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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 shrub *Darwinia glaucophylla* B.G.Briggs as an ENDANGERED SPECIES in Part 2 of Schedule 1 of the Act and, as a consequence, to omit reference to *Darwinia glaucophylla* B.G.Briggs in Part 3 of Schedule 1 (Vulnerable Species). Listing of Endangered species is provided for by Part 4 of the Act.

Summary of Conservation Assessment

Darwinia glaucophylla B.G.Briggs was found to be Endangered in accordance with the following provisions in the *Biodiversity Conservation Regulation 2017*: Clause 4.3(b)(d)(e i,ii,iii,iv) because: 1) it has a highly restricted geographic range with an extent of occurrence (EOO) of 54–88 km^2 and an area of occupancy (AOO) of 48–64 km^2; 2) it occurs at five threat-defined locations; and 3) there is continuing decline observed and inferred in the EOO, AOO, area, extent and quality of habitat, number of locations and subpopulations, and number of mature individuals of *D. glaucophylla* due to the combined effects of adverse fire regimes, clearing and land degradation, and increased frequency, intensity and duration of drought due to climate change.

The NSW Threatened Species Scientific Committee has found that:

1. *Darwinia glaucophylla* B.G.Briggs (family Myrtaceae) is described in PlantNET (2022) as: “Spreading, prostrate shrub with ascending branchlets to 15 cm high. Leaves laterally compressed, 8–17 mm long, glabrous, glaucous, and often tinged red purple. Flowers mostly in clusters of 2–4; peduncles 1–1.5 mm long; bracts leaf-like, 8–12 mm long; bracteoles oblong, 4–6 mm long, red brown. Hypanthium 7–8 mm long, 0.5–1.5 mm diam., with prominent ribs. Sepals triangular, ≤ 0.5 mm long, entire or toothed; much shorter than petals. Style straight, 12–16 mm long, white.”

2. *Darwinia glaucophylla* is endemic to the New South Wales (NSW) Central Coast region. It occurs entirely within the Gosford local government area, having a small geographical range between the area of Narara and the Hawkesbury River, and extending west to Calga (Focus Flora 2018).

3. Within its narrow range, *Darwinia glaucophylla* has been recorded in four discrete areas: an area west of Mooney Mooney Creek (Mooney Mooney West), to the east of Mooney Mooney Creek (Mooney Mooney East), Strickland State Forest, and near to Patonga (Focus Flora 2018). Given these four areas are separated by a minimum distance of 2.9 km between Strickland and Mooney Mooney East and a maximum distance of 7 km between Mooney Mooney East and Patonga, there is likely to be limited genetic exchange between areas, and each is considered a separate subpopulation as defined by IUCN (2024).

4. As *Darwinia glaucophylla* often forms large dense mats, accurately determining the number of individuals present during survey efforts is difficult (Booyens 2010). As of April 2021, surveys have counted a minimum of 5,189 individuals across the population (Focus Flora 2018, 2019, 2020). These counts are based on transects across occupied areas with individuals counted when they can be distinguished, or

otherwise counting a continuous mat as one individual (which may not reflect the true abundance in some areas; Focus Flora 2018).

5. These counts were then converted to an occupied area of the habitat searched, with this density then extrapolated across other verified but uncounted records in areas of suitable habitat. This results in a minimum current estimate of 6,860 mature individuals across the entire population (Focus Flora 2021), with over 70% of the population occurring within Brisbane Water and Popran National Parks (NPs).

6. *Darwinia glaucophylla* has a very highly restricted geographic distribution. The EOO is estimated as 54–88 km^2, based on a minimum convex polygon containing all known occurrences, the method of assessment recommended by IUCN (2024). The AOO is estimated as 48–64 km^2 using 2 x 2 km grid cells, the scale recommended by IUCN (2024). Minimum figures for AOO and EOO exclude the Patonga subpopulation which has not been recorded since 2000, and the southernmost records in the Mooney Mooney East subpopulation which have not been recorded since 1978 despite intensive surveys in recent years (Focus Flora 2018), with the maximum figures inclusive of all confirmed records of the species.

7. *Darwinia glaucophylla* inhabits friable, shallow skeletal soils on Hawkesbury Sandstones (Booyens *et al*. 2014). The species is associated with sandy heath, scrub and woodlands often associated with sandstone rock platforms or near hanging swamps. Associated vegetation communities are adapted and prone to fire (OEH 2017). *Darwinia glaucophylla* appears to grow in gaps in the canopy caused by rocky outcrops, fire, and where vegetation has been cleared and maintained for easements. It is conspicuous in areas regularly slashed such as along a gas pipeline and powerline easements within Popran and Brisbane Water NPs (Booyens *et al.* 2014). It is rarely detected in adjacent unslashed habitat, or areas long undisturbed by fire or other means (Focus Flora 2020). *Darwinia glaucophylla* is considered likely to be shade intolerant and therefore will increase in abundance and density after disturbances that improve light availability (Booyens 2010, Booyens *et al.* 2014).

8. *Darwinia glaucophylla* is often associated with species such as *Banksia ericifolia, Acacia terminalis, A. oxycedrus, Angophora hispida, Hakea teretifolia* and *Bauera rubioides* (OEH 2017). It also occurs in open woodland where it is associated with *Corymbia gummifera, C. eximia, Eucalyptus haemastoma* and *E. punctata* (OEH 2017).

9. *Darwinia glaucophylla* is a fire sensitive obligate seeder with adults being killed by fire, and germination being heat stimulated (Auld and Scott 1997, Auld and Ooi 2009). The species has an expected lifespan of 20–30 years (Booyens *et al.* 2014), rare germination outside of mass disturbance events (Focus Flora 2018, 2021), and even-aged stands where it occurs (G. Phillips pers. obs. October 2021). The soil seedbank is likely relatively short-lived. Findings in related *Darwinia* species indicate that the genus has *in situ* seedbank half-lives of less than one year, with a small portion (7–22%) of seeds remaining viable after two years (Auld *et al.* 2000). Consequently, continual seed input is required in most seasons to maintain the soil seedbank and enable seedling recruitment after fires (Auld *et al.* 2000).

10. *Darwinia glaucophylla* has physiologically dormant seeds, with germination cued by heat shock (Auld and Ooi 2009). Anywhere from 39–75% of seeds in a given crop display dormancy, and are therefore available for incorporation into the soil seedbank (Auld and Ooi 2009). The non-dormant portion becomes inviable if it does not germinate soon after dispersal. Ideal temperatures for heat shock treatment to relieve dormancy in *D. glaucophylla* are typically 80–100°C, but temperatures as low as 60°C can stimulate germination in some seed crops (Auld and Ooi 2009). These temperatures are similar to conditions found at burial depths of 1–2 cm during a bushfire (Bradstock and Auld 1995). This indicates that intermittent wildfire likely plays a key role in the recruitment cycle and maintenance of *D. glaucophylla* stands. However, hotter fires producing soil temperatures above 100° C often result in seed mortality up to 100% (Auld and Ooi 2009), and the subsequent decline or loss of stands.

11. Major threats to *Darwinia glaucophylla* include adverse fire regimes, clearing and land degradation for urban development, increased frequency and duration of drought due to climate change, and infection by myrtle rust (*Austropuccinia psidii*) (OEH 2017; Focus Flora 2018; Makinson 2018). Invasion by exotic weeds is considered a minor threat that may act locally at the site level (Focus Flora 2018). 'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition', 'Anthropogenic climate change', 'Clearing of native vegetation', and 'Introduction and establishment of exotic rust fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae' are listed as Key Threatening Processes under the Act.

12. When the threats of adverse fire regimes, in particular more frequent and severe wildfires, and fragmentation and clearing due to development are considered, the population of *Darwinia glaucophylla* can be treated as 5–6 threat-defined locations. This is due to an increase of severe wildfire occurrences being the most serious plausible threat that results in the lowest number of locations for patches that exist within intact bushland, while clearing and land degradation for urban development is the most serious plausible threat for those patches occurring within and immediately adjacent to the urban matrix. The probable loss of the Patonga location results in the lower number of locations (5) being the most appropriate for assessment of extinction risk.

13. Continuing decline has been observed and is inferred to continue in the EOO, AOO, area, extent and quality of habitat, number of locations and subpopulations, and number of mature individuals of *Darwinia glaucophylla*. This is due to the combined effects of adverse fire regimes, clearing and land degradation, and the increased frequency, intensity and duration of drought due to climate change. *Darwinia glaucophylla* appears to have suffered a large contraction in the south of its range since 2000, with the Patonga subpopulation (150 mature individuals) and records on the southern edge of the Mooney Mooney East subpopulation not having been re-recorded since this time despite substantial survey effort (Focus Flora 2018, 2019, 2020, 2021). These areas were affected by high severity fire in 2003 (Mooney Mooney East) and 2006 (Patonga; NSW NPWS 2006, 2022), following on from several years of intense drought (BOM 2023), and it is highly plausible that these events resulted in the loss of the Patonga

subpopulation/location and the southern edge of the Mooney Mooney subpopulation.

14. There was observed dieback of adult *Darwinia glaucophylla* cover at several sites during surveys between 2018 and 2021 that is likely attributable to the acute drought conditions experienced across the Central Coast between August 2017 and September 2019 (Focus Flora 2020). The Central Coast Region is projected to become hotter, have fewer colder nights under 2°C annually, more hot days over 35°C annually and an increase in average and severe fire weather by 2079 (CSIRO and BOM 2022; AdaptNSW 2023). Additionally, fire weather is predicted to become harsher, and the time spent in drought is predicted to increase on the East Coast through the 21st century (CSIRO 2023). This may result in further extirpation of patches and/or subpopulations as has been observed at Patonga or decline in mature individuals over time in cases where fires and/or drought become frequent enough to reduce plant cover, maturation times and soil seed bank development. Inferred decline in habitat quality from clearing and land degradation due to urban development is also apparent. The loss of a number of records within the development footprint of the Somersby Industrial Park (BioNet 2023), remaining plants in the industrial area existing in small, degraded remnants (Connell Wagner 2005) and the threat of further development within the distribution of *D. glaucophylla* (DPE 2022; Umwelt 2022) is resulting in declines in habitat quality and mature individuals. This and other aforementioned threats indicate that the EOO, AOO, area, extent and quality of habitat, number of locations and subpopulations and number of mature individuals of *D. glaucophylla* are likely to remain under pressure, and observed declines are inferred to continue into the future.

15. *Darwinia glaucophylla* B.G.Briggs is not eligible to be listed as a Critically Endangered species.

16. *Darwinia glaucophylla* B.G.Briggs is eligible to be listed as an Endangered species as, in the opinion of the NSW Threatened Species Scientific Committee, it is facing a very high risk of extinction in Australia in the near 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 i,ii,iii,iv)

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 i,ii,iii,iv)

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: Not met

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: Not 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.

Professor Caroline Gross
Chairperson
NSW Threatened Species Scientific Committee

Supporting Documentation:

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