat.
- Hawkes, T. (unpublished) *Captive management of the Striped Legless Lizard and Melbourne Zoo's role in conserving native grassland*.

- Kimber, S. and Timewell, C. (2001). *Salvage of Striped Legless Lizard Delma impar at 'Cairnlea', Deer Park, Victoria*. Unpublished progress report to Urban Land Corporation. Biosis Research Pty. Ltd.
- Koehler, L. (2004). Distribution, status and habitat preferences in far south-western Victoria, RMIT University.
- Maldonado, S. (2009). Phylogeography and conservation genetics. Honours candidate Museum Victoria.
- Peake, P., Frood, D., Carr, G., Muir, A., Ward, L. and Beardsell, C.. (1996). *Conservation Assessment for Cragieburn Grasslands, Cragieburn, Victoria*. Unpublished report. Ecology Australia Pty. Ltd.
- Peterson, G. (2004 – continuing). Influence of fire history and frequency on *D. impar* to determine appropriate fire regimes that are conducive to the species and other small vertebrate fauna. DSE
- Peterson, G, Grant, C. and Rohr, T. (2004 – continuing). Surveys and population monitoring across south western Victoria, assessment of monitoring technique, life-history assessment via capture-mark-recapture and microhabitat preference. DSE and AER.
- Scroggie, M., Peterson, G. and Rohr, T. (current). Determine detection probabilities from artificial shelters and the influence of covariates. Development of survey and monitoring protocols. DSE and AER.
- Thompson, M. (2006). Artificial refuges to census *D. impar* including influence of climatic conditions. Habitat and microhabitat characteristics and morphometrics were also investigated. La Trobe University.
- Webster, A., Humphries, R, and Robertson, P. (1995). The Striped Legless Lizard *Delma impar*, Case Study of a Threatened Species Recovery Programme. In, Bennett, A., Backhouse, G. & Clark, T. (eds.) *People and Nature Conservation – perspective on Private Land Use and Endangered Species Recovery*. Royal Zoological Society of New South Wales, Sydney: 29-34.

## **NSW**

- Cooper, P., Dorough, J. and Nelson, N. (1999). *Monitoring regime for the Striped Legless Lizard (Delma impar) and the Grassland Earless Dragon (Tympanocryptis lineata pinguicollis) at the proposed Kuma Nature Reserve*. Report to the NSW National Parks and Wildlife Service, Queanbeyan.
- Lawler, I. R., Stapley, J., Dennis, S. and Cooper, P. (1999). *Survey for Delma impar and Tympanocryptis lineata pinguicollis in the Yass region*. Report to NSW National Parks and Wildlife Service, Queanbeyan.
- Rowell, A.M., Crawford, I.L. and Kurrajong, M. (2000). *Surveys for the Striped Legless Lizard Delma impar and Grassland Earless Dragon Tympanocryptis pinguicollis in the Queanbeyan-Goulburn district, 1999-2000: Part 1 Fauna*. Report to NSW National Parks and Wildlife Service, Queanbeyan.

## **Appendix VI: Interim management guidelines recommended by the National Recovery Team.**

---

Prior to the finalisation of guidelines for the management of sites supporting *D. impar*, the following comment gives a preliminary overview of the type of measures needed to maintain suitable habitat characteristics at sites supporting populations of the species (taken from Coulson 1995).

“The availability of suitable grassland habitat is critical to the conservation of the Striped Legless Lizard. Evidence suggests that the origin and floristics of a grassland may be less important than its current structure in determining its suitability as habitat. Grassland that is in poor condition due to heavy grazing, for example, can recover its structure rapidly after grazing has ceased. These recovered areas can provide habitat for individuals that have persisted in refugia (e.g. drainage lines) and have later recolonised the area, or for individuals that are translocated to reinforce or re-establish a population. The central aim in managing grasslands as habitat for the Striped Legless Lizard should be to provide adequate structure, particularly vertical cover, and to minimise mowing, grazing and fire, and cease cultivation and tree planting.”

Broad management guidelines for sites known to support populations of the species, suggested by Dorrough (1996), include:

- Where grazing has been a part of management, past grazing regimes should be continued, with monitoring of stocking rates, ground cover and weed species to ensure suitable habitat is maintained.
- Where burning has previously been employed, it should be continued in a mosaic pattern at intervals of 3-5 years, with monitoring of weeds afterwards.
- If mowing or slashing is to be used, mowing heights should be set at approximately 100 mm to maintain suitable structure, and slash raked and removed. This type of activity should be avoided during spring and early summer, as this coincides with the peak flowering season of many native plants and the most active and breeding season of *D. impar*. Care should be taken to minimise importation of weeds carried by equipment.
- As with mowing above, weed control equipment should be cleaned to ensure seed is not transported. In significant grassland sites, including all containing *D. impar*, spot spraying is the preferred method of control.
- No physical soil disturbance, such as ripping or ploughing, or pasture improvement should be undertaken, as this destroys the habitat values of native grasslands.
- Trees should not be planted in areas of remnant grassland.