Australian Capital Territory

Nature Conservation (Draft Action Plan—Pink-tailed Worm-lizard) Public Consultation Notice 2016

Notifiable instrument NI2016–577

made under the

Nature Conservation Act 2014, s 103 (Draft action plan—public consultation)

---

1 Name of instrument

This instrument is the *Nature Conservation (Draft Action Plan—Pink-tailed Worm-lizard) Public Consultation Notice 2016*.

2 Commencement

This instrument commences on the day after its notification day.

3 Details of instrument

(a) I have prepared the Draft Action Plan - Pink-tailed Worm-lizard (the ***draft action plan***) at schedule 1 to this instrument.

(b) I invite submissions from anyone about the draft action plan. Submissions must be sent to:

Conservator of Flora and Fauna
Environment and Planning Directorate
GPO Box 158, CANBERRA ACT 2601
Email: environment@act.gov.au

(c) The closing date for submissions is COB 6 December 2016.

(d) The draft action plan is available for inspection during business hours at Ground Floor South, Dame Pattie Menzies House, 16 Challis Street, Dickson. The draft action plan can also be accessed at: www.environment.act.gov.au and on the Your Say website at: www.yoursay.act.gov.au.

Dr Annie Lane
Conservator of Flora and Fauna
24 October 2016

SCHEDULE 1
DRAFT ACTION PLAN – PINK-TAILED WORM-LIZARD
(See s 3)

DRAFT ACTION PLAN

Pink-tailed Worm-lizard

Aprasia parapulchella

Threatened species

Director-General,
Environment and Planning Directorate, ACT Government,
GPO Box 158, Canberra ACT 2601.
Telephone: 02 6207 1923
Website: www.environment.act.gov.au

Privacy

Before making a submission to this draft action plan, please review the Environment and Planning Directorate's privacy policy and annex at www.environment.act.gov.au/about/privacy
Any personal information received in the course of your submission will be used only for the purposes of this community engagement process. Names of organisations may be included in any subsequent consultation report, but all individuals will be de-identified unless prior approval is gained.

Accessibility

The ACT Government is committed to making its information, services, events and venues as accessible as possible.

If you have difficulty reading a standard printed document and would like to receive this publication in an alternative format, such as large print, please phone Access Canberra on 13 22 81 or email the Environment and Planning Directorate at epd_communications@act.gov.au

If English is not your first language and you require a translating and interpreting service, please phone 13 14 50.

If you are deaf, or have a speech or hearing impairment, and need the teletypewriter service, please phone 13 36 77 and ask for Access Canberra on 13 22 81.

For speak and listen users, please phone 1300 555 727 and ask for Access Canberra on 13 22 81.

For more information on these services visit http://www.relayservice.com.au

DRAFT ACTION PLAN

PINK-TAILED WORM-LIZARD

APRASIA PARAPULCHELLA

PREAMBLE

The Pink-tailed Worm-lizard (*Aprasia parapulchella*) was declared a vulnerable species on 27 March 2008 (Instrument No. DI 2008-53 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. This is the first action plan prepared for this species.

Measures proposed in this action plan complement those proposed in the Conservation Strategy for Aquatic and Riparian Communities, and action plans for Natural Temperate Grassland, Yellow Box / Red Gum Grassy Woodland, and for component threatened species such as the Grassland Earless Dragon (*Tympanocryptis pinguicolla*) and Perunga Grasshopper (*Perunga ochracea*).

Public comments on the Draft Action Plan - Pink-tailed Worm-lizard will be received until 6 December 2016. Written submissions can be sent to the Conservator of Flora and Fauna, Environment and Planning Directorate, PO Box 158, Canberra ACT 2601 or emailed to environment@act.gov.au.

CONSERVATION STATUS

The Pink-tailed Worm-lizard (*Aprasia parapulchella*) is recognized as a threatened species in the following sources:

National
Vulnerable – Environment Protection and Biodiversity Conservation Act 1999.

Australian Capital Territory
Vulnerable - Nature Conservation Act 2014.

New South Wales
Vulnerable – Threatened Species Conservation Act 1995.

Victoria
Threatened – Flora and Fauna Guarantee Act 1988.

SPECIES DESCRIPTION AND ECOLOGY

Description

The Pink-tailed Worm-lizard (*Aprasia parapulchella*) is a small worm-like legless lizard with a slender body, a blunt head and a long round-tipped pinkish tail. *A. parapulchella* and other members of the family Pygopidae lack fore-limbs and have their hind limbs reduced to small inconspicuous vestigial flaps (Cogger 2014). The upper side of the body is grey, grey-brown or brown and the head and nape are dark brown to black. The ventral surface is whitish, although the underside of the tail can be slightly pink. Dark longitudinal marks (dots or bars) on each dorsal scale give the appearance of faint longitudinal lines running down the body and tail. Adult *A. parapulchella* reach a total length of about 240 mm (Jones 1999).

Distribution and Abundance

Aprasia parapulchella is largely confined to rocky landscapes and prior to European settlement is likely to have been patchily distributed in south-eastern Australia, mainly along the western slopes of the Great Dividing Range in NSW though to central Victoria. Agriculture (mainly pasture improvement) resulting in habitat destruction is thought to have greatly reduced the species range (Osborne et al. 1991). Recent records of the species are from relatively few widely separated sites in NSW between Tarcutta and Bathhurst, from sites within the ACT and

from near Bendigo in Victoria (Robertson and Heard 2008).

The population density of *A. parapulchella* is apparently quite low except in the most favorable habitats (Wong et al. 2011). The highest abundance of the species appears to be in the ACT and between Yass and Cooma.

In the ACT *A. parapulchella* has a patchy distribution along the slopes of the Molonglo and Murrumbidgee River corridors and on adjacent outlying hills including Mount Taylor, Cooleman Ridge, Urambi Hills, The Pinnacle and Mount Stromlo (Osborne *et al.* 1991; Osborne and McKergow 1993; Rauhala 1993; Rauhala 1995; Osborne and Jones 1995; Wong and Osborne 2010; Osborne and Wong 2010, 2013). Most sites where the species is known to be present occur within nature reserves, although there are also records of the species from rural leased land (farmland) and from non-reserved areas that are located in other forms of urban or rural open space (e.g. road verges and the land-use zone of Hills, Ridges and Buffers). The highest densities and largest populations of the species have been recorded in the Lower Molonglo Valley (Wong and Osborne 2010) and at Mount Taylor (Osborne and McKergow 1993; Osborne and Wong 2012) but this may in part reflect a lack of survey in other parts of the species range (for example along the Murrumbidgee River corridor). Many sites are located within areas that are subject to current and future urban development in the Molonglo Valley, areas between the Molonglo and Murrumbidgee Rivers and at West Belconnen.

Habitat and Ecology

A. parapulchella is an unusual species because it lives in the burrows of ant nests in soil beneath rocks, where it feeds on the eggs and larvae of ants within these nests (Webb and Shine 1994; Jones 1999). Consequently, it is rarely observed and can be very difficult to find, even when known to be present at a site. Searching under rocks appears to be the most efficient method of detecting the species. In the ACT most specimens have been found in spring which appears to be the best time to detect the species (Wong *et al.* 2011), although individuals have also occasionally been found under rocks during the cooler months of autumn and winter.

Sites containing *A. parapulchella* tend to be well drained and contain numerous scattered surface rocks which are weathered and partially embedded in the soil and grass. The lizards are typically found beneath rocks that range from about 10 to 30 cm in diameter, and less frequently under rocks smaller or larger than this size range. Habitat for *A. parapulchella* usually has a cover of predominantly native tussock-forming grasses and native forbs that are indicative of low disturbance. Dominant grasses in *A. parapulchella* habitat include species from the genera *Themeda* (Kangaroo grass), *Austrodanthonia* (Wallaby grass), *Aristida* (Wire grass), *Bothriochloa* and *Poa*. Non-grass plants often present in suitable habitat include species from the genera *Sourghum, Dianella, Lomandra* and a range of disturbance-sensitive forbs.

Sites that have scattered surface rock, but are situated in forest or tall scrub (e.g. thickets of wattles or *Kunzea ericoides*) with a dense or closed canopy appear not to provide suitable habitat (Wong *et al*. 2011). However, specimens have been found in small clearings and naturally open areas within open forest at Mt Taylor, near Mt Stromlo and at Ginninderra Falls (Osborne and Wong 2012; D. Wong pers comm). The species can also occur in areas of potential habitat identified in open woodland.

Species distribution modelling by Wong (2013) predicted the occurrence of *A. parapulchella* on reserves and leased farmland throughout much of the northern ACT (particularly on land to the west of Canberra between the Murrumbidgee River and the Molonglo River). However, the impact of farming on the lizards' habitat is likely to have been high on properties that have had their pastures fertilized and converted to agronomic non-native pasture species. There relatively has been little survey for *A. parapulchella* on rural leased land and hence the status of the species on farmlands in the ACT is unclear. It is likely that rural properties with suitable habitat comprise an important habitat connection where they are adjacent to discontinuous habitat in the river corridor nature reserves.

In a regional context, the hill-side slopes and gorges associated with the Molonglo River and the Murrumbidgee River corridors, and on some adjacent farmland, form an important landscape

linkage for this species and provide habitat connectivity throughout much of the northern ACT.

PREVIOUS AND CURRENT MANAGEMENT ACTIONS

Many sites in the ACT where *A. parapulchella* occurs have been given protection in reserves, including parts of Canberra Nature Park and the Murrumbidgee and Molonglo River Corridors. New nature reserves are also being established that include extensive areas of *A. parapulchella* habitat in the Molonglo Valley downstream of the Tuggeranong Parkway and in West Belconnen (ACT Planning and Land Authority 2011; ACT Government 2015). Specific management actions for *A. parapulchella* that apply to these reserves are given in reserve management plans prepared by the ACT Government, and include actions aimed at preventing habitat degradation (such as the removal of rocks) by establishing buffer areas and fences between key habitat and urban development, managing weeds, implementing appropriate grazing and fire regimes, and raising public awareness of threats to the species.

In the past decade, the ACT Government has funded predictive GIS-based distribution modelling for *A. parapulchella* across its predicted range in the ACT (Wong 2013) to identify areas for protection and management. This mapping has been accompanied by extensive on-ground habitat surveys and searches for the presence of the lizards in some parts of Canberra Nature Park and in the Molonglo Valley. Habitat mapping has been completed for the following reserves: Mt Taylor, Cooleman Ridge (including Mt Arawang), Urambi Hills, The Pinnacle, Kama and the lower Molonglo Corridor Reserves (including the ANU property "Spring Valley") (Osborne and Wong 2010, 2012, 2013, 2015a,b,c) and some areas adjacent to the Murrumbidgee River (Osborne and Wong 2013).

Maintaining potential in the landscape for dispersal between different populations is an important consideration in the conservation of this species. Connectivity helps prevent the processes that negatively affect very small populations, such as reduced gene flow, inbreeding, genetic drift and the loss of small populations due to unpredictable events. Over the past 5 years the ACT Government has undertaken habitat restoration for the species in the Molonglo Valley by placing scattered surface rock between isolated rocky patches to improve habitat connectivity and facilitate dispersal of individuals.

Figure 1 Pink-tailed Worm-lizard

The ACT Government routinely controls feral animals and weeds across the ACT reserve system. In some areas, such as in new suburbs being built near *A. parapulchella* habitat in the Molonglo Valley, it is proposed that residents will be required to prevent cats from straying from their property. In most nature reserves in the ACT dogs must be walked on leads. Control of foxes and cats can be difficult to implement in reserves near urban areas. Planting of trees and tall shrubs is discouraged in areas of *A. parapulchella* habitat that are within reserves.

Some areas that include habitat for *A. parapulchella* are subject to planned and unplanned fire. Planned burns are used in some areas to maintain the ecological condition of grasslands or to reduce fire fuel loads. Planned burns are undertaken in autumn and winter in key habitat for *A. parapulchella*, when burns are cooler and the lizards are likely to be deep in the soil. Burns carried out in spring and early summer are more likely to directly kill individuals because lizards are at the surface of the soil, or close to the underside of small rocks.

THREATS

Specialised habitat requirements make *A. parapulchella* vulnerable to changes in the condition of its habitat and to processes that lead to further degradation, fragmentation and loss of habitat. The major broad-scale perceived threats to the continued survival of *A. parapulchella* are:

- Loss and fragmentation of habitat by urban development and associated infrastructure.
- Degradation and loss of habitat through incompatible and inadequate land management practices, including fertilizer application, overgrazing and the spread of invasive weeds.
- Application of inappropriate fire regimes and burning practices.
- Direct disturbance to habitat by the removal of loose surface rock.
- Predation by predators (including introduced predators).

Examples of specific threats that can degrade and destroy habitat include:

- Dislodgement and removal of rocks by people or livestock.
- Loss of vegetation cover by prolonged overgrazing by livestock and other activities that lead to loss of vegetation cover.
- Conversion of native grassland and low shrubland to exotic pasture.
- Flooding of habitat or higher moisture levels through increased water run-off upslope of the site.
- Smothering of habitat by sediment resulting from increased erosion from construction sites and roads.
- Establishment of a closed canopy of tall trees and shrubs over habitat.
- Invasion by weeds that smother the habitat or outcompete native species.
- Use of fire at a time when lizards are likely to be on or just underneath the soil surface.
- Dumping of rubbish (including building construction and household waste and organic matter such as lawn clippings).

The potential for dispersal between different populations is an important consideration in the conservation of *A. parapulchella*. Since European settlement, habitat connectivity has been reduced by planting of pine forests, clearing for agriculture, construction of roads, major pipelines and other infrastructure. Substantial areas of potential habitat have been lost during land clearing associated with the construction of new suburbs. Whilst the majority of habitat has been protected in the ACT, new developments (for example in the Molonglo Valley, West Belconnen and in the Uriarra area) are likely to result in further loss and disturbance of habitat.

Increased levels of grazing by livestock, and in some cases by kangaroos, can lead to a reduction in ground cover and increased erosion within *A. parapulchella* habitat (Osborne and Wong 2012, 2015c). Continued overgrazing can lead to deterioration in habitat condition, and the effect of this is greatest during droughts. Large introduced herbivores such as cattle can cause considerable disturbance on steep slopes by dislodging rocks and by trampling, which can lead to incision of slopes and further erosion.

The effect of fire on *A. parapulchella* is unclear. Fire is likely to have little immediate direct mortality on individuals if it occurs at a time of year when the lizards are deep in the soil, or are active and able to escape down into their burrows during the fire. However, loss of grass cover after fire may lead to increased susceptibility to predation or changes in the behaviour of animals in order to avoid predation. Fire interval is also important, as habitats need adequate time to recover from the fire event (Osborne and Wong 2012).

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 *A. parapulchella* are not known, but plants advantaged by climate change are likely to include some weed species, including African Lovegrass, which is an invasive C4 grass and is highly competitive on the low-nutrient soils that are typical of drier native grasslands in the ACT (Sharp 2011). Higher predicted CO_2 levels may also favour woody species over grasses, and lead to increased invasion of woody plants into grasslands (Berry and Roderick 2005; Morgan et al. 2007). This effect could be hastened by rising temperatures in the ACT, where cold air drainage in winter is thought to be one environmental factor inhibiting the growth of trees in the local grassy valleys (ACT Government 2005).

MAJOR CONSERVATION OBJECTIVE

The overall conservation objective of this plan is to maintain in the long-term viable, wild populations of *A. parapulchella* 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:

- Protect sites in the ACT where large and medium-sized populations occur.
- Protect all sites that comprise important linking habitat in defined landscape corridors.
- Manage habitat to conserve populations.
- Enhance the long-term viability of populations through management of buffer zones that surround occupied habitat and through rehabilitation of habitat in corridor areas that will increase connectivity between populations.

CONSERVATION ISSUES AND INTENDED MANAGEMENT ACTIONS

Protection

The conservation of large populations of *A. parapulchella* in the ACT requires the protection of suitable rocky habitat within corridors and other linkages in the landscape throughout the species range in the ACT. Protecting habitat in major corridors and as a network of linked habitat patches allows natural evolutionary processes to continue, including the capacity to disperse in response to long-term environmental change. In this context, large existing corridor areas that are a priority for protection are the Murrumbidgee River Corridor and the Molonglo River Corridor. Where connectivity within the existing reserve network is discontinuous (for example in areas within the river corridors that do not have suitable rocky terrain), connectivity may potentially continue through adjacent rural leased farmland (e.g. via areas with low rocky hills with native pasture).

The population density of *A. parapulchella* is apparently relatively low in most of the species' habitat and so protection of large areas supporting the species is important. Larger populations of the species are considered to be those containing 500 or more individuals, which may occupy a single habitat patch (such as occurs in the Mount Taylor Nature Reserve) or a network of interconnected habitat patches (such as occurs in the Molonglo River Corridor). As a general principle, populations of 500 or more breeding individuals are likely to be genetically robust over the long term, larger areas of habitat are better buffered against edge-effects and provide populations with some resilience against environmental catastrophes and extremes (climate change).

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 are also managed. Habitat supporting a medium-sized population that is not located in a protected area should be managed to conserve the species through appropriate mechanisms such as land management agreements or conservator's directions. Medium-sized populations are likely to be widespread within areas of known and potential habitat in the ACT, such as in the Pinnacle and Cooleman Ridge Nature Reserves.

Small populations (less than 200 individuals) can still form a significant contribution to the conservation of the species, particularly if small populations are connected to other populations by habitat corridors or habitat 'stepping stones' that provide opportunity for dispersal or recolonisation.

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 *A. parapulchella* is "Up to 10% of a habitat patch may be cleared [and offset] if the habitat patch is greater than 5 ha and clearance does not result in fragmentation of the existing patch."

Survey, Monitoring and Research

Over the past two decades there have been extensive surveys for *A. parapulchella* in the ACT. The broader distribution of the species is reasonably well known, particularly for reserved areas. Detailed habitat mapping has been undertaken by the ACT Government in the following reserves: Mount Taylor, Cooleman Ridge, Urambi Hills, The Pinnacle, Kama and Lower Molonglo River Corridor. In addition, habitat on the eastern side of the Murrumbidgee River within Woodstock Nature Reserve and on adjacent rural leased farmland was mapped by Osborne and Wong (2013) for the Riverview Group development company. About a third of the likely habitat for the species appears to occur on leasehold farmland, and this has not been surveyed. Priority for future survey should be given to areas where potential habitat on farmland provides an essential element of the regional conservation corridors supporting the species (for example adjacent to the Murrumbidgee and Molonglo River corridors). Priority should also be given to determining the extent of populations in reserves where survey has been incomplete (including Ainslie-Majura Nature Reserve, McQuoids Hill and Kama nature Reserve).

Monitoring can be used to evaluate ongoing survival of a species and importantly to record any response to management actions (Lindenmeyer and Likens 2010). Osborne and Wong (2012) used direct hand-searching beneath rocks to reassess populations in the Mount Taylor Reserve twenty years after a similar survey was done in the reserve by Osborne and McKergow (1993). The results indicate that there has been little change in the distribution and abundance of the species in the reserve with respect to the two time periods. A long-term monitoring program for *A. parapulchella* has been established by the ACT Government in the Molonglo Valley within the planned expansion of the Molonglo River Corridor Reserve. Monitoring is being conducted at sites that are remote from planned urban development and at sites that are close to planned urban areas, with the aim of assessing any effects of nearby urban development. The monitoring program is also testing whether artificial substrates can be used for monitoring this species so that natural stones are not disturbed.

Aprasia parapulchella has been the subject of several detailed research projects and key aspects of its ecology are reasonably well known. University research projects conducted on populations of the species and their habitat in the ACT include an honours project (Jones 1992) and two PhD theses (Jones 1999; Wong 2013). Research projects have covered life history, habitat, diet, demography, genetics, species distribution modelling and the effect of agricultural disturbance on the species across the regional landscape. The ACT Government is undertaking research on techniques for

rehabilitating habitat for *A. parapulchella* that has been previously disturbed by human activity (for example in areas in the Molonglo River Corridor that were previously pine forest). Rock of a suitable size obtained from nearby development sites has been used to make artificial habitat islands that form a series of "stepping stones" patches linking occupied habitat on either side of disturbed areas.

Further research and adaptive management is required to better understand the habitat requirements of *A. parapulchella* and techniques to maintain habitat.

Research priorities include:

- Land management practices compatible with, or required for, maintaining suitable habitat (including grazing, slashing, burning, weed control), in particular the effect of vegetation biomass and fuel management regimes on populations of the species.
- Habitat requirements (particularly tussock structure and level of vegetation biomass).
- Life history components that are still not understood (dispersal ability and egg-laying sites).
- Impact of weed invasion on habitat condition.
- Techniques to rehabilitate habitat in areas that have been previously disturbed by human activity (e.g. in former pine forests).
- Monitoring techniques that do not adversely affect the species.
- Relative importance of predation by native, and feral and domestic animals.
- The contribution of habitat on farming leases to conservation – particularly in areas that are important dispersal corridors.
- The effect of barriers on movement and dispersal, such as roads and cycle paths.
- Effectiveness of buffer zones in mitigating threats associated with urban development.
- Indirect impacts of urban development on populations of the species.

Required Management

Based on current knowledge of the habitat requirements of *A. parapulchella*, management actions should aim to retain a vegetation community dominated by tussock-forming grasses such as *Themeda* (Kangaroo grass), *Austrodanthonia* (Wallaby grass), *Aristida* (Wire grass), *Bothriochloa* and *Poa*. Retention of these tussock grasses appears to be more important than increasing floristic diversity. Management actions should also prevent disturbance to the species' habitat, including rocks, vegetation and subterranean ant nests. Sites where the species occurs should be protected from pasture improvement activities (e.g. application of fertiliser and sowing with exotic pasture species) and planting of trees and tall shrubs.

The Commonwealth and ACT Governments have recommended the use of buffer zones as a means of protecting the habitat of this species (Brown 2010; ACT Planning and Land Authority 2011). Well-managed buffer zones can be effective at protecting habitat areas by slowing the spread of weeds, reducing the likelihood of pollutants and sediments running onto the habitat and reducing the potential for trampling, removal of stones and other disturbances. Appropriate slashing, burning and herbicide spraying regimes may be required within buffer zones to reduce biomass and to control weeds.

Residential developments close to *A. parapulchella* habitat are likely to contribute to disturbance through increased weed infestation, increased risk of predation by cats and dogs, more frequent fires and increased disturbance to rocks. Minimisation of these impacts will depend on community education, responsible pet ownership and the use of buffer zones between residential development and habitat areas. Guidelines are available for suitable activities that can be conducted in buffer zones (Sharp *et al.* 2015).

Canberra is expected to continue growing rapidly and its expansion is likely to continue to impact on this species. For example, the Molonglo Valley and West Belconnen developments will abut areas of habitat and create an extensive urban/reserve edge that will require careful management to minimise the impacts of adjacent incompatible land use on habitat. The additional network of roads and trails and urban

infrastructure associated with these suburbs has potential to fragment remaining populations. Urban planning has incorporated wide asset protection zones and 20 m buffer zones around high and moderate quality habitat, which will assist in reducing the likelihood of direct impact on lizard habitat. Indirect impacts from urban runoff and human activities (e.g. dumping rubbish, removing rocks, spread of weeds, trampling) will need to be managed during and after suburbs are developed.

Actions to manage *A. parapulchella* habitat should adhere to the following guidelines:

- Grazing, burning and hand slashing are the preferred methods for managing vegetation structure and biomass.
- Frequency of burns should be minimised and burns should be conducted so that the burn is patchy, of low intensity and conducted at a time when the lizards are sheltering deeper below the ground surface (autumn and winter).
- Slashing should not be conducted in or near *A. parapulchella* habitat unless strict protocols for the prevention of the spread of weeds are followed. Slashing should be done by hand and slashed material should be removed to prevent smothering of vegetation (and hence reduce risk of weed invasion).
- Paths, roads and management trails should not be situated within habitat or buffer areas.
- Prevent any non-natural increases in water flows and movement of erosional material into habitat areas.
- Plantings of trees and tall shrubs should not occur in habitat and buffer areas.
- Prevent removal of rocks from habitat areas.
- Restrict or closely control grazing by livestock so that habitat is not degraded by trampling, rock dislodgment and disturbance to the soil.
- Minimise disturbance to habitat from recreational activities.
- Prevent prolonged overgrazing of habitat to the extent that it leads to a loss of vegetation biomass, biodiversity and increased erosion.
- Undertake predator/herbivore control if required.
- Increase public awareness of threats to the species and promote responsible actions by the public in the species habitat.
- Enforce responsible pet ownership.

Implementation

Implementation of this action plan 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 this action plan.
- Collaboration with universities, CSIRO and other research institutions to facilitate and undertake required research.
- 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, ACTION AND INDICATORS

Table 1. Key Objectives, Actions and Indicators

Objective	Action	Indicator
1. Protect all large populations and all populations that occur in important corridor areas. Protect other populations from unintended impacts (unintended impacts are those not already considered through an environmental assessment or other statutory process).	1a. Apply formal measures to ensure all large populations (>500 individuals), and all populations that occur in important corridor areas, are protected. 1b. Protect other populations from unintended impacts.	1a. All large populations and all populations that occur in important corridor areas are protected by formal measures. 1b. All sites where other populations occur are protected by appropriate measures from unintended impacts.
2. Conserve the species and its habitat through appropriate management.	2a. Monitor abundance of key representative populations, together with the effects of management actions. 2b. Implement management actions to conserve the species and its habitat, including an appropriate grazing/ fire/slashing regime for managing herbage biomass (recognising current imperfect knowledge).	2a. Trends in abundance are known for representative sites, management actions recorded. 2b. Habitat is managed to conserve the species (indicated by suitable vegetation structure and composition, the presence of suitable rocks and colonies of ants). Populations are apparently stable or increasing (taking into account seasonal / annual fluctuations in abundance).
3. Increase habitat area and connect populations within important corridor areas.	3. Rehabilitate habitat in suitable areas adjacent to occupied habitat to increase habitat area or habitat connectivity.	3. The condition of degraded habitat areas is improved (indicated by suitable vegetation structure and composition, the presence of suitable rocks and colonies of ants) and habitat within important corridors is linked.
4. Improved understanding of the species' ecology, habitat requirements and threats.	4. Undertake or facilitate research on habitat requirements, techniques to manage habitat, and aspects of the species' ecology directly relevant to its conservation.	4. Research undertaken and reported and where appropriate applied to conservation and management of the species.
5. Promote greater awareness of, and strengthen stakeholder and community engagement in, the conservation of the species.	5. Undertake or facilitate stakeholder and community engagement and awareness activities.	5. Engagement and awareness activities undertaken and reported.

Figure 2 Pink-tailed Worm-lizard

ADDITIONAL BACKGROUND INFORMATION

Description

The Pink-tailed Worm-lizard (*Aprasia parapulchella*) was described in 1974 from 20 specimens collected at Coppins Crossing (the scientific type locality) in the ACT and one specimen from Tarcutta in New South Wales (Kluge 1974). *A. parapulchella* has a slender body, including a long, round-tipped tail that can be voluntarily shed and later regrows. There are 14 mid-body scale rows. There is no external ear opening. Head scales include a single postocular scale, and the fusion of the nasal scale and first supralabial scale into a single scale. There are three enlarged pre-anal scales (Cogger 2014). Adult *A. parapulchella* reach a maximum snout to vent length (SVL) of 150 mm and a total length of about 240 mm (Jones 1999). In the ACT region there are no other species of legless lizards with which *A. parapulchella* would be easily confused. Because of its appearance, including a lack of external ear openings, the lizards could be mistaken for a small snake such as the small Blind Snake (*Ramphotyphlops*). However Blind Snakes have eyes that are reduced to a dark spot under the scales of the head, and by comparison *A. parapulchella* have prominent eyes. The distinctive colour of the tail is thought to be an adaptation related to predation - it would attract the attention of predators away from the head and body to the tail. If lost, the tail slowly regrows. Because the regrown tail is very obvious it can be used as a measure of tail loss in the population, and so provides an indirect measure of predation pressure (Osborne and McKergow 1993; Jones 1999; Osborne and Wong 2012).

Distribution

The first records of *A. parapulchella* were from Coppins Crossing in the ACT (the scientific type locality immediately upstream of Coppins Crossing) and from a single hill near Tarcutta in New South Wales (Kluge 1974). Follow-up surveys by Osborne *et al.* (1991) confirmed that the species had a broader distribution in the ACT, but that it was likely to be rare in NSW (detected at only six of 26 sites surveyed in NSW between Tarcutta and Bathhurst). In recent years there have been a few more records of the species from NSW at very widely-separated locations from Albury to near Gunnedah (Wong *et al*. 2011). The lizards have been recorded in nine reserves within Canberra Nature Park (Table 1) and in the following reserves within the Murrumbidgee River Corridor: Gigerline, Bullen, Stoney Creek and Woodstock. The species also occurs on rural land.

Ecology

Like other legless lizards, *A. parapulchella* is oviparous and has a clutch size of two eggs. Jones (1999) estimated that the species takes three to four years to reach adult size. Males reach adult size in their third year (approximately 100 mm SVL) and females reach adult size in their fourth year (approximately 120 mm SVL). The species has an even sex ratio (Jones 1999; Robertson and Heard 2008). Gravid females have been observed in late November and December (Kluge 1974; Jones 1999). Eggs have never been found in the wild, but is very likely that they are laid within the ant nests. There are no records of hatching date, though very small juveniles have been observed in ant nests beneath stones in late summer and autumn indicating that hatching occurred earlier in spring or summer.

As for other reptile species, *A. parapulchella* are dependent on the temperature of their surroundings for regulating their body temperature (Jones 1999). During cold weather in spring and autumn (when soil temperatures are lower) the lizards move to the upper edges of the ant burrows that they live in. This allows them to "bask" against the warm underside of the rocks that cover the ant nests (Osborne *et al.* 1991; Jones 1999). Osborne *et al.* (1991) also suggest that during unfavourable weather (too hot or too cold) the lizards are likely to move to more sheltered parts of the ant burrows. *A. parapulchella* are thought to be diurnal (Jones 1999), although it is possible they remain active in the ant nests at night if the soil is warm. They have never been found at night on the ground surface or captured at night in pitfall traps, but a few individuals have been observed in grass or on the ground or rock surface on sunny days (Wong *et al.* 2011). Given the captures of male *A. parapulchella* under 'cover' objects, such as fence posts, that are not immediately within rocky areas (Wong *et al.* 2011) it is likely that localised dispersal by males is an important component of the dynamics of colonies.

A. parapulchella have been found in association with the nests of 15 species of ants (Jones 1992, 1999). In the ACT the lizard's diet is known to include eleven species of ants and two species of termites (Jones 1999). The most common genera in the diet were *Iridomyrmex*, *Pheidole*, *Paratrechina*, and *Rytidoponera*. Jones (1992) observed that 53 percent of specimens were in the nests of one species of ant – *Iridomyrmex rufoniger* a small, aggressive species that is very common in rocky grasslands (Robinson 1996). It has been suggested that the reason that *A. parapulchella* occur only in habitats which still support a substantial cover of native grasses may relate to their dietary preference for species of ants that may only occur in native grasslands (for example species that harvest native grasses). However, Jones (1992) found that the ants that are eaten include both generalist foragers and specialized foragers (species that feed on native grass seed) indicating that the availability of prey may not be the reason that *A. parapulchella* does not occur in improved pastures. This is supported by Robinson (1996) who found that the distribution of *A. parapulchella* is not limited by the extent of occurrence of its preferred ant prey species, which extends well beyond that of the lizard.

Habitat and Abundance

Habitat for *A. parapulchella* in the Canberra region is characterized by good drainage and an abundance of shallowly embedded surface rock, usually of igneous or metamorphic origin (e.g. rhyodacite, rhyolite, dacite, quartz) (Osborne *et al*. 1991), though some specimens have also been found under sandstone rocks (at a single site on Black Mountain) and metamorphosed shales (sites near Googong). Suitable habitat typically also lacks trees (or has very low tree cover) and has a ground cover of predominantly native grasses, particularly kangaroo grass (*Themeda triandra*), red-leg grass (*Bothriochloa macra*), purple wire grass (*Aristida ramosa*), barbed wire grass (*Cymbopogon refractus*), snow grass (*Poa sieberiana*) and wallaby grass (*Austrodanthonia*) species and a range of native forbs species and graminoides such as mat rush (*Lomandra*) (Osborne *et al*. 1991; Jones 1992, 1999; Wong 2013).

The likelihood of the occurrence of the lizards is increased with an increasing cover of the aforementioned grasses, which are referred to as the 'large tussock functional group', and with other species indicative of reduced disturbance such as Creamy Candles (*Stakhousia monogyna*), Scaly Buttons *(Leptorhynchos squamatus)* and Early Nancy *(Wurmbea dioica*) (Wong 2013) (see Sharp et al. 2015 for a full list of indicator

species). Sites that still support these 'indicator' plant species have undergone lower levels of disturbance, and native-tussock forming species tend to be sensitive to intensive livestock grazing and pasture improvement (McIntyre and Tongway 2005). In contrast, an increase in the occurrence of spear grasses (*Austrostipa scabra*, *Austrostipa bigeniculata*), River Tussock (*Poa labillardieri*) and Red-anthered Wallaby Grass (*Rytidosperma pallidum*), decrease the likelihood of finding the species. Rocky sites dominated by very tall tussock-forming grasses appear to be avoided (Osborne and McKergow 1993).

The abundance of *A. parapulchella* can sometimes be quite high in moderately disturbed habitat dominated by exotic pasture species, provided some native species remained (Wong *et al.* 2011). For example, Jones (1999) observed that some disturbed sites dominated by exotic pasture species such as oats (*Avena barbata*), Squirrel Tail Grass (*Vulpia bromoides*), Flatweed (*Hypocheirus radicata*), soft brome (*Bromus hordaceous*), Delicate Hairgrass (*Aira elegantissima*), Haresfoot Clover (*Trifolium arvense*), but which also contained native Red-leg Grass (*Bothriochloa macra*), supported at least some individuals. The lizards are not found in areas that have been heavily modified or pasture improved to the extent that all native species have been eliminated from the ground layer (Osborne and McKergow 1993; Jones 1999; Wong *et al*. 2011; Wong 2013).

In high-quality habitat, Jones (1999) recorded a population of 151 individuals from searches beneath 40,000 rocks that were turned during complete removal of all rock from a large construction site with high quality habitat. An earlier estimate of the population at this same site by Barrer (1992) provided an estimate of 37 individuals after 3000 rocks were turned. This indicates that searching beneath rocks provides a reliable index of abundance but does not provide a good estimate of actual population size. Up to eight individuals have been found under a single rock (Jones 1999). Such aggregations typically include adults, sub-adults and juveniles and are most likely cohorts that are related to each other (the larger individuals are typically an adult male and adult female).

Large populations of the species (in the order of 500 individuals) are unlikely to occur at a single site. However, such populations could be expected to occur across a broad local landscape with interconnected or patchily distributed habitat (for example a partially interconnected series of rock outcrops and hills). This reinforces the importance of maintaining the potential for dispersal by lizards between habitat patches that are components of broader landscape corridors. The broadly interconnected and "stepping stone" patches of habitat within the Lower Molonglo River Corridor provide a good example of this.

Land Management

Previous land management by European settlers has affected the distribution and abundance of *A. parapulchella*. Following the clearing of the original timbered landscape it is likely that local population size for the species at many sites would have increased after trees were removed. The partially cleared hills that comprise Canberra Nature Park provide a good example of this. One of the largest recorded populations of *A. parapulchella* occurs at Mt Taylor, but most records of the species in the reserve have been from open and semi-open areas that were formerly cleared (Osborne and Wong 2012). Although the initial clearing of forest would have favoured the lizards, the pasture improvement that followed on many properties has resulted in the loss of much potential habitat (the full extent of this is not known) (Wong 2013). More recently the spread of urban areas and associated infrastructure, such as roads, powerlines, water storage tanks, bushfire asset protection zones, has resulted in a further loss of habitat.

Wong (2013) estimated that agricultural modification through application of fertilizer and overgrazing, resulting in the establishment of exotic pasture species, has affected at least 20-25 percent of potential habitat in the ACT. The lizards were not present at potentially suitable sites that no longer had a native ground cover and lacked native grasses. Because *A. parapulchella* occurs on well-drained nutrient-poor soils, the habitat is somewhat buffered from invasion by weeds. However, the following species present a major threat because they are capable of dominating or smothering habitat: African Love Grass (*Eragrostis curvula*), Serrated Tussock (*Nassella trichotoma*), Blackberry (*Rubus fruticosus*), Saint John's Wort (*Hypericum perforatum*) and Patterson's Curse (*Echium*

plantagineum). African Love Grass and Serrated Tussock are arguably the main threat to Pink-tailed Worm-lizard habitat because of their capacity for rapid spread and tendency to form large tussocks, and in groups can form very dense (and often tall) localised thickets.

Despite the high incidence of fires in the Mount Taylor Nature Reserve, and the fact that vegetation on the mountain was entirely burnt in a very hot wildfire in January 2003, the species is still common in the reserve which suggests that the subterranean behaviour of the Pink-tailed Worm-lizards must provide some protection for the species (Osborne and Wong 2012). However, individuals that shelter beneath small stones can be killed by the heat generated in hot grass fires (W. Osborne personal observation). Following the 2004 bushfires in the ACT, there has been a considerable increase in the use of controlled fire as an approach to hazard reduction in Canberra Nature Park.

Predators

The impact of feral predators on populations of *A. parapulchella* is not known. The largely subterranean lifestyle of the lizards probably protects them from direct predation, except if they are dispersing across the ground surface. The pink colour of the tail is thought to be an adaptation for reducing predation by attracting the attention of predators to the tail, rather than the head or body. In the ACT the observed incidence of tail loss in *A. parapulchella* ranges from 20-60 percent indicating that predation does occur on this species (Wong *et al.* 2011).

The types of predators are not known but are likely to include large arthropods (e.g. scorpions), birds and small mammals including introduced species (rats, cats and foxes). Barrer (1992) reports several instances of dead Pink-tailed Worm-lizards lying on the surface of rocks – these individuals appeared to have been killed by predators.

Genetics

There has been only one study of genetic variation in *A. parapulchella* (Knopp *et al.* 2012). This study, funded by the ACT Government, reported that there were high levels of heterozygosity in the 14 ACT populations examined and that levels of genetic differentiation (between sites) were also high, indicating high levels of genetic subdivision between almost all populations sampled. The authors concluded that there has been effectively no modern dispersal between the sites sampled (all sites were separated by at least one kilometre). The differences in genetic variation were best explained by the presence of biogeographic barriers such as rivers, exotic pine forest and a lack of rocky habitat. These data provide important confirmation of the isolation of individual populations and support the view that the lizards have been mainly confined to patchily-distributed rocky landscapes. Such results underscore the importance of maintaining habitat connectivity for the long-term viability of the species.

Table 2. Reserves known to support populations of *A. parapulchella* in the ACT.

Reserve	Extent of habitat L = Low; M = Moderate; H = High; U = Unknown
Murrumbidgee River Corridor	
Gigerline	H
Bullen Range	U
Stony Creek	H
Woodstock	H
Swamp Creek	U
Molonglo Valley Reserves	
Lower Molonglo Corridor	H
Molonglo Reserve*	H
Canberra Nature Park South	
Mount Taylor	H
Tuggeranong Hill	U
Urambi Hills	H
Red Hill	U
Cooleman Ridge (including Mt Arawang)	M
Wanniassa Hills	U
Farrer Ridge	U
Oakey Hill	U
McQuoids Hill	U
Canberra Nature Park North	
The Pinnacle	M
Black Mountain	L
Mt Ainslie- Mt Majura #	U
Kama	L
Other sites with some formal protection	
Mt Stromlo Park	M
ANU Field Station (Spring Valley)*	H

* Proposed Nature Reserve

\# A single museum specimen collected by a ranger in the 1980's is labelled as the Ainslie- Majura Reserve.

ACKNOWLEDGEMENTS

Dr Will Osborne contributed to the preparation of this action plan. Cover image by Matthew Frawley, Figure 1 image by Richard Milner (ACT Government), Figure 2 image by Will Osborne.

REFERENCES

ACT Government 2015. Variation to the Territory Plan No 351. West Belconnen Urban Development. ACT Planning and Land Authority, Canberra.

ACT Planning and Land Authority 2011. Molonglo Valley Plan for the Protection of Matters of National Environmental Significance (the NES Plan). ACT Planning and Land Authority, Canberra.

Barrer P 1992. A survey of *Aprasia parapulchella* along parts of the lower Molonglo River corridor. Report prepared for ACT Parks and Conservation Service (Wildlife Research Unit), Canberra.

Brown GW 2009. DRAFT National Recovery Plan for the Pink-tailed Worm-lizard *Aprasia parapulchella*. Department of Sustainability

and Environment, East Melbourne, Victoria.

Cogger H 2014. *Reptiles and Amphibians of Australia*. Seventh Edition. CSIRO Publishing, Collingwood.

Jones SR 1992. Habitat relationships, diet and abundance of the endangered pygopodid, *Aprasia parapulchella*. B. App. Sc. (Honours) Thesis, University of Canberra.

Jones SR 1999. Conservation biology of the pink-tailed worm lizard (*Aprasia parapulchella*). Unpublished PhD thesis, Applied Ecology Research Group, University of Canberra.

Kluge AG 1974. A taxonomic revision of the lizard family Pygopodidae. Miscellaneous Publications of the Museum of Zoology University of Michigan 47, 1-221.

Knopp T, Gruber B, Osborne W, Wong D and Sarre S 2012. Conservation genetics of the pink-tailed worm lizard (*Aprasia parapulchella*) in the ACT: What can population genetics tell us about habitat fragmentation and conservation priorities in the face of urban expansion? Report to the ACT Government. Institute for Applied Ecology, University of Canberra.

Lindenmayer DB and Likens GE 2010. *Effective ecological monitoring*. Australian National University Press, Canberra.

McIntyre S and Tongway D 2005. Grassland structure in native pastures: links to soil surface condition. *Ecological Management and Restoration* 6, 43-50.

Osborne W and Wong D 2015a. The extent and condition of habitat for the Pink-tailed Worm-lizard (*Aprasia parapulchella*) in the Cooleman Ridge Nature Reserve. Report and maps prepared for ACT Parks and Conservation Service. Institute for Applied Ecology, University of Canberra.

Osborne W and Wong D 2015b. The extent and condition of habitat for the Pink-tailed Worm-lizard (*Aprasia parapulchella*) in the Pinnacle Nature Reserve. Report and maps prepared for ACT Parks and Conservation Service. Institute for Applied Ecology, University of Canberra.

Osborne W and Wong D 2010. Extent of potential Pink-tailed Worm-lizard (*Aprasia parapulchella*) habitat in the Stage 2 Investigation Area - East Molonglo. Report commissioned by ACT Planning and Land Authority. Institute for Applied Ecology, University of Canberra.

Osborne W and Wong D 2012. Examining the long term survival of Pink-tailed Worm-lizards (*Aprasia parapulchella*) in Canberra Nature Park: a case study in an urbanised landscape. Habitat distribution and abundance in the Mount Taylor Reserve. Report commissioned by Environment and Sustainable Development Directorate, ACT Government. Institute for Applied Ecology, University of Canberra.

Osborne W and Wong D 2013. The extent of habitat for the vulnerable Pink-tailed Worm-lizard (*Aprasia parapulchella*) in the West Belconnen – Ginninderra Creek investigation area – confirmatory distribution surveys and mapping. Report and maps prepared for The Riverview Group Pty Ltd. Institute for Applied Ecology, University of Canberra

Osborne W and Wong D 2015c. The extent and condition of habitat for the Pink-tailed Worm-lizard (*Aprasia parapulchella*) in the Urambi Hills Nature Reserve. Report and maps prepared for ACT Parks and Conservation Service. Institute for Applied Ecology, University of Canberra.

Osborne WS and Jones SR 1995. Recovery Plan for the Pink-tailed Worm Lizard, Technical Report 10. ACT Parks and Conservation Service, Canberra

Osborne WS and McKergow FVC 1993. Distribution, population density and habitat of the pink-tailed legless lizard, *Aprasia parapulchella* in Canberra Nature Park. ACT Parks and Conservation Service, Technical Report 3.

Osborne WS, Lintermans MA and Williams KD 1991. Distribution and conservation status of the endangered pink-tailed legless lizard *Aprasia parapulchella* (Kluge). Research Report 5, ACT Parks and Conservation Service, Canberra.

Rauhala M 1993. The reptile, amphibian and mammal fauna of the Stony Creek Nature Reserve, ACT. Technical Report 6. ACT Parks and Conservation Service,.

Rauhala M 1995. The reptile, amphibian and mammal fauna of the Gigerline Nature Reserve, ACT. Technical Report 11. ACT Parks and Conservation Service.

Robertson P and Heard G 2008. Report on field-surveys for the Pink-tailed Worm-lizard (*Aprasia parapulchella*) in the Bendigo region, central Victoria: Distribution, habitat assoociations and population attributes. Hurstbridge, Victoria: Wildlife Profiles Pty Ltd.

Robinson WA 1996. Ant communities in the grasslands of the Australian Capital Territory and the role of ants in the ecology of the pink-tailed legless lizard *Aprasia parapulchella*. Master of Applied Science thesis, University of Canberra, Canberra.

Sharp S, Osborne W, Taws N and NGH Environmental 2015. Molonglo Reserve and Offset Areas. Ecological Management Guidelines. ACT Government, Territory and Municipal Services Directorate, Canberra.

Webb JK and Shine R 1994. Feeding habitats and reproductive biology of Australian Pygopodid lizards of the genus *Aprasia*. *Copeia* 1994, 390-398.

Wong D and Osborne WS 2010. Confirmatory surveys for Pink-tailed Worm Lizards (*Aprasia parapulchella*) and additional mapping of habitat along the Molonglo River corridor between Coppins Crossing and Tuggeranong Parkway, ACT. Report commissioned by ACT Planning and Land Authority. Institute for Applied Ecology, University of Canberra.

Wong DTY 2013. Environmental factors affecting the occurrence and abundance of the pink-tailed worm-lizard (*Aprasia parapulchella*) in the Australian Capital Territory. Unpublished PhD thesis. Institute of Applied Ecology, University of Canberra.

Wong DTY, Jones SR, Osborne WS, Brown GW, Robertson P, Michael DR and Kay GM 2011. The life history and ecology of the Pink-tailed Worm Lizard *Aprasia parapulchella* Kluge – a review. Australian Zoologist 35, 927-940.