

Consultation on Species Listing Eligibility and Conservation Actions

Darwinia collina

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

- 1) the eligibility of *Darwinia collina* 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@awe.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 1 February 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/recovery-plans.

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: https://www.awe.gov.au/sites/default/files/env/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 <u>'Common Assessment Method' (CAM)</u>. 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 Darwinia collina (yellow mountain bell)

SECTION A - GENERAL

- 1. Is the information used to assess the nationally threatened status of the species 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? If so, in what capacity?

PART 1 – INFORMATION TO ASSIST LISTING ASSESSMENT

<u>SECTION B</u> DO YOU HAVE ADDITIONAL INFORMATION ON THE ECOLOGY OR BIOLOGY OF THE SPECIES? (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?

<u>SECTION C</u> ARE YOU AWARE OF THE STATUS OF THE TOTAL NATIONAL POPULATION OF THE SPECIES? (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? 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 (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 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:

□ <250 □ 250 − 1,000 □ 1,000 − 5,000 □ 5,000 − 10,000 □ >10,000

Level of your confidence in this estimate:

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

 \Box 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

<u>SECTION D</u> ARE YOU AWARE OF TRENDS IN THE OVERALL POPULATION OF THE SPECIES? (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 1980s *(at or soon after the start of the most recent three generation)*? 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 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:

□ <250 □ 250 − 1,000 □ 1,000 − 5,000 □ 5,000 − 10,000 □ >10,000

Level of your confidence in this estimate:

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

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

- \Box 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' total population size over the last approximately 39 to 40.5 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:

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

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

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

- \Box 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? (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? If not, please provide justification for your response.
- 14. Has the survey effort for this species 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:

 \Box <100 km² \Box 100 – 200 km² \Box 200 – 500 km² \Box >500 km²

Level of your confidence in this estimated extent of occurrence

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

 \Box 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:

 \Box <100 km² \Box 100 – 200 km² \Box 200 – 500 km² \Box >500 km²

Level of your confidence in this estimated extent of occurrence:

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

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

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

 \Box 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? (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:

 \Box <100 km² \Box 100 – 200 km² \Box 200 – 500 km² \Box >500 km²

Level of your confidence in this estimated extent of occurrence

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

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

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

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

 \Box 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:

 \Box <100 km² \Box 100 – 200 km² \Box 200 – 500 km² \Box >500 km²

Level of your confidence in this estimated extent of occurrence:

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

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

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

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

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

Threatened Species Scientific Committee

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? (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 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 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? (If no, skip to section I)

- 25. What planning, management and recovery actions are currently in place supporting protection and recovery of the species? 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?
- 27. Would you recommend translocation (outside of the species' historic range) as a viable option as a conservation actions for this species?

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

- 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 has?
- 30. What individuals or organisations are currently, or potentially could be, involved in management and recovery of the species?
- 31. How aware of this species are land managers where the species is found?

- 32. What level of awareness is there with individuals or organisations around the issues affecting the species?
 - 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?

Conservation Advice for Darwinia collina (yellow mountain bell)

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.

<u>Note</u>: 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 draft conservation advice and listing assessment for the species. It provides a foundation for conservation action and further planning.



Darwinia collina (yellow mountain bell) © Copyright S.D. Hopper and A.P. Brown; Western Australian Herbarium, Department of Biodiversity, Conservation and Attractions.

Conservation status

Darwinia collina (yellow mountain bell) 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.*

Darwinia collina was assessed by the Threatened Species Scientific Committee to be eligible for listing as Critically Endangered under Criterion 2. 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(i,ii,iii,iv,v)c(iv): Critically Endangered
- Criterion 3: C2b: Vulnerable
- Criterion 4: Ineligible
- Criterion 5: Insufficient data

The main factors that make the species eligible for listing in the Critically Endangered category are very restricted distribution and locations; continuing decline in extent of occurrence, area of occupancy, area, extent and quality of habitat, number of subpopulations and mature individuals; and extreme fluctuations 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 <u>Species Profile and Threat Database</u>.

Species information

Taxonomy

Conventionally accepted as Darwinia collina Gardner (1923).

Description

The yellow mountain bell (family Myrtaceae) is a dense, bushy shrub, which grows up to 1 m tall. The minutely toothed leaves are 1 cm long and 0.5 cm wide. The large, lemon-yellow bells are clusters of drooping flowers with white petals and stigmas up to 2 cm long, enclosed in yellow petal-like leaf bracts. The flowers may have a red tinge on Bluff Knoll/Bula Meela and Coyanarup Peak, Western Australia (WA). The fruits are brown and leathery when ripe. The yellow mountain bell can be distinguished from other mountain bells by its yellow bracts and more rounded bracts and leaves. Additionally, each mountain bell species has a distinct, well-defined distribution. The yellow mountain bell is known to hybridise with *Darwinia leiostyla* (common mountain bell).

This description is drawn from Rye & Hopper (1981), Keighery (1985), Hopper et al. (1990), Robinson & Coates (1995), Brown et al. (1998) and Cochrane (2013).

Distribution

Current distribution

The yellow mountain bell is endemic to the Stirling Range/Koikyenunuruff in the Esperance Plains bioregion (IBRA7) of WA. The species is part of the Eastern Stirling Range Montane Heath and Thicket Threatened Ecological Community, which is listed as Endangered under the EBPC Act and Critically Endangered under the WA *Biodiversity Conservation Act 2016* (DPAW 2016). The species is only known from four extant subpopulations on the summits and upper slopes of mountain peaks (750–1090 m above sea level (ASL)) at Bluff Knoll/Bula Meela (subpopulation 1), Coyanarup Peak (subpopulation 3), Bakers Knob (subpopulation 6A) and East Bluff (subpopulation 9) (Table 1) (Robinson & Coates 1995; Brown et al. 1998; Hartley & Barrett 2008). All other subpopulations are considered locally extinct (see below). The species' entire distribution occurs within reserved tenure in Stirling Range National Park (Hartley & Barrett 2008).

Past distribution

The yellow mountain bell was also historically recorded in six other subpopulations in the eastern extent of the Stirling Range/Koikyenunuruff on Ellen Peak (subpopulation 2), Moongoongoondurup Hill (subpopulation 4), Pyungoorup Peak (subpopulation 5), Saddle between Third Arrow and Bakers Knob (subpopulation 6B), Isongerup Peak (subpopulation 7) and Kyanorup Eminence (subpopulation 8) (Table 1) (Robinson & Coates 1995; Brown et al. 1998; Hartley & Barrett 2008). However, the species is now presumed to be locally extinct at these sites, as it has not been recorded since at least the 1990s (Table 1) (Hartley & Barrett 2008).

Biogeography

Mountain bells are a group of ten *Darwinia* species, nine of which (including the yellow mountain bell) occur in the Stirling Range/Koikyenunuruff and the adjacent Hamilla Hills (Hopkins et al. 1983; Keighery 2016). Each species has its own distinct and well-defined distribution (Hopkins et al. 1983; Keighery 2016). Taxonomic diversification of mountain bells in this region may have been facilitated by landscape dissection, climatic and microclimatic factors (Hopkins et al. 1983). Mountain bells may have contracted to wetter upland and gully refugia in response to drier conditions during the Holocene (Hopkins et al. 1983).

Translocations

Seedlings are being cultivated in translocations at two sites outside of Stirling Range National Park (DBCA 2021. pers comm 7 September).

| Subpopulation | Status | Survey Year | Number of mature individuals | Habitat condition | Main threats |
|----------------------|------------|----------------|------------------------------|-------------------|----------------|
| 1. Bluff Knoll/Bula | Extant | 1993 | (1000) | Recently burnt | Fire, disease, |
| Meela | | 1995 | >50 | Healthy | drought, |
| | | 1997 | >50 (>100) | Healthy | grazing, |
| | | 1999 | ~1000 | Healthy | recreation |
| | | 2000 | >500 | Poor | |
| | | 2001 | ~1000 (>100) | Healthy-Moderate | |
| | | 2003 | ~1000 (~100s) | Healthy | |
| | | 2004 | >500 (~1000) | Moderate | |
| | | 2008 | 1000 (1000) | | |
| | | 2011 | 1600 (4900) | | |
| | | 2014 | 2500 (4900) | | |
| | | 2015 | 2920 (4697) | | |
| | | 2016 | 3390 (2712) | | |
| | | 2017 | 2000 (2100) | | |
| | | 2018 | 2000 (1800) | | |
| | | 2020 | 120 (4300) | Recently burnt | |
| | | 2021 | 110 (6000) | Poor | |
| 2. Ellen Peak | Presumed | 1986 | Common | | Fire, disease |
| | extirpated | 1989 | >100 | | |
| | | 2004 | 0 (0) | - | |
| | | 2020 | 0 (0) | | |
| 3. Coyanarup Peak | Extant | 1990 | 100s | Drought-affected | Fire, disease, |
| | | 2004 | 1 (<50) | | drought, |
| | | 2005 | 1 (100) | | grazing |
| | | 2007 | 10 (150) | | |
| | | 2009 | 100 | | |
| | | 2011 | (150) | | |
| | | 2013 | 20 (100) | | |
| | | 2015 | 20 (180) | | |
| | | 2017 | 20 (100) | | |
| | | 2018 | 0 | | |
| | | 2019 | 0(1) | Recently burnt | |
| | | 2020 | 0 (250) | Poor | |
| | | 2021 | 0 (244) | Poor | |
| 4. Moongoongoondurup | Presumed | 1987 | ~100 | | Fire, disease |
| Hill | extirpated | 2004 | 0 (0) | - | |
| | | 2021 | 0 (0) | | |
| 5. Pyungoorup Peak | Presumed | 1979 | Common | Healthy | Fire, disease |
| | extirpated | 2003 | 0 (0) | - | |
| | | 2021 | 0 (0) | | |

Table 1 Summary of yellow mountain bell subpopulation information and threats inStirling Range National Park, Western Australia

| Subpopulation | Status | Survey Year | Number of mature individuals | Habitat condition | Main threats |
|------------------------|------------|----------------|------------------------------|-------------------|----------------|
| 6A. Bakers Knob A | Extant | 1986 | Common | Healthy | Fire, disease, |
| | | 1996 | >1000 | Healthy | grazing, |
| | | 1997 | >1000 | Healthy | recreation |
| | | 2004 | >10 (~10,000) | Healthy-Moderate | |
| | | 2009 | 2000 | | |
| | | 2014 | 2000 | | |
| | | 2017 | 4000 | | |
| | | 2019 | 2000 (10,440) | Recently burnt | |
| | | 2021 | 160 (26,000) | Poor | |
| | | 1989 | >100 | Healthy | |
| 6R Bakers Knoh B | Presumed | 1996 | 2100 0 (0) | - | |
| (Saddle between Third | extirpated | 2004 | 0 (0) | | |
| Arrow and Bakers Knob) | - | 2001 | 0 (0) | | |
| 7. Isongerup Peak | Presumed | 1979 | Common | Healthy | Fire, disease |
| | extirpated | 1997 | 0 (0) | - | |
| | | 2004 | 0 (0) | | |
| | | 2021 | 0 (0) | | |
| 8. Kyanorup Eminence | Presumed | 1990 | >200 | | Fire, disease |
| | extirpated | 2000 | 0 (0) | - | |
| 9. East Bluff | Extant | 1996 | (>1000) | Healthy | Fire, disease, |
| | | 2000 | ~200 | Moderate | drought, |
| | | 2004 | ~100 (~300) | Moderate | recreation |
| | | 2007 | 50 (300) | | |
| | | 2011 | 200 (150) | | |
| | | 2012 | 200 (200) | | |
| | | 2014 | 100 (200) | | |
| | | 2015 | >358 | | |
| | | 2016 | 200 (200) | | |
| | | 2017 | 200 (180) | | |
| | | 2018 | 0 | | |
| | | 2019 | 25 (300) | Recently burnt | |
| | | 2020 | 45 (700) | Poor | |
| | | 2021 | 45 (1000) | Poor | |

Note: Information is sourced from Hartley & Barrett (2008) and DBCA (2021). () = seedlings/juveniles; subpopulations which are presumed to be extirpated are italicised. Population estimates vary in their accuracy, particularly older estimates.





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 the 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). Specifically, the 'known and likely to occur' habitat has been restricted to areas with elevation > 500 m ASL; while the 'may occur' habitat encompasses all of Stirling Range National Park. This is a precautionary approach in line with the purpose of the mapping as indicative. 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 section describes some published examples of this significance but is not intended to be comprehensive, applicable to, or speak for, all Indigenous Australians. Such knowledge may be only held by Indigenous Australians who are the custodians of this knowledge.

The yellow mountain bell occurs on the traditional lands of the Ganeang, Goreng and Minang dialectals groups of the Noongar Nation. Koikyenunuruff (Stirling Range) is a culturally significant site to Noongar Peoples and features in Dreaming stories (DPAW 2016; South West Aboriginal Land & Sea Council 2020). Bula Meela (Bluff Knoll), where an extant subpopulation of the yellow mountain bell occurs, is the location where the spirits of Ganeang, Goreng and Minang Traditional Owners go after death (South West Aboriginal Land & Sea Council 2020). An Aboriginal Heritage Place, Kojaneerup (5145), has been registered with the Western Australian Department of Planning, Lands and Heritage in or adjacent to lands where the yellow mountain bell occurs (DPLH 2020). Additionally, the Wagyl Kaip & Southern Noongar Indigenous Land Use Agreements (2018), executed by the Western Australian Government and the Noongar Nation, includes lands in or adjacent to lands where the yellow mountain bell occurs.

Relevant biology and ecology

Habitat ecology

The yellow mountain bell is part of the Eastern Stirling Range Montane Heath and Thicket Threatened Ecological Community (DPAW 2016). The species occurs in dense, low heath and thicket in shallow, siliceous soils over sandstone, schist and shale on mountain summits and upper slopes (750–1090 m ASL) (Robinson & Coates 1995; Brown et al. 1998). Plants occur in dense subpopulations in open areas (Keighery & Marchant 1993). All known extant and presumed extirpated subpopulations are located within habitat significantly affected by *Phytophthora cinnamomi* dieback (CALM 1999; Hartley & Barrett 2008).

Reproductive ecology

The yellow mountain bell flowers from March–April and August–November (Rye & Hopper 1981; Hopper et al. 1990). The juvenile period of the yellow mountain bell is thought to be approximately 6–7 years (based on 50 percent flowering) (Barrett et al. 2009). However, browsing of seedlings and juveniles may significantly influence juvenile period and delay flowering and seed set (DBCA 2021. pers comm 28 September). Individuals in mountain bell populations are thought to decline 20 years after germination, as the surrounding vegetation becomes too dense for individuals to survive (Keighery & Marchant 1993).

Mountain bells are likely pollinated by nectar-feeding birds (Keighery & Marchant 1993). Flowers are brightly coloured and positioned so that birds can probe for nectar from the ground or when perched on the plant (Keighery & Marchant 1993).

Fire and disturbance ecology

The yellow mountain bell regenerates from seed following fire (Hartley & Barrett 2008). Mountain bell seeds have no specialised means of dispersal and remain stored in the soil below adult plants until fire triggers germination (Keighery & Marchant 1993).

As the mature plants of obligate-seeding species are usually killed by fire, they can undergo natural fluctuations in the number of mature individuals if subpopulations are exposed to the same fire event (Gill 1981). Accordingly, there must be sufficient intervals between fires for yellow mountain bell seedlings to reach maturity and replenish the seedbank (Keighery 1985; Brown et al. 1998; Hartley & Barrett 2008). A minimum fire-free interval may be estimated by a doubling of the primary juvenile period (Gill & Nicholls 1989), suggesting that 12–14 years is likely to be the minimum appropriate interval required by the yellow mountain bell.

However, obligate seed regenerators growing on exposed summits and plateaus (such as the yellow mountain bell) grow at extremely slow rates compared to plants growing at lower altitudes or in more sheltered areas and may actually require longer fire-free intervals (Barrett 2000). Many species in this habitat require a fire-free interval of at least 20 years (DBCA 2021. pers comm 28 September). Additionally, the drying climate will lengthen the minimum fire interval required for self-replacement of obligate seed regenerators, due to higher seedling mortality and slower growth resulting from changes in water availability (Enright et al. 2014). Following only 20 percent reduction in post-fire winter rainfall, the minimum fire interval for obligate seed regeneration is predicted to increase by 50 percent (Enright et al. 2014). Accordingly, the fire-free interval required by the yellow mountain bell is likely to be at least 20 years.

Habitat critical to the survival

The yellow mountain bell is part of the Eastern Stirling Range Montane Heath and Thicket Threatened Ecological Community (DPAW 2016). Due to the species' eligibility for listing (very restricted distribution), all habitat (described above) is considered critical to the survival of the species.

Habitat critical to the survival of the Eastern Stirling Range Montane Heath and Thicket Threatened Ecological Community (in which the yellow mountain bell occurs), comprises the area of occupancy of known occurrences; similar habitat adjacent to important occurrences (i.e., within approximately 200 m); and remnant vegetation that surrounds or links several occurrences (this is to provide habitat for pollinators or to allow them to move between occurrences) (DPAW 2016). Small pockets of the ecological community that are less extensively infested with *P. cinnamomi* (including but not limited to areas on Bluff Knoll, Coyanerup Peak, Bakers Knob and East Bluff) have been identified by DPAW (2016) as priority areas for maintaining or improving habitat condition. 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, in keeping with the terminology used in the EPBC Act and state/territory environmental legislation.

All populations of the yellow mountain bell are important for the conservation of the species across its range, because its limited dispersal capabilities mean local extinctions are not readily recolonised.

Threats

The yellow mountain bell is threatened by inappropriate fire regimes, disease, climate change, interactions with native species, habitat loss, disturbance and modification, and invasive species (Table 2). The species' small population size and restricted distribution may increase its' risk of extinction via stochastic processes, such as fire and disease.

| Threat | Status ^a | Evidence | | |
|--|---|--|--|--|
| Habitat loss, disturbance and modifications | | | | |
| Habitat loss, disturbance a Inappropriate fire regimes | Ind modifications Timing: current Confidence: observed Consequence: catastrophic Trend: increasing Extent: across the entire range | The yellow mountain bell is an obligate-seeder and regenerates from soil-stored seed following fire (Keighery & Marchant 1993; Hartley & Barrett 2008). As mature individuals are usually killed by fire, they can undergo natural fluctuations in the number of mature individuals if subpopulations are exposed to the same fire event (Keighery 1985; Brown et al. 1998; Hartley & Barrett 2008). So, a fire-free interval of at least 20 years is required for seedlings to reach maturity and replenish the seedbank in its low productivity habitat (see fire and disturbance ecology). Accordingly, the population size and vigour of the yellow mountain bell is likely to decline under a high-frequency fire regime (<20 years) (Brown et al. 1998; Hartley & Barrett 2008). By 2015, approximately 74% of the Eastern Stirling Range Montane Heath and Thicket Threatened Ecological Community had experienced short, nine-year fire intervals over the previous 50 years (Barrett & Yates 2015). In 2018, an escaped prescribed fire burnt 17,000 hectares in the eastern extent of Stirling Range National Park (OBRM 2018), including parts of all extant subpopulations of the yellow mountain bell (DBCA 2021, pers comm 3 September). In 2019-20, a bushfire burnt 40,000 hectares of the eastern extent of Stirling Range National Park (DAWE 2020; Todd & Maurer 2020), including subpopulation 1, 6A and 9 (Bluff Knoll/Bula Meela, Bakers Knob and East Bluff) (DBCA 2021, pers comm 3 September). Mature individuals and some seedlings (from the 2018 escaped prescribed fire) were killed by these fires (see Attachment A) (DBCA 2021, pers comm 3 September). Additionally, varying levels of seedling mortality have been recorded in all subpopulations after these fires (ue to the impacts of drought, competition, herbivory and/or disease (see Attachment A) (DBCA 2021, pers comm 3 September). The loss of seedling mortality have been recorded in all subpopulations after these fires (ue to the impacts of drought, competition, herbivory and/or disease (see Attachment A) (DBCA 2021 | | |
| | | tollowing fires in 2018 and 2019-20, will result in a net loss of mature individuals and increase the species' extinction risk. A high frequency fire regime can also reduce vegetation | | |
| | | cover, leading to increases in soil temperature from solar insolation and increases in surface or sub-surface flow on mountain slopes, which may exacerbate the impact and spread of <i>P. cinnamomi</i> (Barrett 2000; Moore et al. 2015). Fires can also alter habitat structure, by favouring the post-fire invasion and establishment of weeds (D'Antonio & Vitousek 1992; Grigulis et al. 2005). | | |

Table 2 Threats impacting the yellow mountain bell

| Threat | Status ^a | Evidence |
|--|--|---|
| Damage from recreational activities | Timing: current Confidence: inferred Consequence: minor Trend: static Extent: across part of its range | The mountain peaks of the eastern Stirling Range/ Koikyenunuruff attract visitors interested in bushwalking, nature observation and rock-climbing (Barrett 2000). All subpopulations of the yellow mountain bell are at risk of damage from recreational activities (Barrett et al. 2008). However, subpopulations 1, 6A and 9 (Bluff Knoll/Bula Meela, Bakers Knob and East Bluff) are at heightened risk, due to the popular 'Ridge Walk' from Ellen Peak to Bluff Knoll/Bula Meela via Bakers Knob, which dissects these subpopulations (Barrett 2000; DPAW 2016). |
| | | Recreational activities can result in the spread of <i>P. cinnamomi</i> , track-braiding, side path formation, path erosion, bare-ground occurrences, campfire remains, litter and increased soil fertility due to accumulation of human excreta (Hartley & Barrett 2008). Increased soil fertility could facilitate weed invasion (Specht 1963); however, this has had minor impacts to date in Stirling Range National Park and is presumed to be localised to camp areas (DPAW 2016). |
| | | Effective path drainage is important in the reduction of both erosion and the spread of <i>P. cinnamomi</i> (Watson & Passmore 1993). Soils are moist on the higher peaks for much of the year, particularly near mountain summits, and pooling of water can occur. Wet areas provide ideal sites for the transfer of <i>P. cinnamomi</i> through soil collected on walking boots (Gillen & Watson 1993). |

| Threat | Status ^a | Evidence |
|---|---|---|
| Myrtle rust (<i>Austropuccinia psidii</i>) | Status: future Confidence: inferred Consequence: major Trend: unknown Extent: across the entire range | Myrtle rust is a disease caused by the introduced fungal pathogen <i>A. psidii</i> , which affects the family Myrtaceae (Makinson et al. 2020). The myrtle rust pathogen is included in the 'Novel biota and their impact on biodiversity' key threatening process listed under the EPBC Act (DSEWPC 2013). In susceptible species, it infects young, actively growing foliage and can cause significant damage (including reduced reproductive capacity) and plant death (Makinson et al. 2020). Although not yet detected in WA, the pathogen is naturalized in eastern Australia from Cooktown to Batemans Bay (Makinson et al. 2020). Although the susceptibility of the yellow mountain bell has not been investigated, many <i>Darwinia</i> species are susceptible to myrtle rust (Makinson 2018). Additionally, the moist, Myrtaceae-rich communities in southern WA are considered to be at high risk of infection, if the pathogen spreads to this area (Kriticos et al. 2013). Accordingly, the species may be severely impacted if <i>A. psidii</i> spreads to the Stirling Range/Koikyenunuruff. |

| Threat | Status ^a | Evidence |
|---|---|---|
| Climate change | | |
| Increased temperatures and change to precipitation patterns | Timing: current Confidence: projected Consequence: major Trend: increasing | The unique mesic conditions on the mid- to upper slopes of the Stirling Range/Koikyenunuruff (high rainfall and low temperature) create refugia for specialised flora, such as the yellow mountain bell (Hartley & Barrett 2008). |
| | • Extent: across the entire range | In the twentieth century, south-western WA experienced a significant decrease in autumn and early winter rainfall and an increase in mean ambient temperatures (Bates et al. 2008; CSIRO & Bureau of Meteorology 2015). CSIRO & Bureau of Meteorology (2015) predict south-western WA will continue to experience decreased average rainfall, increased average temperatures and increased frequency of droughts. |
| | | The drier, hotter conditions associated with climate change are likely to reduce the area of mesic habitat available in the Stirling Range (Monks et al. 2019), thereby reducing habitat for the yellow mountain bell. Drought conditions from 2018-2020 resulted in hydraulic stress in mature plants and seedling death in subpopulations 1, 3 and 9 (Bluff Knoll/Bula Meela, Coyanarup Peak and East Bluff) (DBCA 2021. pers comm 3 September). |
| | | Drying climate will also lengthen the minimum fire interval required for self-replacement of obligate seed regenerators, due to higher seedling mortality and slower growth resulting from changes in water availability (Enright et al. 2014). Following only 20% reduction in post-fire winter rainfall, the minimum fire interval for obligate seed regeneration is predicted to increase by 50% (Enright et al. 2014). Given that fire frequency and severity are predicted to continue to increase due to climate change (Dowdy et al. 2019; Bureau of Meteorology & CSIRO 2020; van Oldenborgh et al. 2021), the species is likely to continue to decline as fire-free intervals continue to shorten (i.e., through interval squeeze) (Enright et al. 2015; Gallagher 2020; Gallagher et al. 2021). |
| | | Additionally, while average rainfall is predicted to decline, heavy rainfall events are predicted to become more intense (Bureau of Meteorology & CSIRO 2020). High rainfall from 1989-1993 exacerbated the impacts of <i>P. cinnamomi</i> and contributed to the extirpation of several subpopulations (Hartley & Barrett 2008). Similarly, high rainfall in 2021 is expected to exacerbate the impacts of <i>P. cinnamomi</i> following fires in 2018 and 2019-20 (DBCA 2021. pers comm 3 September) and may increase the risk of local extinction in all subpopulations. The impacts of <i>P. cinnamomi</i> are likely to continue to increase due to climate change (Thompson et al. 2014; Homet et al. 2019). Warmer temperatures and changes to precipitation |
| | | patterns may also favour the spread of some weed species (Scott et al. 2014). |

| Threat | Status ^a | Evidence | | | |
|---|---|---|--|--|--|
| Interactions with native species | | | | | |
| Browsing by <i>Setonix</i> brachyurus (quokka) | Timing: current Confidence: observed Consequence: major Trend: increasing Extent: across the entire range | Montane ecosystems are particularly vulnerable to herbivory by both feral and native animals (Leigh et al. 1987; Kirkpatrick & Bridle 1999; Bridle et al. 2001). Browsing by quokka is a threat to all subpopulations, with subpopulations 1, 3 and 9 (Bluff Knoll/Bula Meela, Coyanarup Peak and East Bluff) being the most impacted (Hartley & Barrett 2008; DBCA 2021. pers comm 3 September). Between 2011-2015, quokka were responsible for 75% of herbivory events on rare native plants in the Eastern Stirling Range Montane Heath and Thicket Threatened Ecological Community (Rathbone & Barrett 2017). Additionally, the yellow mountain bell was evident in 60% of quokka scats (Rathbone & Barrett 2017). | | | |
| | | From 2001, plant cages were installed around some yellow mountain bell plants in subpopulation 1 (Bluff Knoll/Bula Meela) to protect them from browsing, with significant recovery shown in caged plants (Rathbone & Spencer 2011). Between 2014-2015, ten fenced enclosures (25*25 m) were constructed around yellow mountain bell plants in subpopulations 1, 3 and 9 (Bluff Knoll/Bula Meela, Coyanarup Peak and East Bluff) (Rathbone & Barrett 2017). After one year, the size and reproductive output of plants inside enclosures was significantly higher than outside enclosures (Rathbone & Barrett 2017). This evidence suggests browsing reduces growth and reproduction, which in turn influences the length of the juvenile period (DBCA 2021. pers comm 28 September). Repeated browsing can result in plant mortality (DBCA 2021. pers comm 28 September). Accordingly, the quokka is likely to have a major impact on the yellow mountain bell. Quokka populations can increase following fire, due to increased fresh growth (their preferred food source) (Hayward 2005; Rathbone & Barrett 2017). This may increase browsing pressure on the yellow mountain bell and delay post-fire recovery (Rathbone & Barrett 2017). Further down development here installed | | | |
| | | 2017). Further fenced enclosures have been installed around plants in subpopulations 1, 3 and 9 (Bluff Knoll/Bula Meela, Coyanarup Peak and East Bluff) since the 2018 fire (DBCA 2021. pers comm 3 September). In 2020, monitoring commenced in this recently fenced and unfenced habitat to monitor growth and survival of juveniles that recruited after the 2018 fire (DBCA 2021. pers comm 11 May). Additionally, as a result of reduced vegetation cover, browsing by quokka may result in conditions more conducive to <i>P cinnamomi</i> (Barrett 2000) | | | |

| Threat | Status a | Evidence | | | |
|--|--|--|--|--|--|
| Invasive species | | | | | |
| Weed invasion | Timing: future Confidence: projected Consequence: moderate Trend: static Extent: across the entire range | Weed species may outcompete native flora and can adversely impact conservation objectives (CALM 1999). Ninety-three weed species have been recorded in Stirling Range National Park, but they are mostly confined to road verges, amenity areas and some drainage lines (CALM 1999). As weeds most commonly become established in areas of disturbance, recreational activities may facilitate the spread and establishment of weeds. Control of weeds entering the Park along roads and boundaries, as well as weed hygiene within the Park are required to prevent further weed invasion and establishment (CALM 1999). Additionally, with ongoing climate change, weed species in the lowlands may rapidly move upwards and threaten mountain ecosystems (Petitpierre et al. 2016). Although weed invasion is not considered a current threat to the yellow mountain bell, it may become a threat in the future, if not appropriately managed (CALM 1999). | | | |
| Grazing by rabbits (<i>Oryctolagus cuniculus</i>) | Timing: current Confidence: inferred Consequence: minor Trend: unknown Extent: across the entire range | Grazing by rabbits is a threat to all subpopulations, with subpopulations 1, 3 and 9 (Bluff Knoll/Bula Meela, Coyanarup Peak and East Bluff) being the most impacted (Hartley & Barrett 2008; DBCA 2021. pers comm 3 September). However, between 2011-2015, rabbits were infrequently observed to graze on rare native plants in the Eastern Stirling Range Montane Heath and Thicket Threatened Ecological Community (Rathbone & Barrett 2017). Additionally, the yellow mountain bell was not detected in any rabbit scats (Rathbone & Barrett 2017). This evidence suggests rabbits may have a minor impact on the yellow mountain bell. Rabbit control using 1080 (sodium monofluoroacetate) oats was trialled in 2001 and implemented annually from 2008 to 2015 in subpopulations 1 and 9 (Bluff Knoll/Bula Meela and East Bluff) (DPAW 2016). Calicivirus RH DV1-K5 has been released in subpopulations 1 and 9 (Bluff Knoll/Bula Meela and East Bluff) since 2017 (DBCA 2021. pers comm 3 September). Rabbits were evident in regenerating vegetation in the Eastern Stirling Range Montane Heath and Thicket Threatened Ecological Community after a bushfire in 2000 (Rathbone & Barrett 2017). Grazing pressure on | | | |
| | | 2000 (Rathbone & Barrett 2017). Grazing pressure on the yellow mountain bell may increase following fire and delay post-fire recovery (Rathbone & Barrett 2017). Additionally, as a result of reduced vegetation cover, grazing by rabbits may result in conditions more | | | |

| Threat | Status ^a | Evidence |
|---|---|---|
| Hybridisation | | |
| Hybridisation with the common mountain bell | Timing: current Confidence: observed Consequence: unknown Trend: static Extent: across the entire range | The yellow mountain bell is known to hybridise with the common mountain bell (Robinson & Coates 1995). These species co-occur on two summits, Bluff Knoll/Bula Meela and Bakers Knob, noting that the common mountain bell also occurs on other mountain summits and valleys in the Stirling Range/Koikyenunuruff (Western Australian Herbarium 1998; AVH 2020). Hybridisation may increase genetic diversity and |
| | | viability (genetic rescue) of the yellow mountain bell (Whiteley et al. 2015). However, hybridisation could also drive the species to extinction via genetic swamping, where it is replaced by hybrids, or demographic swamping, where population numbers decline due to outbreeding depression (Rhymer & Simberloff 1996; Wolf et al. 2001; Todesco et al. 2016). |
| | | Narrow-range endemic species are particularly vulnerable to extinction following hybridisation (Wolf et al. 2001; Whiteley et al. 2015), so hybridisation with the common mountain bell could threaten the yellow mountain bell. However, as both species are endemic and co-occurring, hybridisation may have limited consequences for the yellow mountain bell. This threat should be investigated in more detail. |

^aTiming—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.

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

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 3 Yellow mountain bell risk matrix

| Likelihood | Consequences | | | | |
|----------------|-----------------|---|---------------------------------------|--|---|
| | Not significant | Minor | Moderate | Major | Catastrophic |
| Almost certain | Low risk | Moderate risk | Very high risk | Very high risk Increased temperatures and change to precipitation patterns Browsing by quokka | Very high risk Dieback caused by <i>P.</i> <i>cinnamomi</i> |
| Likely | Low risk | Moderate risk Damage from recreational activities` | High risk | Very high risk | Very high risk Inappropriate fire regimes |
| Possible | Low risk | Moderate risk Grazing by rabbits | High risk | Very high risk Myrtle rust | Very high risk |
| Unlikely | Low risk | Low risk | Moderate risk Weed invasion | 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 extirpation/extinction

Note: Hybridisation with the common mountain bell has not been included in Table 3 as the consequences are unknown.

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 a watching brief.

Conservation and recovery actions

Primary conservation objective

Within the next three generations, the population of the yellow mountain bell will have increased in abundance and EOO/AOO will have increased or remained stable.

Conservation and management priorities

Fire

- Ensure that planned burns do not occur in areas occupied by the yellow mountain bell before an accumulation of a seedbank large enough to replace the number of fire-killed standing plants.
- Develop and implement an evidence-based fire management strategy that optimises the survival of the species during planned burns and bushfires. Avoid planned burns and control the impacts of herbivory in recently burnt habitat.
- Provide maps of known occurrences to fire services and seek inclusion of mitigation measures in fire risk management plan/s, risk register and/or operation maps.

Disease

- Implement a hygiene management plan and risk assessment to protect known subpopulations from introduction of new isolates of *P. cinnamomi* or other pathogens. This may include but is not limited to:
 - Ensure contaminated water and/or soil are not introduced into the area for firefighting, track maintenance, infrastructure development or revegetation activities, e.g., ensure all nursery propagation is through disease accredited production facilities.
 - Ensure appropriate phyto-hygiene protocols are adhered to when entering or exiting known localities of the Yellow Mountain Bell, such as those outlined in Podger et al. (2001).
- Implement mitigation measures in areas that are known to be infected by *P. cinnamomi*, e.g., appropriate application of phosphite, until alternative disease treatments are developed. In order to minimise potential off-target impacts that may result from the build-up of phosphorus in low-nutrient soils (Lambers et al. 2013; Hopper et al. 2021), ensure that applications of phosphite are highly localised where possible.
- Ensure strict quarantine measures are in place to ensure *A. psidii* does not spread to WA, such as those outlined in Makinson & Olde (2020), supplemented where appropriate (due to low seed outputs and/or lack of germinability in seed) by cutting propagation.

Climate change and severe weather

• Map all habitat that would be suitable for this species currently and under climate change scenarios, and investigate the establishment of translocated subpopulations in suitable climate refugia.

Interactions with native species

• Implement browsing management actions, in consultation with land managers and community groups, to reduce the impacts of quokka on the Yellow Mountain Bell, e.g., maintain existing fenced enclosures around plants and establish new ones as required.

Habitat loss, disturbance and modifications

- Avoid or minimise further loss and fragmentation of habitat.
- Prevent further habitat degradation from recreational activities, e.g., avoid disturbances to native vegetation and soil, apply recommended buffer zones around the Yellow Mountain Bell, and control run-off from tracks.

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

- Implement weed management actions in consultation with land managers and community groups, using appropriate techniques to minimise the effect of herbicide on native vegetation, according to the Australian Weeds Strategy 2017-2027 (IPAC 2016).
- Implement management actions for rabbits, in consultation with land managers and community groups, as detailed in the relevant threat abatement plan (DOEE 2016).

Ex situ recovery actions

- To manage the risk of losing genetic diversity, undertake appropriate seed collection and storage, and determine the viability of stored seeds, according to Martyn Yenson et al. (2021).
- Continue cultivation of seedlings in translocation sites outside Stirling Range National Park. If required, investigate the possibility of establishing additional translocated subpopulations (Commander et al. 2018) in areas free from *P. cinnamomi*.
- Investigate the possibility of reinforcement translocation at extinct or extant populations.

Stakeholder engagement/community engagement

- Engage and involve Traditional Owners in conservation actions, including the implementation of Indigenous fire management practices and other survey, monitoring 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.

Survey and monitoring priorities

- Undertake annual monitoring of habitat condition/degradation (including impacts from herbivores, weed invasion and diseases, such as *P. cinnamomi*), population stability (expansion or decline), pollination activity, seed production, recruitment and longevity.
- Continue to monitor and evaluate the effectiveness of disease and herbivore management.
- Monitor the size, structure and reproductive status of subpopulations at different stages in the fire cycle, taking opportunities to monitor after planned and unplanned fires (where they occur) and improve understanding of the fire response of the species.

Information and research priorities

- Investigate options for linking, enhancing or establishing additional subpopulations.
- Survey habitat to locate any additional subpopulations/occurrences/remnants to assess population size and distribution more precisely.
- Map habitat critical to the survival of the species and identify any critical habitat on Commonwealth land.
- Promote research and development of alternative treatments of *P. cinnamomi* and the disease it causes, in order to reduce potential off-target impacts caused by the application of phosphite.
- Investigate the ecological requirements of the Yellow Mountain Bell, that are relevant to persistence, including:
 - population genetic structure, levels of genetic diversity and minimum viable population size,
 - soil seed bank dynamics and the role of various disturbances (including fire), competition, rainfall and grazing in germination and recruitment,
 - reproductive strategies, phenology and seasonal growth,
 - the effects of hybridisation with the Common Mountain Bell, and
 - pollinator biology and requirements.
- Avoid any use of managed fire research and other activities that impact upon the persistence of the species, unless there is evidence to show there would be a positive and enduring effect on the species' persistence.
- Ascertain the cultural significance of the species to Traditional Owners.

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.

Links to relevant implementation documents

Declared rare and poorly known flora in the Albany district, Western Australian wildlife management program no. 20 (1995)

Montane heath and thicket of the south west botanical province, above approximately 900 m above sea level (Eastern Stirling Range Montane Heath and Thicket Community) 2016 – 2021 (2016)

Threat abatement plan for competition and land degradation by rabbits (2016)

<u>Threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* (2018)</u>

Yellow mountain bell (Darwinia collina) recovery plan (2008)

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THREATENED SPECIES SCIENTIFIC COMMITTEE

Established under the Environment Protection and Biodiversity Conservation Act 1999

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

Attachment A: Listing Assessment for Darwinia collina

Reason for assessment

The yellow mountain bell 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 <u>EPBC Regulations</u>. The thresholds used correspond with those in the <u>IUCN Red List criteria</u> except where noted in Criterion 4, subcriterion 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.

| Metric | Estimate used in the assessment | Minimum plausible value | Maximum plausible value | Justification |
|------------------------------------|---------------------------------------|-------------------------------|-------------------------------|--|
| Number of mature individuals | <6220 | 315 | 6220 | The yellow mountain bell undergoes natural fluctuations in the number of mature individuals, as mature individuals are killed following fire and germination of dormant seeds is stimulated (Hartley & Barrett 2008; DBCA 2021). |
| | | | | The minimum estimate of the number of mature individuals is the 2021 post-fire estimate (DBCA 2021); the maximum estimate is the 2017 pre-fire estimate (DBCA 2021). |
| | | | | The estimate used in this assessment is <6220 mature individuals (i.e., less than estimated number of mature individuals in 2017), as a net loss of mature individuals is projected, due to the ongoing impacts of inappropriate fire regimes, dieback caused by <i>Phytophthora cinnamomi</i> , altered rainfall patterns and browsing on seedling survival (see Criterion 2 for further information) (DBCA 2021. pers comm 3 September). |
| Trend | Declining | | | A net loss of mature individuals is projected, due to the ongoing impacts of inappropriate fire regimes, dieback caused by <i>P. cinnamomi</i> , altered rainfall patterns due to climate change and browsing on seedlings following fires in 2018 and 2019-20 (see Criterion 2 for further information) (DBCA 2021. pers comm 3 September). |
| Generation time (years) | 13-13.5 years | Unknown | Unknown | The species is likely to have a generation time of approximately 13-13.5 years (see Criterion 1). |

Table 4 Key assessment parameters

| Metric | Estimate used in the assessment | Minimum plausible value | Maximum plausible value | Justification |
|----------------------------------|---------------------------------------|---|-------------------------------|--|
| Extent of Occurrence (EOO) | 20 km ² | =A00 =20 km ² (originally 7 km ²) | 51 km ² | The minimum plausible value has been calculated using record data from 1996-2019 for extant subpopulations and applying the smallest polygon boundary which can be drawn to encompass these records, as outlined in the Guidelines for Using the IUCN Red List Categories and Criteria (IUCN 2019). As EOO was smaller than AOO, the AOO estimate was also used as the minimum EOO estimate (IUCN 2019). The maximum plausible value is an estimate based on a minimum convex polygon encompassing all cleaned occurrence data associated with herbarium specimens for the species from 1950-2020, as used in the Gallagher (2020) rapid assessment of the impacts of the 2019-20 fire season on the Australian flora. The minimum plausible value was used in this assessment, as the maximum plausible value includes records of subpopulations that are now locally extinct. All values are within the range of the Critically Endangered category of Criterion 2. |
| Trend | Contracting | | | Six subpopulations (subpopulations 2, 4, 5, 6B, 7 and 8) are presumed to be locally extinct since the 1990s, due to the combined impacts of inappropriate fire regimes, dieback caused <i>P.</i> <i>cinnamomi</i> and high rainfall (exacerbating the impacts of <i>P. cinnamomi</i>) (Hartley & Barrett 2008; DBCA 2021). The very low number of mature individuals in 2021 (<100 in each subpopulation, DBCA 2021) is likely to increase each subpopulation's extinction risk, following further impacts from these threats. In particular, subpopulation 3 (Coyanarup Peak) appears to be at extreme risk of extinction, as no mature individuals and only a small number of seedlings (<300) were present in 2021 (DBCA 2021). Accordingly, EOO is considered to be contracting and is likely to continue to decline. |
| Area of Occupancy (AOO) | 20 km ² | 12 km ² | 20 km ² | The minimum plausible value is an estimate based on applying 2 x 2 km grid cells, as outlined in the Guidelines for Using the IUCN Red List Categories and Criteria (IUCN 2019), to occurrence information accompanying herbarium specimens for the species used in the Gallagher (2020) rapid assessment. The maximum plausible value has been calculated using record data from 1996-2019 for extant subpopulations and applying 2 x 2 km grid cells, as outlined in the Guidelines for Using the IUCN Red List Categories and Criteria (IUCN 2019). The maximum plausible value has been used in this assessment, as it includes all extant records. All values are within the range of the Endangered category of Criterion 2. |

| Metric | Estimate used in the assessment | Minimum plausible value | Maximum plausible value | Justification | |
|--|--|------------------------------------|-----------------------------------|--|--|
| Trend | Contracting | | | Using the same reasoning as EOO (above), AOO is considered to be contracting and is likely to continue to decline. | |
| Number of subpopulations | 4 | 4 | 4 | There are 4 extant subpopulations. A further 6 subpopulations are presumed to be extirpated. | |
| | | | | For further information, see 'Basis of assessment of subpopulation number'. | |
| Trend | Declining | | | Using the same reasoning as EOO (above), the number of subpopulations is considered to be declining. | |
| Basis of assessment of subpopulation number | Each subpopu Range/Koikye | llation occurs o enunuruff (DPI | n a different m E 2021) and ge | ountain summit in the eastern extent of the Stirling ne flow is presumed to be limited. | |
| No. locations | 1 | 1 | 1 | At the time of this assessment (in 2021), approximately 99% of individuals were juveniles (DBCA 2021), and the seedbank may be depleted, following two fires in short succession in 2018 and 2019-20 within a restricted area of the Stirling Range/Koikyenunuruff. | |
| | | | | If another threatening event (e.g., fire) were to occur within the next 20 years (i.e., the minimum fire-free interval required by the species), almost all individuals would be at high risk of poor recovery and there may not be sufficient seed in the seedbank to replenish the population. | |
| | | | S | As all subpopulations were impacted by the 2018 escaped prescribed fire, it is feasible for a single fire to affect the species' entire distribution. Accordingly, only a single threatening event (e.g., fire) would be required within the next 20 years for all individuals to be rapidly affected. Accordingly, one location has been used in this accordingly. | |
| Trend | Stable One location has been used in this assessment, it is not possible for the number of locations to decline any further. However, the intensity, frequency and scale of catastrophic bushfires v likely increase due to climate change. | | | One location has been used in this assessment, so it is not possible for the number of locations to decline any further. However, the intensity, frequency and scale of catastrophic bushfires will likely increase due to climate change. | |
| Basis of assessment of location number | See justification for number of locations. | | | | |
| Fragmentation | The species is not considered to be severely fragmented. The species occurs within a very restricted distribution in the Stirling Range/Koikyenunuruff (see EOO/AOO and Map 1). Over 50% of the species' AOO occurs in habitat patches that can support a viable population. | | | | |
| Fluctuations | In each extant subpopulation of the yellow mountain bell, the number of mature individuals has increased and decreased by at least one order of magnitude, i.e., undergone extreme fluctuations (Figure 2) (Hartley & Barrett 2008; DBCA 2021). Such fluctuations represent change in the total population (rather than a flux of individuals between different life stages), because all subpopulations were impacted by the same fire events, which occurred within a restricted area of the Stirling Range/Koikyenunuruff (so there are no demographic differences in age-classes among subpopulations), and dormant life stages (i.e., soil-stored seeds) may have been depleted during fires. | | | | |

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 | Enda Seve | ngered re reduction | | Vulnerable Substantial reduction |
| A1 | | ≥ 90% | ≥ 70% | б | | ≥ 50% |
| A2, A | 3, A4 | ≥ 80% | ≥ 50% | б | | ≥ 30% |
| A1 A2 | Population reduction observed, estimat past and the causes of the reduction are understood AND ceased. Population reduction observed, estimat past where the causes of the reduction be understood OR may not be reversible | ed, inferred or suspected in e clearly reversible AND ed, inferred or suspected in may not have ceased OR ma e. | n the n the ny not | | (a) (b) (c) | direct observation [except A3] an index of abundance appropriate to the taxon a decline in area of occupancy, extent of occurrence and/or quality of habitat |
| A3 A4 | Population reduction, projected or susp to a maximum of 100 years) [(<i>a</i>) cannot An observed, estimated, inferred, projec reduction where the time period must i future (up to a max. of 100 years in futur reduction may not have ceased OR may | bected to be met in the futur t be used for A3] cted or suspected populatio nclude both the past and th ure), and where the causes of not be understood OR may | re (up n e of not | Based on any of the following | (d) (e) | actual or potential levels of exploitation the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites |
| | be reversible. | | | | | |

Criterion 1 evidence

Insufficient data to determine eligibility

Generation time

The juvenile period of the yellow mountain bell is thought to be approximately 6–7 years (based on 50 percent flowering) (Barrett et al. 2009). The health of mountain bells is thought to decline 20 years after germination (Keighery & Marchant 1993). Accordingly, generation time is likely to be:

Generation time = age of first reproduction + [0.5 * (length of reproductive period)]Generation time = 6 + [0.5 * (20 - 6)] = 13 years

OR

Generation time = 7 + [0.5 * (20 - 7)] = 13.5 years

This gives an estimated three-generation period of approximately 39–40.5 years.

Past population reduction

No monitoring data is available prior to the early 1990s, so population trends prior to this time are considered data deficient.

Since the early 1990s (approximately 30 years ago), six subpopulations are presumed to have gone extinct (Hartley & Barrett 2008; DBCA 2021), suggesting population reduction over this time. However, given that the yellow mountain bell undergoes natural fluctuations in the number of mature individuals (Hartley & Barrett 2008; DBCA 2021), the data available for these six subpopulations are not adequate for assessing population reduction (resulting from these extirpations). Although some monitoring data are available for these subpopulations (Table 1), there are not sufficient data to compare population minima/maxima with subsequent population minima/maxima.

There are sufficient monitoring data available for all four extant subpopulations (Table 1) to allow comparison between population minima/maxima (Figure 1A-D) (Hartley & Barrett 2008; DBCA 2021). However, older estimates are less reliable and may underestimate population size, particularly as several subpopulations occur in remote areas. Despite this, the number of mature individuals has clearly undergone large fluctuations (i.e., increased and decreased) in all extant subpopulations (Figure 1A-D) (Hartley & Barrett 2008; DBCA 2021). When comparing the last population minima to the current population minima, there appears to be no substantial population reduction in any extant subpopulations, except subpopulation 3 (Figure 1A-D) (Table 4), noting that some older estimates may be underestimates. The reduction in subpopulation 3 (from 1 to 0 mature individuals) is overinflated due to the very small size of this subpopulation and does not substantially reduce the total population size (Table 2). Given the evidence presented above, the species appears to be ineligible for listing under A1 or A2 (past reduction).



Figure 1 Number of mature individuals by year (1990–2021) in extant subpopulations of the yellow mountain bell

Note: The number of mature individuals is sourced from Hartley & Barrett (2008) and DBCA (2021); and is presented in Table 1. Where '>' or '~' is included in the estimate in Table 1, the minimum value has been graphed. The minimum assessment period for this species (for A1 & A2) is 2006-2021. * denotes the population minima. Population estimates vary in their accuracy in particular older estimates.

| Table 5 Population change in | extant subpopulations | of the yellow mountai | in bell between |
|---------------------------------|-----------------------|-----------------------|-----------------|
| the last and current population | on minima | | |

| Subpopulation | Last population minima (# mature individuals) | Current population minima (# mature individuals) | Population change (%) |
|---|--|---|--------------------------|
| Subpopulation 1 (Bluff Knoll/Bula Meela) | >50 (1997) | 110 (2021) | +120 |
| Subpopulation 3 (Coyanarup Peak) | 1 (2005) | 0 (2021) | -100 |
| Subpopulation 6A (Bakers Knob A) | >10 (2004) | 160 (2021) | +1500 |
| Subpopulation 9 (East Bluff) | 50 (2007) | 45 (2021) | -10 |
| Total | 111 | 315 | +184 |

Note: The number of mature individuals is sourced from Hartley & Barrett (2008) and DBCA (2021). Population estimates vary in their accuracy in particular older estimates.

Future population reduction

In 2018, an escaped prescribed burn burnt 17,000 hectares in the eastern extent of Stirling Range National Park (OBRM 2018), including parts of all extant subpopulations of the yellow mountain bell (DBCA 2021. pers comm 3 September). In 2019-20, a bushfire burnt 40,000 hectares of the eastern extent of Stirling Range National Park (DAWE 2020; Todd & Maurer 2020), including additional parts of subpopulation 1, 6A and 9 (Bluff Knoll/Bula Meela, Bakers Knob and East Bluff) (DBCA 2021. pers comm 3 September). Therefore, all subpopulations were burnt by fires in either 2018 or 2019-20 (approximately 95 percent of mature individuals), with small parts of subpopulation 1, 6A and 9 (Bluff Knoll/Bula Meela, Bakers Knob and East Bluff) burnt by both fires (DBCA 2021. pers comm 3 September).

The yellow mountain bell undergoes natural fluctuations in the number of mature individuals, characterised by the death of mature individuals and recruitment of seedlings (Hartley & Barrett 2008; DBCA 2021). However, during the 2019-20 fire, some areas of seedlings that had emerged following the 2018 fire in subpopulations 6A and 9 (Bakers Knob and East Bluff) were killed (DBCA 2021. pers comm 3 September). Following the 2019-20 bushfires, germination has been patchy, with no recruitment in some parts of subpopulation 9 (East Bluff) (DBCA 2021. pers comm 3 September). Varying levels of seedling mortality have been observed in all subpopulations, particularly in the summer 2019/20 due to the interacting impacts of drought, competition, herbivory and/or disease (DBCA 2021. pers comm 3 September). Further seedling deaths are expected during the spring/summer of 2021-22, as high rainfall in the winter of 2021 is likely to exacerbate the impacts of *P. cinnamomi* (DBCA 2021. pers comm 3 September).

The loss of seedlings, following fires in 2018 and 2019-20, will result in a net reduction of mature individuals. The net reduction of mature individuals is projected to increase over the next decade, due to ongoing impacts of inappropriate fire regimes, dieback caused *P. cinnamomi*, altered rainfall patterns (causing both increased time in drought & high rainfall exacerbating the impacts of *P. cinnamomi*) and browsing by quokka. However, the rate of this decline is unknown. As such, there appears to be is insufficient evidence to consider the species under A3 or A4 (future reduction).

Conclusion

There are insufficient data to demonstrate if the species is eligible for listing 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/C |)R |
|---|----|
| 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 km² | |
| AND | at least 2 of the following 3 conditi | ons: | | | |
| (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) | (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(i,ii,iii,iv,v)c(iv) for listing as Critically Endangered

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

The EOO and AOO are estimated at 20 km². These figures are based on the mapping of point records from 1996–2019, obtained from state governments, museums and CSIRO. The AOO was calculated using a 2 x 2 km grid cell method (IUCN 2019). As EOO was smaller than AOO, the AOO estimate was also used as the EOO estimate in this assessment (see Table 4) (IUCN 2019).

The species' EOO appears to meet the requirements for listing as Critically Endangered under B1 (<100 km²). The species' AOO appears to meet the requirements for listing as Endangered under B2 (<500 km²).

Number of locations

As described in Criterion 1, all subpopulations were impacted by fires in either 2018 or 2019-20, with small parts of subpopulations 1, 6A and 9 (Bluff Knoll/Bula Meela, Bakers Knob and East Bluff) burnt by both fires (DBCA 2021. pers comm 3 September). Accordingly, at the time of this assessment (in 2021), approximately 99 percent of individuals were juveniles (approximately 33,200 individuals) (DBCA 2021), which are incapable of replenishing the seedbank until mature (6–7 years post-germination). Additionally, the species may have a depleted seedbank due to the scale of the 2018 and 2019-20 fires. In species with soil-stored seedbanks, there may be little to no residual soil-stored seedbank following fire (Auld & Denham 2006) and the size of the residual soil-stored seedbank declines with increasing fire severity (Palmer et al. 2018).

If another threatening event (e.g., fire) were to occur within the next 20 years (i.e., the minimum fire-free interval required by the species) across all subpopulations, almost all individuals would be at high risk of death or poor recovery and there may not be sufficient seed in the seedbank to replenish the population. As all subpopulations were impacted by the 2018 escaped prescribed fire, it is feasible for a single fire to affect the species' entire distribution. Accordingly, only a single threatening event (e.g., fire) would be required within the next 20 years for all individuals to be rapidly affected.

The number of locations used in this assessment is one. The species' number of locations appears to meet the requirement for listing as Critically Endangered under this criterion.

Severe fragmentation

The yellow mountain bell is not considered to be severely fragmented. Although subpopulations occur on different mountain summits, more than 50 percent of its total AOO is in habitat patches that are (1) larger than would be required to support a viable population, and (2) separated from other habitat patches by a small distance, relative to its dispersive potential.

The species does not appear to meet the severe fragmentation requirement for listing under this criterion.

Continuing decline (EOO, AOO and number of subpopulations)

Six subpopulations of the yellow mountain bell (subpopulations 2, 4, 5, 6B, 7 and 8) are presumed to be locally extinct since the 1990s, due to the combined impacts of inappropriate fire regimes, dieback caused *P. cinnamomi* and high rainfall (exacerbating the impacts of *P. cinnamomi*) (Hartley & Barrett 2008; DBCA 2021). Accordingly, the EOO, AOO and number of subpopulations of the yellow mountain bell have declined since 1990.

The very low number of mature individuals in 2021 (<100 in each subpopulation, DBCA 2021) is likely to increase each subpopulation's extinction risk, following further impacts from threats, such as inappropriate fire regimes and dieback caused *P. cinnamomi*. In particular, subpopulation 3 (Coyanarup Peak) appears to be at extreme risk of extirpation, as no mature individuals and only a small number of seedlings (<300) were present in 2021 (DBCA 2021). This suggests that EOO, AOO and number of subpopulations will continue to decline.

The species appears to be undergoing continuing decline in EOO, AOO and number of subpopulations. Accordingly, the species appears to meet the continuing decline requirement for listing under this criterion.

Continuing decline (number of mature individuals)

As described in Criterion 1, all subpopulations were impacted by fires in either 2018 or 2019-20, with small parts of subpopulation 1, 6A and 9 (Bluff Knoll/Bula Meela, Bakers Knob and East Bluff) burnt by both fires (DBCA 2021. pers comm 3 September). Approximately 95 percent of mature individuals were burnt across the four extant subpopulations by either the 2018 or 2019-20 fires (DBCA 2021. pers comm 3 September).

The yellow mountain bell undergoes natural fluctuations in the number of mature individuals, characterised by the death of mature individuals and recruitment of seedlings (Hartley & Barrett 2008; DBCA 2021). During the 2019-20 fire, some areas of seedlings that had emerged following the 2018 fire in subpopulations 6A and 9 (Bakers Knob and East Bluff) were killed (DBCA 2021. pers comm 3 September). Following the 2019-20 bushfires, germination has been patchy, with no recruitment in some parts of subpopulation 9 (East Bluff) and varying levels of seedling mortality in all subpopulations, due to the interacting impacts of drought, competition, herbivory and/or disease (DBCA 2021. pers comm 3 September). Further seedling deaths are expected during the spring/summer of 2021-22, as high rainfall in the winter of 2021 is likely to exacerbate the impacts of *P. cinnamomi* (DBCA 2021. pers comm 3 September).

The loss of seedlings, following fires in 2018 and 2019-20, will result in a net loss of mature individuals. The loss of mature individuals is projected to continue, due to ongoing impacts of inappropriate fire regimes, dieback caused *P. cinnamomi*, altered rainfall patterns (causing both increased time in drought & high rainfall exacerbating the impacts of *P. cinnamomi*) and browsing by quokka.

The species appears to be undergoing continuing decline in the number of mature individuals. Accordingly, the species appears to meet the continuing decline requirement for listing under this criterion.

Continuing decline (area, extent and/or quality of habitat)

The species' habitat is impacted by ongoing threats, including inappropriate fire regimes and *P. cinnamomi*, increased temperatures and changes to precipitation patterns (causing both increased time in drought & high rainfall exacerbating the impacts of *P. cinnamomi*) and browsing by quokka (reducing vegetation cover and resulting in conditions more conducive to *P. cinnamomi*) (see Table 2 for impact of threats on habitat), which are likely to cause continuing decline in the area, extent and/or quality of the species' habitat.

The species appears to be undergoing continuing decline in the area, extent and/or quality of habitat. Accordingly, the species appears to meet the continuing decline requirement for listing under this criterion.

Extreme fluctuations

Extreme fluctuations represent changes in the total population (rather than a flux of individuals between different life stages), which exceed one order of magnitude (IUCN 2019). Extreme fluctuations can be diagnosed by interpreting population trajectories which show a recurring pattern of increases and decreases; or by using life history characteristics (IUCN 2019).

In each extant subpopulation of the yellow mountain bell, the number of mature individuals has increased and decreased by at least one order of magnitude, i.e., undergone extreme fluctuations, since regular monitoring commenced in 1990 (Table 1, Figure 2) (Hartley & Barrett 2008; DBCA 2021). Although older estimates are less reliable and may underestimate population size, extreme fluctuations were observed (i.e., the number of mature individuals decreased by at least one order of magnitude) in all subpopulations following the 2018 and/or 2019-20 fires (Table 1, Figure 2). This suggests that extreme fluctuations are linked to the species' life history (i.e. mature individuals are killed and germination of dormant seeds is stimulated following fire; Hartley & Barrett 2008; DBCA 2021). Although extreme fluctuations were not obvious following fires in 1991 and 2000 (Table 1, Figure 2), monitoring was not conducted consistently until ~2011 (DBCA 2021), so there are large data gaps obscuring population trends.

Such fluctuations represent change in the total population (rather than a flux of individuals between different life stages), because all subpopulations were impacted by the same fire events, which occurred within a restricted area of the Stirling Range/Koikyenunuruff (so there are no demographic differences in age-classes among subpopulations), and dormant life stages (i.e., soil-stored seeds) may have been depleted. In species with soil-stored seedbanks, there may be little to no residual soil-stored seedbank following a single fire (Auld & Denham 2006) and the size of the residual soil-stored seedbank declines with increasing fire severity (Palmer et al. 2018).



Figure 2 Number of mature individuals (log scale) by year (1990–2021) in extant subpopulations of the yellow mountain bell

Note: The number of mature individuals is sourced from Hartley & Barrett (2008) and DBCA (2021); and is presented in Table 1. Where '>' or '~' is included in the estimate in Table 1, the minimum value has been graphed. Population estimates vary in their accuracy in particular older estimates.

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

The species appears to show extreme fluctuations in the number of mature individuals. Accordingly, the species appears to meet the extreme fluctuations requirement for listing under this criterion.

Conclusion

The species' EOO and number of locations appear to be very restricted; EOO, AOO, area, extent and/or quality of habitat, number of subpopulations and mature individuals appear to be undergoing continuing decline; and the number of mature individuals appears to be undergoing extreme fluctuations.

The data presented above appear to demonstrate that the species is eligible for listing as **Critically 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 | < 2500 | < 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: | | | |
| (i) Number of mature individuals in each subpopulation | ≤ 50 | ≤ 250 | ≤ 1000 |
| (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 C2b for listing as Vulnerable

Number of mature individuals

The yellow mountain bell undergoes natural fluctuations in the number of mature individuals, characterised by the death of mature individuals and recruitment of seedlings (Hartley & Barrett 2008; DBCA 2021). For taxa that naturally lose all or a subset of mature individuals at some point in their life cycle, the number of mature individuals should be estimated at the appropriate time, when mature individuals are available for reproduction (i.e., before fires occur when mature individuals are present; or enough time after fires when mature individuals to have recruited back from seed) (IUCN 2019).

In 2017 (before 2018 and 2019-20 fires), there was a total of approximately 6220 mature individuals (Table 1) (DBCA 2021). However, in 2021 (following 2018 and 2019-20 fires), the total number of mature individuals had decreased to approximately 315 mature individuals (Table 1) (DBCA 2021). The total number of mature individuals is projected to increase over the next 5–10 years as seedlings become mature. However, a net loss of mature individuals (relative to 2017 estimate) is also projected, due to the ongoing impacts of inappropriate fire regimes, dieback caused by *P. cinnamomi*, altered rainfall patterns and browsing on seedling survival (see Criterion 2) (DBCA 2021. pers comm 3 September).

Accordingly, the number of mature individuals is considered to be fewer than 6220 (i.e., less than estimated number of mature individuals in 2017), due to the projected net loss of mature individuals following the 2018 and 2019-20 fires. The number of mature individuals appears to meet the requirements for listing as Vulnerable (<10,000).

Continuing decline

As discussed in Criterion 2 (see above), the species appears to be undergoing continuing decline in the number of mature individuals. However, the rate of decline for the yellow mountain bell is unknown. Accordingly, the species appears to only meet the C2 continuing decline requirement for listing under this criterion and not the C1 continuing decline requirement.

Number of mature individuals in each subpopulation

In 2017 (before 2018 and 2019-20 fires), approximately 2000 mature individuals occurred in subpopulation 1 (Bluff Knoll/Bula Meela) and approximately 4000 mature individuals occurred in 6A (Bakers Knob A) (Table 1) (DBCA 2021). Accordingly, the number of mature individuals in each subpopulation is considered to be greater than 1000, so the species does not appear to meet this requirement for listing under this criterion.

Percentage of mature individuals in one subpopulation

Given that mature individuals occur in at least three subpopulations (subpopulations 1, 6A and 9) (DBCA 2021), it is not possible for 100 percent of mature individuals to occur in one subpopulation. The percentage of mature individuals in one subpopulation is considered to be less than 100 percent, so the species does not appear to meet this requirement for listing under this criterion.

Extreme fluctuations in the number of mature individuals

As discussed in Criterion 2 (see above), the species appears to show extreme fluctuations in the number of mature individuals. Accordingly, the species appears to meet the extreme fluctuations requirement for listing under this criterion.

Conclusion

The species' population size appears to be <10,000 mature individuals, and the number of mature individuals appears to be undergoing continuing decline and extreme fluctuations.

The data presented above appear to demonstrate that the species is eligible for listing as **Vulnerable** 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 | < 1000 |
| 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 <u>common</u> <u>assessment method</u>.

Criterion 4 evidence

Not eligible

Number of mature individuals

As per the evidence presented above for Criterion 3, the number of mature individuals is considered to be greater than 1000. The species does not appear to meet the requirements for listing under this criterion.

Species cannot be listed under Criterion D2 (see ¹). However, the species meets the requirements for the Vulnerable category under D2, given the number of locations is one (see Criterion 2).

Conclusion

The data presented above appear to demonstrate the species is not eligible for listing 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 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

Population viability analysis has not been undertaken for the yellow mountain bell.

Conclusion

There are insufficient data to demonstrate if the species is eligible for listing 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 determined. The purpose of this consultation document is to elicit additional information to help inform this decision.

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