

NSW Threatened Species Scientific Committee

Conservation Assessment of mukarrhippi grasswren *Amytornis striatus striatus* Gould, 1840 (Maluridae)

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Mukarrhippi grasswren *Amytornis striatus striatus* Gould, 1840 (Maluridae)

Distribution: Endemic to NSW

Current *EPBC* Act Status: Not listed

Current NSW *BC* Act Status: Striated grasswren *Amytornis striatus*, Vulnerable.

Australian Plan for Australian Birds 2020: Critically Endangered (Todd *et al.* 2021)

Proposed listing on NSW *BC* Act and *EPBC* Act: Critically Endangered (B1ab (i.ii.iii.iv.v), B2ab (i.ii.iii.iv.v), C1, C2a(i) and D)

Conservation Advice: mukarrhippi grasswren *Amytornis striatus striatus*

Summary of Conservation Assessment

The mukarrhippi grasswren *Amytornis striatus striatus* Gould, 1840 was assessed by Todd *et al.* (2021, in Garnett and Baker 2021) as Critically Endangered and this assessment supports the findings of Todd *et al.* (2021).

The main reasons for this sub-species being eligible are: the total population is very likely to be <50 mature individuals, undergoing a continuing decline (based on ongoing threats of wildfire, habitat deterioration and fragmentation), and consists of 2 threat-based locations containing up to 4 subpopulations.

Description and Taxonomy

The striated grasswren, of which the mukarrhippi grasswren is a subspecies, is a medium sized grasswren, similar in appearance to the related fairy-wrens (*Malurus* spp.), though significantly larger in size (14.5–19 cm; 15–23 g) (Rowley *et al.* 2020; DPIE 2021a). It has a relatively slender bill, long tail, which is held cocked and is blackish-brown in colour (Rowley *et al.* 2020). The upperparts are a soft reddish-brown, with white streaks while the underparts are buff with heavy white streaking on the breast. The eyebrow is rufous-brown and a heavy black whisker-streak is present. The throat is white, the bill blackish or grey and legs grey. The sexes differ slightly in plumage with the female having pale chestnut flanks. The mukarrhippi grasswren (Central NSW) and the sub-species that is closest geographically, Murray Mallee striated grasswren *A. striatus howei*, are similar in appearance but the white dorsal feather striations are narrower in the mukarrhippi grasswren (Black *et al.* 2020b) and the sub-species are allopatric (geographically distinct).

The taxonomy of the striated grasswren complex is complicated and remains unresolved (Black *et al.* 2020b). Despite these complications there is strong evidence that *Amytornis striatus* is monophyletic, and there is strong support for the subclade formed by the mukarrhippi grasswren (Black *et al.* 2020b). Additionally, the mukarrhippi grasswren is widely geographically disjunct (Black *et al.* 2020b). A recent comprehensive review of Australian birds reviewed this sub-species (Garnett and Baker 2021; Verdon *et al.* 2021), adopting the taxonomy of Black *et al.* (2020b). For

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these reasons it is considered appropriate to assess the mukarrhippi grasswren as a sub-species.

Seven sub-species of striated grasswrens are currently recognised (Black *et al.* 2020b; Garnett and Baker 2021). Black *et al.* (2020b) separated the allopatric central New South Wales populations of *A. striatus striatus sensu lato* sub-specifically, resulting in the mukarrhippi grasswren *A. striatus striatus sensu stricto* (Gould 1840) in central NSW (type-locality Liverpool Plains at the eastern extremity of records in NSW) and the Murray Mallee striated grasswren *A. striatus howei* (Mathews 1911) (type-locality Kow Plains in the Victorian Murray Mallee). These two sub-species were reviewed in the 2020 Action Plan for Australian Birds (Garnett and Baker 2021) with the mukarrhippi grasswren, the focus of this review, being found to be Critically Endangered (Todd *et al.* 2021) and the Murray Mallee striated grasswren, Endangered (Verdon *et al.* 2021). Additionally, some sub-species previously contained within the striated grasswren have now been included by Black *et al.* (2020a) in the rufous grasswren *Amytornis whitei* complex. These sub-species are *A. whitei oweni* and an undescribed (or uncertain) sub-species.

Recent taxonomic changes, particularly the understanding of the distribution of sub-species, has had significant implications on the conservation status of this taxa as the mukarrhippi grasswren is more threatened than the striated grasswren (*sensu lato*) or the other striated grasswren sub-species (Black *et al.* 2020b; Garnett and Baker 2021). Some grasswren (*Amytornis*) sub-species have narrow fragmented distributions, while others exhibit ecophenotypic clinal variation in plumage patterns (Christidis *et al.* 2010; 2013), and genetic techniques have been required to separate morphologically similar sub-species and better understand these geographic patterns.

The NSW population of striated grasswrens was identified as being of conservation concern (Vulnerable) at the inception of the *NSW Threatened Species Act* 1999 (Lunney *et al.* 1997), although this listing included both what is now considered mukarrhippi grasswren and Murray Mallee striated grasswren and as such the existing listing of striated grasswren on the *NSW Biodiversity Conservation Act* 2016 requires revision. Striated grasswren is listed as Rare on the South Australian *National Parks and Wildlife Act* 1972 as *A. striatus*, however, the revised taxonomy of Black *et al.* (2020b) and the findings of Todd *et al.* (2021) and Verdon *et al.* (2021) have implications on this listing and it requires revision.

Distribution and Abundance

Distribution

The mukarrhippi grasswren is endemic to NSW. Todd *et al.* (2021) state that “mukarrhippi grasswrens occur only in central New South Wales. They are known to persist with certainty only on a single 30 ha sandhill on the western side of Yathong Nature Reserve and have not been found elsewhere in the reserve despite searching. They may persist 60 km to the north at two sites, separated by 11 km, on the border of the Paddington and Hampton stations, but were last seen there in 2012 (M Todd, G Chapman unpublished). Historically, there are specimens from the Liverpool Plains (type locality), Namoi Valley, Coronga Peak and 'the Mossgiel district', and sight records from Coonamble in 1905 and Cobar in 1974 (McAllan 1987, Black *et al.* 2014). The 'Mossgiel' population was rediscovered at Taringo Downs north of Yathong in

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1973 (Izzard *et al.* 1973; Miller 1973) and in Yathong Nature Reserve in 1975 (J Brickhill unpublished). However, the last record within the 60 km gap between recent records was in 2002 (M Todd unpublished).”

Todd *et al.* (2021) estimate that there are at minimum one population and at a maximum four, with a best estimate of two (all contained in NSW). The number of threat-based locations are 1–2, as Todd *et al.* (2021) state that two fire events could lead to the extinction of this sub-species, which indicate 2 locations are likely, however one of these areas lacks recent (after 2012) records of presence. Additionally, drought increases the likelihood of large fire events and it is plausible that within a single drought event all sites could burn.

There is limited information available on the mukarrhippi grasswren, however available evidence indicates a restricted distribution, which suggests a need for specific habitats which are uncommon and limited further by habitat degradation, fire and grazing regimes. Furthermore, closely related taxa (Murray Mallee striated grasswren) are in rapid decline (Dooley 2019; Verdon *et al.* 2021) and face similar threats. It is likely that the mukarrhippi grasswren was geographically restricted historically and that recent threats have led to decline.

Many grasswrens have, as a result of historic land degradation, suffered large reductions in their geographic ranges, with some sub-species extinct (e.g. *Amytornis striatus parvus* possibly extinct, *Amytornis textilis carteri*, *Amytornis textilis giganturus*, *Amytornis textilis macrourus*, *Amytornis modestus modestus*) and most others threatened at the sub-species level (Garnett and Baker 2021). Grasswrens are poor flyers, with limited dispersal capability and specific habitat requirements, and are as such highly susceptible to population fragmentation (Karubian 2001; Garnett and Crowley 2000; Higgins *et al.* 2001; Black 2016). The limited information available for mukarrhippi grasswren (Black *et al.* 2020b) fits the pattern seen in other threatened grasswren species, which are of high conservation concern due to fragmented or isolated small populations.

Abundance

Todd *et al.* (2021) state that “the total known population is possibly <20 mature individuals”, which is an order of magnitude lower than the IUCN (2019) Redlist requirement for Critically Endangered under clause C1. Todd *et al.* (2021) state that “One mukarrhippi grasswren pair has been recorded regularly on the sandhill site at Yathong Nature Reserve since 2010, and two pairs were found on one occasion (D Egan unpublished). There were known to be two pairs at one of the Paddington/Hampton sites in 2012 and a small number at the other site, but their persistence needs confirmation.”

The population may have declined by 50%–80% in the last ten years (generation time 3.0 years) based on the deterioration of habitat (Todd *et al.* 2021) and decline of this magnitude observed in the Murray Mallee striated grasswren (Dooley 2019; Verdon *et al.* 2021),

Ecology

Like many grasswrens, mukarrhippi grasswrens are inferred to be habitat specialists. Todd *et al.* (2021) state that “mukarrhippi grasswrens are thought to be confined to mature spinifex *Triodia* spp. with an overstorey of mallee eucalypts, particularly the *Eucalyptus socialis*–*E. dumosa*–*E. gracilis* community that covers most of the sandplain and dune areas in the central and western parts of the parks (NSW NPWS 1996). Striated grasswrens forage mostly on the ground, eating seeds, fruits, insects and other invertebrates (Higgins *et al.* 2001). Striated grasswrens may recolonise habitat within three years after fires (Carpenter and Matthew 1986) but prefer habitat that has not been burnt for 5–15 years (S Vernon, ML Clarke unpublished). In Yathong Nature Reserve, the habitat last burnt in 1985 and is known to have been occupied since 1998. The Paddington/Hampton sites also last burnt in 1985, and birds were known to be present after 2002 (Cullenward 1989).”

Generation length is estimated at 3 (2.3-3.8) years (Bird *et al.* 2020; Todd *et al.* 2021). Grasswrens are typically found in pairs, are strongly territorial and nest in cryptic nests on the ground (Karubian 2001). The breeding of the mukarrhippi grasswrens has not been studied and the following information is from general accounts of the striated grasswren. Nests are built by the female and are a substantial dome (with a side entrance) of interwoven grasses, bark and spinifex, well-hidden towards the top or edge of a spinifex clump (Rowley *et al.* 2020; DPIE 2021). Breeding has been recorded between Aug–Jan, and also following rainfall (Rowley *et al.* 2020). Breeding territory is approximately 3 hectares and there is some evidence of cooperative breeding (Rowley *et al.* 2020). Clutch size is 2–3 eggs with an incubation of 14 days; chicks are fed by both parents, independent at 4 weeks, but probably stay with the family for a longer period (Rowley *et al.* 2020).

Threats

The threats to the mukarrhippi grasswrens vary by location as populations are known from Yathong Nature Reserve (managed for conservation) and private land (Todd *et al.* 2021). All known populations are very small and at elevated extinction risk from stochastic events (e.g. fire, high predator numbers, drought or heatwaves) and inbreeding depression (Keller and Waller 2002; O’Grady *et al.* 2006; Todd *et al.* 2021). On private land, additional threats including intensive grazing, browsing and trampling of habitat by dorper sheep *Ovis aries* and feral and semi-domesticated goats *Capra hircus* are present (Todd *et al.* 2021).

Populations on all tenures are threatened by fire. Fire could adversely impact an entire sub-population in a single event, in the worst case leading to local extinction (Todd *et al.* 2021). Habitat is fragmented and an entire fragment can burn in a single event (Saddler *et al.* 2019). The IUCN (2019), define a location in this statement “The term ‘location’ defines a geographically or ecologically distinct area in which a single threatening event can rapidly affect all individuals of the taxon present. The size of the location depends on the area covered by the threatening event and may include part of one or many subpopulations”. Under this definition there could be two locations, however if fires are linked to a drought event, it is plausible that all habitat could burn

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in a single drought event, which reduces the number of locations to 1. Drought and heat waves increase fire risk and also impact this sub-species in the absence of fire and all of these phenomena are predicted to increase in severity in the future across all tenures (Evans *et al.* 2017; Herold *et al.* 2018; Eldridge and Beecham 2018; Di Virgilio *et al.* 2019; Dooley 2019; Dowdy *et al.* 2019; Todd *et al.* 2021). Predicted decreased rainfall and reduced ground-storey plant cover (Eldridge and Beecham 2018) are expected to negatively impact this sub-species.

Habitat degradation is likely to occur from grazing by rabbits *Oryctolagus cuniculus* and high densities of kangaroos *Macropus* and *Osphranter* spp., given the sensitivity of the vegetation this sub-species prefers (Giljohann *et al.* 2017; Todd *et al.* 2021; Mills *et al.* 2020). Introduced predators, feral cats *Felis catus* (Woinarski *et al.* 2018) and foxes *Vulpes vulpes* may also limit population size (Todd *et al.* 2021). In the arid and semi-arid parts of Australia densities of these feral predators peak (boom) after large rainfall and breeding events of prey species (e.g. rabbits) (Catling 1988; Pavey *et al.* 2008), indicating possible temporal variability in this threat. Grasswrens nest on or very close to the ground, which makes the nest accessible to a range of predators including cats, foxes, birds and monitors, exposing them to a similar suite of threats (predation, trampling, loss of cover) as small terrestrial mammals, many of which have declined dramatically in the arid zone (Reid and Fleming 1992; Smith *et al.* 1994; Short and Smith 1994; Short 2004).

The threats to this sub-species occur over a wide area, and may impact all habitat fragments simultaneously and reduce the ability to recover from adverse events such as fire (Gergis and Ashcroft 2013; Saddler *et al.* 2019; Mills *et al.* 2020). The failure to detect this sub-species at more than one location in Yathong Nature Reserve (Todd *et al.* 2021) indicates that even in a threat managed landscape abundance remains low and that some threats cannot currently be adequately managed. Given the low dispersal ability of this species a floating population (non-breeding animals that usually persist in sub-optimal habitat) is therefore likely absent or very small which reduces the resilience of known populations to disturbance events (Robles and Ciudad 2017).

'Competition and land degradation by rabbits', 'Competition and land degradation by unmanaged goats', 'Land clearance', 'Predation by European red fox', 'Predation by feral cats', are listed as Key Threatening Processes under the Commonwealth *EPBC Act* 1999.

'Clearing of native vegetation', 'Competition and grazing by the feral European rabbit', 'Competition and habitat degradation by feral goats, *Capra hircus* Linnaeus 1758', 'Ecological consequences of high frequency fires', 'Human-caused Climate Change', 'Predation by feral cats' and 'Predation by the European red fox' are listed as Key Threatening Processes under the NSW *BC Act*.

Assessment against IUCN Red List criteria

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

Criterion A

Population Size reduction

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Assessment Outcome: Endangered under Criterion A2c

Justification: The population may have declined by 50–80% in the last ten years (generation time 3.0 years) based on the deterioration of habitat (Todd *et al.* 2021). Given the small initial population size, there is likely to be significant variability in rates of decline as this is an expert-driven estimate without empirical data. Murray Mallee striated grasswren, based on empirical measurements has declined between 50 and 80% in a ten-year period (Dooley 2019; Verdon *et al.* 2021), and given similarities between these taxa a similar rate of decline is likely to be applicable to this taxon. Todd *et al.* (2021) found that two large fires could kill all remaining birds; one fire could halve the number of subpopulations, leading to irreversible decline. It is plausible that in a single period of high fire risk all populations could be impacted by fire, resulting in extinction in short period of time.

Criterion B *Geographic range*

Assessment Outcome: Critically Endangered under Criterion B1+2ab(i,ii,iii,iv,v)

Justification: The AOO is 4–16 km², with a best estimate of 8 km² (Todd *et al.* 2021), based on 2 x 2 km grid cells, the scale recommended for assessing area of occupancy by IUCN (2019).

The EOO range considered in this assessment is 4–600 km². Todd *et al.* (2021) estimated EOO in the range of 0.02-600 km² with a best estimate of 386 km² based on a minimum convex polygon enclosing all mapped occurrences of the sub-species using the assessment method recommended by IUCN (2019). The minimum EOO was changed to make it equal to AOO to ensure consistency with the definition of AOO following IUCN (2019).

For both AOO and EOO the lower range is the single pair known from Yathong, while the upper range includes all known records and the best estimate is all records since 2012. The best estimate has been used for this clause, and the AOO is <10 km² the basis of the Critically Endangered finding under this clause.

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: Severely fragmented habitat, ≤5 (EN) locations with possibly, under the worst case, only one location (CR)

Justification: The habitat of the sub-species is severely fragmented as a result of habitat deterioration from land clearing and altered vegetation patterns due to the impact of introduced herbivores (Todd *et al.* 2021). All known populations are at immediate risk of extinction in the near future.

Todd *et al.* (2021) estimate there are at minimum one population and maximum four, with a best estimate of two. The number of threat-based locations are ≤5 (EN), however if the minimum number of populations of one is used (e.g. if all known locations burn within a single event) the outcome is Critically Endangered.

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Todd *et al.* (2021) state that two fire events could lead to the extinction of this sub-species, which indicate 2 locations are likely, however one of these areas lacks recent (after 2012) records and an extended drought could lead to population loss in both sites within the same drought event. The best estimate (as determined by Todd *et al.* 2021) of 2 locations has been used.

- 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 grazing, browsing and trampling by feral semi-domesticated and native animals, changed fire regimes and climate change. Populations are small even in threat managed conservation reserves. Todd *et al.* (2021) found past decline and continuing declines are likely to have occurred and continue to occur. Two large fires could kill all remaining birds; one could halve the number of subpopulations.

- c) Extreme fluctuations.

Assessment Outcome: Sub-criterion not met.

Justification: Not subject to extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals (Todd *et al.* 2021)

Criterion C Small population size and decline

Assessment Outcome: Critically Endangered under Criterion C1 and C2a(i)

Justification: Todd *et al.* (2021) found the total population is likely to be between 4 and 20 mature individuals, although reliability is listed as low.

Based on targeted surveys for this sub-species in NSW, the population size is extremely small and very likely (despite uncertainty) to be under the IUCN (2019) thresholds for Critically Endangered under clause C1 (<250 mature individuals, with a continuing decline) and under Clause D (<50 mature individuals).

It is considered unlikely that further survey will increase this estimate by an order of magnitude given the species has been threatened in NSW since 1995 (which increases targeted survey effort; Lunney *et al.* 2018), has been of considerable interest to birdwatchers and any undiscovered population is also likely to have a small number of mature individuals, be in decline and at high risk of local extinction.

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) (CR); 20% in 5 years or 2 generations (whichever is longer) (EN); or 10% in 10 years or 3 generations (whichever is longer) (VU).

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Assessment Outcome: Critically Endangered

Justification: The sub-species is estimated to have declined by 50–80% in the last ten years based on loss and degradation of habitat (Todd *et al.* 2021) and empirical rates of decline in a sister taxon (Dooley 2019; Verdon *et al.* 2021). Given the small initial population size there is likely to be significant variability in rates of decline as this is an expert-driven estimate without empirical data, however the loss of a small number of birds in short period of time (or poor reproductive success) would plausibly lead to a decline exceeding 25% in three years (the generation length of this species). A single future fire event in any of the known populations is likely to lead to potentially irreversible decline in a very short period of time.

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

Assessment Outcome: Continuing decline inferred

Justification: See C1. The sub-species is inferred to have declined by 50%–80% in the last ten years (generation length is three years) (Todd *et al.* 2021). There is a continuing decline based on the ongoing threats of habitat loss and degradation as a result of grazing, browsing and trampling by feral semi-domesticated and native animals, changed fire regimes and climate change (Todd *et al.* 2021).

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: Critically Endangered

Justification: Todd *et al.* (2021) found the maximum population is 20 individuals.

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

Assessment Outcome: Data deficient.

Justification: Todd *et al.* (2021) found the minimum estimate of number of populations is 1, so 100% of the population may be confined to a single sub-population. However, the population size and status of known sub-populations is uncertain.

- b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: Sub-clause not met.

Justification: Todd *et al.* (2021) found no evidence of extreme fluctuations

Criterion D *Very small or restricted population*

Assessment Outcome: Critically Endangered

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Justification: Population size is estimated to likely be < 20 and highly likely <50 mature individuals (Todd *et al.* 2021). Population estimated between 4–20 mature individuals (Todd *et al.* 2021)

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: Vulnerable

Justification: Population estimated between 4–20 mature individuals (Todd *et al.* 2021)

D2. Restricted area of occupancy (typically <20 km²) 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: Number of locations (based on threat of fire) is between one and two; AOO is estimated to be between 4 and 16 km² (Todd *et al.* 2021). The sub-species is considered to be CR under other clauses as a result of ongoing threats including habitat loss and degradation as a result of grazing, browsing and trampling by feral semi-domesticated and native animals, changed fire regimes and climate change. Todd *et al.* (2021) found that two large fires could kill all remaining birds; one fire could halve the number of subpopulations. It is plausible that in a single drought period all populations could be impacted by fire, resulting in extinction.

Criterion E Quantitative Analysis

Assessment Outcome: Data Deficient

Justification: Not applicable: no population viability analysis has been undertaken.

Conservation and Management Actions

Conservation objectives

- All available habitat supports sustainable populations (Todd *et al.* 2021)
- Appropriate fire regime is established, enabling regeneration and sustained *Triodia* habitat as well as reducing the risk of wildfire (Todd *et al.* 2021)
- Grazing pressure from stock is maintained at or below a level at which habitat remains suitable for grasswrens (Todd *et al.* 2021)

Conservation actions under way

- Part of the population is within a protected area (Todd *et al.* 2021)
- There is active management of feral animals in Yathong Nature Reserve (Todd *et al.* 2021; Mills *et al.* 2020)
- Fire management on Yathong Nature Reserve which aims to reduce the extent of unplanned wildfire events (Todd *et al.* 2021)

Research required

- Ascertain the current distribution (Todd *et al.* 2021)

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- Document habitat requirements and the relationship between structural attributes of *Triodia* and fire history (Todd *et al.* 2021)
- Investigate groundcover and stocking rates (considering drought) for the sustainable maintenance of *Triodia* and grasswrens (Todd *et al.* 2021)
- Create a fire management strategy that will maintain the grasswrens and their habitat (Todd *et al.* 2021)
- Investigate feasibility and risks of genetic rescue, captive breeding, translocation or other interventions

Management actions required

- Actively protect all known populations from unplanned wildfire and manage vegetation age at other sites to maintain and enhance potential habitat (Todd *et al.* 2021)

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Experts consulted

Michael Todd
Stephen Garnett

APPENDIX 1

Assessment against *Biodiversity Conservation Regulations 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 4.4 (a) (d) (e i,iiA) and Clause 4.5 (a).

Clause 4.2 – Reduction in population size of species

(Equivalent to IUCN criterion A)

Assessment Outcome: Endangered under Clause 4.2 (b) 2 (c,e)

(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.

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(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)

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.

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

(Equivalent to IUCN criterion C)

Assessment Outcome: Critically Endangered under Clause 4.4 (a) (d) (e i,iiA)

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: Critically Endangered under Clause 4.5 (a)

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.

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**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.
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