Australian Government
Department of Agriculture, Water and the Environment

Consultation on Species Listing Eligibility and Conservation Actions

Eucalyptus forresterae (Brumby sallee)

You are invited to provide your views and supporting reasons related to:

1) the eligibility of *Eucalyptus forresterae* (Brumby sallee) for inclusion on the EPBC Act threatened species list in the Endangered category; and

2) the necessary conservation actions for the above species.

The purpose of this consultation document is to elicit additional information to better understand the status of the species and help inform on conservation actions and further planning. As such, the below draft assessment should be considered to be **tentative** as it may change following responses to this consultation process.

Evidence provided by experts, stakeholders and the general public are welcome. Responses can be provided by any interested person.

Anyone may nominate a native species, ecological community or threatening process for listing under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) or for a transfer of an item already on the list to a new listing category. The Threatened Species Scientific Committee (the Committee) undertakes the assessment of species to determine eligibility for inclusion in the list of threatened species and provides its recommendation to the Australian Government Minister for the Environment.

Responses are to be provided in writing by email to:
species.consultation@environment.gov.au

Please include species scientific name in Subject field.
or by mail to:

The Director
Bushfire Affected Species Assessments Section
Department of Agriculture, Water and the Environment
John Gorton Building, King Edward Terrace
GPO Box 858
Canberra ACT 2601

Responses are required to be submitted by 29 June 2022.

Listing assessment	35

General background information about listing threatened species

The Australian Government helps protect species at risk of extinction by listing them as threatened under Part 13 of the EPBC Act. Once listed under the EPBC Act, the species becomes a Matter of National Environmental Significance (MNES) and must be protected from significant impacts through the assessment and approval provisions of the EPBC Act. More information about threatened species is available on the department's website at: https://www.awe.gov.au/environment/biodiversity/threatened.

Public nominations to list threatened species under the EPBC Act are received annually by the department. In order to determine if a species is eligible for listing as threatened under the EPBC Act, the Threatened Species Scientific Committee (the Committee) undertakes a rigorous scientific assessment of its status to determine if the species is eligible for listing against a set of criteria. These criteria are available on the Department's website at: http://www.awe.gov.au/system/files/pages/d72dfd1a-f0d8-4699-8d43-5d95bbb02428/files/tssc-guidelines-assessing-species-2021.pdf.

As part of the assessment process, the Committee consults with the public and stakeholders to obtain specific details about the species, as well as advice on what conservation actions might be appropriate. Information provided through the consultation process is considered by the Committee in its assessment. The Committee provides its advice on the assessment (together with comments received) to the Minister regarding the eligibility of the species for listing under a particular category and what conservation actions might be appropriate. The Minister decides to add, or not to add, the species to the list of threatened species under the EPBC Act. More detailed information about the listing process is at: https://www.awe.gov.au/environment/biodiversity/threatened/nominations.

To promote the recovery of listed threatened species and ecological communities, conservation advices and where required, recovery plans are made or adopted in accordance with Part 13 of the EPBC Act. Conservation advices provide guidance at the time of listing on known threats and priority recovery actions that can be undertaken at a local and regional level. Recovery plans describe key threats and identify specific recovery actions that can be undertaken to enable recovery activities to occur within a planned and logical national framework. Information about recovery plans is available on the department's website at: https://www.awe.gov.au/environment/biodiversity/threatened/recovery-plans.

Privacy notice

The Department will collect, use, store and disclose the personal information you provide in a manner consistent with the Department's obligations under the Privacy Act 1988 (Cth) and the Department's Privacy Policy.

Any personal information that you provide within, or in addition to, your comments in the threatened species assessment process may be used by the Department for the purposes of its functions relating to threatened species assessments, including contacting you if we have any questions about your comments in the future.

Further, the Commonwealth, State and Territory governments have agreed to share threatened species assessment documentation (including comments) to ensure that all States and Territories have access to the same documentation when making a decision on the status of a potentially threatened species. This is also known as the 'Common

Assessment Method' (CAM). As a result, any personal information that you have provided in connection with your comments may be shared between Commonwealth, State or Territory government entities to assist with their assessment processes.

The Department's Privacy Policy contains details about how respondents may access and make corrections to personal information that the Department holds about the respondent, how respondents may make a complaint about a breach of an Australian Privacy Principle, and how the Department will deal with that complaint. A copy of the Department's Privacy Policy is available at: https://www.awe.gov.au/about/commitment/privacy .

Information about this consultation process

Responses to this consultation can be provided electronically or in hard copy to the contact addresses provided on Page 1. All responses received will be provided in full to the Committee and then to the Australian Government Minister for the Environment.

In providing comments, please provide references to published data where possible. Should the Committee use the information you provide in formulating its advice, the information will be attributed to you and referenced as a 'personal communication' unless you provide references or otherwise attribute this information (please specify if your organisation requires that this information is attributed to your organisation instead of yourself). The final advice by the Committee will be published on the department's website following the listing decision by the Minister.

Information provided through consultation may be subject to freedom of information legislation and court processes. It is also important to note that under the EPBC Act, the deliberations and recommendations of the Committee are confidential until the Minister has made a final decision on the nomination, unless otherwise determined by the Minister.

CONSULTATION QUESTIONS FOR *Eucalyptus forresterae*

SECTION A - GENERAL

1. Is the information used to assess the nationally threatened status of the species/subspecies robust? Have all the underlying assumptions been made explicit? Please provide justification for your response.

2. Can you provide additional data or information relevant to this assessment?

3. Can you provide additional information or insight relevant to the taxonomy of the species?

4. Have you been involved in previous state, territory or national assessments of this species/subspecies? If so, in what capacity?

PART 1 – INFORMATION TO ASSIST LISTING ASSESSMENT

SECTION B DO YOU HAVE ADDITIONAL INFORMATION ON THE ECOLOGY OR BIOLOGY OF THE SPECIES/SUBSPECIES? (If no, skip to section C)

Biological information

5. Can you provide any additional or alternative references, information or estimates on longevity, average life span and generation length?

6. Do you have any additional information on the ecology or biology of the species/subspecies not in the current advice?

SECTION C ARE YOU AWARE OF THE STATUS OF THE TOTAL NATIONAL POPULATION OF THE SPECIES/SUBSPECIES? (If no, skip to section D)

Population size

7. Has the survey effort for this taxon been adequate to determine its national adult population size? If not, please provide justification for your response.

8. Do you consider the way the population size has been derived to be appropriate? Are there any assumptions and unquantified biases in the estimates? Did the estimates measure relative or absolute abundance? Do you accept the estimate of the total population size of the species/subspecies? If not, please provide justification for your response.

9. If not, can you provide a further estimate of the current population size of mature adults of the species/subspecies (national extent)? Please provide supporting justification or other information.

If, because of uncertainty, you are unable to provide a single number, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of possible species/subspecies numbers, and also choose the level of confidence you have in this estimate:
Number of mature individuals is estimated to be in the range of:

☐ 1–1000 ☐ 1000–2000 ☐ 2000–5000 ☐ >5000 ☐ >10,000

Level of your confidence in this estimate:

☐ 0–30% - low level of certainty/ a bit of a guess/ not much information to go on

☐ 31–50% - more than a guess, some level of supporting evidence

☐ 51–95% - reasonably certain, information suggests this range

☐ 95–100% - high level of certainty, information indicates quantity within this range

☐ 99–100% - very high level of certainty, data are accurate within this range

SECTION D **ARE YOU AWARE OF TRENDS IN THE OVERALL POPULATION OF THE SPECIES/SUBSPECIES? (If no, skip to section E)**

10. Does the current and predicted rate of decline used in the assessment seem reasonable? Do you consider that the way this estimate has been derived is appropriate? If not, please provide justification of your response.

Evidence of total population size change

11. Are you able to provide an estimate of the total population size during the early 1700s *(at or soon after the start of the most recent three generation period)*? Please provide justification for your response.

    If, because of uncertainty, you are unable to provide a single number, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of possible species/subspecies numbers, and also choose the level of confidence you have in this estimate.

    Number of mature individuals is estimated to be in the range of:

    ☐ 1–1000 ☐ 1000–2000 ☐ 2000–5000 ☐ >5000 ☐ >10,000

    Level of your confidence in this estimate:

    ☐ 0–30% - low level of certainty/ a bit of a guess/ not much information to go on

☐ 31–50% - more than a guess, some level of supporting evidence

☐ 51–95% - reasonably certain, information suggests this range

☐ 95–100% - high level of certainty, information indicates quantity within this range

☐ 99–100% - very high level of certainty, data are accurate within this range

12. Are you able to comment on the extent of decline in the species/subspecies' total population size over the last approximately 300 years (i.e. three generations)? Please provide justification for your response.

    If, because of uncertainty, you are unable to provide an estimate of decline, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of ranges of decline, and also choose the level of confidence you have in this estimated range.

    Decline estimated to be in the range of:

    ☐ 1–30% ☐31–50% ☐51–80% ☐81–100% ☐90–100%

    Level of your confidence in this estimated decline:

    ☐ 0–30% - low level of certainty/ a bit of a guess/ not much information to go on

    ☐ 31–50% - more than a guess, some level of supporting evidence

    ☐ 51–95% - reasonably certain, suggests this range of decline

    ☐ 95–100% - high level of certainty, information indicates a decline within this range

    ☐ 99–100% - very high level of certainty, data are accurate within this range

13. Please provide (if known) any additional evidence which shows the population is stable, increasing or declining.

<u>SECTION E</u> ARE YOU AWARE OF INFORMATION ON THE TOTAL RANGE OF THE SPECIES/SUBSPECIES? (If no, skip to section F)

Current Distribution/range/extent of occurrence, area of occupancy

14. Does the assessment consider the entire geographic extent and national extent of the species/subspecies? If not, please provide justification for your response.

15. Has the survey effort for this species/subspecies been adequate to determine its national distribution? If not, please provide justification for your response.

16. Is the distribution described in the assessment accurate? If not, please provide justification for your response and provide alternate information.

17. Do you agree that the way the current extent of occurrence and/or area of occupancy have been estimated is appropriate? Please provide justification for your response.

18. Can you provide estimates (or if you disagree with the estimates provided, alternative estimates) of the extent of occurrence and/or area of occupancy.

    If, because of uncertainty, you are unable to provide an estimate of extent of occurrence, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of ranges of extent of occurrence, and also choose the level of confidence you have in this estimated range.

    Current extent of occurrence is estimated to be in the range of:

    ☐ <100 km^2 ☐ 100 – 5 000 km^2 ☐ 5 001 – 20 000 km^2 ☐ >20 000 km^2

    Level of your confidence in this estimated extent of occurrence

    ☐ 0–30% - low level of certainty/ a bit of a guess/ not much data to go on

    ☐ 31–50% - more than a guess, some level of supporting evidence

    ☐ 51–95% - reasonably certain, data suggests this range of decline

    ☐ 95–100% - high level of certainty, data indicates a decline within this range

    ☐ 99–100% - very high level of certainty, data is accurate within this range

    f, because of uncertainty, you are unable to provide an estimate of area of occupancy, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of ranges of area of occupancy, and also choose the level of confidence you have in this estimated range.

    Current area of occupancy is estimated to be in the range of:

☐ <10 km^2 ☐ 11 – 500 km^2 ☐ 501 – 2000 km^2 ☐ >2000 km^2

Level of your confidence in this estimated extent of occurrence:

☐ 0–30% - low level of certainty/ a bit of a guess/ not much data to go on

☐ 31–50% - more than a guess, some level of supporting evidence

☐ 51–95% - reasonably certain, data suggests this range of decline

☐ 95–100% - high level of certainty, data indicates a decline within this range

☐ 99–100% - very high level of certainty, data is accurate within this range

<u>SECTION F</u> **ARE YOU AWARE OF TRENDS IN THE TOTAL RANGE OF THE SPECIES/SUBSPECIES? (If no, skip to section G)**

Past Distribution/range/extent of occurrence, area of occupancy

19. Do you consider that the way the historic distribution has been estimated is appropriate? Please provide justification for your response.

20. Can you provide estimates (or if you disagree with the estimates provided, alternative estimates) of the former extent of occurrence and/or area of occupancy.

    If, because of uncertainty, you are unable to provide an estimate of past extent of occurrence, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of ranges of past extent of occurrence, and also choose the level of confidence you have in this estimated range.

    ast extent of occurrence is estimated to be in the range of:

    ☐ <100 km^2 ☐ 100 – 5 000 km^2 ☐ 5 001 – 20 000 km^2 ☐ >20 000 km^2

    Level of your confidence in this estimated extent of occurrence

    ☐ 0–30% - low level of certainty/ a bit of a guess/ not much data to go on

    ☐ 31–50% - more than a guess, some level of supporting evidence

    ☐ 51–95% - reasonably certain, data suggests this range of decline

☐ 95–100% - high level of certainty, data indicates a decline within this range

☐ 99–100% - very high level of certainty, data is accurate within this range

If, because of uncertainty, you are unable to provide an estimate of past area of occupancy, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of ranges of past area of occupancy, and also choose the level of confidence you have in this estimated range:

Past area of occupancy is estimated to be in the range of:

☐ <10 km^2 ☐ 11 – 500 km^2 ☐ 501 – 2000 km^2 ☐ >2000 km^2

Level of your confidence in this estimated extent of occurrence:

☐ 0–30% - low level of certainty/ a bit of a guess/ not much data to go on

☐ 31–50% - more than a guess, some level of supporting evidence

☐ 51–95% - reasonably certain, data suggests this range of decline

☐ 95–100% -high level of certainty, data indicates a decline within this range

☐ 99–100% - very high level of certainty, data is accurate within this range

PART 2 – INFORMATION FOR CONSERVATION ADVICE ON THREATS AND CONSERVATION ACTIONS

<u>SECTION G</u> **DO YOU HAVE INFORMATION ON THREATS TO THE SURVIVAL OF THE SPECIES/SUBSPECIES? (If no, skip to section H)**

21. Do you consider that all major threats have been identified and described adequately?

22. To what degree are the identified threats likely to impact on the species/subspecies in the future?

23. Are the threats impacting on different populations equally, or do the threats vary across different populations?

24. Can you provide additional or alternative information on past, current or potential threats that may adversely affect the species/subspecies at any stage of its life cycle?

25. Can you provide supporting data/justification or other information for your responses to these questions about threats?

<u>SECTION H</u> DO YOU HAVE INFORMATION ON CURRENT OR FUTURE MANAGEMENT FOR THE RECOVERY OF THE SPECIES/SUBSPECIES? (If no, skip to section I)

26. What planning, management and recovery actions are currently in place supporting protection and recovery of the species/subspecies? To what extent have they been effective?

27. Can you recommend any additional or alternative specific threat abatement or conservation actions that would aid the protection and recovery of the species/subspecies?

28. Would you recommend translocation (outside of the species' historic range) as a viable option as a conservation actions for this species/subspecies?

<u>SECTION I</u> DO YOU HAVE INFORMATION ON STAKEHOLDERS IN THE RECOVERY OF THE SPECIES/SUBSPECIES?

29. Are you aware of other knowledge (e.g. traditional ecological knowledge) or individuals/groups with knowledge that may help better understand population trends/fluctuations, or critical areas of habitat?

30. Are you aware of any cultural or social importance or use that the species/subspecies has?

31. What individuals or organisations are currently, or potentially could be, involved in management and recovery of the species/subspecies?

32. How aware of this species/subspecies are land managers where the species/subspecies is found?

33. What level of awareness is there with individuals or organisations around the issues affecting the species/subspecies?

    a. Where there is awareness, what are these interests of these individuals/organisations?

    b. Are there populations or areas of habitat that are particularly important to the community?

PART 3 – ANY OTHER INFORMATION

34. Do you have comments on any other matters relevant to the assessment of this species/subspecies?

Australian Government
Department of Agriculture, Water and the Environment

Conservation Advice for *Eucalyptus forresterae* (brumby sallee)

This draft document is being released for consultation on the species listing eligibility and conservation actions

The purpose of this consultation document is to elicit additional information to better understand the status of the species and help inform conservation actions, further planning and a potential recovery plan. The draft assessment below should therefore be considered **tentative** at this stage, as it may change as a result of responses to this consultation process.

Note: Specific consultation questions relating to the below draft assessment and preliminary determination have been included in the consultation cover paper for your consideration.

This document combines the approved conservation advice and listing assessment for the species. It provides a foundation for conservation action and further planning.

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Conservation status

Eucalyptus forresterae (brumby sallee) is not currently listed under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act).

Eucalyptus forresterae was assessed by the Threatened Species Scientific Committee to be eligible for listing under the EPBC Act in the Endangered category. The Committee's assessment is at Attachment A. The Committee's assessment of the species' eligibility against each of the listing criteria is:

- Criterion 1: Insufficient data
- Criterion 2: B1ab(iii)+2ab(iii): Endangered
- Criterion 3: Insufficient data
- Criterion 4: Ineligible
- Criterion 5: Insufficient data

The main factors that make the species eligible for listing as Endangered are a restricted Extent of Occurrence (EOO) and Area of Occupancy (AOO), a restricted number of locations and ongoing decline in quality of habitat.

Species can also be listed as threatened under state and territory legislation. For information on the current listing status of this species under relevant state or territory legislation, see the Species Profile and Threat Database.

Species information

Taxonomy

Until 2011, *Eucalyptus forresterae* was considered a mallee form of the more widespread *Eucalyptus stellulata* (black sallee). A 2011 paper suggested that *Eucalyptus forresterae* differs from *E. stellulata* by the former having a shrub habit, with smooth bark (blackish basal bark present in black sallee) and smaller, blue-grey juvenile leaves (dull green or blue-green in black sallee) and smaller peduncles and fruits (Rule & Molyneux 2011). Also, *E. forresterae* occurs on ridge tops, while black sallee typically occurs in cold-air drainage basins (VicFlora 2021). However, despite its acceptance on the Australian Plant Census (APC 2021), there is continuing uncertainty regarding its taxonomic distinctiveness from *E. stellulata*. Indeed, *E. forresterae* was listed as data deficient by Fensham et al. (2019), due to taxonomic uncertainty, with the justification that it was probably synonymous with *E. stellulata* (Nicolle 2018) and is not a reliable taxon (G. Phillips 2018 pers comm cited in Fensham et al. 2019) though no phylogenetic analysis has been conducted to support this assumption. There is a need for these taxonomic issues to be investigated in order to resolve this issue. Most importantly, a molecular study may help to clarify whether *E. forresterae* is genetically different from *E. stellulata*, though further work may also be needed to investigate whether the characters in which *E. forresterae* is morphologically separable from *E. stellulata* make it sufficiently distinctive to warrant a specific status (K Rule 2022. pers comm 17 January).

Information in this paragraph was provided by Kevin Rule, one of the botanists who described *E. forresterae* (K Rule 2022. pers comm 17 January). Eucalypts matching the description of *E.*

forresterae were not known from New South Wales at the time of the publication of the paper describing it. Since then, images of New South Wales eucalypts have circulated that appear quite compelling with regard to their identity, and they are known to grade into forms of typical *E. stellulata*. These observations and information are in contrast to what was observed in Victoria when *E. forresterae* was described. Though there is some sentiment that the taxon may be better placed as a subspecies within *E. stellulata*, a potential problem that arises with merging *E. forresterae* and *E. stellulata* is the way that *E. forresterae* behaves as a cultivated plant. Observations of some *E. forresterae* specimens growing ex situ (marketed commercially as *E. stellulata* 'Little Star') have found that they are consistent in exhibiting the same features as the wild plants. This would suggest that these features are genetically fixed, not environmentally determined, and that the isolated Brumby Point type population is genetically separate. Notably how the plant behaves in cultivation is insufficient evidence alone to conclude that the species is 'good'. This also contrasts with the observations of Dr. Dean Nicolle, who found *E. forresterae* and *E. stellulata* grow into the same plant under the same conditions (see below). There is a need for these unresolved taxonomic issues to be clarified, most notably to clarify whether it is genetically unique using a molecular study, though also whether the characters in which it is morphologically separable from *E. stellulata* make it sufficiently distinctive to warrant a specific status.

Dr. Dean Nicolle, a botanist and Eucalyptus expert, is of the opinion that *E. forresterae* is likely not a distinct species. Morphological variation in leaf, bud and fruit size with no genetic basis can result from local environmental conditions (e.g., Rutherford et al. 2016), and Dr. Nicolle found that cultivation trials of both taxa at Currency Creek Arboretum (a common garden experiment for eucalypts; Kahmen et al*.* 2006, Turner et al. 2010, Wallis et al. 2010) in South Australia indicated that both *E. forresterae* (from the type locality at Brumby Point, Victoria) and *E. stellulata* grow into small trees of similar habit and size when grown under the same conditions (D Nicolle 2021 pers comm 18 October). This comparison indicates that the habit of *E. forresterae* is environmentally determined, not genetically fixed. Observations from the field also show that larger *E. stellulata* trees occur in relatively sheltered valley flats on deep soils, and smaller, often multi-stemmed trees or mallees occur on exposed ridges with very thin, skeletal soils (D Nicolle 2021 pers comm 18 October), although this provides no insight into whether the variation is genetically fixed. In addition, seedling leaves of *E. forresterae* and *E. stellulata* are indistinguishable (in contrast to the original description of *E. forresterae*), and the adult morphology is identical (D Nicolle 2021 pers comm 18 October). Therefore, it is the view of Dr. Nicolle that *E. forresterae* cannot be regarded as a distinct species because the only reliable distinguishing characteristic (being a shrubby mallee or multi-stemmed tree rather than a single-trunked tree) is environmentally (rather than genetically) determined (D Nicolle 2021 pers comm 18 October).

Other researchers with eucalypt phylogenetic and taxonomic experience also suggest that the differences between *E. forresterae and E. stellulata* may not limit interbreeding between the taxa, and phylogenetic work would be required to determine the distinctiveness of *E. forresterae* from *E. stellulata* (A Thornhill 2021. pers comm 18 October). As the distinction between taxa is currently based only on minor morphological differences, it is possible that *E. forresterae* is a morphological variant responding to growing conditions (A Thornhill 2021. pers comm 18 October), although it remains possible that these morphological differences are indicative of underlying genetic variation. Genetic analysis would be useful to fully determine whether the taxon is environmentally determined or genetically district.

The Department sought an independent opinion from botanist and researcher Dr. Stephen Hopper on the the validity and robustness of the various claims and counterclaims regarding the taxonomy of *E. forresterae*. Dr. Hopper suggests that, in the absence of genetic information and quantitative tests of trait variation, it's difficult to argue strongly for or against the recognition of *E. forresterae*. The hypothesized morphological differences between *E. forresterae* and *E. stellulata* need rigorous quantitative field studies in both Victoria and NSW, and dismissal of the entity as a 'good' species is not rigorous if based on unpublished anecdotal observations, noting that sample sizes in tests for differentiating characters require peer review. Dr. Hopper also states that whether *E. forresterae* intergrades or hybridizes with *E. stellulata* in ecotonal situations is not a concern for judging taxonomic validity, as this is typical of closely related eucalypt taxa, and the genomics and morphology of plants in typical habitat is what is critical to decide taxonomic status. Finally, Dr. Hopper noted that in general literature, distinctive marginal populations of widespread species are commended for conservation because of their evolutionary potential. Hence, in the case of *E. forresterae*, the precautionary principle would suggest continuing to recognise it as a species (or subspecies) unless/until compelling genomic and morphometric data are furnished and published to establish unequivocally that the taxon is based on environmentally induced phenotypically plastic characters, not genetic diversification. Information in this paragraph was provided by Dr. Stephen Hopper (S Hopper 2021. pers comm 18 January).

The taxonomy of *E. forresterae* remains uncertain and evidence for alternative hypotheses about the underlying basis of its distinguishing features is weak. Based on the advice of Dr Hopper, *E. forresterae* could plausibly be a distinctive taxon of conservation significance. An assessment of the taxon against the listing criteria has been undertaken invoking the precautionary principle, and consistent with the current status of the taxon on the Australian Plant Census and by the Victorian Scientific Advisory Committee, where the species will continue to be recognised unless and until sufficient evidence to the contrary emerges.

Description

Brumby sallee (family: Myrtaceae) is a mallee to 5 m tall, with smooth bark throughout. Juvenile leaves are sessile (attached directly by its base without a stalk or peduncle), opposite for many pairs, orbicular to cordate (heart shaped), to 4 cm long and wide, and initially glaucous (covered with a greyish, bluish, or whitish waxy coating or bloom). Adult leaves are alternate, narrowly ovate to lanceolate, 4–6 cm long, 1.2–2 cm wide and concolorous (uniform in colour). Inflorescences are axillary, unbranched, with buds in clusters and white flowers. Fruits are sessile, with three valves below the rim of the fruit.

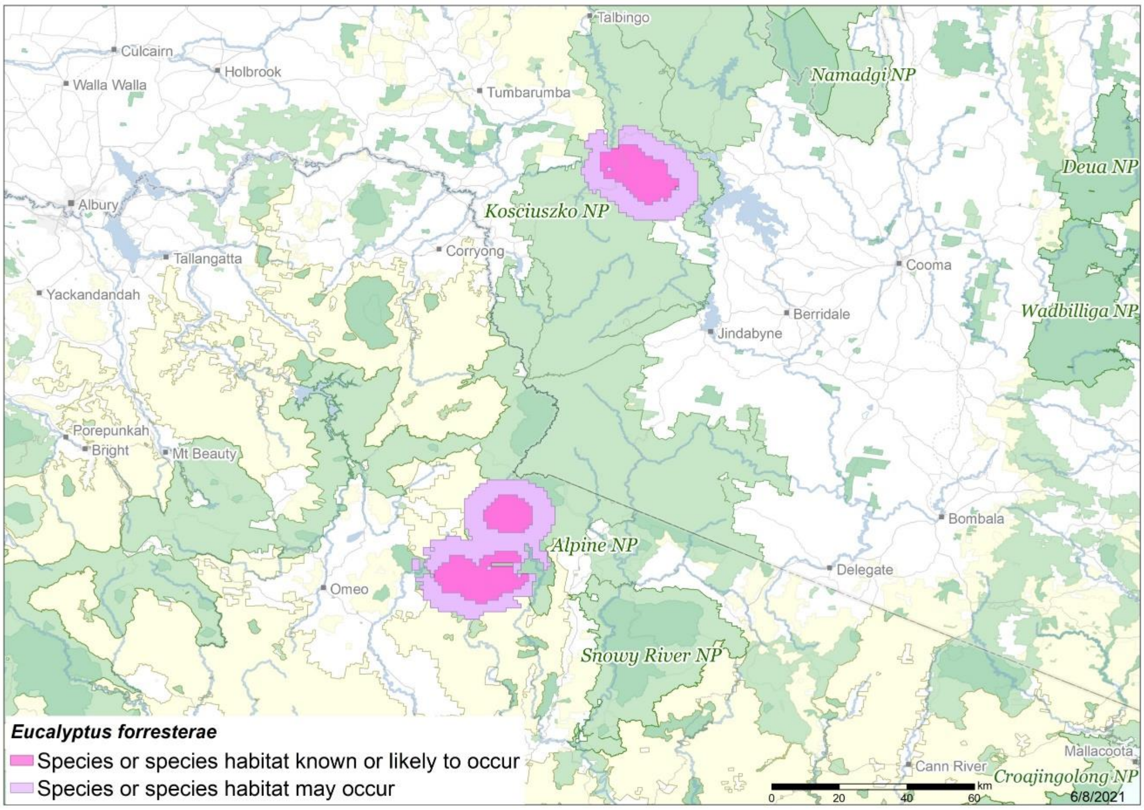
Distribution

Brumby sallee is known from the eastern Alps in Victoria and the Snowy Mountains near Tumut in New South Wales (NSW). In Victoria, the species occurs at four subpopulations on the northern edge of the Nunniong Plateau, and one subpopulation at Native Dog Flat, approximately 20 km to the north of the Nunniong Plateau (Table 1). In NSW, brumby sallee is known from four subpopulations in Kosciuszko National Park, three near Happy Jacks Creek/Pondage and one at Tumut Dam (Table 1). Estimates of subpopulation sizes are not available for most subpopulations (Table 1). Fensham et al. (2019) estimated that the total population size of brumby sallee was 2000–10,000 individuals, including estimates of >1000 individuals at both Brumby Point, Vic and Happy Jacks Creek in NSW, although it is unclear which subpopulation in Table 1 corresponds to Happy Jacks Creek.

Table 1. Known subpopulations of brumby sallee.

Subpopulation	Tenure	Size	Year last recorded	Fire history	Source
		Victoria			
Brumby Point Track (type locality)	Alpine National Park	*"locally abundant"* (ALA 2021) *"1000s"* (N Walsh 2021. pers comm 28 July) *">1000"* (Fensham et al. 2019)	2020 2021 (likely)	2019/20: burnt 2002/03: burnt	ALA 2021; DELWP 2021a; Tolsma & Sutter 2022
Diggers Hole Track, 2 km east of Brumby Point Track and 1 km north of Diggers Hole Track	Alpine National Park	?	2009 2021 (likely)	2019/20: burnt 2002/03: burnt	ALA 2021; DELWP 2021a; Tolsma & Sutter 2022
Nunniong Road, 300 m south of Garron Point Track	Nunniong State Forest and Alpine National Park	?	2009 2021 (likely)	2019/20: unburnt 2002/03: burnt	ALA 2021; DELWP 2021a; Tolsma & Sutter 2022
Diggers Hole Track, 4 km east of Brumby Point Track intersection	Alpine National Park	?	1987 2021 (likely)	2019/20: burnt 2002/03: burnt	ALA 2021; DELWP 2021a; Tolsma & Sutter 2022
Native Dog Flat, above Buchan River falls	Alpine National Park	?	1991 2021 (unlikely)	2019/20: unburnt 2002/03: burnt	ALA 2021; DELWP 2021a; Tolsma & Sutter 2022
		New South Wales			
Tumut Dam Wall	Kosciuszko National Park	*"prolific"*	2013	2019/20: burnt 2002/03: burnt	ALA 2021; DPIE 2021
Intake E113 Track, Happy Jacks Pondage	Kosciuszko National Park	?	2013	2019/20: burnt 2002/03: burnt	ALA 2021; DPIE 2021
Happy Jacks Road, 1.2 km direct SE from Happy Jacks Pondage dam wall	Kosciuszko National Park	"tens of plants"	2013	2019/20: burnt 2002/03: burnt	ALA 2021; DPIE 2021
Happy Jacks Road, 5.3 km SE of bridge over Happy Jacks Pondage	Kosciuszko National Park	*"occasional to rare"*	2016	2019/20: burnt 2002/03: burnt	ALA 2021; DPIE 2021

Map 1 Modelled distribution of brumby sallee



Source: Base map Geoscience Australia; species distribution data [Species of National Environmental Significance] database.
Caveat: The information presented in this map has been provided by a range of groups and agencies. While every effort has been made to ensure accuracy and completeness, no guarantee is given, nor responsibility taken by the Commonwealth for errors or omissions, and the Commonwealth does not accept responsibility in respect of any information or advice given in relation to, or as a consequence of, anything containing herein.
Species distribution mapping: The species distribution mapping categories are indicative only and aim to capture (a) the specific habitat type or geographic feature that represents to recent observed locations of the species (known to occur) or preferred habitat occurring in close proximity to these locations (likely to occur); and (b) the broad environmental envelope or geographic region that encompasses all areas that could provide habitat for the species (may occur). These presence categories are created using an extensive database of species observations records, national and regional-scale environmental data, environmental modelling techniques and documented scientific research.

Cultural and community significance

The cultural, customary and spiritual significance of species and the ecological communities they form are diverse and varied for Indigenous Australians and their stewardship of Country. This section describes some examples of this significance but is not intended to be comprehensive or applicable to, or speak for, Indigenous Australians. Such knowledge may be held by Indigenous Australians who are the custodians of this knowledge and have the rights to decide how it is shared and used.

Indigenous Australians have a long and profound history of management of the country on which brumby sallee occurs. The species occurs in the Wagonga Aboriginal Land Council in NSW (New South Wales Aboriginal Land Council 2021). Traditional Owners have not been formally recognised for the Victorian subpopulation (Aboriginal Victoria 2021).

Relevant biology and ecology

Habitat ecology

Brumby sallee occurs in rocky, well-drained montane or subalpine woodland. Taxa associated with NSW subpopulations include *Eucalyptus pauciflora* (snow gum), *E. perriniana* (spinning gum), *Eucalyptus stellulata* (black sallee), *Hakea lissosperma* (mountain needlewood), *Correa lawrenciana* (mountain correa) and *Callistemon* spp. (bottlebrush) (ALA 2021). The Victorian subpopulations occur on harsh skeletal soils, with associated taxa including *Eucalyptus.* sp. aff. *dives, E. elaeophloia* (nunniong gum), *E. glaucescens* (tingaringy gum), *E. kybeanensis* (mallee ash), *E. mannifera* (brittle gum), *E. pauciflora* subsp. *niphophila* (snow gum), spinning gum, *E. rubida* (candlebark), *E. viminalis* subsp. *viminalis* (manna gum) *Banksia canei* (mountain banksia), *Bossiaea foliosa* s.l. (leafy bossiaea), *Daviesia ulicifolia* (gorse bitter-pea), *Podolobium alpestre* (alpine shaggy-pea), *Monotoca rotundifolia* (trailing monotoca), *Mirbelia oxylobioides* (mountain mirbelia) and *Hakea asperma* (native dog hakea).

Reproductive ecology

The reproductive ecology of brumby sallee is not well understood and requires further investigation. The species flowers in summer (VicFlora 2021). The pollinators are likely to be generalist insects and birds like most eucalypts (House 1997). Eucalypts have a mixed mating system (combination of outcrossing and self-pollination) but outcrossing usually predominates (Potts and Wiltshire 1997; Horsley and Johnson 2007; Byrne 2008). The hermaphroditic flowers are protandrous in their development (pollen is produced before the stigma becomes receptive), which reduces the probability of self-pollination (House 1997). Seed is stored in serotinous fruits (a canopy seed bank) and released following fire or limb death (Zimmer et al. 2021), leading to post-fire recruitment (Zimmer et al. 2021). Following release from fruits, germination of subalpine eucalypts is often enhanced by cold stratification (Beardsell & Mullet 1984).

The primary juvenile period of brumby sallee is unknown. Snow gums (*Eucalyptus pauciflora* s.l.) planted above the snow line took 13-18 years to produce flowers (Ferrar et al. 1988), but this likely underestimates the onset of seedbank accumulation in a wild population of *E. forresterae* in its exposed habitat. The species is suspected to be very long-lived with generation length estimated at 70 years by Fensham et al. (2019) and 100–250 years by DELWP (2021b).

The secondary juvenile period (fire-free interval required by resprouts to reach maturity and bear a crop of seeds) is unknown. In other mallee species, at lower elevations in the Sydney region, this period has been recorded as taking four–five years (D Keith unpublished data), but it may be longer in the brumby sallee, as slower growth rates generally occur in plants in alpine/subalpine environments (Atkin et al. 1996). The primary juvenile period (fire-free interval required from germination to produce seeds), where plants have become large enough to develop regenerative organs (e.g., thick bark or lignotubers) needed to survive fire (Fairman et al. 2017, 2019) is likely much longer.

Fire ecology

Fire is a natural ecological process that interacts with the evolutionary and climatic history of landscapes, influencing the distribution and abundance of biota (Lynch et al. 2007; Bowman et al. 2009; Crisp et al. 2011). The natural fire regime within the distribution range of the brumby sallee is unknown, but in alpine landscapes, the dendrochronological evidence is for large fires occurring once every 50–100 years over the last 400 years (Williams et al. 2008), likely in the warmer, dryer summer season. However, anthropogenic fragmentation of ecosystems, alteration to ignition patterns, and climate change are causing major alterations to the core elements of fire regimes (intensity/severity, frequency, season, and type of fire) across alpine/subalpine regions (Kelly et al. 2020).

Brumby sallee resprouts from its lignotuber after fire. The subpopulation at Brumby Point was observed to be vigorously resprouting following the 2019-20 bushfires, which burnt most of the subpopulation (A. Messina 2021. pers comm 28 July), but survival rates were not estimated. Being a small eucalypt species, it is likely to be limited to basal resprouting rather than also resprouting from the stem (epicormically) (Denham et al. 2016; Zimmer et al. 2021). As is typical of many eucalypt species, it is likely that fire also promotes the release of the seed bank from the canopy and subsequent germination of seedlings post-fire (Zimmer et al. 2021).

Although adult trees are more resilient to high fire frequency, the cumulative effects of multiple fires in a short period of time can cause substantial mortality. Fairman et al. (2017) recorded 50 percent mortality of the closely related mature lignotuberous *Eucalyptus pauciflora* s.l. (snow gum) following three bushfires in a 10-year period. Plant diseases or herbivore impacts may further exacerbate post-fire mortality.

Increasing fire frequency may cause increasing mortality of mature brumby sallee. Short intervals between fires may kill juveniles before they become large enough to develop regenerative structures (e.g. lignotubers) needed to survive subsequent fires (Keith 1996). Keith (1996) identified that at least 15 years between successive fires is needed to ensure the juveniles of most -long lived woody plant species can develop their fire -regenerative organs, with some tree species requiring at least 25 years. Brumby sallee may require considerably longer because of the slower growth rates expected in alpine and subalpine environments. (Atkin et al. 1996). This suggests that a reasonable fire-free interval for the successful recruitment of brumby sallee may be 25 years or longer, though this requires further research (see conservation and recovery actions).

Habitat critical to the survival

Brumby sallee occurs in montane and subalpine mallee and woodland in eastern Victoria and south-east NSW. Habitat critical to the survival of brumby mallee includes the area occupied by all known populations (see the species distribution in Map 1), areas of similar habitat surrounding known populations, additional occurrences of similar habitat within the Australian Alps bioregion that may contain undiscovered subpopulations of the species or be suitable for future translocations.

No Critical Habitat as defined under section 207A of the EPBC Act has been identified or included in the Register of Critical Habitat.

Important populations

In this section, the word population is used to refer to subpopulation (as defined by IUCN 2001), in keeping with the terminology used in the EPBC Act and state/territory environmental legislation.

There is sufficient evidence through the species eligibility for listing, to declare all populations/the national population as important populations of this species under particular pressure of survival and which therefore require protection to support the recovery of the species.

Threats

Key threats to this species are inappropriate fire regimes, increased temperatures due to climate change and, potentially, dieback caused by insect attack. Browsing and trampling by feral horses (*Equus caballus*) or other feral herbivores has not been observed to impact brumby sallee, and is not listed in Table 2, however it may become a threat, especially to seedlings of the species. Dieback caused by insect damage from *Phoracantha* sp. (longicorn beetle) is affecting snow gum in parts of the Australian Alps (SOS 2021), but there is no available research on its impacts on brumby sallee or the closely related black sallee.

Table 2 Threats impacting brumby sallee

Threats in Table 2 are noted in approximate order of highest to lowest impact, based on available evidence.

Threat	Status [a]	Evidence
Habitat disturbance and modification		
Fire regimes causing declines in biodiversity*	• Timing: current • Confidence: inferred • Consequence: major • Trend: increasing • Extent: across the entire range	Anthropogenic fragmentation of ecosystems, alteration to ignition patterns, and climate change are causing major alterations to the core elements of fire regimes, in particular increasing the frequency (number of fires per unit time at a point in the landscape) and intensity/severity of fire (heat release at a point in the landscape during a specified fire event, including correlates of flame length and scorch height). 'Fire regimes that cause biodiversity decline is being considered for inclusion on the EPBC Act list of [Key Threatening Processes](). The area around the northern part of the known brumby sallee distribution (Kosciuszko NP) has been burnt twice in 20 years and 3 times in ~30 years (DPIE 2021) and the southern section has also been burnt twice in the last 20 years (DELWP 2021). Brumby sallee apparently had high survival rates following the 2003 bushfires, and the subpopulation at Brumby Point was observed to be vigorously resprouting following the 2019-20 bushfires which burnt most of the subpopulation (A. Messina 2021. pers comm 28 July). However, high frequency fires may still pose a threat to this species. Three bushfire events in 10 years were shown to cause a 50% decline in snow gum stands (Fairman et al. 2017), and it is possible that similar declines could occur if brumby sallee was impacted by similar high fire frequencies. The specific mechanisms of this

		threat include amplified mortality of adults, loss of developing juvenile plants before they fully develop fire-resistant organs, and disruption of seed bank accumulation. (see Fire Ecology section for details). *Fire- insect herbivory interactions* Predators of plants – herbivores and granivores – interact with fire in ways that amplify threats to the plants. Indeed, there is some evidence that physical and chemical defences of plants can be weaker in regrowth during the immediate post-fire period (Keith 2012), which may encourage post-fire herbivory. For *E. forresterae*, herbivory by arthropods is most important (see below), and fire can have a range of impacts on herbivorous arthropods, and is dependent on the herbivore, plant and frequency and severity of fire (Murphy et al. 2018). Fires are also thought to amplify general impacts of dieback associated with trophic dysfunction, such as rural dieback (Landsberg 1988) and *Manorina melanophrys (*bell-miner) associated dieback (Florence 2005; Wardell-Johnson & Stone 2006), which is expected to weaken capacity for recovery of trees after fire. The latter is particularly relevant to *E. forresterae*, as bell-miner associated dieback is associated with high densities of *Psyllid* insects and *E. forresterae* is also potentially threatened by dieback caused by high insect densities (see below). Therefore, *E. forresterae* plants that are impacted by mild insect herbivory may struggle to recover after a fire event. *Fire-drought interactions* Water is a key resource, and often the most limiting one that influences the health and condition of individuals prior to a fire event and their ability to recover and reproduce in the post-fire environment. The timing of fire in relation to inter-annual droughts can therefore have profound effects on population outcomes and extinction risks (Choat et al. 2018). In plants, fire-drought interactions influence the risk of hydraulic failure and mortality (Choat et al. 2018), with potentially long-term impacts on ecosystems and habitats. Resprouting woody plants are susceptible to elevated mortality in post-fire droughts because their regrowth tissues are more susceptible to xylem embolism than mature tissues (Pratt et al. 2014). While this has implications for persistence of threatened fire-prone forest and woodland communities under climate change, investigations are at an early stage (Choat et al. 2018; de Kauwe et al. 2020).
Native species		
Insect herbivory	• Timing: current • Confidence: inferred • Consequence: moderate • Trend: increasing	Insect herbivory from native *Phoracantha* sp. (longicorn beetles) is a major threat to some subpopulations of snow gum (*E. pauciflora* subsp. *niphophila*) in NSW and Vic, which shares similar habitats and traits to *E. forresterae*. This is referred to as snow-gum dieback. The wood boring longicorn beetles feed on the wood and

	• Extent: across parts of the range	bark of trees from the canopy down, leaving ring shaped tracks in affected trees. This leads to declines in tree health and often eventual death. Snow gum dieback is known to have occurred occasionally throughout the latter 20th century, though the current outbreak is much more widespread and intense than previous records (SOS 2021). The current outbreak has been recorded mostly in areas 1600m above sea level, in Kosciusko, Brindabella, Namadgi and Alpine National NPs, though the full extent is unknown (SOS 2021). It is unclear why this outbreak has occurred, though it is suspected that recent drought conditions and warmer than average temperatures may have contributed (SOS 2021). Dieback due to longicorn beetles has not been observed in brumby sallee or the related black sallee, though the latter species is found in places that are not often visited and it is possible that the condition has spread to the species. Furthermore, the threat has emerged relatively recently, and it is possible that the species will be impacted in the future.
Invasive plants	• Timing: future • Confidence: inferred • Likelihood: possible • Consequence: low • Trend: unknown • Extent: across the entire range	Invasive plants (i.e., *Pilosella* species (hawkweeds), *Ulex* species (gorse), *Salix* species (willows), *Rubus* species (blackberries) and *Leycesteria formosa* (Himalayan honeysuckle)) could become a threat in alpine/subalpine regions as the habitat warms and dries (Parks Victoria 2016). Climate change, including a reduced snowpack and disturbance and loss of native groundcover through an altered fire regime, can promote the establishment of high density populations of invasive plants that can transform the structure and composition of native plant communities (Williams & West 2000; Hughes 2003; Pickering 2008).
Climate change		
Increased temperature,, decreased snowfall and changes to precipitation patterns	• Timing: current/future • Confidence: observed/projected • Consequence: major • Trend: increasing • Extent: across the entire range	In Australia, average maximum and minimum temperatures have increased by 0.6 °C and 1.2 °C respectively over the 20th century (Hennessy et al. 2007), with warming occurring rapidly in the Australian Alps (Slatyer 2010; McGowan et al. 2018). In conjunction, precipitation has reduced in the Australian Alps, especially during the cooler months (Slatyer 2010). Snowpack depths measured at alpine sites, including in the Victoria Alps (Rocky Valley Dam), have declined from the 1950s to 2011, with an earlier end to the snow season recorded (Hennessey et al. 2003; Slatyer 2010; Bhend et al. 2012), predominantly as a result of reduced precipitation. These trends are projected to continue in the future under all modelled emissions scenarios (CSIRO & BoM 2015; BoM & CSIRO 2020). Warmer than average temperatures may be driving outbreaks of longicorn beetles, as the beetles emerge and mate only under warm conditions (SOS 2021). Low mean annual temperatures (or low mean maxima in the short growing season) is the principal environmental determinant of subalpine communities (Cheal et al. 2011).

		Climate change may also have indirect effect through longer growing seasons, changes in prevailing soil moisture, and changes in vegetative competition with a reduced snowpack (Pickering et al. 2004). Seed germination of some alpine/subalpine species is reliant on cold stratification during winter. With warming, seedling regeneration after future fires may be reduced with flow-on effects on seed bank replenishment (Gallagher 2020). In the region (Central Highlands of Victoria), modelling by Nitschke & Hickey (2007), using low-moderate changes in temperature and precipitation (1.4 °C rise in temperature and a 5 % decline in annual precipitation), predicted a significant contraction in 20 eucalypt species regeneration niches and significant changes in the size and location of distribution ranges. These results conform to the narrow climatic breadth of > 800 Australian eucalypt species identified by Hughes et al. (1996). Precipitation is projected to continue to decrease, but with heavy rainfalls to become more intense and more frequent (CSIRO & BoM 2015; BoM & CSIRO 2020). In southern Australia, an average decrease of 4 % (maximum of 9 %) in annual rainfall is projected by 2030 relative to the 1986-2005 period under all modelled emissions scenarios. By 2090, under a moderate scenario, a decrease of 7 % (maximum of 16 %) is projected, and under a high scenario, a decrease of 8 % (maximum of 26 %) is projected (CSIRO & BoM 2015). Correspondingly, across the Australian Alps, the snowpack is projected to decrease by ~ 15 % by 2030 and ~ 60 % by 2070 (Luca et al. 2018). In the south-east and tablelands region of NSW, there is a projected increase in minimum and maximum temperatures, the number of hot days (above 35°C), fire danger weather and extreme events (e.g., drought), a projected decrease in snowfall and changes to precipitation patterns (increased precipitation in autumn and decreased precipitation in spring) (OEH 2014).
Increase in fire frequency and severity	• Timing: current/future • Confidence: observed/projected • Consequence: major • Trend: increasing • Extent: across the entire range	*Climate change impacts on fire* Increased temperatures and decreased precipitation through climate change increase the incidence of large fires through their effects on moisture levels within vegetation, plant litter and soils, and promotion of fire spread (Clarke et al. 2019; Nolan et al. 2016). These flammable conditions are heightened in droughts, which are occurring with increasing severity and duration in the Australian Alps. Together with a greater ignition rate through more 'dry' lightning storms, these conditions have contributed to recent repeated fires in the Australian Alps (Bates et al. 2018; Holz et al. 2020; Mariani et al. 2018; Styger et al. 2018). Indeed, following severe drought, catastrophic bushfire conditions resulted in unprecedented, extensive bushfires across

		Australia in 2019-20 (Nolan et al. 2020). These fires burnt an estimated 63% of the modelled range of the species (Gallagher 2021), including seven of the nine known subpopulations of brumby sallee (Table 1), although the species is vigorously resprouting at Brumby Point in Victoria (A. Messina 2021. pers comm 28 July; Tolsma & Sutter 2022). All subpopulations of the species were burnt in 2003, with no evidence of decline following that fire event. The south-east of NSW is expected to undergo an increase in severe and average Forest Fire Danger Index values, which are used as an indicator of fire risk (OEH 2014). These increases are projected for summer and spring, which represent peak fire risk season (OEH 2014). Indeed, modelled climatic conditions have increased the Forest Fire Danger Index (FFDI) by 5 % across all seasons in the Australian Alps in the near future (by 2040), with an increase up to 30 % in FFDI projected for winter and spring. Over the longer term (2060-79), an annual increase of 5–10 % in FFDI is projected across all seasons in this region, with an increase > 30 % for winter and spring (Ji 2019). These changes to fire conditions will likely increase the frequency of bushfires, and may negatively impact brumby sallee into the future (see fire-related threats above).
Droughts	• Timing: current/future • Confidence: observed/projected • Consequence: major • Trend: increasing • Extent: across the entire range	From 2017-19, south-eastern NSW and eastern Victoria experienced severe drought (Bureau of Meteorology 2020; DPIE 2021), which are expected to increase in frequencxy and severity in the future. Drought may also lead to plant mortality in forest ecosystems, as many plants are vulnerable to drought stress and hydraulic failure (Allen et al. 2010, Choat et al. 2012). However, susceptibility of eucalypts to drought can be variable among species from montane woodland, with some species more susceptible than others (Davidson & Reid 1989). Eucalypt species are known to be sensitive to drought and soil moisture deficits in their regeneration phase (often post fire), with mortality of seedlings and resprouts highest during the first growing season due to soil water deficits. In eucalypt species, drought has inhibited the germination of seeds until conditions become favourable and has resulted in seed mortality with extended drought periods (Nitschke & Hickey 2007). Drought can also affect inflorescence bud development and flowering in eucalypt species, which in turn can lead to insufficient seed crops for regeneration (Keatley et al. 2002). Drought stressed trees are often susceptible to infestation by longicorn beetles, and larvae persist more successfully in water-stressed trees (Ward Jones n.d).

*Fire regimes that cause declines in biodiversity include the full range of fire-related ecological processes that directly or indirectly cause persistent declines in the distribution, abundance, genetic diversity or function of a species or ecological community

'fire regime' refers to the frequency, intensity or severity, season, and types (aerial/subterranean) of successive fire events at a point in the landscape

Timing—identify the temporal nature of the threat;
Confidence—identify the extent to which we have confidence about the impact of the threat on the species;
Consequence—identify the severity of the threat;
Trend—identify the extent to which it will continue to operate on the species;
Extent—identify its spatial content in terms of the range of the species.

Each threat has been described in Table 2 in terms of the extent that it is operating on the species. The risk matrix (Table 3) provides a visual depiction of the level of risk being imposed by a threat and supports the prioritisation of subsequent management and conservation actions. In preparing a risk matrix, several factors have been taken into consideration, they are: the life stage they affect; the duration of the impact; and the efficacy of current management regimes, assuming that management will continue to be applied appropriately. The risk matrix and ranking of threats has been developed in consultation with experts and using available literature.

Table 1 Brumby sallee risk matrix

Likelihood	**Consequences**				
	Not significant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Low risk	Moderate risk	Very high risk	Very high risk	Very high risk
Likely	Low risk	Moderate risk	High risk	Very high risk **Fire regimes causing declines in biodiversity** **Increased temperature, decreased snowfall and changes to precipitation patterns** **Increase in fire frequency and severity** **Droughts**	Very high risk
Possible	Low risk **Invasive plants**	Moderate risk	High risk **Insect herbivory**	Very high risk	Very high risk
Unlikely	Low risk	Low risk	Moderate risk	High risk	Very high risk
Unknown	Low risk	Low risk	Moderate risk	High risk	Very high risk

Categories for likelihood are defined as follows:
Almost certain – expected to occur every year
Likely – expected to occur at least once every five years
Possible – might occur at some time
Unlikely – such events are known to have occurred on a worldwide bases but only a few ties
Unknown – currently unknown how often the incident will occur

Categories for consequences are defined as follows:

Not significant – no long-term effect on individuals or populations
Minor – individuals are adversely affected but no effect at population level
Moderate – population recovery stalls or reduces
Major – population decreases
Catastrophic – population extinction/extirpation

Priority actions have then been developed to manage the threat particularly where the risk was deemed to be 'very high' (red shading) or 'high' (yellow shading). For those threats with an unknown or low risk outcome (green and blue shading) it may be more appropriate to identify further research or maintain monitoring.

Conservation and recovery actions

Primary conservation objective

By 2032, the population of brumby sallee will have increased in abundance and subpopulations are sustained in habitats in which very high threats are managed effectively.

Conservation and management priorities

Fire

- Develop and implement a fire management strategy that optimises the survival of brumby sallee.
  - Avoid planned burns in all subpopulations (particularly recently burnt subpopulations), until the fire ecology of the species is better understood.
  - Avoid impacts to subpopulations during fire-fighting operations, or other fire management works, by ensuring accurate location information of the species is available in databases used by the relevant fire management agencies.

Habitat loss, disturbance and modifications

- Ensure local governments, relevant state agencies and utility service providers have access to adequate distribution information and use best practice methods for fire and land management activities to protect brumby sallee and its habitat.

Climate change

- Identify and protect current and future habitat likely to remain or become suitable habitat with climate change.

Ex situ recovery

- Collect and store sufficient quantities of seed from all known subpopulations in long-term storage to preserve genetic material, in accordance with the Plant Germplasm Conservation Guidelines (Martyn Yenson et al. 2021).

- If appropriate, undertake ex situ propagation and translocations in accordance with the *Guidelines for the Translocation of Threatened Plants in Australia* (Commander et al. 2018). Translocations should be monitored to document recruitment and show that the translocated subpopulation(s) are self-sustaining and contribute to the conservation of the species.

Stakeholder engagement/community engagement

- Engage and involve Traditional Owners in conservation actions, including surveying for new populations and management actions.
- Liaise with the local community and government agencies to ensure that up-to-date population data and scientific knowledge inform the implementation of conservation actions for this species.
- Engage community groups by encouraging participation in surveys or monitoring for the species.
- Inform managers of sites where there are known populations and consult with these groups regarding options for conservation management and protection of the species.

Survey and monitoring priorities

- Conduct targeted surveys to locate any unknown subpopulations and sample for genetic analysis to estimate the number of plants in all subpopulations and resolve taxonomic status.
- Maintain a monitoring program to:
  - record response to future bushfires (particularly seedling recruitment, survival, development of fire-resistant organs, and the length of the primary and secondary juvenile periods);
  - determine trends in population size and distribution;
  - determine threats and their impacts; and,
  - monitor the effectiveness of management actions and the need to adapt them if necessary.

Information and research priorities

- Determine the taxonomic distinctiveness of brumby sallee from the closely related black sallee (e.g., using genetic analysis, adequately replicated growth trials and field experiments).
- Identify fire regimes that are detrimental to the species and those that allow population persistence.
- Investigate the susceptibility to and extent of dieback caused by insect damage (e.g., by longicorn beetles) on brumby sallee and black sallee, and if present, possible management options.

Recovery plan decision

A decision about whether there should be a Recovery Plan for this species has not yet been determined. The purpose of this consultation document is to elicit additional information to help inform this decision.

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The Threatened Species Scientific Committee finalised this assessment on DD Month Year.

Attachment A: Listing Assessment for *Eucalyptus forresterae*

Reason for assessment

This assessment follows prioritisation of a nomination from the TSSC.

Assessment of eligibility for listing

This assessment uses the criteria set out in the EPBC Regulations. The thresholds used correspond with those in the IUCN Red List criteria except where noted in criterion 4, sub-criterion D2. The IUCN criteria are used by Australian jurisdictions to achieve consistent listing assessments through the Common Assessment Method (CAM).

Key assessment parameters

Table 4 includes the key assessment parameters used in the assessment of eligibility for listing against the criteria.

Table 4 Key assessment parameters

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of mature individuals	unknown	2000	10,000	There is very limited information on subpopulation sizes of brumby sallee. There are reportedly "thousands" of plants at Brumby Point in Victoria (N Walsh 2021. Pers comm 28 July) and in NSW, the species is "prolific" at Tumut Dam and "occasional to rare" at Happy Jacks Road, 5.3 km south-east of the bridge over Happy Jacks Pondage (ALA 2021). Therefore, the minimum population size is at least several thousand individuals, but as subpopulation size estimates are unavailable for six of the nine known subpopulations, the total population size of the species is unknown. The total population size was estimated by Fensham et al. (2019) as 2000–10,000 individuals, although it is undocumented how this maximum estimate was generated.

Metric	**Estimate used in the assessment**	**Minimum plausible value**	**Maximum plausible value**	**Justification**
Trend	unknown (probably stable)			There is no information on population trends of brumby sallee and the trend of the population size is unknown. The species is vigorously resprouting at Brumby Point in Victoria, following the 2019-20 bushfires (A. Messina 2021. Pers comm 28 July), and on-ground reports from Brumby Point state plants are all resprouting vigorously from lignotubers, and there is nothing to suggest any snow gum-like decline for *E. forresterae* (Tolsma & Sutter 2022). Therefore, substantial mortality is not considered to have been experienced. The population trend for the species was listed as stable by Fensham et al (2019), likely based on the above factors and the lack of documented decline from other threats.
Generation time (years)	100	70	250	Brumby sallee is likely to be very long-lived, based on inference from *Eucalyptus* species in similar habitats. The primary juvenile period of brumby sallee is unknown, but longer than that of snow gum seedlings planted above the tree line, which has been reported to be 13-18 years (Ferrar et al. 1988). The species is suspected to be very long-lived with a generation time estimated at 100–250 years by DELWP (2021b) and 70 years by Fensham et al. (2019).
Extent of occurrence	1658 km^2	1658 km^2	>1658 km^2	The extent of occurrence (EOO) is estimated at 1658 km^2. This figure is based on the mapping of all available point records (covering a period from 1987–2021) obtained from state governments, museums and CSIRO. The maximum EOO is unknown, but given that the EOO is quite long and thin, it may be prone to large increases if other subpopulations were found to the east or west. EOO was calculated using a minimum convex hull, based on the IUCN Red List Guidelines (IUCN 2019).
Trend	unknown (probably stable)			There is no evidence that any subpopulations of brumby sallee have declined or gone extinct. However, there has been limited survey and monitoring of the species. The population trend for the species was listed as stable by Fensham et al. (2019).

Metric	**Estimate used in the assessment**	**Minimum plausible value**	**Maximum plausible value**	**Justification**
Area of Occupancy	36 km^2	36 km^2	<500 km^2	This estimate used in the assessment is based on the mapping of all available point records (covering a period from 1987–2021) obtained from state governments, museums and CSIRO. The area of occupancy (AOO) was calculated using a 2x2 km grid cell method, based on the IUCN Red List Guidelines (IUCN 2019). This may be an underestimate due to lack of survey for the species. The maximum estimate is based on the species possibly being more widespread than currently known. It occurs in a remote area of southeast Australia and is morphologically similar to the widespread black sallee. However, the current known distribution is patchy within its EOO, and therefore it is likely that the maximum AOO is only a small fraction of the species' EOO, and likely to be less than 500 km^2.
Trend	unknown (probably stable)			There is no evidence that any subpopulations of brumby sallee have declined or gone extinct. However, there has been limited survey and monitoring of the species. The population trend for the species was listed as stable by Fensham et al. (2019).
Number of subpopulations	9	9	unknown	There are nine known subpopulations of brumby sallee (Table 1). However, the species is very similar in morphology to black sallee, and occurs in remote parts of the Australian Alps, therefore it may be under surveyed, and additional subpopulations may exist.
Trend	unknown (probably stable)			There is no evidence that any subpopulations of brumby sallee have declined or gone extinct. However, there has been limited survey and monitoring of the species. The population trend for the species was listed as stable by Fensham et al. (2019).
Basis of assessment of subpopulation number	There are nine known subpopulations of brumby sallee (Table 1). However, the species is very similar in morphology to black sallee, and occurs in remote parts of the Australian Alps, therefore it may be under surveyed, and additional subpopulations may exist.			

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
No. locations	2	2	5	The most plausible threat to brumby sallee is high fire frequency. Although the species appears resilient to single fire events, research on the cumulative impact of multiple fires in short succession on snow gum showed that three fires within 10 years caused a 50% decline in the affected subpopulations (Fairman et al. 2017). A high frequency fire regime may therefore cause large declines of brumby sallee within one generation as this species occupies similar habitat and has similar traits to snow gum. The south-east of NSW is expected to undergo an increase in severe and average Forest Fire Danger Index values, which are used as an indicator of fire risk (OEH 2014). These increases are projected for summer and spring, which represent peak fire risk season (OEH 2014). These changes to fire conditions will likely increase the frequency of bushfires and may negatively impact brumby sallee into the future by creating short intervals for the recovery of subpopulations and the accumulation of sufficient physiological resources to remain resilient to fire in the long-term. Areas in and around northern and southern sections of the distribution have both been burnt twice within 20 years (DPIE 2021; DEWLP 2021a). Based only on the known distribution, this would place the number of locations at two though there are likely unknown occurrences of the species that would increase this estimate. Taking these into account and given that the species likely has a fairly restricted distribution, it is considered likely that estimated that the number of locations is less than five.
Trend	Unknown			There is no evidence that any locations of brumby sallee have declined or gone extinct. However, there has been limited survey or monitoring of the species.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Basis of assessment of location number	The most plausible threat to brumby sallee is high fire frequency but the species appears resilient to single bushfire events. There is no evidence it declined following the 2003 bushfires, and it has been observed to be vigorously resprouting following the recent 2019-20 bushfires (A. Messina 2021. Pers comm 28 July). Research on the cumulative impact of multiple fires in short succession on snow gums showed that three fires within 10 years caused a 50% decline in the affected subpopulations (Fairman et al. 2017). A high frequency fire regime may therefore cause decline of brumby sallee if it were to occur and the likelihood of this is expected to increase under climate change.			
Fragmentation	Not severely fragmented. Most subpopulations are clustered close to one another. As eucalypts are pollinated by birds, it is likely that these clusters of subpopulations exchange pollen flow (Breed et al. 2015) and are therefore not reproductively isolated. In addition, subpopulation sizes are unknown for six of the nine known subpopulations, and it is unknown if the majority of subpopulations are smaller or larger than rudimentary minimum viable population size estimates of 1000 individuals (Frankham et al. 2014).			
Fluctuations	Not subject to extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals.			

Criterion 1 Population size reduction

Reduction in total numbers (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	Critically Endangered **Very severe reduction**	**Endangered** **Severe reduction**	**Vulnerable** **Substantial reduction**
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

Criterion 1 evidence

Insufficient data to determine eligibility

Brumby sallee has an estimated minimum generation length of 100 years (DELWP 2021b), giving a three-generation timeframe of 300 years (although the timeframe for assessing future declines is limited to a maximum of 100 years; IUCN 2019).

The total population size of brumby sallee is unknown, as data on subpopulation size are unavailable for six of the nine known subpopulations, although it is at least several thousand plants (Table 1). There has been no monitoring of any subpopulation and, therefore, it is unclear whether there has been a decline in the total population size. Burnt subpopulations are resprouting vigorously after the 2019-20 fires (A. Messina 2021. pers comm 28 July), and it is unlikely that these fires have caused a substantial decline of affected subpopulations. Future declines are unable to be projected with any certainty, given the current population size is unknown, and also because that the species is very long-lived and not known to face threats capable of causing the rapid elimination of affected subpopulations.

The Committee considers that there is insufficient information to determine the eligibility of brumby sallee for listing in any category under this criterion.

However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 2 Geographic distribution as indicators for either extent of occurrence AND/OR 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			

Criterion 2 evidence

Eligible under Criterion 2 B1ab(iii)+2ab(iii) for listing as Endangered

Extent of occurrence (EOO) and area of occupancy (AOO)

The AOO and EOO of brumby sallee are considered restricted and are estimated at 36 km² and 1658 km² respectively (Table 4). These figures are based on the mapping of all available point records (covering a period from 1987–2021) obtained from state governments, museums and CSIRO. The AOO was calculated using a 2x2 km grid cell method, based on the IUCN Red List Guidelines (IUCN 2019). The EOO was calculated using a minimum convex hull.

Severely fragmented

Not severely fragmented. Four subpopulations are clustered around the northern Nunniong Plateau in Victoria, three of which are approximately 6 km apart. Five subpopulations are clustered around Happy Jacks Pondage in northern Kosciuszko National Park in NSW (maximum inter-subpopulation distance of approximately 6 km). As many eucalypts are pollinated by birds, it is likely that these clusters of subpopulations occasionally exchange pollen flow (Breed et al. 2015) and are therefore not reproductively isolated. In addition, subpopulation sizes are unknown for six of the nine known subpopulations, and it is unknown if the majority of subpopulations are smaller or larger than rudimentary minimum viable population size estimates of 1000 individuals (Frankham et al. 2014).

Locations

The most plausible threat to brumby sallee is high fire frequency, and hence the number of locations is two (Table 2).

The species appears resilient to single bushfire events. There is no evidence it declined in the Happy Jacks area or Brumby Point following the 2003 bushfires, and it has been observed to be vigorously resprouting following the recent 2019-20 bushfires at Brumby Point, Victoria (A. Messina 2021. pers comm 28 July). However, research on the cumulative impact of multiple fires in quick succession on *Eucalyptus pauciflora* s.l. (snow gum) showed that three fires in the space of 10 years caused a 50 percent decline in the affected subpopulations (Fairman et al. 2017). A high frequency fire regime may therefore cause decline of brumby sallee if it were to occur as this species occupies similar habitat and has similar traits to snow gum.

The south-east of NSW is expected to undergo an increase in severe and average Forest Fire Danger Index values, which are used as an indicator of fire risk (OEH 2014). These increases are projected for summer and spring, which represent peak fire risk season (OEH 2014). These changes to fire conditions will likely increase the frequency of bushfires and may negatively impact brumby sallee into the future by creating fire intervals that are too short to enable the recovery of subpopulations and the accumulation of sufficient physiological resources to remain resilient to fire in the long-term. Given that brumby sallee has an estimated generation time of 100 years, large declines due to successive bushfires are plausible within a one generation timeframe.

Areas in and around northern and southern sections of the distribution have both been burnt twice within 20 years (DPIE 2021; DEWLP 2021a), so numerous fires occurring over the next 100 years is likely. It is plausible that the entirety of each section of the distribution could be affected by a single fire, and the number of locations is therefore estimated at two based on possible large declines due to the impacts of fire as found in Fairman et al. (2017). There are likely unknown occurrences of the species that would increase this estimate, though it is unlikely that the number of locations would increase to more than five.

Continuing decline

There is no evidence that bushfires in 2003 or 2019-20 have negatively impacted brumby sallee, though notably survival and recruitment have not been estimated after these fires. The species is vigorously resprouting at Brumby Point in Victoria (A. Messina 2021. pers comm 28 July) and the Happy Jacks valley (G. Wright 2021 pers comm 13 Oct), following the 2019-20 bushfires, and there is nothing to suggest any snow gum-like decline for *E. forresterae* (Tolsma & Sutter 2022). Both of these subpopulations were burnt in 2003. The population trend for the species was listed as stable by Fensham et al. (2019), though ongoing post-fire surveys are required to determine the long-term impact of the fires on population trajectory. It is possible that high frequency fire regimes may cause declines in future, as has been documented in snow gum (Fairman et al. 2017). Therefore, there is a projected continuing decline in the number of mature individuals as a result of increasingly frequent fire regimes due to climate change (see Table 2).

Extreme fluctuations

The species is not subject to extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals.

Conclusion

Following assessment of the data the Committee has determined that the geographic distribution is restricted, the number of locations is less than five and although currently stable there is projected decline in the number of mature individuals. Therefore, the species qualifies for listing as **Endangered** under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 3 Population size and decline

	Critically Endangered **Very low**	**Endangered** **Low**	**Vulnerable** **Limited**
Estimated number of mature individuals	**< 250**	**< 2,500**	**< 10,000**
AND either (C1) or (C2) is true			
C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future)	**Very high rate** **25% in 3 years or 1 generation** **(whichever is longer)**	**High rate** **20% in 5 years or 2 generation** **(whichever is longer)**	**Substantial rate** **10% in 10 years or 3 generations** **(whichever is longer)**
C2. An observed, estimated, projected or inferred continuing decline AND its geographic distribution is precarious for its survival based on at least 1 of the following 3 conditions:			
(a) (i) Number of mature individuals in each subpopulation	**≤ 50**	**≤ 250**	**≤ 1,000**
(a) (ii) % of mature individuals in one subpopulation =	**90 – 100%**	**95 – 100%**	**100%**
(b) Extreme fluctuations in the number of mature individuals			

Criterion 3 evidence

Insufficient data to determine eligibility

The total number of individuals are unknown. Frankham et al. (2019) estimated the population size at 2000–10,000 individuals, although it is unclear how the maximum estimate was generated (the only subpopulation estimates provide were >1000 individuals at both Brumby Point and “Happy Jacks Creek”). The Brumby Point subpopulation estimate is corroborated by Walsh (2021) as “thousands” of plants (N. Walsh 2021. pers comm 28 July), and in NSW the comments on subpopulation size for the species are “prolific” at Tumut Dam and “occasional to rare” at Happy Jacks Road, 5.3 km SE of bridge over Happy Jacks Pondage (ALA 2021). Therefore, the minimum population size is at least several thousand individuals. However, as subpopulation size estimates are unavailable for six of the nine known subpopulations, the total population size of the species is unknown.

There is no information on population trends of brumby sallee and the trend of the population size is also unknown. The species is vigorously resprouting at Brumby Point in Victoria, following the 2019-20 bushfires (A. Messina 2021. pers comm 28 July), and it seems unlikely that substantial mortality was experienced by that fire event. The population trend for the species was listed as stable by Fensham et al. (2019).

The Committee considers that there is insufficient information to determine the eligibility of brumby sallee for listing in any category under this criterion.

However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 4 Number of mature individuals

	Critically Endangered **Extremely low**	**Endangered** **Very Low**	**Vulnerable** **Low**
D. Number of mature individuals	< 50	< 250	< 1,000
D2.[1] *Only applies to the Vulnerable 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: area of occupancy < 20 km² or number of locations ≤ 5

[1] The IUCN Red List Criterion D allows for species to be listed as Vulnerable under Criterion D2. The corresponding Criterion 4 in the EPBC Regulations does not currently include the provision for listing a species under D2. As such, a species cannot currently be listed under the EPBC Act under Criterion D2 only. However, assessments may include information relevant to D2. This information will not be considered by the Committee in making its recommendation of the species' eligibility for listing under the EPBC Act, but may assist other jurisdictions to adopt the assessment outcome under the *common assessment method*.

Criterion 4 evidence

Not eligible

The total number of individuals are unknown. Frankham et al. (2019) estimate the minimum population size at 2000 individuals. The Brumby Point subpopulation estimate is corroborated by Walsh (2021) as "thousands" of plants (N. Walsh 2021. pers comm 28 July), and in NSW the comments on subpopulation size for the species are "prolific" at Tumut Dam and "occasional to rare" at Happy Jacks Road, 5.3 km SE of bridge over Happy Jacks Pondage (ALA 2021). Therefore, the minimum population size is at least several thousand individuals, but as subpopulation size estimates are unavailable for six of the nine known subpopulations, the total population size of the species is unknown.

The Committee considers that brumby sallee is ineligible for listing in any category under this criterion, as its total population size exceeds 1000 individuals.

However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 5 Quantitative analysis

	Critically Endangered **Immediate future**	**Endangered** **Near future**	**Vulnerable** **Medium-term future**
Indicating the probability of extinction in the wild to be:	≥ 50% in 10 years or 3 generations, whichever is longer (100 years max.)	≥ 20% in 20 years or 5 generations, whichever is longer (100 years max.)	≥ 10% in 100 years

Criterion 5 evidence

Insufficient data to determine eligibility

Population viability analysis has not been undertaken. Therefore, there is insufficient information to determine the eligibility of brumby sallee for listing in any category under this criterion.

Adequacy of survey

Although there is limited data on brumby sallee, the survey effort has been considered adequate and there is sufficient scientific evidence to support the assessment.

Cataloguing data

This publication (and any material sourced from it) should be attributed as: Department of Agriculture, Water and the Environment 2022, *Conservation Advice for Eucalyptus forresterae* (brumby sallee), Canberra.

This publication is available at the SPRAT profile for *Eucalyptus forresterae* (brumby sallee).

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