Australian Government
Department of Agriculture, Water and the Environment

Consultation on Species Listing Eligibility and Conservation Actions

Veronica lithophila (no common name)

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

1) the eligibility of *Veronica lithophila* for inclusion on the EPBC Act threatened species list in the Endangered category; and

2) the necessary conservation actions for the above species.

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

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

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

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

Please include species scientific name in Subject field.

or by mail to:

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

Responses are required to be submitted by 29 June 2022.

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General background information about listing threatened species

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

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

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

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

Privacy notice

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

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

Further, the Commonwealth, State and Territory governments have agreed to share threatened species assessment documentation (including comments) to ensure that all States and Territories have access to the same documentation when making a decision on the status of a potentially threatened species. This is also known as the 'Common Assessment Method' (CAM). As a result, any personal information that you have provided in connection with your comments may be shared between Commonwealth, State or Territory government entities to assist with their assessment processes.

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

Information about this consultation process

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

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

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

CONSULTATION QUESTIONS FOR *VERONICA LITHOPHILA*

SECTION A - GENERAL

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

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

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

PART 1 – INFORMATION TO ASSIST LISTING ASSESSMENT

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

Biological information

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

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

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

Population size

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

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

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

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

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

   ☐ 1–250 ☐ 250–1000 ☐ 1000–2500 ☐ 2500–10,000 ☐ >10,000

   Level of your confidence in this estimate:

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

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

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

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

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

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

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 1990s *(at or soon after the start of the most recent three generation period)*? Please provide justification for your response.

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

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

☐ 1–250 ☐ 250–1000 ☐ 1000–2500 ☐ 2500–10,000 ☐ >10,000

Level of your confidence in this estimate:

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

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

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

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

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

11. Are you able to comment on the extent of decline in the species/subspecies' total population size over the last approximately 27 years (i.e. three generations period)? Please provide justification for your response.

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

Decline estimated to be in the range of:

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

Level of your confidence in this estimated decline:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

    ☐ <100 km^2 ☐ 100 – 5000 km^2 ☐ 5000 – 20,000 km^2 ☐ >20,000 km^2

    Level of your confidence in this estimated extent of occurrence

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

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

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

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

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

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

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

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

Level of your confidence in this estimated extent of occurrence:

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

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

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

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

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

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

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

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

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

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

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

    ☐ <100 km^2 ☐ 100 – 5000 km^2 ☐ 5000 – 20,000 km^2 ☐ >20,000 km^2

    Level of your confidence in this estimated extent of occurrence

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

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

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

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

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

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

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

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

    Level of your confidence in this estimated extent of occurrence:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

PART 3 – ANY OTHER INFORMATION

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

Conservation Advice for *Veronica lithophila* (no common name)

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

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

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

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

Veronica lithophila © Copyright, Philip Gleeson

Conservation status

Veronica lithophila is proposed to be listed as Endangered under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwlth) (EPBC Act).

Veronica lithophila was assessed by the Threatened Species Scientific Committee to be eligible for listing as 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: Endangered: B1ab(iii)+B2ab(iii)
- Criterion 3: Insufficient data
- Criterion 4: Insufficient data
- Criterion 5: Insufficient data

The main factors that make the species eligible for listing are its restricted geographic range and continuing decline in habitat quality.

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

Species information

Taxonomy

Conventionally accepted as *Veronica lithophila* (B.G.Briggs & Ehrend.) B.G.Briggs. Family: Plantaginaceae.

The species was included in the genus *Parahebe* when it was first described in 1992 (Briggs & Ehrendorfer 1992), but was transferred to *Veronica* in 2007 (Garnock-Jones 2007). It was previously referred to as *Parahebe* sp. A in Jacobs & Pickard (1981).

Description

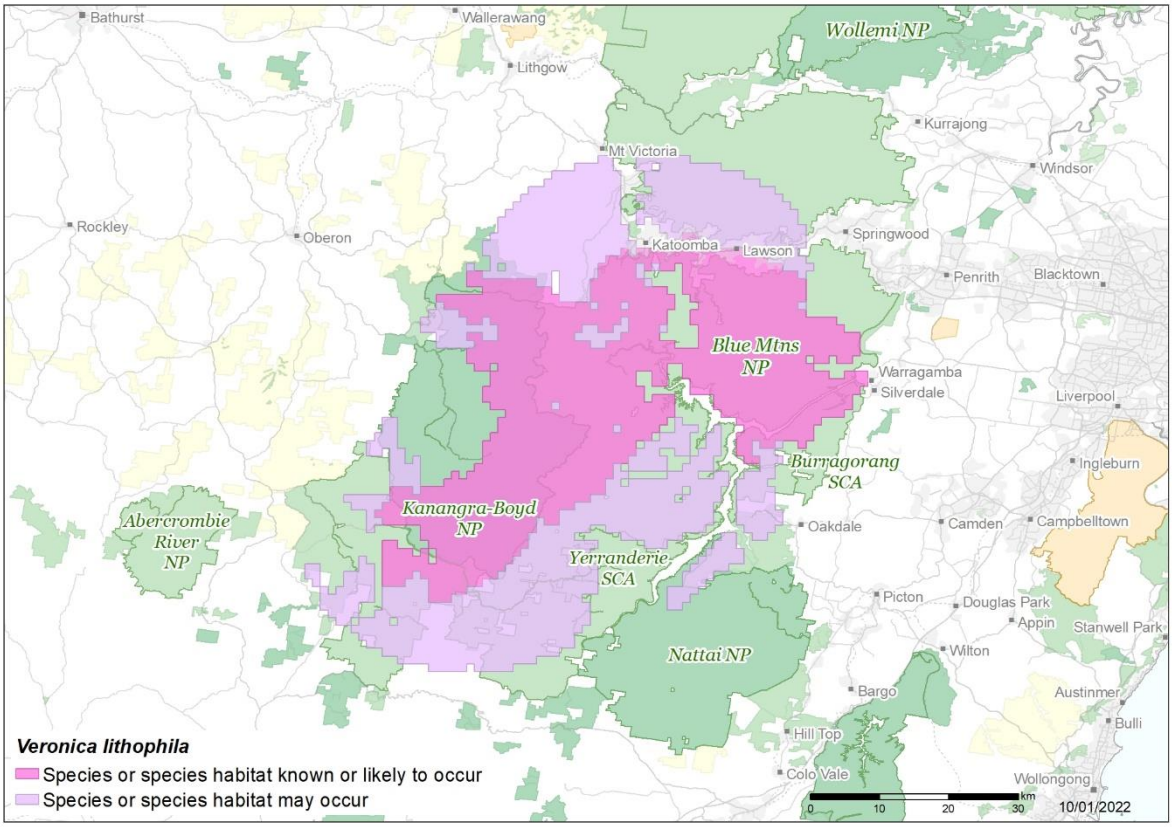
Veronica lithophila is a trailing perennial herb with stems sometimes woody at the base. Stems are either prostrate to 50 cm long and rooting at nodes, or erect leafy lateral flowering stems to 30 cm or more high, with short curved hairs in longitudinal bands or densely covering stem. Leaves are mostly 12–25 mm long and 8–15 mm wide with margins having 2–9 small teeth on either side, green on top, often purple on the underside and hairless. Flower spikes are usually 2–15 cm long with 3–18 flowers. Flowers are very pale purple (lavender to almost white) with darker purple veins. The fruit is a 3–5.5 mm long and wide glabrous, glossy capsule. Description from Briggs & Ehrendorfer (1992) and PlantNet (2022).

Distribution

Veronica lithophila is endemic to the Blue Mountains–Colong region in the southeast of the Central Tablelands of New South Wales (Briggs & Ehrendorfer 1992; PlantNet 2022). All known subpopulations of the species occur in Kanangra–Boyd National Park (NP) and Blue Mountains NP.

Based on spatial clustering of records, there appear to be, or have been historically, approximately nine known subpopulations of *V. lithophila* (ALA 2022). There are no population estimates for *V. lithophila* nor estimates on the number of individuals in individual subpopulations (ALA 2022).

Map 1 Modelled distribution of *Veronica lithophila*



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). These presence categories are created using an extensive database of species observations records, national and regional-scale environmental data, environmental modelling techniques and documented scientific research.

Cultural and community significance

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

Veronica lithophila occurs on the lands of the Gundangarra language group and possibly the Wiradjuri of the south-western slopes (NPWS 2001). Kanangra-Boyd National Park lies within the areas of the Wiradjuri Local Aboriginal Land Council, the Gandangara Local Aboriginal Land Council and Gundangarra Tribal Council (NPWS 2001).

Given the acknowledged importance to Aboriginal peoples of Connection to Country and the widespread importance of Caring for Country (which includes biodiversity, 'place', custom and totemic elements) it is considered likely that the species has or is associated with some cultural and/or community significance. Other species of *Veronica* are known to have been used in traditional medicine around the world (Salehi et al. 2019). It is possible that this was also the case for *V. lithophila*, and that management by Indigenous Australians may have contributed to the health and resilience of this species.

Relevant biology and ecology

Habitat

Veronica lithophila occurs in shallow pockets of soil with high soil moisture (e.g. wet seepage areas) in crevices on flat to almost vertical rock faces or cliffs, mostly in sheltered situations on south-facing slopes (usually shaded for most of the day), sometimes in deep ravines, or near creeks or waterfalls. Subpopulations often occur on small cliff lines or rock faces inside or rising up through the forest, rather than on large escarpments (G. Steenbeeke 2021 pers. comm. 13 Dec), although this could also be partly due to the difficulty in surveying large escarpments. It occurs on exposures of coarse sandstone, conglomerate, and quartzite, surrounded by eucalypt forest on ridges in the Blue Mountains–Colong region (Briggs & Ehrendorfer 1992). Associated species occurring with *V. lithophila* include *Hymenophyllum cupressiforme* (common filmy-fern), *Lindsaea* spp. (screw fern), *Todea barbara* (king fern), *Dendrobium striolatum* (striated rock-orchid), *Pyrrhosia rupestris* (rock felt fern), *Liparis reflexa* (tom cats orchid), *Leptospermum* spp. (tea tree), *Crassula* spp. (stonecrop) and various moss and lichen species (ALA 2022). Dominant eucalypts in surrounding forest include *Eucalyptus deanei* (mountain blue gum), *E. sieberi* (silvertop ash), *E. piperita* (Sydney peppermint), *E. smithii* (gully peppermint/blackbutt peppermint), *E. fastigata* (cut tail) and *E. agglomerata* (blue-leaved stringybark) (ALA 2022).

Reproductive biology

Little is known about the reproductive ecology of *V. lithophila*, and as a result, this section draws largely on published literature from congeneric or confamilial species.

Veronica lithophila flowers in spring–summer (PlantNet 2022). Plants are hermaphroditic (Sjöström & Gross 2006 in Falster et al. 2021) and are likely pollinated by insects, with fly, bee or beetle species pollinating related *Parahebe* from lowland parts of New Zealand (Garnock-

Jones 1976; Delph 2021). Flowers could be dichogamous, where male and female parts mature at different times to encourage outcrossing, as observed in New Zealand *Parahebe* (Delph 2021).

Seeds of *Veronica* species usually lack dispersal mechanisms (Falster et al. 2021), but being small they are probably dispersed by water and gravity. Seeds of some *Veronica* species have morphophysiological dormancy that prevents germination, which can be broken by gibberellic acid in laboratory conditions, or by fire-related cues including heat and smoke water (Guerin et al. 2013). Germination may be temperature specific, with the optimal temperature for germination of *V. parnkalliana* seeds being 10–18 °C (Guerin et al. 2013). Viability of seeds of *Veronica* species is often high (e.g. usually >30%) (Plants of South Australia 2022). Seeds of some species may remain viable in the soil for many years (Guerin et al. 2013).

The primary juvenile period (time from germination to reproductive maturity) for *V. lithophila* is unknown but likely to be short, as other *Veronica* species can have primary juvenile periods of <1 year to up to 5 years (Falster et al. 2021). Estimates of longevity are <50 years or <100 years for most species of *Veronica* (Falster et al. 2021), or 10–30 years for the obligate seeder *V. hillebrandii* (DELWP 2021).

Fire ecology

The fire response of *V. lithophila* is not known. Mature plants were observed flowering at Mount Solitary in October 2021 at two sites, one at Singajingawell Creek in vegetation recovering from a prescribed fire in May/June 2018, and another at Chinamans Gully in vegetation also recovering from fire, although it is not known if the latter site was burnt in the same 2018 prescribed fire, or if it was burnt in the 2019/20 bushfires, or burnt by both fires (P. Gleeson 2021 pers. comm. 23 Dec). It is unknown if these had germinated from seed or resprouted post-fire. *Veronica* includes a mix of resprouter and obligate seeder species, although the majority of species with documented fire response traits are resprouters (Falster et al. 2021). Most species can germinate and establish in the absence of fire, although some species display strong post-fire germination (Guerin et al. 2013; Falster et al. 2021). *Veronica lithophila* is known to germinate following soil disturbance (Briggs & Ehrendorfer 1992), suggesting it may also have the ability to germinate post-fire, although the extent to which this occurs is unknown.

Habitat critical to the survival

Veronica lithophila occurs in crevices, shallow pockets of soil, or wet seepage areas on flat to almost vertical rock faces, mostly in sheltered situations, in the Blue Mountains–Colong region.

At this point in time there is insufficient information available to describe, with spatial information, areas of habitat that are critical to the survival of the species. Further research is needed to do this (see conservation actions). Until such information is available, all habitat for this species should be considered habitat critical for the species' long-term survival.

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.

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

Threats

The major threats to *V. lithophila* include inappropriate fire regimes, feral goat herbivory and climate change.

Table 1 Threats impacting *Veronica lithophila*

Threat	Status [a]	Evidence
Habitat loss, disturbance and modifications		
Fire regimes that cause biodiversity decline[1]	• Timing: current • Confidence: suspected • Likelihood: likely • Consequence: high • Trend: increasing • Extent: across the entire range	The fire response of *V. lithophila* is not known, and *Veronica* contains both resprouter and obligate seeder species (Falster et al. 2021). However, the species occurs in habitat that experiences fire infrequently, with rock outcrops, cliffs and a humid microclimate likely offering some physical protection. This is supported by the observations of co-occurring species including common filmy-fern and rock felt fern at some subpopulations, both of which are killed by fire (Falster et al. 2021). Approximately 84% of the modelled range area of the species was burnt in the 2019/20 bushfires, including all known Australasian Virtual Herbarium records (Gallagher 2020). There are a number of mechanisms by which the fire regime impacts a species (Keith 1996; DAWE 2021). These include the frequency of fire (high vs low); the severity of fires (high vs low); the season of fire; and the interactions between fire and climate change and other threats (herbivory, disease, etc.). *Veronica lithophila* may be sensitive to high fire severity, high fire frequency, and interactions between fire and climate change, and potentially fire and pollinator availability. *High severity/intensity fires* High severity fire can kill adult plants of species usually capable of resprouting through extreme and extended soil heating that damages regenerative organs located below ground (tubers, rhizomes, bulbs, etc; Bowman et al. 2009). Below ground heat transfer depends on the mass of ground fuel consumed (Tunstall et al. 1976) and period of burn (short vs long). Thus, the threat to soil stored seed and vegetative organs is exacerbated when depth of burial is shallow, fire residence time is high, ground fuel consumption is high and soil moisture is low (DAWE 2021). High severity fire may also reduce habitat quality, making habitat less amenable to seedling survival due to erosion of the humic layer or by removing fire-sensitive species and opening of the canopy, causing a drying of the previously humid microclimate (Russell-Smith & Stanton 2002). *Low severity/intensity fires* Temperature-sensitive obligate seeders require soil temperatures to be sufficient to break seed dormancy

Threat	Status [a]	Evidence
		(either physically or physiologically) and initiate germination (Auld & O'Connel 1991; Auld & Ooi 2009). Failure to do this can result in a low rate of recruitment and subsequent population decline (Regan et al. 2003). Low severity fires can occur when fuel loads are low, e.g., because previous fire has reduced vegetation load, or when fires occur out-of-season. If *V. lithophila* is an obligate seeder, then low fire severity may threaten its post-fire recruitment by failing to initiate germination of soil-stored seed. *High frequency fires* Most plants require a minimum time between successive fires, either for obligate seeders to allow time to accumulate sufficient soil-stored seed, or for resprouters to recover sufficiently to be able to resprout following the next fire (Keith 1996, DAWE 2021). Although *V. lithophila* likely has a short primary juvenile period of around one year as inferred from other species in the genus (Falster et al. 2021), high frequency fires are still a threat to this species. This could occur if high fire frequency degrades the species' ability to resprout following fire by reducing its ability to develop fire resistant organs (Fairman et al. 2019), or if high frequency fire degrades its habitat by removing fire-sensitive species and opening the canopy, causing a drying of the previously humid microclimate (Russell-Smith & Stanton 2002). Prescribed burning can also contribute to a reduced fire-free interval. *Interactions between fire and other threats* There are a range of mechanisms by which fire interacts with other threats and impacts the species recovery potential following fire (DAWE 2021). For *V. lithophila*, the interaction between climate change and the fire regime could lead to significant impacts on the population. Climate change can increase the frequency of fire through changes in moisture levels at landscape scales increasing the risk of localised extinctions (Nolan et al. 2021). For example, climate change is predicted to increase the number of days of elevated temperatures and increase the Forest Fire Danger Index in the Sydney region (CSIRO & Bureau of Meteorology 2020). This indicates a likely reduction in the fire-free interval which may affect species capacity to recover (Enright et al. 2015; Gallagher et al. 2021). Climate associated warming and drying can also reduce the species' resilience by interacting with natural hydrological cycles (see Climate Change section). This is particularly important for a species that depends on sheltered microhabitats with high moisture availability like *V. lithophila*. The two climate associated threat pathways can also act in concert through processes such as the 'interval squeeze', whereby climate change drives increased pressure via higher fire frequency, while also reducing resilience via slower rates of maturation and lower fecundity (Enright et al. 2015; Henzler et al. 2018). Other potential fire-related threats include fire-competition (if fire regimes result in increasing competition from other native plants), and possibly fire-pollinator interactions (if pollinator communities are negatively impacted by inappropriate fire regimes, which is poorly understood for *V. lithophila*).

Threat	Status [a]	Evidence
Competition with native species		
Post-fire competition with native plant species	• Status: current • Confidence: observed • Likelihood: likely • Consequence: moderate • Trend: unknown • Extent: across the entire range	Vigorous post-fire regrowth of native plants appears capable of suppressing recovery of *V. lithophila*. At McMahons Point, several native plant species, particularly the scrambling peas *Hardenbergia violacea* (purple coral-pea) and *Kennedia rubicunda* (dusky coral-pea), were observed to have very vigorous post-fire regrowth that dominated the ground layer and could possibly suppress post-fire recovery of *V. lithophila* seedlings and adult plants on clifftop areas (G. Phillips 2021 pers. comm. 9 Dec). Post-fire competition with native species like purple coral-pea is also likely to threaten recovery in other burnt subpopulations (G. Steenbeeke 2021 pers. comm. 13 Dec).
Invasive species		
Grazing by feral goats (*Capra hircus*)	• Status: current • Confidence: suspected • Likelihood: possible • Consequence: major • Trend: unknown • Extent: across the entire range	Feral goats are a Key Threatening Process under the EPBC Act (DEWHA 2008). Feral goats have a negative impact on native plant communities through soil damage and overgrazing. This grazing can cause erosion and prevent regeneration and recruitment. They may also spread weeds and diseases (Bayne et al. 2005; DEWHA 2008). Feral goats occur across the range of *V. lithophila* (NPWS 2001). Unlike many other feral herbivores, goats graze on cliff and rocky outcrops where *V. lithophila* grows. Related species of *Hebe* are known to be highly palatable to feral goats and threatened by feral goat herbivory (de Lang & Rolfe 2008). Therefore, herbivory from feral goats is a possible threat to the species, despite no documented impacts on the species (probably largely due to low survey and monitoring effort for *V. lithophila* to date).
Climate change		
Changes to temperature and precipitation patterns	• Timing: current • Confidence: suspected • Likelihood: almost certain • Consequence: major • Trend: increasing • Extent: across the entire range	In the Sydney region (including the Blue Mountains), maximum temperatures are projected to increase by 0.3–1.0°C by 2030 and 1.6–2.5°C by 2070, fire weather is predicted to increase in spring and summer, the number of hot days is predicted to increase and rainfall is predicted to decrease in spring and winter and increase in summer and autumn, due to the effects of climate change (OEH 2014; CSIRO & Bureau of Meteorology 2020). *Veronica lithophila* may be directly threatened by changes to rainfall and temperature, particularly by increasing severity and frequency of drought events. *Veronica lithophila* is likely susceptible to droughts as it occurs in situations where regular moisture availability is required (G. Steenbeeke 2021 pers. comm. 13 Dec). Impacts on *V. lithophila* are inferred based on observations of the negative impacts of drought on other threatened plant species occurring nearby (e.g. *Hakea dohertyi* (Kowmung hakea) south of Kanangra Walls) (G. Steenbeeke 2021 pers. comm. 13 Dec). However, Proteaceae are prone drought stress by having limited ability to adjust their hydraulic architecture in response to environmental change (Li et al. 2019). Therefore, observations of drought stress on nearby Proteaceae shrubs may not be immediately applicable to *V. lithophila*. *Veronica lithophila* may be threatened by changes to rainfall patterns and warming which can act synergistically with inappropriate fire regimes to increase the risk of repeat fire events at intervals below or approaching the tolerable fire interval for the taxon, leading to seedbank depletion, exhaustion and local extinction. Post-fire recruitment and

Threat	Status [a]	Evidence
		seedling survival is threatened by drought, particularly where drought conditions are present pre- or post-fire (Nolan et al. 2021).

Timing—identify the temporal nature of the threat;
Confidence—identify the extent to which we have confidence about the impact of the threat on the species;
Likelihood—identifies the likelihood of the threat impacting on the whole population or extent of 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;
[1] Fire regimes that cause biodiversity decline include the full range of fire-related ecological processes that directly or indirectly cause persistent declines in the distribution, abundance, genetic diversity or function of a species or ecological community. 'Fire regime' refers to the frequency, intensity or severity, season, and types (aerial/subterranean) of successive fire events at a point in the landscape.

Each threat has been described in Table 1 in terms of the extent that it is operating on the species. The risk matrix (Table 2) provides a visual depiction of the level of risk being imposed by a threat and supports the prioritisation of subsequent management and conservation actions. In preparing a risk matrix, several factors have been taken into consideration, they are: the life stage they affect; the duration of the impact; and the efficacy of current management regimes, assuming that management will continue to be applied appropriately. The risk matrix and ranking of threats has been developed in consultation with experts and using available literature.

Table 2 *Veronica lithophila* risk matrix

Likelihood	Consequences				
	Not significant	Minor	Moderate	Major	Catastrophic
Almost certain				Increased temperature, fire danger weather, autumn rainfall, and decreased winter rainfall	
Likely			Competition with native species	Fire regimes that cause biodiversity decline	
Possible				Grazing by feral goats	
Unlikely					
Unknown					

Risk Matrix legend/Risk rating:

Low Risk	Moderate Risk	High Risk	Very High Risk

Categories for likelihood are defined as follows:
Almost certain – expected to occur every year
Likely – expected to occur at least once every five years
Possible – might occur at some time

Unlikely – such events are known to have occurred on a worldwide bases but only a few ties
Unknown – currently unknown how often the incident will occur

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

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

Conservation and recovery actions

Primary conservation objective

By 2030, the population of *V. lithophila* will have increased in abundance and viable subpopulations are sustained in habitats where threats are managed effectively.

Conservation and management priorities

Habitat loss, disturbance and modifications impacts

- Avoid further loss and fragmentation of habitat.

Fire, climate change and extreme weather impacts

- Ensure that the locations of all subpopulations are recorded on relevant state databases, including those used by land management and fire response agencies.
- Exclude planned fire (and bushfire where possible) from all subpopulations. If planned fire impacts the subpopulations, managers must ensure that subsequent unplanned fires do not occur within the critical regeneration period to allow the species to recover and rebuild its soil seed bank to sustain the population through the next fire event.
- Develop and implement a fire management strategy that optimises the survival of *V. lithophila*, including:
    - Fires must be managed to ensure that prevailing fire regimes do not disrupt the life cycle of the taxon, that they support rather than degrade the habitat, and that they do not promote invasion of weeds or increase competition from native plant species.
    - Physical damage to the habitat and individual plants must be avoided during and after fire operations.
    - Avoid the use of fire retardants and firefighting foams during fire operations.

Invasive species impacts

- Maintain or increase feral goat population control measures in consultation with land managers and community groups in and near subpopulations of *V. lithophila*, including through the use of aerial and ground shooting (DEWHA 2008).

Ex situ recovery actions

- Collect and store seed from known subpopulations to preserve genetic material, in accordance with the *Plant Germplasm Conservation in Australia* (Martyn Yenson et al. 2021).
- If appropriate, undertake ex situ propagation and translocations in accordance with the *Guidelines for the Translocation of Threatened Plants in Australia* (Commander et al. 2018). Monitor all translocated individuals to maturity, seed set and recruitment to ensure they are viable and are contributing to a reduction in the extinction risk for the species. Although translocations may be deemed appropriate, there appears to be substantial unsurveyed habitat for the species, suggesting a focus on additional survey effort should be a priority.

Stakeholder engagement/community engagement

- Engage and involve Traditional Owners in conservation actions, including surveying for new populations, monitoring and management actions (e.g. fire management, feral goat control), and to determine the cultural significance of the species.
- Liaise with relevant land managers to ensure that subpopulations are not accidentally damaged or destroyed. The approval and assistance of land managers should also be sought to implement recovery actions, and recent population data should inform management.
- Engage community groups by encouraging participation in surveys or monitoring for the species.
- Promote public awareness of biodiversity conservation and protection through dissemination of information through print and digital media.

Survey and monitoring priorities

- Undertake surveys throughout the species' range.
- Commence a monitoring program to:
    - monitor species recruitment and plant health before and after fire and drought events;
    - estimate population size and trends;
    - document the post-fire recovery and causes of any recruitment failure;
    - determine threats and their impacts; and,
    - monitor the effectiveness of management actions and the need to adapt them if necessary.

Information and research priorities

- Increase knowledge surrounding the ecology of *V. lithophila*. This includes improving understanding of fire response, habitat requirements, recruitment and soil-seed bank dynamics (especially seed bank longevity and germination cues), appropriate fire frequency, pollination biology (e.g. identity of pollinators and their ecological requirements), primary juvenile period and adult longevity, genetic structure, and minimum viable population size.
- Understand the potential influence of climate change on the long-term survival prospects of the species, due to altered temperatures, rainfall patterns, bushfires, and environmental stressors, particularly the effect of drought (including post-fire drought).

- Investigate the impact of drought on *V. lithophila* mortality, recruitment and seedling growth.
- Ascertain the cultural significance of *V. lithophila*.
- Determine habitat critical to the survival of the species and important populations.

Links to relevant implementation documents

This Conservation Advice is developed to be able to subsequently inform other planning instruments such as a Bioregional Plan or a multi-entity Conservation Plan.

Draft listing assessment for Key Threatening Process 'fire regimes that cause biodiversity loss' (2021)

Threat abatement plan for competition and land degradation by unmanaged goats (2008)

Conservation Advice and Listing Assessment references

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

Attachment A: Listing Assessment for *Veronica lithophila*

Reason for assessment

This assessment follows prioritisation of a nomination from the TSSC.

Assessment of eligibility for listing

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

Key assessment parameters

Table 3 includes the key assessment parameters used in the assessment of eligibility for listing against the criteria.

Table 3 Key assessment parameters

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of mature individuals	Unknown	Unknown	Unknown	The total number of mature individuals is unknown and there are no available anecdotal observations or subpopulation estimates to enable any estimate of population size.
Trend	Unknown (possibly declining)			The population size is unknown and no monitoring has been undertaken of the species. There are no data on population trends. A newly discovered subpopulation at Mount Solitary occurring in habitat recovering from recent fire indicates the species is capable of recovering post-fire. However, two unsuccessful searches for the species were undertaken in 2021 at McMahons Point near Wentworth Falls (G. Phillips 2021 pers. comm. 9 Dec). Therefore, it is possible that the population size may be declining, although this inference is based on very limited data.
Generation time (years)	6–26	6	26	The generation length of *V. lithophila* is not documented. *Veronica* species may reach reproductive maturity at approximately one year of age (Falster et al. 2021; DELWP 2021) and are probably capable of living for 10–50 years (Falster et al. 2020; DELWP 2021). Therefore, a plausible generation length for *V. lithophila*

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
				may be approximately 6–26 years (see Criterion 1 below).
Extent of occurrence	323 km^2	~200 km^2	~500 km^2	The extent of occurrence (EOO) is based on the mapping of available point records from 1985 to 2021. This timeframe was used due to the species occurring in relatively remote, rarely surveyed areas. The EOO was calculated using a minimum convex hull, based on the IUCN Red List Guidelines (IUCN 2019). The maximum plausible value represents the plausible EOO if unknown subpopulations exist, which is likely as the species occurs in remote areas. The minimum plausible value represents the plausible EOO if some older records no longer exist.
Trend	Unknown (possibly declining)			Two unsuccessful searches for the species were undertaken in 2021 at McMahons Point near Wentworth Falls (G. Phillips 2021 pers. comm. 9 Dec). Therefore, it is possible that the species has declined or is extinct at this locality, although there is substantial remote habitat in the vicinity, requiring abseil or drone access to survey (G. Phillips 2021 pers. comm. 9 Dec). If some historic subpopulations are extinct, it is possible that the EOO is in decline, although the existence of substantial unsurveyed habitat and lack of monitoring of known subpopulations means evidence for declining EOO is currently uncertain.
Area of Occupancy	40 km^2	~30 km^2	40–100 km^2	The AOO estimate is based on the mapping of available point records from 1985 to 2021. This timeframe was used due to the species occurring in relatively remote, rarely surveyed areas. The AOO is calculated using a 2x2 km grid cell method, based on the IUCN Red List Guidelines (IUCN 2019). The maximum plausible value represents a very uncertain AOO estimate if unknown subpopulations exist, which is likely as the species occurs in remote areas. The minimum plausible value represents the plausible AOO if some older records no longer exist.
Trend	Unknown (possibly declining)			Two unsuccessful searches for the species were undertaken in 2021 at McMahons Point near Wentworth Falls (G. Phillips 2021 pers. comm. 9

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
				Dec). Therefore, it is possible that the species has declined or is extinct at this locality, although there is substantial remote habitat in the vicinity, requiring abseil or drone access to survey (G. Phillips 2021 pers. comm. 9 Dec). If some historic subpopulations are extinct, it is possible that the AOO is in decline, although the existence of substantial unsurveyed habitat and lack of monitoring of known subpopulations means evidence for declining AOO is currently uncertain.
Number of subpopulations	9	<9	>9	Based on spatial clustering of records, there appear to be approximately nine known subpopulations of *V. lithophila* with the nearest subpopulations 2.2 km distant (ALA 2022). There are substantial areas of habitat for the species in remote and difficult to survey areas of the Blue Mountains – Colong region. Therefore, the existence of additional subpopulations is likely. Alternatively, some populations may have declined or become extinct (e.g. McMahons Point), or additional survey effort may prove nearby subpopulations to be part of the same, larger subpopulation, which could reduce the number of subpopulations.
Trend	Unknown (possibly declining)			Two unsuccessful searches for the species were undertaken in 2021 at McMahons Point near Wentworth Falls (G. Phillips 2021 pers. comm. 9 Dec). Therefore, it is possible that the species has declined or is extinct at this locality, although there is substantial remote habitat in the vicinity, requiring abseil or drone access to survey (G. Phillips 2021 pers. comm. 9 Dec). The existence of substantial unsurveyed habitat throughout the Blue Mountains – Colong region, and lack of monitoring of known subpopulations, means evidence for a decline in the number of subpopulations is currently uncertain.
Basis of assessment of subpopulation number	See justification for Number of subpopulations.			
No. locations	2–5	1	5–9	The number of locations is estimated at 2–5 based on the presence of

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
				threats from climate change, inappropriate fire regimes, feral goat herbivory and interactions among inappropriate fire regimes, climate change, competition with native species and feral goat herbivory. *Veronica lithophila* sometimes co-occurs with fire-sensitive epiphytic ferns like common filmy-fern and rock felt fern (Falster et al. 2021; ALA 2022), suggesting its habitat experiences fire infrequently. High severity fire or high frequency fire may also reduce habitat quality, making it less amenable to seedling survival by removing fire-sensitive species and opening the canopy, causing a drying of previously humid microclimates (Russell-Smith & Stanton 2002). Although the impacts of the 2019/20 bushfires on the species are not well understood, two unsuccessful searches for the species were undertaken in 2021 at McMahons Point near Wentworth Falls (G. Phillips 2021 pers. comm. 9 Dec). This suggests the McMahons Point subpopulation may have declined or become extinct, potentially due to the impacts of the 2019/20 bushfire. Interaction between the threat of inappropriate fire regimes with climate change and competition with native species may also cause the rapid elimination of subpopulations of *V. lithophila*. The interaction between climate change and inappropriate fire regimes could cause the rapid elimination of subpopulations if climate change drives increased pressure via higher fire frequency, while also reducing resilience via slower rates of maturation, lower fecundity or higher post-fire seedling mortality through post-fire drought or increased competition from native plant species (Enright et al. 2015; Henzler et al. 2018). Due to the nature of the species' habitat in rocky escarpments and cliffs, impacts from fire are likely to be heterogeneous across the species' range, depending on local conditions. Therefore, it is more likely that several large drought and/or fire events would be required to impact all subpopulations of *V. lithophila*, and thus the species is estimated to

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
				have approximately two to five locations. Continuing decline in habitat quality is inferred from threats of inappropriate fire regimes, climate change, post-fire competition with native plant species, and feral goat herbivory.
Trend	Unknown (possibly declining)			Two unsuccessful searches for the species were undertaken in 2021 at McMahons Point near Wentworth Falls (G. Phillips 2021 pers. comm. 9 Dec). Therefore, it is possible that the species has declined or is extinct at this locality, although there is substantial remote habitat in the vicinity, requiring abseil or drone access to survey (G. Phillips 2021 pers. comm. 9 Dec). In addition, the existence of substantial unsurveyed habitat and lack of monitoring of known subpopulations means evidence for declining number of locations is currently uncertain.
Basis of assessment of location number	See justification for No. locations.			
Fragmentation	There are no estimates of the number of mature individuals, therefore an assessment of severe fragmentation is not possible as it is unknown whether more than 50 percent of its subpopulations are smaller than a rudimentary estimate of minimum viable population size (IUCN 2019).			
Fluctuations	No evidence of extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals.			

Criterion 1 Population size reduction

Reduction in total numbers (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	Critically Endangered **Very severe reduction**	**Endangered** **Severe reduction**	**Vulnerable** **Substantial reduction**
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3, A4	≥ 80%	≥ 50%	≥ 30%

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

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

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

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

Based on any of the following

(a) direct observation [except A3]
(b) an index of abundance appropriate to the taxon
(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat
(d) actual or potential levels of exploitation
(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites

Criterion 1 evidence

Insufficient data to determine eligibility

Generation time

The primary juvenile period of *V. lithophila* is unknown, but other *Veronica* species are thought to have a primary juvenile period of approximately 1 year (Falster et al. 2021; DELWP 2021) and can live for 10–50 years (Falster et al. 2021; DELWP 2021). Assuming *V. lithophila* has similar reproductive traits, plausible maximum and minimum generation times are likely to be:

Maximum:

$$\text{Generation time} = \text{age of first reproduction} + [0.5 * (\text{length of reproductive period})]$$
$$\text{Generation time} = 1 + [0.5 * (50 - 1)] = 26 \text{ years}$$

Minimum:

$$\text{Generation time} = \text{age of first reproduction} + [0.5 * (\text{length of reproductive period})]$$
$$\text{Generation time} = 1 + [0.5 * (10 - 1)] = 6 \text{ years}$$

This gives an estimated three-generation period of approximately 18–78 years.

Population trend

There are no data on population trends of *V. lithophila* as the population size is unknown and no monitoring has been undertaken of the species. A newly discovered subpopulation at Mount Solitary occurring in habitat recovering from recent fire indicates that at least some subpopulations of the species are capable of recovering post-fire. However, two unsuccessful searches for the species were undertaken in 2021 at McMahons Point near Wentworth Falls (G. Phillips 2021 pers. comm. 9 Dec). Therefore, it is possible that the population size may be declining, although this inference is based on very limited data. There are inadequate data to estimate the magnitude of any putative decline. As such, there are insufficient data to determine the species' eligibility under this criterion.

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

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

		Critically Endangered Very restricted	Endangered Restricted	Vulnerable Limited
B1.	Extent of occurrence (EOO)	**< 100 km²**	**< 5,000 km²**	**< 20,000 km²**
B2.	Area of occupancy (AOO)	**< 10 km²**	**< 500 km²**	**< 2,000 km²**
AND at least 2 of the following 3 conditions:				
(a)	Severely fragmented OR Number of locations	**= 1**	**≤ 5**	**≤ 10**
(b)	Continuing decline observed, estimated, inferred or projected in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) area, extent and/or quality of habitat; (iv) number of locations or subpopulations; (v) number of mature individuals			
(c)	Extreme fluctuations in any of: (i) extent of occurrence; (ii) area of occupancy; (iii) number of locations or subpopulations; (iv) number of mature individuals			

Criterion 2 evidence

Eligible under B1ab(iii)+B2ab(iii) as Endangered

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

The EOO of *V. lithophila* is 323 km² and the AOO is 40 km² (see Table 3).

The species' EOO appears to meet the requirements for listing as Endangered under B1 (<5,000 km²). The species' AOO appears to meet the requirements for listing as Endangered under B2 (<500 km²).

Severely fragmented

There are no estimates of the number of mature individuals, therefore an assessment of severe fragmentation is not possible as it is unknown whether more than 50 percent of its subpopulations are smaller than a rudimentary estimate of minimum viable population size (IUCN 2019). There are insufficient data to asses *V. lithophila* for severe fragmentation and the species does not appear to meet the severe fragmentation requirement for listing under this criterion.

Number of locations

The number of locations is estimated at 2–5 based on the presence of threats from climate change, inappropriate fire regimes, feral goat herbivory and interactions among inappropriate fire regimes, climate change, competition with native species and feral goat herbivory.

Inappropriate fire regimes are a threat to *V. lithophila* that could cause the rapid elimination of subpopulations. The fire response of *V. lithophila* is unknown, as the genus includes both resprouter and obligate seeder species (Falster et al. 2021). However, *V. lithophila* is confined to habitat that probably experiences fire infrequently, and some subpopulations co-occur with fire-sensitive epiphytic ferns (e.g. common filmy-fern and rock felt fern) (Falster et al. 2021; ALA 2022), suggesting fire is a rare occurrence at these sites. *Veronica lithophila* may be sensitive to high fire severity and high fire frequency. Approximately 84% of the modelled range area of the species was burnt in the 2019/20 bushfires, including all known subpopulations recorded in the Australasian Virtual Herbarium (Gallagher 2020). The impact of the 2019/20 bushfires on the habitat of *V. lithophila* was substantial. The area around McMahons Point was severely burnt with much of the area suffering partial to complete crown consumption (G. Phillips 2021 pers. comm. 9 Dec). It is likely that the species' habitat throughout its range was impacted greatly by the 2019/20 bushfires, as small cliff lines on which the species grows were generally severely burnt (G. Steenbeeke 2021 pers. comm. 13 Dec). The related *Veronica continua* in Tasmania, and many species of *Parahebe* (with which *V. lithophila* was previously placed) and *Hebe* in New Zealand, only occur in fire-protected rocky sites, suggesting susceptibility to fire is a trait common to some related species (Heads 1994; Wagstaff & Wardle 1999; Briggs & Ehrendorfer 2006).

Although impacts to individual subpopulations of *V. lithophila* from the 2019/20 bushfires are unlikely to be uniform (e.g. depending on the severity or direction of the fire, proximity of plants to fuel, etc.), it is possible that some subpopulations may have been eliminated by the 2019/20 fire or could be eliminated by similar high severity bushfires in the future. For example, the McMahons Point subpopulation has not been seen despite two searches following the 2019/20 bushfires (G. Phillips 2021 pers. comm. 9 Dec). The area was severely burnt, and it is plausible that high fire severity has eliminated this subpopulation. High severity fire or high frequency fire may also reduce habitat quality, making it less amenable to seedling survival due to erosion of the humic layer or by removing fire-sensitive species and opening the canopy, causing a drying of previously humid microclimates (Russell-Smith & Stanton 2002). If *V. lithophila* is a resprouter, high fire frequency could also degrade its capacity to resprout following future fires by reducing the ability of mature plants to develop fire resistant organs (Fairman et al. 2019), or increase competitive pressure from native plant species in the post-fire environment.

Climate change could cause the elimination of *V. lithophila* subpopulations. *Veronica lithophila* is restricted to moist microhabitats, including sheltered rocky crevices in damp, shaded pockets of soil or wet seepage areas, often near small creeks or waterfalls. Increasing frequency and severity of droughts is likely to occur across the range of *V. lithophila* due to climate change (CSIRO & Bureau of Meteorology 2020). If the precipitation regime changes substantially, species reliant on high soil moisture can be negatively affected, through mortality or increased competition from species adapted to drier soil conditions (Alba et al. 2019). Drought may also have a substantial impact on the vegetation structure of the region, as some plants are vulnerable to mortality through drought stress and hydraulic failure (Choat et al. 2018). *Veronica lithophila* is likely susceptible to droughts as it occurs in situations where regular moisture availability is required (G. Steenbeeke 2021 pers. comm. 13 Dec). Negative impacts on *V. lithophila* are inferred based on observations of other threatened plant species occurring nearby (e.g. *Hakea dohertyi* (Kowmung hakea) south of Kanangra Walls) that are negatively impacted by drought conditions (G. Steenbeeke 2021 pers. comm. 13 Dec). Although Proteaceae may be predisposed to more severe drought stress than many other plants (Li et al. 2019). Whether climate change impacts such as severe drought could cause the elimination of a subpopulation within one generation (6–26 years) is less clear. More likely is that the interaction between the threats of drought and inappropriate fire regimes could cause the rapid elimination of subpopulations.

Feral goats have a negative impact on native plant communities through soil damage and overgrazing (DEWHA 2008). Feral goats are present across the range of *V. lithophila* (NPWS 2001) and graze on cliff and rocky outcrops where *V. lithophila* occurs. Related species of *Hebe* are known to be highly palatable to feral goats and threatened by feral goat herbivory (de Lang & Rolfe 2008). Therefore, herbivory from feral goats is a plausible threat to the species that could cause the rapid elimination of affected subpopulations. Herbivory from feral goats may also interact with threats of fire and climate change.

The interaction of the threat of inappropriate fire regimes with climate change, herbivory and competition with native species is probably the most likely threat that could cause the rapid elimination of subpopulations of *V. lithophila*. For example, the frequency of potential large-fire ignition days in the Blue Mountains is expected to increase by 20–84 percent by 2050 due to climate change, which is likely to result in increased fire frequency (Bradstock et al. 2008). The interaction between climate change and inappropriate fire regimes could cause the rapid elimination of subpopulations if climate change drives increased pressure via higher fire frequency, while also reducing resilience via slower rates of maturation, lower fecundity or higher post-fire seedling mortality through post-fire drought or increased competition from native plant species (Enright et al. 2015; Henzler et al. 2018). Competition with native species, which is thought to be a substantial threat to post-fire recovery of *V. lithophila* at some subpopulations (G. Phillips 2021 pers. comm. 9 Dec; G. Steenbeeke 2021 pers. comm. 13 Dec), is also likely to become more serious if the inter-fire period decreases as a result of increasing fire frequency caused by climate change. Although the impact of feral goat herbivory is not well understood, if high grazing pressure reduces the size of the soil seed bank through reduced adult fecundity or post-fire seedling survival, it could increase the likelihood that inappropriate fire regimes or drought could cause the elimination of the species.

Therefore, the rapid elimination of subpopulations is plausible due to the threats of inappropriate fire regimes, climate change, or the interaction between these threats with each other and with competition from native plant species and feral goat herbivory. Although it is possible that a severe drought event combined with a severe bushfire event could cause the elimination of all subpopulations (i.e. one location), the discovery of a previously unknown subpopulation at Mount Solitary in 2021 following the severe drought and fire events of 2019/20 (Nolan et al. 2020), suggests this is probably unlikely. Due to the nature of the species' habitat in rocky escarpments and cliffs, impacts from fire (e.g. severity and frequency) are likely to be heterogeneous across the species' range, depending on local conditions (e.g. some subpopulations are likely to escape a single fire event, or be burnt at lower severity). Therefore, it is more likely that several large drought and/or fire events would be required to impact all subpopulations of *V. lithophila*, and thus the species is estimated to have approximately two to five locations.

Continuing decline

There is a possible decline in EOO, AOO, the number of locations or subpopulations, or number of mature individuals, if the McMahons Point subpopulation is extinct. This is possible, as two surveys failed to find this subpopulation in 2021 (G. Phillips 2021 pers. comm. 9 Dec). However, there is substantial habitat on the larger escarpment faces, which is impossible to survey without abseil or drone access (G. Phillips 2021 pers. comm. 9 Dec), so it is unclear if this subpopulation is extinct.

The habitat quality of some subpopulations is inferred to be declining due to inappropriate fire regimes, climate change, post-fire competition with native plant species, and feral goat herbivory. Increases to fire and drought frequency and severity, caused by climate change, is likely to degrade the habitat of *V. lithophila* by causing a drying of previously humid microclimates, either due to the removal of fire-sensitive species and opening the canopy of surrounding forest, or through direct decreases to humidity and soil moisture conditions. Increased fire frequency could also result in increased competition from native plants, if the length of the inter-fire period decreases and the habitat is more frequently in a post-fire recovery phase where native scrambling pea species may suppress *V. lithophila*. Feral goats occur across the range of *V. lithophila* (NPWS 2001) and are likely to graze in rocky areas (DEWHA 2008), and are a potential contributor to a decline in habitat quality, particularly if goat populations are not controlled.

Therefore, *V. lithophila* appears to be undergoing continuing decline in the area, extent and/or quality of habitat. It may also be experiencing continuing decline in EOO, AOO, the number of locations or subpopulations, and number of mature individuals, although these are less certain. Accordingly, the species appears to meet the continuing decline requirement for listing under this criterion.

Extreme fluctuations

There are no known extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals. Therefore, *V. lithophila* does not meet the threshold for listing under sub-criterion (c).

Conclusion

The data presented above appear to demonstrate that *V. lithophila* is eligible for listing as Endangered under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 3 Population size and decline

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

Criterion 3 evidence

Insufficient evidence to determine eligibility

The total number of mature individuals is unknown and there are few available anecdotal observations or subpopulation estimates to enable any estimate of population size. Therefore, there are insufficient data to determine the species' eligibility under this criterion.

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

Criterion 4 Number of mature individuals

	Critically Endangered Extremely low	Endangered Very Low	Vulnerable Low
D. Number of mature individuals	< 50	< 250	< 1,000
D2.[1] *Only applies to the Vulnerable category* Restricted area of occupancy or number of locations with a plausible future threat that could drive the species to critically endangered or Extinct in a very short time			D2. Typically: area of occupancy < 20 km² or number of locations ≤ 5

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

Criterion 4 evidence

Insufficient evidence to determine eligibility

The total number of mature individuals is unknown and there are few available anecdotal observations or subpopulation estimates to enable any estimate of population size. Therefore, there are insufficient data to determine the species' eligibility 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 has not been undertaken. Therefore, there is insufficient information to determine the eligibility of the species for listing in any category under this criterion.

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

Adequacy of survey

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

Listing and Recovery Plan Recommendations

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

Cataloguing data

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

This publication is available at the SPRAT profile for *Veronica lithophila.*

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