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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 tree *Eidothea hardeniana* P.H.Weston & Kooyman as a CRITICALLY ENDANGERED SPECIES in Part 1 of Schedule 1 of the Act and, as a consequence, to omit reference to *Eidothea hardeniana* P. H.Weston & Kooyman from Part 2 of Schedule 1 (Endangered species) of the Act. Listing of Critically Endangered species is provided for by Part 4 of the Act.

Summary of Conservation Assessment

Eidothea hardeniana P.H.Weston & Kooyman 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) and Clause 4.4(a)(d i)(e i,ii B) because: 1) it has a very highly restricted geographic distribution with an extent of occurrence and area of occupancy of 8 km^2; 2) it occurs in one threat-defined location; 3) it has a very low total number of mature individuals (estimated at 181), all of which occur in one subpopulation; 4) continuing decline in the area, extent and quality of habitat, and the number of mature individuals is estimated and observed due to the combined and interactive threats of adverse fire regimes (particularly high frequency fire and high severity fire), drought, and extreme rainfall and flood events; and 5) there has been a population reduction of ~30% in less than three years.

The NSW Threatened Species Scientific Committee has found that:

1. *Eidothea hardeniana* P.H.Weston & Kooyman (family Proteaceae) is described as "trees 15–40 m high, with one main trunk but often with up to 40 smaller shoots branching from the base. Juvenile leaves in false whorls of 3–6, narrowly elliptical to obovate or ovate, with spinose-dentate margins, 8–15 cm long, 2–5 cm wide. Adult leaves in false whorls of 4–7, narrowly elliptical to obovate, with entire, flat to slightly recurved margins, (2.5–)8–13.5 cm long, (0.7–)1.7–4.2 cm wide; petiole (3–)5–10 mm long; apical spine 1–4.5 mm long. Inflorescence 7–11-flowered; peduncle 6–7 mm long. Male flowers with perianth 8.0–9.6 mm long, basally connate for 2.2–3.3 mm; anthers 4.0–5.0 mm long. Bisexual flowers with perianth 10.0–12.0 mm long, basally connate for *c*. 3.4 mm; anthers 4.9–5.0 mm long; pistil 9.5–10.6 mm long; ovary densely covered in ascending hairs. Fruits dull golden yellow, broad-ovoid to broad-ellipsoidal, 3.5–4.0 cm long. 3.0–3.7 cm diameter; mesocarp 2–4 mm thick, composed of soft, pithy, cream-coloured tissue; pyrene 2.7–3.4 cm long, 2.3–3.1 cm diameter" (PlantNet 2024).
2. *Eidothea hardeniana* is endemic to New South Wales (NSW) in the South Eastern Queensland Bioregion (Commonwealth DCCEEW 2012), where it is restricted to the southern side of the Nightcap Range (Weston and Kooyman 2002) within Nightcap National Park and Whian Whian State Conservation Area. The distribution of *E. hardeniana* occurs on the traditional lands of the Bundjalung people (AIATSIS 1996; Native Land Digital 2024).
3. The extent of occurrence (EOO) was calculated at 1.91 km^2 and is based on a minimum convex polygon enclosing all mapped occurrences of the species, the

method of assessment recommended by IUCN (2024). The area of occupancy (AOO) is estimated to be 8 km^2 and was calculated using 2 x 2 km grid cells, the scale recommended by IUCN (2024). The IUCN (2024) states that "if EOO is less than AOO, EOO should be adjusted to make it equal to AOO to ensure consistency with the definition of AOO as an area within EOO". Therefore, EOO is estimated at 8 km^2.

4. *Eidothea hardeniana* occurs in a single known subpopulation, as per the IUCN (2024) definition. Genetic analysis has shown that *E. hardeniana* can be treated as a single subpopulation due to low genetic differentiation between the (marginally) spatially separated sites (ReCER 2021). The geographical distance between sampled parents and seedlings indicates that while pollen dispersal typically occurs over short distances (<50 m) it can occasionally move over longer distances (500–700 m) (ReCER 2021). Analysis of population genetics has shown that seed dispersal is limited, with dispersal away from the maternal tree uncommon (Rossetto and Kooyman 2005; ReCER 2021).

5. The current known population size of *Eidothea hardeniana* is 181 mature individuals, of which 109 are classed as being in good health and 72 in poor-fair condition (R. Kooyman *in litt.* October 2024). The 72 individuals in poor-fair condition are either declining in health or have lost their adult stems and persist as basal suckers only (Kooyman *in litt.* October 2024). At last survey, there were 409 individuals including juveniles and seedlings (Kooyman 2023).

6. *Eidothea hardeniana* occurs in upland warm temperate rainforest (OEH 2018) at elevations ranging from 360–750 m, where it is restricted to simple notophyll vine forest on soils derived from acid volcanic rocks (rhyolite lithology) (Weston and Kooyman 2002). Average annual rainfall in the Nightcap Range exceeds 2,500 mm (Graham 2001, cited in DEC 2004).

7. *Eidothea hardeniana* appears to have some ability to persist after fire due to its ability to resprout basally (DPE 2023). However, given the high rates of mortality that occurred among individuals that were burnt in the 2019–2020 wildfire, the frequency of resprouting might be low. Resprouting responses are likely to vary depending on a number of factors including growth stage, pre-fire health of plants, post-fire moisture availability and the frequency and severity of fires. The species is largely confined to refugial rainforest habitat which very rarely burns (Rossetto and Kooyman 2005).

8. It is possible that native rodents aid seed dispersal by caching the fruit (DEC 2004); however, further research is required to verify this. Germination can only occur once the woody endocarp has been partially or fully removed, which enables water to penetrate to the seed (DEC 2004). In glasshouse conditions, fresh seed takes up to six months to germinate at 25°C (Offord and Azzopardi 2002). It is thought seeds may be short lived (1–3 years), based on the failure to germinate any seeds collected from the ground (C. Offord pers comm., cited in DEC 2004).

9. *Eidothea hardeniana* is threatened by adverse fire regimes (particularly high frequency fire and high severity fire), drought, and extreme rainfall and flood events. The introduction of *Phytophthora cinnamomi* is a plausible future threat. Logging from the 1950s to the late 1990s is likely to have been a historical threat (R. Kooyman *in litt*. October 2024) and all stands of *Eidothea hardeniana* are now

protected in National Park and State Conservation Areas. '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.

10. *Eidothea hardeniana* occurs at one threat-defined location as per the IUCN (2024) definition, based on the most serious plausible threat which results in the lowest number of locations being adverse fire regimes. With a very highly restricted geographic distribution, it is highly plausible that a single future fire could affect all or most of the individuals present.

11. *Eidothea hardeniana* has been observed to be undergoing continuing decline in the number of mature individuals and is estimated to be experiencing continuing decline in the area, extent and quality of habitat due to the combined and interactive threats of adverse fire regimes (particularly high frequency and high severity fire), drought, and extreme rainfall and flood events. The Mount Nardi wildfire in 2019–2020 burnt ~30% of the species' habitat and resulted in a ~30% decline in its population size (R. Kooyman *in litt.* October 2024). The fire had a variable effect on the population: less than half of the individuals recorded with full canopy consumption in 2020–2021 were killed by the fire (DPE 2023), with the remainder surviving and resprouting. Drought exacerbates the threat of fire by drying normally wet, fire-resistant habitat. Drought can combine with extreme fire weather – characterised by high temperatures, low humidity, and strong winds – to increase the likelihood of severe wildfire (Squire *et al*. 2019; Richardson *et al*. 2022). Although fire is normally rare in rainforest, the antecedent drought conditions in 2017–2019 enabled large areas of rainforest to burn regionally (Godfree *et al*. 2021). Drought also threatens *Eidothea hardeniana* by resulting in low flower to fruit ratios and low seed production, as was recorded during the 2017–2019 drought (R. Kooyman *in litt.* October 2024). Erosion and landslips following heavy rainfall and subsequent flooding during the 2020–2023 La Niña event, resulted in the further loss of several mature individuals (R. Kooyman *in litt.* October 2024).

12. Climate change projections indicate a future trend of increased frequency of severe fire weather and more frequent fires (Abatzoglou *et al*. 2019; Dowdy *et al*. 2019; Jones *et al*. 2022). The North Coast region is projected to become hotter, have fewer cold nights under 2°C, have more hot days over 35°C, have more dangerous fire weather days, and have a longer fire season by 2079 (BOM and CSIRO 2022; AdaptNSW 2024). Regionally, it is projected with high confidence that climate change will result in a harsher fire-weather climate in the future (CSIRO 2024). It is plausible that these changes will lead to more frequent, intense, and severe fires, and changes in fire season, which may in turn adversely affect the *Eidothea hardeniana* population in the future.

13. *Eidothea hardeniana* P.H.Weston & Kooyman 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: *Eidothea hardeniana* was found to be Critically Endangered under Clause 4.3(a)(d)(e i,iii) and Clause 4.4(a)(d i)(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,	
	(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 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 C)
Assessment Outcome: Critically Endangered under Clause 4.4(a)(d i)(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: 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

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:

Saunders M (2025) *Eidothea hardeniana* P.H.Weston & Kooyman (Proteaceae). NSW NSW Department of Climate Change, Energy, the Environment and Water.

References:

Abatzoglou JT, Williams AP, Barbero R (2019) Global emergence of anthropogenic climate change in fire weather indices. *Geophysical Research Letters* **46**, 326–336.

AdaptNSW (2024) Interactive climate change projections map [Online]. Available at: https://www.climatechange.environment.nsw.gov.au/projections-map (accessed on 01 October 2024)

Australian Institute of Aboriginal and Torres Strait Islander Studies (AIATSIS) (1996) Map of Indigenous Australia [Online]. Available at: https://aiatsis.gov.au/explore/map-indigenous-australia (accessed 21 August 2024)

Bureau of Meteorology and Commonwealth Scientific and Industrial Research Organisation (BOM and CSIRO) (2022) State of the Climate 2022. Bureau of Meteorology and Commonwealth Scientific and Industrial Research Organisation, Commonwealth of Australia (Online). Available at: http://www.bom.gov.au/state-of-

the-climate/2022/documents/2022-state-of-the-climate-web.pdf (accessed 01 October 2024)

Commonwealth Department of Climate Change, Energy, the Environment, and Water (Commonwealth DCCEEW) (2012) Interim Biogeographic Regionalisation for Australia (IBRA), Version 7 (Regions) [spatial dataset]. Available at: https://datasets.seed.nsw.gov.au/dataset/interim-biogeographic-regionalisation-for-australia-ibra-version-7-regions (accessed 28 March 2025)

Commonwealth Scientific and Industrial Research Organisation (CSIRO) (2024) Climate Change in Australia: East Coast South projection summaries (Online). Available at: https://www.climatechangeinaustralia.gov.au/en/projections-tools/regional-climate-change-explorer/sub-clusters/?current=ECSC&tooltip=true&popup=true (accessed 01 October 2024)

Department of Environment and Conservation (DEC) (2004) Recovery Plan for the Nightcap oak (*Eidothea hardeniana*). (DEC: Hurstville)

Department of Planning and Environment (DPE) (2023) Saving our Species Nightcap oak 2021–2022 annual report card. Department of Planning and Environment, Parramatta, NSW.

Dowdy AJ, Ye H, Pepler A, Thatcher M, Osbrough SL, Evans JP, Di Virgilio G, McCarthy N (2019) Future changes in extreme weather and pyroconvection risk factors for Australian wildfires. *Scientific Reports* **9**(1), 10073.

Godfree RC, Knerr N, Encinas-Viso F, Albrecht D, Bush D, Christine Cargill D, Clements M, Gueidan C, Guja LK, Harwood T, Joseph L (2021) Implications of the 2019–2020 megafires for the biogeography and conservation of Australian vegetation. *Nature Communications* **12**(1), 1023.

IUCN Standards and Petitions Subcommittee (2024) Guidelines for Using the IUCN Red List Categories and Criteria. Version 16 [Online]. Available at: http://www.iucnredlist.org/documents/RedListGuidelines.pdf (accessed on 21 August 2024)

Jones MW, Abatzoglou JT, Veraverbeke S, Andela N, Lasslop G, Forkel M, Smith AJ, Burton C, Betts RA, van der Werf GR, Sitch S (2022) Global and regional trends and drivers of fire under climate change. *Reviews of Geophysics* **60**(3), e2020RG000726.

Kooyman R (2023) Risk Assessment inclusive of fire impacts in the habitat of Nightcap Oak (*Eidothea hardeniana* Weston & Kooyman; Proteaceae) Demography and Evaluation. Research Centre for Ecosystem Resilience, Sydney.

Native Land Digital (2024) Native Land [Online]. Available at https://native-land.ca/ (accessed 21 August 2024)

Office of Environment and Heritage (OEH) (2018) Nightcap Oak - profile [Online]. Available at: https://threatenedspecies.bionet.nsw.gov.au/profile?id=10260 (accessed 1 October 2024)

Offord C, Azzopardi A (2002) Propagation of the Nightcap oak (*Eidothea hardeniana*). *Australian Plants* **21**, 343–344.

PlantNet (2024) *Eidothea hardeniana* P.H.Weston & Kooyman [Online]. Available at: https://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Eidothea~hardeniana (accessed 16 August 2024)

Research Centre for Ecosystem Resilience (ReCER) (2021) Conservation genomics of *Eidothea hardeniana* in support of management and translocation activities. Royal Botanic Gardens and Domain Trust, Sydney.

Richardson D, Black AS, Irving D, Matear RJ, Monselesan DP, Risbey JS, Squire DT, Tozer CR (20220 Global increase in wildfire potential from compound fire weather and drought. *NPJ Climate and Atmospheric Science* **5**(1), 23.

Rossetto M, Kooyman RM (2005) The tension between dispersal and persistence regulates the current distribution of rare palaeo-endemic rain forest flora: a case study. *Journal of Ecology* **1**, 906–917.

Squire DT, Richardson D, Risbey JS, Black AS, Kitsios V, Matear RJ, Monselesan D, Moore TS, Tozer CR (2021) Likelihood of unprecedented drought and fire weather during Australia's 2019 megafires. *NPJ Climate and Atmospheric Science* **4(**1), 64.

Weston PH, Kooyman RM (2003) Botany and ecology of the 'Nightcap oak', *Eidothea hardeniana* [Online]. Available at: https://anpsa.org.au/APOL32/dec03-4.html (accessed 30 September 2024)