

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 *Leucochrysum albicans* subsp. *tricolor* (DC.) N.G. Walsh 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.

The NSW Threatened Species Scientific Committee is satisfied that *Leucochrysum albicans* subsp. *tricolor* (DC.) N.G. Walsh has been duly assessed by the Commonwealth Threatened Species Scientific Committee under the Common Assessment Method (Department of Agriculture, Water, and the Environment (DAWE) 2021). The acceptance of this assessment is provided for by Part 4.14 of the Act.

Summary of Conservation Assessment

The NSW Threatened Species Scientific Committee accepts the assessment undertaken by the Commonwealth Threatened Species Scientific Committee in its Conservation Advice for *Leucochrysum albicans* subsp. *tricolor* (DAWE 2021).

Leucochrysum albicans subsp. *tricolor* (DC.) N.G. Walsh was found to be Endangered in accordance with the following provisions. Clause: 4.2 (1)(b) and (2)(a)(b)(c) of the *Biodiversity Conservation Regulation 2017*. The main reason for this subspecies being eligible for listing in the Endangered category is that it has undergone a large reduction in population size over the last three generations, due to land clearing and land use change, infrastructure maintenance, adverse fire regimes, competition with invasive weeds, low genetic diversity, changes to habitat suitability due to climate change, and overgrazing by domestic stock.

The NSW Threatened Species Scientific Committee has found that:

1. *Leucochrysum albicans* subsp. *tricolor* was first described by Paul G. Wilson in 1992 as *Leucochrysum albicans* var. *tricolor* (DC.) Paul G. Wilson. Following the elevation of rank by Walsh (2015), the name of this taxon is now conventionally accepted as *Leucochrysum albicans* subsp. *tricolor* (DC.) N.G. Walsh (DAWE 2021).
2. *Leucochrysum albicans* subsp. *tricolor* is a perennial everlasting daisy belonging to the family Asteraceae. Stems are 10–15 cm tall, and have narrow leaves 2–10 cm long, covered in white cottony hairs. The yellowish flower heads are 2–5 cm in diameter and surrounded by numerous white overlapping ovate-oblong bracts, with the outer layer often tinged purple or brown. The fruits are brown, ovoid, 2–3 mm long, with 14–20 pappus bristles (Wilson 1992; Short 1999).
3. *Leucochrysum albicans* subsp. *tricolor* is endemic to south-eastern Australia, where it occurs in three geographically separate areas across NSW and the ACT, Victoria, and Tasmania. The largest of these distributions is in NSW and ACT;

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located on the Southern Tablelands roughly from Bombala to Goulburn, with several records from further north near Mudgee. While locally common in NSW and the ACT, some NSW populations may be declining (Sinclair 2010; ALA 2020). Victorian and Tasmanian distribution is more restricted, and in decline with local extinctions (DAWE 2021).

4. There are approximately 129 populations of *Leucochrysum albicans* subsp. *tricolor* across the species' total distribution (ALA 2020; Morgan *et al.* 2013). In NSW, there are 88 records from approximately 30 populations recorded since 2000 (ALA 2020). Populations are identified as geographically distinct records that are further than a few kilometers apart on the basis that they show little genetic exchange (DAWE 2021).
5. Approximately half of the NSW populations of *Leucochrysum albicans* subsp. *tricolor* occur on roadsides, around a third on unsecured private land, and the remainder in reserves or state forest (ALA 2020).
6. A number of populations important for maintaining genetic diversity and ecological functions have been identified in response to the observed declines of *Leucochrysum albicans* subsp. *tricolor* in Victoria and Tasmania, (Morgan *et al.* 2013; DAWE 2021). In NSW, important populations include: any populations of >10,000 individuals, due to their potential as key source populations for dispersal of *L. albicans* subsp. *tricolor* propagules and gene flow, and any populations near the limit of the range of the NSW/ACT region and near or north of Goulbourn (DAWE 2021).
7. The geographic distribution of *Leucochrysum albicans* subsp. *tricolor* is moderately restricted (DAWE 2021). The Extent of Occurrence (EOO) is estimated at 438,166km² based on the mapping of point records from 2000 to 2020, obtained from state governments, herbaria and CSIRO (DAWE 2021). The EOO was calculated using a minimum convex hull, based on the IUCN Red List Guidelines 2019. The Area of Occupancy (AOO) of *L. albicans* subsp. *tricolor* is limited and estimated at 1376 km² based on the mapping of point records from 2000 to 2020, obtained from state governments, herbaria and CSIRO (DAWE 2021). The AOO was calculated using a 2x2km grid cell method, based on the IUCN Red List Guidelines 2019.
8. The total number of mature individuals is estimated at approximately 250,000–280,000 (DAWE 2021). The combined total number of individuals in NSW and the ACT was estimated to be >200,000 plants (Sinclair 2010). There is no evidence to suggest this has changed substantially since 2010, although some roadside populations may be declining (DAWE 2021). The total population size of *Leucochrysum albicans* subsp. *tricolor* is inferred to be contracting due to the decline and extinction of many populations in Victoria and Tasmania (Collier 2016; Tasmanian Land Conservancy 2019; DAWE 2021).
9. In other range states *Leucochrysum albicans* subsp. *tricolor* flowers between October–December, and this is likely also true in NSW (DPIPWE 2017; VicFlora 2020). *Leucochrysum albicans* subsp. *tricolor* is reliant on cross-pollination by

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insects of the orders Hymenoptera and Diptera (McClaren 2013) and does not set seed when self-pollinated (Costin *et al.* 2001).

10. *Leucochrysum albicans* subsp. *tricolor* produces many small, wind-dispersed seeds that generally have high seed viability and germinate quickly (Morgan *et al.* 2013). Seeds are thought to be short-lived in the soil seed bank (Morgan *et al.* 2013), although germination from soil cores has been observed, suggesting they may be capable of surviving at least for short periods of time (Gilfedder & Kirkpatrick 1993). Germination usually occurs in June–July (Gilfedder & Kirkpatrick 1993) and adult plants usually resprout following fire (DELWP 2015).
11. Individual plants are estimated to live for a maximum of 15 years (Gilfedder & Kirkpatrick 1994; DELWP 2015), although numbers of plants can fluctuate widely between years (Berechee 2003; McClaren 2013; Collier 2016). Plants die back over summer, where they survive as a perennial rootstock (Sinclair 2010).
12. In NSW, *Leucochrysum albicans* subsp. *tricolor* occurs in grasslands, grassy areas in woodlands and dry open forests, and modified habitats on a variety of soil types including clays, clay loams, stony and gravelly soil (Sinclair 2010; ALA 2020). Across its distribution, this species occurs in a wide variety of grassland, woodland, and forest habitats, generally on relatively heavy soils. This species relies on the presence of bare ground for germination and establishment, free from competition with grasses (Sinclair 2010).
13. The major threats to this species are: land use conversion and land clearing, deleterious impacts from road maintenance, adverse fire regimes, competition with invasive weeds and grasses, genetic risks associated with small, fragmented populations, impacts of climate change on weather conditions, and over-grazing by domestic stock (DAWE 2021). ‘Anthropogenic Climate Change’, ‘Clearing of native vegetation’ and ‘Invasion of native plant communities by exotic perennial grasses’ are listed as Key Threatening Processes under the Act.
14. Conversion of land use poses a risk to *Leucochrysum albicans* subsp. *tricolor* populations on private land. Conversion of land use from grazing to cropping and from native grassland to introduced pasture has the potential for permanent destruction of populations (DAWE 2021).
15. The restriction of many populations to roadside remnants in NSW places *Leucochrysum albicans* subsp. *tricolor* at risk from road and utility construction and maintenance (DELWP 2015, Sinclair 2010). Roadside widening activities to increase road safety and roadside spraying for fire control can impact the species and its native grassland habitat (DAWE 2021). Populations have previously been recorded to be impacted by roadworks, including one NSW population along the Snowy Mountains Highway near Adaminaby (Sinclair 2010).
16. Inappropriate fire regimes pose a threat to *Leucochrysum albicans* subsp. *tricolor* populations through biomass accumulation or potential weed invasion. Long fire-free intervals are detrimental to this species as they result in high biomass accumulation in productive grasslands that kills forbs like *L. albicans* subsp. *tricolor*

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(DELWP 2015; Morgan 2015). When biomass accumulates over periods of 7–11 years or more, the longer-term integrity of productive Kangaroo Grass-dominated grasslands can be compromised by death of the dominant Kangaroo Grass sward, followed typically by weed invasion (Morgan 2015), which is likely to negatively affect the habitat suitability and likelihood of recovery for *L. albicans* subsp. *tricolor*. Local extinctions and decline in Victorian and Tasmanian populations have been attributed to a lack of biomass reduction, suggesting this may also be a significant threat in NSW.

17. *Leucochrysum albicans* subsp. *tricolor* does not tolerate strong competition, and is at high risk from competition with weeds throughout its range (Sinclair 2010; DELWP 2015). Weeds currently threatening the taxon include Cat's Ear (*Hypochaeris radicata*), Clovers (*Trifolium* spp.), Toowoomba Canary-grass (*Phalaris aquatica*), Brown-top Bent (*Agrostis capillaris*), Paspalum (*Paspalum dilatatum*), Cocksfoot (*Dactylis glomerata*) and South African Weed Orchid (*Disa bracteata*) (Sinclair 2010; McClaren 2013). 'Invasion of native plant communities by exotic perennial grasses' is listed as a Key Threatening Process under the Act.
18. Many populations of *Leucochrysum albicans* subsp. *tricolor* are small and it is likely that genetic threats are a serious threat to those populations (DAWE 2021). Small, isolated populations are subject to the effects of fragmentation on genetic diversity, with allelic richness, observed and expected heterozygosity, percent seed set, and seed germination all positively correlated with population size (Morgan *et al.* 2013).
19. Drought appears detrimental to *Leucochrysum albicans* subsp. *tricolor*, probably by negative effects on adult growth, increasing mortality, and reducing recruitment (Gilfedder & Kirkpatrick 1994a; McClaren 2013). Climate projections for south-eastern Australia include increasing frequency and intensity of drought (CSIRO & Bureau of Meteorology 2015), and drought has previously been implicated in the decline of *L. albicans* subsp. *tricolor* in other range states (Collier 2016).
20. Historic overgrazing may have contributed to the decline of *Leucochrysum albicans* subsp. *tricolor* in some locations (Sinclair 2010). While light stock grazing appears to be beneficial to this species by maintaining low biomass conditions, changes to grazing regimes that were previously beneficial may subsequently cause a shift in conditions that no longer favour this species, and allow other species, especially invasive weeds, to establish and exclude it (Sinclair 2010).
21. *Leucochrysum albicans* subsp. *tricolor* is eligible to be listed as an 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*:

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Assessment against *Biodiversity Conservation Regulation 2017* criteria

The Clauses used for assessment are listed below for reference.

Overall Assessment Outcome: Endangered under Clause 4.2 (1)(b) and (2)(a)(b)(c)

Clause 4.2 – Reduction in population size of species (Equivalent to IUCN criterion A)

Assessment Outcome: Endangered under Clause 4.2 (1)(b) and (2)(a)(b)(c)

(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: Vulnerable under Clause 4.3 (c)(d)(e ii,iii,iv)

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.

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Clause 4.4 – Low numbers of mature individuals of species and other conditions

(Equivalent to IUCN criterion Clause C)

Assessment Outcome: Clause 4.4 is 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
			(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: Clause 4.5 is 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.

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Clause 4.7 – Very highly restricted geographic distribution of species–vulnerable species (Equivalent to IUCN criterion D2)

Assessment Outcome: Clause 4.7 is not applied.

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 Kristine French
Chairperson
NSW Threatened Species Scientific Committee

Supporting Documentation:

DAWE (Department of Agriculture, Water, and the Environment) (2021) Conservation Advice for *Leucochrysum albicans* subsp. *tricolor* (Hoary Sunray). Canberra: Department of Agriculture, Water and the Environment. Available from: http://www.environment.gov.au/cgi-bin/sprat/public/publicspecies.pl?taxon_id=89104

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