

Notice of 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 Atlas Rainforest Ground-beetle *Nurus atlas* (Castelnau, 1867) as a CRITICALLY ENDANGERED SPECIES in Part 1 of Schedule 1 of the Act and, as a consequence, to omit reference to *Nurus atlas* Castelnau in Part 2 of Schedule 1 (Endangered) of the Act. Listing of Critically Endangered species is provided for by Part 4 of the Act.

Summary of Conservation Assessment

Nurus atlas (Castelnau, 1867) was found to be Critically Endangered in accordance with the following provisions in the *Biodiversity Conservation Regulation 2017*: Clause 4.3 (a) (d) (e, i, iii). The main reasons for this species being eligible are i) It has a very highly restricted geographic range (Extent of Occurrence is 88 km²); ii) The population is considered to occur within one threat-defined location based both on the impact of drought, and competition and predation by Cane Toads; iii) There is inferred continuing decline in habitat quality as a consequence of the compounding effects of habitat removal and fragmentation by land clearing, stormwater discharge, more frequent and intense drought and other extreme events from climate change, and the small size of remnants leading to increased ecosystem impacts; and, iv) There is an inferred continuing decline in abundance caused by Cane Toad competition and predation.

The NSW Threatened Species Scientific Committee has found that:

1. *Nurus atlas* (Castelnau, 1867) (family Carabidae) is a large flightless ground beetle. The species is broad-bodied and largely black, with a metallic green or bronze pronotum, although the colour is sometimes subtle and difficult to distinguish. Overall length is 28.5-30.5 mm and greatest width of elytra is 10.8-12.9 mm. It has prominent, straight jaws and a strong bite. Males of *N. atlas* can be distinguished from all other *Nurus* species by the presence of squamose setae pads ventrally on protarsomeres one and two, and not on three (Will & Monteith 2018).
2. Currently, *Nurus atlas* is only known from 12 small, fragmented rainforest patches on the Alstonville Plateau in northeast NSW, which has increased from five following targeted surveys conducted from 2018 onward (Charley & Andren 2018). *N. atlas* occurs in small patches of mature lowland subtropical rainforest on red krasnozem soils, within a 10 km radius of Alstonville. They are surrounded by a matrix of agriculture and urban development (Charley & Andren 2018). The species habitat, Lowland Rainforest of the NSW North Coast and Sydney Basin Bioregions, is listed as an Endangered ecological community under the NSW *Biodiversity Conservation Act 2016*.

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3. *Nurus atlas* has an 88 km² Extent of Occurrence (EOO), calculated as a minimal convex polygon containing all known occurrences, the method of assessment recommended by IUCN (2022). The Area of Occupancy (AOO) is estimated to be 48 km² based on 2 x 2 km grid cells, the scale recommended for assessing Area of Occupancy by IUCN (2022).
4. The *Nurus atlas* population is estimated to contain approximately 6,300-12,600 mature individuals, based on burrow counts and density data collected in each sampled occupied remnant (Charley & Andren 2018; Lloyd 2021).
5. *Nurus* beetles use their mandibles to construct a fixed, deep burrow with a distinctive, cleared entrance stage where they ambush prey. Burrows are built under rocks, logs, and tree roots, and are generally absent from areas where there is deep or complete cover of leaf litter (Charley & Andren 2018). The two sexes live separately and only one individual occupies a burrow, which is used throughout its life. *Nurus* beetles are nocturnal and are presumed to spend the day in the terminal chamber (G. Monteith pers. comm. January 2022).
6. *Nurus atlas* is a flightless ground-beetle. Both sexes remain in their burrows for much of the year. During pitfall surveys, most *N. atlas* are caught in summer and many more males than females are detected. Males are particularly active outside of their burrows on warm, wet nights. Likewise, newly emerged adults (i.e., with soft cuticle) of both sexes are taken in pitfall traps. These are assumed to be seeking burrow sites (G. Monteith pers. comm. January 2022.). Individuals rarely disperse more than a few hundred metres, as seen in other flightless carabids (Den Boer 1990). All extant populations are in small rainforest remnants separated by extensive areas of unsuitable habitat (drier forests, exotic pasture, roads etc.) and it is highly unlikely that there is any connectivity between extant populations (D. Charley pers. comm. December 2021).
7. *Nurus atlas* is predatory and feeds on leaf litter invertebrates (M. Andren pers. comm. December 2021). *Nurus* beetles typically only become active at their burrow entrances at night, where they wait for small passing prey. *N. atlas* does not hunt in the wider landscape (Lloyd 2021). The remains of large millipedes have been observed at the entrances of burrows (Charley & Andren 2018) and form a major part of the diet, likely because they are slow moving (G. Monteith pers. comm. January 2022).
8. Adult lifespan is likely to be between two and four years (G. Monteith pers. comm. January 2022), and the generation length is one year, as is seen in other carabid species (Lawrence & Slipinski 2013). *Nurus atlas* has an extraordinarily low reproductive output for an insect. Females lay a maximum of 10 large eggs (5-6 mm long) in the summer/wet season (G. Monteith pers. comm. January 2022). The eggs hatch within a few weeks, producing five to 10 larvae that are approximately half the length of a female. The larval period is unknown but is likely to be between three and six months. It is assumed that larvae pupate in April – May and overwinter as pupae. The pupal period ends at the start of summer/the wet season when soil is soft, enabling newly emerged adults to dig their burrows (G. Monteith pers. comm. January 2022).

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9. Historically, 98% of the Alstonville Plateau has been cleared for intensive agriculture and residential development (Frith 1977) resulting in the species' present restricted and fragmented distribution, with the 12 known patches being fragments of a formerly continuous rainforest patch. Predatory beetles, such as *Nurus*, decline most severely in fragmentation of forest (Davies *et al.* 2000). The current main threats to *N. atlas* are habitat removal and fragmentation by land clearing, Cane Toad competition and predation, more frequent and intense drought, and other extreme events from climate change, stormwater discharge into remnants, and the small size and fragmentation and isolation of remnants leading to increased ecosystem impacts. The most serious plausible threats are considered to be climate-change induced drought, and competition and predation by Cane Toads, which are likely to affect all populations simultaneously as they all occur in small remnants in a restricted geographical area. As such, the species is considered to occur in a single threat-defined location. 'Invasion and establishment of the Cane Toad (*Bufo marinus*)', 'Clearing of native vegetation' and 'Anthropogenic climate change' are listed as Key Threatening Processes under the Act.
10. The introduced Cane Toad (*Rhinella marina*) is known to be present in rainforest remnants occupied by *Nurus atlas* and is considered a major threat. Cane Toads are likely to compete with the species for food resources, as well as directly reducing *N. atlas* subpopulations through predation. *Nurus atlas* is particularly vulnerable to predation by toads during two critical periods: 1) when adult males emerge on warm wet nights; and 2) after pupa hatch and young adults have not yet dug their first burrow (Charley & Andren 2018). *Nurus atlas* is long-lived and has a low reproductive rate for an invertebrate, so predation of adult beetles by Cane Toads will reduce the population over time (G. Monteith pers. comm. January 2022).
11. *Nurus atlas* is sensitive to dry conditions and becomes more difficult to find during periods of drought (M. Andren pers. comm. December 2021). Droughts are predicted to become more frequent and intense under climate change in northern NSW (Herold *et al.* 2018). Species occupying small, fragmented habitat patches, such as *N. atlas*, are particularly threatened by drought (Oliver *et al.* 2013).
12. There are stormwater discharge issues in some remnants, reducing the area of suitable habitat and increasing the threat of inundation (Charley & Andren 2018).
13. Ninety-eight percent of the Alstonville Plateau has been cleared for intensive agriculture and residential development (Frith 1977). As a result of land clearing, *Nurus atlas* is only known from 12 small, fragmented rainforest patches (1.4 – 15.5 ha). Fragmentation and small remnant size can lead to high population densities of competing native and introduced species and exacerbate the negative impact of climate events such as drought (Oliver & Morecroft 2014).
14. Increased evaporation and drier winter conditions from climate change are predicted in northern NSW (DECCW 2010) which may cause fires in the rainforest habitat remnants of *N. atlas*. Climate change is predicted to cause extreme storms and localised flooding that may impact *N. atlas*.

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15. *Nurus atlas* (Castelnau, 1867) is eligible to be listed as a Critically Endangered species as, in the opinion of the NSW Threatened Species Scientific Committee, it is facing an extremely 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:

Nurus atlas was found to be Critically Endangered under Clause 4.3 (a)(d)(e, i, iii).

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, i, iii)

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:			

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	(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,

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		(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: Not met

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

**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: Not met

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

Supporting Documentation:

Collett, R. (2022) Conservation Assessment of *Nurus atlas* Castelnau, 1867 (Carabidae). NSW Threatened Species Scientific Committee.

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References:

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