

Notice and reasons for the Final Determination

The NSW Threatened Species Scientific Committee, established under the *Biodiversity Conservation Act 2016* (the Act), has made a Final Determination to list *Pseudomys australis* (Gray 1832) as a VULNERABLE species in Part 3 of Schedule 1 of the Act and, as a consequence, to omit reference to *Pseudomys australis* (Gray 1832) from Part 1 of Schedule 3 (Extinct species) of the Act. Listing of Vulnerable species is provided for by Part 4 of the Act.

Summary of Conservation Assessment

Pseudomys australis is currently listed as an extinct species in New South Wales (NSW) under the Act. Populations of the species have recently been recorded from areas in western NSW. Consequently, *Pseudomys australis* is to be removed from Part 1 of Schedule 3 (Extinct Species) of the Act.

Pseudomys australis was found to be eligible for listing as Vulnerable under Clause 4.3(c)(d)(f)(i). The main reasons for this species being eligible are: i) it has a moderately restricted geographical range; ii) it occurs at less than ten locations; and iii) it experiences extreme fluctuations in the number of mature individuals.

The Scientific Committee has found that:

1. *Pseudomys australis* is also known as Palyoora, plains mouse, plains rat, and eastern mouse, and was described by Gray in Owens (1832) as “a quadruped ... forming a new genus of the Order Rodentia ... The fur is soft, close, thick, blackish brown, and slightly grizzled at the tips of the hairs; beneath, it is of a reddish ash; and on the throat and breast greyish ash. The whiskers are slender, weak, and reach beyond the ears. The head and body measure 5¹/₄ inches [13.3 cm]; the tail 3¹/₄ [8.3 cm]; the fore foot 5¹/₂ lines [1.2 cm]; and the hind foot 1 inch [2.5 cm].” There has been some taxonomic instability involving this species mostly relating to reconciling the identity of a number of historically named forms which no longer occur over a large area of southern Australia (Woinarski *et al.* 2012). Watts and Aslin (1981) include all specimens previously described as *Pseudomys minnie*, *P. rawlinnae*, *P. australis* and *P. auritus* which were collected over a large area of southern Australia. Whilst there continues to be some doubt about the relationship between these taxa, Brandle *et al.* (1999) assume that the remaining arid-zone *P. australis* represent a single species.
2. *Pseudomys australis* historically had a patchy distribution over northern South Australia, southern Northern Territory, central and south-western Queensland, south-eastern Western Australia, southern Eyre Peninsula and Lake Albert in South Australia, northern New South Wales and southern Victoria. The current distribution remains patchy in the western Lake Eyre Basin from Billa Kalina Station, south-east of Coober Pedy, to Charlotte Waters, Northern Territory (Lee 1995). *Pseudomys australis* has suffered significant reduction in distribution since European colonisation and was considered extinct in NSW (DPIE 2019) with no live

NSW Threatened Species Scientific Committee

animals recorded for over 150 years (Atlas of Living Australia, accessed March 2020). Individuals have been found more recently in western NSW in the Sturt National Park in 2008 and 2020 (ABC 2008; D. Cullen pers. comm. 1 Apr 2020), and the Fowlers Gap area and Strzelecki Dune field between 2015 and 2017 (Leggett *et al.* 2017; P. Story *in litt.* 23 Jun 2020).

3. *Pseudomys australis* is found on the barren gibber plains or stony deserts and cracking clay plains with a high gypsum content in arid and semi-arid regions of the Lake Eyre basin (Brandle and Moseby 1999). It occurs at sites with surface soil complexity which enables it to burrow in cracks or at the bases of low shrubs (Brandle 1998). These cracking clay areas provide refuges for *P. australis* during non-irruptive periods providing more reliable resources of food and shelter (Brandle and Moseby 1999). *Pseudomys australis* temporarily inhabits a variety of habitat types during natural irruptions. Brandle (1998) recorded *P. australis* from four main vegetation communities in a biological survey of the Stony Deserts in South Australia, including: Low Open Shrubland (*Sclerolaena divaricata* / *Eragrostis setifolia* / *Atriplex vesicaria*); Low Very Open Shrubland (*Atriplex nummularia* subsp. *omissa* / *Abutilon halophilum*); Low Very Open Shrubland (*Maireana aphylla* / *Eragrostis setifolia* / *Astrebla pectinata* / *Atriplex vesicaria*); and Low Woodland (*Eucalyptus coolabah*).
4. The diet of *Pseudomys australis* is comprised of seeds and plant material although insects may also be taken (Murray *et al.* 1999). Pavey *et al.* (2016) found that many of the plants consumed by *P. australis* were shallow rooted, short lived grazing tolerant and are likely to germinate after small rainfall events. This includes species such as *Dactyloctenium radulans*, *Chloris pectinata* and *Boerhavia schomburgkiana*. The generation length of *P. australis* is one year (Woinarski *et al.* 2012), and individuals are highly social and huddle in burrows. A burrow usually contains a single nest chamber and a few side passages with neighbouring burrows generally located within 10m and connected by surface runways (Nunn 2006). *Pseudomys australis* has an oestrus period of seven to eight days, gestation period of 30 to 31 days, litter sizes of one to four pups and the females experience post-partum oestrus (Nunn 2006). Breeding continues during dry periods in refuge areas but is known to cease during droughts and periods with low resources (Watts and Aslin 1981). Captive breeding in Alice Springs has shown that there are significantly less litters during winter (Nunn 2006). *Pseudomys australis* has also been found to have a multimale breeding system with multiple paternity within the one litter being occasionally identified (Breed and Adams 1992).
5. The abundance of *Pseudomys australis* Australia-wide is estimated during drought periods to be <10,000 mature individuals (Woinarski *et al.* 2012). Within NSW, the population size is unknown although individuals have recently been caught at five sites including Fowlers Gap between 2015 and 2017 (Leggett *et al.* 2017; P. Story *in litt.* 23 Jun 2020), the Strzelecki Dune field in 2015-2016 (Leggett *et al.* 2017) and in the Sturt National Park in 2008, 2019 and 2020 (ABC 2008; M. Letnic *in litt.* 5 Mar. 2020; D. Cullen pers. comm. 1 Apr 2020). All individuals were between four and 69 km from the South Australian border and are considered not to be transient individuals from a population in another state as the species has a foraging range of less than five hectares, and typically, one hectare (Young *et al.* 2017).

NSW Threatened Species Scientific Committee

6. *Pseudomys australis* has a moderately restricted geographical range. The national area of occupancy (AOO) is estimated to be approximately 648 km² based on 2 x 2 grid cells (as recommended by IUCN 2019). Species with an area of occupancy (AOO) of less than 2,000 km² qualify under the Vulnerable threatened category, contingent on meeting 2 of 3 other conditions. The extent of occurrence (EOO) was estimated to be about 521,337 km² based on a convex hull polygon fitted around all species occurrences. In NSW, the EOO is estimated to be 3,467 km² and the AOO is 20 km².
7. *Pseudomys australis* is an irruptive species with extreme fluctuations in numbers occurring in response to rainfall events (Murray *et al.* 1999). Numbers remain high while conditions are favourable and then decline rapidly (Moseby 2012).
8. Grazing and browsing and trampling of burrows by herbivores, is a key threat to *P. australis*. In a landscape scale study in South Australia, Pedler *et al.* (2016) found that when rabbit populations were dramatically suppressed through biological control, *P. australis* increased 241% in extent of occurrence and 64% in area of occupancy. The explanation for these observations is that *P. australis* benefits both from changes in bottom-up ecosystem effects, such as reduced competition for plant and seed biomass, plus increased vegetation cover providing greater protection from predators (Pedler *et al.* 2016). Pavey *et al.* (2016) identified that most of the plants consumed by *P. australis* are also palatable to cattle and Moseby *et al.* (2020) found that an index of *P. australis* activity dropped dramatically from the outside edge of a fenced conservation area to zero 250m from the fence where cattle were present. Predation by introduced cats and foxes is a threat to *P. australis*. During good conditions, foxes and cats may suppress sub-population irruptions and prevent large scale dispersal events (Moseby 2012). During drought conditions isolated populations are vulnerable to predation and local extinction (Moseby 2012). Increasing temperatures associated with climate change are likely to be a threat to remaining populations (Moseby 2012). The shallow burrows may become too hot for habitation and populations may contract even further to just the deepest cracking clay areas (Moseby 2012). 'Competition and grazing by the feral European Rabbit, *Oryctolagus cuniculus* (L.)', 'Predation by the European Red Fox *Vulpes vulpes* (Linnaeus, 1758)' and 'Predation by the Feral Cat *Felis catus* (Linnaeus, 1758)' are listed under the Act as Key Threatening Processes.
9. *Pseudomys australis* naturally undergoes significant declines in extent of occurrence, area of occupancy, number of locations and number of mature individuals during drought periods. Since European colonisation there has been a reduction in distribution of 50-90% (Lee 1995), believed to be due to the impact of introduced stock and rabbits on vegetation, and predation from dingoes, foxes and owls. While these threats remain, the reduction in rabbit numbers from haemorrhagic disease virus, and subsequent associated decline in predator numbers, is considered to have reduced those threats to *P. australis*.
10. *Pseudomys australis* (Gray 1832) is not eligible to be listed as an Endangered or Critically Endangered species.

NSW Threatened Species Scientific Committee

11. *Pseudomys australis* (Gray 1832) is eligible to be listed as a Vulnerable species as, in the opinion of the NSW Threatened Species Scientific Committee, it is facing a high risk of extinction in Australia in the medium-term future as determined in accordance with the following criteria as prescribed by the *Biodiversity Conservation Regulation 2017*:

Appendix 1

Assessment against Biodiversity Conservation Act criteria

The Clauses used for assessment are listed below for reference.

Clause 4.2 – Reduction in population size of species

(Equivalent to IUCN criterion A)

Assessment Outcome: Data deficient

(1) - The species has undergone or is likely to undergo within a time frame appropriate to the life cycle and habitat characteristics of the taxon:			
	(a)	for critically endangered species	a very large reduction in population size, or
	(b)	for endangered species	a large reduction in population size, or
	(c)	for vulnerable species	a moderate reduction in population size
(2) - The determination of that criteria is to be based on any of the following:			
	(a)	direct observation,	
	(b)	an index of abundance appropriate to the taxon,	
	(c)	a decline in the geographic distribution or habitat quality,	
	(d)	the actual or potential levels of exploitation of the species,	
	(e)	the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.	

Clause 4.3 - Restricted geographic distribution of species and other conditions (Equivalent to IUCN criterion B)

Assessment Outcome: Vulnerable under Clause 4.3(c)(d)(f)(i).

The geographic distribution of the species is:			
	(a)	for critically endangered species	very highly restricted, or
	(b)	for endangered species	highly restricted, or
	(c)	for vulnerable species	moderately restricted,
and at least 2 of the following 3 conditions apply:			
	(d)	the population or habitat of the species is severely fragmented or nearly all the mature individuals of the species occur within a small number of locations,	
	(e)	there is a projected or continuing decline in any of the following:	
		(i)	an index of abundance appropriate to the taxon,
		(ii)	the geographic distribution of the species,
		(iii)	habitat area, extent or quality,

NSW Threatened Species Scientific Committee

	(iv)	the number of locations in which the species occurs or of populations of the species,
	(f)	extreme fluctuations occur in any of the following:
	(i)	an index of abundance appropriate to the taxon,
	(ii)	the geographic distribution of the species,
	(iii)	the number of locations in which the species occur or of populations of the species.

Clause 4.4 - Low numbers of mature individuals of species and other conditions

(Equivalent to IUCN criterion Clause C)

Assessment Outcome: Near Threatened.

The estimated total number of mature individuals of the species is:		
	(a)	for critically endangered species very low, or
	(b)	for endangered species low, or
	(c)	for vulnerable species moderately low
and either of the following 2 conditions apply:		
	(d)	a continuing decline in the number of mature individuals that is (according to an index of abundance appropriate to the species):
	(i)	for critically endangered species very large, or
	(ii)	for endangered species large, or
	(iii)	for vulnerable species moderate
	(e)	both of the following apply:
	(i)	a continuing decline in the number of mature individuals (according to an index of abundance appropriate to the species), and
	(ii)	at least one of the following applies:
	(A)	the number of individuals in each population of the species is:
	(I)	for critically endangered species extremely low, or
	(II)	for endangered species very low, or
	(III)	for vulnerable species low
	(B)	all or nearly all mature individuals of the species occur within one population,
	(C)	extreme fluctuations occur in an index of abundance appropriate to the species.

Clause 4.5 - Low total numbers of mature individuals of species

(Equivalent to IUCN criterion D)

Assessment Outcome: Clause not met.

The total number of mature individuals of the species is:		
	(a)	for critically endangered species extremely low, or
	(b)	for endangered species very low, or
	(c)	for vulnerable species low.

NSW Threatened Species Scientific Committee

Clause 4.6 - Quantitative analysis of extinction probability (Equivalent to IUCN criterion E)

Assessment Outcome: Data deficient

The probability of extinction of the species is estimated to be:			
	(a)	for critically endangered species	extremely high, or
	(b)	for endangered species	very high, or
	(c)	for vulnerable species	high.

Clause 4.7 - Very highly restricted geographic distribution of species (Equivalent to IUCN criterion D2)

Assessment Outcome: Clause not met.

For vulnerable species,	the geographic distribution of the species or the number of locations of the species is very highly restricted such that the species is prone to the effects of human activities or stochastic events within a very short time period.
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NSW Threatened Species Scientific Committee

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NSW Threatened Species Scientific Committee

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