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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 the Bathurst Grassland Earless Dragon *Tympanocryptis mccartneyi* Melville, Chaplin, Hutchinson, Sumner, Gruber, MacDonald & Sarre 2019 as a CRITICALLY ENDANGERED SPECIES in Part 1 of Schedule 1 of the Act and, as a consequence omitting reference to *Tympanocryptis pinguicolla* (Mitchell 1948) in Part 2 of Schedule 1 (Endangered species) of the Act. Listing of Critically Endangered species is provided for by Part 4 of the Act.

Summary of Conservation Assessment

Tympanocryptis mccartneyi was found to be Critically Endangered in accordance with the following provisions in the *Biodiversity Conservation Regulation* 2017: Clause 4.3 (a) (d) (e ii, iii, iv) because: i) the distribution of the species is very highly restricted with an extent of occurrence and area of occupancy of 4 km^2; ii) the species is known from one location; and iii) there is a continuing decline in the geographic distribution and the area, extent and quality of habitat of the species.

The NSW Threatened Species Scientific Committee has found that:

1. *Tympanocryptis pinguicolla*, the South-eastern Lined Earless Dragon was listed as an Endangered Species on Part 1 of Schedule 1 of the Threatened Species Act 1995 in 15/11/1996. Individuals of *Tympanocryptis pinguicolla* in NSW were recently recognised as two separate species *Tympanocryptis mccartneyi,* Bathurst Grassland Earless Dragon and *Tympanocryptis osbornei,* Monaro Grassland Earless Dragon (Melville *et al.* 2019).

2. *Tympanocryptis mccartneyi* is described by Melville *et al.* (2019) as: “Lateral neck fold well developed, from angle of jaw to gular fold; spines along extent of fold. Head and snout with strongly keeled dorsal scales; keels irregular, those on the lateral scales aligned more obliquely than those on the more medial scales. Snout shape smoothly tapering in profile, the canthal scales continuous with the rostral scale. Nasal scale dorsal margin does not cross onto the dorsal side of the canthus rostralis. No row of enlarged scales along the ventral margin of the nasal scale between the nasal and small snout scales. Dorsal body scales weakly to moderately keeled and imbricate. Numerous scattered strongly enlarged spinous dorsal scales, at least twice the width of adjacent body scales, each with a strong median keel ending in prominent spine directed posterodorsally; posterior edge weakly raised, not convex. Ventral body scales weakly keeled, throat scales keeled. Thigh scalation heterogeneous, with scattered enlarged tubercular scales similar to those on body. Lateral fold between axilla and groin present. Snout–vent length of the two known specimens, 53 mm (holotype) and 51 mm (paratype); femoral pores = 0; preanal pores = 2. Dorsal colour pattern (in preservative) brownish grey with six dark brown transverse bands and with 5- lined pattern well defined and continuous. Dorsolateral lines as wide as or wider than the vertebral line, well defined, straight edged, not expanding around the vertebral blotches. Vertebral and dorsolateral stripes continue weakly onto the tail

outlining 12–14 dark caudal blotches. Pale supra-ocular bar usually strongly contrasting. Venter whitish, with dark speckled pigmentation on throat and sides of the belly."

3. *Tympanocryptis mccartneyi* is part of the *T. lineata* species complex (which includes *T. lineata, T. mccartneyi*, *T. osbornei*, and *T. pinguicolla*) which is referred to as the "grassland earless dragons", being the only members of the family Agamidae to be restricted to natural temperate grasslands. *T. mccartneyi* was previously considered a population of *T. pinguicolla,* but a recent taxonomic revision has described this as a separate species, based on genomics and morphology (Melville *et al.* 2019). *Tympanocryptis mccartneyi* differs from both *T. lineata* and *T. osbornei* in having enlarged tubercular scales scattered on the thighs and keeled rather than smooth throat scales. This species differs from *T. pinguicolla* from Victoria in having more acutely pointed dorsal tubercles directed more posteriorly than vertically and keeled rather than smooth gular scales (Melville *et al.* 2019).

4. *Tympanocryptis mccartneyi* is endemic to New South Wales (NSW), Australia where it is restricted to the grasslands and open country on the alluvial plains around Bathurst in the Central Tablelands of NSW (Melville *et al.* 2019). The grasslands occur at altitudes up to approximately 1200 m and are naturally treeless or sparsely treed, with native tussock grasses being the dominant vegetation (Melville *et al.* 2019).

5. *Tympanocryptis mccartneyi* is a grassland specialist, inhabiting treeless plains and open grasslands. The species has been found along railway tracks, with weedy *Paspalum* grass thickets, and in vacant paddocks with tall pasture grass (Melville *et al.* 2019).

6. Little is known about habitat requirements of this species, but other species of grassland earless dragons have been discovered beneath rocks in either burrows, rock crevices or depressions (Osborne *et al.* 1993). Burrows excavated by wolf spiders (*Lycosidae* sp.) associated with partially embedded surface rocks are of critical importance to *T. mccartneyi*. These burrows provide shelter sites for overwintering, refuge from trampling by livestock and predation and as locations where eggs can be laid (McGrath 2015). Fidelity to these burrows is known to increase with the onset of winter (Stevens *et al.* 2010) and the species is reported to be torpid in winter between May and September (McGrath *et al.* 2015).

7. Like the other grassland earless dragons, *Tympanocryptis mccartneyi* is likely to be a sit-and-wait predator, feeding mainly on small invertebrates including ants, beetles, spiders and moths (McGrath 2015).

8. There are no detailed studies of the life history of *T. mccartneyi* and most information is based on better understood related species of grassland earless dragons (Smith 1994, Langston 1996, Nelson 2004, Stevens *et al*. 2010, Dimond *et al*. 2012). Grassland earless dragons are oviparous, laying clutches of 3-6 eggs in late spring or early summer, in shallow nests. The eggs develop over 9-12 weeks before hatching in late summer or early autumn (Smith 1994, Langston 1996, Nelson 2004). The young disperse probably soon after hatching (Smith 1994, Dawson 2003). No information is available concerning either hatching success or juvenile mortality. They

quickly grow to adult size (by late autumn-early winter), with males maturing earlier than females (Langston 1996, Nelson 2004). Mating occurs the following spring (Robertson and Evans 2009).

9. Generation length of *Tympanocryptis mccartneyi* in the wild is estimated to be one to two years. Based on information of other species of grassland earless dragons, this species is likely to be short-lived. The closely related *T. osbornei* lives for one to three years in the wild, though they can reach the age of four to six years, sometimes up to nine years within captivity (Nelson 2004, Robertson and Evans 2009; S. Sarre *in litt*. Jan 2021). Female *T. osbornei* can breed in their first year and in the wild most seem to only survive long enough to produce one clutch of eggs. In captivity they have occasionally been recorded to produce a second clutch (Langston 1996; Nelson 2004; S. Sarre *in litt*. Jan 2021).

10. Adult grassland earless dragons have been shown to move as much as 40 to 110 m per day (Langston 1996, Nelson 2004), with some movements in excess of 230 m over longer periods. The closely related *T. lineata* has been recorded to occupy home ranges of between 925 m^2 and 4768 m^2 (Stevens *et al.* 2010). Nothing is known about movements of juveniles, although this stage may be when dispersal occurs (Robertson and Evans 2009). Population density may be influenced by social interactions, as aggressive encounters between individual lizards, involving vocalisations and displays, have been observed in captive animals and in the field (Smith 1994, Robertson and Evans 2009).

11. The distribution of *Tympanocryptis mccartneyi* is considered to be highly restricted. Using the recorded occurrences of the species (ALA 2020; NSW BioNet 2020), *Tympanocryptis mccartneyi* occupies an extent of occurrence (EOO) estimated to be <1 km^2, based on a minimum convex polygon enclosing all known mapped occurrences of the species, the method of assessment recommended by IUCN (2019). The area of occupancy (AOO) for all records was estimated to be 4 km^2, based on 2 x 2 km grid cells, the scale recommended for assessing area of occupancy by IUCN (2019). If the EOO is less than AOO, EOO should be changed to make it equal AOO to ensure consistency with the definition of AOO as an area within EOO' (IUCN 2019). Therefore, the EEO is also 4 km^2.

12. Since European settlement, 99.5% of the Natural Temperate Grassland of the South Eastern Highlands (a nationally critically endangered ecological community, EPBC Act 1999), which *Tympanocryptis mccartneyi* relies upon, has been destroyed or drastically altered and now only occurs in small highly fragmented patches (Kirkpatrick *et al.* 1995, Environment ACT 2005; Threatened Species Scientific Committee 2016). Genetic studies of populations of the related species *T. lineata* identified a substantial population structure in the highly urbanised Canberra region where this species occurs, despite relatively short distances between sites. Populations were found to only likely have migration between them where there is some integrity and connectedness of the natural temperate grasslands (Hoehn *et al.* 2013). These results suggest that significant development can cause rapid isolation and population fragmentation and it is likely that any extant populations of *T. mccartneyi* would also be severely fragmented due to urbanisation of its habitat around Bathurst.

13. The population size of *Tympanocryptis mccartneyi* is unknown. The species is known from only three records (two in 1966 and one from the early 1990s). The species has not been encountered for more than 30 years, although there have been few surveys targeting this species. In September 2019, a week-long search was conducted in the Bathurst region focussed on finding appropriate habitat for the species and searching potential burrows, but the species was not located. Of the six sites visited only two had some possible but unlikely habitat for the species and even those sites contained no more than 50 x 50 m patches of potential but unlikely habitat (S. Mahony *in litt.* January 2021). Areas of other private and public land still need to be assessed as potential habitats for *T. mccartneyi*, including Travelling Stock Reserves and roadside and rail verges (Melville *et al.* 2019).

14. Urban, rural and infrastructure development has resulted in a reduction of much of the natural grassland habitat of south-eastern Australia (Benson and Redpath 1997; Threatened Species Scientific Committee 2016). The Bathurst area may have contained around 20 000 hectares of native grasslands at the time of European discovery, which has now been mostly replaced by weeds, horticultural crops and/or trees (Semple 1997). Only five surveyed sites in the Bathurst-Orange range have been identified as potential tussock grassland sites suitable for this species (Department of Environment 2016; Melville *et al.* 2019). The remaining areas of grassland habitat are subject to ongoing degradation processes including crash grazing practices or overstocking, ploughing or sowing of exotic pastures, pasture improvements through use of agricultural chemicals and rock removal (Robertson and Evans 2009, McGrath 2015). A change in grazing regime by domestic stock and feral animals significantly impacts grassland community structure and composition (Costin 1954; Clarke 2003; Keith 2004; Environment ACT 2005; Threatened Species Scientific Committee 2016). Ground-dwelling reptiles are vulnerable to changes in the intensity of grazing and trampling by stock due to their use of a particular vegetation structure and microhabitat features that are important for foraging, shelter, reproduction and thermoregulation (McElhinny *et al.* 2006). Furthermore, their limited dispersal ability prevents them from migrating into higher quality areas when habitat is degraded (Brown *et al.* 2011). A study of ground-dwelling reptiles in grassy habitats showed that species' abundance and diversity were highest at low grazing intensities (Howland *et al.* 2014). The closely related *T. lineata* has never been captured in grassland that is highly modified, such as through ploughing and conversion to exotic grassland (Stevens *et al.* 2010). Ploughing and overgrazing is likely to also reduce the number of arthropods that *T. mccartneyi* relies on to form burrows reducing availability for shelter and may also reduce the abundance of prey items (Nelson 2004).

15. The removal of bushrock from grassland habitats either by farming activities or for home landscaping removes important habitat elements for grassland earless dragons (Threatened Species Scientific Committee 2016). "Bushrock removal" is listed as a Key Threatening Process under the Act.

16. Fire can regenerate native grasslands and maintain diversity in grassland structure, but too frequent burning and wildfire may also kill *T. mccartneyi*, alter vegetation composition and structure and reduce the abundance of prey (Environment ACT 2005; ACT Government 2017). The related *T. lineata* has been recorded both escaping from and being killed by an unplanned fire (Osborne *et al.* 2009). Too-

frequent burning or fires that are too hot or at inappropriate times are identified as a threat to native grasslands, and particularly to the small, relatively immobile fauna species that occur in small, fragmented sites (Environment ACT 2005; Dunlop *et al.* 2012; Threatened Species Scientific Committee 2016). "High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition" is listed as a Key Threatening Process under the Act.

17. Introduced plant species have had a major impact upon grassland habitats. Species such as *Hypericum perforatum* (St John's Wort), *Nassella trichotoma* (Serrated Tussock) and *Nassella neesiana* (Chilean Needlegrass) can outcompete native grassland species for water, light and nutrients and can form a monoculture. The young plants can grow into inter-tussock spaces, potentially restricting movement and obscuring sheltering burrows (ACT Government 2017).

18. The burrowing and grazing activities of the European rabbit (*Oryctolagus cuniculus*) and the wallowing and rooting behaviour of the feral pig (*Sus scrofa*) are sources of disturbance to grassland habitats (Costin 1954; Environment ACT 2005; Threatened Species Scientific Committee 2016). Impacts by these animals include soil disturbance and erosion which can promote the invasion of weeds and prevent the recruitment and survival of native plants, which can adversely affect the microhabitat requirements of *T. osbornei* (Costin 1954; Environment ACT 2005; DEWHA 2008). "Competition and grazing by the feral European Rabbit, *Oryctolagus cuniculus*" and "Predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*)" are listed as key threatening processes under the Act.

19. The reduction of vegetation cover as a result of grazing in grassland habitats is likely to increase the impact of predators such as feral cats, dogs and foxes. Foxes are likely to be more numerous on the rural sites and predation by domestic pets and feral cats might increase where *T. mccartneyi* sites are closer to urban developments (Robertson and Evans 2009). The impact of native predators such as ravens, raptors, magpies and snakes may also increase with lack of vegetation and increased exposure (Robertson and Evans 2009). 'Predation by the European Red Fox *Vulpes vulpes*' and 'Predation by the Feral Cat *Felis catus*' are listed as Key Threatening Processes under the Act.

20. Modelling of the effect of climate change predicts warmer year-round temperatures for south eastern Australia by the end of the century, with an increase in the intensity and frequency of hot days and heatwaves, intensifying drought conditions and changing rainfall patterns (OEH 2014). These changed conditions have the potential to impact the habitat quality, population resilience and recruitment of all grassland earless dragons (J. Melville *in litt.* Sept 2020). Monitoring data of the related *T. lineata* from 2002-2010, showed that successive years of drought led to population declines and local extinctions, suggesting this species may be sensitive to the predicted effects of climate change (Dimond *et al.* 2012). As a result of drought, sparser ground cover will lead to higher ground temperatures, which may increase mortality of eggs and hatchlings through desiccation (Dimond *et al.* 2012), thermal refuges may also be less effective and at high temperatures the daily activity period may reduce foraging time (Sinervo *et al*. 2010). Associated impacts correlated with, or exacerbated by, anthropogenic climate change also includes an increase in the severity and frequency

of fire (Flannigan *et al.* 2009) and any effects on populations from habitat fragmentation and degradation (Hoehn *et al.* 2013). The relatively low fecundity and short life span of *T. mccartneyi* makes local populations vulnerable to the effects of wildfire, drought and other environmental changes on their habitat. 'Anthropogenic Climate Change' is listed as a Key Threatening Process under the Act.

21. The NSW Threatened Species Scientific Committee is of the opinion that an amendment to the Schedule is necessary or desirable to reflect the reclassification and reassessment of the newly described species as a result of taxonomic revision and that *Tympanocryptis mccartneyi* Melville, Chaplin, Hutchinson, Sumner, Gruber, MacDonald & Sarre 2019 is eligible to be listed as a Critically Endangered species as it is facing a very high risk of extinction in Australia in the immediate future as determined in accordance with the following criteria as prescribed by the *Biodiversity Conservation Regulation 2017*:

Assessment against *Biodiversity Conservation Regulation 2017* criteria
The Clauses used for assessment are listed below for reference.

Overall Assessment Outcome: Critically Endangered under Clause 4.3 (a) (d) (e ii, iii, iv)

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: Critically Endangered under Clause 4.3 (a) (d) (e ii, iii, iv).
[Equivalent to IUCN Criterion B via B1ab (i, ii, iii, iv, v) and B2ab (i, ii, iii, iv, v)]

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,			
		(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 C)
Assessment Outcome: Data Deficient

The estimated total number of mature individuals of the species is:						
	(a)	for critically endangered specie			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: Data Deficient

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.

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–vulnerable species
(Equivalent to IUCN criterion D2)
Assessment Outcome: Vulnerable

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 stochasti events within a very short time period.

Dr Anne Kerle
Chairperson
NSW Threatened Species Scientific Committee

Supporting Documentation:

NSW Threatened Species Scientific Committee (2021) Conservation Assessment of *Bathurst Grassland Earless Dragon Tympanocryptis mccartneyi Melville, Chaplin, Hutchinson, Sumner, Gruber, MacDonald & Sarre 2019* (Agamidae). NSW Threatened Species Scientific Committee.

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