Conservation Assessment of *Eidothea hardeniana* P.H.Weston & Kooyman (Proteaceae)

Matt Saunders 12/03/2026
NSW Department of Climate Change, Energy, the Environment and Water

Eidothea hardeniana P.H.Weston & Kooyman (Proteaceae)

Distribution: Endemic to NSW
Current EPBC Act Status: Critically Endangered
Current NSW BC Act Status: Endangered

Proposed listing on NSW BC Act: Critically Endangered

Reason for change: *Eidothea hardeniana* was originally listed as Endangered on the *Threatened Species Conservation Act 1995*, the highest category under the legislation at that time. In 2005, the *Threatened Species Conservation Act 1995* was amended to provide for the listing of Critically Endangered species, but the eligibility of *Eidothea hardeniana* for listing as a Critically Endangered species has not been assessed until now. This new assessment has found that the species meets the IUCN Red List criteria for Critically Endangered status.

Summary of Conservation Assessment

Eidothea hardeniana was found to be Critically Endangered under IUCN Criteria B1ab(iii,v)+2ab(iii,v), C1, C2a(ii).

The reasons for the species being eligible for listing in the Critically Endangered category are: (1) it has a very highly restricted geographic distribution with an area of occupancy and extent of occurrence 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); (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.

Eidothea hardeniana. Photo: Justin Mallee/DCCEEW

Description and Taxonomy

Eidothea hardeniana P.H.Weston & Kooyman, also known as the nightcap oak, is a conventionally accepted species in the family Proteaceae (CHAH 2024; PlantNet 2024). *Eidothea hardeniana* 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).

Eidothea hardeniana can be distinguished from its congener *E. zoexylocarya* by having acuminate adult leaves, with a prominent, needle-like, apical spine 1–4.5 mm long; venation more prominent on the adaxial leaf surface than the abaxial; floral bracts surrounding inflorescence strongly recurved to revolute; widest part of perianth tube distinctly thickened; sterile gynoecium of male flowers with a prominently bifid tip; and style tip prominently capitate (adult leaves obtuse to acuminate, lacking a spinose mucro; venation more prominent on the abaxial leaf surface than the adaxial; floral bracts surrounding inflorescence slightly recurved or incurved; widest part of perianth tube unthickened; sterile gynoecium of male flowers absent, or present but with a spathulate, obscurely bilobed tip; and style abruptly tapered at tip, not capitate as in *E. zoexylocarya* (Weston and Kooyman 2002).

Distribution and Abundance

Eidothea hardeniana is endemic to the South Eastern Queensland bioregion of New South Wales (NSW; NSW DCCEEW 2024) where it is restricted to a single catchment on 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).

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 long distances (500–700 m; ReCER 2021).

The current distribution estimate is based on 252 unique and cleaned records compiled from NSW BioNet Atlas, Atlas of Living Australia, and herbarium specimens (ALA 2024; ANHSIR 2024; BioNet 2024; RBGDT 2024). Two hundred and seventy-four records were excluded from the assessment: 26 records had inadequate data to spatially validate or were of cultivated origins and 248 records were database duplicates.

Extent of occurrence and area of occupancy

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 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 IUCN (2024) states that "if EOO is less than AOO, EOO should be changed 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. Both EOO and AOO were calculated using ArcGIS (Esri 2015), enclosing all confirmed survey records, and cleaned spatial datasets.

Population size and trends

The current population size of *Eidothea hardeniana* is estimated at 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 in decline or have lost their adult stems and persist as suckers only (Kooyman *in litt.* October 2024). There are currently 409 individuals including juveniles and seedlings (Kooyman 2023).

In 2019, antecedent drought and fire weather conditions resulted in a wildfire that burnt through part of the *Eidothea hardeniana* population (Kooyman 2023). The fire burnt a substantial part of the population and resulted in significant mortality (DPE 2023). In 2022, extreme rainfall events led to flooding, landslips, and treefalls, with the subsequent loss of several mature individuals (Kooyman *in litt.* October 2024). Collectively, the fire and floods resulted in the loss of 153 individuals (of all age classes and including individuals which have not been relocated; Kooyman 2023), most of which were lost to the fire (R. Kooyman *in litt.* October 2024). Consequently, the population size of *E. hardeniana* is estimated to have declined by ~30% (Kooyman 2023) over a period of two years.

Ecology

Habitat

Eidothea hardeniana occurs in upland warm temperate rainforest (OEH 2018) at elevations ranging from 360–650 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).

Eidothea hardeniana has been recorded in the following mapped Plant Community Types (PCTs): Northern Ranges Coachwood Warm Temperate Rainforest (PCT 3035) and Northern Brush Box Subtropical Wet Forest (PCT 3165) (NSW DCCEEW 2023). It is possible that the species occurs in other rainforest PCTs in the Nightcap Ranges.

Co-occurring threatened species listed on the *Biodiversity Conservation Act 2016* include *Corokia whiteana*, *Elaeocarpus sedentarius*, *Endiandra hayesii*, *Hibbertia hexandra*, *Hicksbeachia pinnatifolia*, *Symplocos baeuerlenii*, and *Uromyrtus australis* (DEC 2004).

Fire and disturbance ecology

Eidothea hardeniana appears to have some ability to persist after fire due to its ability to resprout basally and produce suckers (DPE 2023). However, given the high rates of mortality that occurred in individuals burnt in the 2019–2020 wildfire, this response is likely to be limited to low frequency and low severity fire. The species is largely confined to refugial rainforest habitat which very rarely burns (Rossetto and Kooyman 2005).

Reproductive and seed ecology

Eidothea hardeniana flowers from mid-October to mid-November (Weston and Kooyman 2003) and is thought to be insect-pollinated. Diurnal and nocturnal beetles, katydids (Tettigoniidae), and hoverflies (Syrphidae) have been observed visiting flowers (DEC 2004). Fruit set occurs approximately 15–18 months after flowering, reaching full size around the middle of December, then changing colour from green to dull yellow before falling from mid-February to early March (Weston and Kooyman 2002; DEC 2004). Bush rats (*Rattus fuscipes*) regularly gnaw through the mesocarp and hard endocarp to eat the seed (Weston and Kooyman 2003).

Population genetics has shown that seed dispersal is limited, with dispersal away from the maternal tree uncommon (Rossetto and Kooyman 2005; ReCER 2021). It is possible rats aid dispersal by caching the fruit (DEC 2004).

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)

Lifespan and generation length

Eidothea hardeniana is likely to be long-lived (DEC 2004) and individuals may live for hundreds or even thousands of years (R. Kooyman *in litt.* October 2024). The primary juvenile period is not known and will vary relative to shade and competition (R. Kooyman *in litt.* October 2024). Seed longevity in the soil seedbank is thought to be no more than 1–3 years (C. Offord pers comm., cited in DEC 2004; R. Kooyman *in litt.* October 2024). Due to the high uncertainty around all parameters relating to lifespan and reproductive maturity, it is not possible to estimate generation length.

Cultural significance

It is unknown whether *Eidothea hardeniana* has cultural significance to Aboriginal peoples. This assessment is not intended to be comprehensive of the traditional ecological knowledge that exists for *Eidothea hardeniana*, or to speak for Aboriginal people. Aboriginal people have a long history of biocultural knowledge, which comes from observing and being on Country, and evolves as it is tested, validated, and passed through generations (Woodward *et al*. 2020). Aboriginal peoples have cared for Country for tens of thousands of years (Bowler *et al*. 2003; Clarkson *et al*. 2017). There is traditional ecological knowledge for all plants, animals and fungi connected within the kinship system (Woodward *et al*. 2020).

Threats

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 are now protected in National Park and State Conservation Areas.

Adverse fire regimes

Eidothea hardeniana is threatened by adverse fire regimes, particularly high frequency fire and high severity fire. The Mt 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, with less than half of the individuals recorded with full canopy consumption in 2020–2021 found to have been killed by the fire (DPE 2022). The ability of some individuals to resprout following fire confers some capacity to persist in response to fire, but still results in the loss of mature (reproductive) stems (R. Kooyman *in litt.* October 2024). The high mortality following the Mt Nardi wildfire indicates a low tolerance for fire, with survival likely to be lowest at high fire severity. Furthermore, repeated short interval fires can lead to depressed or failed resprouting in resprouting species (Karavani *et al.* 2018; Fairman *et al.* 2019).

Historic logging and expansion of commercial eucalypt forests reduced and modified rainforest in the Nightcap Ranges, resulting in an increase in eucalypt forest, a simplified mosaic of wet forest, and the removal of riparian forest along smaller creeks (Kooyman 2023). The legacy of those actions, together with the effects of the Mt Nardi wildfire, which increased the representation of pyrophytic elements in community assemblages (*e.g.*, *Acacia orites*) in proximity to the *Eidothea hardeniana* population, is an ongoing increased fire risk (Kooyman 2023).

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 will in turn adversely affect the *Eidothea hardeniana* population in the future.

'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition', is listed as a Key Threatening Processes under the *Biodiversity Conservation Act 2016*. 'Fire regimes that cause declines in biodiversity' is listed as a Key Threatening Processes under the *Environment Protection and Biodiversity Conservation Act 1999*.

Drought

Drought 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). Drought also threatens *E. hardeniana* by predisposing normally wet habitat to fire by drying it out. Drought can compound with 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). This interaction was highlighted by the Mt Nardi wildfire. While fire is normally rare in rainforest, the antecedent drought conditions enabled large areas of rainforest to burn regionally (Godfree *et al.* 2021).

On average, cool season rainfall is predicted to continue to decrease in eastern Australia, which will likely lead to more time in drought (BOM and CSIRO 2022). Regionally, time spent in drought is projected, with medium confidence, to increase over the course of the century (CSIRO 2024). It is plausible that these changes will lead to more extreme and prolonged droughts, which may in turn adversely affect the *Eidothea hardeniana* population in the future.

There is also a risk of extreme drought resulting in more frequent or severe fires, which could in turn adversely affect the *Eidothea hardeniana* population. Projections indicate a trend of increasing temperatures and more dangerous fire weather days by 2079 (BOM and CSIRO 2022; AdaptNSW 2024), which is likely to contribute to drier, more flammable fuel loads (Williams *et al.* 2019). Drought has been shown to lead to an increased chance of wildfire (Cui *et al.* 2023) and has been identified as one of the major drivers of the 2019–2020 fires that burned large swathes of southeastern Australia (Deb *et al.* 2020).

'Anthropogenic Climate Change' is listed as a Key Threatening Process under the *Biodiversity Conservation Act 2016*. 'Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases' is listed as a Key Threatening Process under the *Environment Protection and Biodiversity Conservation Act 1999*.

Extreme rainfall and flood events

Eidothea hardeniana is threatened by extreme rainfall and flood events, which can result in landslips and treefalls. Heavy rainfall and subsequent flooding and landslips during the 2020–2023 La Niña event resulted in the loss of several mature individuals (R. Kooyman *in litt.* October 2024). Regionally, extreme rainfall is projected, with high confidence, to increase in the future, although the magnitude of the increases cannot be confidently predicted (CSIRO 2024). It is plausible these changes will lead to more frequent floods and landslips, which could in turn adversely affect the *E. hardeniana* population.

'Anthropogenic Climate Change' is listed as a Key Threatening Process under the *Biodiversity Conservation Act 2016*. 'Loss of climatic habitat caused by anthropogenic emissions of greenhouse gases' is listed as a Key Threatening Process under the *Environment Protection and Biodiversity Conservation Act 1999*.

Introduction of *Phytophthora cinnamomi*

The introduction of *Phytophthora cinnamomi* into habitat areas is a plausible future threat to *Eidothea hardeniana*. *Phytophthora cinnamomi* is an oomycete that causes root rot and subsequent dieback in a wide range of plant species and poses a risk of serious decline to thousands of plant species nationally (DEE 2018). The susceptibility

of *E. hardeniana* to *P. cinnamomi* is not known. Proteaceae contains a high proportion of susceptible genera and species (Weste 1994; DEE 2018; Hart *et al*. 2024); however, members of the family show a range of responses to infection with *P. cinnamomi*, from resistant to susceptible (Shearer *et al*. 2013). Transmission pathways include humans (*e.g*., bushwalkers), animals, and passively, via overland or subsurface water flow (DEE 2018). The pathogen has been recorded in Whian Whian SCA (NPWS 2010).

Number of locations

Eidothea hardeniana occurs at one threat-defined location as per the IUCN (2024) definition, due to the most serious plausible threat which results in the lowest number of locations being adverse fire regimes. The Mt Nardi wildfire in 2019–2020 burnt ~30% of the species' habitat (R. Kooyman *in litt.* October 2024). However, 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. Furthermore, consideration of the threat of drought would also result in a single threat-defined location.

Assessment against IUCN Red List criteria

For this assessment it is considered that the survey of *Eidothea hardeniana* has been adequate and there is sufficient scientific evidence to support the listing outcome.

Criterion A *Population size reduction*

A. Population size reduction. Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4

	Critically Endangered	Endangered	Vulnerable
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3 & A4	≥ 80%	≥ 50%	≥ 30%

A1 Population reduction observed, estimated, inferred, or suspected in the past where the causes of the reduction are clearly reversible AND understood AND have ceased.

A2 Population reduction observed, estimated, inferred, or suspected in the past where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.

A3 Population reduction projected, inferred or suspected to be met in the future (up to a maximum of 100 years) *[(a) cannot be used for A3]*.

A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.

based on any of the following:

(a) direct observation *[except A3]*

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy (AOO), extent of occurrence (EOO) and/or habitat quality

(d) actual or potential levels of exploitation

(e) effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites.

Outcome

Eidothea hardeniana is Data Deficient under Criterion A.

Population reductions

The combined effects of fire and extreme rainfall and flood events are observed to have led to a ~30% reduction in population size and habitat area/quality in just two years (R. Kooyman *in litt.* October 2024). Historical logging is also likely to have resulted in population reductions (R. Kooyman *in litt*. October 2024), although the magnitude of this past threat cannot be quantified.

Conclusion

Eidothea hardeniana is Data Deficient under Criterion A as the generation length is not known. Consequently, it is not possible to quantify decline over a three-generation timeframe.

Criterion B *Geographic range*

B. Geographic range in the form of either B1 (extent of occurrence) AND/OR B2 (area of occupancy)			
	Critically Endangered	Endangered	Vulnerable
B1. Extent of occurrence (EOO)	< 100 km²	< 5,000 km²	< 20,000 km²
B2. Area of occupancy (AOO)	< 10 km²	< 500 km²	< 2,000 km²
AND at least 2 of the following 3 conditions:			
(a) Severely fragmented OR Number of locations	= 1	≤ 5	≤ 10
(b) Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			

Outcome

Eidothea hardeniana is Critically Endangered under Criterion B1ab(iii,v)+2ab(iii,v).

EOO and AOO

Eidothea hardeniana is endemic to the Nightcap Ranges of NSW. The extent of occurrence (EOO) and area of occupancy (AOO) have been calculated at 8 km^2.

Number of threat-defined locations

Eidothea hardeniana is found at one threat-defined location when considering the most serious plausible threat of adverse fire regimes. Consideration of the threat of drought would also result in one threat-defined location.

Severely fragmented

Eidothea hardeniana is not considered to be severely fragmented, as the species occurs in a single subpopulation which is considered to be viable.

Continuing decline

Eidothea hardeniana has an observed continuing decline in the number of mature individuals and estimated 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.

Extreme fluctuations

There is no evidence to suggest *Eidothea hardeniana* undergoes extreme fluctuations and as a long-lived tree, it is unlikely to.

Conclusion

Eidothea hardeniana is eligible to be listed as Critically Endangered as it has a very highly restricted geographic distribution (an AOO and EOO of 8 km^2), occurs in one threat-defined location, and is undergoing continuing decline in the number of mature individuals and the area, extent, and quality of habitat.

Criterion C Small population size and decline

C. Small population size and decline				
		Critically Endangered	Endangered	Vulnerable
Number of mature individuals		< 250	< 2,500	< 10,000
AND at least one of C1 or C2				
C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future):		25% in 3 years or 1 generation (whichever is longer)	20% in 5 years or 2 generations (whichever is longer)	10% in 10 years or 3 generations (whichever is longer)
C2. An observed, estimated, projected or inferred continuing decline AND at least 1 of the following 3 conditions:				
(a)	(i) Number of mature individuals in each subpopulation	≤ 50	≤ 250	≤ 1,000
	(ii) % of mature individuals in one subpopulation =	90–100%	95–100%	100%
(b) Extreme fluctuations in the number of mature individuals				

Outcome

Eidothea hardeniana is Critically Endangered under Criterion C1 and Criterion C2a(ii).

Number of mature individuals

The current population size of *Eidothea hardeniana* is estimated at 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).

Continuing decline

The combined effects of wildfire and extreme rainfall and flood events have resulted in an observed decline in the number of mature individuals exceeding the threshold of 25% within three years, meeting the requirements for Critically Endangered under Criterion C1.

Mature individuals in each subpopulation

Eidothea hardeniana occurs in a single subpopulation with an estimated 181 mature individuals.

% of mature individuals in a single subpopulation

As *Eidothea hardeniana* occurs in a single subpopulation, 100% of the mature individuals occur in one subpopulation.

Extreme fluctuations

There is no evidence to suggest *Eidothea hardeniana* undergoes extreme fluctuations and as a long-lived tree, it is unlikely to.

Conclusion

Eidothea hardeniana is eligible to be listed as Critically Endangered as it has a very small population size of 181 mature individuals, has undergone a population reduction of 30% in less than three years, and occurs in a single subpopulation.

Criterion D Very small or restricted population

D. Very small or restricted population			
	Critically Endangered	Endangered	Vulnerable
D. Number of mature individuals	< 50	< 250	D1. < 1,000
D2. *Only applies to the VU category* Restricted area of occupancy or number of locations with a plausible future threat that could drive the taxon to CR or EX in a very short time.	-	-	D2. typically: AOO < 20 km² or number of locations ≤ 5

Outcome

Eidothea hardeniana is Endangered under D.

Number of mature individuals

The current population size of *Eidothea hardeniana* is estimated at 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).

Risk of future extinction in a very short amount of time (D2)

Eidothea hardeniana occurs at one threat-defined location and has an estimated AOO of 8 km^2. Its highly restricted distribution is such that the population is prone to the effects of stochastic fire events in an uncertain future, and is thus capable of becoming Critically Endangered or even Extinct in a very short time period (e.g., within one or two generations), noting that the species is already eligible for Critically Endangered status under criteria C and D. Although meeting criterion D2 for Vulnerable status (the maximum possible category for that subcriterion), the overall status of *Eidothea hardeniana* under criterion D is Endangered due to its small number of mature individuals (see above).

Criterion E Quantitative Analysis

E. Quantitative Analysis			
	Critically Endangered	Endangered	Vulnerable
Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)	≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)	≥ 10% in 100 years

Outcome

Eidothea hardeniana is considered Data Deficient under Criterion E.

Probability of extinction

No quantitative analysis has been undertaken to assess the extinction probability of this species and there are currently insufficient data to undertake one.

Conservation and Management Actions

Eidothea hardeniana is currently listed on the NSW *Biodiversity Conservation Act 2016* and a conservation project has been developed by the NSW Department of Climate Change, Energy, the Environment and Water under the Saving our Species program. The conservation project identifies priority locations, critical threats and required management actions to ensure the species is extant in the wild in 100

years. *Eidothea hardeniana* sits within the 'site-managed species' management stream of the SoS program and the conservation project can be viewed here: https://savingourspecies.environment.nsw.gov.au/project/290.

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Expert Communications

Dr. Robert Kooyman, Hon. Research Fellow, Department of Biological Sciences, Macquarie University, Sydney.

APPENDIX 1

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), Clause 4.4(a)(d i), 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,
	(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,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) and 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:			
			(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.