

NSW Threatened Species Scientific Committee

Conservation Assessment of the Black Grass-dart Butterfly *Ocybadistes knightorum* Lambkin & Donaldson, 1994 (Hesperiidae)

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Black Grass-dart Butterfly *Ocybadistes knightorum* Lambkin & Donaldson, 1994 (Hesperiidae)

Distribution: Endemic to the mid north coast of New South Wales (NSW).

Current EPBC Act Status: Not listed

Current NSW BC Act Status: Endangered

Reason for change: Inclusion of conservation assessment to support current listing.

Summary of Conservation Assessment

The Black Grass-dart Butterfly, *Ocybadistes knightorum*, was found to be eligible for listing as Endangered under Criteria B1ab (iii) + B2ab (iii).

The main reasons for this species being eligible are i) it has a highly restricted geographic range; ii) it occurs at three locations; iii) there are projected continuing declines in area and quality of habitat.

Description and Taxonomy

Ocybadistes knightorum is described by Braby (2000) as: 'Wingspan: male 19 mm; female 18 mm. *Upperside:* dark brown-black: fore wing with cell and basal half of costa orange, an irregular postmedian band of three orange spots, a subapical band of three orange spots, two orange subterminal spots between veins M1 and M3 and a faint orange streak along dorsum; hind wing with an obscure orange subbasal spot in cell, and a broad orange postmedian band from vein M1 to 1A+2A. *Underside:* ground colour dark brown-black suffused with yellow, spots and bands similar to upperside but yellow. The male can be distinguished from the female by the presence of a broad patch of black sex-scales which extends from just above vein M3 to 1A+2A on the upperside of the fore wing. In the female the tergum of the wings is more rounded, the markings on the upperside are yellower, and the suffusion of yellow scales on the underside is less extensive. *Egg:* 0.8 mm wide, 0.5 mm high; white to pale cream when laid; dome shaped and smooth. *Larva:* up to 25 mm long; body pale green except prothoracic and anal segments pale blue-green, with faint darker green middorsal line; head pale yellow-brown with dark and pale brown variable longitudinal bands. *Pupa:* 13-15 mm long; pale brown to greenish-brown becoming darker at anterior and posterior ends.'

Ocybadistes knightorum is distinguished from similar species by its small size, darker appearance (due to less extensive orange markings on the upperside) and the pattern of discrete orange patches on the upper forewing (NSW Government 2017).

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Distribution and Abundance

Ocybadistes knightorum is found on the NSW mid-north coast from Coffs Harbour to Scotts Head (NSW Government 2017). It is currently known from two disjunct areas: a northern distribution centred around Sawtell and a southern distribution. The butterfly is restricted to areas supporting its larval food plant, Floyd's Grass (*Alexfloydia repens*), which is listed as an Endangered species in NSW on the NSW *Biodiversity Conservation Act 2016* (BC Act). Habitat is generally located on floodplain alluvial deposits, 1 - 2 m above the mean sea level, although there are two atypical headland occurrences at Coffs Harbour and Sawtell (NSW Government 2017). Between 2008 and 2011, Andren and Cameron (2012) searched for, and mapped, patches of *A. repens* from Woolgoolga to Scotts Head. Patches were mapped by walking their boundaries with a hand-held GPS and all patches greater than 1 m² were recorded. Andren and Cameron (2012) mapped a total of 293 patches, encompassing 32.5 ha of potential *O. knightorum* habitat. Across its distribution, *A. repens* patch size ranges from 0.0001 ha to 4.18 ha and 81% of patches are <0.1 ha. *O. knightorum* habitat is intrinsically patchy. Even prior to European settlement, areas of swamp forest on rich alluvial substrates suitable for *A. repens* would have been sporadically distributed along the lower reaches of watercourses (Andren & Cameron 2012).

NSW National Parks and Wildlife Service reserves contain 54% of the mapped habitat and an additional 37% of habitat occurs in environmental protection zones applied by local government (Andren & Cameron 2012). Therefore, 91% of known habitat has some level of protection and this includes most of the large (>0.1 ha) patches identified by Andren and Cameron (2012). However, 10 of the large patches (comprising 1.3 ha collectively) fall wholly or partly on private land (Andren & Cameron 2012).

Ocybadistes knightorum has a 312 km² Extent of Occurrence (EOO), calculated as a minimal convex polygon containing all known *Alexfloydia repens* habitat, based on the mapping of Andren and Cameron (2012). The Area of Occupancy (AOO) is estimated to be 76 km² based on 2 x 2 km grid cells, the scale recommended for assessing area of occupancy by IUCN (2019).

During habitat mapping, Andren and Cameron (2012) also thoroughly surveyed for adult butterflies in each *Alexfloydia repens* patch. 3,208 butterflies were recorded in 155 of the 293 patches and hundreds more were observed in passing (Andren & Cameron 2012). For many butterfly species, population size is known to fluctuate widely, and the number of adults present at any time is dependent on the success of each stage in the life cycle (Sands & New 2002). This uncertainty, combined with lack of detailed knowledge of *O. knightorum* biology, confounds the interpretation of observed adult population size and abundance is therefore considered to be largely unknown (Andren & Cameron 2012).

Since 2013, monitoring of *Alexfloydia repens* and *Ocybadistes knightorum* has been carried out at Diggers Creek, Pine Creek and Warrell Creek, encompassing 46 *A. repens* sites (60% of known habitat). At these sites, *A. repens* cover and condition is monitored using 5 x 5 m floristic plots and *O. knightorum* is surveyed three times annually (between October and March) to assess the occupancy of habitat patches. Some sites are also subject to ongoing weed control. Weed management has resulted in an increase of *A. repens* crown cover across monitoring plots in two national parks near Coffs Harbour, and an increasing *O. knightorum* population trajectory is expected

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as the area of suitable habitat expands. Conversely, occupancy monitoring has shown drought driven *O. knightorum* declines at some sites, with full recovery not yet apparent (NSW Government 2021). As there have been both increases in habitat quality as a result of weed management, and observations of butterfly decline in some areas caused by drought, overall population patterns are unclear. Drought may become an ongoing problem for all subpopulations (M. Andren pers. comm. March 2022).

Ecology

Ocybadistes knightorum is monophagous on the grass *Alexfloydia repens* (Sands 1997), which is the only known larval food plant. Adult butterflies are also generally found within about 50 m of suitable *A. repens* patches (Andren & Cameron 2012). Habitat is predominantly located in swamp sclerophyll forest where Swamp Oak (*Casuarina glauca*) and/or Broad-leaved Paperbark (*Melaleuca quinquenervia*) are the dominant canopy species (NSW Government 2017). The larval food plant, *A. repens*, favours areas with moderate to high sunlight exposure in this habitat. High salinity levels are not tolerated by *A. repens*. Most of its distribution is between 1 m and 2 m above the mean tide level, immediately above the zone of king tide inundation. The most vigorous and extensive examples of *A. repens* are found on rich alluvial floodplain terraces. However, the grass will grow on a wide variety of substrates, and also occurs on two coastal headlands. *Ocybadistes knightorum* is generally found in riparian zones within 5 km of the coast but reaches inland along Warrell Creek as far as Macksville, over 7 km from the coast (Andren & Cameron 2012), in line with the *A. repens* distribution.

Adults have been recorded from September to December and February to April, suggesting that *Ocybadistes knightorum* is a multi-voltine species. Two or more overlapping generations occur annually (Atkins 1996; Sands & New 2002), and generation length is therefore approximately six months. Eggs are laid on the underside of a leaf tip on the larval food plant, and the first instar emerges after 12-14 days (Atkins 1996). Larvae construct a tubular shelter at the base of the leaf and rest inside the shelter for much of the day and night, emerging to feed at dusk and dawn. Pupation takes place inside a shelter of dead leaves and litter joined by silk (NSW TSSC 2002). Winter broods are slow to develop, and eggs laid in April do not produce adults until September/October (Atkins 1996). In captivity, adult butterflies live for 10–16 days, and 16 days is estimated to be their maximum adult lifespan in the wild (Andren & Cameron 2012). Adults fly close to the larval food plant and are active in sunny or warm conditions. Flight activity is limited to between mid-morning and mid-afternoon. Males establish territories (NSW TSSC 2002).

Threats

Sea level rise associated with climate change

The habitat of *Ocybadistes knightorum* is low-lying and highly susceptible to any rise in sea level. There is strong indication that the butterfly's food plant, *Alexfloydia repens*, is unable to tolerate highly saline conditions (Andren & Cameron 2014). Andren and Cameron (2014) used a detailed digital elevation model to show that 85%

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of the current habitat will be inundated or become too saline for *A. repens* to persist by 2100, based on a predicted 0.9 m sea level rise on the NSW north coast (DECCW 2009). Furthermore, they found that the remaining 15% of habitat will occur in thin, isolated strips that may be unable to support *O. knightorum*. The butterfly is more likely to be absent from small *A. repens* patches and those in low quality environments, where the grass is not vigorous (Andren & Cameron 2012).

Although the 0.9 m sea level rise estimate used by Andren and Cameron (2014) is from 2009, the 2021 IPCC report predicts a similar mean increase in sea level rise. On the NSW central coast, sea level is predicted to increase between 0.21 m and 1.06 m by 2100, and this will be highest in the north of the state. These projections do not include processes associated with melting ice sheets, which could result in a NSW sea level rise of up to 2.3 m by 2100 (IPCC 2021). Even a slight rise in sea level will result in the loss and degradation of *Alexfloydia repens* patches, and this appears to have already occurred in some areas (M. Andren pers. comm. March 2022).

It is highly unlikely that *Alexfloydia repens* will be able to migrate to higher elevations with sea level rise, because i) the alluvial terraces that the species currently occupies will not have time to reform at higher elevations; and ii) there are many instances where higher elevations are occupied by weeds that readily outcompete *A. repens* and will restrict migration (Andren & Cameron 2014). *Ocybadistes knightorum* is unable to persist without its larval food plant (Sands 1997).

Inundation from more frequent and severe storms

Rising average temperature in NSW is increasing the likelihood of extreme weather events such as heavy rainfall, thunderstorms and storm surges near the coast (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. When combined with projected sea level rise, more frequent and severe coastal storms and floods are likely to be even more damaging (Wilby & Keenan 2012), as erosion and flooding will occur further up the shoreline (NSW Government 2022; IPCC 2021). An increase in frequency and magnitude of storm surges, in conjunction with sea level rise, will lead to increased events of extended and frequent inundation of *A. repens* patches from the sea (Andren & Cameron 2014). This will cause a reduction in, or decline in quality of, *O. knightorum* habitat.

Increased frequency, height and duration of floods

The frequency, height and extent of floods are predicted to increase under climate estimates (DECCW 2010; IPCC 2021), and this is likely to impact the low-lying, riparian habitat occupied by *Ocybadistes knightorum*. In 2009, one small patch of *A. repens* was largely lost and another severely impacted by a major flood (Andren & Cameron 2014). The small size of habitat patches makes *O. knightorum* particularly vulnerable to local extirpations caused by stochastic events like floods (Piessens *et al.* 2009).

More frequent and intense drought

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Ocybadistes knightorum is sensitive to dry conditions. Drought in 2019 contributed to a decline at sites around Warrell Creek, with recovery not yet apparent. Sites at Pine Creek (which mostly occur in Bongil Bongil National Park), demonstrated resilience to the drought, possibly due to higher habitat quality in this area (NSW Government 2021). Droughts are predicted to become more frequent and intense under climate change in northern NSW (Herold *et al.* 2018) and are an ongoing threat to the species (M. Andren pers. comm. March 2022).

Changes in frequency and seasonality of fire

To date, there is no evidence of a negative effect of fire on *Ocybadistes knightorum* or *Alexfloydia repens*. However, fire regimes are being modified by climate change and this represents a potential future threat. Increased evaporation and drier winter conditions are predicted on the NSW north coast (DECCW 2010), which will lead to seasonal changes in fire frequency and intensity. Immature stages of *O. knightorum* are unable to escape fire. Therefore, fires that occur early in the season (for example, August or September) may have a severe impact if the population is predominantly made up of immature individuals (Andren & Cameron 2012). Some of the best *O. knightorum* habitat is associated with peat formations (Sands 1997), which are particularly susceptible to fire. At least one *A. repens* patch has experienced a protracted burn consistent with a peat fire (Andren & Cameron 2012).

Weeds

Invasion by introduced weeds, particularly *Lantana camara* and *Paspalum mandiocanum*, has been identified as a major threat to the habitat quality of *Ocybadistes knightorum*. Weeds can outcompete the larval food species and reduce open space in the overstorey where adults fly (Braby 2000; Sands & New 2002). Historical decline has not been documented but can be inferred from the observed extent of weed invasion in habitat patches (Andren & Cameron 2014). Andren and Cameron (2014) assessed weed invasion in the Sawtell region and recorded *L. camara* in 102 patches (63%) and *P. mandiocanum* in 72 patches (45%). *L. camara* was abundant in 64 (40%) of patches and *P. mandiocanum* in 43 (27%) of patches. Other weeds recorded less frequently included *Ochna serrulata*, *Senna pendula*, *Tradescantia fluminensis*, *Plantago lanceolata* and *Chloris gayana*. These surveys were conducted ~10 years ago, and since this time there has been weed control at Diggers Creek, Pine Creek and Warrell Creek. Weed control has re-established areas of high-quality habitat throughout the species distribution. Grass patches have expanded, and grass condition has improved at managed sites (NSW Government 2021). However, there are some large, unmanaged *Alexfloydia repens* patches where weeds are continuing to increase, causing ongoing habitat decline. This problem is particularly severe on private land around Warrell Creek. Across all sites, cessation of weed management programs due to funding constraints would lead to a rapid increase in weed invasion and abundance. Weeds continue to be a major threat to *O. knightorum* (M. Andren pers. comm. March 2022).

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Assessment against IUCN Red List criteria

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

Criterion A Population Size reduction

Assessment Outcome: Data deficient.

Justification: Increased frequency, severity and duration of extreme events associated with climate change, including drought, flood and inundation from the sea, have already caused some loss and degradation of *Alexfloydia repens* patches (M. Andren pers. comm. March 2022). Extreme events associated with climate change are likely to lead to ongoing *Ocybadistes knightorum* declines caused by loss of the butterfly's larval food plant over the next 10 years, however there is insufficient data available to quantitatively assess this under criterion A3. Similarly, there is insufficient data to determine if there has been a reduction in the population size of *O. knightorum* over the past ten years.

Criterion B Geographic range

Assessment Outcome: Endangered under Criterion B1ab(iii) + B2ab(iii).

Justification: *Ocybadistes knightorum* has a 312 km² Extent of Occurrence (EOO <5000 km² = EN), calculated as a minimal convex polygon containing all known *A. repens* patches. The Area of Occupancy is estimated to be 76 km² (AOO <500 km² = EN) using 2x2 km grid cells based on *A. repens* habitat. All potential habitat patches were included in this assessment, as over 97% of grid cells were found to be occupied by *O. knightorum* during Andren and Cameron's (2012) surveys.

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 – 3 locations (EN). There are three locations when considering loss of the species larval food plant through increased frequency, severity and duration of extreme events associated with climate change, which meets the Endangered threshold. It is not known whether the species is severely fragmented.

Justification: Increased frequency, height and duration of floods and increased inundation from the sea are predicted to impact all low-lying patches of the butterfly's larval food plant, and these are therefore defined as a single location. Only the two headland occurrences of the larval food plant, located at Boambee Headland and Diggers Headland, will not be impacted by these threats. Each small headland occurrence could easily be affected by a single threat, including more frequent and intense drought, changes in frequency and seasonality of fire or weed invasion (Andren & Cameron 2014). Therefore, there are a total of three *O.*

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knighthorum locations. As there are less than five locations, *O. knighthorum* qualifies as Endangered under this sub criterion.

It is not possible to ascertain whether the population is severely fragmented, as little is known about dispersal between patches and what constitutes a viable subpopulation (M. Andren pers. comm. March 2022).

- 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 projected in (iii) area, extent, and quality of habitat.

Justification: Increased frequency, severity and duration of extreme events associated with climate change, including flood, inundation from the sea, and drought are predicted to cause continuing decline in area, extent and quality of the butterfly's larval food plant (Andren & Cameron 2014).

Weed invasion is inferred to be causing ongoing decline in area and quality of large patches of *O. knighthorum* habitat, and this is particularly apparent on private land where management is not possible (M. Andren pers. comm. March 2022).

- c) Extreme fluctuations.

Assessment Outcome: Data deficient.

Justification: There is no direct evidence of extreme 10-fold fluctuations, however *O. knighthorum* is susceptible to drought, and the butterfly is less abundant during times of reduced rainfall (M. Andren, pers. comm. November 2021).

Criterion C Small population size and decline

Assessment Outcome: Data deficient.

Justification: Number of mature individuals is unknown

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.

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

Assessment Outcome: Sub criterion met.

Justification: A large proportion of *O. knightorum*'s current habitat will be impacted by sea level rise and increased frequency, severity and duration of extreme events associated with climate change (Andren & Cameron 2014). Therefore, there is an inferred continuing decline in the number of mature individuals.

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: The number of mature individuals in each subpopulation is unknown.

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

Assessment Outcome: Data deficient.

Justification: The number of mature individuals in each subpopulation is unknown. However, 93% of *O. knightorum* habitat is found in the Sawtell area, occurring across a range 8 km from north to south (Andren & Cameron 2012).

- b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: Data deficient.

Justification: There is no direct evidence of extreme 10-fold fluctuations.

Criterion D *Very small or restricted population*

Assessment Outcome: Not met.

Justification: Surveys carried out between 2008 and 2011 provided an estimate of 3,500 mature individuals (Andren & Cameron 2012). Since this time, habitat quality has improved at several sites, and there have also been drought driven declines at some sites (NSW Government 2021). It is unlikely that there are $< 1,000$ butterflies. The species has a 76 km² Area of Occupancy, and there is no clear future threat to *O. knightorum* that would contribute to the extinction of the species in a very short time. As a result, *O. knightorum* 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:

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

Assessment Outcome: Not met.

Justification: Surveys carried out between 2008 and 2011 provided an estimate of 3,500 mature individuals (Andren & Cameron 2012). Since this time, habitat quality has improved at several sites, and there have also been drought driven declines at some sites (NSW Government 2021). It is unlikely that there are <1,000 butterflies.

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: Not met.

Justification: While *O. knightorum* only occurs at three locations, the species has a 76 km² Area of Occupancy, 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. *Ocybadistes knightorum* 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=10573>).

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Expert communications

Mick Andren – NSW Government, Department of Planning and Environment

Appendix 1

Assessment against Biodiversity Conservation Act criteria

The Clauses used for assessment are listed below for reference.

Overall Assessment Outcome:

Ocybadistes knightorum was found to be Endangered under Clause 4.3 (b)(d)(e, 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, | |

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| | | |
|--|-----|---|
| | (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. |

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**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, 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: | |

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| | | | | |
|--|--|--|-------|--|
| | | | (A) | the number of individuals in each population of the species is: |
| | | | (I) | for critically endangered species |
| | | | (II) | for endangered species |
| | | | (III) | for vulnerable species |
| | | | (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. |
|-------------------------|--|