Exhibition period: 01/02/19 – 29/03/19 Proposed Listing date: 01/02/19

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 *Rhodamnia rubescens* (Benth.) Miq. as a CRITICALLY ENDANGERED SPECIES in Part 1 of Schedule 1 of the Act. Listing of Critically Endangered species is provided for by Part 4 of the Act.

Summary of Conservation Assessment

Rhodamnia rubescens is eligible for listing as Critically endangered under Clause 4.2 (a) (e) because: i) the species is projected to experience a population reduction of > 80% (CR threshold) over three generations or 10 years due to the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites.

The NSW Threatened Species Scientific Committee has found that:

1. *Rhodamnia rubescens* (Benth.) Miq. (family Myrtaceae) is described as a "Shrub or small tree to 25 m high, bark reddish brown, fissured; young stems densely tomentose. Leaves with lamina ovate to elliptic, 5–10 cm long, 2–4.5 cm wide, shortly acuminate, base cuneate to rounded, upper surface green and sparsely hairy, lower surface paler and sparsely to densely hairy with erect hairs; strongly 3-veined from base, lateral veins transverse; oil glands distinct, moderately dense; petiole 4–9 mm long. Inflorescences 1–3 per axil, each usually 3-flowered; peduncle 5–22 mm long. Hypanthium sparsely pubescent. Sepals 2–3 mm long, caducous. Petals 4–6 mm diam., white. Stamens 3–5 mm long. Style 4–5 mm long. Fruit globose, 5–8 mm diam., red turning black." (PlantNET 2018).

2. *Rhodamnia rubescens* is currently known to occur in coastal districts north from Batemans Bay in New South Wales (NSW), approximately 280 km south of Sydney, to areas inland of Bundaberg in Queensland. Populations of *R. rubescens* typically occur in coastal regions and occasionally extend inland onto escarpments up to 600 m a.s.l. in areas with rainfall of 1,000-1,600 mm (Benson and McDougall 1998).

3. *Rhodamnia rubescens* flowers in late winter through to spring, with a peak in October, and fruits typically begin to appear in December (PlantNET 2018). Populations and individuals of *R. rubescens* are often found in wet sclerophyll associations in rainforest transition zones and creekside riparian vegetation (Benson and McDougall 1998). *Rhodamnia rubescens* commonly occurs in all rainforest subforms except cool temperate rainforest. The species occupies a range of volcanically derived and sedimentary soils and is also a common pioneer species in eucalypt forests (Floyd 2008). Suitable habitat for *R. rubescens* is likely to occur in the following vegetation types: Subtropical Rainforests, Warm Temperate Rainforests, Littoral Rainforests, and Wet Sclerophyll Forests. It may also occur as a pioneer in adjacent areas of dry sclerophyll and grassy woodland associations (Keith 2004; Floyd 2008;). *Rhodamnia rubescens* has been documented occurring in association with *Acacia melanoxylon*, *Acmena smithii*, *Breynia oblongifolia*, *Corymbia intermedia*, *Endiandra discolor*, *Eucalyptus bosistoana*, *E. tereticornis*, *Glochidion sumatranum, Guioa semiglauca, Lophostemon suaveolens* and *Mallotus philippensis.*

4. In NSW, *Rhodamnia rubescens* is listed as a characteristic species in the Final Determination for the Endangered Ecological Community (EEC) 'Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Comer Bioregions'. *Rhodamnia* spp. are listed as characteristic species for the Final Determination of the EEC 'Lowland Rainforest in the NSW North Coast and Sydney Basin Bioregions' and the distribution of *R. rubescens* coincides with the documented spatial extent of this EEC. The species is also highly likely to occur in the followings EECs listed under the Act (although is not listed as a characteristic species): 'Lowland Rainforest on Floodplain in the New South Wales North Coast Bioregion', 'Subtropical Coastal Floodplain Forest of the New South Wales North Coast Bioregion' and 'Illawarra Subtropical Rainforest in the Sydney Basin Bioregion'. *Rhodamnia rubescens* may possibly occur in the following EECs listed under the Act (although is not listed as a characteristic species): 'Hunter Lowland Redgum Forest in the Sydney Basin and New South Wales North Coast Bioregions', 'River-Flat Eucalypt Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions', 'Swamp Sclerophyll Forest on Coastal Floodplains of the New South Wales North Coast, Sydney Basin and South East Corner Bioregions', 'Kurnell Dune Forest in the Sutherland Shire and City of Rockdale', 'Milton Ulladulla Subtropical Rainforest in the Sydney Basin Bioregion' and 'Pittwater and Wagstaffe Spotted Gum Forest in the Sydney Basin Bioregion'.

5. *Rhodamnia rubescens* has a large geographic range. The estimated extent of occurrence (EOO) of *R. rubescens* across Australia is 147,340 km^2. The EOO is based on a minimum convex polygon enclosing all occurrences of the species, the method of assessment recommended by IUCN (2016). The area of occupancy (AOO) is estimated as 3,360 km^2 based on 2 km x 2 km grid cells, the scale recommended for assessing AOO by IUCN (2016).

6. The number of mature individuals of *Rhodamnia rubescens* is currently unknown. No formal estimates of total abundance of the species across its range prior to 2010 has been located (B. Makinson *in litt*. April 2016). However, it is reasonably suspected that given the large geographic range size of *R. rubescens* and its characterisation as a common species (Benson and McDougall 1998; Floyd 2008) that a large number of mature individuals may have existed prior to 2010.

7. The survival of *Rhodamnia rubescens* is severely threatened by infection from the exotic rust fungus *Austropuccinia psidii* (myrtle rust). *Austropuccinia psidii* was first detected in Australia on the NSW Central Coast in April 2010 and has since established in natural ecosystems throughout coastal NSW, south-east Queensland and far north Queensland (Carnegie and Lidbetter 2012; Pegg *et al*. 2014). *Austropuccinia psidii* also has a limited distribution in Victoria, Tasmania and the Northern Territory (Carnegie *et al*. 2016). The 'Introduction and establishment of Exotic Rust Fungi of the order Pucciniales pathogenic on plants of the family Myrtaceae' is listed as a Key Threatening Process under the Act.

8. *Rhodamnia rubescens* is a known host of *Austropuccinia psidii* (Zauza *et al*. 2010) and is characterised as 'Highly to Extremely Susceptible' to infection (Pegg *et al*. 2014). All plant parts have been documented as being affected by *A. psidii* infection, including leaves, stems, flowers and fruits (Pegg *et al*. 2014; Carnegie *et al.* 2016). The disease rating system of Pegg *et al*. (2014) documents species susceptibility to *A. psidii* infection along a continuum from 'Relatively Tolerant' to 'Extremely Susceptible'. 'Highly Susceptible' species exhibit "rust sori…on 50–80% of expanding leaves and shoots, evidence of rust on juvenile stems and older leaves, leaf and stem blighting and distortion, multiple sori per leaf/stem" whereas 'Extremely Susceptible' species exhibit "rust sori…on all expanding leaves, shoots and juvenile stems; foliage dieback;

evidence of stem and shoot dieback" (Pegg *et al*. 2014). Results of field trials designed to actively prevent infection of *R. rubescens* by *A. psidii* establish a clear relationship between the incidence/severity of *A. psidii* infection and subsequent crown loss (% crown transparency) in this species (Carnegie *et al*. 2016). Any alternative causal agents of crown loss have been discounted. A similar, but smaller, trial was established at Tucki Tucki Nature Reserve in northern NSW to examine the impact of *A. psidii* infection on flower and fruit production and survival in *R. rubescens*. Branches with flowers were sprayed with fungicide monthly and survival compared to untreated branches. While fruit were produced on the untreated branches, all became infected and none survived until maturity (G. Pegg *in litt.* July 2016). Approximately 17 populations of *R. rubescens* have been identified as having lower incidence of damage from *A. psidii* and these may be useful targets for germplasm collection (J. Willis *in litt*. April 2018).

9. Extensive field assessments of *Austropuccinia psidii* infection on *Rhodamnia rubescens* across its entire range show infection is widespread and severe (Carnegie *et al*. 2016; J. Willis *in litt*. April 2018). Carnegie *et al*. (2016) assessed 43 sites for the impact of *A. psidii* on *R. rubescens* between January and October 2014, approximately 3–3.5 years after *A. psidii* had established across the range of this host species. Sites were distributed between Murramarang National Park, near Batemans Bay in NSW, to Traveston Crossing, near Gympie, Queensland. Sites were a mixture of locations where *A. psidii* infection on *R. rubescens* was already known to occur, and where no known infection had been documented (A. Carnegie *in litt*. July 2016). *Austropuccinia psidii* was detected as present on *R. rubescens* plants in a range of age classes at all sites, and no other plant disease established in Australia presents similar symptoms (Walker 1983). At all sites, approximately 20 individuals of *R. rubescens* were assessed for crown transparency using the scheme of Schomaker *et al*. (2007), the incidence of *A. psidii* (% infected) on mature leaves, immature leaves, flowers and fruit and rated for disease prevalence using the scheme from Pegg *et al.* (2012). Individuals were considered dead when crown transparency reached 100%. These comprehensive assessments of populations document mortality in *R. rubescens* across 18 of the 43 sites surveyed, where 12% of all the 669 surveyed trees were dead. Most sites contained only a few dead trees with the following exceptions: five sites had between 20 and 40% mortality, one site with 50% mortality and one site with 75% mortality (Carnegie *et al.* 2016). Across all sites mean crown transparency was 76.3% (standard error 0.8%), with the majority (79%) of trees having greater than 60% transparency. Based on prior knowledge of the species the normal crown transparency in an understorey is approximately 30-35% (Carnegie *et al*. 2016). All age classes of trees, as assessed by tree height, were similarly affected by *A. psidii* infection (Carnegie *et al*. 2016). Across all sites surveyed, disease incidence was greater on immature leaves (average incidence of 56.4%; standard error 2.1%) than on mature leaves (average incidence of 29.8%; standard error 1.2%) and an average disease rating score of 2.4 (0-4 scale; standard error 0.08) was documented.

10. Ongoing observations in 2016 of a smaller sub-sample of populations from Carnegie *et al*. (2016) since the end of the documented study period (2011–2014) estimate mortality has increased to over 50% at Bongil Bongil National Park and Royal National Park (A. Carnegie *in litt.,* July 2016). Greater than 50% mortality has also been observed at a new monitoring site in Pine Creek State Forest on the mid-north coast of NSW (B. Makinson *in litt*. April 2016). Ongoing observations also indicate that there has been no evidence of regenerating populations surviving, with all seedlings/suckers observed being killed by *A. psidii* (A. Carnegie *in litt*. July 2016). The continued decline of mature plants and lack of successful regeneration threaten the long-term viability of *R. rubescens* in the wild.

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11. Populations of *Rhodamnia rubescens* are projected to continue to rapidly decline due to infection by *Austropuccinia psidii*. Reductions in population size across the range of *R. rubescens* since infection from *A. psidii* have been documented over a short period of time (12% mortality over a period of 3–3.5 years (2011–2014)) relative to the inferred generation length of at least 30–40 years (Floyd 2008). Soil-stored seed banks are unlikely to be extensive for this species given its affinity for rainforest environments with high litter decomposition rates. Under documented rates of decline due to infection by *A. psidii*, *R. rubescens* is projected to undergo a 96–99% reduction in population size across its range within three generations. All age classes of *R. rubescens* have been documented to be affected by *A. psidii* (Carnegie *et al*. 2016) which severely reduces the capacity of infected populations to recover through time.

12. Quantitative findings of very large declines in *Rhodamnia rubescens* populations due to *Austropuccinia psidii* infection reported in Carnegie *et al*. (2016) are supported by field botanists who have encountered the species during routine botanical surveys and seed collecting over multiple years (B. Makinson *in litt*. April 2016; J. Willis *in litt*. April 2018).

13. There has been no confirmed evidence of resistance to *Austropuccinia psidii* infection in field populations of *Rhodamnia rubescens* to date (Pegg *et al*. 2014). Approximately 17 populations assessed across the range of *R. rubescens* have relatively low damage following infection by *A. psidii* (J. Willis *in litt*. April 2018). These populations may be important sources of naturally resistant germplasm. However, the prospect for naturally selected resistance emerging before the collapse of populations is currently considered small.

14. No effective or practical chemical, biological or management control is currently available for protecting populations of *Rhodamnia rubescens* in natural ecosystems from *Austropuccinia psidii* infection. Repeated monthly application of registered fungicides (e.g. triadimenol) for extremely high value assets concentrated in small local areas may be feasible but is impractical for widespread control. Where triadimenol has been used in experimental trials of *A. pisdii* control in natural populations of *R. rubescens*, applications repeated at longer than a monthly interval did not control infection (Carnegie *et al*. 2016). Whilst some biological control agents have been trialled to control *A. psidii* in *Eucalyptus* plantations overseas the likelihood that these controls will become viable options for eradication in Australia in the time frame relevant to the regeneration capacity of *R. rubescens* is negligible (Glen *et al*. 2007). Manipulation of the environment via management actions (e.g. fire management) to control *A. psidii* on *R. rubescens* would likely lead to high infection rates on resprouting leaf material which is known to be highly susceptible to infection (Carnegie *et al*. 2016). In the absence of an effective control strategy for *A. psidii* further rapid declines of *R. rubescens* populations are highly likely.

15. The ubiquity of susceptible species in the family Myrtaceae in the Australian landscape makes broad-scale eradication or containment of *Austropuccinia psidii* unlikely (Glen *et al*. 2007). The predominantly airborne nature of the rust spores and inadvertent dispersal by human activity (Carnegie and Cooper 2011) infers that *Rhodamnia rubescens* populations and individuals in conservation reserves may be no more secure than any other land tenure. It is expected that surviving plants and populations of *R. rubescens* will continue to be subject to a significant spore load, whether as wind-borne spores or by other vectors. This continued exposure severely reduces the likelihood of population recovery in *R. rubescens* (B. Makinson *in litt*. April 2016).

16. No adequate *ex-situ* collections of *Rhodamnia rubescens* material exist (G. Errington *in litt*. October 2016). Current holdings of wild-collected seed at the NSW Seedbank number < 20

seeds from two accessions. Tests on these seed-lots have shown extremely variable rates of seed fill (ranging from less than 1% to about 70%) (B Makinson *in litt*. April 2016). Soft-fruited Myrtaceae from rainforest environments are characterised by seeds which are desiccation-intolerant and, therefore, not suited to long-term conservation storage (Sommerville and Offord 2014). The Australian Seed Bank partnership reports that the conservation seed bank at Mt Coot-tha, Brisbane, has one batch of *R. rubescens* seed (B. Makinson *in litt.* April 2016). On the basis that field observations have shown a severe decline in fruit production since 2012, NSW Seedbank collectors do not expect to be able to find significant collectable quantities of fruit or seed of *R. rubescens* now or in the future (R. Johnstone *in litt*. October 2014). Some tissue culture collections are currently held within the NSW PlantBank at the Australian Botanic Garden, Mount Annan NSW.

17. It is reasonably suspected that some populations of *Rhodamnia rubescens* may also have undergone significant decline because of other past and current threats, such as land-clearing (particularly in rainforest clearing efforts in northern NSW for agriculture), fragmentation of populations, and weed invasion. These threats have been documented as causes of decline in the EEC ‘Littoral Rainforest in the New South Wales North Coast, Sydney Basin and South East Comer Bioregions’ where *R. rubescens* is named as a characteristic species (Adam 1987; 1992; Floyd 1990; Mills 1996).

18. *Rhodamnia rubescens* (Benth.) Miq. 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 Regulation 2017*:

Clause 4.2 – Reduction in population size of species
(Equivalent to IUCN criterion A)
Assessment Outcome: Critically Endangered under Clause 4.2 1 (a), 2 (e).

(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
	~~(b)~~	~~endangered species~~	~~a large reduction in population size~~
	~~(c)~~	~~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)
<u>Assessment Outcome</u>: Clause/Criterion not met.

The geographic distribution of the species is:				
	~~(a)~~	~~for critically endangered~~		~~very highly restricted~~
	~~(b)~~	~~endangered species~~		~~highly restricted~~
	~~(c)~~	~~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:						
	~~(b)~~	~~for critically endangered species~~ ~~endangered species~~ ~~vulnerable species~~				~~very low~~ ~~low~~ ~~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):~~				
		~~(ii)~~	~~for critically endangered species~~ ~~endangered species~~ ~~Vulnerable species~~			~~Very large~~ ~~Large~~ ~~moderate, or~~
	~~(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:~~		
				~~(II)~~	~~for critically endangered species~~	~~Extremely low~~

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					~~endangered species~~ ~~Vulnerable species~~	~~very low~~ ~~low, or~~
			~~(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:			
	~~(b)~~	~~for~~ ~~critically endangered species~~ ~~endangered species~~ ~~Vulnerable species~~	 ~~Extremely low~~ ~~very low~~ ~~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:			
	~~(b)~~	~~for~~ ~~critically endangered species~~ ~~endangered species~~ ~~Vulnerable species~~	 ~~Extremely high~~ ~~very high.~~ ~~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.

Dr Marco Duretto
Chairperson
NSW Threatened Species Scientific Committee

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