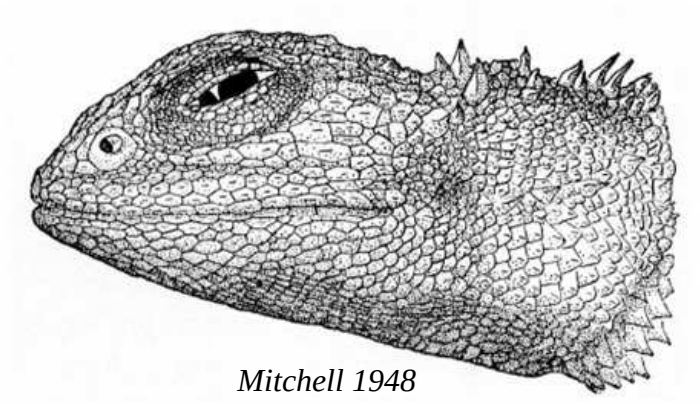
The conservation and ecology of a rare and declining agamid lizard, the grassland earless dragon *Tympanocryptis pinguicolla* in the Monaro region of New South Wales, Australia.



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Abstract

The conservation of the world's biodiversity is a challenge of paramount importance as the world changes rapidly and global land use intensifies. Today, nearly 20% of reptile species across the globe are threatened with extinction yet knowledge of diversity in this group remains poor. The problem is most critical in the world's expanding agricultural environments where there have been extensive declines and localised extinctions of reptiles. The Monaro region of south eastern NSW in Australia is a prominent agricultural region where livestock grazing has occurred for some 180 years, largely replacing natural grassland modification processes that included wildfire, kangaroo grazing and burning by indigenous people. Much of the vertebrate fauna that once occupied this region (e.g. emus, bandicoots, rat kangaroos, wallabies and bustards) has disappeared since European settlement. Yet reptiles remain a significant component of the vertebrate fauna in this region.

The grassland earless dragon *Tympanocryptis pinguicolla* is one such species. This cryptic lizard is one of Australia's rarest and most endangered reptiles having declined and contracted in range dramatically. The rediscovery of this species in the Monaro region in 1993 was followed by limited surveys that suggested a relatively broad but undefined distribution within the region. Despite this, little was known about the species habitat preferences, making difficult informed decisions about its conservation management. This was concerning given the region is subject to agricultural intensification, changes to vegetation clearing laws, increasing renewable energy developments such as wind turbines and the potential sale of Travelling Stock Reserves.

In this thesis, I report on three key aspects of the ecology of *T.pinguicolla*: (1) the effectiveness of detection techniques, (2) the extent of its distribution and habitat requirements, and (3) how land management practices in the region may affect the lizard. To address these aims, I employed a targeted, landscape wide, probabilistic sampling program which accounted for *T. pinguicolla* rarity through statistical inference. Specifically, I conducted repeated presence/absence winter rock turning surveys at 67 sites over four years and used a robust binomial mixture model in WINBUGS and logistic regression modelling using R to estimate occupancy and detectability and the landscape and microhabitat variables that drive its presence. I determined that *T. pinguicolla* has a very low detectability (0.0098) and an occupancy estimate of 0.46 suggesting the species was likely to have been missed at

some sites during survey. It is therefore likely that the lizards are more widespread across the Monaro region than previously thought. I also found that the lizard's occupancy is likely to be greatest at higher elevations in native grasslands not dominated by *Themeda triandra* on private lands, on both basalt and sedimentary geology between the Murrumbidgee and MacLauchlan river systems. Occupancy was not influenced by Travelling Stock Reserves or Nature Reserve indicating private grazing lands make up most of the species area of occupancy.

By considering survey effort and the level of confidence in the estimate of detectability I assessed detection at 60 sites. This analysis revealed that about 2400 rocks need to be turned at an occupied site to have a 90% chance of detecting *T. pinguicolla*. The number of rocks increased to 5400 to raise confidence to 99%. My survey effort was sufficient to infer absence with high confidence at some sites highlighting serious concern for the species at numerous sites around Cooma in particular the Kuma Nature Reserve; the only grassland reserve for this lizard in the Monaro region. Overall, my analysis confirms the low effectiveness and likely destructive nature of rock turning as a survey technique for this lizard and other threatened rupicoline reptiles, suggesting the need for alternative survey approaches.

I also compared remote activated cameras at one site in the Monaro region with rock turning. The cameras provided clear and easily identifiable photos and video recordings of the lizard while rock turning failed to detect the species. This preliminary trial indicates that camera traps are likely to offer an effective less invasive and less labour intensive alternative approach to the detection and monitoring of *T. pinguicolla*. Despite the species extremely low level of detection, my surveys resulted in the discovery of new locations for *T. pinguicolla* on private properties and Travelling Stock Reserves, extending our understanding of the species range and habitats.

Analysis of habitat data collected at sites using logistic regression modelling confirmed that Lycosid spider burrows associated with partially embedded surface rocks of any size are of critical importance to *T. pinguicolla*. This is because these burrows provide shelter sites for overwintering, refuge from trampling by livestock and predation and as locations where eggs can be laid. *T. pinguicolla* showed a clear preference for overwintering sites where there were no other burrows in the immediate vicinity. Surprisingly, the number of medium or large rocks showed no relationship with the occurrence of the lizards. Individuals were found

overwintering beneath rocks of different sizes including small rocks and large boulders. The analysis revealed that high densities of small rocks in moderate height grasslands (200-300 mm average tussock height), particularly those dominated by *Poa sieberiana* and *Austrostipa spp* were good predictor's of *T. pinguicolla* habitat. Where this habitat occurred in close proximity to landscape and habitat structural changes such as rock outcrops this improved the likelihood of it being habitat for the lizard.

Modelling for both occupancy and paddock scale habitat preferences revealed a negative influence of *Themeda triandra* dominated grasslands on *T. pinguicolla* occupancy. I identified that occupancy is improved in *T. triandra* dominated sites with abundant small rocks that have a moderate to high density of mature tussocks and which are in close proximity to landscape and habitat structural features such as rock outcrops. I discovered that landform and aspect were not good predictors of *T. pinguicolla* habitat with surveys confirming *T. pinguicolla* inhabited the full spectrum of landforms and aspects available in the Monaro region including native grasslands with a dominant exotic herbaceous understory. These habitat findings are most important given the current protection criteria of natural grasslands and proposed changes to vegetation clearing laws in the Monaro region.

This research has provided the first ever comprehensive review and investigation into the ecology and conservation of *T.pinguicolla* in the Monaro region of NSW providing a baseline for future research and conservation action. It provides an improved understanding of this species' ecology and conservation needs and addressed several priority recovery actions identified in the National Recovery Plan for the species. A key message from this research is that managed grazing regimes in natural temperate grasslands are likely to be compatible with the conservation of *T. pinguicolla* in the Monaro region. Such managed grazing practices that exclude overgrazing are best placed to mimic pre European settlement modification processes. By contrast the overwintering and microhabitat preferences of this lizard indicate pasture improvement through ploughing, application of fertiliser and removal of rocks are not compatible with the conservation of this species.

Additional efforts in conservation are required for this nationally critically endangered lizard and must involve further surveys across the region, prompt investigation into suspected declines in parts of its range and exploration into spatial and temporal land use and its role in driving occupancy. This will require improved collaboration and relationships with private landholders in the Monaro region and an adaptive plan that has the objective of monitoring,

protecting and managing lizard populations on private lands and ultimately entering into conservation agreements with private landholders. Where feasible it may also involve addition to the reserve network.

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