

NSW Threatened Species Scientific Committee

Conservation Assessment of *Boronia inflexa* subsp. *torringtonensis* Duretto (Rutaceae)

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***Boronia inflexa* subsp. *torringtonensis* Duretto (Rutaceae)**

Distribution: Endemic to NSW

Current EPBC Act Status: Not listed

Current NSW BC Act Status: Not listed

Proposed listing on NSW BC Act and EPBC Act: Critically Endangered

Conservation Advice: *Boronia inflexa* subsp. *torringtonensis*

Summary of Conservation Assessment

Boronia inflexa subsp. *torringtonensis* was found to be eligible for listing as Critically Endangered under Criteria B1ab(iii); D.

This taxon is eligible because i) it has a very highly restricted geographical range with an Area of Occupancy of 20 km² and an Extent of Occurrence of 57 km²; ii) it occurs in a single threat-defined location (the whole population of the subspecies could be adversely affected by a single drought event); iii) there is continuing decline in the quality of habitat due to grazing, human disturbance, inappropriate fire regimes and drought; and iv) it has a very small population of <50 mature individuals.

Description and Taxonomy

Boronia inflexa subsp. *torringtonensis* (Rutaceae) was described as a “Shrub to 1.5 m tall. Branchlets not glandular tuberculate, hispidulous between leaf decurrencies, hairs 0.25(–0.5) mm long. Leaves imparipinnate, 3(–5)-foliolate, entire leaf in outline (9–)16–25 mm long, (8–)17–30 mm wide, glabrous or glabrescent; petiole 4–9 mm long; rachis segments 4–5 mm long; terminal leaflets (4–)10–16 mm long, (0.75–)1–1.25 mm wide; lateral leaflets similar to terminal leaflets. Inflorescence 3-flowered, shorter than leaves; peduncles (2.5–)4–5 mm long; prophylls 1–2.5 mm long, glabrous; anthopodia 2–3 mm long. Sepals pink, deltate, 1.5–3 mm long, 1–1.5 mm wide, glabrous, tip acuminate due to involute margins. Petals white, 4.5–6 mm long, glabrous or minutely ciliate. Anther apicula with a few simple hairs. Style glabrescent to pilose. Cocci c. 3.5 mm long, c. 2 mm wide, glabrous. Seed c. 3 mm long, c. 1.5 mm wide.” (Duretto 2003). It is distinguishable from the type subspecies by the larger petals (4.5–6 mm long; cf. 2.5–3.5 mm long) and from *B. inflexa* subsp. *grandiflora* by the glabrous or glabrescent leaves (cf. minutely pilose)” (Duretto 2003).

Distribution and Abundance

Boronia inflexa subsp. *torringtonensis* occurs in a small number of sites north and west of Torrington in the New England Tablelands bioregion close to the New South Wales (NSW) border with Queensland. The subspecies has only been recorded 12 times, three between 1911-1916 and the most recent in 2012.

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All except one of the records have been from the Torrington State Conservation Area, with the remaining record located approximately 1.5 km north of the northern border of Torrington State Conservation Area.

Based on a minimum convex polygon fitted around all known records as per IUCN guidelines (IUCN 2017), *Boronia inflexa* subsp. *torringtonensis* is estimated to have an Extent of Occurrence (EOO) of 57 km², which meets the threshold for Critically Endangered (EOO <100 km²). *Boronia inflexa* subsp. *torringtonensis* has an Area of Occupancy (AOO) of 20 km² calculated using a 2 x 2 km grid as per IUCN guidelines (IUCN 2017), which meets the threshold for Endangered (AOO <500 km²).

The known population of the species remains very small despite relatively intensive botanical surveys in apparently suitable habitat in the vicinity by Clarke *et al.* (1998) and Hunter (2012). Four of the recent records note that *Boronia inflexa* subsp. *torringtonensis* is rare (three to five plants seen). Dr Lachlan Copeland, who has done extensive survey work in the area, reports that he has only seen the taxon once (*in litt.* April 2019). Although there have been no targeted surveys for the subspecies and its population size is unknown, it is likely to be less than 50.

Ecology

Boronia inflexa subsp. *torringtonensis* grows on granite derived soils among granite outcrops, in heath and dry sclerophyll forests (Duretto 2003). Associated species, according to herbarium records, include *Eucalyptus andrewsii* (New England blackbutt), *E. brunnea*, *E. caliginosa* (Broad-leaved stringybark), *Eucalyptus prava* (Orange gum), *E. subtillior*, *E. williamsiana*, *Acacia betchei* (Red-tip wattle), *Boronia granitica* (Granite boronia), *Brachyloma saxicola*, *Callitris endlicheri* (Black cypress pine), *Kunzea bracteolata*, *Leionema ambiens* (Forest phebalium), *Leptospermum novae-angliae*, *Leucopogon* sp., *Persoonia cornifolia*, *Prostanthera staurophylla*, *Ricinocarpus pinifolius* (Wedding bush), and *Xanthorrhoea johnsonii* (Johnson's grass tree).

Flowering material of *Boronia inflexa* subsp. *torringtonensis* has been collected in September, October and January and fruiting material in September (Duretto 2003). Pollinators are unknown, however other *Boronia* species are mostly pollinated by bees and occasionally beetles, flies, moths or butterflies (Armstrong 1979).

Time until maturation and generation length in *Boronia inflexa* subsp. *torringtonensis* are also unknown. Other *Boronia* species live ~15 years (NPWS 2002) and the juvenile period of plants in the Rutaceae family generally is 2 to 5 or more years (Auld 2001).

Boronia species typically employ ballistic dispersal of seeds, followed by myrmecochory (e.g. Drake 1981, and see Berg). Adaptations for ant dispersal are common in species growing in infertile soils (Westoby *et al.* 1990) such as the granite soils in which *Boronia inflexa* subsp. *torringtonensis* grows. The mean dispersal distance of seeds by ants in sclerophyllous vegetation worldwide has been estimated to be 1.19 m (range 0.06–77 m), with 89% of recorded distances between 0 and 2 m (Gomez and Espadaler 1998).

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The viability of the seed bank of *Boronia inflexa* subsp. *torringtonensis* is unknown. *Boronia granitica*, a sympatric granite outcrop species, has a small soil-stored seed bank which is likely moderately long-lived (Clarke and Fulloon 1999, cited in NPWS 2002). Germination cues in *B. inflexa* subsp. *torringtonensis* are unknown. Cues in other *Boronia* species include seasonal temperature (some species have summer, others winter requirements) and fire, specifically heat shock and smoke (Mackenzie *et al.* 2016). The response of *B. inflexa* subsp. *torringtonensis* to fire is unknown, though it is closely related to *B. bipinnata* (Duretto 2003) which is known to be killed by fire. In addition, Clarke *et al.* (2009) found that only 33% of shrubs in the New England Tablelands rocky outcrop communities had a resprouting capacity.

Threats

Feral goats and other browsers

In addition to browsing, feral goats (*Capra hircus*) can negatively impact plant species by preventing their establishment (Harrington 1976), contributing to soil erosion (Bayne *et al.* 2004), and dispersing the seeds of invasive species (DEWHA 2008). In Torrington SCA, feral goats inhabit rocky outcrop areas throughout the park and there is a large rabbit population around Nomads Picnic Area (NPWS 2003) which is close to one of the sites where *Boronia inflexa* subsp. *torringtonensis* occurs.

Heavy browsing by feral goats has impacted other species of Rutaceae in close proximity to *Boronia inflexa* subsp. *torringtonensis* (L Copeland, pers. comm. Apr. 2019). However, there is no record of the subspecies being directly impacted by browsers, possibly because it is not commonly encountered.

Inappropriate fire regimes

Frequent fires can lead to population declines in taxa where juvenile plants have not had time to mature and replenish soil seed banks in the interval between fire episodes, and in taxa where individuals are small at maturation and have low seed output until they increase in size (e.g. *Boronia serrulata*) (Auld 2001). Given the physiological dormancy of *Boronia* seeds (Mackenzie *et al.* 2016), this species could also be sensitive to out-of-season fires.

In Torrington State Conservation Area there is a “preliminary indication that large wildfires appear to occur every 10 years due to lightning strikes, arson and hazard reduction burns escaping from adjacent areas. However, it is likely that the overall fire frequency is much higher due to the occurrence of many small fires that are undetected, do not require suppression activities or are prescribed burns within grazing license areas.” (NPWS 2003). According to the NSW OEH fire history spatial layer, in the last 30 years, one of the currently known sites of *Boronia inflexa* subsp. *torringtonensis* has been subjected to three fires with 7- and 8-year intervals between them, which could have caused a decline in the number of individuals located there. There is a high risk to the subspecies of frequent ignitions in the area due to the proximity of the subpopulations to the village of Torrington (L Copeland, pers. comm. April 2019).

The 2019/2020 wildfires appear to have burnt all known sites of *Boronia inflexa* subsp. *torringtonensis* (Auld *et. al* 2020).

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Mining

Mining activities often result in vegetation damage and/or soil disturbance. According to the Torrington State Conservation Area Plan of Management, the area's rich mineral and semi-precious gemstone deposits have been identified as an important mineral exploration and mining area, and the vast majority of land in and around the current EOO of *Boronia inflexa* subsp. *torringtonensis* is being explored for mining operations (NPWS 2003).

The NSW OEH mining spatial layer shows that most of the land in and around the current EOO of *Boronia inflexa* subsp. *torringtonensis* is being explored for mining operations – mining titles have either been granted or applications have been submitted. All but two of the currently known sites where the subspecies has been reported are potentially at risk of future mining activities.

Human disturbance

Human disturbance in the form of trampling and bushrock removal may degrade the habitat of *Boronia inflexa* subsp. *torringtonensis* and lead to population decline. Since the 1950s, the subspecies has been recorded only on ten occasions, of which one was next to a road in an unprotected area, and four were close to roads, camping facilities and the popular Mystery Face walking track in the Torrington SCA. There is also a proposal to construct a walking track to Bismuth Falls, which is another site where the subspecies has been found (NPWS 2003).

Changes in Climate and Drought

Adapt NSW (2019) suggests that for New England and North west areas (which contains the distribution of this taxon) "Hots days are projected to increase across the region by an average of 24 days per year by 2070." while autumn rainfall may marginally increase and winter rainfall decrease over the same time". Populations of shrubs that grow in shallow sandy soil in the area are particularly susceptible to drought, and it is likely that *Boronia inflexa* subsp. *torringtonensis* will be affected by droughts as well (L Copeland, pers. comm. April. 2019).

Assessment against IUCN Red List criteria

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

Criterion A Population Size reduction

Assessment Outcome: Data Deficient

Justification: There are no long-term data that can be used to determine whether the population size of *Boronia inflexa* subsp. *torringtonensis* has experienced or is experiencing a reduction.

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Criterion B Geographic range

Assessment Outcome: Critically Endangered under Criterion B1ab(iii)

Justification: Based on a minimum convex polygon fitted around all known records as per IUCN guidelines (IUCN 2017), *Boronia inflexa* subsp. *torringtonensis* is estimated to have an Extent of Occurrence (EOO) of 57 km², which meets the threshold for Critically Endangered (EOO<100 km²). Its Area of Occupancy (AOO) measured with a 2 x 2 km grid as per IUCN guidelines (IUCN 2017) is 20 km², which meets the threshold for Endangered (AOO<500 km²).

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: Critically Endangered

Justification: Drought in combination with fire represents the most serious plausible threat to *Boronia inflexa* subsp. *torringtonensis*. Although its total population consists of multiple small subpopulations scattered across its EOO, it occupies a single threat-defined location. The species is at risk of large declines due to combined fire and drought events that affect the entire population through death of adult plants and high mortality of re-establishing seedlings. A single prolonged and severe drought alone could also affect survival of established plants across all subpopulations.

- 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: *Boronia inflexa* subsp. *torringtonensis* meets sub-criteria (iii)

Justification: The area, extent and/or quality of habitat of *Boronia inflexa* subsp. *torringtonensis* are inferred to be declining due to the impacts of feral herbivores, human disturbance (including mining activity), predicted climate change and high fire frequency.

- c) Extreme fluctuations.

Assessment Outcome: Data Deficient

Justification: There are no data on which to base an assessment regarding extreme fluctuations of *Boronia inflexa* subsp. *torringtonensis*.

Criterion C Small population size and decline

Assessment Outcome: Data Deficient

Justification: The precise population size of *Boronia inflexa* subsp. *torringtonensis* is currently unknown because there have been no targeted surveys, however, an estimate was made after examining the herbarium records and consulting an expert

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in the taxon. Since 1916, *Boronia inflexa* subsp. *torringtonensis* has been recorded nine times, four of which include abundance notes listing 3, 3, 4, and 5 plants. Based on these numbers and the fact that non-target vegetation surveys in the area have failed to find evidence of the subspecies elsewhere, it is estimated that the total number of mature individuals is likely to be <50 (L Copeland, pers. comm May 2019), which meets the threshold for Critically Endangered.

At least one of two additional conditions must also be met. These are:

- C1. An observed, estimated or projected continuing decline of at least: 25% in 3 years or 1 generations (whichever is longer) (CE); 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: It is currently unknown whether *B. inflexa* subsp. *torringtonensis* is experiencing a decline, due to the lack of long-term population size data.

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

Assessment Outcome: Data Deficient

Justification: It is currently unknown whether *B. inflexa* subsp. *torringtonensis* is experiencing a decline in mature individuals, due to the lack of long-term population size data.

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: The number of mature individuals in each subpopulation is likely to be <50.

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

Assessment Outcome: Sub-criterion not met

Justification: Based on the abundance notes from occurrence records, it is unlikely that one subpopulation contains 90% or more of the mature *B. inflexa* subsp. *torringtonensis* individuals.

- b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: Sub-criterion not met

Justification: There is currently no information suggesting extreme fluctuations in the number of mature individuals.

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Criterion D Very small or restricted population

Assessment Outcome: Critically Endangered under Criterion D

Justification: Based on abundance notes in the sighting records and expert opinion, it is estimated that the total number of *Boronia inflexa* subsp. *torringtonensis* mature individuals is <50 (L Copeland, pers. comm May 2019), which meets the threshold for Critically Endangered.

Criterion E Quantitative Analysis

Assessment Outcome: Data Deficient

Justification: A quantitative analysis estimating the probability of extinction of the subspecies in the wild has not been performed and there are insufficient data to do so.

Conservation and Management Actions

There is no National Recovery Plan or NSW Saving our Species program for *Boronia inflexa* subsp. *torringtonensis*. The following are derived from the threat information and the NSW Recovery Plan of *Boronia granitica*, which is a sympatric granite outcrop species (NPWS 2002).

Habitat loss, disturbance and modification

- Control and monitor feral goat populations. Targeted efforts to protect the limited range and known locations of the subspecies would be appropriate, including fencing off areas that are found to have large numbers of individuals of the taxon.
- Implement an appropriate fire regime within the subspecies' range. Avoid burning at high fire frequencies and suppress unplanned fires when they occur within short timeframes (less than approximately eight years since preceding fires) in the same subpopulations.
- Fires regimes must be managed to ensure that they do not disrupt the life cycle of *Boronia inflexa* subsp. *torringtonensis*, that they support rather than degrade the habitat necessary to the subspecies, that they do not promote invasion of exotic species, and that they do not increase impacts of grazing/predation.
- Physical damage to the habitat and individuals of the threatened species must be avoided during and after fire operations.
- Review proposed mining activities in the range of the subspecies.
- Ensure that Torrington SCA workers know the location of the populations and that infrastructure and maintenance does not interfere with the subspecies, specifically construction of the proposed walking track to Bismuth Falls.

Ex situ conservation

- Develop a targeted seed collection program for ex-situ seed banking.

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Stakeholders

- Inform land-owners and managers of sites where there are known populations and consult with these groups regarding options for conservation management and protection of the subspecies.
- Currently there is only one record of *B. inflexa* subsp. *torringtonensis* outside of the Torrington SCA, however, the taxon could potentially be found in other privately-owned land as well. Contact the owners of land adjacent to the currently known locations of the subspecies to facilitate targeted surveys that establish whether there are subpopulations on their properties and to discuss conservation options.
- Provide fire management authorities and land management agencies with relevant maps showing the locations of population to enable the installation of field markers to avoid damage to subpopulations.

Survey and Monitoring priorities

- Targeted population surveys to determine the size and structure of the population.
- Regular monitoring to evaluate changes in the population size and structure and gather data for modelling.
- Monitoring for herbivory and degradation by recreational activities and bushrock collecting.
- Monitoring for seed production and recruitment.
- Monitoring for the impacts of droughts.
- Assess recovery of the species after the 2019/ 2020 fires.
- Monitor for the impacts of fire regimes including monitoring the size and structure and reproductive status of populations at different stages in the fire cycle, taking opportunities to monitor after planned and unplanned fires (where they occur) and improve understanding of the fire response of the species.
- Precise fire history records must be kept for the habitat and extant (confirmed and suspected) subpopulations

Information and Research priorities

- Improve understanding of the mechanisms of response to different fire regimes and identify appropriate fire regimes for conservation of the species by undertaking appropriately designed experiments in the field and/or laboratory.
- For example - Understanding of the sensitivity of the seeds of *B. inflexa* subsp. *torringtonensis* to fire-related germination cues and seasonal dormancy, is essential to inform conservation efforts. The seeds of some *Boronia* species

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require a very specific combination of seasonal temperature and fire cues to germinate and if *B. inflexa* subsp. *torringtonensis* has similar requirements, then the construction of climate change scenarios for its predicted range would be an appropriate research priority. Understanding population responses to variation in fire season should also be a priority.

- Where appropriate, use understanding and research on fire responses among related (e.g. congeneric) or functionally similar species to develop fire management strategies for conservation.
- There is very little information about *B. inflexa* subsp. *torringtonensis* and research into the life history and ecology of the taxon would improve its conservation. This includes determining life stage longevity, pollinators, recruitment, seed bank viability and dynamics, seed dispersal methods and distances, and fire response.
- Given the rarity of the subspecies, a DNA analysis of the subpopulations would help to determine whether inbreeding is an issue that needs to be addressed when implementing recovery plans.

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Expert Communications

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Dr Marco Duretto, Manager Plant Diversity, National Herbarium of New South Wales Botanic Gardens & Centennial Parklands Australia.

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Appendix 1

Assessment against NSW *Biodiversity Conservation Act* criteria

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 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. |

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Clause 4.4 - Low numbers of mature individuals of species and other conditions
(Equivalent to IUCN criterion Clause 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 extremely low, or species |
| | | | (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
(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.