Threatened Species Assessment

Asterolasia asteriscophora subsp. *albiflora*
White star bush

Taxonomy

Asterolasia asteriscophora subsp. *albiflora* B.J. Mole Family: Rutaceae.

Current conservation status

Asterolasia asteriscophora subsp. *albiflora* is nominated for inclusion as Critically Endangered under the EPBC Act.

The taxon is currently listed as threatened in Victoria under the *Flora and Fauna Guarantee Act 1988*. Since the taxon is endemic to Victoria the Victorian regional assessment also represents a national assessment.

Proposed conservation status

Critically Endangered

Criteria A4abce; B1ab(i,ii,iii,iv,v)

Species Information

Description and Life History

Asterolasia asteriscophora subsp. *albiflora* (white star bush), also known as the Emerald Star-bush), is a slender upright shrub growing to 1.5 metres tall with dark green obovate to almost circular leaves, reaching 30 x 10 mm in size. The upper surface of the leaves has a few stellate hairs, while the lower surface is densely covered with rusty coloured stellate hairs. The flowers are usually white (occasionally pale lemon), star-shaped with 5 petals and 10 showy protruding stamens, often alternating long and short. The sepals are reduced to scales at the base of petals. The flowers are borne in umbels of 3 to 5, on stalks (pedicels) 6 to 15 mm long which are supported on a common stalk (peduncle), which is up to 5 mm long.

White star bush typically flowers from early October to late November (DSE 2015). Plants may flower as early as their second year and reach reproductive maturity within 4-5 years. The taxon is a fire-sensitive obligate seed regenerator (OSR). Intense fire therefore results in mortality of all affected age classes.

Generation Length

Generation length is estimated at 35-90 years with a plausible best estimate of 60 years. This is based on the inferred pre-European settlement fire frequency and the inference that the taxon is a fire-sensitive obligate seed regenerator (OSR) which recruits primarily in response to intense fire events from a long-persistent soil-stored seedbank. Episodic recruitment in response to fire is likely to be supplemented by a low frequency of sporadic or continuous recruitment in optimal seasons in response to localised site or soil disturbance such as animal activity or storm damage. Like other members of the Rutaceae, the taxon has a hard seed coat which is highly resistant to damage (Collette & Ooi 2017) and is expected to persist in the seedbank for many decades, often persisting beyond the life span of earlier cohorts of seed-based recruits. Fire intervals under undisturbed pre-European settlement conditions are estimated to be in the range 30-90 years with a plausible mean of 60 years based on the mix of Wet Forest dominated by *Eucalyptus regnans* (Mountain Ash) and other ecological vegetation classes (EVCs) across the taxon's range with estimated times to full post-fire recovery typically in the 50–100-year range or more (Ashton 1977).

Distribution

The taxon is endemic to Victoria and is only known from the south-eastern slopes of the Dandenong Ranges from Belgrave, Monbulk, Emerald and Avonsleigh (DSE 2015, VicFlora 2017).

Habitat

The taxon occurs in damp sclerophyll forest at foothill elevations of approximately 150-300 m altitude (DSE 2015, VicFlora 2017).

Threats

The taxon occurs in a peri-urban and semi-rural district on the outer eastern fringe of metropolitan Melbourne where housing and peri-urban development are major threats as is the changed fire regime. Fire is necessary for significant recruitment from seed. A sequence of fires at short intervals at or below the tolerable fire interval (TFI) for the taxon is likely to result in seedbank depletion or exhaustion and local extinction whilst transforming the habitat into a highly flammable disclimax community dominated by Bracken (*Pteridium esculentum* subsp. *esculentum*). Long-term fire exclusion may allow the incursion of exotic weeds, animals and plant diseases and risks causing seedbank depletion once the last cohort of episodic recruits reach their natural life span. For example, members of the Rutaceae family (which includes this taxon) are selectively targeted for browsing or antler rubbing by deer, particularly by Sambar (*Cervus unicolor*) (Bilney 2013) and many taxa in this family are also known to be susceptible to damage by Cinnamon Fungus (*Phytophthora cinnamomi*). Sambar are currently undergoing an explosive increase in population density across the region and pose an increasing threat of targeted browsing resulting in compromised flowering and seed set, seedbank depletion, adult mortality and recruitment failure and local extinction. This is exacerbated by the increasing risk of intense and prolonged drought stress and the risk of adult mortality, recruitment failure, seedbank depletion and local extinction in response to climatic drying. Incremental habitat loss and habitat degradation in response to agricultural and urban intensification are ongoing threats throughout the highly restricted peri-urban range of the taxon and in response to targeted road management and fire management activity including mineral earth breaks, repeat slashing and high frequency fuel reduction burning on both private and public land.

IUCN Criteria

Standard of scientific evidence and adequacy of survey

For this assessment is it considered that the survey of the taxon has been adequate and there is sufficient scientific evidence to support estimates of population size, decline, EoO, AoO, subpopulation number and, therefore, the listing outcome. The taxon is restricted to a highly populated district with numerous points of access to public and private land with 134 site records of the taxon in the Victorian Biodiversity Atlas (VBA) and 37 specimen records in the Australasian Virtual Herbarium (AVH), most of which are recent, reliably determined and locationally accurate.

Criterion A. Population size reduction. Population reduction (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	Critically Endangered	Endangered	Vulnerable
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3, A4	≥ 80%	≥ 50%	≥ 30%

A1 Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.

A2 Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible.

A3 Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [*(a) cannot be used for A3*]

A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.

based on any of the following:

(a) direct observation [*except A3*]

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites

Evidence:

Eligible under Criterion A2abce as Endangered

An estimate of population reduction over the past 105 to 270 years of 50-85%, with a nominal mean of 70%, is based on (a), (b), (c) and (e) above. This estimate of past decline is inferred from the extent of historic land clearing across the restricted range of the taxon. Most losses will have occurred in the last 80-90 years through urbanisation. Population size is confidently inferred to have at least halved and, potentially, to have exceeded the 80% threshold in response to habitat loss, habitat degradation and the increasing synergistic impacts of weed invasion, browsing by feral herbivores, unfavourable fire regimes, prolonged and extreme drought stress and the potential impact of infection by *Phytophthora cinnamomi*. Land clearance for agriculture is less likely to have occurred in the nineteenth century since the habitat range of the taxon was not regarded as optimal for agriculture. Instead, habitat loss through peri-urban development occurred mostly after 1920 as people took up bush blocks in the area.

Eligible under Criterion A3ce as Endangered

Population reduction over the next 100 years is projected to be 50-80%, with a nominal mean of 65%, based on (c) and (e) above. The causes of reduction have not ceased, are well understood and are not reversible.

This estimate of future decline is based on the projected impact of the identified threats. Subpopulations in conservation reserves are unlikely to be directly lost to development but are subject to the increasing and synergistic impacts of weed invasion, browsing by feral herbivores, unfavourable fire regimes, prolonged and extreme drought stress and the potential impact of infection by *P. cinnamomi*. Subpopulations outside the reserves system are also at ongoing stochastic risk from road upgrades, fire management activity and incremental impacts of peri-urban and agricultural intensification. Whilst there was no evidence of Sambar activity at Emerald Quarry

(the largest known subpopulation) as of 2020, the increasing threat of targeted browsing by Sambar alone is projected to cause catastrophic declines in many, if not most, subpopulations irrespective of tenure.

Eligible under Criterion A4abce as Critically Endangered

Population reduction over any 105 to 270-year period, including both past and future (up to 100 years in the future), is estimated to be 50-90% with a nominal mean of 75%, based on (a), (b), (c) and (e) above. The causes of reduction have not ceased, are well understood and are not reversible.

An estimate of past decline is inferred from the extent of historic land clearing across the restricted range of the taxon. Most losses will have occurred in the last 80-90 years through urbanisation. Population size is confidently inferred to have at least halved and, potentially, to have exceeded the 80% threshold in response to habitat loss, habitat degradation and the increasing synergistic impacts of weed invasion, browsing by feral herbivores, unfavourable fire regimes, prolonged and extreme drought stress and the potential impact of infection by *P. cinnamomi*. Land clearance for agriculture is less likely to have been concentrated in the nineteenth century since the habitat range of the taxon was not regarded as optimal for agriculture. Instead, habitat loss through peri-urban development occurred mostly after 1920 as people took up bush blocks in the area.

An estimate of future decline is based on the projected impact of the identified threats. Subpopulations in conservation reserves are unlikely to be directly lost to development but are subject to the increasing and synergistic impacts of weed invasion, browsing by feral herbivores, unfavourable fire regimes, prolonged and extreme drought stress and the potential impact of infection by *P. cinnamomi*. Subpopulations outside the reserves system are also at ongoing stochastic risk from road upgrades, fire management activity and incremental impacts of peri-urban and agricultural intensification. Whilst there was no evidence of Sambar activity at Emerald Quarry (the largest known subpopulation) as of 2020, the increasing threat of targeted browsing by Sambar alone is projected to cause catastrophic declines in many, if not most, subpopulations irrespective of tenure.

Criterion B. Geographic range in the form of either B1 (extent of occurrence) and/or B2 (area of occupancy			
	Critically Endangered Very restricted	Endangered Restricted	Vulnerable Limited
B1. Extent of occurrence (EOO)	< 100 km²	< 5,000 km²	< 20,000 km²
B2. Area of occupancy (AOO)	< 10 km²	< 500 km²	< 2,000 km²
AND at least 2 of the following 3 conditions:			
(a) Severely fragmented OR Number of locations	= 1	≤ 5	≤ 10
(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			
(c) Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			

Evidence:

Eligible under Criterion B1ab(i,ii,iii,iv,v) as Critically Endangered

The Extent of Occurrence (EoO) across the taxon's range is estimated to be 52 km², based on accepted, post-1970 records from the Victorian Biodiversity Atlas (VBA). Historic, mislocated or locationally imprecise records are excluded from this assessment.

The taxon is estimated to be severely fragmented and is estimated to have a single location. It has a continuing decline in (i), (ii), (iii), (iv) and (v) above, based on the current and projected impact of the identified threats, many

of which operate synergistically across the limited ecological and geographic range of the taxon irrespective of tenure and localised stochastic risks.

The taxon is severely fragmented both naturally and anthropogenically at the landscape scale with most discrete stands occurring at distances greatly exceeding the seed dispersal capacity of the taxon (Auld 2001). The only plausible vectors are ants (myrmecochory) which disperse seeds at the metre scale. Like many other Australian members of the Rutaceae, stands of the taxon tend to have clear geographic boundaries, supporting the inference that the taxon has very limited dispersal range.

The taxon is considered to occur in a single location since the most significant identified threats (Sambar browsing, inappropriate anthropogenic fire regimes, intense and prolonged drought stress and incremental weed invasion) apply across its range and can rapidly affect all individuals of the taxon present.

Spatial analysis of likely habitat for the taxon indicates that 62% occurs within the CAR reserve system, including parks and reserves and special protection zones.

Eligible under Criterion B2ab(i,ii,iii,iv,v) as Endangered

The Area of Occupancy (AoO) across the taxon's range is estimated to be 36 km², based on 2 x 2 km² grids derived from accepted, reliable, locationally accurate post-1970 records from the VBA.

The taxon is estimated to be severely fragmented and is estimated to have a single location. It has a continuing decline in (i), (ii), (iii), (iv) and (v) above, based on the current and projected impact of the identified threats, many of which operate synergistically across the limited ecological and geographic range of the taxon irrespective of tenure and localised stochastic risks.

Criterion C. Small Population size and decline				
		Critically Endangered	Endangered	Vulnerable
Number of mature individuals		< 250	< 2,500	< 10,000
AND at least one of C1 or C2				
C1	An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future):	25% in 3 years or 1 generation (whichever is longer)	20% in 5 years or 2 generations (whichever is longer)	10% in 10 years or 3 generations (whichever is longer)
C2	An observed, estimated, projected or inferred continuing decline AND least 1 of the following 3 conditions:			
(a)	(i) Number of mature individuals in each subpopulation	≤ 50	≤ 250	≤ 1,000
	(ii) % of mature individuals in one subpopulation =	90 – 100%	95 – 100%	100%
(b) Extreme fluctuations in the number of mature individuals				

Evidence:

Eligible under Criterion C1 as Vulnerable

It is estimated that there are 2,000 to 6,000 (with a best estimate of 3,500) mature individuals, based on field survey and monitoring of key subpopulations, and population size is projected to decline in the next 100 years by 50-80%, with a median estimate of 65% future decline.

Criterion D. Very small or restricted population			
	Critically Endangered	Endangered	Vulnerable
Number of mature individuals (observed or estimated)	< 50	< 250	< 1,000
D2 Only applies to the VU category Restricted area of occupancy or number of locations with a plausible future threat that could drive the species to critically endangered or Extinct in a very short time.	-	-	D2. Typically: AoO < 20 km2 or number of locations ≤ 5

Evidence:

Eligible under Criterion D2 as Vulnerable

The taxon is estimated to be very restricted, with an estimated AoO of 36 km² and a single location, such that the taxon is at risk of becoming extinct (EX) within a period of one to two generations in response to the projected impact of the identified threats.

Criterion E (Quantitative Analysis) was not addressed as the taxon has not been subjected to a detailed Population Viability Analysis.

Primary conservation objective

To maintain *Asterolasia asteriscophora* subsp. *albiflora* populations and population processes that allow ongoing recruitment success while managing threats effectively to ensure survival and retention of evolutionary development in the wild.

Conservation and management priorities

Habitat loss, disturbance and modifications impacts

- Investigate formal conservation arrangements, management agreements and/or covenants on private land. For crown and private land, investigate inclusion of habitat into reserves if possible.
- Secure populations in the Comprehensive, Adequate and Representative (CAR) Reserve System
- Incorporate information regarding the location and management of white star bush sites into local planning schemes, including environmental significance overlays, to protect these sites.

Invasive species impacts (including from grazing, trampling, predation)

- Identify and remove weeds in the local area of known sites using appropriate methods and manage sites to prevent introduction of invasive weeds that threaten or could become a threat to white star bush. At the Lawson Road site near Emerald the exotic *Eucalyptus macarthurii* (Camden Woollybutt) requires targeted culling to reduce competition for light.
- Reduce densities of feral herbivores (specifically deer) and maintain at low levels through appropriate control programs.
- Manage grazing pressure at important/significant sites through exclusion fencing or other barriers.
- Erect fences around seedlings, when detected, to encourage establishment and prevent browsing by herbivores.

Fire impacts

- Develop and implement a suitable fire management strategy for white star bush.
- Where appropriate, provide information on location of known occurrences to local and state Country Fire Authority and seek inclusion of mitigative measures in bush fire risk management plans, risk register and/or operation maps.

Disease impacts

- Raise awareness of the threat of *Phytophthora cinnamomi* (root rot).
- Develop and implement suitable hygiene and biosanitation protocols to protect known sites from spread of *P. cinnamomi* and to prevent dieback of white star bush habitat caused by *P. cinnamomi*.

Impacts of native species

- Carefully manage competitive native species, including bracken, *Pultenaea* spp. and Dusty Miller (*Spyridium parvifolium*) following ecological burns to encourage growth of white star bush.

Ex situ recovery actions

- Develop a targeted seed collection program for ex situ seed banking.
- Investigate options for linking, enhancing or establishing additional populations between known and suitable habitat areas.
- Any translocation, either for ex situ populations or reintroductions, should be conducted in accordance with the *Guidelines for the Translocation of Threatened Plants in Australia* (Commander et al. 2018).

Stakeholder engagement/community engagement

- Inform and consult with landowners and managers of sites where there are known populations to mitigate the risk of unintentional damage to populations, such as non-target effects of weed control or inappropriate fire regimes.
- Provide information regarding location and management of white star bush to local government and Catchment Management agencies.
- Liaise with relevant stakeholders and landholders to discuss and coordinate pest and weed control.

Survey and monitoring priorities

- More precisely assess population size, distribution, ecological requirements and the relative impacts of threatening processes.
- Coordinate targeted surveys of potential habitat for white star bush to identify new populations.
- Monitoring for increased habitat degradation and assess threats at all locations, including further impacts of herbivory.
- Conduct post-burn monitoring to determine optimal fire regimes for promoting seed production and germination and provide further information on how white star bush responds to fire over time.
- Conduct survey and surveillance monitoring for P*. cinnamomi* in known areas of white star bush occurrence to assess impact on the species.

Information and research priorities

- Research to further understand the impact and spread of *P. cinnamomi* and the potential threat to white star bush.
- Investigate the impacts of climate change on the long-term survival prospects of the subspecies.
- Investigate options for establishing additional populations; or if new populations are discovered, investigate options for enhancing or increasing connectivity with these populations.

- Determine if there is gene flow between populations, and whether the subspecies is suffering from any negative effects of small population size.
- Research the seed ecology of the subspecies including germination and dormancy mechanisms, fire response and seedbank longevity.
- Investigate the specific threats of plant to reduce the impacts on populations and newly established seedlings.
- Assess drought tolerance and susceptibility and interactive effects of multiple coinciding disturbances such as drought followed by fire.
- Investigate species fire response to determine fire regimes that are detrimental to the species and those that allow population persistence.

This list does not necessarily encompass all actions that may be of benefit to white star bush but highlights those that are considered to be of highest priority at the time of preparing the conservation advice.

References

Ashton, D. (1977). Estimates of the time required for recovery of Victorian plant communities from ground and crown fires. Report prepared for the Interim Reference Areas Advisory Committee.

Auld, T.D. (2001). The ecology of the Rutaceae in the Sydney region of south-eastern Australia: Poorly known ecology of a neglected family. *Cunninghamia*, 7(2): 213-239.

Bilney, R.J. (2013). Antler rubbing of Yellow-wood by Sambar in East Gippsland, Victoria. *The Victorian Naturalist*, 130(2): 68-74.

Collette, J.C. & Ooi, M.K. (2017). Germination ecology of the endangered species *Asterolasia buxifolia* (Rutaceae): smoke response depends on season and light. *Australian Journal of Botany*, *65*(3): 283-291.

DEPI (2014). *Advisory list of rare or threatened plants in Victoria - 2014*. Department of Environment and Primary Industries, Melbourne.

DSE (2015). Action Statement - White Star-bush *Asterolasia asteriscophora* subsp.*albiflora* (261). Department of Sustainability and Environment, East Melbourne. Retrieved from: https://www.environment.vic.gov.au/__data/assets/pdf_file/0017/33056/White-Star-bush_action-statement.pdf

VicFlora (2017). Flora of Victoria, Royal Botanic Gardens Victoria: *Asterolasia asteriscophora* subsp. *albiflora* Mole. Emerald Star-bush. Retrieved from: https://vicflora.rbg.vic.gov.au/flora/taxon/a4ad85fc-869c-472b-83af-40dfeb54b10d.