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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 the herb *Veronica lithophila* (B.G.Briggs & Ehrend.) as an ENDANGERED SPECIES in Part 1 of Schedule 1 of the Act. Listing of Endangered species is provided for by Part 4 of the Act.

The NSW Threatened Species Scientific Committee is satisfied that *Veronica lithophila* (B.G.Briggs & Ehrend.) has been duly assessed by the Commonwealth Threatened Species Scientific Committee under the Common Assessment Method as provided for by Part 4.14 of the Act. After due consideration of DCCEEW (2023), the NSW Threatened Species Scientific Committee has made a decision to list the species as Endangered.

Summary of Conservation Assessment

Veronica lithophila (B.G.Briggs & Ehrend.) was found to be Endangered in accordance with the following provisions in the *Biodiversity Conservation Regulation 2017*: Clause 4.3 (b) (d) (e iii) because: i) it has a highly restricted distribution with an EOO of 323 km^2 and AOO of 40 km^2; ii) it is estimated to occur in 2–5 threat-defined locations; iii) it is inferred to be undergoing continuing decline in the area, extent and/or quality of habitat as a consequence of adverse fire, increasing drought frequency and severity, post-fire competition with native plant species, and feral goat herbivory; and iv) there may continuing decline in EOO, AOO, the number of locations or subpopulations, and number of mature individuals if the McMahons Point subpopulation is extinct.

The NSW Threatened Species Scientific Committee has found that:

1. *Veronica lithophila* (Plantaginaceae) is described as a "trailing perennial with stems ± woody only at base and to 50 cm long, prostrate and rooting at nodes; erect leafy lateral flowering stems to 15 *c*. or more high, with short curved hairs in longitudinal bands or densely covering stem. Leaves spreading, broad-ovate, mostly 1.2–2.5 cm long, 8–15 mm wide, margins with 2–9 pairs shallow acute teeth, mostly glabrous; petiole 2–7.5 mm long. Racemes 2–15 cm long, 3–18-flowered. Calyx lobes 2–4.5 mm long and 0.7–1.8 mm wide in fruit, glabrous or sparsely hairy. Corolla 6–7 mm long, pale violet with darker veins. Capsule broad-obovate or broad-elliptic, usually 3–5.5 mm long and wide, emarginate, glabrous, glossy" (PlantNet 2023a).

2. *Veronica lithophila* is endemic to the Blue Mountains–Colong region in the southeast of the Central Tablelands of New South Wales (Briggs and Ehrendorfer 1992; PlantNet 2023a). All known subpopulations of the species occur in Kanangra–Boyd National Park and Blue Mountains National Park.

3. There are an estimated nine subpopulations of *Veronica lithophila* recorded since 1980: Mount Solitary, Coxs River near upper reaches of Lake Burragorang, Butchers Creek, Cedar Creek, near Ti Willa Plateau, Kowmung River, McMahons Point, Ferny Flat Creek, Kanangra Boyd Lookout (ALA 2022). Older records from the 1950s and 1960s exist at

Colong Point/upper Colong Creek and Coxs River near Bowtells Suspension Bridge (ALA 2022).

4. There are no population estimates for *Veronica lithophila* nor estimates on the number of individuals in individual subpopulations (ALA 2022).

5. The geographic distribution of *Veronica lithophila* is highly restricted. The Extent of Occurrence (EOO) is estimated at 323 km^2 while the Area of Occupancy (AOO) is estimated to be 40 km^2. Both EOO and AOO were calculated using records from 1985–2021. The EOO was calculated using a minimum convex hull, and the AOO calculated using a 2 x 2 km grid cell method, based on the IUCN Red List Guidelines (2022).

6. *Veronica lithophila* occurs in shallow pockets of soil with high soil moisture (*e.g.* wet seepage areas) in crevices on flat to almost vertical rock faces or cliffs, mostly in sheltered situations on south-facing slopes (usually shaded for most of the day), sometimes in deep ravines, or near creeks or waterfalls. Subpopulations often occur on small cliff lines or rock faces inside or rising up through the forest, rather than on large escarpments (G. Steenbeeke *in litt.* December 2021). It occurs on exposures of coarse sandstone, conglomerate, and quartzite, surrounded by eucalypt forest on ridges in the Blue Mountains–Colong region (Briggs and Ehrendorfer 1992).

7. Associated species occurring with *Veronica lithophila* include *Hymenophyllum cupressiforme* (Common Filmy Fern), *Lindsaea* spp., *Todea barbara* (King Fern), *Dendrobium striolatum* (Streaked Rock Orchid), *Pyrrosia rupestris* (Rock Felt Fern), *Cestichis reflexa*, *Leptospermum* spp. (Tea Tree), *Crassula* spp. (Stonecrop) and various moss and lichen species (ALA 2022). Dominant eucalypts in surrounding forest include *Eucalyptus deanei* (Mountain Blue Gum), *E. sieberi* (Silvertop Ash), *E. piperita* (Sydney Peppermint), *E. smithii* (Ironbark Peppermint), *E. fastigata* (Brown Barrel) and *E. agglomerata* (Blue-leaved Stringybark) (ALA 2022).

8. *Veronica lithophila* flowers in spring–summer (PlantNet 2023a) and produces hermaphroditic flowers (PlantNet 2023b). Flowers are likely pollinated by insects, based on studies of related species (Garnock-Jones 1976; Tasker *et al.* 2020; Delph 2021).

9. Seeds of *Veronica* species usually lack dispersal mechanisms (Falster *et al*. 2021) but being small they are probably dispersed by water and gravity. Seeds of some Veronica species have morphophysiological dormancy that prevents germination, which can be broken by fire-related cues including heat and smoke water (Guerin *et al*. 2013). Viability of seeds of *Veronica* species is often high (*e.g*. usually >30%) (Plants of South Australia 2022). Seeds of some species may remain viable in the soil for many years (Guerin *et al*. 2013).

10. The primary juvenile period for *Veronica lithophila* is unknown but likely to be short, as other *Veronica* species can have primary juvenile periods of <1 year to up to five years (Falster *et al*. 2021). The fire response of *V. lithophila* is not known. *V. lithophila* has been observed flowering three years post-fire, but it is unclear whether these plants had germinated from seed or resprouted post-fire. The species is known to germinate following soil disturbance (Briggs & Ehrendorfer 1992), suggesting it may also have the ability to germinate post-fire, although the extent to which this occurs is unknown.

11. *Veronica lithophila* is considered to have 2–5 threat-defined locations based on the most plausible threats of adverse fire regimes, drought or changes in precipitation resulting from climate change, and interactions among adverse fire regimes, climate change, post-fire competition with native species, and Feral Goat (*Capra hircus*) herbivory.

12. It is suspected that *Veronica lithophila* may be sensitive to high fire severity, low severity fire, high fire frequency, interactions between fire and climate change, and post-fire competition with native plant species. High severity fire can kill adult plants of species usually capable of resprouting through extreme and extended soil heating (Bowman *et al*. 2009) and may also reduce habitat quality through erosion of the humic layer or by opening of the canopy, causing a drying of the previously humid microclimate (Russell-Smith and Stanton 2002). If *V. lithophila* is an obligate seeder, then low fire severity may threaten its post-fire recruitment by failing to initiate germination of soil-stored seed, as temperature-sensitive obligate seeders require soil temperatures to be sufficient to break seed dormancy (either physically or physiologically) and initiate germination (Auld and O'Connel 1991; Auld and Ooi 2009). Although *V. lithophila* likely has a short primary juvenile period of around one year as inferred from other species in the genus (Falster *et al*. 2021), high frequency fires may still be a threat to this species. For *V. lithophila*, the interaction between climate change and the fire regime could lead to significant impacts on the population. Climate change can increase the frequency of fire through changes in moisture levels at landscape scales increasing the risk of localised extinctions (Nolan *et al.* 2021).

13. In the Sydney region (including the Blue Mountains), maximum temperatures are projected to increase by 0.3– 1.0°C by 2030 and 1.6–2.5°C by 2070, fire weather is predicted to increase in spring and summer, the number of hot days is predicted to increase and rainfall is predicted to decrease in spring and winter and increase in summer and autumn, due to the effects of climate change (OEH 2014; CSIRO and Bureau of Meteorology 2020). *Veronica lithophila* may be directly threatened by changes to rainfall and temperature, particularly by increasing severity and frequency of drought events. *Veronica lithophila* is likely susceptible to droughts as it occurs in situations where regular moisture availability is required (G. Steenbeeke *in litt.* December 2021). Drought is suggested as a possible factor behind the apparent decline of the McMahon Point subpopulation (V. Wong *in litt.* June 2022).

14. *Veronica lithophila* may be threatened by changes to rainfall patterns and warming which can act synergistically with inappropriate fire regimes to increase the risk of repeat fire events at intervals below or approaching the tolerable fire interval for the taxon, leading to seedbank depletion, exhaustion and local extinction. Post-fire recruitment and seedling survival is threatened by drought, particularly where drought conditions are present pre- or post-fire (Nolan *et al*. 2021).

15. There is a possible decline in EOO, AOO, the number of locations or subpopulations, or number of mature individuals, if the McMahons Point subpopulation is extinct. This is possible, as two surveys failed to find this subpopulation in 2021 (G. Phillips *in litt.* December 2021). However, there is substantial habitat on the larger escarpment faces, which is impossible to survey without abseil or drone access (G. Phillips *in litt.* December 2021), so it is unclear if this subpopulation is extinct.

16. The habitat quality of some subpopulations is inferred to be declining due to adverse fire regimes, climate change, post-fire competition with native plant species, and Feral Goat herbivory. Increases to fire and drought frequency and severity, caused by climate change, is likely to degrade the habitat of *Veronica lithophila* by causing a drying of previously humid microclimates, either due to the removal of fire-sensitive species and opening the canopy of surrounding forest, or through direct decreases to humidity and soil moisture conditions. Increased fire frequency could also result in increased competition from native plants if the length of the inter-fire period decreases and the habitat is more frequently in a post-fire recovery phase where native scrambling pea species may suppress *V. lithophila*. Feral Goats occur across the range of *V. lithophila* (NPWS 2001) and are likely to graze in rocky areas (DEWHA 2008), and are a potential contributor to a decline in habitat quality, particularly if goat populations are not controlled.

17. *Veronica lithophila* (B.G.Briggs & Ehrend.) is not eligible to be listed as a Critically Endangered species.

18. *Veronica lithophila* (B.G.Briggs & Ehrend.) is eligible to be listed as an Endangered species as, in the opinion of the NSW Threatened Species Scientific Committee, it is facing a 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: 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,	
	(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: 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 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 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: Data deficient.

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: Data deficient.

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.

Senior Professor Kristine French
Chairperson
NSW Threatened Species Scientific Committee

Supporting Documentation:

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