

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 shrub *Boronia boliviensis* J.B.Williams & J.T.Hunter as a CRITICALLY ENDANGERED SPECIES in Part 1 of Schedule 1 of the Act and, as a consequence, to omit reference to *Boronia boliviensis* J.B.Williams & J.T.Hunter in Part 2 of Schedule 1 (Endangered Species) of the Act. Listing of Critically Endangered species is provided for by Part 4 of the Act.

Summary of Conservation Assessment

Boronia boliviensis J.B.Williams & J.T.Hunter 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) because: (i) *B. boliviensis* has a highly restricted Extent of Occurrence (EOO) of 12 km²; (ii) *B. boliviensis* is known from a single threat-defined location; and (iii) continuing decline has been observed and is projected to continue in the area, extent and/or quality of habitat and number of mature individuals due to the combined effects of increased frequency and duration of drought due to climate change, adverse fire regimes and browsing by feral goats.

The NSW Threatened Species Scientific Committee has found that:

1. *Boronia boliviensis* J.B.Williams & J.T.Hunter is described by Williams and Hunter (2006) as a “much-branched shrub to 1.5 (–2.2) m tall, odoriferous; branchlets with a dense covering of very short, sessile, multi-angular yellowish stellate hairs, becoming glabrous with age. Leaves pinnate with mostly 7–11 leaflets, rarely with 1–5 leaflets on some leaves (especially on flowering branchlets); rachis 2–12 (–20) mm long, jointed, 8–15 mm wide, narrowly winged, rachis wings flat or recurved; leaflets narrow-elliptic, sessile, 3.8–9 mm long, 0.5–1.5 mm wide, apex acute to sub-obtuse, broadest above the middle, margins entire and closely revolute, rarely only recurved, upper surface deep green with a sparse indumentum of stellate hairs or ± glabrous, the surface and margin dotted with large, sunken oil glands, lower surface often hidden by revolute margins but when visible markedly paler, usually glabrous; petiole 1–3 mm long. Inflorescences axillary, 1–3-flowered; prophylls unifoliate; peduncle 1.5–2 mm long; pedicels 2–3 mm long. Calyx lobes deep red, narrow-deltate, acute or acuminate, 2.5–3.8 mm long, 1–2 mm wide, shortly stellate hairy abaxially. Petals pink, 4–9 mm long, 3–4 mm wide, valvate in bud, very shortly stellate-tomentose abaxially, glabrous or almost so with fine simple hairs adaxially, persistent in fruit. Filaments 1–2 mm long, glandular to tuberculate; anther with erect apiculum. Style glabrous or sparsely hairy. Fruit with cocci glabrous, 4–5 mm long, 2–3 mm wide. Seed 3–4 mm long, 1–2 mm wide.”
2. *Boronia boliviensis* is an uncommon species endemic to the Bolivia Range south of Tenterfield in northern New South Wales (NSW) with all known plants reserved within the National Parks and Wildlife Service managed Bolivia Hill Nature Reserve (NSW NPWS 2011). It is restricted to the higher parts of the Bolivia Range,

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especially around granite outcrops at 900–1200 m elevation (Williams and Hunter 2006).

3. The geographic distribution of *Boronia boliviensis* is very highly restricted. The Area of Occupancy (AOO) of *B. boliviensis* was calculated using 2 x 2 km grid cells, the scale recommended by IUCN (2022) and was estimated to be 12 km². The Extent of Occurrence (EOO) is based on a minimum convex polygon enclosing all mapped occurrences of the species, the method of assessment recommended by IUCN (2022) and was estimated to be 4.8 km². However, where EOO is less than or equal to AOO then IUCN guidelines recommend EOO estimates be changed to be equal to AOO to ensure consistency with the definition of AOO as an area that fits within EOO (IUCN 2022). Therefore, the EOO for *B. boliviensis* is also estimated to be 12 km².
4. The population of *Boronia boliviensis* is currently known to consist of approximately 14 discrete patches across a 5 km stretch of the Bolivia Range (T. Soderquist pers. comm. August 2022). The patches are not continuous and are often separated by areas of largely unvegetated granite slabs 200–750 m across (Morsley and Falconer 1999). A single patch, previously the largest known, is further distant, being some 3–4 km to the northeast of all other patches and so the population of *B. boliviensis* is regarded as consisting of two subpopulations.
5. Prior to the 2017-2019 drought there were at least 8,000 mature individuals in the population of *Boronia boliviensis*, including two large patches consisting of approximately 1,200 and 5,000 mature individuals (T. Soderquist pers. comm. September 2022). Post drought, surveys have recorded reasonable recovery in the smaller patches and the largest patch, with recruitment at least expected to maintain pre-drought numbers in these patches (Hunter 2022; T. Soderquist *in litt.* December 2022). However, there has been little to no recruitment in the second largest known patch, with this patch reduced from 1,200 to only 5–10 plants as of December 2022 (T. Soderquist *in litt.* August 2022, December 2022). As a result, the population during the 2017-2019 drought has reduced from a minimum of 8,000 mature individuals to a current estimated minimum of 6,800 mature individuals.
6. When the most serious plausible threat of increased frequency and duration of drought due to climate change is considered, both subpopulations of *Boronia boliviensis* can be considered to be a single threat-defined location, as per the IUCN definition (IUCN 2022), given drought effects are likely to be consistent across the full range of the species.
7. Patches of *Boronia boliviensis* commonly occur in shallow accumulations of coarse sandy soils in erosional fissures and depressions among granite outcrops, and on the edge of expansive granite sheeting, often in open, southeast to southwest aspects with low tree cover (Quinn *et al.* 1995; Morsley and Falconer 1999; RBGDT 2022). It appears that the ecological niche occupied by *B. boliviensis* is characterised by soil depth, soil moisture and light levels, with mature plants tending to be found in areas near to outcrops with greater soil depths, higher levels of leaf litter, persistent drainage and partial shade (Morsley and Falconer 1999).

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8. *Boronia boliviensis* commonly co-occurs with *Leucopogon neoanglicus* and *Micromyrtus sessilis* in pockets of heath among the granite slabs, but also associates with *Acacia pycnostachya*, *Boronia anethifolia*, *Brachyloma saxicola*, *Kunzea bracteolata*, *Leptospermum novae-angliae*, *L. brevipes*, *Melichrus urceolatus* and *Cryptandra lanosiflora* on the outcrops (Williams and Hunter 2006). When it occurs within adjacent low forest and woodland surrounding the granite slabs, it is commonly associated with *Acacia adunca*, *Callitris endlicheri*, *Eucalyptus andrewsii*, *E. prava* and *E. youmanii* (Williams and Hunter 2006). The species is mostly found in the plant community type (PCT) of New England Rockplate Shrubland (PCT 3854) with occasional occurrences in Tenterfield Plateau Stringybark Sheltered Forest (PCT 3507) (DPE 2022).
9. Despite a lack of fire response observations to date (T. Soderquist *in litt.* August 2022), *Boronia boliviensis* is currently considered an obligate seeding species as it appears to recruit primarily in flushes of seedlings when environmental conditions suit (J. Hunter *in litt.* July 2022). Indeed, a considerable portion of *in-situ* *B. boliviensis* seeds appear to be able to germinate and maintain mature stand numbers in the absence of fire, with reasonable germination observed up to 20 years post-fire on several occasions (Morsley and Falconer 1999; J. Hunter *in litt.* July 2022; T. Soderquist pers. comm. September 2022). This may indicate that a substantial proportion of the soil seed bank lacks deeper physiological dormancies requiring breaking by fire and that stand maintenance is not strictly dependent on fire cycles but other environmental stimuli for the majority of recruitment.
10. The main threats to *Boronia boliviensis* include increased frequency and duration of drought due to climate change, adverse fire regimes and browsing by feral goats and occasionally over-abundant macropods which compound drought impacts (J. Hunter *in litt.* July 2022; T. Soderquist *in litt.* August 2022). “Anthropogenic climate change”, “High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition” and “Competition and habitat degradation by feral goats (*Capra hircus*)” are listed as a Key Threatening Processes under the Act.
11. Decline has been observed and is strongly inferred to continue in the area, extent and/or quality of habitat and number of mature individuals of *Boronia boliviensis* due to the combined effects of increased frequency and duration of drought due to climate change, adverse fire regimes and browsing by feral goats. Since the 2017-2019 drought, substantial mortality has occurred in the population of *B. boliviensis*, with a previous minimum population of 8,000 mature individuals reducing to approximately 6,800 mature individuals (Hunter 2022; T. Soderquist pers. comm. August 2022; *in litt.* December 2022). Projections of future climate conditions indicate an increased frequency and duration of droughts when they occur in the region (Reichstein *et al.* 2013; Trenberth *et al.* 2013; Allen *et al.* 2015; AdaptNSW 2022). Therefore, it can be reasonably inferred that future mortality events in *B. boliviensis* such as that seen in 2017-2019 will become more common, exacerbating observed declines.

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12. Seedling recruitment is also impacted by continuing browsing by feral goats and macropods (Morsley and Falconer 1999; T. Soderquist *in litt.* August 2022) as well as tree canopy death resulting from drought reducing the niche habitat available for seedlings to successfully establish in (Morsley and Falconer 1999; Allen *et al.* 2015, T. Soderquist pers. comm. August 2022). Adverse fire regimes may also contribute to decline by the exhaustion of soil seedbanks if fires become more frequent (Shapcott *et al.* 2005) or conversely by limiting recruitment episodes required to replenish senescent stands if fire is excluded for too long (Auld *et al.* 2000; Shapcott *et al.* 2005). These threats mean that the quality and availability of habitat and number of mature individuals of *B. boliviensis* are likely to remain under pressure and currently observed declines are strongly inferred to continue into the future.
13. *Boronia boliviensis* J.B.Williams & J.T.Hunter 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: 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: Clause not met.

(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.	

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**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: Vulnerable under Clause 4.4 (c) (d) (iii).

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: Clause 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: Clause 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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Professor Caroline Gross
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NSW Threatened Species Scientific Committee

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Supporting Documentation:

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