

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 remove *Muehlenbeckia* sp. Mt Norman (J.T.Hunter 3847) Makinson from the Schedules of the Act by omitting reference to this species from Part 3 of Schedule 1 (Vulnerable species). The omission of species from the Schedules is provided for by Part 4 of the Act.

Summary of Conservation Assessment

The NSW Threatened Species Scientific Committee has found that:

1. *Muehlenbeckia* sp. Mt Norman (J.T.Hunter 3847) Makinson, now described as *Muehlenbeckia costata* K.L.Wilson & Makinson, is “a scrambling or decumbent subshrub or twiner to 4 m in height, dioecious. Stems slender, green to reddish, not glaucous, weakly striate, to 5 m long. Leaves solitary, persistent, not succulent, yellow-green, slightly paler abaxially, often reddish on margins and veins, not glaucous, simple, petiolate; petiole 10–20(–25) mm long, usually no more than 1/3 as long as blade; blade ovate to oblong-ovate, 25–75(–140) mm long, 10–50(–90) mm wide; distal third of blade with edges strongly convex; base truncate to more or less cordate or sagittate; margins strongly crisped, slightly wavy; apex obtuse, emarginate, or acute, occasionally short-apiculate (apiculum to 3 mm long); ocrea short-tubular, not ciliate on upper margin, soon disintegrating. Flowers 2–5 per cluster in usually axillary spikes 0.5–10 cm long, spikes not crowded at branch ends. Perianth 5-merous, sepaloid, divided for 2/3–3/4 of its length in female flowers, rather more in male flowers; perianth segments 1.5–2.0 mm long, persistent, greenish becoming orange and fleshy in fruiting stage, papery when dry. Stamens 8; anthers 0.7–0.9 mm long. Style 3-fid. Nut broad-elliptical in outline, subterete to broadly trigonous, 3–4 mm long, with 6 broad rounded longitudinal ridges, black, dull, tuberculate, partly enclosed by persistent perianth” (Wilson and Makinson 2024).
2. *Muehlenbeckia costata* is locally restricted to a number of rocky outcrops scattered widely across the New England Tableland of northern NSW and southeast Queensland, with two outlying sites in the Pilliga and the NSW Central Tablelands near Lithgow. The species is currently known from six subpopulations (per the IUCN (2022) definition) across its range, with each typically consisting of localised clusters of records on and amongst rocky outcrops in an area of continuous habitat that may be affected by a single fire event.
3. The Extent of Occurrence (EOO) of *Muehlenbeckia costata* is estimated to be 47,932 km² and is based on a minimum convex polygon enclosing all mapped occurrences of the species, the method of assessment recommended by IUCN (2022). The Area of Occupancy (AOO) is estimated to be 68 km² using 2 x 2 km grid cells, the scale recommended by IUCN (2022). Both EOO and AOO were calculated using ArcGIS (Esri 2015), enclosing all confirmed survey records and cleaned spatial datasets.

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4. The current estimated population size of *Muehlenbeckia costata* includes at least 8,250 mature individuals. The species' short-lived standing plants, their synchronous fire-cued emergence, and propensity to persist during long intervening periods (see paragraphs 7, 8 and 9) result in variable detectability of mature individuals through time, which makes it difficult to estimate their overall number more precisely.
5. *Muehlenbeckia costata* is typically found around recently burnt montane rocky outcrops, with most occurrences above 1,100 m elevation (Hunter *et al.* 1998), though the most westerly record is as low as 500 m elevation (Hunter 2011a). While it often occurs in heath and mallee vegetation on large outcrops with significant areas of bare rock (Hunter *et al.* 1998), the species has also been recorded within the forest and woodland matrix adjoining the outcrops at some sites (Hunter 2020; G. Phillips pers. obs. April 2020). Plants are mostly found on granite (Hunter *et al.* 1998), although they have also been recorded on trachyte and sandstone (Hunter 2011a, 2015). The plants often occur in shallow soils within cracks and fissures on outcrops and can come to completely dominate these habitats in the early post-fire period (G. Phillips pers. obs. March 2020, April 2020).
6. *Muehlenbeckia costata* is dioecious, with male and female flowers borne on separate plants (Hunter *et al.* 1998). This species is primarily likely to be wind pollinated as per other *Muehlenbeckia* (Wodehouse 1931). However, large numbers of insects such as small flies, ladybeetles (Coccinellidae), and ants have been observed visiting inflorescences in peak flower on *Muehlenbeckia costata* and related species (Schuster *et al.* 2011; G. Phillips pers. obs. March 2020) and may therefore play an additional role in pollination. The seeds of *Muehlenbeckia costata* develop within a fleshy perianth that turns bright orange/red at maturity (Hunter *et al.* 1998). This colour attractant makes birds and lizards primary candidates for dispersal across and between habitat areas (Hunter *et al.* 1998).
7. *Muehlenbeckia costata* is an obligate seeding species dependent on the passage of hot fire to complete its short lifecycle (Hunter *et al.* 1998), with no plants ever recorded without a preceding spring or summer fire. Fire-cued mass germination events are often 10–30 years apart, although the longest recorded time between fires inferred to be sufficiently hot to trigger germination at any known site is approximately 55 years (NSW NPWS 2022). This suggests that the species can remain dormant in the soil seedbank for at least several decades (Hunter 1999).
8. *Muehlenbeckia costata* recruits *en masse* immediately following a hot fire (Hunter *et al.* 1998). Following a germination event, flowering follows after only 2–3 months and continues throughout the typical 1–3-year lifespan, with female plants continually producing fruit over a similar timeframe (Hunter *et al.* 1998; Hunter 1999, 2006, 2011b). Standing plants then succumb quickly at the end of the lifecycle, with most plants infected by a rust fungus prior to and during their rapid senescence (Hunter *et al.* 1998). Within two years from the time of fire, most plants have fully senesced (Hunter *et al.* 1998), though persistent individuals have been recorded up to 4–5 years after fire (Hunter 2006, 2011b; G. Phillips pers. obs. August 2023).

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9. *Muehlenbeckia costata* appears to have complex seed dormancy which enables the seeds to persist long-term in the soil seedbank and germinate in the post-fire environment when conditions are most suitable. Seeds of many *Muehlenbeckia* species exhibit physiological dormancy requiring environmental cues for germination and may also have a hard seed coat (South Australian Seed Conservation Centre 2018a, 2018b, 2018c; Wotton 2018). *Muehlenbeckia costata* appears to require soil heating and exposure to smoke for germination: Hunter (1999) found weak evidence of greater germination rates following smoke treatment and heating for 10 minutes at temperatures from 80°C to as high as 120°C, than in controls and after heating without smoke treatment. These temperatures are representative of the conditions experienced by the top 1–2 cm of soil in high intensity wildfires (Bradstock and Auld 1995). This suggests that high intensity fires may result in the strongest germination.
10. Previously identified threats to *Muehlenbeckia costata* include adverse fire regimes, particularly the exclusion of suitably hot fire for extended periods, trampling where the species occurs on trails, road maintenance where the species abuts roads and tracks, and browsing by feral goats (*Capra hircus*) (Hunter *et al.* 1998; OEH 2021). Another more recently identified threat is invasion by disturbance-promoted weed species such as inkweed (*Phytolacca octandra*; G. Phillips pers. obs. March 2021). 'Competition and habitat degradation by feral goats (*Capra hircus*)' is listed as a key threatening process under the Act.
11. A reduction of sufficiently hot wildfires is considered to be the most serious plausible threat. Large distances separating the six subpopulations of *Muehlenbeckia costata* suggest that they can be interpreted as 4-6 threat-defined locations (IUCN 2022) due to the relatively low likelihood of synchronous fire events (NSW NPWS 2022). This, combined with differing fire management strategies and priorities across differing national parks (NSW NPWS 2005a, 2005b, 2005c, 2013), means each location is likely to have a different risk profile for fire-related threats.
12. Based on available time series data, there is no evidence of continuing decline in the number of mature individuals of *Muehlenbeckia costata* and none of the identified threats appear to be currently causing continuing declines in mature individuals, distribution, or extent or quality of habitat (Philips 2024). Adverse fire regimes may contribute to future declines in the population of *Muehlenbeckia costata* if hot wildfires are excluded from subpopulations over long periods of time or if fire precedes severe droughts that may limit seedling recruitment. A reduction in the occurrence of intense fires may limit germination events and diminish subsequent recruitment for the species. Furthermore, if occurrences of lower intensity fire or out-of-season fires increase in future, they may also disrupt the lifecycle of *Muehlenbeckia costata* as suboptimal fire cues may limit the magnitude of germination responses.
13. In view of the above, the NSW Threatened Species Scientific Committee is of the opinion that *Muehlenbeckia costata* K.L.Wilson & Makinson (syn. *Muehlenbeckia* sp. Mt Norman (J.T.Hunter 3847) Makinson) is not eligible to be listed as a threatened species in any category under the Act.

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Assessment against *Biodiversity Conservation Regulation 2017* criteria

The Clauses used for assessment are listed below for reference.

Overall Assessment Outcome:

Muehlenbeckia sp. Mt Norman (J.T.Hunter 3847) Makinson was found to be ineligible for listing as none of the criteria were met.

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: Not met

The geographic distribution of the species is:		
	(a)	for critically endangered species
	(b)	for endangered species
	(c)	for vulnerable species
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,

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	(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:					
	(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

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			(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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Professor Angela Moles
Chairperson
NSW Threatened Species Scientific Committee

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Supporting Documentation:

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