Conservation Assessment of *Leionema westonii* L.M.Copel. & I.Telford (Rutaceae)

J Scott 18/11/2021
NSW Threatened Species Scientific Committee

***Leionema westonii* L.M.Copel. & I.Telford (Rutaceae)**
Distribution: Endemic to NSW
Current EPBC Act Status: Not listed
Current NSW BC Act Status: Not listed

Proposed listing on NSW BC Act and EPBC Act: Critically Endangered

Conservation Advice: *Leionema westonii*

Summary of Conservation Assessment

Leionema westonii was found to be eligible for listing as Critically Endangered under Criterion B1ab(iii)+2ab(iii) and Criterion D.

The main reasons for this species being eligible are: i) it has a very highly restricted geographical range; ii) the estimated total number of mature individuals is extremely low; iii) it is only found at a single location; and (iv) there is inferred continuing decline due to habitat disturbance from feral goats. All known individuals were burnt in the 2019-2020 fire season and recruitment is absent 18 months post burn. Drought conditions may have killed adults and prevented recruitment.

Description and Taxonomy

Leionema westonii L.M.Copel. & I.Telford (Rutaceae) was first discovered in 2004 and recently described by Copeland and Telford (2018). *Leionema westonii* is described by PlantNET 2020 as a "shrub, rhizomatous and much-branched, to 70 cm tall. Stems pilose with spreading white simple hairs. Leaves narrowly elliptic or linear, 6–16 mm long, 1–1.8 mm wide, apex obtuse, margin revolute, upper surface pilose, lower surface minutely white-papillose and sparsely pilose. Inflorescence terminal cymose, solitary flowers in the upper axils, exceeding leaves; pedicels 3–5.5 mm long, pilose, bearing a subulate, pilose bracteole 2.4–2.8 mm long just below the calyx. Calyx cup-shaped, 1.3–1.6 mm long, sparsely hispidulous, sometimes with minute stellate hairs, 5-toothed, the teeth triangular, c.1 mm long. Petals spreading, 4–4.6 mm long, white, upper surface glabrous, lower surface glandular punctate and sparsely and shortly pilose. Ovary papillose."

Leionema westonii has also been known as *Leionema* sp. Oxley Wild Rivers National Park (L.M. Copeland 3683) (L. Copeland *in litt.* May 2016), *Leionema* sp. Macleay Gorges (PlantNET 2020), and *Leionema* sp. aff. *gracile* (L. Copeland *in litt.* May 2016).

Leionema westonii is similar to *Leionema gracile,* which occurs in the Boonah area of south-eastern Queensland c. 400 km to the north of the *L. westonii* population. *Leionema gracile* is a narrow-ranged endemic confined to trachyte volcanic plugs and differs from *L. westonii* in a number of morphological attributes (Copeland and Telford 2018).

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Distribution and Abundance

Leionema westonii is endemic to NSW. The geographic distribution of *L. westonii* is very highly restricted. The species is known only from a single population in the Oxley Wild Rivers National Park (OWRNP) on the New England Tablelands of north eastern New South Wales (see Appendix 2). It occurs near the rim of a gorge in a relatively flat to gentle sloping area of woodland dominated by *Eucalyptus campanulata* and A*llocasuarina littoralis* over *Poa sieberiana*, on shallow, loamy soil on metasediments at an altitude of 1080 m a.s.l. (Copeland and Telford 2018).

Although there is a large area of potentially suitable habitat in the vicinity of the known site, no other populations of *Leionema westonii* have been found, despite a number of general surveys in the area (Copeland *in litt*. May 2016). Copeland *(in litt*. May 2016) further suggests that the species is "certainly not widespread or common".

Most of OWRNP was burnt by a wildfire in late 2019 with high to extreme fire severity recorded in the vicinity of the *Leionema westonii* population (FESM 2020). All the understorey shrubs at the site were consumed in the fire, including the *L. westonii* individuals (L. Copeland *in litt.* October 2020). When the site was visited in 2004, there were estimated to be fewer than 50 mature individuals of *L. westonii* in a single population (Copeland and Telford 2018). Copeland (*in litt.* May 2016) suggests approximately 30 mature individuals were observed when the full extent of the population was assessed in 2004 (spread over less than one hectare). To date (May 2021), there has been no regeneration of *L. westonii* after approximately 18 months since the 2019 fire (L. Copeland *in litt.* October 2020, L. Copeland *in litt.* May 2021).

The area of occupancy is estimated to be 4 km^2, based on the species occupying one 2 km x 2 km grid cell, the spatial scale of assessment recommended by IUCN (2019). The extent of occurrence (EOO) is also estimated to be 4 km^2. The EOO is reported as equal to AOO, despite the range of the species measured by a minimum convex polygon containing all the known sites of occurrence, being less than AOO. This is to ensure consistency with the definition of AOO as an area within EOO, following IUCN Guidelines (2019).

Ecology

Little is known about the ecology of *Leionema westonii.* The species is thought to be rhizomatous (Copeland and Telford 2018) which may enable it to resprout after fire. Its response to fire, however, is unknown and no regeneration in the species has been observed since the 2019 fire (L. Copeland *in litt.* October 2020, L. Copeland *in litt.* May 2021), although the period leading up to this fire event was suffering from severe drought and plants may have already succumbed to water stress. Several other *Leionema* taxa on the NSW Northern Tablelands are killed by fire and rely on a soil-stored seed bank (e.g. *L. ambiens*, *L. rotundifolium* and *L. dentatum*) (Clarke *et al.* 2009), while there are also some *Leionema* species known to resprout after fire (NSW OEH 2014). Copeland and Telford (2018) were unable to find any fruits or seed in the population of *L. westonii* on two occasions in 2004, even though they visited at times when developing fruits, if present, were likely to have been observable. Instead, all they observed were "numerous flowering plants with unopened floral buds, open flowers, and old withered flowers in both surveys" but no developing or mature fruits (L. Copeland *in litt*. May 2016). Copeland and Telford (2018) speculated that the rhizomatous nature of this species suggests that it may be clonal and limited to vegetative reproduction. Further surveys are required to monitor for any post-fire regeneration by either

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vegetative means or seedlings. Recovery of *L. westonii* has not occurred in the 18 months post-fire, perhaps due to the impact of pre-fire drought or the high severity of the fire in this area. There are signs of regeneration of other species, mainly forbs and wattles, but more time is needed to see if, and how, *L. westonii* responds. The habitat is now (May 2021) dominated by seedlings of *Acacia nova-anglica* J.B.Williams ms. (Williams 97011) which have formed a 1 m high dense ground layer (L. Copeland *in litt.* May 2021). As these wattles grow, they may increase shading and slow any *Leionema westonii* recovery (L. Copeland *in litt.* May 2021) however wattles will thin out over time.

Threats

Prior to the fire in late 2019, the main threats to *Leionema westonii* were disturbance to the habitat and possible browsing by feral goats as well as the effects of drought. As there has been no regeneration of *L. westonii* since the 2019 fire, the plants may have succumbed to pre-fire drought or the high severity of the fire or a combination of both. Further monitoring is required to determine if the species can recover post-fire. As there is only one known population of the species, if there is no regeneration, the species will become extinct in the wild if no new populations are located.

Feral Goats: Prior to the 2019 fire, feral goats (*Capra hircus* Linnaeus 1758) were relatively widespread and common throughout OWRNP and there was evidence of severely grazed vegetation in the National Park (L. Copeland *in litt.* May 2016). No grazing was specifically observed on *Leionema westonii* shrubs on the two occasions when the population was visited in 2004 (L. Copeland *in litt.* May 2016) but grazing was a concern for the nearby Critically Endangered *Pimelea cremnophila* (Delgado 2018). Since the 2019 fire, goat numbers in the gorge are low (A. Fawcett pers. comm. November 2020). As goats are still present in the area, vegetation regenerating after the 2019 fire is considered to be at risk from goat grazing. 'Competition and habitat degradation by Feral Goats, *Capra hircus* Linnaeus 1758' is listed as a Key Threatening Process on the BC Act.

Drought: The New England area was in severe drought in the years prior to the bushfires in late 2019 with some areas experiencing the driest conditions on record (BOM 2020). It is unknown how *Leionema westonii* was affected by the drought conditions as the population had not been visited since December 2015. Climate change projections for the east coast of Australia indicate that time spent in drought conditions will, with medium confidence, increase over the course of the century (CSIRO 2015). There is very high confidence in continued substantial increases in projected mean, maximum and minimum temperatures and extreme temperatures are projected to increase at a similar rate to mean temperature, with a substantial increase in the temperature reached on hot days, the frequency of hot days, and the duration of warm spells (CSIRO 2015; OEH 2014). Rainfall trends are less clear, with rainfall predicted to decrease in winter and to increase in autumn (OEH 2014). However, annual rainfall is expected to increase across the New England and North West region of NSW by 2070 (OEH 2014). There is high confidence in a future increase in the intensity of extreme rainfall events, although the magnitude of any increase cannot be confidently projected (CSIRO 2015).

Fire: The area where *Leionema westonii* occurs had not been burnt since at least 2004, the year in which the species was discovered (L. Copeland *in litt.* November 2020). The species would have survived fires in the past likely through the capacity to resprout and/or regenerate from seedlings. The fire in late 2019 was of high to extreme severity

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in the area where *L. westonii* was known to occur (FESM 2020). The recovery of the habitat was initially very slow and the prolonged drought stress prior to the fire may have compromised the ability of many species, including *L. westonii*, to recover. Under climate change, the New England and North West Region is projected to experience an increase in severe FFDI values (Forest Fire Danger Index) in the near and far future (OEH 2014) indicating more harsh fire-weather is likely to occur (CSIRO 2015). It is unclear how the 2019 fire has affected *L. westonii* as it is unknown if the plants may have died back prior to the fire, although if a soil seed bank was present it should have survived drought. Further monitoring of the site is required to see if there is any regeneration of *L. westonii.*

Assessment against IUCN Red List criteria

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

Criterion A Population size reduction

Assessment Outcome: Data Deficient

Justification: There is no available data to determine if there has been a reduction in the population size of *Leionema westonii.* Further post-fire survey over the next year or two is required to determine if the single known population of the species is still extant.

Criterion B Geographic range

Assessment Outcome: Critically Endangered under Criterion B1ab(iii)+2ab(iii).

Justification: *Leionema westonii* has a very highly restricted geographic distribution. The area of occupancy (AOO) is estimated to be 4 km^2, based on the species occupying one 2 km x 2 km grid cell, the spatial scale of assessment recommended by IUCN (2019). The extent of occurrence (EOO) is also estimated to be 4 km^2. The EOO is reported as equal to AOO, despite the range of the species measured by a minimum convex polygon containing all the known sites of occurrence, being less than AOO. This is to ensure consistency with the definition of AOO as an area within EOO, following IUCN Guidelines (2019). *Leionema westonii* meets the Critically Endangered thresholds for both EOO (<100 km^2) and AOO (<10 km^2).

In addition to these thresholds, at least two of three other conditions must be met. These conditions are:

a) The population or habitat is observed or inferred to be severely fragmented or there is 1 (CR), ≤5 (EN) or ≤10 (VU) locations.

   Assessment Outcome: There is only one location, which meets the threat category of Critically Endangered.

   Justification: The main threat for defining the number of locations is the combination of fire (a single fire burning the entirety of the species known distribution), drought, and habitat disturbance and possible grazing by feral goats.

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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

Assessment Outcome: met for (iii).

Justification: The only known population of *Leionema westonii* was burnt in the wildfire in late 2019 after experiencing drought. Recovery has been slow for the vegetation in the area of OWRNP where *L. westonii* occurs and no recovering *L. westonii* plants could be found in a recent survey of the site (L. Copeland *in litt.* October 2020, L. Copeland *in litt.* May 2021). More time is needed to monitor the site for any post-fire recovery of the species. Continuing decline is inferred in the quality of the habitat due to presence of feral goats in the vicinity of the site and the potential for disturbance and grazing of seedlings/resprouting plants. If there is no or little regeneration in *L. westonii,* high fire severity, in combination with pre-fire drought and possibly goat herbivory, would also trigger decline in (v) number of mature individuals.

c) Extreme fluctuations.

Assessment Outcome: Data Deficient.

Justification: It is unknown if *Leionema westonii* has extreme fluctuations and more information about the ecology of the species is required before this can be determined.

Criterion C Small population size and decline

Assessment Outcome: Data Deficient

Justification: Prior to severe drought and fire, there were estimated to be fewer than 50 mature individuals of *L. westonii* in a single population (Copeland and Telford 2018). This meets the threshold for Critically Endangered (<250 mature individuals). Further searches have failed to find any more plants. No plants have been observed after the 2019/2020 fires (L. Copeland *in litt.* October 2020, L. Copeland *in litt.* May 2021).

At least one of two additional conditions must be met. These are:

C1. An observed, estimated or projected continuing decline of at least: 25% in 3 years or 1 generation (whichever is longer) (CE); 20% in 5 years or 2 generations (whichever is longer) (EN); or 10% in 10 years or 3 generations (whichever is longer) (VU).

Assessment Outcome: Data Deficient.

Justification: There is currently insufficient data to quantitatively assess decline in the population of *Leionema westonii.* If there remains no or little post-fire regeneration in *L. westonii*, an estimate of decline could be made.

C2. An observed, estimated, projected or inferred continuing decline in number of mature individuals.

Assessment Outcome: Data Deficient.

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Justification: The only known population of *Leionema westonii* was burnt in the wildfire in late 2019. Recovery has been slow for the vegetation in the area of OWRNP where *L. westonii* occurs and no plants of the species were found during two recent surveys of the site (L. Copeland *in litt.* October 2020, L. Copeland *in litt.* May 2021). Whilst there is inferred decline in the quality of habitat of *L. westonii,* more time and surveys post-fire are required to ascertain if there has also been a decline in the number of mature individuals.

In addition, at least 1 of the following 3 conditions:

a (i). Number of mature individuals in each subpopulation ≤50 (CR); ≤250 (EN) or ≤1000 (VU).

Assessment Outcome: met for Critically Endangered.

Justification: Observations prior to the 2019 fire estimated there were <50 mature individuals in a single population.

a (ii). % of mature individuals in one subpopulation is 90-100% (CR); 95-100% (EN) or 100% (VU)

Assessment Outcome: met for Critically Endangered.

Justification: 100% of mature individuals were in the one population prior to the 2019 fire.

b. Extreme fluctuations in the number of mature individuals

Assessment Outcome: Data Deficient.

Justification: It is unlikely that the population of *Leionema westonii* has extreme fluctuations, but more information about the ecology of the species is required before this can be determined.

Criterion D Very small or restricted population

Assessment Outcome: met for Critically Endangered.

Justification: Copeland and Telford (2018) estimated there were <50 mature individuals in 2004. There are currently (May 2021) no above ground plants and no regeneration has occurred since the 2019 fire.

To be listed as Vulnerable under D, a species must meet at least one of the two following conditions:

D1. Population size estimated to number <50 (CR), <250 (E), or <1000 mature individuals.

Assessment Outcome: met for Critically Endangered.

Justification: Copeland and Telford (2018) estimated there were <50 mature individuals in 2004. There are currently (May 2021) no above ground plants and no regeneration has occurred since the 2019 fire.

D2. Restricted area of occupancy (typically <20 km^2) or number of locations (typically <5) with a plausible future threat that could drive the taxon to CR or EX in a very short time.

Assessment Outcome: met for Vulnerable

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Justification: There is a restricted area of occupancy of 4 km^2 and only one location. Adverse climatic conditions and impacts of fire(s) and future disturbance to the species and the habitat by feral goats could drive the taxon to CR or EX in a very short time.

Criterion E Quantitative Analysis

Assessment Outcome: Data Deficient.

Justification: There are insufficient data to quantify the extinction risk for this species.

Conservation and Management Actions

There is no National Recovery Plan for this species. The NSW Save our Species (SoS) program is developing a draft conservation strategy outlining threats and actions for the species (A. Fawcett *in. litt.* June 2021). The SoS program also has relevant threat information and management actions for the Critically Endangered shrub *Pimelea cremnophila* that occurs nearby to *Leionema westonii.*

The following conservation and management actions are derived from the threat information and from the SoS draft conservation strategy.

Habitat loss, disturbance and modification

- Feral animal control for goats.
- Aim for a fire-free interval of at least 10-15 years to ensure recovery of the habitat. The interaction between an increased frequency of fire under future climates and prescribed burning should be managed to reduce the likelihood of short intervals between fire.
- As the one known site where the species was present was burnt in 2019/2020, ensure this site is not burnt by a prescribed fire until at least 2031 and suppress natural fire in the vicinity of the population where possible during this period
- Ensure any regenerating plants from 2019/2020 fire are protected from browsing.

Ex situ conservation

- Maintain an active ex situ conservation strategy with the Australian National Botanic Gardens centered around the *Leionema westonii* plants they have grown from cuttings for *ex situ* conservation and their possible translocation.
- If there is no recovery of the wild population and no further populations are found in the wild, translocation of *ex situ* plants should be considered and follow national translocation guidelines (Commander *et al.* 2018). Any translocation should be done only after a suitable period of time has passed, where surveys and monitoring have been undertaken to ensure there has been no recovery in the wild site. The suitable period of time will be determined by assessing the recovery of the habitat, the recovery time of other similar species, etc., but this is likely to be a number of years (after 2023). The success of translocations will depend on understanding the extinction risk for the species, threats to the habitat and threats at the potential translocation sites.

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Engaging with stakeholders

- Liaise with managers of OWRNP for conservation management and protection of the species.
- Liaise with authorities with fire management responsibilities to ensure there is effective communication between agencies regarding the requirement of fire-free intervals in *Leionema westonii* habitat.
- Update the Fire Management Strategy for Macleay Gorges Reserves to ensure the area where *Leionema westonii* occurs ideally has a fire-free interval of at least 10-15 years (to be updated once further data on any recovery of the species is available).

Survey and Monitoring priorities

- Monitor for the recovery of the *Leionema westonii* population by periodic searches for resprouting plants and seedlings at the known site. Determine the efficacy of caging regenerating plants and/or seedlings to protect them from browsing.
- Monitor for increased habitat degradation. Monitor for the presence of feral goats.
- Survey surrounding habitat for *Leionema westonii.* Document any further populations that are discovered but also document nil finds.

Information and Research priorities

- Research priorities will depend on whether the wild population is extant. If the species does recover, regeneration needs to be documented with details regarding recruitment and response to fire, seedling survival, time to first flowering, pollination, breeding system, etc. This is needed to inform future management of the species and effective fire management.

References

BOM (2020) Bureau of Meteorology recent and historical rainfall maps. Commonwealth of Australia 2020. Available at: http://www.bom.gov.au/climate/maps/rainfall/?variable=rainfall&map=drought&period=12month&region=ns&year=2019&month=12&day=31

Clarke PJ, Knox KJE, Campbell ML, Copeland LM (2009) Post-fire recovery of woody plants in the New England Tableland Bioregion. *Cunninghamia* **11**, 221–239.

Commander LE, Coates D, Broadhurst L, Offord CA, Makinson RO and Matthes M (2018) Guidelines for the translocation of threatened plants in Australia. Third Edition. Australian Network for Plant Conservation, Canberra.

Copeland LM, Telford IRH (2018) *Leionema westonii* (Rutaceae), a rare new species from north-eastern New South Wales, Australia. *Telopea* **21**, 19–24.

CSIRO (2015) Climate change in Australia, Projections for Australia's NRM regions. Climate Change in Australia. Commonwealth Scientific and Industrial Research Organisation (CSIRO). Accessed via:

https://publications.csiro.au/rpr/download?pid=csiro:EP154327&dsid=DS1

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Delgado E (2018) Conservation Assessment of *Pimelea cremnophila.* NSW Threatened Species Scientific Committee.

Fire Extent and Severity Mapping (FESM) (2020) New South Wales Department of Planning, Industry and Environment. This dataset can be accessed at: https://data.gov.au/dataset/ds-nsw-c28a6aa8-a7ce-4181-8ed1-fd221dfcefc8/details?q=

IUCN Standards and Petitions Committee (2019) Guidelines for Using the IUCN Red List Categories and Criteria. Version 14. Prepared by the Standards and Petitions Committee. Accessed from http://www.iucnredlist.org/documents/RedListGuidelines.pdf.

NSW OEH (2014) NSW Flora Fire Response Database, Version 2.1, February 2010 (last update May 2014). New South Wales Office of Environment and Heritage.

OEH (2014) New England North West, Climate change snapshot. AdaptNSW, Office of Environment and Heritage, Sydney.
Accessed at: https://climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/Interactive-map

PlantNET (The NSW Plant Information Network System) Royal Botanic Gardens and Domain Trust, Sydney. http://plantnet.rbgsyd.nsw.gov.au (accessed 09 September 2020). Available at:
https://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Leionema~westonii

Expert Communications

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APPENDIX 1

Assessment against *Biodiversity Conservation Regulation 2017* criteria
The Clauses used for assessment are listed below for reference.

Overall Assessment Outcome: Critically Endangered under Clause 3(a)(d)(e iii) and Clause 4.5(a)

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 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,

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	(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.

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: Critically Endangered under Clause 4.5 (a).

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.

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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 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.

APPENDIX 2

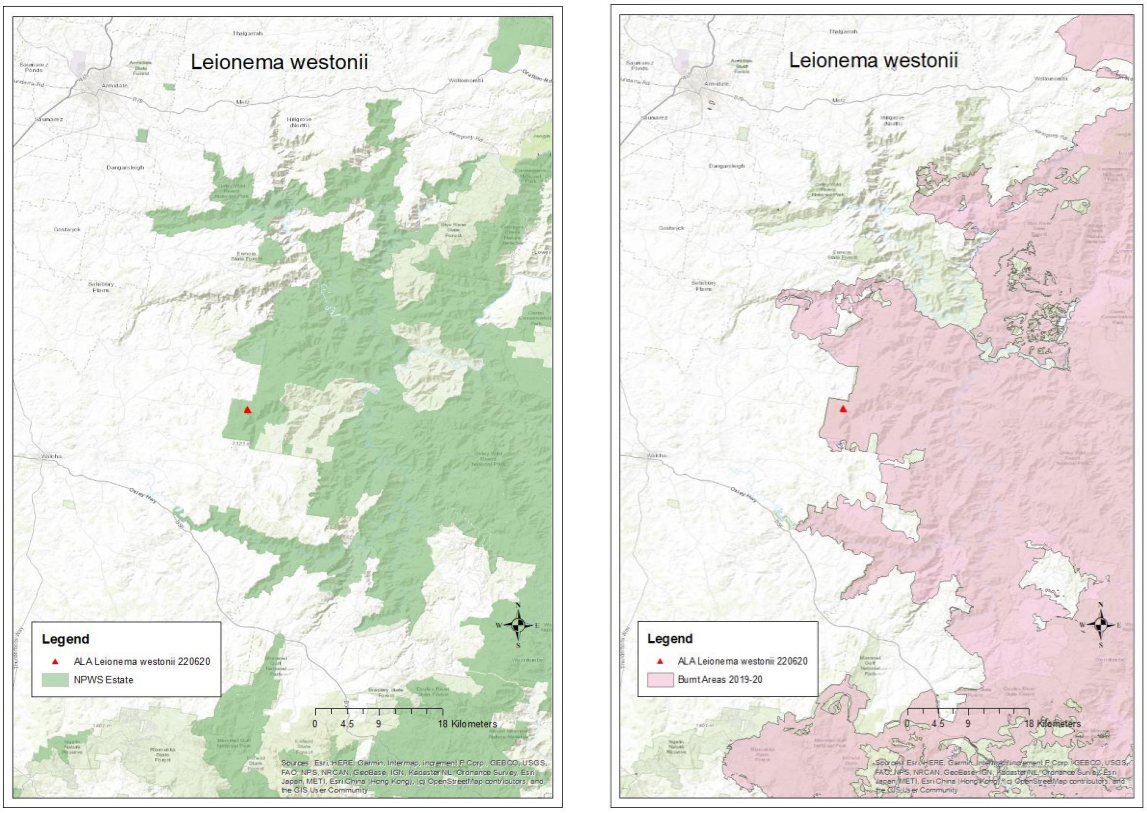

Figure 1. *Leionema westonii* distribution.

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Notice 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 shrub *Leionema westonii* L.M.Copel. & I.Telford 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

Leionema westonii was found to be Critically Endangered in accordance with the following provision in the *Biodiversity Conservation Regulation 2017*: Clause 4.3(a)(d)(e iii) and Clause 4.5(a). The main reasons for this species being eligible are: i) it has a very highly restricted geographical range; ii) the estimated total number of mature individuals is extremely low; iii) it is only found at a single location; and (iv) there is inferred continuing decline due to habitat disturbance from feral goats. All known individuals were burnt in the 2019-2020 fire season and recruitment is absent 18 months post burn. Drought conditions may have killed adults and prevented recruitment.

The NSW Threatened Species Scientific Committee has found that:

1. *Leionema westonii* L.M.Copel. & I.Telford (Rutaceae) was first discovered in 2004 and recently described by Copeland and Telford (2018). *Leionema westonii* is described by PlantNET 2020 as a "shrub, rhizomatous and much-branched, to 70 cm tall. Stems pilose with spreading white simple hairs. Leaves narrowly elliptic or linear, 6–16 mm long, 1–1.8 mm wide, apex obtuse, margin revolute, upper surface pilose, lower surface minutely white-papillose and sparsely pilose. Inflorescence terminal cymose, solitary flowers in the upper axils, exceeding leaves; pedicels 3–5.5 mm long, pilose, bearing a subulate, pilose bracteole 2.4–2.8 mm long just below the calyx. Calyx cup-shaped, 1.3–1.6 mm long, sparsely hispidulous, sometimes with minute stellate hairs, 5-toothed, the teeth triangular, c.1 mm long. Petals spreading, 4–4.6 mm long, white, upper surface glabrous, lower surface glandular punctate and sparsely and shortly pilose. Ovary papillose."

2. *Leionema westonii* is endemic to New South Wales. The species is known only from a single population in the Oxley Wild Rivers National Park (OWRNP) on the New England Tablelands of northeastern NSW. *Leionema westonii* occurs in a relatively flat to gently sloping area of woodland dominated by *Eucalyptus campanulata, Allocasuarina littoralis* and *Poa sieberiana* on shallow, loamy soil on metasediments at an altitude of 1080 m a.s.l. (Copeland and Telford 2018). Although there is a large area of potentially suitable habitat in the vicinity of the known site, no other populations of *L. westonii* have been found, despite several general surveys in the area (L. Copeland *in litt*. May 2016). Copeland (*in litt*. May

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2016) further suggests that the species is "certainly not widespread or common". The area was subject to a prolonged drought then burnt in late 2019 by a wildfire with high to extreme fire severity recorded in the area where the *L. westonii* population occurs (FESM 2020).

3. The geographic distribution of *Leionema westonii* is very highly restricted. The area of occupancy of *L. westonii* is estimated to be 4 km², based on the species' occupying one 2 km x 2 km grid cell, the spatial scale of assessment recommended by IUCN (2019). The extent of occurrence (EOO) is also estimated to be 4 km². The EOO is reported as equal to AOO, despite the range of the species measured by a minimum convex polygon containing all the known sites of occurrence, being less than AOO. This is to ensure consistency with the definition of AOO as an area within EOO, following IUCN Guidelines (2019).

4. In 2004, there were estimated to be fewer than 50 mature individuals of *Leionema westonii* in a single population over an area of less than 1 hectare (Copeland and Telford 2018). The fire in late 2019 burnt the entire population and there has been no regeneration of *L. westonii* to date (May 2021), some 18 months since the fire (L. Copeland *in litt.* October 2020, L. Copeland *in litt.* May 2021).

5. Little is known about the ecology of *Leionema westonii.* The species was observed to be rhizomatous (Copeland and Telford 2018) which may enable it to resprout after fire. Its response to fire, however, is unknown and further monitoring of the site is required to see if there is any post-fire regeneration of *L. westonii* from seedlings or resprouting plants.

6. Prior to the 2019 fire, the Northern Tablelands was in severe drought with some areas experiencing the driest conditions on record (BOM 2020). It is possible that most or all *Leionema* plants may have succumbed to water stress prior to the fire event. Since the fire, the recovery of the habitat where *Leionema westonii* occurs has been very slow and drought stress prior to the fire may have compromised the ability of many species, including *L. westonii,* to recover.

7. Grazing by feral goats (*Capra hircus* Linnaeus 1758) may be a threat to the recovery of *Leionema westonii* and its habitat. Prior to the 2019 fire, feral goats were relatively widespread and common throughout OWRNP and there was evidence of severely grazed vegetation in the National Park (L. Copeland *in litt.* May 2016). No grazing was specifically observed on *L. westonii* shrubs on the two occasions when the population was visited in 2004 (L. Copeland *in litt.* May 2016), but grazing has been a concern for the nearby Critically Endangered *Pimelea cremnophila* (Delgado 2018). Since the 2019 fire, feral goats are still present in the gorge, but numbers are low (A. Fawcett pers. comm. November 2020). However, as goats are still present in the area, vegetation regenerating after the fire is considered to be at risk from grazing. 'Competition and habitat degradation by Feral Goats, *Capra hircus* Linnaeus 1758' is listed as a Key Threatening Process on the BC Act.

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8. *Leionema westonii* L.M.Copel. & I.Telford 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 3(a)(d)(e iii) and Clause 4.5(a)

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)

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Assessment Outcome: Critically Endangered under Clause 4.3 (a) (d) (e 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: Data Deficient.

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

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		(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.		

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Clause 4.5 - Low total numbers of mature individuals of species

(Equivalent to IUCN criterion D)

Assessment Outcome: Critically Endangered under Clause 4.5 (a).

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 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.

Dr Anne Kerle
Chairperson
NSW Threatened Species Scientific Committee

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Supporting Documentation:

Scott J (2020) Conservation Assessment of *Leionema westonii* L.M.Copel. & I.Telford (Rutaceae). NSW Threatened Species Scientific Committee.

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References:

BOM (2020) Bureau of Meteorology recent and historical rainfall maps. Commonwealth of Australia 2020. Available at: http://www.bom.gov.au/climate/maps/rainfall/?variable=rainfall&map=drought&period=12month&region=ns&year=2019&month=12&day=31

Copeland LM, Telford IRH (2018) *Leionema westonii* (Rutaceae), a rare new species from north-eastern New South Wales, Australia. *Telopea* **21**, 19–24.

Delgado E (2018) Conservation Assessment of *Pimelea cremnophila.* NSW Threatened Species Scientific Committee.

Fire Extent and Severity Mapping (FESM) (2020) New South Wales Department of Planning, Industry and Environment. This dataset can be accessed at: https://data.gov.au/dataset/ds-nsw-c28a6aa8-a7ce-4181-8ed1-fd221dfcefc8/details?q=

IUCN Standards and Petitions Committee (2019) Guidelines for Using the IUCN Red List Categories and Criteria. Version 14. Prepared by the Standards and Petitions Committee. Accessed from http://www.iucnredlist.org/documents/RedListGuidelines.pdf.

PlantNET (The NSW Plant Information Network System) Royal Botanic Gardens and Domain Trust, Sydney. http://plantnet.rbgsyd.nsw.gov.au (accessed 09 September 2020). Available at: https://plantnet.rbgsyd.nsw.gov.au/cgi-bin/NSWfl.pl?page=nswfl&lvl=sp&name=Leionema~westonii

A notice of determination to provisionally list this species as a critically endangered species was listed on 30/01/2020

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