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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 *Leionema scopulinum* B.M. Horton & Crayn as an ENDANGERED SPECIES in Part 2 of Schedule 1 of the Act. Listing of Endangered species is provided for by Part 4 of the Act.

### Summary of Conservation Assessment

*Leionema scopulinum* B.M. Horton & Crayn was found to be Endangered in accordance with the following provisions in the *Biodiversity Conservation Regulation 2017*: 4.3(b)(d)(e,i iii)

The main reasons for this species being eligible for listing are: i) it has a highly restricted geographic distribution; ii) it occurs at only two threat-defined locations; and iii) there is inferred continuing decline in habitat quality and number of mature individuals due to drought and fire, which are becoming more severe and frequent as a consequence of anthropogenic climate change.

The NSW Threatened Species Scientific Committee has found that:

1. *Leionema scopulinum* (Rutaceae) was formally described by Horton et al. (2004). *Leionema scopulinum* is described by PlantNET (2022) as a 'Shrub, inhabiting rocky ledges and clefts. Branchlets angled, stellate-hairy. Lamina 24–65 mm long, 4.5–10.0 mm wide, margins frequently serrulate. Inflorescence erect with 9–32 flowers. Petals valvate, 6.6–8.1 mm long, 1.5–2.0 mm wide, greenish-yellow to yellow. Fruit a schizocarp capsule; cocci 5.5–7.0 mm high, rostrate, the beak 1.5–3.0 mm long.' *Leionema scopulinum* has also been known as *Leionema* sp. 'Nullo Mountain' and *Leionema* sp. Lee Creek (PlantNET 2022).
2. *Leionema scopulinum* is similar to *L. ralstonii*, *L. sympetalum* and *L. viridiflorum* but can be distinguished from these species by its larger leaves and cocci and erect inflorescence (Horton et al. 2004). Of these species, only *L. sympetalum* overlaps in distribution with *L. scopulinum*. *Leionema sympetalum* occupies similar rocky outcrop habitat and replaces *L. scopulinum* in habitat between the main cluster of *L. scopulinum* occurrences in northwest Wollemi National Park and the site southwest of Glen Davis (S. Clarke *in litt.* May 2022). The two species do not co-occur at known sites (NSW Government 2022b; Royal Botanic Gardens NSW 2022). In addition to the morphological differences outlined above, *L. sympetalum* can be distinguished from *L. scopulinum* by its tubular flowers and glabrous branchlets (Horton et al. 2004).
3. *Leionema scopulinum* is endemic to New South Wales. The entire known population is located within Wollemi National Park, which is managed by the NSW National Parks and Wildlife Service as a protected area, known only from limited areas of pagoda habitat (large, bare, conical rock formations) in Wollemi National Park on the Central Tablelands of NSW.
4. *Leionema scopulinum* grows in shallow sandy soil on rocky ledges and ridgetops and in clefts among sandstone pagoda formations at 660–900 m above sea level

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(Horton *et al.* 2004; Royal Botanic Gardens NSW 2022). *Leionema scopulinum* habitat is relatively inaccessible, however the species distribution is considered well surveyed (H. Washington *in litt.* August 2018; S. Clarke *in litt.* May 2022).

5. The main cluster of *Leionema scopulinum* localities, reported in 2004, are located in the northwest of Wollemi National Park on rocky ridges of the Lee Creek and Growee River catchment and in the vicinity of Nullo Mountain (Horton *et al.* 2004).
6. Two additional sites were documented in 2012 and 2016, one site ~55 km to the south of the main cluster, on cliffs above the tributary of Canobla Creek southwest of Glen Davis, and the other ~11 km east of the main cluster, around Emu Creek (Royal Botanic Gardens NSW 2022). These are the Traditional Lands of the Wiradjuri, Dharug, Wonnarua and Darkinjung people (Horton 1996).
7. Extensive areas of similar pagoda habitat exist between the northern localities and the site southwest of Glen Davis (S. Clarke *in litt.* May 2022). However, *Leionema scopulinum* has not been detected and is replaced by *L. sympetalum* (S. Clarke *in litt.* May 2022).
8. *Leionema scopulinum* has a highly restricted range, with an Area of Occupancy (AOO) of only 72 km<sup>2</sup>, and an Extent of Occurrence (EOO) of 450km<sup>2</sup>.
9. It occurs at only two threat-defined locations, restricted to small, closely clustered areas of pagoda habitat in Wollemi National Park on the Central Tablelands of NSW.
10. A reliable population estimate is not available for *Leionema scopulinum*. Horton *et al.* (2004) estimated that there were <1,500 plants, including mature individuals and others, in the initial occurrences reported in 2004 (H. Washington *in litt.* July 2022). In addition, >240 plants were recorded at additional sites in 2012 and 2016 (Royal Botanic Gardens NSW 2022).
11. Substantial reductions in the number of mature individuals were observed during the 2017–19 drought and following the 2019–20 fires (H. Washington *in litt.* August 2018, September 2022; S Clarke *in litt.* May 2022).
12. A ~50% reduction in plant numbers was reported at one site west of Nullo Mountain in 2018, with a second unquantified reduction observed at a separate site northwest of Nunkeri (H. Washington *in litt.* August 2018; Appendix 3). Following the 2019–20 fires, 100% mortality was reported at one site on Spring Log Ridge, with *L. scopulinum* reduced to post-fire seedlings at this locality (S Clarke *in litt.* May 2022).
13. *Leionema scopulinum* is commonly 1.5 m in height (range 0.5–3 m) (Horton *et al.* 2004). The species grows in heath under a sparse overstory characterised by *Eucalyptus oreades* and *E. sparsifolia* (Horton *et al.* 2004). Common co-occurring species include *Acacia obtusifolia*, *A. terminalis*, *A. ulicifolia*, *Allocasuarina distyla*, *Amperea xiphoclada*, *Boronia anemonifolia*, *B. angustisepala*, *Callitris endlicheri*, *Calytrix tetragona*, *Caustis pentandra*, *Cooperhookea barbata*, *Dampiera adpressa*, *Dillwynia retorta*, *Eucalyptus rossii*, *Epacris reclinata*, *Exocarpos cupressiformis*, *Goodenia decurrens*, *Hibbertia monogyna*, *Isopogon anemonifolius*, *Leptospermum arachnoides*, *L. parvifolium*, *L. sphaerocarpum*, *Leucopogon muticus*, *L. setiger*, *Logania albiflora*, *Monotoca scoparia*, *Ochrosperma oligomerum*, *Persoonia linearis*, *Phebalium squamulosum* subsp. *gracile*,

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*Philotheca salsolifolia* subsp. *salsolifolia*, and *Pseudanthus pimeleoides* (Horton et al. 2004).

14. *Leionema scopulinum* produces green-yellow flowers in April–September and fruits which mature in December, however pollinators and dispersal mechanism are unknown (Horton et al. 2004; H. Washington *in litt.* August 2018). *Leionema* species utilise a broad range of pollinators and dispersal mechanisms, including ballistic seed dispersal, seed dispersal by ants, and bird pollination, and so there is no clear candidate for these processes in *L. scopulinum* (Auld 2001). Without long-range seed dispersal between outcrops, each *L. scopulinum* site would be isolated, and the population fragmented, with minimal capacity to (re)colonise unoccupied habitat (H. Washington *in litt.* July 2022).
15. *Leionema scopulinum* is very likely an obligate seed regenerator with fire-cued recruitment from a soil-stored seedbank. This fire response was observed at one site in the Spring Log Ridge area in northwest Wollemi National Park, burnt by medium–extreme severity fire in 2019–20 and visited in August 2021 (NSW Department of Planning and Environment 2020; S. Clarke *in litt.* June–September 2022). At this site all adult plants were killed and strong post-fire recruitment from soil-stored seed was reported (S. Clarke *in litt.* May 2022).
16. The longevity of *Leionema scopulinum* plants and their seedbank are unknown. A related species *L. ralstonii*, is reported to be relatively long-lived (NSW National Parks and Wildlife Service 2003).
17. *Leionema scopulinum* may struggle in drought, with lack of recruitment noted during the 2017–19 drought (H. Washington *in litt.* August 2018). Sites are discrete, scattered on ridges and pagoda formations of rocky outcrops (H. Washington *in litt.* July 2022). Rocky outcrops generally have shallow soil overlaying bedrock with limited capacity for water storage, and as a consequence soil moisture is largely dependent on recent rainfall and temperature and can fluctuate widely (Benwell 2007).
18. The main threats to *Leionema scopulinum* are decline in habitat and mature individuals as a consequence of adverse fire regimes and exacerbated by climate change, and decline in habitat and mature individuals as a consequence of drought and exacerbated by climate change. Of these ‘*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 NSW Biodiversity Conservation Act.
19. Changes in fire frequency and severity as a consequence of climate change poses a severe and ongoing threat to *Leionema scopulinum*. While *L. scopulinum* is an obligate seeder, with germination events triggered by burning, recurrent, high-severity, short-interval fires are likely to lead to decline in the species.
20. Where fire is too severe it is likely to kill all mature individuals, and cause the soil to reach temperatures that kill seeds in the seedbank, rather than prompting germination. Where fire is too frequent seedbanks are quickly exhausted, as successive fires repeatedly prompt germination events, but kill juvenile cohorts before they are able to reach maturity and produce seed to replenish the soil-stored seedbank. As such *Leionema scopulinum* is particularly vulnerable to a return of fire at burnt sites before post-fire seedlings reach maturity and replenish the soil-stored seedbank.

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21. Large areas of Wollemi National Park were burnt during the 2019–20 fire season, including approximately 56% of spatially distinct *Leionema scopulinum* occurrence records, with fire severity ranging from low to extreme.
22. Fire is predicted to become more frequent and severe across the entire range of *Leionema scopulinum* (NSW Government Local Land Services 2016; Collins *et al.* 2022). Average fire weather, average temperatures, and aridity are all projected to increase as a consequence of climate change, placing Wollemi National Park and *L. scopulinum*, at increased risk of more severe and frequent fires (NSW Government Local Land Services 2016; NSW Government 2022a; CSIRO 2022).
23. The pagoda formations which *Leionema scopulinum* occupies are particularly vulnerable to high-severity fire, which can quickly spread up inclines and cliffs and burn this habitat (G. Purcell *in litt.* July 2022). More frequent fires in outcrop habitats will in turn reduce competitive advantages for obligate seeders in outcrop habitats, enabling migration of plant species from adjacent habitat, particularly of resprouter species (Hunter 2003). Large areas of Wollemi National Park were burnt during the 2019–20 fire season, including approximately 56% of spatially distinct *L. scopulinum* occurrence records, with fire severity ranging from low to extreme.
24. A minimum fire interval for *Leionema scopulinum* is inferred to be 11–16 years, based on related species in similar habitats (Burrows *et al.* 2008; Clarke *et al.* 2009). While *L. scopulinum* has historically been subjected to relatively frequent fire ( $\leq 11$  years), the intensity of these fires has generally not been high. However, with fire severity projected to increase (Canadell *et al.* 2021; CSIRO 2022), this past pattern of repeated short-interval fires suggests that *L. scopulinum* plants are likely to experience high severity fires at too high a frequency for *L. scopulinum* to easily persist.
25. Increasing aridity and drought is an ongoing threat to *Leionema scopulinum*, and is projected to become more frequent due to the effects of climate change (NSW Government Local Land Services 2016; CSIRO 2022). *Leionema scopulinum* has persisted through numerous previous droughts, however high mortality observed during recent severe drought events demonstrates that drought poses an ongoing threat to the species. will continue to be a threat and may contribute to species decline by exacerbating impacts from fire, reducing resilience and seedbank maintenance prior to fire, and reducing seedling establishment if occurring post-fire.
26. While there is variability in rainfall projections for the region, time spent in drought is projected to increase in frequency and severity in eastern Australia over the course of the century (NSW Government Local Land Services 2016; CSIRO 2022). As *Leionema scopulinum* grows towards the highest altitudes in the area, and appears to have low dispersal ability, the species has no capacity to retreat to higher ground to mitigate drought impacts (H. Washington *in litt.* August 2018).
27. Rocky outcrop vegetation is more desiccation-prone than other habitats due to its characteristic shallow soil overlaying rock, which retains water poorly (Benwell 2007). In addition to desiccation and plant death, under warmer and drier conditions woody plants on average produce fewer seeds, impacting seedbank maintenance, and experience reduced seedling survival (Benwell 2007; Enright *et al.* 2014, 2015).

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28. Increasing aridity and drought also reduces micro-climate differences between outcrops and adjacent habitat, which over time may result in greater homogeneity between outcrop and adjacent vegetation, and outcrop-restricted species becoming less abundant (McGann 2002; Hunter 2003).
29. In 2018, an estimated 50% reduction in the number of *Leionema scopulinum* plants was observed at one site compared with 2003 levels, with a second unquantified decline observed at a second site (H. Washington *in litt.* August–September 2018). These plant losses are likely related to drought, which impacted much of NSW, including the area of the species distribution, in 2017–19 (H. Washington *in litt.* August 2018; Australian Government Bureau of Meteorology 2020; Government Bureau of Meteorology 2022). As these observations were made mid-drought, they may not capture the full extent of *L. scopulinum* dieback. A similarly pronounced drought-induced dieback was documented for a different rocky outcrop community at Bald Knob Mountain, NSW (Benwell 2007). In this habitat, ~56% of shrubs died during a period of relatively low-intensity drought in 2000, with mortality ranging from 12–100% depending on the species (Benwell 2007).
30. Drought may have a particularly severe impact on *Leionema scopulinum* if it extends after or follows fire. Overlapping disturbance events, including fire, drought, and heatwaves, can negatively impact recruitment, seedling establishment, post-fire flowering, seedbank restoration, and seed quality (Nolan et al. 2021). If drought extends after fire, these impacts may severely compromise recovery and lead to population decline.
31. *Leionema scopulinum* B.M. Horton & Crayn was not found to be eligible for listing as a Critically Endangered species.
32. *Leionema scopulinum* B.M. Horton & Crayn is eligible to be listed as an Endangered species as, in the opinion of the NSW Threatened Species Scientific Committee, it is facing a very high risk of extinction in Australia in the near future as determined in accordance with the following criteria as prescribed by the *Biodiversity Conservation Regulation 2017*:

## Assessment against *Biodiversity Conservation Regulation 2017* criteria

The Clauses used for assessment are listed below for reference.

**Overall Assessment Outcome:** *Leionema scopulinum* is Endangered under Clause 4.3(b)(d)(e,i,iii)

### Clause 4.2 – Reduction in population size of species

(Equivalent to IUCN criterion A)

**Assessment Outcome: Data Deficient**

| <b>(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:</b> |     |                                   |   |
|--|-----|-----------------------------------|---|
|  | (a) | for critically endangered species | a very large reduction in population size, or |
|  | (b) | for endangered species            | a large reduction in population size, or      |

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|   |     |   |  |
|---|-----|---|--|
|   | (c) | for vulnerable species  | a moderate reduction in population size. |
| <b>(2) - The determination of that criteria is to be based on any of the following:</b> |     |   |  |
|   | (a) | direct observation,   |  |
|   | (b) | an index of abundance appropriate to the taxon,   |  |
|   | (c) | a decline in the geographic distribution or habitat quality,                                    |  |
|   | (d) | the actual or potential levels of exploitation of the species,                                  |  |
|   | (e) | the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites. |  |

### Clause 4.3 - Restricted geographic distribution of species and other conditions (Equivalent to IUCN criterion B)

**Assessment Outcome: Endangered under Clause 4.3(b)(d)(ei,iii)**

|  |     |   |   |
|--|-----|---|---|
| <b>The geographic distribution of the species is:</b>      |     |   |   |
|  | (a) | for critically endangered species   | very highly restricted, or  |
|  | (b) | for endangered species  | highly restricted, or   |
|  | (c) | for vulnerable species  | moderately restricted,  |
| <b>and at least 2 of the following 3 conditions apply:</b> |     |   |   |
|  | (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: Data Deficient**

|  |     |   |                 |
|--|-----|---|-----------------|
| <b>The estimated total number of mature individuals of the species is:</b> |     |   |                 |
|  | (a) | for critically endangered species   | very low, or    |
|  | (b) | for endangered species  | low, or         |
|  | (c) | for vulnerable species  | moderately low, |
| <b>and either of the following 2 conditions apply:</b>                     |     |   |                 |
|  | (d) | a continuing decline in the number of mature individuals that is (according to an index of abundance appropriate to the species): |                 |

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|  |       |   |  |
|--|-------|---|--|
|  | (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: Not met**

| The total number of mature individuals of the species is: |     |   |
|---|-----|---|
|   | (a) | for critically endangered species extremely low, or |
|   | (b) | for endangered species very low, or                 |
|   | (c) | for vulnerable species low.                         |

**Clause 4.6 - Quantitative analysis of extinction probability  
(Equivalent to IUCN criterion E)  
Assessment Outcome: Data Deficient**

| The probability of extinction of the species is estimated to be: |     |  |
|--|-----|--|
|  | (a) | for critically endangered species extremely high, or |
|  | (b) | for endangered species very high, or                 |
|  | (c) | for vulnerable species high.                         |

**Clause 4.7 - Very highly restricted geographic distribution of species–vulnerable species  
(Equivalent to IUCN criterion D2)  
Assessment Outcome: Not met**

|                         |  |
|-------------------------|--|
| For vulnerable species, | the geographic distribution of the species or the number of locations of the species is very highly restricted such that the species is prone to the effects of human activities or stochastic events within a very short time period. |
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Senior Professor Kristine French  
Chairperson  
NSW Threatened Species Scientific Committee

## Supporting Documentation:

Kelly, A. Rowell, T. (2024) Conservation Assessment of *Leionema scopulinum* B.M. Horton & Crayn. NSW Threatened Species Scientific Committee.

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