



Consultation on Species Listing Eligibility and Conservation Actions

Eucalyptus imlayensis (Imlay mallee)

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

- 1) the eligibility of *Eucalyptus imlayensis* (Imlay mallee) for inclusion on the EPBC Act threatened species list in the Critically 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 24 March 2022.

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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 imlayensis* (Imlay mallee)

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. 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

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

6. Has the survey effort for this taxon been adequate to determine its national adult population size? If not, please provide justification for your response.
7. 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.
8. 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:

☐ 1–50 ☐ 51–250 ☐ 251–1000 ☐ >1000

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)**

9. 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

10. 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 generations*)? 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:

☐ 1–50 ☐ 51–250 ☐ 251–1000 ☐ >1000 ☐ >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

11. 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

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

SECTION E **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

- 13. Does the assessment consider the entire geographic extent and national extent of the species/subspecies? If not, please provide justification for your response.
- 14. Has the survey effort for this species/subspecies been adequate to determine its national distribution? If not, please provide justification for your response.
- 15. Is the distribution described in the assessment accurate? If not, please provide justification for your response and provide alternate information.
- 16. 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.
- 17. 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 km² ☐ 100 – 5 000 km² ☐ 5 001 – 20 000 km² ☐ >20 000 km²

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 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 km² ☐ 11 – 500 km² ☐ 501 – 2000 km² ☐ >2000 km²

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

SECTION F 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

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

19. 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.

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

☐ <100 km² ☐ 100 – 5 000 km² ☐ 5 001 – 20 000 km² ☐ >20 000 km²

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 km² ☐ 11 – 500 km² ☐ 501 – 2000 km² ☐ >2000 km²

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

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

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

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

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

23. 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?

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

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

25. 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?
26. Can you recommend any additional or alternative specific threat abatement or conservation actions that would aid the protection and recovery of the species/subspecies?
27. Would you recommend translocation (outside of the species' historic range) as a viable option as a conservation actions for this species/subspecies?

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

28. 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?
29. Are you aware of any cultural or social importance or use that the species/subspecies has?
30. What individuals or organisations are currently, or potentially could be, involved in management and recovery of the species/subspecies?
31. How aware of this species/subspecies are land managers where the species/subspecies is found?
32. 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

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

DRAFT

Consultation Document on Listing Eligibility and Conservation Advice for *Eucalyptus imlayensis* (Imlay mallee)

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 eligibility of the species for listing and inform conservation actions, further planning and the potential need for a 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 actions and further planning.



Eucalyptus imlayensis © Copyright, Genevieve Wright

Conservation status

Eucalyptus imlayensis (Imlay mallee) is proposed to be transferred from the Endangered category to the Critically Endangered category of the threatened species list under the *Environment Protection and Biodiversity Conservation Act 1999*.

The species was eligible for listing under the EPBC Act as on 16 July 2000 it was listed as Vulnerable under Schedule 1 of the preceding Act, the *Endangered Species Protection Act 1992* (Cwth).

Eucalyptus imlayensis was assessed by the Threatened Species Scientific Committee to be eligible for listing as Critically Endangered under criteria 2, 3 and 4. 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: A4a: Endangered
- Criterion 2: B1ab(v)+2ab(v): Critically Endangered
- Criterion 3: C1+C2a(i,ii): Critically Endangered
- Criterion 4: D1: Critically Endangered
- Criterion 5: Insufficient data

The main factors that make the species eligible for listing in the Critically Endangered category are its very restricted distribution, its vulnerability as a single population persisting in a single location, an extremely low number of mature individuals, and a poorly understood continuing decline in the number of mature individuals.

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

Conventionally accepted as *Eucalyptus imlayensis* Crisp & Brooker (1980), Family: *Myrtaceae*.

Description

Imlay mallee displays a multi-stemmed mallee growth form with smooth bark that is green when fresh, aging to orange-brown and grey, and shed from the stems in ribbons (Crisp & Brooker 1980). Plants grow to 7 m high from large lignotubers. Adult leaves are 10 – 15 cm long by 1.5 – 2 cm wide and glossy green in colour. Flowers of the species are in groups of three. Buds are ovoid, 6 -7 mm long. Fruits are cylindrical to bell shaped, 5 – 7 mm long (PlantNET 2021). The species is similar to *E. subcrenulata* but has ascending discs on its fruits. The species is also similar to *E. baeuerlenii* but differs by its narrower, wingless seedling leaves and larger fruits (Crisp & Brooker 1980).

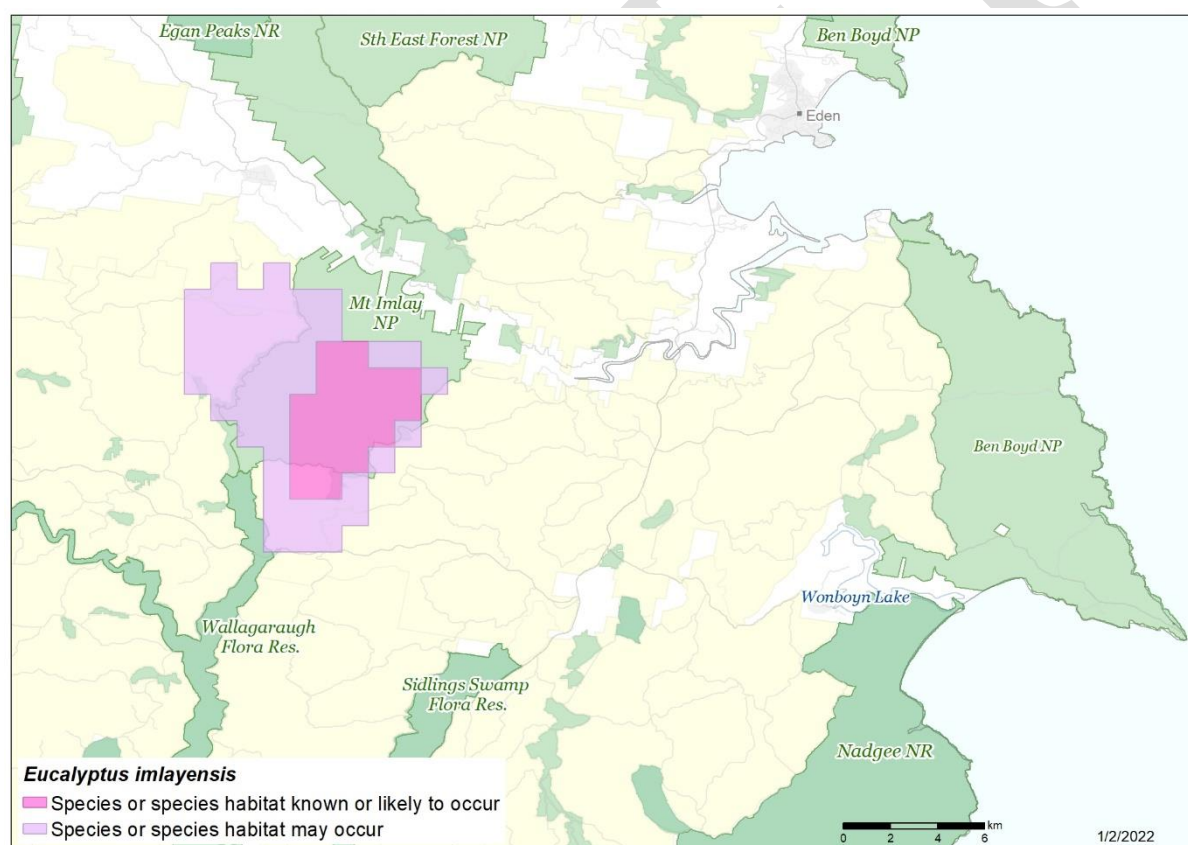
Although plants can produce flowers and buds annually, seed production is rare and therefore establishment from seed is also a rare event (James & McDougall 2007). No juvenile plants have ever been observed in the population (G Wright 2021. pers comm 19 November).

Distribution

Imlay mallee is found on Mount Imlay (Balawan) (see Map 1), in Mount Imlay National Park, near Eden, in south-eastern New South Wales (NSW). It grows on a steep, rocky slope at an altitude of 850–870 m in shrubland that is around 3 m high and dominated by *Leptospermum scoparium* (manuka) (Crisp & Brooker 1980). Since coming to the attention of science in 1977, the population has never comprised more than approximately 80 stems, however, there are considerably fewer genetically distinct individuals due to substantial clonal growth (James & McDougall 2007).

The species had been propagated and translocated to nearby sites on Mount Imlay (Balawan), however, all 37 surviving plants were killed in the 2019-20 fires (TRS Hub 2020).

Map 1 Modelled distribution of Imlay mallee



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 habitat or geographic feature that represents to recent observed locations of the species (known to occur) or 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

This statement of significance is not intended to be comprehensive, applicable to, or speak for, all Indigenous Australians and it is acknowledged that Indigenous groups and individuals are the custodians of this knowledge.

Imlay mallee occurs in the Eden Aboriginal Land Council in NSW (New South Wales Aboriginal Land Council 2021). Mount Imlay is known to the local Bidwell/Bidhawal people as 'Balawan', and is a place of great spiritual significance (NSW NPWS 2021). Balawan has been traditionally used for ceremonial practices and as a place of learning with numerous sites located in the surrounding locality. The mountain has been identified through documented and oral history as containing Aboriginal cultural heritage, however, does not contain archaeological sites. Balawan has been recommended to become the subject of future archaeological surveys (Dale Donaldson 2010). The cultural significance of Imlay mallee is unknown.

The mountain is named after the three Imlay brothers, who played an important part in opening the Eden-Monaro district to European settlement in the 1830s and 40s (Australian National Parks, 2019).

Relevant biology and ecology

Habitat

The entire population of Imlay mallee occurs within the Mount Imlay NP. The site is a steep quartzite outcrop which receives significant moisture in the form of orographic cloud (i.e., clouds produced when moist air encounters a mountain and is forced to higher elevation, cooling the air and causing condensation or even precipitation). Other species common at the site include *Cassytha pubescens* (downy dodder-laurel), *Veronica perfoliata* (digger's speedwell), *Dianella tasmanica* (Tasman flax-lily), *Doodia media* (rasp fern), *Leptospermum scoparium* (manuka), *Lomandra longifolia* (spiny-head mat-rush), *Melaleuca squarrosa* (scented paperbark), *Oxylobium ellipticum* (common shaggy-pea) and *Prostanthera walteri* (blotchy mint-bush) and the locally endemic *Hibbertia circinate* (Connie's Guinea flower) and *Boronia imlayensis* (Mount Imlay boronia). The ground layer is dominated by mosses. Presumably, the mountain has served as a climate refuge for Imlay mallee dating from periods of earlier, prehistoric climate change.

Life history

The reproductive ecology of Imlay mallee is not well understood and requires further investigation. All individuals have large lignotubers, which have grown around and between quartzite rocks at the site and are apparently quite old (Crisp & Brooker 1980). Flowers can be produced annually, primarily during summer (James & McDougall 2007). Some plants have produced viable seeds that have been used to establish a few ex situ individuals. However, natural establishment from seed appears to be a very rare event, as no seedling or juveniles have ever been observed on Mount Imlay since the species came to the attention of science in 1977 (Crisp & Brooker 1980; James & McDougall 2007; G Wright 2021. pers comm 19 November).

Most individuals appear to have arisen through clonal reproduction by a small number of genetically distinct ancestors. James & McDougall (2007) sampled 27 individual Imlay mallee stems from across the population to determine the extent of clonality and levels of genetic diversity in the population. In order to identify genetic variation they used inter simple sequence repeats (ISSRs), a method suitable where little or no information is available on the genome of a species (Zietkiewics et al. 1994). They found that most of the 27 individuals were products of clonal reproduction and represented only five distinct genotypes (James & McDougall 2007). Although they only sampled between one third and one half of the population at the time, based on the spatial distribution of samples and their genotypes, it is likely that there were fewer than 10 distinct genotypes in the population at the time of James & McDougall's (2007) analyses and likely even fewer as a result of continuing population decline (see Criterion 1 below).

Fire ecology

The single population of Imlay mallee had not been burned for many years prior to the 2019–20 bushfires. Surveys following those fires have observed approximately 90 percent of individuals resprouting from lignotubers, with the other approximately 10 percent having been killed by the intense fire. No seedlings have been observed since the fires.

Although its large lignotubers make it well adapted to surviving fire, increasing severity and frequency of fire may pose a serious threat to Imlay mallee (Auld et al. 2020). The secondary juvenile period (fire-free interval required by resprouts of Imlay mallee to reach maturity and bear a crop of seeds) is unknown, but could be up to four to five years based on mallee ash species in the Sydney region (Keith unpublished data). However, as Imlay mallee is a clonal species and a resprouter, this may not be relevant. Keith (1996) states that for most woody plant species, up to 15 years between successive fires is needed to ensure that a seed bank is sufficiently replenished to maintain future post-fire populations, although some trees may require longer fire-free periods. No data exist on the fire-free interval required for the successful recruitment of Imlay mallee either from seed or from resprouting.

Short intervals between fires may kill juvenile Imlay mallee before they become large enough to develop regenerative structures (i.e., lignotubers) needed to survive subsequent fires. A translocated population of Imlay mallee between three and six years old planted on Mount Imlay were all killed by high intensity (G Wright pers comm 13 December). At least 15 years between successive high-severity fires is needed to ensure the juveniles of most woody plant species can develop their fire-regenerative organs, although some tree species may require at least 25 years (Keith 1996). This suggests that the fire-free interval required for the successful recruitment of Imlay mallee may be 25 years or longer if seedlings emerge after fire.

Mature Imlay mallee may be threatened by the cumulative effects of multiple fires, given that 10 percent mortality of standing plants occurred after a single fire in 2019–20. Cumulative attrition of the population will occur regardless of fire frequency if mortality is not compensated by recruitment, as appears to have been the case after the 2019–20 fires. High frequency fires would likely accelerate the decline, Fairman et al. (2017), for example, recorded 50 percent mortality of mature lignotuberous *E. pauciflora* (snow gum) following three fires in 10 years.

Habitat critical to the survival

Imlay mallee persists only as a tiny remnant population near the summit of Mount Imlay. Therefore, habitat critical to the survival of the species would include all currently occupied habitat, any areas of similar habitat surrounding this population, and any additional areas of similar habitat in the region that could 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 a subpopulation, in keeping with the terminology used in the EPBC Act and state/territory environmental legislation.

Given the species’ eligibility for listing as Critically Endangered (see Attachment A), there is sufficient evidence to declare the only known population of Imlay mallee as an important population for the species. This population is under particular pressure for survival and requires protection to support the recovery of the species.

Threats

Imlay mallee is threatened by inappropriate fire regimes, insect herbivory, dieback caused by *Phytophthora cinnamomi* and/or other factors, low genetic diversity, and, most seriously given its mountaintop location, climate change. Historically the species was threatened by infrastructure development, as two developments were proposed on Mount Imlay. However, due to the documentation of the species the development was averted (Crisp & Brooker 1980). No new developments have threatened the species.

Many of these threats will interact synergistically. For example, the species’ lack of genetic diversity could limit its ability to adapt to climate change. Climate change, in turn, will likely magnify the negative impacts of most of the other threats.

A general lack of knowledge of the species’ biology and ecology currently limits our ability to understand and predict threats and to develop suitable recovery actions.

Table 1 Threats

Threats in Table 1 are noted in approximate order of highest to lowest impact, based on available evidence.

Eucalyptus imlayensis (Imlay mallee) Conservation Advice

Threat	Status ^a	Evidence
Climate change		
Lower rainfall, more frequent droughts, and increasing temperatures	<ul style="list-style-type: none"> • Timing: current/future • Confidence: observed/projected • Likelihood: almost certain • Consequence: catastrophic • Trend: increasing • Extent: across the entire range 	<p>In the south-east and tablelands regions 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), and a projected decrease in snowfall and changes to precipitation patterns (increased precipitation in autumn and decreased precipitation in spring) (OEH 2014). During 2017–19, south-eastern NSW experienced severe drought (Bureau of Meteorology 2020; DPIE 2021), however, there is little evidence to show the role climate change played in the severity of the drought.</p> <p>The potential effects of decreasing rainfall and changes in water balance on Imlay mallee have not been quantified. Drought was identified as a factor causing seedling mortality in <i>E. luehmanniana</i>, another mallee eucalypt species, and seedlings in burnt sites were particularly susceptible to drought conditions (Tozer & Bradstock 1997). Drought conditions post-fire also affects resprouting from lignotubers, which is discussed further in the next section.</p> <p>Imlay mallee currently occupies a very restricted area. The suitability of the habitat in this area is likely to change with increasing temperatures and decreasing rainfall, potentially resulting in the species' inability to persist in its current site. Changing bioclimatic zones may open up new suitable sites for Imlay mallee, however, more research is needed on the climatic requirements of the species in order to predict this. Auld et al. (2020) assessed that susceptibility to drought was one of the main drivers putting the Imlay mallee at high risk of extinction following the 2019–20 bushfires.</p>
Fire		
Inappropriate fire regimes	<ul style="list-style-type: none"> • Timing: current/future • Confidence: observed/projected • Likelihood: likely • Consequence: major • Trend: increasing • Extent: across the entire range 	<p>While the lignotubers of Imlay mallee are relatively resilient to fire, they may be vulnerable to increasingly severe fires and to the cumulative effects of multiple fires. The extent that fire affects Imlay mallee is unknown.</p> <p>There are a number of mechanisms by which the fire regime impacts a species with resprouter traits (Keith 1996; DAWE 2021). These include the frequency of fire (high vs low), the severity of fire (high vs low), the season of fire and the interactions between fire and climate change and other threats (weeds, disease, etc.). Imlay mallee is sensitive to high fire severity, high fire frequency, interactions between fire and drought, and potentially fire and disease.</p>

		<p><i>High severity fire</i></p> <p>Extreme and extended heating of soil can damage the survival of regenerative organs located below ground, such as lignotubers (Bowman et al. 2009), while also increasing the hydrophobicity of the soil (Santin & Doerr 2016). As the species is found in shallow soils, it is at higher risk of damage or mortality than species found buried deeper.</p> <p><i>High fire frequency</i></p> <p>Although 90 percent of individuals had been observed resprouting after the 2019 – 20 bushfires, the likelihood of lignotuber resprouting decreases after short-interval fires (Fairman et al. 2019). There is a risk of decline in the population if another fire was to occur within the species fire-free interval.</p> <p>The extent to which the Imlay mallee is affected by high-frequency fires is unknown. Another lignotuber resprouter, <i>E. pauciflora</i>, has been shown to be vulnerable to physical damage due to a loss of protective soil after fire (Fairman et al. 2017).</p> <p><i>Interactions between fire and drought</i></p> <p>Post-fire drought can inhibit flowering and seed germination, and increase necrosis of immature plants (DAWE 2021). Resprouters are susceptible to elevated mortality in post-fire drought as their regrowth tissues are more susceptible to xylem embolism than mature tissues (Pratt et al. 2014). Lignotubers in eucalypts function as both a reserve of non-structural carbohydrates and a substantial bud bank (Fairman et al. 2019). During the resprouting process post-fire, species may deplete these carbohydrate reserves if in drought conditions, due to restriction of water loss and CO₂ uptake (Pratt et al. 2014).</p> <p><i>Interactions between fire and disease</i></p> <p>Fire can increase the susceptibility of plants to disease, especially <i>P. cinnamomi</i> (Moore et al. 2015) and <i>Austropuccinia psidii</i> (myrtle rust) (Pegg et al. 2020). Although Imlay mallee has been shown to be tolerant of <i>P. cinnamomi</i> under controlled conditions (Liew and McDougall unpublished data, cited in TRS Hub 2020), it is unknown how the species would be affected under stressed conditions post-fire.</p> <p><i>Other concerns</i></p> <p>The frequency of dry lightning events have increased about 50 percent between 2000 and 2016 compared to the period between 1980 and 1999 (Canadell et al. 2021). Lightning-ignited fires are common, accounting for roughly 30 percent of the total number of fires, but account from 50 – 90 percent of the total area burnt (Dowdy & Mills 2012). Approximately three quarters of lightning-ignited fires are observed within three days of ignition (Dowdy & Mills 2012). Considering the limited area of Imlay mallee, a lightning-</p>
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Eucalyptus imlayensis (Imlay mallee) Conservation Advice

Threat	Status ^a	Evidence
		ignited fire has the potential to cause considerable damage to the population.
Threats resulting from small and fragmented populations		
Allee effects and low genetic diversity	<ul style="list-style-type: none"> • Timing: current/future • Confidence: known • Likelihood: almost certain • Consequence: major • Trend: increasing • Extent: across the entire range 	<p>Small, isolated subpopulations can be subject to various Allee effects, including inbreeding depression caused by low genetic diversity (Frankham et al. 2014).</p> <p>When Imlay mallee was first identified in 1977, there were only around 70 individuals; by 2020 this had decreased to 48 individuals. James & McDougall (2007) extracted genetic samples from across the population and were only able to identify five distinct genotypes. While their sampling was only partial, their results and the continued decline of Imlay mallee suggests that the entire population probably consists of fewer than 10 distinct genotypes.</p>
Native species		
Insect damage	<ul style="list-style-type: none"> • Timing: current/future • Confidence: known • Likelihood: likely • Consequence: minor • Trend: unknown • Extent: across the entire range 	James & McDougall (2007) noted abundant psyllid leaf galls on many Imlay mallee, and OEH (2021) lists gall-forming psyllids as a potential threat to the species. Insect herbivory, particularly on young leaves, may also present a threat to the species (G Wright 2021. pers comm 19 November).
Competition from native plants	<ul style="list-style-type: none"> • Timing: current/future • Confidence: suspected • Likelihood: possible • Consequence: moderate • Trend: unknown • Extent: across the entire range 	<p>No seedling recruitment has been observed since the species' discovery in 1977; one factor impeding such recruitment may be competition from other native trees and shrubs, but seedling establishment in this species is a rare event (G Wright 2021. pers comm 19 November).</p> <p>After the 2019–20 fires, large numbers of <i>E. sieberi</i> germinated within the Imlay mallee population. This species is dominant upslope but not usually found within the Imlay mallee site. These seedlings are to be removed (TRS Hub 2020).</p>

Threat	Status ^a	Evidence
Disease		
Dieback caused by <i>Phytophthora cinnamomi</i> or other plant pathogens	<ul style="list-style-type: none"> • Timing: current/future • Confidence: suspected • Likelihood: possible • Consequence: minor • Trend: unknown • Extent: across the entire range 	<p><i>Phytophthora cinnamomi</i> is an introduced soil-borne pathogen which infects a large range of plant species and may contribute to plant death, especially when other stresses are present, such as waterlogging, drought and fire (DOEE 2018). The pathogen can disperse in water flowing from roots of infected plants to roots of healthy plants and mud clinging to vehicles, animals and walkers (DOEE 2018). Dieback caused by <i>P. cinnamomi</i> is listed as a key threatening process under the EPBC Act (DOEE 2018).</p> <p><i>Phytophthora cinnamomi</i> has been isolated from soil and the roots of other plant species around the summit of Mount Imlay, however, as stated earlier Imlay mallee has been shown to be tolerant of <i>P. cinnamomi</i> in controlled environments (TRS Hub 2020).. While OEH (2021) lists <i>P. cinnamomi</i> as a possible threat to Imlay mallee, it is unlikely to constitute a major threat (G Wright 2021, pers comm 19 November).</p> <p>Other plant pathogens such as myrtle rust may also threaten the species. Myrtle rust is not currently known to affect the Imlay mallee, but is present in eastern Australia and may pose a threat in the future.</p>

^aTiming—identifies the temporal nature of the threat

Confidence—identifies the nature of the evidence about the impact of the threat on the species

Likelihood—identifies the likelihood of the threat impacting on the whole population or extent of the species

Consequence—identifies the severity of the threat

Trend—identifies the extent to which it will continue to operate on the species

Extent—identifies its spatial context in terms of the range of the species

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 –known to have occurred only a few times

Unknown – currently unknown how often the threat 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 stable or declining

Major – population decline is ongoing

Catastrophic – population trajectory close to extinction

Each threat has been described in Table 1 in terms of the extent that it is operating on the species. The risk matrix (Table 2) 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; the spatial extent, 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 2 Risk Matrix

Likelihood	Consequences				
	Not significant	Minor	Moderate	Major	Catastrophic
Almost certain				Allee effects and low genetic diversity	Lower rainfall, more frequent droughts, and increasing temperatures
Likely		Insect damage		Inappropriate fire regimes	
Possible		Dieback caused by <i>P. cinnamomi</i> or other plant pathogens	Competition from native plants		
Unlikely					
Unknown					

Risk Matrix legend/Risk rating:

Low Risk	Moderate Risk	High Risk	Very High Risk
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Priority actions have then been developed to manage the threats, particularly where the risk was deemed to be 'very high' (red shading) or 'high' (orange shading). For those threats with an unknown or low risk (blue and green shading respectively) research and monitoring actions have been developed to understand and evaluate the impact of the threats, where appropriate.

Conservation and recovery actions

Primary conservation objective

By 2030, the population of Imlay mallee will have increased in abundance, a viable ex situ collection will be maintained, and new subpopulations will have been established via translocations into suitable habitat.

Conservation and management priorities

Climate change impacts

- Map all habitat suitable for this species currently and under future climate change scenarios and ensure impacts of other threats to this habitat are minimised.
- Identify climate refuges suitable for translocations, ensuring that some are geographically distant enough to increase the number of locations of the species (see "Ex situ recovery actions" below) if suitable habitat exists elsewhere.

Fire impacts

- Develop and implement an evidence-based fire management strategy that optimises the survival of the species during planned burns and bushfires, including:

- Fires must be managed to ensure that prevailing fire regimes do not disrupt the life cycle of the species, that they support rather than degrade the habitat, and that they do not promote invasion of weeds.
- Prohibit use of prescribed aerial ignitions on Mt Imlay
- Physical damage to the habitat and individual plants must be avoided during and after fire operations.
- Avoid the use of fire retardants and fire-fighting foams during fire operations.
- Provide maps of known occurrences (including any translocations) to local and state Rural Fire Services and seek inclusion of mitigation measures in fire risk management plans, risk registers and/or operation maps.

Ex situ recovery actions

- Collect tissue samples from as much of the population as possible to facilitate genetic analyses to determine the current extent of genetic variability in the population (see “Information and research priorities” below).
- Continue collecting seed from all known genotypes and place in long-term storage to preserve genetic material, in accordance with the plant germplasm conservation guidelines (Martyn Yenson et al. 2021).
- Additional plants should be established in cultivation at appropriate institutions (e.g., botanic gardens) to facilitate further study of the species’ reproductive biology and to support translocation efforts.
- Undertake conservation translocations into suitable habitat with secure land tenure in accordance with the Guidelines for the Translocation of Threatened Plants in Australia (Commander et al. 2018). Translocation sites should occur at varying distances from the current site, including some sites sufficiently distant to establish new “locations” as defined by the IUCN Guidelines (IUCN 2019).

Impacts of native species

- Where significant impacts from insect herbivory or gall-forming psyllids are observed on Imlay mallee, consider implementing management actions to control or repel these insects, ensuring that any unintended environmental impacts from such actions are minimised.
- Where competition from native vegetation is suspected, including from other *Eucalyptus* species, of impeding seedling recruitment by Imlay mallee, continue thinning this vegetation while ensuring that any unintended environmental impacts from this action are minimised.

Disease impacts

- Monitor the presence of *P. cinnamomi* at the site, and determine the susceptibility of Imlay mallee under stressed, post-fire conditions.
- Confirm the susceptibility of Imlay mallee to other species of *Phytophthora* or other plant pathogens, such as myrtle rust. Implement a management plan to ensure new pathogens are not introduced into the population or the surrounding areas.
- Implement a treatment plan if plants were to become symptomatic within the population.

- Ensure that appropriate hygiene protocols, such as those outlined by Podger et al. (2001), are followed when entering or exiting known locations of Imlay mallee.

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 Imlay mallee and its habitat (including future translocation sites).
- Protect individual plants near tracks from trampling and accidental damage through the use of signage, track markers or fencing.

Stakeholder engagement/community engagement

- Engage and involve Traditional Owners in surveying, monitoring and other conservation 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.

Survey and monitoring priorities

- Maintain a monitoring program to:
 - monitor species recruitment and plant health, fruit production and survival annually, including after fire events (including the 2019–20 bushfires);
 - detect trends in population size;
 - document the extent of post-fire recovery and causes of recruitment failure;
 - better identify threats and their relative impacts; and,
 - monitor the effectiveness of management actions and the need to adapt them if necessary.
- Survey suitable habitat for new subpopulations (however unlikely), but particularly to locate suitable sites for translocations.
- Monitor all translocated individuals to maturity, seed set and recruitment to ensure they are viable and are contributing to a reduction in the extinction risk for the species.

Information and research priorities

- Undertake genetic research to determine, as precisely as possible, the distribution of distinct genotypes across the population of Imlay mallee. Such detailed knowledge will be required to guide ex situ conservation efforts.
- Investigate the species' reproductive ecology, including: aspects of its mating system (e.g., the prevalence of sexual vs clonal reproduction and self-fertilisation vs cross-fertilisation), pollination ecology, and factors influencing seed storage and viability including temporal changes in viability with time.
- Investigate limitations on post-fire survival and recruitment success.
- Investigate potential causes of historic and current lack of recruitment in the species, and potential management actions to encourage seed production and seedling establishment.

- Analyse the ecological and bioclimatic requirements of Imlay mallee, particularly in the context of current and projected climate change, and use results to identify potential habitat that may be suitable for the species under both current and projected climate conditions.
- Improve knowledge of the relative impact of other threats to the species and the efficacy of conservation and management actions. These threats may include (but not necessarily be limited to): fire, drought, various forms of insect infestation, competition from native plants, infection by *P. cinnamomi*, other *Phytophthora* species, and other plant pathogens such as myrtle rust inbreeding depression, and any form of physical disturbance of the site.
- Ascertain the cultural significance of Imlay mallee to improve engagement with Traditional Owners around management actions and increase understanding of the value of conserving the species.

Links to relevant implementation documents

[NSW Government. Imlay mallee \(*Eucalyptus imlayensis*\) Saving our Species Strategy](#)

[Department of the Environment and Energy. Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* \(2018\)](#)

Conservation Advice and Listing Assessment references

Auld TD, Mackenzie BDE, Le Breton T, Keith DA, Ooi MKJ, Allen S & Gallagher RV (2020) *A preliminary assessment of the impact of the 2019/2020 fires on NSW plants of national significance*. Report to the NSW Department of Planning, Industry and Environment.

Bowman DMJS, Balch JK, Artaxo P, Bond WJ, Carlson JM, Cochrane MA, D'Antonio CM, DeFries RS, Doyle JC, Harrison SP, Johnston FH, Keeley JE, Krawchuk MA, Kull CA, Marston, JB, Moritz MA, Prentice IC, Roos CI, Scott AC, Swetnam TW, van der Weef GR & Pyne SJ (2009) Fire in the Earth System. *Science* 324, 481 – 484

Bureau of Meteorology (2020) *Drought rainfall deficiencies and water availability*. Bureau of Meteorology. Accessed: 29 October 2021. Available at: <http://www.bom.gov.au/climate/drought/archive/20200107.archive.shtml>

Commander E, Coates D, Broadhurst L, Offord C A, Markinson R O & Matthes M (2018) *Guidelines for the translocation of threatened plants in Australia Third Edition*. Australian Network for Plant Conservation, Canberra.

Crisp MD & Brooker MIH (1980) *Eucalyptus imlayensis*, a new species from a mountain of south coastal New South Wales. *Telopea* 2, 41–47.

Dale Donaldson S (2010) *Bega Valley Shire Aboriginal Cultural Heritage Study*

DAWE (2021) *Fire regimes that cause biodiversity decline as a key threatening process (draft)*. Department of Agriculture, Water and the Environment, Canberra, February.

DELWP (Department of Environment, Land, Water and Planning) (2021) *Threatened Species Assessment – Eucalyptus forresterae (Brumby Sallee)*. Department of Environment, Land, Water and Planning, Victoria.

- DOEE (Department of the Environment and Energy) (2018) *Threat abatement plan for disease in natural ecosystems caused by Phytophthora cinnamomi*. Department of the Environment and Energy, Canberra.
- DPIE (2021) *Google Earth Burnt Area Map*. Department of Planning, Industry and Environment, New South Wales. Accessed: 29 October 2021. Available at: <https://datasets.seed.nsw.gov.au/dataset/google-earth-engine-burnt-area-map-geebam>
- Fairman TA, Bennett LT, Tupper S, Nitschke CR (2017) Frequent wildfires erode tree persistence and alter stand structure and initial composition of a fire-tolerant sub-alpine forest. *Journal of Vegetation Science* 28, 1151–1165.
- Fairman TA, Bennett LT & Nitschke CR (2019) Short-interval wildfires increase likelihood of resprouting failure in fire-tolerant trees. *Journal of Environmental Management* 231, 59 – 65
- Gallagher RV. 2020. *Interim national prioritisation of Australian plants affected by the 2019–2020 bushfire season ver 1.4*. Report to the Commonwealth Department of Agriculture, Water and Environment, Canberra.
- IUCN (2019) *Guidelines for using the IUCN Red List Categories and Criteria. Version 14*. Prepared by the Standards and Petitions Subcommittee. IUCN. Gland, Switzerland.
- James EA & McDougall KL (2007) Extent of clonality, genetic diversity and decline in the endangered mallee *Eucalyptus imlayensis*. *Australian Journal of Botany* 55, 548–553.
- Keith D (1996) Fire-driven extinction of plant populations: A synthesis of theory and review of evidence from Australian vegetation. *Proceedings of the Linnean Society of New South Wales* 116, 37–78.
- Martyn Yenson AJ, Offord CA, Meagher PF, Auld T, Bush D, Coates DJ, Commander LE, Guja LK, Norton SL, Makinson RO, Stanley R, Walsh N, Wrigley D, Broadhurst L (2021) *Plant Germplasm Conservation in Australia: strategies and guidelines for developing, managing and utilising ex situ collection. Third edition*. Australian Network for Plant Conservation, Canberra.
- Moore N, Barrett S, Howard K, Craig MD, Bowen B, Shearer B & Hardy G (2015) Time since fire and average fire interval are the best predictors of *Phytophthora cinnamomi* activity in heathlands of south-western Australia. *Australian Journal of Botany* 62, 587 – 593
- New South Wales Aboriginal Land Council (2021) Map of Local Aboriginal Land Council boundaries. Accessed: 7 October 2021. Available on the internet at: <https://alc.org.au/>
- NSW NPWS (2021) *Mount Imlay National Park*. National Parks and Wildlife Service (NSW) Viewed: 7 October 2021. Available on the internet at: <https://www.nationalparks.nsw.gov.au/visit-a-park/parks/mount-imlay-national-park>.
- OEH (2014) *South East and Tablelands climate change snapshot*. Office of Environment and Heritage, New South Wales. Accessed: 29 October 2021. Available at: <https://climatechange.environment.nsw.gov.au/Climate-projections-for-NSW/Climate-projections-for-your-region/South-East-and-Tablelands-Climate-Change-Downloads>

- OEH (2021) *Imlay mallee – profile*. Office of Environment and Heritage (NSW) Viewed: 7 October 2021. Available on the internet at:
<https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10296>
- Pegg GS, Entwistle P, Giblin FR & Carnegie AJ (2020) Fire and rust – the impact of *Austropuccinia psidii* (myrtle rust) on regeneration of Myrtaceae in coastal heath following wildfire. *Southern Forests* 82, 280 – 291
- Podger FD, James SH & Mulcahy MJ (2001) *Phytophthora cinnamomi* and disease caused by it – a protocol for identifying ‘protectable areas’ and their priority for management. Draft report prepared for Department of Parks and Wildlife (WA), Perth.
- Pratt RB, Jacobsen AL, Ramirez AR, Helms AM, Traugh CA, Tobin MF, Heffner MS & Davis SD (2014) Mortality of resprouting chaparral shrubs after a fire and during record drought: physiological mechanisms and demographic consequences. *Global Change Biology* 20, 893 – 907
- Santin C & Doerr SH (2016) Fire effects on soils: the human dimension. *Philosophical Transactions, The Royal Society B* 371: 20150171
- Tozer MG & Bradstock RA (1997) Factors influencing the establishment of seedlings of the mallee, *Eucalyptus luehmanniana* (Myrtaceae). *Australian Journal of Botany* 45, 997 – 1008
- Wright G (2021) Personal communication by email, 19 November 2021. Ecosystems and Threatened Species, South East Branch. Department of Planning, Industry and Environment, NSW.
- Zietkiewicz E, Rafalski JA & Labuda D (1994) Genome fingerprinting by simple sequence repeats (SSR)-anchored polymerase chain reaction amplification. *Genomics* 20, 176 – 183



Attachment A: Listing Assessment for *Eucalyptus imlayensis*

Reason for assessment

The Imlay mallee was listed as Endangered under the *Endangered Species Protection Act 1992* and transferred to the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act) when it commenced in July 2000.

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 3 includes the key assessment parameters used in the assessment of eligibility for listing against the criteria. The definition of each of the parameters follows the [Guidelines for Using the IUCN Red List Categories and Criteria](#).

Table 3 Key assessment parameters

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of mature individuals	48	5	48	Surveys conducted on 6 November 2020 (after the bushfires) counted 48 mature individuals. All of these were resprouting from the base after being severely burnt. The minimum plausible value is based on genetic analyses by James & McDougall (2007), which documented the prevalence of clonal reproduction in the species. Only five distinct genotypes could be identified from a sample of 27 apparently distinct individuals, though less than half of all individuals were sampled.
Trend	Declining			When the Imlay mallee was discovered in 1977, there were estimated to be about 70+ individuals. Until the 2019–20 bushfires, more than 50 individuals persisted, but approximately 10% of these perished in the fires, reducing the number of mature individuals to about 48.

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Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Generation time (years)	100	100	Unknown	The subspecies' generation length is unknown and difficult to estimate. Lignotubers are believed to be hundreds (perhaps thousands) of years old and juvenile recruitment has never been observed (G Wright 2021. pers comm 19 November). However, based on the generation length of other lignotuberous mallee <i>Eucalyptus</i> species, for example <i>E. forresterae</i> (brumby sallee) (DEWLP 2021) the generation length is estimated to be a minimum of 100 years.
Extent of occurrence	4 km ²	4 km ²	4 km ²	The extent of occurrence (EOO) is almost certainly less than 1 km ² . This figure is based on the mapping of point records from the thorough survey of all individuals on 6 November 2020. The EOO was calculated using a minimum convex hull, based on the IUCN Red List Guidelines (IUCN 2019). However, IUCN Red List Guidelines state that: "If EOO is less than AOO, EOO should be changed to make it equal to AOO to ensure consistency with the definition of AOO as an area within EOO" (IUCN 2019). Therefore, EOO values presented here have been increased to match AOO values (see below).
Trend	Contracting			Small patches of Imlay mallee have disappeared over the past 44 years (1977–2021), suggesting that EOO is declining. However, given that EOO cannot be less than AOO for a species (see above) and that AOO is already at the minimum possible value (see below), EOO is stable and can only decline further if the species becomes extinct.
Area of Occupancy	4 km ²	4 km ²	4 km ²	This estimate is based on the mapping of point records from the thorough survey of all individuals on 6 November 2020. The area of occupancy (AOO) was calculated using a 2x2 km grid cell method, based on the IUCN Red List Guidelines (IUCN 2019).
AOO is a standardised spatial measure of the risk of extinction, that represents the area of suitable habitat known, inferred or projected to be currently occupied by the taxon. It is estimated using a 2 x 2 km grid to enable comparison with the criteria thresholds. The resolution (grid size) that maximizes the correlation between AOO and extinction risk is determined more by the spatial scale of threats than by the spatial scale at which AOO is estimated or shape of the taxon's distribution. It is not a fine-scale estimate of the actual area occupied. In some cases, AOO is the smallest area essential at any stage to the survival of existing populations of a taxon (e.g. breeding sites for migratory species).				
Trend	Stable			AOO has likely declined over the past generation. However, under the IUCN's recommended 2x2 km grid cell method, the minimum possible value of AOO is 4 km ² (i.e., the area of a single grid cell). As the species is already at this minimum value, AOO is stable and can only decline further if the species becomes extinct.

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Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of subpopulations	1	1	1	
Trend	Stable			The number of subpopulations can only decline if the species goes extinct and can be increased only via translocation.
Basis of assessment of subpopulation number	The entire population of the species persists within an area of less than 1 hectare.			
No. locations	1	1	1	The most serious plausible threats are climate change and fire.
Trend	Stable			The number of locations can only decline if the species goes extinct and increase only via translocation to a geographically distant location.
Basis of assessment of location number	The entire population of the species persists within an area of less than 1 hectare. Given this severely restricted distribution, any number of threats are capable of affecting the entire population.			
Fragmentation	Given that the population of Imlay mallee must have been more widespread in the past and that it currently persists in a single remnant patch of less than 1 hectare, the species should be considered to be severely fragmented.			
Fluctuations	Not subject to extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals – no parameter was changed by an order of magnitude by the 2019–20 bushfires.			

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%
<p>A1 Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.</p> <p>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.</p> <p>A3 Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [(a) <i>cannot be used for A3</i>]</p> <p>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.</p> <p>Based on any of the following</p> <ul style="list-style-type: none"> (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

Eligible under Criterion 1 A4a for listing as Endangered

Generation time

The generation time of Imlay mallee was estimated to be at least 100 years (see Table 3). Therefore, three generations represents a period of approximately 300 years for the purposes of this criterion.

Population decline and eligibility under Criterion A2

When the Imlay mallee was discovered in 1977, there were estimated to be about 70 individuals (Crisp & Brooker 1980). The population had declined to around 60 individuals by 2000 (G Wright 2021. pers comm 19 November). Between 2000 and the 2019–20 bushfires the population declined by approximately 10 percent with another 10 percent perishing in the fires, bringing the number of mature individuals down to about 48 (G Wright 2021. pers comm 19 November). This represents a total population reduction over the past 44 years (1977 to 2021) of over 31 percent, which makes the species eligible for listing as Vulnerable under Criterion A2. However, given that the generation time of the Imlay mallee is at least 100 years, the decline observed over this relatively short time period almost certainly underestimates the true rate of decline for the species. It is likely that the true rate of decline is substantially greater than 31 percent, however, there is insufficient information available to justify this extrapolation.

Eligibility under Criterion A4

Under Criterion A4, however, we can assess population decline over a time period including both the past and the future (but no more than 100 years into the future). The decline of the Imlay mallee population over the past 44 years appears to have been relatively steady. If we assume the rate of decline has been constant between 1977 and 2021, then this implies an annual population reduction of approximately 0.85 percent. Projecting this exponential rate of decline another 100 years into the future, we would predict that the population size would be reduced to 20 mature individuals by the year 2121. Thus, we can project a population decline of over 58 percent over the next 100 years, and a decline of over 71 percent over the full 144-year period between 1977 and 2121.

Conclusion

The Committee considers that the species is projected to experience a severe reduction in numbers over the time period from 1977 to 2121 (100 years into the future), declining from around 70 mature individuals to a predicted 20 individuals, which is equivalent to at least a 71 percent reduction. Therefore, the species has met the relevant elements of Criterion 1 to make it eligible for listing as **Endangered**.

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 km ²	< 5,000 km ²	< 20,000 km ²
B2. Area of occupancy (AOO)	< 10 km ²	< 500 km ²	< 2,000 km ²
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(v)+2ab(v) for listing as Critically Endangered

EOO and AOO

Imlay mallee occurs at a single small site. The species has an EOO and an AOO of 4 km² (see Table 3). The figures for EOO and AOO are based on the mapping of point records from the thorough survey of all individuals on 6 November 2020. The EOO was calculated using a minimum convex hull, as outlined in the IUCN Guidelines (IUCN 2019). The AOO was calculated using the 2x2 km grid cell method as outlined in the IUCN Guidelines (IUCN 2019).

Given that the EOO is less than 100 km² and AOO is less than 10 km², the species meets the threshold for listing as Critically Endangered under sub-criterion B1 and sub-criterion B2.

Severely fragmented and number of locations

To be considered severely fragmented, over 50 percent of the AOO must be in small and isolated patches that cannot support a minimum viable population (IUCN 2019). Given that the entire population of Imlay mallee currently persists in a single remnant patch of less than 1 hectare and comprises fewer than 50 individuals, the species must be considered to be severely fragmented.

Imlay mallee occurs at one location, based on most of the plausible threats to the species. The 2019–20 bushfires severely burnt the entire population, and there is a risk of increasingly short fire intervals from the combined effects of prescribed burning (depending on future fire mitigation policies) and the increasing prevalence of bushfire conditions across the species habitat (Gallagher et al. 2021; Auld et al. 2020). Therefore, the species meets the threshold for listing as Critically Endangered under sub-criterion (a).

Continuing decline

The number of mature individuals has been observed to be declining consistently over the past 44 years (1977–2021), thereby meeting sub-criterion (b(v)).

Fluctuations

There are no known extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals.

Conclusion

Based on the above evidence, the Committee considers that the species' geographic distribution (as measured by both EOO and AOO) is very restricted, it is severely fragmented, its number of locations is very restricted, and continuing decline is observed in the number of mature individuals.

Therefore, the species has met the relevant elements of Criterion 2 to make it eligible for listing as **Critically Endangered**.

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

Eligible under Criterion 3 C1+C2a(i,ii) for listing as Critically Endangered

As of 2021, there were no more than 48 mature individuals of Imlay mallee persisting on Mount Imlay and the population had been observed to decline by more than 31 percent between 1977 and 2021 (a period considerably shorter than one generation) (see Criterion 1). In addition to this observed continuing decline, 100 percent of mature individuals are located in a single subpopulation comprising fewer than 50 mature individuals.

Thus, the Committee considers that the estimated total number of mature individuals of this species is very low, with an observed continuing decline and a geographic distribution that is precarious for the survival of the species.

Therefore, the species has met the relevant elements of Criterion 3 to make it eligible for listing as **Critically Endangered**.

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 km ² 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

Eligible under Criterion 4 D for listing as Critically Endangered

The Committee considers that the total number of mature individuals is 48 which is extremely low. Therefore, the species has met the relevant elements of Criterion 4 to make it eligible for listing as **D Critically Endangered**.

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 the species 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.

Adequacy of survey

The survey effort has been considered adequate and there is sufficient scientific evidence to support the assessment.

Listing and Recovery Plan Recommendations

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

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Cataloguing data

This publication (and any material sourced from it) should be attributed as: Department of Agriculture, Water and the Environment 2021, *Conservation advice for Eucalyptus imlayensis (Imlay mallee)*, Canberra.



This publication is available at the [SPRAT profile for *Eucalyptus imlayensis* \(Imlay mallee\)](#).

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Version history table

Document type	Title	Date [dd mm yyyy]
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