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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 *Asterolasia buxifolia* Benth. as a CRITICALLY ENDANGERED species in Part 1 of Schedule 1 of the Act and, as a consequence, to omit reference to *Asterolasia buxifolia* Benth. in Part 2 of Schedule 1 (Endangered species) of the Act. Listing of Critically Endangered species is provided for by Part 4 of the Act.

The NSW Threatened Species Scientific Committee is satisfied that *Asterolasia buxifolia* Benth. 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 Commonwealth DCCEEW (2023), the NSW Threatened Species Scientific Committee has made a decision to list the species as Critically Endangered.

Summary of Conservation Assessment

Asterolasia buxifolia Benth. 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: i) the species has a very highly restricted geographic distribution with an Extent of Occurrence and Area of Occupancy of 4 km²; ii) it is known from a single threat-defined location; iii) there is observed decline in the area, extent and quality of habitat due to competition from exotic weeds; iv) the total number of mature individuals is very low with <250 estimated; v) a continuing decline in the number of mature individuals estimated at 35% has occurred in one generation (10 years) due to the effects of drought and flooding; and vi) all known individuals of the species occur within a single population.

The NSW Threatened Species Scientific Committee has found that:

1. *Asterolasia buxifolia* Benth. (Rutaceae) is a shrub to 1 m; stems stellate-hairy. Leaves obovate, 0.5–1.8 cm long, 3–10 mm wide, apex rounded or slightly emarginate; lamina leathery, margins slightly recurved, upper surface glabrous; lower surface stellate-hairy; petiole 2–7 mm long. Flowers axillary, solitary; pedicels 1–1.5 mm long. Petals 5, elliptic, 6–7 mm long, yellow; outer surface with an indumentum of sessile stellate hairs; inner surface glabrous. Stamens 10, filaments glabrous; anthers 1–1.5 mm long, each with a terminal gland. Ovary glabrous. Carpels five, glabrous; style glabrous; stigma hemispherical. Cocci glabrous, beaked (Mole *et al.* 2002; PlantNET 2021, based on Harden 2002).
2. *Asterolasia buxifolia* is endemic to NSW, where it is known from a single population on public tenure. It occurs in the Cox's River catchment in the western Blue Mountains (Hartley area), which is a tributary of the east-flowing Hawkesbury-Nepean system. The population is essentially linear in configuration along approximately 2.5 km of the River Lett in the Hartley Valley, at 720–770 m above sea level. The population occurs patchily on both banks, with the great majority of

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plants concentrated within an approximate 1 km stretch of river. *Asterolasia buxifolia* occurs on the edge of Wiradjuri and Dharug country, and on the land of the Therabulat people (Lithgow City Council 2008).

3. *Asterolasia buxifolia* has a very highly restricted geographic distribution. The area of occupancy (AOO) was estimated to be 4 km², based on the species occupying a single (2 x 2 km) grid cell, the scale recommended for assessing area of occupancy by IUCN (2022). The extent of occurrence (EOO) is reported as equal to AOO (4 km²), despite a minimum convex polygon enclosing all mapped occurrences of the species, the method of assessment recommended by IUCN (2022), being less than AOO. This is to ensure consistency with the definition of AOO as an area within EOO, following IUCN (2022).
4. *Asterolasia buxifolia* occurs at one threat-defined location. This definition of location is based on the fact that the sole population may be rapidly impacted by any of the most serious plausible threats — altered flow regime, drought, adverse fire regimes, or increased flood frequency or severity.
5. The last comprehensive population surveys of *Asterolasia buxifolia* (Collette 2016) estimated a maximum of 1693 mature individuals and a minimum of 901, based on extrapolation from transect surveys. The maximum number of plants observed was 643 (Collette 2016). A previous survey in 2012 recorded 386 mature individuals (Germon 2012). Preliminary observations after floods in 2020 indicated declines from the numbers observed in 2015 and 2016, as many mature plants and seedlings were killed by the combination of the 2017–2019 drought and subsequent floods (Ooi 2021). Surveys in October 2021 detected only 57 individuals, with many plants noted to have been flattened or buried under debris (C Jonkers pers. comm. 14 October 2022). This represents a significant decline in the number of individuals and extent along the river from previous years (C Jonkers pers. comm. 14 October 2022). Noting the observed declines, and accounting for the possibility that surveys in 2021 did not record all plants present, an estimate of <250 mature individuals is used as a plausible estimate for the current number of mature individuals. This represents a 35% decline since 2012 (one generation).
6. *Asterolasia buxifolia* flowers are bisexual and probably protandrous (Kubitzki *et al.* 2011). Martyn *et al.* (2009) reported 65% seed fill during the millennium drought while in years with better rainfall seed fill was between 92–93% (R. Johnstone *in litt.* April 2015). Seeds of *A. buxifolia* are small and possess physiological dormancy which is broken by smoke, and germination requires winter temperatures (Collette and Ooi 2017). Seeds are resilient to high-fire related temperatures but experience slowed germination when pre-treated with heat above 80°C (Collette and Ooi 2017). *Asterolasia buxifolia* also experiences dormancy cycling where the dormant seeds cycle between dormancy and conditional dormancy (i.e., able to germinate only at winter temperatures) throughout the year (Collette and Ooi 2020). Seeds are released via ballistic dispersal generally in late November–early December (R Makinson pers. obs. 2014; R Johnstone pers. obs. 2008, *in litt.* 2014). Once dispersed, the seeds form a long-lived soil seedbank with initial viability of fresh seed around 98% and decaying by only 20% after 1.5 years

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in the soil (Collette and Ooi 2020). The maximum time that seeds may remain viable in the soil is unknown.

7. Observations of the life history of *Asterolasia buxifolia* can provide some indication of the length of the species' primary juvenile period, lifespan and generation length. Field observations indicate that the primary juvenile period is around 6–10 years (R Makinson pers. obs.) and the half-life of the soil seedbank is several years to a decade (Collette and Ooi 2017, 2020). The species' slow growth rate coupled with the height of some of the tallest individuals (>320 cm) would indicate a lifespan measured in decades rather than years. With the observations above in mind it seems reasonable to assume that generation length is at a minimum close to a decade and likely longer.
8. The genus *Asterolasia* is generally regarded as being fire-sensitive and comprising obligate seeders, although limited re-sprouting from the main stem base or root crownstock after very low severity fire cannot be ruled out. Some instances of regrowth from *A. buxifolia* stem bases after flood damage have been noted (R Makinson pers. obs. 2014).
9. *Asterolasia buxifolia* is currently restricted to the riparian zone with plants at times extending to lower upslope areas which tend towards dry sclerophyll type vegetation. Part of the distribution of *A. buxifolia* is dominated by a steep-sided rocky gorge; the remainder of the distribution is along an incised granitic valley with variable (moderate to steep), often rocky sloping sides (Collette 2016). The riparian zone vegetation where *A. buxifolia* occurs is "dominated by lemon scented tea tree (*Leptospermum polygalifolium*), with occurrences of river bottlebrush (*Callistemon sieberi*) and river lomatia (*Lomatia myricoides*). The riparian zone in this area is unusual due to the absence of river oak (*Casuarina cunninghamiana*), typical of Coxs River riparian zone, which commences a few hundred metres downstream and continues further downstream through the Coxs system" (Lithgow City Council 2008). *Asterolasia buxifolia* also grows with *Micrantheum hexandrum* (box micrantheum), *Bursaria spinosa* subsp. *lasiophylla*, *Grevillea acanthifolia* subsp. *acanthifolia* (acanthus-leaved grevillea) and *Lomandra longifolia* (spiny-headed mat rush) (AVH 2022).
10. The main threats to *Asterolasia buxifolia* include competition from non-herbaceous and grassy weeds, changes in flood regimes and hydrology and the extent and severity of drought due to climate change, and adverse fire regimes. 'Loss and degradation of native plant and animal habitat by invasion of escaped garden plants, including aquatic plants', 'Alteration to the natural flow regimes of rivers and streams and their floodplains and wetlands', 'Anthropogenic climate change', and 'High frequency fire resulting in the disruption of life cycle processes in plants and animals and loss of vegetation structure and composition' are listed as Key Threatening Processes under the Act.
11. Non-herbaceous weeds and exotic grasses have been observed to be contributing to continuing decline in the area, extent and quality of habitat of *Asterolasia buxifolia*. The species of most concern are Japanese honeysuckle (*Lonicera japonica*), blackberry (*Rubus* sp.), and Scotch broom (*Cytisus scoparius*). These

and other aggressive non-herbaceous weeds dominate the riparian zone upstream of the *A. buxifolia* population and smother plants, retard growth and progression, and change microclimate and soil conditions. Pampas grass (*Cortaderia* spp.) also occurs upstream, as does Buddleja (*Buddleja davidii*), Himalayan honeysuckle (*Leycesteria formosa*), and Formosan lily (*Lilium formosanum*). Invasion by annual and perennial grasses may also pose a problem - no recruitment and few adults have been observed in the few heavily grassed areas with reduced shrub cover, except where these are interrupted by microsites of rock crevices or bare gravel/sand. Significant time and investment have been successfully allocated in the last three years for the location and eradication of Japanese honeysuckle and blackberry within the site, although recolonisation, especially after floods, will remain an ongoing problem requiring periodic management.

12. Changes in flood regimes and hydrology and the extent and severity of drought due to climate change are inferred to be contributing to continuing decline in the number of mature individuals of *Asterolasia buxifolia*. Climate change is expected to increase the severity and frequency of both droughts and flooding (Head *et al.* 2014). An increase in the severity or frequency of flooding, especially in combination with other disturbances such as drought or fire, poses a significant risk to the species. The increased mortality following the 2017–2019 drought and subsequent floods is evidence of this. Drought susceptibility of *A. buxifolia* is unknown, however, in combination with flooding there was a marked increase in mortality following the severe 2017–2019 drought. An increase in the extent and severity due to climate change may in turn increase the risk of altered flow regimes that negatively affect *A. buxifolia*. A major and permanent reduction in flow of the River Lett would undoubtedly further affect core *A. buxifolia* habitat, both through direct effects on the species and through reducing the density of the preferred shrubby habitat.
13. Adverse fire regimes are inferred to be a driver of future continuing decline in the number of individuals of *Asterolasia buxifolia*. Although fire is rare in the riverside habitat of *A. buxifolia* and it was not burnt in the 2019–2020 bushfires, fire regimes that cause declines in biodiversity pose a significant threat to the species. Climate change is resulting in higher average temperatures throughout the year, more frequent dry periods and droughts and overall worse fire weather which is contributing to an increase in fire severity, frequency and changes to seasonality (Williamson *et al.* 2016; Abram *et al.* 2020). Mature plants are typically killed by fire. It is not known if *A. buxifolia* seeds survive fire in the soil, but seed from similar small-seeded species can be killed in the soil seedbank when exposed to extreme temperatures during high severity fires (Liyanaage and Ooi 2018). An increase in the frequency of fire could disrupt post-fire recovery by killing seedlings before they mature and are able to replenish the seed bank, leading to population declines. The timing of fire if or when it does occur may pose a significant threat to the species as the seeds require exposure to winter temperatures to germinate successfully (Collette and Ooi 2020). Spring fires may delay germination for up to a year until seed germination temperatures are suitable, resulting in delayed recruitment, increasing the time required between fires for seedlings to mature and replenish the soil seedbank, and the possibility of being outcompeted by other species which can establish more quickly.

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14. *Asterolasia buxifolia* Benth. 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: 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 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,

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	(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: 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.

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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 under Clause 4.7.

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.
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Senior Professor Kristine French
Chairperson
NSW Threatened Species Scientific Committee

Supporting Documentation:

Commonwealth DCCEEW (Department of Climate Change, Energy, the Environment and Water) (2023) Conservation Advice for *Asterolasia buxifolia*. Australian Government, Canberra, ACT.

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