Conservation Assessment of the Atlas Rainforest Ground-beetle *Nurus atlas* (Castelnau, 1867) (Carabidae)

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Atlas Rainforest Ground-beetle *Nurus atlas* (Castelnau, 1867) (Carabidae)

Distribution: Endemic to rainforest habitat on the Alstonville Plateau in northeast New South Wales (NSW)
Current EPBC Act Status: Not listed
Current NSW BC Act Status: Endangered

Proposed listing on NSW BC Act: Critically Endangered

Reason for change: Genuine change based on new information on the threats to the species

Summary of Conservation Assessment

The Atlas Rainforest Ground-beetle, *Nurus atlas*, was found to be eligible for listing as Critically Endangered under Criterion B1ab (iii, v).

The main reasons for this species being eligible are i) it has a very highly restricted geographic range (EOO = 88 km^2; AOO = 48 km^2); ii) there is one location; iii) there is inferred continuing decline in the number of mature individuals from competition and predation from Cane Toads *Rhinella marina*, and in the quality of habitat caused by the combined impact of the small size, fragmentation and isolation of remnants of habitat, stormwater discharge, and more frequent and intense drought and extreme events from climate change.

Description and Taxonomy

Nurus atlas (Castelnau, 1867) is a large flightless ground beetle from the family Carabidae. 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 the 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). No larval descriptions are available.

There are eight *Nurus* species and phylogenetic analyses show three clades. *Nurus atlas* is grouped with *Nurus perater,* and the two species ranges are separated by the deep valley of the Wilson River. Except for *Nurus moorei* and *N. perater*, the currently known distributions of *Nurus* species are mutually exclusive (Will & Monteith 2018).

Distribution and Abundance

Historically, *Nurus atlas* is thought to have had an extensive distribution throughout the Big Scrub rainforest on the north coast of NSW. There are many collection records of *N. atlas* in this region from the 19th and early 20th centuries. Following extensive clearing of the Big Scrub, *N. atlas* was considered extinct until 1973 when the species was re-discovered by G. Monteith in Victoria Park, near Lismore (G. Monteith pers. comm. in NSW TSSC 2001).

Currently, *Nurus atlas* is known only from 12 small, isolated, mature rainforest patches on the Alstonville Plateau in northeast NSW, an increase from five following targeted surveys conducted in 2017 and 2018 (Charley & Andren 2018). These are considered subpopulations, as they are geographically distinct groups between which there is little demographic or genetic exchange (IUCN 2022). Subpopulations of *N. atlas* occur in small patches of mature lowland subtropical rainforest on red krasnozem soils, within a 10 km radius of Alstonville. A lack of genetic diversity between subpopulations supports the idea that these fragments are of recent origin (Will and Monteith 2018). The remnant rainforest patches are surrounded by a matrix of agriculture and urban development (Charley & Andren 2018). There are 33 remaining mature rainforest remnants on the Alstonville Plateau (Parkes *et al*. 2012) and the total area of rainforest is only 7 km^2. The area of potential habitat is less than the area of remaining rainforest, because not all remnants provide suitable habitat. For example, *N. atlas* does not occur in areas with extensive past disturbance, occasional flood inundation, or rocky and steep topography. It appears unlikely that many additional subpopulations will be found (D. Charley pers. comm. December 2021). 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*. Lowland Rainforest of Subtropical Australia is also listed as a Critically Endangered ecological community under the federal *Environment Protection and Biodiversity Conservation Act 1999*.

Nurus atlas has an 88 km^2 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 km^2 based on 2 x 2 km grid cells, the scale recommended for assessing Area of Occupancy by IUCN (2022).

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 occupied remnant (Charley & Andren 2018; Lloyd 2021). Recording burrows is a highly accurate survey method for calculating *Nurus* population density. Each burrow is inhabited by one individual, and the beetles actively remove items that fall on their cleared hunting arenas. Burrows rapidly become covered with leaf litter and disappear

from the landscape when they are unoccupied (G. Monteith pers. comm. January 2022).

In 2018, Charley and Andren surveyed 17 remnants (of 33 remnants that were identified as the most likely habitat for *N. atlas*). Where possible, the whole remnant or area of suitable habitat was surveyed and they recorded the number of *N. atlas* burrows in each area of rainforest. In other instances, only a portion of the remnant was searched, and in these cases, density was multiplied by the area of suitable habitat to determine the size of the subpopulation. Burrows were recorded at 10 of the 17 sites, which included seven new localities. The number of mature individuals in these 10 remnants is estimated to be 6,300 (D. Charley pers. comm. December 2021). If the population size in the 16 most likely habitat remnants that were not surveyed is similar to the 17 remnants that were surveyed, then the estimated population could be as large as 12,600. Following these surveys, D. Charley discovered an 11th subpopulation at Duck Creek, which is estimated to contain around 5 individuals, with a maximum of 20 (David Charley pers. comm. December 2021). A further subpopulation (#12) was found at Meridian Drive, during pre-construction surveys for the Woolgoolga to Ballina Pacific Highway upgrade. This subpopulation is similarly small, with three burrows recorded at monitoring plots in 2020/2021 (Lloyd 2021), and the species is sparsely distributed across the total area of suitable habitat, with an estimated minimum of 10 individuals at this site (P. Lloyd pers. comm. March 2022).

Detailed knowledge of the species' distribution and population size has been scarce until recent work, and there is limited quantitative data documenting the *Nurus atlas* population trend. However, extensive historical clearing of the Alstonville Plateau has resulted in loss of 98% of the species' habitat (Frith 1977). More recently, regular surveys of Lumley Park in Alstonville have shown that this subpopulation has been extirpated, and this may have occurred as early as the 1980s (Charley & Andren 2018). There is no data on the historical size of this subpopulation, but G. Monteith (pers. comm. January 2022) described many burrows occurring in Lumley Park in the 1970s. Other subpopulations are likely to have been lost without knowledge of their existence. *Nurus atlas* is absent from many rainforest remnants that appear to be suitable habitat, and it is not clear whether these subpopulations have been extirpated or whether the remnants were never occupied (G. Monteith pers. comm. January 2022).

Ecology

All species of *Nurus* are thought to have highly similar ecology and life history (G. Monteith pers. comm. January 2022), but little has been published on the genus. Sections of the following information are based on personal communication with G. Monteith (January 2022), who has spent many years researching and observing *Nurus* beetles, including *Nurus atlas*. Some of this information is inferred based on

knowledge of other aspects of *Nurus* life history, and comparison with similar ground-dwelling carabid species.

Burrows

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 burrow slopes gently into the soil at a shallow gradient and broadly spirals down to a terminal chamber. Total burrow length is approximately 20-40 cm, and the entrance is 3-5 cm wide and 2 cm high. 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).

Dispersal

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 subpopulations 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 subpopulations (D. Charley pers. comm. December 2021).

Diet

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. Any invertebrate that walks across the cleared hunting arena is potential prey, which *Nurus* beetles kill and consume using their long mandibles. Once killed, bits of the prey item are dragged back into the burrow (G. Monteith pers. comm. January 2022). *Nurus 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).

Life history

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). Each egg is laid inside an oval mud capsule, which is the same brood care strategy as described for the pterostichine genus *Percus* in Europe (Kavanaugh 1998). The eggs hatch within a few weeks, producing five to 10 larvae that are approximately half the length of a female. The larvae probably remain in the burrow for their first instar and then leave to become free-ranging predators in the leaf litter. Young larvae leave the burrow during the wet season, when they can take advantage of abundant prey. 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 underground 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. There is limited evidence for timing of the life cycle; the version presented here is supported by differences in burrow counts between seasons. In winter, burrow counts are generally low, as mortality has reduced the number of adults surviving in the population. Furthermore, adult mortality is likely to be highest in the winter months. During summer, burrow counts are much higher, as they incorporate the newly emerged adults (G. Monteith pers. comm. January 2022).

Threats

Habitat removal and fragmentation by land clearing

Ninety-eight percent of the Alstonville Plateau has been cleared for intensive agriculture and residential development (Frith 1977). 'Land clearance' is listed as a key threatening process for Lowland Rainforest of Subtropical Australia (Australian Government 2011). As a result of land clearing, *Nurus atlas* is only known from 12 small, fragmented rainforest patches (1.4 – 15.5 ha). Beetle predators, such as *Nurus*, decline most severely in fragmentation of forest (Davies *et al.* 2000).

Fragmentation and small remnant size can lead to high population densities of competing or predatory native and introduced species which might exacerbate the negative impact of climate events such as drought, severe storms and localised flooding (Oliver & Morecroft 2014). For example, there are high Brush Turkey (*Alectura lathami*) and Flying Fox (*Pteropus* spp.) population densities throughout rainforest remnants on the Alstonville Plateau, as a result of past fragmentation and the small size of remnants (Charley & Andren 2018). Brush Turkey densities are considered elevated as a result of increased food availability from urban areas causing a decline in the litter layer across many parts of the forest. A large colony of Flying Foxes in the Dalwood remnant is reducing tree canopy cover which results in drying of the forest floor (Charley & Andren 2018). Fragmentation and small remnant size facilitates invasion and competiton from weeds (Charley & Andren 2018).

More than 50% of known *Nurus atlas* subpopulations occur on private land. Any additional clearing of remnants or land use changes will further reduce available habitat for *N. atlas*. Conversely, there is a high rate of rainforest restoration on the Alstonville Plateau, and 2018 surveys showed that three *N. atlas* subpopulations had spread into adjacent revegetation areas (Charley & Andren 2018). *Nurus atlas* appears to be capable of occupying revegetation areas older than 15-18 years. Ongoing revegetation will continue expanding available *N. atlas* habitat on the Alstonville Plateau (M. Andren pers. comm. December 2021). However, fragmentation still poses a barrier to dispersal and colonisation of new remnants.

Competition and predation by Cane Toads

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* adults have powerful chemical defence in the form of strong-smelling spray from anal glands when disturbed. The common presence of *Nurus* adults in toad guts shows that this is not effective against toad predation (G. Monteith pers. comm. January 2022). *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 may reduce the population over time (G. Monteith pers. comm. January 2022).

While there is no direct evidence of Cane Toad mediated *N. atlas* declines, other *Nurus* species have disappeared from lowland places where they used to be common in Queensland. This has been attributed to predation by Cane Toads, as *Nurus* remained abundant at high elevation sites where Cane Toads were not present (Newell 2011). Cane Toads have since invaded Bulburin and the Border Ranges National Park, and *Nurus* species have been detected in Cane Toad gut content from these locations (G. Monteith pers. comm. January 2022). Similarly, subtropical carabids of the genus *Pamborus* used to occur in extremely high abundance but disappeared from several lowland localities in southern Queensland following the arrival of the Cane Toad (G. Monteith pers. comm. January 2022).

Stormwater discharge

There are stormwater discharge issues at Willowbank and Lumley Park, reducing the area of suitable habitat and increasing the threat of inundation in these remnants. There are few burrows at Willowbank for the size of the remnant (21 burrows in 1.9 ha), and the subpopulation is restricted to a low ridge between two drainage lines. The Lumley Park subpopulation has been extirpated (Charley & Andren 2018).

Frequent and intense drought

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 because: 1) the critical thresholds of habitat availability and quality below which a decline in mature individuals is likely to occur, are likely to increase with environmental change (Oliver *et al*. 2013; Travis 2003); 2) small areas of habitat are particularly sensitive to drying (Oliver & Morecroft 2014; Sutcliffe *et al*. 1997); 3) habitat fragmentation will prevent the recovery of subpopulations after drought, as an extirpated subpopulation's habitat patch is unlikely to be recolonised (Piessens *et al*. 2009) and; 4) food availability is likely to decline as leaf litter invertebrate numbers decrease and animals in small, fragmented patches have reduced opportunity to seek food in other locations (Lindberg *et al*. 2002).

Other e*xtreme events associated with climate change*

Increased evaporation and drier winter conditions are predicted in northern NSW (DECCW 2010), which will lead to seasonal changes in fire frequency and intensity. Many rainforest remnants could have sustained a ground fire during the 2019 drought (M. Andren pers. comm. June 2022). However, there is no record of any fires at any of the rainforest remnant habitat sites of *N. atlas* (records may be incomplete) and the isolation of the remnants within a landscape of cleared land make high fire frequency and widespread fire unlikely. Fire can have severe consequences for rainforest species such as *N. brevis*, as they are not fire adapted (Berlinck and Batista 2020).

The Lismore-Alstonville region is susceptible to flooding rains, and while *Nurus atlas* habitat is generally above the flood zone, prolonged rainfall could impact the species by inundating burrows (M. Andren pers. comm. June 2022). Rising average temperature in NSW is increasing the likelihood of extreme weather events such as heavy rainfall and thunderstorms (Hennessy *et al.* 2004). East coast lows are the main cause of extreme storms along the NSW coast and climate modelling predicts there will be an increase in extreme low-pressure systems during the warmer months (NSW Government 2022; IPCC 2021).

Combined threats

The compounding impact of these threats is apparent at Lumley Park, where there were many *Nurus atlas* burrows in the 1970s (G. Monteith pers. comm. January 2022). Recent surveys suggest that the Lumley Park subpopulation is now extirpated. All the listed threats are present at Lumley Park, including Cane Toads, stormwater drains directed into the reserve and habitat degradation resulting from fragmentation (D. Charley pers. obs.). These combined threats are likely to have caused the extirpation of the *N. atlas* subpopulation at Lumley Park (Charley & Andren 2018).

Assessment against IUCN Red List criteria

Criterion A *Population Size reduction*

Assessment Outcome: Data Deficient.

Justification: At present, there is insufficient evidence to determine the extent to which the population has reduced over the relevant time period, being the last 10 years.

Criterion B *Geographic range*

Assessment Outcome: Critically Endangered under Criterion B1ab(iii, v).

Justification: *Nurus atlas* is assessed as Critically Endangered, based on the EOO meeting the threshold for Critically Endangered, in combination with having one threat-defined location based on the threat of drought, and inferred continuing decline.

Nurus atlas has a best estimate 88 km^2 Extent of Occurrence (EOO <100 km^2 = CR), calculated as a minimal convex polygon containing all known occurrences, as per the IUCN guidelines (2022). The Area of Occupancy is best estimated to be 48 km^2 (AOO<500 km^2 = EN) using 2x2 km grid cells, as per the IUCN guidelines (2022). The EOO and AOO were calculated in Geocat (Bachman *et al*. 2011) using BioNet records, which were cleaned to exclude the extirpated Lumley Park subpopulation, and incorrect identifications (M. Andren pers. comm. December 2021).

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: Sub criterion met for one location. The current subpopulations are fragments of a formerly continuous rainforest patch on red krasnozem soils and can be treated as one population overall. Both drought and competition and predation by Cane Toads are likely to affect all subpopulations simultaneously

   Justification: Although many threats are common between subpopulations, the remnants are geographically separated, and many threats are likely to act independently. However, there is one location based on the threat of drought which is likely to affect all populations simultaneously as they all occur in small remnants in a restricted geographical area. There is also one threat based on competition and predation by cane toads, which become widespread throughout any area they have invaded.

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: Sub criterion met - continuing decline is inferred in (iii) quality of habitat, and (v) number of mature individuals.

Justification: There is inferred continuing decline in the quality of *Nurus atlas* habitat, caused by the compounding effects of stormwater discharge into some remnants. more frequent and intense drought and other extreme events from ongoing climate change and the small size of remnants leading to increased ecosystem impacts (D. Charley and M. Andren pers. comm. December 2021). There is also an inferred decline in the number of mature individuals caused by Cane Toad competition and predation, the fragmentation and isolation of remnants, stormwater discharge, and more frequent and intense drought (G. Monteith pers. comm. January 2022) and other extreme events from ongoing climate change

c) Extreme fluctuations.

Assessment Outcome: Data deficient.

Justification: There is no direct evidence of extreme fluctuations. However, *Nurus atlas* is likely to be susceptible to drought (M. Andren pers. comm. December 2021).

Criterion C Small population size and decline

Assessment Outcome: Data deficient under C1 and not met under C2.

Justification: The *Nurus atlas* population is best estimated to contain approximately 6,300 – 12,600 mature individuals, based on population density data collected in each occupied remnant (Charley & Andren 2018; Lloyd 2021). Therefore, adopting the precautionary principle of recommending the taxon be listed under the higher category, the species falls within the Vulnerable threshold for number of mature individuals. However, there is insufficient data to estimate the rate of continuing decline under C1, and the combination of conditions required under C2 are not met.

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).

Assessment Outcome: Data deficient.

Justification: Rates of decline are unknown.

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

Assessment Outcome: Sub criterion met.

Justification: There is an inferred decline in the number of mature individuals caused by Cane Toad competition and predation, the fragmentation and isolation of remnants, stormwater discharge, and more frequent and intense drought (G. Monteith pers. comm. January 2022).

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: Not met.

Justification: One subpopulation is estimated to contain a minimum of 3,640 mature individuals.

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

Assessment Outcome: Not met.

Justification: No subpopulation contains more than 90% of individuals.

b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: Data deficient.

Justification: There is insufficient data to determine whether extreme fluctuations occur.

Criterion D Very small or restricted population

Assessment Outcome: Not met.

Justification: The total population size is estimated to be 6,300-12,600, based on population density data collected in each sampled occupied remnant (Charley & Andren 2018; Lloyd 2021). The species has a 48 km^2 Area of Occupancy, and there is no clear future threat to *Nurus atlas* that would contribute to the extinction of the

species in a very short time. As a result, *N. atlas* does not meet the thresholds for listing under Criterion D.

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: Not met.

Justification: The total population size is estimated to be 6,300 – 12,800, based on population density data collected in each sampled occupied remnant (Charley & Andren 2018; Lloyd 2021).

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: Not met.

Justification: The Area of Occupancy is estimated to be 48 km^2, and there is no clear future threat to that would contribute to the extinction of the species in a very short time.

Criterion E Quantitative Analysis

Assessment Outcome: Data deficient.

Justification: Sufficient data are not available to conduct a quantitative analysis.

Conservation and management actions

This species is currently listed on the NSW *Biodiversity Conservation Act 2016* and a conservation project has been developed by the NSW Department of Planning and Environment under the Saving our Species program. The conservation project identifies priority locations, critical threats and required management actions to ensure the species is extant in the wild in 100 years. *Nurus atlas* sits within the site-managed species management stream of the SoS program and the conservation project can be viewed here (https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10564).

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Expert communications

Mick Andren – NSW Government, Department of Planning and Environment
David Charley – Wildsearch Environmental Services
Geoff Monteith – Queensland Museum
Penn Lloyd – BAAM Ecological Consultants

APPENDIX 1

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:			
	(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: 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.