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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 *Eucalyptus stenostoma* L.A.S.Johnson & Blaxell as an Endangered species in Part 2 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 *Eucalyptus stenostoma* L.A.S.Johnson & Blaxell 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 DCCEEW (2023), the NSW Threatened Species Scientific Committee has made a decision to list the species as Endangered.

Summary of Conservation Assessment

Eucalyptus stenostoma L.A.S.Johnson & Blaxell was found to be Endangered in accordance with the following provisions in the *Biodiversity Conservation Regulation 2017*: Clause 4.3 (b)(d)(e i)(f i) because: i) the species has a highly restricted geographic distribution with an Extent of Occurrence estimated at 1,976 km^2 and an Area of Occurrence estimated at 188 km^2; ii) it is known from five threat-defined locations; iii) continuing decline in the number of mature individuals is inferred due to adverse fire regimes; and iv) the species is susceptible to extreme fluctuations in the number of mature individuals.

The NSW Threatened Species Scientific Committee has found that:

1. *Eucalyptus stenostoma* L.A.S.Johnson & Blaxell (family Myrtaceae) is a small to medium sized tree to 25 m tall with persistent, rough grey bark on the lower trunk and smooth, yellow or creamy white upper bark (PlantNET 2022). The smooth upper bark is often characterised by fine zig-zag scribbles caused by burrowing moth larvae (Bucculatricidae: *Ogmograptis*) and each year this bark is shed in ribbons. Juvenile leaves are grey-green and sometimes glaucous (whitish waxy covering). Juvenile leaves are up to 18 cm long and 6 cm wide with an oval to lance shape that is stemless (sessile) on very young growth. The mature leaves are glossy green, lance to sickle shaped and measure up to 19 cm long and 3 cm wide. Flower buds are in clusters of 11 to 20 or more and develop to become white flowers seen from around September to December (CANBR 2020; PlantNET 2022). Glaucous fruits are globular in shape and have a narrow opening (CANBR 2020).

2. *Eucalyptus stenostoma* is endemic to New South Wales (NSW), known only from the South East Corner and South Eastern Highlands bioregions (DAWE 2020) on the land of the Yuin People and possibly the Ngarigo People (AIATSIS 2021). Most records are located within Wadbilliga and Deua National Parks (NPs) from the Tuross and Deua river catchments (DPE 2021a). The species also occurs in South East Forest NP and in Dampier State Forest, with minor occurrences on private

land (DPE 2021a). The currently known distribution encompasses three local government areas: Bega Valley, Eurobodalla and Snowy Monaro. A minor occurrence may also exist within the Queanbeyan-Palerang Regional Council area.

3. The number of subpopulations of *Eucalyptus stenostoma* is currently uncertain. Collection notes with past records of the species indicate it can be locally abundant in suitable habitat, often forming pure stands, but records indicate that areas of suitable habitat are restricted (DPE 2021a), widely separated and generally inaccessible for survey. Based on the spatial distribution of records, at least 26 extant subpopulations are estimated. Estimates of subpopulation size are not available for most subpopulations and the available estimates are highly uncertain and mostly rely on abundance descriptors.

4. The geographic distribution of *Eucalyptus stenostoma* is highly restricted. The extent of occurrence (EOO) and area of occupancy (AOO) of *E. stenostoma* are estimated at 1,976 km^2 and 188 km^2 respectively. These figures are based on the mapping of all available point records from 1928-2021 obtained from governments, museums and the CSIRO. The EOO was calculated using a minimum convex hull and the AOO was calculated using a 2x2 km grid cell method, the methods of assessment recommended by IUCN (2022).

5. The number of mature individuals of *Eucalyptus stenostoma* is unknown, however, expert opinion suggests there are at least 1000 mature individuals (G Phillips pers. comm. 2018 in Fensham *et al*. 2019). Given that *E. stenostoma* often occurs in small, pure stands where it is locally abundant (CANBR 2020; PlantNET 2022) and that 26 subpopulations are estimated, the number of mature individuals is likely to be >5000 individuals.

6. Intersecting available records for *Eucalyptus stenostoma* with surface geology mapping (DRNSW 2018) indicates that the species grows on rhyolite, hornfels, sandstone, mudstone, slate and granitoid rocks. It is restricted to very steep slopes, rocky hill tops and ridgelines with shallow, stony soils that are somewhat infertile (CANBR 2020; PlantNET 2022). However, available records (DPE 2021a) suggest that it is not restricted by aspect, with records from a range of aspects without a clear preference for sheltered or exposed sites.

7. *Eucalyptus stenostoma* often forms pure, even-aged stands where it is locally dominant, but can sometimes grow in mixed stands with other eucalypts. It commonly occurs near stands of *E. sieberi* (Silvertop Ash), which tends to dominate the surrounding forest (DPE 2021a). Other tree species in the vicinity of *E. stenostoma* sites are *Angophora floribunda* (Rough-barked Apple), *Eucalyptus agglomerata* (Blue-leaved Stringybark), *E. baeuerlenii* (Baeuerlen's Gum), *E. blaxlandii* (Blaxland's Stringybark), *E. fraxinoides* (White Ash), *E. globoidea* (White Stringybark) and *E. olsenii* (Woila Gum). Understorey species include *Dodonaea rhombifolia* (Broad-leaf Hop-bush), *Prostanthera porcata, Allocasuarina littoralis* (Black She-oak), *Hakea dactyloides* (Finger Hakea), *Lepidosperma urophorum* (Tailed Rapier-sedge), *Monotoca scoparia* (Prickly Broom-heath), *Lomandra confertifolia* (Slender Mat-rush), *Persoonia linearis* (Narrow-leaved Geebung), *Choretrum candollei* (White Sour Bush), *Platysace lanceolata* (Shrubby Platysace)

and *Olearia iodochroa* (Violet Daisy-bush) (DPE 2021a). At Belowra, *E. stenostoma* grows in association with the rare *Acacia georgensis* (Dr George Mountain Wattle) (J. Miles pers. comm. March 2022).

8. In response to severe (crown) fires, mature *Eucalyptus stenostoma* does not regenerate from a lignotuber or epicormic shoots and is killed, giving it an obligate seeder-type life history (Nicolle 2006; Kenny *et al.* 2014; Clarke *et al*. 2015). In the early stages following severe fires, seedlings proliferate, exploiting elevated resource availability and reduced competition in the post-fire environment (iNaturalist contributors, iNaturalist 2022a, b). It is possible that mature, relatively uniform stands of *E. stenostoma* comprise single-aged cohorts that originated from a single, historic fire event. The species may therefore rely on severe fires at low frequency to stimulate population turnover, although it is possible that low intensity fires may also permit some seedling regeneration due to gap creation in the understorey.

9. The time from seed germination to sexual maturity (the primary juvenile period) is unknown. Estimates of the primary juvenile period of obligate seeder eucalypts from more productive habitats than *Eucalyptus stenostoma* range from 5 to 20 years for *E. delegatensis* (Alpine Ash), *E. regnans* (Mountain Ash) and *E. fraxinoides* (White Ash) (Cheal 2017; White *et al*. 2020). The longevity of mature *E. stenostoma* plants is also unknown but could be in the order of 300-400 years based on other ash forest eucalypts.

10. Whether *Eucalyptus stenostoma* is serotinous (seed held in an aerial seed bank) or weakly serotinous and released during inter-fire periods is unknown, but in eucalypts, obligate seeders are generally more strongly serotinous than resprouters. Eucalypt seed is short-lived and typically dispersed over short distances such that range shifts of species is restricted to an average rate of 1–2 m per annum (Booth 2017). The pollinators are likely to be generalist insects and birds like most eucalypts (House 1997). Many eucalypts have a mixed mating system (combination of cross-pollination and self-pollination) but outcrossing usually predominates (Potts and Wiltshire 1997, Horsley and Johnson 2007, Byrne 2008).

11. Following severe (canopy) fires the serotinous seed bank of *Eucalyptus stenostoma* is exhausted at the same time as the death of parent plants, meaning that a decline in mature individuals represents a decline in the total number at this time. In such taxa, extreme fluctuations of mature individuals can arise from stochastic variation in post-fire seedling establishment. Therefore, *E. stenostoma* is considered prone to extreme fluctuations of mature individuals (IUCN 2022).

12. The main threats to *Eucalyptus stenostoma* are adverse fire regimes, including high frequency fire and high severity fire, and the interaction between drought and fire with more frequent droughts as a result of 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 ‘Anthropogenic climate change’ are listed as Key Threatening Processes under the Act.

13. When the most serious plausible threat of short-interval, high severity fires is considered, the population of *Eucalyptus stenostoma* can be treated as having up to five threat-defined locations. These five threat-based locations are identified corresponding to geographical clusters of the known subpopulations, each of which may be feasibly impacted by successive high severity fires at short intervals. While fewer locations may be justified given the fire extent of the 2019-20 fires overlapped 93% of AVH records of the species (Gallagher 2022), the estimate of five is considered most plausible considering the current species' spatial distribution and the likely extent and severity of fires exacerbated by climate change.

14. Adverse fire regimes, particularly high frequency, high severity fires, are inferred to be contributing to continuing decline in the number of mature individuals of *Eucalyptus stenostoma.* Obligate seeder forests have been identified as facing a high risk of population decline under short-interval fire regimes (Bowman *et al*. 2014; Fairman *et al*. 2015; McColl-Gausden *et al*. 2022). Most fire-affected *E. stenostoma* sites are expected to have sustained high mortality of mature individuals because their habitat was exposed to high severity fire, in contrast to low lying areas and valleys (DPIE 2020). At these sites the mature individuals have been transferred to the juvenile life stage; the maintenance of each subpopulation will therefore be reliant on juvenile plants that reach maturity and replenish the seed bank prior to further disturbances that cause decline. Being a long-lived, slow growing species, it is possible that the time required to produce large seed quantities sufficient to buffer subpopulations from future fires is much greater than the age to reproductive maturity of up to 20 years, further increasing the length of the minimum tolerable fire interval.

15. A closely related species, *Eucalyptus delegatensis* (Alpine Ash) has undergone declines as high as 97% in regenerating plants as a result of short-interval fires occurring over 11 years in the Victorian Alps (Bowman *et al*. 2014). The situation facing *E. stenostoma* (i.e. increase in high frequency fire driven by climate change impacting obligate seeder eucalypts) is similar to that already observed in *E. delegatensis* (Bowman *et al*. 2014), and widespread population declines are likely to occur if fires occur within the minimum tolerable fire interval. Fire history data indicates the landscape of *E. stenostoma* experiences frequent fires, including multiple large-scale high severity bushfires in recent decades (DPE 2021b). The frequency of fire in the landscape is currently very close to the estimated tolerable fire limit for the species of 20 years, putting it in a precarious state should more fires occur.

16. Based on the modelling of Bradstock *et al.* (2010), the fidelity of *Eucalyptus stenostoma* to topographically exposed, rocky ridgelines and steep slopes poses a hazard to the species if further bushfires occur under extreme fire weather. Young stands of regrowth that are relatively short and dense, but which have undergone partial self-thinning may be at greater risk of canopy fire than older, mature forest or very young regrowth that are missing fine fuels (Taylor *et al*. 2014). Evidence of landscape-scale changes in the flammability of regrowth forests and their susceptibility to massive losses of regenerating plants has been observed across the Australian Alps and the Victorian Eastern Highlands (Lindenmayer *et al*. 2011; Bowman *et al*. 2014; Zylstra 2018).

17. Climate change projections show that southern Australia is likely to experience a longer fire season and an increase in the number of dangerous fire weather days (CSIRO 2015; CSIRO and BOM 2020), increasing the risk of fires that drive the impacts described above. Importantly, climate change is also increasing the risk that fires will be preceded by, or followed by, severe drought or heat waves. Fire-drought interactions could increase mortality of the species and hence the rate of population decline (DAWE 2022). The incidence of further drought is likely to place limits on seed production, growth rates and lengthen the reproductive maturity required for *E. stenostoma* to sufficiently replenish seed banks (Nolan *et al*. 2020) and therefore further increase the threshold for the species' minimum tolerable fire limit.

18. *Eucalyptus stenostoma* L.A.S.Johnson & Blaxell is not eligible to be listed as a Critically endangered species

19. *Eucalyptus stenostoma* L.A.S.Johnson & Blaxell 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)(f i)

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)(f i)

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: 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.

Senior Professor Kristine French
Chairperson
NSW Threatened Species Scientific Committee

Supporting Documentation:

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