

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 *Gentiana wissmannii* J.B.Williams as a CRITICALLY ENDANGERED SPECIES in Part 1 of Schedule 1 of the Act and, as a consequence, to omit reference to *Gentiana wissmannii* J.B.Williams from Part 3 of Schedule 1 (Vulnerable species) 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 *Gentiana wissmannii* J.B.Williams has been duly assessed by the Commonwealth Threatened Species Scientific Committee under the Common Assessment Method as provided for by section 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 Critically Endangered.

Summary of Conservation Assessment

Gentiana wissmannii J.B.Williams 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, ii, iii) and Clause 4.4 (a) (e i, ii (B)) because: (i) the species has a very highly restricted Area of Occupancy and Extent of Occurrence of 4 km²; (ii) it is known from one threat-defined location; (iii) there is an inferred continuing decline in distribution, extent and area of habitat, and number of mature individuals due to adverse fire regimes and increased occurrences of severe droughts due to climate change; (iv) the total estimated number of mature individuals is below 250; and (v) 100% of the known mature individuals are found within a single population.

The NSW Threatened Species Scientific Committee has found that:

1. *Gentiana wissmannii* J.B.Williams (family Gentianaceae) is a small upright annual herb 3–8 cm tall, usually with a single soft, hairless stem, occasionally with 2 to 4 short branches. The species has 3 to 10 pairs of leaves which are ovate (egg-shaped), 4–10 mm long and 3–6 mm wide, curving away from the stem towards the ground. The species has one to 5 flowers which are greenish on the outside and sky blue on the inside, 8–15 mm long. The flower grows on a stalk c. 2 mm long that elongates to 10–15 mm when in fruit (Adams and Williams 1988, OEH 2018; PlantNET 2021).
2. *Gentiana wissmannii* is endemic to the New England Tablelands in northern New South Wales (NSW), specifically in Cathedral Rock NP and the surrounding area (OEH 2018).
3. *Gentiana wissmannii* has a very highly restricted geographic range, with both an Extent of Occurrence (EOO) and an Area of Occupancy (AOO) of 4km², based on mapping of point records from a survey in November 2021, where the species was found at only one site. The extent of occurrence (EOO) is based on a minimum convex polygon enclosing all mapped occurrences of the species, the method of

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assessment recommended by IUCN (2022). The EOO values presented here have been increased to match AOO values, consistent with the definition of the AOO as an area within the EOO (IUCN 2022). The AOO is based on 2 x 2 km grid cells, the scale recommended for assessing area of occupancy by IUCN (2022).

4. *Gentiana wissmannii* was observed in numerous healthy populations in 1976 (J. Smith pers. comm. 2021 cited in Eco Logical Australia 2021). Post-fire surveys in 2021, which included 14 sites (previous record locations and opportunistic sites with similar habitat), found the species at only one site. The cause of this apparent decline is unknown. *Gentiana wissmannii* occurs at one threat-defined location, based on the most plausible serious threat of fire as per the IUCN Guidelines (IUCN 2022).
5. Post-fire surveys of *Gentiana wissmannii* found a total of 90 individuals at one site. The species may also persist within the seedbank at other sites, although it is not known how long the seeds of the species survive. Many of the sites also showed evidence of burning deep into the peat layer and post-fire erosion following the fires, which may have caused significant mortality to the seedbank. Based on current evidence, it is likely that the entire population of New England gentian is less than 250 individuals.
6. *Gentiana wissmannii* is not considered to be severely fragmented. All historic sites exist within a restricted area and gamete exchange is likely to occur across the known population. There is no direct evidence of extreme fluctuations in EOO, AOO, number of populations, locations, or mature individuals.
7. *Gentiana wissmannii* is an annual herb and relies on germination from a seedbank for persistence. Other species of *Gentiana* require cold stratification to break seed dormancy (Cuenca-Lombraña et al 2018; Simpson & Webb 1980) but the germination response to fire is unknown. Miller (2004) found that experimentally buried seeds of *Gentiana nivalis* (Alpine gentian) had a half-life of 15 to 32 years. The longevity of *G. wissmannii* seeds within the seedbank is unknown. *Gentiana wissmannii* flowers between September and November (OEH 2018). Little is known about the pollination requirements of *G. wissmannii*; however, many other species of *Gentiana* rely on insects for pollination (Cuenca-Lombraña et al. 2018; Olsson et al. 2015; Mu et al. 2011). The seed dispersal method employed by *G. wissmannii* is unknown. Some *Gentiana* species, including *G. zollingeri*, rely on rain for seed dispersal (Nakanishi 2002). Dispersal distance with this method is short, usually one metre or less; however, there may be secondary dispersal by surface water flows.
8. *Gentiana wissmannii* is found in short herbfields and wet heath areas on the margins of upland swamps in moist sandy soils on granitic sedimentation at altitudes of 1,100–1,450 m (Quinn et al. 1995; OEH 2018). The only currently known site is at 1,280 m altitude (L. Copeland 2022 pers. comm. 24 May). The species may depend on the presence of open patches of short, grazed vegetation and is known to occur among *Leptospermum* sp., *Baloskion* sp., and *Sphagnum* sp. (Quinn et al. 1995; DEWHA 2008).

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9. *Gentiana wissmannii* is threatened by adverse fire regimes, disturbance of habitat by feral pigs (*Sus scrofa*), and changes in rainfall as a result of climate change.
10. *Gentiana wissmannii* may be affected by adverse fire regimes (DAWE 2022), including changes in fire season, high fire severity, the interactive effects of fire and drought, post-fire herbivory, interactive effects of fire and weeds, and fire effects on habitat suitability. Fire season is being altered due to climate change and increased anthropogenic ignition sources (Miller et al. 2019). Fires that occur in spring or early summer could be detrimental to the persistence of *G. wissmannii*, because fires that occur during the flowering period of a species can prevent seed production that year and thus reduce recruitment (DAWE 2022). *Gentiana wissmannii* relies on a seedbank likely with seasonal dormancy. Seeds are minute, reducing the likelihood of survival in the top layers of the soil during high intensity fires unless buried. The adults of the species are also susceptible to fires of any severity. Peat fires pose unique and transformational threats to peat-associated species and ecological communities of cool temperate climates (French et al. 2016; Keith et al. 2020). Many of the sites surveyed after the 2019–20 fires were on the margins of swamps but showed evidence of burning 10–15 cm deep into the peat layer and the species could not be found. Because *G. wissmannii* seeds are usually located within the first few centimetres of soil, they may be removed by post-fire erosion. Pre- or post-fire drought can inhibit flowering and seedling germination and increase mortality of seedlings and immature plants (DAWE 2022). Leigh et al. (1991) found empirical evidence of strong fire-herbivore interactions suppressing survival, growth and reproduction in subalpine herbs in woodlands. Fire can mediate competition between species and allow invasive exotic plants to dominate. This puts *G. wissmannii* at risk from exotic species such as Blackberry (*Rubus anglocandicans* A.Newton) and other *Rubus* spp..
11. Feral pigs occur within Cathedral Rock NP and are known to be destructive to habitat, particularly in the wetlands of the park (NSW NPWS 2002). Feral pigs could directly damage *Gentiana wissmannii* and its habitat when digging in search of food or creating wallows. They could also introduce weed seeds and nutrients to native habitat and disturb soil, encouraging the establishment of weeds (DoEE 2017). During surveys in November 2021, one site was found to have evidence of damage from feral pigs (Eco Logical Australia 2021). 'Predation, habitat degradation, competition and disease transmission by Feral Pigs, *Sus scrofa* Linnaeus 1758' is listed as a Key Threatening Process under the Act.
12. CSIRO & Bureau of Meteorology (2015) predicted that eastern Australia will be exposed to increased average temperatures, and increased frequency of droughts, due to climate change. For the New England Tablelands in NSW, minimum temperatures have been projected to increase by 0.5–1°C by 2030 and 1.6–2.7°C by 2070, with more hot days and fewer cool nights (OEH 2014). This could have negative impacts on *Gentiana wissmannii* as it is thought to rely on periods of low temperature to break seed dormancy. *Gentiana wissmannii* flowers during spring, which was predicted to see a decrease in rainfall of between 21 and 28% by 2070 (OEH 2014). High altitude swamps like those *G. wissmannii* occupies depend upon the natural hydrology regime of the area and may be particularly vulnerable to

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species loss under future climate predictions (DECCW 2010). Although it is an unpredictable environment with alternating periods of flooding and dry spells, significant changes in the frequency and severity of these processes pose a threat to *G. wissmannii* (Nielsen & Brock 2009). Increasing severe rain events and floods may bring increased impact of erosion to *G. wissmannii*, especially following fire. 'Anthropogenic Climate Change' is listed as a Key Threatening Process under the Act.

13. The EOO, AOO, habitat quality and number of individuals of *Gentiana wissmannii* are inferred to be declining due to adverse fire regimes and increased occurrences of severe droughts due to climate change. The species is found on the margins of upland swamps which rely on the natural hydrological regime of the region and may be at risk under future climate projections (Nielsen & Brock 2009). Both high severity bushfires and extreme weather events are expected to become more frequent due to climate change (CSIRO & Bureau of Meteorology 2015), suggesting that decline in distribution and habitat quality due to these factors is likely to occur in the future. Periods of severe drought, such as those experienced during 2017-2019, may impact the wet habitats needed for the survival of the species. The exact dynamics of the species within the soil seedbank are unknown. However, changes to the frequency and severity of disturbances may lead to a decline in the number of extant seedlings, which will ultimately lead to continuing declines in the number of mature individuals.

14. *Gentiana wissmannii* J.B. Williams 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, ii, iii) and Clause 4.4 (a) (e i, ii (B)).

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.

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, ii, 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: Critically Endangered under Clause 4.4 (a) (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:	

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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: Endangered under Clause 4.5 (b).

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.
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Supporting Documentation:

DCCEEW (Department of Climate Change, Energy, the Environment and Water) (2023). Conservation Advice for *Gentiana wissmanii* (New England Gentian). Department of Climate Change, Energy, the Environment and Water, Canberra, Australia.

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