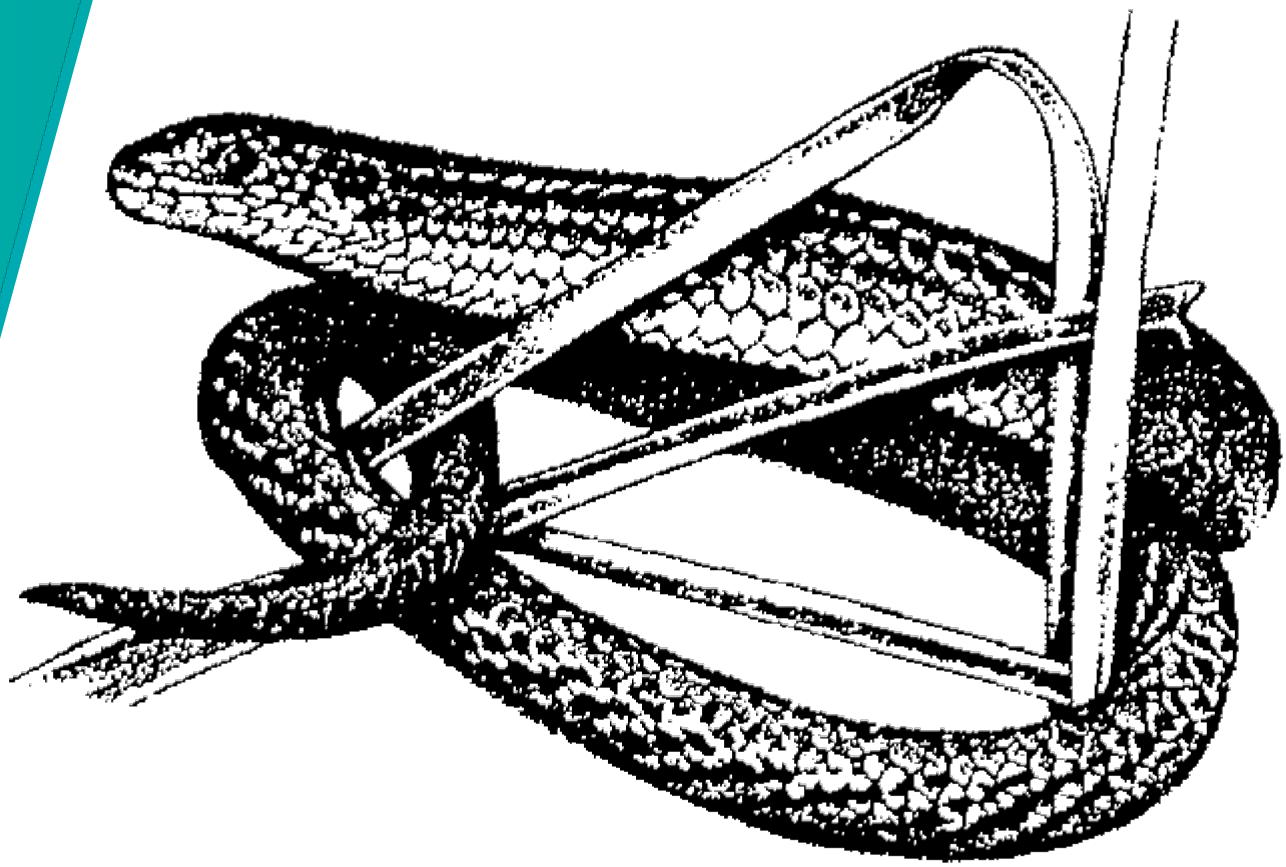
STRIPED LEGLESS LIZARD

DELMA IMPAR

ACTION PLAN



PREAMBLE

The Striped Legless Lizard (*Delma impar* (Fisher, 1882)) was declared a vulnerable species on 15 April 1996 (Instrument No. DI1996-29 under the *Nature Conservation Act 1980*). Under section 101 of the *Nature Conservation Act 2014*, the Conservator of Flora and Fauna is responsible for preparing a draft action plan for listed species. The first action plan for this species was prepared in 1997 (ACT Government 1997) and the second in 2005 (ACT Government 2005). This revised edition supersedes the earlier editions. This action plan includes the ACT Native Grassland Conservation Strategy set out in schedule 1 to the 'Nature Conservation (Native Grassland) Action Plans 2017', to the extent it is relevant.

Measures proposed in this action plan complement those proposed in the action plans for Natural Temperate Grassland, Yellow Box/Red Gum Grassy Woodland, and component threatened species such as the Grassland Earless Dragon (*Tympanocryptis pinguicolla*) and the Golden Sun Moth (*Synemon plana*).

CONSERVATION STATUS

Delma impar is recognised as a threatened species in the following sources:

International

Vulnerable – IUCN (2015).

National

Vulnerable – *Environment Protection and Biodiversity Conservation Act 1999* (Commonwealth).

Australian Capital Territory

Vulnerable – Section 91 of the *Nature Conservation Act 2014*. Special Protection Status Species - Section 109 of the *Nature Conservation Act 2014*.

New South Wales

Vulnerable – *Threatened Species Conservation Act 1995*.

Victoria

Threatened – *Flora and Fauna Guarantee Act 1988*.

South Australia

Endangered – *National Parks and Wildlife Act 1972*.

CONSERVATION OBJECTIVES

The overall conservation objective of this action plan is to maintain in the long term, viable, wild populations of *D. impar* as a component of the indigenous biological resources of the ACT and as a contribution to regional and national conservation of the species.

This includes the need to maintain natural evolutionary processes.

Specific objectives of the action plan are to:

- Conserve large and medium-sized populations in the ACT.
- Manage the species and its habitat to maintain the potential for evolutionary development in the wild.
- Enhance the long-term viability of populations through management of adjacent grassland to increase habitat area and connect populations.

SPECIES DESCRIPTION AND ECOLOGY

DESCRIPTION

The Striped Legless Lizard (*Delma impar* Fischer 1882) is a member of the family Pygopodidae, a

group of lizards that lack forelimbs and have hind limbs reduced to small vestigial flaps (Cogger 2000). Legless lizards can be readily distinguished from small snakes by having a visible ear opening, fleshy broad tongue, the presence of remnant hind limbs (reduced to two small flaps near the vent), and a long tail that can be voluntarily shed.

Delma impar attains a maximum length of about 300 mm, of which the tail (when intact) comprises about two-thirds of the overall length. Fully grown *D. impar* attain a snout–vent length of around 90 mm–110 mm, though individuals are considered to be adults when they reach a snout–vent length of 70 mm (Banks *et al.* 1999), based on the minimum length of wild-caught gravid females in the ACT (Rauhala 1996, 1997). Adults average around 3–4 g but gravid females can weigh over 8 g (Hadden and Humphries 1994; Kukolic 1994; Osmond 1994; Coulson 1995).

Delma impar are usually pale grey-brown on the dorsal surface and white or cream on the ventral surface. As the name suggests, the species typically has a pattern of alternate dark and light brown stripes running the length of the body on the dorsal-lateral and lateral surfaces, beginning at the neck and becoming diagonal on the tail. The stripes may be faint or absent in some individuals, particularly juveniles. The head is usually slightly darker than the body (slate grey to black), more conspicuously so in juveniles, and the sides of the face (from the posterior infralabial scales to around the tympanum) usually have a yellow flush (Coulson 1990).

The pattern of the head scales is unique to each individual and enables individuals to be identified. Some individuals have a salmon-pink coloration on the flanks that may extend to the ventral surface (ACT Government 1997). The ring of small scales around the eye is pale (almost white) in some individuals. The sexes are externally similar, though males may be distinguished by the presence of small, rounded, cloacal spurs under each hind limb flap (Rauhala and Andrew 1998; Robertson and Smith 2010). When handled, individuals often emit a high-pitched 'squeaking' vocalisation.

Delma impar can usually be distinguished from the Olive Legless Lizard (*Delma inornata*), a closely related species which also occurs in the ACT region, by the presence of stripes and the smaller size of adults. However, differences in nostril scales and pre-anal scales (Cogger 2000) are the most reliable features distinguishing the species.

DISTRIBUTION AND ABUNDANCE

Prior to European settlement, *D. impar* was most likely distributed broadly in south-eastern Australia wherever suitable habitat (native grassland) was present. Historic and current records of the species come from South Australia, Victoria, New South Wales and the Australian Capital Territory. Victoria encompasses the largest part of the known distribution; most records are from the central and western plains, with a few isolated records from the north-east of the state. The species is known to still occur at about 70 sites in Victoria, though many of these are small in area (such as road reserves) and only ten sites are protected in conservation reserves (Robertson and Smith 2010). In South Australia the species is known to occur in three areas, two of which are protected (one in a conservation reserve and another in a catchment reserve) (Robertson and Smith 2010). In New South Wales *D. impar* are known to still occur at seven locations, all of which are within 100 km of the ACT. Only one of these locations is protected (Kuma Nature Reserve).

In the ACT *D. impar* are known to occur in four discrete areas: the Gungahlin/Belconnen area, the Majura Valley in the vicinity of the Canberra International Airport, in Central Canberra on land adjacent to Yarrumundi Grassland on Lake Burley Griffin and in the Jerrabomberra Valley.

These four populations are effectively isolated by geographic and anthropogenic barriers, and may represent genetically distinct sub-populations. The species occurs on a range of land tenures, including nature reserve and other land managed by the ACT Government, land owned and managed by the Commonwealth Government, and leasehold land.

In Gungahlin *D. impar* is protected in three reserves (Crace, Gungaderra and Mullanggari grassland reserves), which total over 500 ha and contain Natural Temperate Grassland, native grassland and areas dominated by exotic grasses. The boundaries of these reserves were determined on the basis of both the remaining fragments of Natural Temperate Grassland and the distribution of *D. impar*. Surveys in 2012

(Eco Logical 2013) indicate that each of the three Gungahlin reserves contains at least 1000 *D. impar*, representing some of the largest remaining populations of the species. *Delma impar* also occurs across a broad area (about 250 ha) in Kenny in the south of Gungahlin. This area was surveyed for *D. impar* in 2011 and 2012 (Biosis 2011b, 2012a) and is estimated to contain 1000 or more individuals. Other locations where *D. impar* occur in Gungahlin/Belconnen include a patch of grassland (14 ha) to the north of the Mitchell industrial area (Franklin Grassland) and several small grassland fragments.

In the Majura Valley *D. impar* occurs in a large patch of native grassland (about 100 ha) on the Majura Training Area (Defence land), in a large patch of native grassland (about 150 ha) adjacent to Mt Majura Nature Reserve (Majura West grassland), and in grassland between Woolshed Creek and the Majura Parkway (Woolshed Creek grassland) (about 47 ha) (Biosis 2014). The species has also been recently recorded in grassland north of Majura Training Area (SMEC 2015) and in Piallago (Jessop 2014).

In the Jerrabomberra Valley *D. impar* occurs across extensive areas of grassland in the central and eastern parts of the valley, mostly between the Monaro Highway and the ACT–NSW Border (SMEC 2015). The species also occurs in grassland (about 18 ha) on the Amtech East Estate and in several grassland patches to the east of Fyshwick. The density of *D. impar* in habitat in the Jerrabomberra Valley is apparently lower than that of Gungahlin and the Majura Valley indicating lower quality habitat for the species in the Jerrabomberra Valley, which might be due to past or current land management practices.

The small patch of grassland at Yarramundi Grassland in Central Canberra supports a small population of *D. impar* scattered across the site at low density (Kukolic 1994; ACT Government unpublished data). This patch of grassland also supports a small population of the related Olive Legless Lizard (*D. inornata*).

The most up to date distribution data for this species is publicly available on the ACT Government's mapping portal (Visit the ACTmapi website).

HABITAT AND ECOLOGY

Surveys to better understand the distribution, abundance and habitat preferences of *D. impar* in the ACT have been undertaken since 1990 by the ACT Government (Conservation Research or contracted consultants) (e.g. Williams and Kukolic 1991; Kukolic *et al.* 1994; Rauhala *et al.* 1995; Rauhala 1996, 1997, 1999; Dunford 1998; Nelson *et al.* 2000; Dunford *et al.* 2001; Moore *et al.* 2010; Biosis 2011a, 2011b, 2012a, 2012b 2013, 2014; Eco Logical 2011, 2013; Jessop 2014; Howland *et al.* 2016; SMEC 2015). These surveys have involved the use of pitfall traps and more recently the use of roof tiles as artificial shelters.

The habitat of *D. impar* has been broadly described as naturally treeless grassland dominated by native, perennial, tussock-forming grass, particularly Kangaroo Grass (*Themeda triandra*), Wallaby Grasses (*Austrodanthonia* spp.) and Speargrasses (*Austrostipa* spp.) (Coulson 1990; Osborne *et al.* 1993; Hadden 1995). Although *D. impar* is largely restricted to areas that are (or were) lowland Natural Temperate Grassland, the species has also been found in grassland with scattered Eucalyptus trees (but not where canopy cover is high) and in grassland that has been derived from clearing of Eucalypts ('secondary grasslands') (Coulson 1990; Williams and Kukolic 1991; Osborne *et al.* 1993; Dorrough 1995; Hadden 1995; Howland *et al.* 2014). Records of *D. impar* in secondary grasslands are invariably from within two kilometres of the original boundary of the primary grasslands.

Delma impar has been recorded in degraded Natural Temperate Grasslands that are now dominated by exotic species such as Phalaris (*Phalaris aquatica*), Cocksfoot (*Dactylis glomerata*) and Serrated Tussock (*Nassella trichotoma*) (Coulson 1990; Williams and Kukolic 1991; Kukolic *et al.* 1994; Dorough 1995; Hadden 1995; Rauhala *et al.* 1995; Dunford *et al.* 2001; Biosis 2012; Howland *et al.* 2016). Degraded areas where the species has been recorded include a former quarry in Crace (Biosis 2012) that was converted to an asbestos dump and rehabilitated to grassland in the 1980s.

Delma impar has been found in areas with intermediate to tall grass, including surveys using roof tiles (Moore *et al.* 2010; Biosis 2012; EcoLogical 2013) and pitfall traps (e.g. Rauhala *et al.* 1995; Rauhala 1996, 1997, 1999). Pitfall trapping for the species during extensive

surveys in the 1990s found capture rates were highest in "extensive and intact swards and a well-developed grass thatch" (Williams and Kukolic 1991) and at sites where tussock leaf height was between 20 cm and 50 cm and projected foliage cover of tussocks was between 35% and 80% (Rauhala *et al.* 1995; Rauhala 1996, 1997, 1999).

In the peer reviewed papers by Howland *et al.* (2014; 2016) habitat preferences for *D. impar* were modelled and the researchers concluded the species preferred grass swards of intermediate biomass rather than very low or very high biomass, and a structurally complex sward.

Grass structure and biomass are related; intermediate levels of biomass tend to be structurally complex (tussocks and inter-tussock spaces) whereas a grass sward that is very short, or very high and dense, tends to be more uniform in structure. The role of intermediate levels of kangaroo grazing in maintaining habitat for *D. impar* is highlighted by Howland (2014, 2016).

In Victoria, *D. impar* can occur in areas where the grass sward is short if deep-cracking soil or scattered surface rock is present as these are used as refuges (particularly for over-wintering) (Coulson 1990; Hadden 1995). Such habitats are not a feature of *D. impar* habitat in the ACT.

There is anecdotal evidence to suggest that unpalatable tussock-forming plants such as *Juncus* spp. and Serrated Tussock can apparently act as temporary refuge for *D. impar* during periods of heavy grazing, facilitating the species' recolonisation of areas of native grasses when stock are removed (Kukolic *et al.* 1994; Rauhala 1997).

There are still large knowledge gaps in the life history and ecology of *D. impar*, which is partly a reflection of the difficulty in studying this shy, cryptic species. *Delma impar* are thought to reach breeding age at 2–3 years for males and 3–4 years for females (ARAZPA 1996). This is based on evidence for other lizard species and a single ACT record of a female captured at about one year old (based on snout–vent length) that was recaptured three years later in a gravid condition and subsequently laid eggs in captivity (ARAZPA 1996). From observations of *D. impar* laying in captivity (Banks *et al.* 1999) and data from other Pygopodids (Cogger 2000), only two eggs are produced, most probably each year (Coulson 1995; ARAZPA 1996). Cohabitation of wild gravid *D. impar* (Rauhala 1996) and communal clutches of up to 36 eggs (Robertson and Smith 2010) have been observed. There is some evidence that rocks are used as oviposition sites (Rauhala 1996), as well as soil cavities (including artificial arthropod burrows used to capture Grassland Earless Dragons (Osborne and Dimond 2008; M. Evans and E. Cook pers. obs.). Eggs are laid in December and January and, following a variable incubation period (38–47 days in Banks *et al.* 1999 and 35–60 days in Coulson 1995), hatch in January and February.

Longevity of individuals is not known, though adults in the wild have been recaptured almost seven years after first capture (Rauhala 1997) and adults have been held in captivity for 12 years (Robertson and Smith 2010). Based on data from other lizard species, it is likely that longevity of *D. impar* is between 10 and 20 years (ARAZPA 1996).

There have been a number of studies of the diet of *D. impar* (e.g. Coulson 1990; Wainer 1992; Nunan 1995; O'Shea and Hocking 2000) and these have shown that the lizards will eat a broad spectrum of invertebrates found in grasslands, with apparent preference (selectivity) for spiders, crickets, caterpillars and cockroaches. Prey types eaten to a lesser extent were grasshoppers, butterflies, moths, beetles and flies. Slaters, ants and bugs, while relatively common in the field, were rarely eaten.

Little information exists on the activity and movement of *D. impar* due to their cryptic behaviour and small size, which precludes using radio transmitters. Most movement and activity data come from trapping and mark–recapture studies. *Delma impar* are more readily caught in pitfall traps during spring and summer, particularly October to December (Kutt 1991; Kukolic 1993, 1994; Osborne *et al.* 1993; Osmond 1994). Individuals are often caught in pitfall traps later in the day, rather than overnight or early in the morning (R. Spiers pers comm.). The highest detection rates for the species using roof tiles are in spring and early summer, though few individuals are found under tiles after December. Gravid females are caught mostly from late November to early January (Kutt 1991; Kukolic 1993; Osmond 1994), with capture rates steadily declining through January and February (Osmond 1994). In captivity *D. impar* have been found to be

active over a wide range of temperatures, with a preference for an ambient temperature of around 24–26^{0}C, and up to 29^{0}C for gravid females (Coulson 1990; Osmond 1994). Captive animals have been observed to burrow into soil during the late afternoon, re-emerge in the morning as temperatures increase and remain active during most of the day, including basking in sunshine (Martin 1972; Osmond 1994). Field observations (Coulson 1990) suggest the animals are also diurnally active in the wild.

Distances moved by *D. impar* (and hence home range size) appear to be highly variable between individuals. Using pitfall traps, Kukolic *et al.* (1994) recaptured 13 individuals that had moved between 2.5 m and 62.5 m (mean 14 m) straight line distance between captures that spanned an interval of up to nine days. One individual travelled 60 m in two days. Rauhala *et al.* (1995) found no relationship between distance moved and number of days since recapture. Of the ten individuals recaptured by Rauhala *et al.* (1995), the two longest straight-line distances were 52 m and 58 m, which occurred over a short period (two days), whereas the shortest movement (5 m) occurred over a relatively long period of 20 days. Dunford (1998) recaptured an individual that was 160 m away from where it had been captured three years previously. Tracking individuals marked with fluorescent powder has revealed movements vertically and horizontally through grass tussocks and along the surface of the soil for distances up to 20 m in a day (Kutt 1993).

A survey using arrays of roof tiles (as shelter sites) to detect the species found most lizards were recaptured under the same tile, and less than 10% of recaptures were further than 10 m from the original capture location, though one individual was found to have moved 80 m (Eco Logical 2013). Home ranges have been conservatively estimated at 10 m^2 based on recaptures using tiles in Victoria (Robertson and Smith 2010), though a larger area between 25 m^2 (5 m x 5 m) and 100 m^2 (10 m x 10 m) appears to be a reasonable generalisation based on pitfall and tile recapture data.

PREVIOUS AND CURRENT MANAGEMENT

In the ACT, *D. impar* occurs in areas with a variety of management regimes, which includes

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grazed, slashed, occasionally burnt and relatively undisturbed. The species occurs in native grassland on the Majura Training Area (MTA) (Department of Defence land), which is managed for conservation and is generally only lightly grazed by kangaroos. *Delma impar* has also been recorded in the Airport Services Beacon paddock, a fenced area of about 10 ha that is contiguous with habitat on the MTA and which has not been grazed for at least three decades. In contrast, *D. impar* has not been detected in the adjoining native grassland on Canberra Airport, which is subject to a slashing regime to maintain a moderately short (10 cm high) grass sward. The grassland at Majura West is grazed by kangaroos and in the past has been grazed by sheep. The Woolshed Creek grassland (adjacent to the Majura Parkway) is part of a grazing lease and is subject to grazing by stock and kangaroos.

Management of the three Gungahlin grassland reserves (Crace, Mulanggari, and Gungaderra) is aimed at maintaining a grass sward mostly above 10 cm height. These areas have been previously grazed by cattle. Current management of these reserves includes grazing by kangaroos, slashing along tracks and fence lines, and patchy fuel reduction burns.

Management of the small patch of grassland at Yarramundi Grassland has included slashing, occasional patch burns and weed control, which (at least over the past decade) has maintained generally moderate to high herbage mass. Grassland habitat for *D. impar* in the Jerrabomberra Valley (most of which until recently was on land managed by Defence) is subject to generally light grazing by kangaroos and stock.

During the 2001–09 drought, most sites where *D. impar* occur in the ACT were overgrazed by kangaroos and at some sites by stock. Overgrazing was particularly severe in the Majura Valley at the MTA (kangaroos) and West Majura (kangaroos and sheep). Sheep were removed from Majura West during the drought when overgrazing became evident. The height and biomass of the grass sward has since recovered at overgrazed sites, though weeds, such as Saffron Thistle, remain abundant at some sites.

Grasslands in the ACT, including *D. impar* habitat, are subject to planned and unplanned fire. Planned fire is used in grassland for ecological purposes and for fuel reduction. Burning in grasslands can cause direct mortality of *D. impar* (Kukolic 1994; Coulson 1995; Walton 1995).

Dunford (1998) captured *D. impar* in unburnt grassland and adjacent grassland that had been burnt by wildfire the previous year, suggesting the species is capable of using grassland at least one year following fire if animals are able to disperse into the area from adjacent unburnt areas. The species has continued to be present in the burnt area in subsequent years (Nelson *et al.* 2000).

THREATS

Delma impar is a grassland specialist, being found only in areas of native grassland or grassy woodland and nearby exotic pasture (Robertson and Smith 2010). Approximately 99.5% of Natural Temperate Grassland (a nationally critically endangered ecological community, *EPBC Act 1999*) in Australia has been destroyed or drastically altered since European settlement (Kirkpatrick *et al.* 1995).

The major perceived threats to the continued survival of *D. impar* are:

- Loss and fragmentation of habitat through clearing of native grasslands for urban, industrial and infrastructure development and for agricultural purposes.
- Modification and degradation of native grassland habitat through incompatible and inadequate land management practices, weed invasion.
- Other potential effects of urbanisation, including increased incidence of predation and frequency of fires.

Delma impar may persist for some time in modified (largely exotic) grasslands, but 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 (Robertson and Smith 2010).

It is likely that *D. impar* is preyed upon by a range of natural predators, including predatory birds and snakes, though the extent of such predation is unquantified. However, there is speculation that an increase in perching structures (electricity poles, fence posts) in and adjacent to *D. impar* habitat may lead to an increase in predation rates. *Delma impar* may also be susceptible to predation by introduced predators; there is anecdotal evidence to suggest foxes may prey upon the lizards (Robertson and Smith 2010) and domestic/stray cats could have a large impact on local populations where suburban housing abuts grasslands.

Overgrazing or drought resulting in lack of ground cover for this diurnal species would be expected to expose the lizards to increased predation.

The effect of fire on *D. impar* is not well understood. Fire has been observed to cause direct mortality of individuals (Coulson, 1995; Walton, 1995) and recently burnt habitat is likely to expose the lizards to increased predation. The species has been found to persist in areas that have been burnt in both short and medium timeframes (Roberson and Smith 2010). It is likely that intense, widespread fires have a greater impact on the species than low-intensity, patchy burns over small areas.

CHANGING CLIMATE

The predicted changes in climate in the next 50 years are likely to see the ACT become warmer and drier, with increases in extreme weather events and bushfire risk (ACT Government 2009). Species that tolerate such conditions will have an advantage over those species more sensitive to change. The likely direct effects on *D. impar* are not known. Higher mortaility of

eggs buried in soil (due to dessication in hot dry periods) has been identified as a risk for Tympanocryptis pinguicolla, and is also likely to be a risk for *D. impar* eggs.

A meta-analysis of studies that measured the ability of animals to deal with extremes of heat and cold found that terrestrial ectotherms such as reptiles have a limited ability to physiologically acclimate to higher temperatures, and species that are close to their heat tolerance limit will be most at risk from climate change (Gunderson and Stillman 2015). The limited mobility of *D. impar* also makes it less able to adapt by moving to accommodate habitat change. Maintaining high quality habitat (with adequate grass cover to provide shelter and to shade soil) might facilitate resilience of *D. impar* to changing rainfall and temperature regimes.

CONSERVATION ISSUES AND INTENDED MANAGEMENT ACTIONS

PROTECTION

The long-term conservation of *D. impar* depends on protecting its grassland habitat as a cluster of sites across the geographic range of the species in the ACT. This cluster of sites should contain the larger populations of *D. impar* in formally protected areas, and medium-sized populations in areas that are managed to conserve the species.

Larger populations of the species are considered to be those containing 500 or more individuals that occupy habitat patches of 50 ha or more. As a general principle, populations of around 500 or more breeding individuals are genetically robust over the longer term. Larger areas of habitat are better buffered against edge-effects and provide populations with some resilience against planned or unplanned fire (there is less chance the whole area will burn because of natural vegetation patchiness). These areas can also protect against climatic extremes because of the greater heterogeneity of microhabitats likely to be present across the site. Thus, large populations, because of their size and the extent of their habitat, are expected to have the greatest chance of long-term viability. Sites likely to contain large populations of *D. impar* are Crace, Mullanggari and Gungaderra Nature Reserves, Kenny, Majura Training Area, Majura West and the large area of grassland habitat east of the Monaro Highway in the Jerrabomberra Valley (East Jerrabomberra, Bonshaw, Cookanalla).

Medium-sized populations are considered in this plan to contain 200 or more individuals (but do not meet the criteria for a 'large' population). A medium-sized population has the potential to be viable over the longer-term if habitat quality is maintained through appropriate management and threats (such as predation by foxes and cats) are also managed. Habitat for medium-sized populations that do not occur on a protected area should be managed to conserve the species through an appropriate mechanism such as land management agreement or Conservator's Directions. Medium-sized populations are likely to be present in the Franklin grassland, Jerrabomberra West Nature Reserve, patches of grassland in the Majura Valley (east of the Majura Parkway), in Fyshwick (east) and in the Woolshed Creek grassland.

Small populations (less than 200 individuals) can still form a significant contribution to the conservation of the species, particularly if small populations are connected by habitat so that they function as a linked cluster or a small population is connected by a habitat corridor to a larger population.

Protecting intact native ecosystems is generally preferable to protecting areas solely for a single threatened species. Priority should be given to protecting habitat for *D. impar* that results in broader conservation gains, such as conserving other threatened, declining or rare species, or conserving native grasslands with component native fauna.

In the ACT *D. impar* occurs on Territory land (including nature reserves and leasehold rural land) and Commonwealth land controlled and managed by the Department of Defence. The ACT Government will liaise with the Department of Defence to encourage continued protection and management of *D. impar* populations on their land.

ENVIRONMENTAL OFFSET REQUIREMENTS

Environmental offset requirements for species and ecological communities in the ACT are

outlined in the ACT Environmental Offsets Policy and associated documents such as the ACT Environmental Offsets Assessment Methodology and the Significant Species Database. In the Assessment Methodology and Database, some of the threatened species have special offset requirements to ensure appropriate protection. The special offset requirement for *D. impar* is "no loss of known habitat within Conservation Significance Category 1 grasslands as specified in the ACT Native Grassland Conservation Strategy".

SURVEY, MONITORING AND RESEARCH

Over the past two decades there have been numerous, extensive surveys to determine the distribution of *D. impar* in the ACT, and it is unlikely any large populations remain undiscovered. However, it is possible that small populations of *D. impar* persist in some of the numerous small fragments of grassland (many of which are dominated by exotic grasses) that have not been surveyed for the species. Knowledge of the distribution and abundance of *D. impar* in the ACT will be refined from data collected during surveys for other grassland fauna species or from opportunistic observations from naturalists and other interested persons.

A representative set of sites containing *D. impar* will need to be monitored to determine long-term population trends and to evaluate the effects of management.

Research and adaptive management is required to better understand the habitat requirements for the species and techniques to maintain the species' habitat. Specific research priorities include:

- Optimal habitat requirements, particularly soil characteristics and invertebrates.
- Land management practices compatible with, or required for, maintaining suitable habitat (including grazing, slashing, burning).
- Susceptibility to fires and seasonal effects of fires, optimum fire regimes, value and use of firebreaks.
- Seasonal home range area, movements, habitat use (including daily shelter sites, over-wintering sites and oviposition sites), dispersal ability.
- Continue to refine methods for monitoring abundance, absolute population size, long-term population trends and magnitude of seasonal/annual population fluctuations.
- Impact of barriers such as roads and cycle paths.
- Relative importance of predation by native, feral and domestic animals.

Current research includes:

- Trialling fire as a tool to manage herbage mass/structure in *D. impar* habitat (ACT Government).
- Translocating individuals from a proposed development site in Kenny to potential habitat in NSW (Scottsdale Bush Heritage property) (Bush Heritage and ANU) and to Kama Nature Reserve, ACT (PCS), to investigate methods for translocation and establishment of new populations of this species.

MANAGEMENT

Based on current knowledge of the habitat requirements of *D. impar*, management actions should aim to maintain a heterogeneous grass sward structure, with a grass sward between 10 and 20 cm high (i.e. the height of the bulk of the tussock leaves, not including the often few taller leaves and seed-bearing culms). Whilst *D. impar* has been recorded in areas where the grass sward (or biomass) is high (such as areas dominated by Phalaris), Howland et al (2014, 2016) concluded from a habitat modelling study that *D. impar* prefers intermediate levels of grass structure and intermediate to high levels of grass cover. Such grass structure/cover characteristics tend to be most prominent at intermediate levels of herbage mass. Retaining patches of dense, taller grass might be important for providing refugia for the species during dry periods or when other parts of the habitat are heavily grazed.

A heterogeneous sward containing a mixture of tall and medium height tussock patches, with linked inter-tussock areas containing shorter grass and forbs, is likely to provide *D. impar* with a greater range of sites for shelter and thermoregulation, and a wider range and/or density of prey. From an ecological community perspective, maintaining a diverse (or 'patchy') sward structure across *D. impar* habitat is likely

to provide a greater range of habitat niches and hence support a greater diversity of grassland flora and fauna. Maintaining a diverse (or 'patchy') sward with generally intermediate levels of herbage mass is also an appropriate goal given imperfect knowledge of the long-term habitat requirements for *D. impar*. Until knowledge of the *D. impar* habitat requirements indicates otherwise, actions to manage herbage mass/structure (whether for ecological or fuel reduction purposes) should adhere to the following guidelines:

- Grazing is the preferred method for managing grass structure/biomass.
- Where slashing is determined as necessary, grass should not be slashed below 20 cm.
- Where burns are determined as necessary, burns:
- must be patchy and low-intensity
- should be conducted during the middle of the day or in the afternoon, rather than early morning when the lizards may be cold and slow moving
- should be restricted to early spring (September–October), before the summer breeding season, or early autumn (March–April) to ensure sufficient regrowth of vegetation before winter.

Residential developments close to *D. impar* habitat are likely to contribute to disturbance (vehicle traffic, increased visitation by people and dogs, weed infestation, more frequent fires) and increase the risk of predation by uncontrolled roaming of domestic cats and, in some cases, dogs. Minimisation of these impacts will depend on responsible pet ownership or stronger controls and, where possible, buffer areas between residential development and grassland habitat.

IMPLEMENTATION

Implementation of this action plan and the ACT Native Grassland Conservation Strategy will require:

- Land planning and land management areas of the ACT Government to take into account the conservation of threatened species.
- Allocation of adequate resources to undertake the actions specified in the strategy and action plans.
- Liaison with other jurisdictions (particularly NSW) and other land holders (Commonwealth Government and Canberra International Airport) with responsibility for the conservation of a threatened species or community.
- Collaboration with universities, CSIRO and other research institutions to facilitate and undertake required research.
- Collaboration with non-government organisations such as Greening Australia to undertake on-ground actions.
- Engagement with the community, where relevant, to assist with monitoring and other on-ground actions, and to help raise community awareness of conservation issues.

OBJECTIVES, ACTIONS AND INDICATORS

Table 1. Objectives, Actions and Indicators

Objective	Action	Indicator
1. Conserve all large populations in the ACT. Protect other ACT populations from unintended impacts (unintended impacts are those not already considered through an environmental assessment or other statutory process).	Apply formal measures to protect all large populations on Territory-owned land. Encourage formal protection of all large populations on land owned by other jurisdictions.	All large populations protected by appropriate formal measures.
	Protect all medium size populations on Territory-owned land from unintended impacts. Encourage other jurisdictions to protect all medium size populations from unintended impacts.	All sites with medium-sized populations are protected by appropriate measures from unintended impacts.
	Ensure sites where small populations occur on Territory owned land are protected from unintended impacts, where this contributes to broader conservation aims (such as protecting multiple threatened species at a site). Encourage other jurisdictions to undertake similar protection of small populations.	All sites with small populations are protected by appropriate measures from unintended impacts, where sites have broader conservation value.
2. Manage the species and its habitat to maintain the potential for evolutionary development in the wild.	Monitor abundance at a representative set of sites, together with the effects of management actions.	Trends in abundance are known for representative sites, management actions recorded.
	Manage habitat to maintain its suitablilty for the species, including implementing an appropriate grazing / slashing / burning regime (recognising current imperfect knowledge).	Habitat is managed appropriately (indicated by maintenance of an appropriate sward structure and herbage mass). Potential threats (e.g. weeds) are avoided or managed. Populations are apparently stable or increasing (taking into account probable seasonal/annual effects on abundance fluctuations).
3. Enhance the long-term viability of populations through management of adjacent grassland to increase habitat area and connect populations, or to establish new populations.	Manage grassland adjacent to the species' habitat to increase habitat area or habitat connectivity. If suitable habitat exists, re-establish populations where they have become locally extinct.	Grassland adjacent to or linking habitat is managed to improve suitability for the species (indicated by an appropriate sward structure and plant species composition). If suitable habitat exists, research and trials have been undertaken to establish new populations.

Objective	Action	Indicator
4. Improved understanding of the species' ecology, habitat and threats.	Undertake or facilitate research on habitat requirements, techniques to manage habitat, and aspects of ecology directly relevant to conservation of the species.	Research undertaken and reported and where appropriate applied to the conservation management of the species.
5. Promote a greater awareness of, and strengthen stakeholder and community engagement in the conservation of the species.	Undertake or facilitate stakeholder and community engagement and awareness activities.	Engagement and awareness activities undertaken and reported.

ACKNOWLEDGMENTS

The illustration of the species was prepared for the ACT Government by John Pratt.

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