Conservation Assessment of Monaro Grassland Earless Dragon *Tympanocryptis osbornei* Melville, Chaplin, Hutchinson, Sumner, Gruber, MacDonald & Sarre 2019 (Agamidae)

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NSW Threatened Species Scientific Committee

Monaro Grassland Earless Dragon *Tympanocryptis osbornei* Melville, Chaplin, Hutchinson, Sumner, Gruber, MacDonald & Sarre 2019 (Agamidae)
Distribution: Endemic to NSW
Current EPBC Act Status: Endangered as *Tympanocryptis pinguicolla*
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Proposed listing on NSW BC Act and EPBC Act: Endangered

Conservation Advice: *Tympanocryptis osbornei*

Summary of Conservation Assessment

Tympanocryptis osbornei was found to be eligible for listing as Endangered under Criterion B1ab (i,ii,iii,iv,v) and B2ab (i,ii,iii,iv,v). The main reasons for this species being eligible are; a very restricted geographical range, small number of locations, and ongoing threats, including the loss, fragmentation and degradation of habitat through pastoral and agricultural development, adverse fire regimes, weed invasion, predation by native and introduced species and climate change (Robertson and Evans 2009; McGrath 2015).

Description and Taxonomy

Taxonomy: *Tympanocryptis osbornei* is part of the *T. lineata* species complex (which includes *T. lineata, T. mccartneyi*, *T. osbornei*, and *T. pinguicolla*) and are referred to as the "grassland earless dragons", being the only members of the family Agamidae to be restricted to natural temperate grasslands. *T. osbornei* 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).

Description: Melville *et al.* (2019) describe *Tympanocryptis osbornei* 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 a prominent spine directed posterodorsally; sharply convex trailing edge not raised into a rim. Ventral body scales and throat scales smooth. Thigh scalation homogeneous, lacking scattered enlarged tubercular scales. Lateral fold between axilla and groin present. Snout–vent length 49–58 mm; femoral pores = 0; preanal pores = 2.”

"Dorsal colour pattern variable in degree of development and colour hue, from reddish brown to greybrown with six or seven dark brown transverse bands and with 5-lined pattern well defined, and usually continuous, or at most briefly interrupted on the paler interspaces between the dark cross bands. 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 present but usually weakly contrasting. Venter whitish, often heavily patterned with blackish speckling, especially on the throat."

Common Name: Monaro Grassland Earless Dragon

Distribution and Abundance

Tympanocryptis osbornei is endemic to New South Wales (NSW) where it is restricted to native tussock grasslands of the Monaro high plains. The species is known to occur in a 20 x 60 km region bounded by the Maclaughlin and Murrumbidgee Rivers in the south and north, the Monaro Highway in the east and Berridale in the west (Melville *et al.* 2019).

The species is mainly known to occur on freehold agricultural land used for sheep and cattle grazing and limited crops but has also been recorded in a number of travelling stock reserves (TSRs) and in Kuma Nature Reserve (NR) near Cooma. Kuma NR is the only grassland reserve on the Monaro, managed for *T. osbornei* and Natural Temperate Grassland of the South Eastern Highlands (a nationally critically endangered ecological community, EPBC Act 1999; NSW NPWS 2007). The species was last recorded in Kuma NR in 1998 (NSW BioNet) and may no longer occur there.

The species, as *T. pinguicolla,* was first documented to occur in the Monaro grasslands in 1907, but was presumed extinct until its rediscovery in 1993, when it was recorded around 10 km south of Cooma (Osborne *et al.* 1993b). Surveys conducted in 1999 and 2003 located the species in additional sites in the Kuma NR and an adjacent private property near Cooma alongside the Monaro Highway (McGrath 2015). The species appears to have been relatively common at some sites in the region from the mid-1990s to early 2000, including in the Kuma NR and around the dry plains, north west of Cooma (McGrath 2015). In 2009, surveys targeting the species resulted in the discovery of previously unknown populations, extending the southerly known range limit for the species to south west of Nimmitabel with several populations discovered on private properties in the vicinity of 'Boco' off the Springfield and Avon Lake Roads (Eco Logical Australia 2009, McGrath 2015).

Intensive surveys of 67 sites over four years up to 2015 failed to detect the species at some sites at which they had previously been recorded (McGrath 2015, McGrath *et al*. 2015). Surveys in 2019 confirmed occupancy at several TSRs and at several locations on private land. These sites are thought to represent the extant distribution of *T. osbornei* on the Monaro and some of these detections were minor range extensions. (R. Pietsch *in litt.* Sept 2020)

The population size of *Tympanocryptis osbornei* is unknown and information regarding population trends of the species is limited (Osborne *et al.* 1993b, Robertson

and Evans 2009). The detection rate of this species is extremely low, making it difficult to accurately estimate population (McGrath *et al*. 2015, Melville *et al.* 2019).

Ecology

Key habitat requirements:

Tympanocryptis osbornei is known to occur in rocky open grassland communities dominated by *Poa sieberiana* and *Austrostipa scabra* with sub dominant *Rytidosperma caespitosum* or *Rytidosperma racemosum,* on predominantly basalt geology with heavy clay soils (Robertson and Evan 2009, Eco Logical Australia 2009, McGrath 2015, Melville *et al.* 2019). Some studies have indicated that grasslands dominated by *Themeda triandra* may lower species occupancy (Osborne *et al.* 1993a; McGrath 2015, McGrath *et al.* 2015). Sites in the Cooma region were noted to be on well drained north facing slopes that had not been subject to ploughing or pasture modification and "were open in structure and characterised by intertussock spaces that were occupied by bare ground, cryptogams and low growing forbs" (Nelson 2004). The species has been recorded at elevations of 758 to 1234 m above sea level though sites at higher elevations are more likely to contain the species (McGrath *et al.* 2015, Melville *et al.* 2019).

The species has been discovered beneath rocks in either burrows, rock crevices or depressions (Osborne *et al.* 1993b). Burrows excavated by wolf spider (*Lycosidae* sp.) associated with partially embedded surface rocks are of critical importance to *T. osbornei*. 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).

Tympanocryptis osbornei is a sit-and-wait predator, feeding mainly on small invertebrates including ants, beetles, spiders and moths (McGrath 2015).

Habitat Fragmentation:

Since European settlement, 99.5% of the Natural Temperate Grassland of the South Eastern Highlands ecological community, has been destroyed or drastically altered, due mostly to urban and agricultural development in the region (Kirkpatrick *et al.* 1995, Environment ACT 2005) These grasslands now only occur in highly fragmented patches, with most less than 10 ha in size (Kirkpatrick *et al.* 1995, Environment ACT 2005; Threatened Species Scientific Committee 2016). The effects of fragmentation include the restriction or prevention of the movement of native fauna species and dispersal between sites and may lead to inbreeding and local extinctions (Hoehn *et al*. 2013).

Although little is known about dispersal distances in *T. osbornei*, it is likely that they are small. The closely related *T. lineata* has been recorded to have restricted movement (usually less than 100 metres in six weeks of monitoring) and occupy home ranges of between 925 m^2 and 4,768 m^2, focussed around one or two burrows (Stevens *et al.* 2010). Nothing is known about movements of juveniles, although this stage may be when dispersal occurs (Robertson and Evans 2009).

Genetic studies of populations of the closely related species *T. lineata* identified substantial population structure in the highly urbanised Canberra region where this species occurs, despite relatively short distances between sites. Populations were found to only be likely to migrate between them where there is some integrity and connectedness of the natural temperate grassland remnants (Hoehn *et al.* 2013).

In contrast, Carlson *et al*. (2016) found low levels of genetic structure in *T. osbornei* in the largely rural Monaro region, with no indication of significant isolation by distance. Known locations of *T. osbornei* in the Monaro are widely spaced, separated by up to 50 km (McGrath *et al*. 2015), but connectivity among extant populations may occur as potentially suitable tracts of contiguous natural grassland have been retained (Carlson *et al*. 2016). However, low genetic structuring may be a result of historical rather than present-day connectivity as extant sites are small (no more than 650 ha), and often delineated by unsuitable habitat such as cultivated improved pastures or are separated by distances greater than 300 m, well beyond the recorded home range of the species (Stevens *et al*. 2010; Department of Environment 2016; T. McGrath *in litt.* Sept 2020). Further clearing for agricultural and rural residential development is planned in the Monaro region resulting in greater contraction of suitable habitat, increased fragmentation and reduction of connectivity between suitable habitat patches (NSW Government 2017; Fallding 2002). Development appears to have caused rapid isolation and population fragmentation in *T. lineata* (Hoehn *et al.* 2013), and it is likely that any extant populations of *T. osbornei* could become further fragmented in the future.

Life History: Detailed studies of *T. osbornei* are limited (other than Nelson 2004) and most information is based on the better understood related species *T. lineata* (Smith 1994, Langston 1996, 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 which 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, and mating occurs the following spring (Langston 1996, Nelson 2004; Robertson and Evans 2009).

The species is short lived, surviving usually for only one to three years in the wild though they can reach the age of four to six years, sometimes up to nine years in captivity (Nelson 2004, Robertson and Evans 2009; S. Sarre *in litt*. Jan 2021). They are able to breed in their first year and most females in the wild seem to only survive long enough to produce one clutch of eggs, however, in captivity they have occasionally been recorded to produce a second clutch (Langston 1996; Nelson 2004; S. Sarre *in litt*. Jan 2021). The generation length of *Tympanocryptis osbornei* in the wild is estimated to be one to two years.

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).

Threats

The main threat to *Tympanocryptis osbornei* is the historic and ongoing loss, fragmentation and degradation of its native grassland habitat through agricultural development (ploughing, pasture improvement, removal of rocks, changed grazing regimes), inappropriate fire regimes and invasive flora and fauna. Other threats include predation by native species (raptors, snakes) of individuals from small populations in a fragmented landscape, predation by non-native species (feral cats, foxes) and climate change.

Agricultural development and other related disturbances:

Tympanocryptis osbornei is a grassland specialist, being restricted to remaining fragments of native grassland. Since European settlement much of the natural grassland habitat of south-eastern Australia has been cleared and has undergone extensive structural and compositional degradation (Costin 1954; Benson and Redpath 1997; Threatened Species Scientific Committee 2016). 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). Over-grazing is known to affect grassland species composition by reducing those plant species that have higher palatability to stock and lower capacity to regenerate (McIntyre and Lavorel 1994; McIntyre *et al*, 2003) and too little grazing may result in increased biomass and a reduction of inter-tussock spaces, altering the structure of the grassland community (Threatened Species Scientific Committee 2016).

Changes in grazing intensity have been shown to adversely affect reptile abundance, richness and diversity (Kay *et al*. 2017; Howland *et al.* 2014) and livestock grazing has been implicated in historical changes to several Australian reptile assemblages (Sadlier and Pressey 1994; Smith *et al*. 1996; Landsberg *et al*. 1997). Ground-dwelling reptiles are vulnerable to changes in the intensity of grazing due to their reliance on particular vegetation structures and microhabitat features that are important for foraging, shelter, reproduction and thermoregulation (McElhinny *et al.* 2006). In addition, their limited dispersal ability is likely to prevent them from moving to other areas when habitat is degraded (Brown *et al.* 2011). Heavy grazing by kangaroos, rabbits, stock, or close mowing leads to loss of tussock structure and excessive bare ground. 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). Trampling by stock is also likely to damage grassland structure (McGrath 2015).

Ploughing and overgrazing are likely to reduce the density of arthropods that *T. osbornei* relies on to form burrows reducing availability for shelter and may also

reduce the abundance of prey items (Nelson 2004). The related *T. lineata* has never been detected in grassland that is highly modified, such as through ploughing and conversion to exotic grassland (Stevens *et al.* 2010).

Physical soil disturbances such as ploughing, cultivation and infrastructure works may remove or destroy the native vegetation, contributing to fragmentation by creating areas of unsuitable habitat which may act as barriers to movement between surviving populations of this species. These activities may also encourage weed invasion and lead to erosion and soil compaction of the grassland habitat. The inappropriate use of herbicide is also known to affect grassland composition (Threatened Species Scientific Committee 2016).

The removal of bushrock from grassland habitats either for facilitation of farming activities or for home landscaping use removes important habitat elements for grassland earless dragons (Threatened Species Scientific Committee 2016). 'Bushrock removal" is listed as a key threatening process under the NSW Biodiversity Conservation Act.

Invasive flora and fauna:

Introduced fauna and flora species have had a major impact upon grassland habitats. Invasions of feral animals and weeds have been documented since the early 1950s (Costin, 1954), and are still considered as severe threats throughout the range of *T. osbornei* (Environment ACT, 2005; Threatened Species Scientific Committee 2016).

The perennial grass *Eragrostis curvula* (African Lovegrass) is regarded as one of the weeds of most concern within the Snowy Monaro region due to its invasiveness and potential for spread. As *Eragrostis curvula* has little grazing value due to its low nutritional value and palatability, stock and other wildlife avoid it unless there is nothing else to eat and so it rapidly replaces more palatable grasses, especially during drought, forming a monoculture. It also invades native vegetation including grassland, by establishing in thin and bare patches, blocking movement and obscuring burrows essential for *T. osbornei*. Other species identified as priority weeds impacting the Monaro grasslands include *Nassella trichotoma* (Serrated Tussock), *Nassella neesiana* (Chilean Needle Grass) and *Hypericum perforatum* (St John's Wort) (Environment ACT 2005; Threatened Species Scientific Committee 2016; Snowy Monaro Regional Council 2018).

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 NSW Biodiversity Conservation Act and the Environment Protection and Biodiversity Conservation Act.

Predation by introduced and native animals

Reduced vegetation cover as a result of grazing 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. osbornei* sites are closer to urban developments (Robertson and Evans 2009). The impact of native predators like 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 NSW Biodiversity Conservation Act and the Environment Protection and Biodiversity Conservation Act.

Climate Change

Modelling of the effects 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 *T. osbornei* (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 include 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. osbornei* 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 NSW Biodiversity Conservation Act.

Changed and inappropriate fire regimes:

Fire can regenerate native grasslands and maintain diversity in grassland structure, but too frequent burning and wildfire may also kill *T. osbornei*, 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). Individuals have been recorded occupying an area in the year following a fire (Nelson *et al.* 1998, Osborne *et al.* 2013) and in subsequent years (Evans and Ormay 2002, Cook *et al*. 2015). Too-frequent burning or fires that are too hot or occur 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 NSW Biodiversity Conservation Act.

Assessment against IUCN Red List criteria

For this assessment it is considered that the survey of *Tympanocryptis osbornei* has been adequate and there is sufficient scientific evidence to support the listing outcome.

Criterion A Population Size reduction

Assessment Outcome: Data Deficient
Justification: To be listed as threatened under Criterion A, the species must have experienced a population reduction of ≥30% (VU threshold) over three generations or 10 years (whichever is longer). Although the species may have undergone a reduction in population size as a result of habitat loss and degradation, there are no quantitative data available on the population size or dynamics of this animal and there are no data on population declines over any relevant time frames (10 years or 3 generations). Therefore, there are insufficient data to assess *Tympanocryptis osbornei* against this criterion.

Criterion B Geographic range

Assessment Outcome: Endangered under Criterion B1ab (i,ii,iii,iv,v) and B2ab (i,ii,iii,iv,v)
Justification: *Tympanocryptis osbornei* is restricted to native tussock grasslands of the Monaro high plains in NSW.
Extent of occurrence (EOO) for all known records of the species was estimated to be 1258 km^2, based on a minimum convex polygon enclosing all known mapped occurrences of the species, the method of assessment recommended by IUCN (2019). A species with an EOO of less than 5 000 km^2 qualifies under the Endangered threshold.
AOO - The area of occupancy (AOO) for all records was estimated to be 124 km^2, based on 2 x 2 km grid cells, the scale recommended for assessing area of occupancy by IUCN (2019). A species with an AOO of less than 500 km^2 qualifies under the Endangered threshold.

Tympanocryptis osbornei meets the Endangered category for Criterion B1 and B2. In addition to these thresholds, at least two of three other conditions must be met. These conditions are:

a) The population or habitat is observed or inferred to be severely fragmented or there is 1 (CR), ≤5 (EN) or ≤10 (VU) locations.

   Assessment Outcome: Endangered (≤5 locations).

   Genetic studies (Carlson *et al*. 2016) found low levels of genetic structure in *T. osbornei* populations which are connected by tracts of contiguous natural temperate grassland and have few barriers such as significant rivers and roads. Thus, the species is not considered to be severely fragmented.

There are three threat-defined locations with the main threat being habitat loss and degradation as a result of agricultural development and related activities. Locations are based on land use i.e. primary production (which covers over 90% of the species EEO), TSRs and reserves managed for conservation. Each location is subject to the different development pressures, regulatory regimes and planning authority.

Justification: The species occurs in three locations based on the threat posed to all populations on private land by the continued threat of habitat loss and degradation associated with agricultural development.

b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals

Assessment Outcome: Continuing decline in i,ii,iii,iv,v.

Justification: There is a continuing decline based on the ongoing threats of habitat loss and degradation as a result of pastoral and agricultural development, changed fire regimes, weed invasion, predation by native and introduced species, and climate change.

c) Extreme fluctuations.

Assessment Outcome: Data Deficient

Justification: There are no available data to suggest that extreme fluctuations occur in population size or geographic distribution of *Tympanocryptis osbornei.*

Criterion C Small population size and decline

Assessment Outcome: Data Deficient
Justification: There have been no comprehensive surveys for *Tympanocryptis osbornei* due the low detectability of the species and issues with access to private land, making it difficult to accurately estimate population size. Therefore, there is insufficient information to assess this species under Criterion C.

At least one of two additional conditions must be met. These are:

C1. An observed, estimated or projected continuing decline of at least: 25% in 3 years or 1 generation (whichever is longer) (CE); 20% in 5 years or 2 generations (whichever is longer) (EN); or 10% in 10 years or 3 generations (whichever is longer) (VU).

Assessment Outcome: Data Deficient

Justification: There are no data on population declines over any relevant time frames to determine whether or not there is a continuing decline in population size.

C2. An observed, estimated, projected or inferred continuing decline in number of mature individuals.

Assessment Outcome: Data Deficient

Justification: There is no information for this species for which to determine whether or not there is a measurable continuing decline in population size.

In addition, at least 1 of the following 3 conditions:

a (i). Number of mature individuals in each subpopulation ≤50 (CR); ≤250 (EN) or ≤1000 (VU).

Assessment Outcome: Data Deficient

Justification: There are no available census data to assess number of mature adults per subpopulation of the species.

a (ii). % of mature individuals in one subpopulation is 90-100% (CR); 95-100% (EN) or 100% (VU)

Assessment Outcome: Data Deficient

Justification: The percentage of mature adults per subpopulation is unknown. There are insufficient data to assess the species against this subcriterion.

b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: Data Deficient

Justification: There is no available data to suggest that extreme fluctuations occur in population size or geographic distribution of *Tympanocryptis osbornei.*

Criterion D Very small or restricted population

Assessment Outcome: Vulnerable under Criterion D2
Justification: Although currently there are no available census data to assess the population size of *Tympanocryptis osbornei*, the species has only three threat-defined locations.

To be listed as Vulnerable under D, a species must meet at least one of the two following conditions:

D1. Population size estimated to number fewer than 1,000 mature individuals

Assessment Outcome: Data Deficient

Justification: There have been no comprehensive surveys for *Tympanocryptis osbornei* due to private land access issues and difficulties with survey and detection methods, making it difficult to accurately estimate population. Currently there are no available census data to assess the population size of *Tympanocryptis osbornei*. Therefore, there is insufficient information to assess this species under this subcriterion.

D2. Restricted area of occupancy (typically <20 km^2) or number of locations (typically <5) with a plausible future threat that could drive the taxon to CR or EX in a very short time.

Assessment Outcome: Vulnerable

Justification: There is estimated to be only three locations, (with habitat loss and degradation associated with agricultural development and related activities being the main threat), with a plausible future threat that could drive the taxon to critically endangered or extinct in a very short time. Therefore, the species meets the conditions for listing under this criterion.

Criterion E Quantitative Analysis

Assessment Outcome: Data Deficient
Justification: As there are no quantitative data available, there is insufficient information to determine eligibility for listing *Tympanocryptis osbornei* in any category under this criterion.

Conservation and Management Actions

As part of the Saving Our Species (SOS) program, the NSW government has a targeted strategy for managing this species. Currently, four management sites have been identified for this threatened species on the Monaro including at Sherwin's Range, Cooma, the Brothers and Dry Plain. Activities underway include further surveys and monitoring of populations.

The NSW South East Local Land Services is also providing funding to secure several sites where landholders have been engaged in vegetation management across 50 ha with fencing and monitoring involved.

The NSW Biodiversity Conservation Trust is also actively working with landholders in managing native grasslands throughout the Monaro.

Habitat loss, disturbance and modification

- Maintain native grassland habitat across the full area of occupancy to maximise the opportunities for habitat resilience and drought refuge under climate change impacts.
- Ongoing weed surveillance and control targeting outbreaks of *Nassella trichotoma* (Serrated Tussock), and *Eragrotis curvula* (African lovegrass) where they occur as small or isolated occurrences in native grassland.
- Monitor for evidence of overgrazing and/or disturbance such as trampling due to stock access.
- Reduce pest species densities and maintain at low levels - Use a detector dog to determine whether feral cats occur in known sites and identify areas where targeted control could be implemented. Undertake cat control program in and around the Cooma tip site.

Survey and Monitoring priorities

- Continued monitoring across the landscape to track population trends to avoid sharp decline and prevent disappearance of this species (which has been the case for other threatened *Tympanocryptis* species in south east Australia).

- Continued surveys in known sites and areas of similar habitat with the aim of discovering more occupied sites to help understand and secure appropriate conservation management.
- Determine current occupancy at all known sites and assess recruitment (juveniles) by checking spider tube transects. Determine vegetation condition and structure using the grassland fauna habitat assessment method. Collect habitat data every 3 years during Autumn (March-May).

Information and Research priorities:

- Improved and ongoing engagement with private landholders with the aim of entering into incentive-based grassland management agreements.
- Improved collaboration with Local Land Services NSW who provide on ground and front-line support to farmers on land management and responsible for weed management advice.
- Development and implementation of an education strategy aimed at increasing uptake of grazing regimes that maintain habitat for the species and which are compatible with the productivity needs of landholders. Provide incentives for landholders to ensure habitat for the species is appropriately maintained or enhanced into the future. Incentives should be directed to managing grazing, weeds, prevent pasture improvement and rock removal or disturbance.

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Appendix 1
Assessment against Biodiversity Conservation Act criteria
The Clauses used for assessment are listed below for reference.

Assessment of *Tympanocryptis osbornei* against BC Act criteria

Overall Assessment Outcome: Endangered under Clause 4.3 (b) (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: Endangered under Clause 4.3 (b) (d) (e ii, iii, iv).
[Equivalent to IUCN Criterion B Endangered 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 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: 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 stochastic events within a very short time period.