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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 *Boronia imlayensis* Duretto as a CRITICALLY ENDANGERED SPECIES in Part 1 of Schedule 1 of the Act. Listing of Critically Endangered species is provided for by Part 4 of the Act.

The NSW Threatened Species Scientific Committee is satisfied that *Boronia imlayensis* Duretto has been duly assessed by the Commonwealth Threatened Species Scientific Committee under the Common Assessment Method, as provided by Section 4.14 of the Act. After due consideration of Commonwealth DCCEEW (2024), the NSW Threatened Species Scientific Committee has made a decision to list the species as Critically Endangered.

Summary of Conservation Assessment

Boronia imlayensis Duretto 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: 1) *B. imlayensis* has a very highly restricted geographic distribution with an area of occupancy (AOO) and extent of occurrence (EOO) of 8 km^2; 2) the species is known from one threat-defined location; and 3) *B. imlayensis* is inferred to be undergoing continuing decline due to the soil pathogen *Phytophthora cinnamomi*, adverse fire regimes (particularly high fire frequency), and an increased likelihood of drought due to anthropogenic climate change.

The NSW Threatened Species Scientific Committee has found that:

1. *Boronia imlayensis* Duretto (family Rutaceae) is described by Duretto (2003) as an *"*Erect, woody shrub to 1 m high. Branchlets glandular tuberculate, pubescent, hair density greater between leaf decurrencies, becoming glabrous with age, hairs to 0.25 mm long. Leaves imparipinnate, 7–13-foliolate, entire leaf in outline 16–29 mm long, 13–30 mm wide, often glandular tuberculate, especially petiole and rachis segments, hispidulous on petiole and rachis segments, hairs concentrated on adaxial surface, margins and nodes, and usually on the proximal portion of the lower leaflets; petiole 4–8 mm long; rachis segments 2–5.5 mm long; terminal leaflets 3.5–10 mm long, 1.5–4 mm wide, elliptic to narrowly elliptic or oblong to narrowly oblong, slightly discolorous, abaxial surface paler, dorsiventral, margins finely serrate, flat, apex acute to obtuse; lateral leaflets similar to but longer than terminal leaflets, 4–16 mm long, 1–4 mm wide. Inflorescence axillary, (1–)3–9-flowered, usually longer than leaves; peduncles 2–9 mm long, hispidulous, at least between the decurrent bract bases, secondary inflorescence units 4–5 mm long; prophylls and metaxyphylls to 1 mm long, persistent; anthopodia 5–10 mm long. Sepals deltate, 1–1.5 mm long, c. 1 mm wide, slightly glandular tuberculate, ciliate if only minutely and then with few hairs or glabrous, tip acute, with or without small subterminal apiculum. Petals pale to deep pink or white, 5–7.5 mm long, adaxial surface sparsely pilose in distal half, abaxial surface glabrous, ciliate, tip with small subterminal apiculum. Staminal filaments pilose, glandular tuberculate towards apex; anthers glabrous, not apiculate. Gynoecium glabrous; stigma entire, minute, barely wider than the style, style and stigma together 0.5–0.6 mm

long. Cocci 3–4 mm long, 1–2 mm wide, glabrous apart from simple hairs along suture. Seed (mature seed not seen) black to very dark red-brown, c. 2 mm long, c. 1–1.5 mm wide."

2. *Boronia imlayensis* is known from one population in Mount Imlay National Park, near Eden in southeastern New South Wales (NSW) (Duretto 2003). It is unlikely that additional populations of the species exist as extensive surveys have been carried out in similar habitat and the topography of Balawan / Mount Imlay is unique (McDougall *et al*. 2023).

3. *Boronia imlayensis* has a very highly restricted geographic distribution, with an area of occupancy (AOO) and an extent of occurrence (EOO) of 4 km^2. The AOO is based on 2 x 2 km grid cells, the scale recommended for assessing area of occupancy by IUCN (2024), using all confirmed records of the species. The EOO is based on a minimum convex hull polygon encompassing all mapped occurrences of the species, the method of assessment recommended by IUCN (2024). The EOO has been increased to be equal to the AOO, consistent with the IUCN (2024) definition of the AOO as an area within the EOO.

4. An estimated 1,000–5,000 plants were present before the 2019/20 fires (K. McDougall pers. comm. October 2022). This provides some guidance on the current population size if the population remains stable between the previous and current fire intervals. Surveys after the 2019/20 bushfires in November 2021 estimated seedling densities as 11–280 seedlings across five plots (of 2 x 2 m) (G. Wright pers. comm. February 2023). Unconditional extrapolation of this limited sampling suggests the amount is 2,750–70,000 seedlings per hectare, with the population occurring across three hectares. The upper estimate assumes that 280 seedlings occur in every 4 m^2 across the entire site and that all survive to maturity, and is therefore likely to be an overestimate given some areas of this three-hectare area are rocky and uninhabitable for this species. In addition, substantial thinning is expected as the seedlings mature. Given the site is only small, it is unlikely to support more than 10,000 mature individuals (G. Wright pers. comm. February 2023).

5. *Boronia imlayensis* occurs in stunted *Eucalyptus sieberi* open forest in shallow sandy soils over sandstone. It occurs on a ridge where it dominates the understorey and as scattered plants on upper slopes (Duretto 2003; ALA 2022). The summit of Balawan / Mount Imlay stands at 886 m above sea level and forms a narrow rocky spine with cliffs of Devonian sedimentary rocks on all but the southern aspect. The summit is fringed by a forest of *E. fraxinoides* on the eastern and northern sides (McDougall *et al*. 2023).

6. *Boronia imlayensis* flowers in spring (Duretto 2003) and is likely to be mainly pollinated by insects, including bees, beetles, flies and butterflies, as is typical of the genus (Armstrong 1979; Auld 2001). Pollinated flowers produce dehiscent fruits that open at maturity to release seeds ballistically. Secondary dispersal likely occurs via ants that disperse seeds further away from parent plants, over short distances (Berg 1975; Auld 2001). *Boronia* seeds are generally persistent in the soil and moderately long-lived (Auld 2001).

7. *Boronia imlayensis* is an obligate seeder – mature plants are killed by fire and regeneration of populations is only through germination from the soil seed bank

(Wright and Bain 2021; McDougall *et al*. 2023). Germination cues in other *Boronia* species include seasonal temperature (some species have summer, others winter temperature requirements) and fire, specifically heat shock and smoke (Mackenzie *et al*. 2016, 2021), and it is expected that germination in *B. imlayensis* will be similarly initiated. Reliance on these germination cues means the species is likely to be sensitive to changing fire regimes and climate change (Mackenzie *et al*. 2016, 2021). Interactions between seasonal and fire-related germination cues may lead to delayed and reduced germination responses to out-of-season fires (Mackenzie *et al*. 2021). Less than 5% of *B. imlayensis* seedlings recruited after the 2019/20 fires were flowering in November 2021, with seed collection undertaken following the 2022 flowering period (G Wright pers. comm. June 2025).

8. Threats to *Boronia imlayensis* include the soil-borne pathogen *Phytophthora cinnamomi*, adverse fire regimes (particularly high fire frequency and potentially, out-of-season fires), and an increased likelihood of drought due anthropogenic climate change. 'Infection of native plants by *Phytophthora cinnamomi*', 'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition', and 'Anthropogenic Climate Change' are Key Threatening Processes under the Act.

9. *Boronia imlayensis* occurs at one threat-defined location, based on the most serious plausible threats of adverse fire regimes (particularly high frequency fire) or disease caused by *Phytophthora cinnamomi*. *Boronia imlayensis* is only known from one population and so either of these threats could rapidly affect the entire population, leading to possible species extinction.

10. Continuing decline is inferred in the area, extent and quality of habitat and in the number of mature individuals of *Boronia imlayensis* due to the ongoing effects of *Phytophthora cinnamomi* and adverse fire regimes. *Phytophthora cinnamomi* was first detected at Balawan / Mount Imlay in 1999 and the diversity of understorey species in the habitat has since declined (McDougall and Liew 2020). There has been a recent increase in this pathogens' activity with the wet seasons following the 2019/20 fires. *Phytophthora cinnamomi* has been found in the roots of symptomatic *Boronia imlayensis* plants (K. McDougall pers. comm. October 2022). The proportion of plants affected on recent visits to Balawan / Mount Imlay has been estimated at around 1% in areas where *P. cinnamomi* is known to occur (K. McDougall pers. comm. October 2022), though the pathogen may be further spread across the species' habitat via bushwalkers as there is a track to the summit of Balawan / Mount Imlay that passes through the population of *B. imlayensis*. The pathogen affects plant vigour, survival, fecundity and the replenishment of the soil seed bank. The long-term effect of *P. cinnamomi* on the *B. imlayensis* population will depend on whether infected populations are still able to accumulate a sizeable seed bank.

11. Changes to fire conditions and drought frequency under climate change are also inferred to contribute to continuing decline in the area, extent and quality of habitat available for *Boronia imlayensis* in the future. Changes to climate may expose *B. imlayensis* to "interval squeeze", which is a narrowing of the favourable interval between fires, accelerating population decline (Enright *et al*. 2015). Severe fire weather is projected to increase across the NSW southeast and tablelands region

by 2070 (AdaptNSW 2022). *Boronia imlayensis* is an obligate seeder, and sufficient time is needed between fires for seedlings to mature and replenish the soil seed bank. Intervals between past fires have been eight, 10 and 29 years (most recent). A minimum fire free period for other *Boronia* species has been suggested to range from 12-20 years (Chuter 2010). More frequent fires under future climate change scenarios are likely to prevent replenishment of the soil seed bank and lead to decline in population numbers. The species is particularly vulnerable to the impacts of fire while most plants are juvenile. Fire can also increase the susceptibility of *B. imlayensis* to pathogens including *P. cinnamomi* (Moore *et al*. 2014) by enhancing pathogen dispersal, increasing sporulation and increased physiological stresses during the seedling establishment phase (Commonwealth DAWE 2022). *Boronia* species are also particularly sensitive to out-of-season fires, which may increase under future climate change scenarios. Climate change result in an increased likelihood of droughts which reduce the size of the soil seed bank and reduce seedling and adult survival. The species is likely to be susceptible to drought as the shallow coarse-textured soils on upper slopes in which *B. imlayensis* occurs retain little water following rain. Time spent in drought in the region where *B. imlayensis* occurs is projected, with medium confidence, to increase over the course of the century (CSIRO 2022).

12. *Boronia imlayensis* Duretto 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: 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 Clause C)
Assessment Outcome: Vulnerable under Clause 4.4(c)(e i,ii B).

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: Vulnerable under Clause 4.7.

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.

Professor Angela Moles, FRSN
Chairperson
NSW Threatened Species Scientific Committee

Supporting Documentation:

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