

Consultation on Species Listing Eligibility and Conservation Actions

Grevillea banyabba

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

1) the eligibility of *Grevillea banyabba* 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@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.

Contents of this information package	Page
General background information about listing threatened species	1
Information about this consultation process	2
Consultation questions specific to the assessment	4
Information about the species and its eligibility for listing	13
Conservation actions for the species	24
References cited	27
Listing assessment	34

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 Grevillea banyabba (Banyabba grevillea)

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:

□ 1–50 □ 51–250 □ 251–1,000 □ >1,000 □ >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)

 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 1940s? 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:

□ 1–50 □ 51–250 □ 251–1,000 □ >1,000 □ >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
- \Box 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 80 years? 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

- 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

□ 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

□ 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

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

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?

SECTION I 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?

Threatened Species Scientific Committee



Conservation Advice for Grevillea banyabba (Banyabba grevillea)

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.



Photo of Grevillea banyabba (Banyabba grevillea) © Copyright, Adrian Gale (2020)

Department of Agriculture, Water and the Environment

Conservation status

Grevillea banyabba (Banyabba grevillea) was listed in the Vulnerable category of the threatened species list under the *Environment Protection and Biodiversity Conservation Act 1999* effective from 16 July 2000. The species was eligible for listing because prior to the EPBC Act, it was listed as Vulnerable under the *Endangered Species Protection Act 1992* (Cwlth).

Grevillea banyabba is proposed to be transferred from the Vulnerable category to the Endangered category of the threatened species list under the *Environment Protection and Biodiversity Conservation Act 1999.*

Grevillea banyabba 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: B1ab(iii,v)+2ab(iii,v): Endangered
- Criterion 3: Ineligible
- Criterion 4: Ineligible
- Criterion 5: Insufficient data

The main factors that make the species eligible for listing in the Endangered category are restricted distribution and locations; and projected continuing decline in area, extent and quality of habitat and the number of mature individuals, due to changes to fire weather conditions, rainfall patterns and temperatures, and more time in drought.

There are estimated to be <10,000 mature individuals, which all occur within reserved tenure and are primarily threatened by inappropriate fire regimes and the impacts of climate change, with no other major current threats.

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 Grevillea banyabba Olde & Marriott (1994).

Description

The Banyabba grevillea (family Proteaceae) is an open, few-branched shrub, which grows to 0.8–1.5 m tall. The branchlets are covered with long fine hairs. Leaves are 2.5–3.8 cm long and 0.5–1 cm wide, with slightly curved back edges, finely pointed tips and sparse silky hairs on the lower surface. The flowers are red with a yellow-green base and fine silver hairs on most surfaces. Flowers usually occur in loose clusters of three to thirteen flowers. The flower buds have pointed tips. The fruits are oval capsules with sparse hairs. They split down one side to release flat rectangular seeds with a wing on one side. This description is drawn from Olde & Marriott (1994), Makinson (2000) and Harden (2002).

The Banyabba grevillea can be distinguished from the related *Grevillea quadricauda* (four-tailed grevillea) by its longer leaves and an erect style on the fruit (Makinson 2000). It can be distinguished from *Grevillea masonii* (Mason's grevillea) by its longer leaves, smaller flowers and less oblique fruit (Makinson 2000).

Distribution

Current distribution

The Banyabba grevillea is endemic to north-eastern NSW in the Clarence Lowlands and Clarence Sandstones subregions of the South Eastern Queensland bioregion (IBRA7) (DPIE 2020b). The species is only known from three subpopulations between Grafton and Whiporie (Map 1; Table 1) (Olde & Marriott 1994; DPIE 2021. pers comm 24 June; Sheringham & Westaway 1995; Makinson 2000; DPIE 2020a). All subpopulations occur within Nature Reserve, State Conservation Areas or National Park (Table 1).

Population size

Knowledge of the species' population size requires further survey work. However, based on surveys in 2019–2021, local experts from the NSW DPIE estimated a total population size of \geq 10,000 individuals (DPIE 2021. pers comm 8 September), while suggesting the number of mature individuals may be fewer than 10,000 (Table 1).

In addition to the recent estimates (above; Table 1), Bailey (2019) also estimated a total population size of at least approximately 5000 individuals from field surveys in 2018–2019. Makinson & Olde (2020) inferred that the total population included approximately 800–2000 mature individuals from limited field observations. In 1997, the total population size was estimated at approximately 14,000 individuals (NPWS 1999).

Subpopulation	Surveyed number of individuals	Estimated number of individuals	Estimated number of mature individuals
Banyabba Nature Reserve/Banyabba State Conservation Area	1071	5,000	<5000
Fortis Creek National Park	1597	5,000	<5000
Wombat Creek State Conservation Area	Unknown	Unknown	Unknown
Total	2641	≥10,000	<10,000

Table 1 Population information for the Banyabba grevillea

Note: Population information provided by DPIE (2021. pers comm 1 November) based on surveys conducted in 2019-2021. Surveys did not cover the entire species' distribution, so DPIE has factored this into the estimated number of individuals.

Environment Australia (1999) estimated the population size required for the Banyabba grevillea to withstand the influences of demographic/environmental uncertainty in the absence of additional disturbance (i.e., the population size required to ensure there is less than one percent chance of the population declining to 50 individuals at least once over the next 50 years) was approximately 7780 individuals.

Past distribution and erroneous records

The historical distribution of the Banyabba grevillea is likely to be similar to its current distribution (NPWS 1999). However, similar vegetation adjoining known subpopulations has been moderately cleared for agriculture or used for forestry activities, which is likely to have reduced the number of individuals and opportunities for recolonisation (NPWS 1999).

An outlying record for the species from Gibberagee State Forest was checked in the field and reassigned to Mason's grevillea (DPIE 2021. pers comm 24 June).



Map 1 Modelled distribution of the Banyabba grevillea

Source: Base map Geoscience Australia; species distribution data Species of National Environmental Significance database.

Caveat: The information presented in this map has been provided by a range of groups and agencies. While every effort has been made to ensure accuracy and completeness, no guarantee is given, nor responsibility taken by the Commonwealth for errors or omissions, and the Commonwealth does not accept responsibility in respect of any information or advice given in relation to, or as a consequence of, anything containing herein.

Species distribution mapping: The species distribution mapping categories are indicative only and aim to capture (a) the specific habitat type or geographic feature that represents to recent observed locations of the species (known to occur) or preferred habitat occurring in close proximity to these locations (likely to occur); and (b) the broad environmental envelope or geographic region that encompasses all areas that could provide habitat for the species (may occur). These presence categories are created using an extensive database of species observations records, national and regional-scale environmental data, environmental modelling techniques and documented scientific research.

Cultural and community significance

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.

Grevilleas are a culturally significant plant for Indigenous Australians (Royal Botanic Gardens Victoria 2014). Grevillea flowers are bush tucker and can be sucked or soaked in water to produce a sweet drink (Flood 1980; Australian National Botanic Gardens 2007). Ascertaining the cultural significance of this species is an information/research priority identified in the Conservation and Recovery Actions.

The Banyabba grevillea and its habitat occur on Country belonging to the Bundjalung People. The Bundjalung People have lived on Country since the beginning of the Dreaming. Native title rights of the Bundjalung People over Banyabba Nature Reserve have been legally recognised by the Federal Court of Australia (2013). This reserve is part of a landscape of cultural importance to the Bundjalung People and these lands will continue to be places of ceremony, learning and inspiration for generations to come. The NSW National Parks and Wildlife Service (NPWS) is working with the Bundjalung People to help promote culture and reconciliation within the Banyabba Nature Reserve (NPWS 2020).

Relevant biology and ecology

Habitat ecology

The Banyabba grevillea grows in dry sclerophyll forests on low sandstone ridges in welldrained, sandy soils, and on rocky cliffs or major rocky outcrops (Makinson 2000; DPIE 2020b). It often grows in association with *Eucalyptus planchoniana* (needlebark stringybark), *Eucalyptus psammitica* (bastard white mahogany), *Angophora robur* (sandstone rough-barked apple), *Corymbia gummifera* (red bloodwood) and *Corymbia intermedia* (pink bloodwood) (NPWS 2002; DPIE 2020a; DPIE 2021. pers comm 15 April).

Reproductive ecology

The reproductive ecology of the Banyabba grevillea is not well understood and requires further investigation. The species flowers from August to October (Makinson 2000). The primary and secondary juvenile periods are unknown. However, Environment Australia (1999) estimate a three-year recovery time for the Banyabba grevillea (i.e., the time between disturbance and the point when the species has developed sufficiently to reproduce, including the time required to reach reproductive maturity). The species is suspected to be long-lived (up to 50 years) (DPIE 2021. pers comm 24 June). The pollinators and seed dispersal methods are also unknown.

Fire and disturbance ecology

In many plants in family Proteaceae (including *Grevillea* spp.), germination of dormant seeds is triggered by fire-related cues, including heat, smoke and scarification (Edwards & Whelan 1995; Bradstock et al. 1996; Morris 2000). The Banyabba grevillea is predominately an obligateseeding species (Richards 1999; Makinson 2000; Auld et al. 2020; Gallagher et al. 2021). Following the 2019-20 bushfires, regeneration was mostly observed from seed germination, however resprouting was also observed in plants in a small patch (along Dilkoon Trail) in Fortis Creek National Park (DPIE 2021. pers comm 15 April). The reason for this resprouting fire response in this small patch is unknown.

As the mature plants of obligate-seeding species are usually killed by fire, they can undergo natural fluctuations in the number of mature individuals, and accordingly, there must be sufficient intervals between fires to allow new seedlings to reach maturity and replenish the seedbank (Edwards & Whelan 1995; Auld et al. 2007). Typically, populations of woody plant species can be sustained under mean fire return intervals of approximately 15 years (Keith 1996). However, the Banyabba grevillea may be able to tolerate fire-free intervals as short as approximately 5–7 years (pending further research) (NSW RFS 2013; DPIE 2021. pers comm 24 June).

The Banyabba grevillea is likely to have a soil-stored seedbank (NPWS 1999). In species with soil-stored seed, some residual seed may remain in the soil following fire (Auld & Denham 2006). However, this is not always the case, as little to no residual seedbank was reported in a grevillea species in south-eastern Australia after a low-moderate intensity fire (Auld & Denham 2006).

Habitat critical to the survival

The Banyabba grevillea grows in dry sclerophyll forests on low sandstone ridges in welldrained, sandy soils, and on rocky cliffs or major rocky outcrops (Makinson 2000; DPIE 2020b). Within the distribution of the Banyabba Grevillea in north-eastern NSW, such habitat is likely to be necessary for dispersal activities, long-term maintenance and evolutionary development of the species.

The habitat critical to the survival of the Banyabba grevillea includes the area of occupancy of known subpopulations; areas of similar habitat adjoining known subpopulations (as described above), which provide potential habitat for natural range extension; areas of similar habitat that may contain the species or be suitable for translocations (as described above); and the local catchment for the surface and/or groundwater that maintains the habitat of the species.

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 Banyabba grevillea are important for the long-term recovery and survival of this species.

Threats

The Banyabba grevillea is predominately threatened by fire and climate change (Table 2). The species' restricted distribution may increase its' risk of extinction via stochastic processes (DPIE 2020a).

ThreatStatus and severity a		Evidence		
Habitat loss, disturbance a	and modification			
Inappropriate fire regimes	 Timing: current Confidence: observed Consequence: major Trend: increasing Extent: across the entire range 	The Banyabba grevillea is predominately an obligate- seeding species (Richards 1999; Makinson 2000; Auld et al. 2020; Gallagher et al. 2021). The mature plants of obligate-seeding species are usually killed by fire, so a fire-free interval is required to allow new seedlings to reach maturity and replenish the seedbank (Edwards & Whelan 1995; Auld et al. 2007). Accordingly, a high-frequency fire regime (<5-7 years) is likely to reduce the population size and health of the Banyabba grevillea (Sheringham & Westaway 1995; DPIE 2020a; Makinson & Olde 2020). This could be exacerbated by interval squeeze (Gallagher et al. 2021) or earlier fire season (Miller et al. 2019). Interactions between fire and seed predators may also elevate risks of decline, especially under small or patchy fires (Regan et al. 2003). Fires can also alter habitat structure, by favouring the invasion and establishment of weeds (D'Antonio & Vitousek 1992; Grigulis et al. 2005). The species' restricted distribution may increase its extinction risk, following stochastic events, such as fire (DPIE 2020a), especially when they interact with		
Land clearing	 Timing: historical Confidence: inferred Consequence: moderate Trend: unknown Extent: across part of its range 	All known subpopulations occur within reserved tenure (Table 1), with most individuals occurring within Banyabba Nature Reserve (DPIE 2020a). This area was declared wilderness and protected under the Wilderness Act (NPWS 2001), so land clearing is prohibited. However, some areas of similar habitat adjoining known subpopulations has been cleared for agriculture or used for forestry activities, which is likely to have reduced the number of individuals and opportunities for recolonisation (NPWS 1999).		
Damage associated with timber harvesting	 Timing: historical Confidence: suspected Consequence: low Trend: static Extent: across part of its range 	The Banyabba State Conservation Area was created in 2003 (NPWS 2021). Prior to gazettal, the area was part of the Banyabba State Forest (NPWS 2021). Historically, individuals occurring in this area may have been accidentally destroyed during timber harvesting from Banyabba State Forest (DECCW 2010; DPIE 2020a). However, this is no longer considered a threat as the area is now reserved for conservation. Illegal timber harvesting has been reported within Southern Richmond Range Parks and may impact the Banyabba grevillea (OEH 2016). However, the species occurs on low fertility soils, which are unlikely to be substantially impacted by illegal timber harvesting (DPIE 2021, pers comm 24 lune)		

Table 2 Threats impacting the Banyabba grevillea

Threat	Status and severity ^a	Evidence
Damage associated with road maintenance	 Timing: current Confidence: suspected Consequence: low Trend: static Extent: across part of its range 	The Banyabba grevillea may be damaged accidentally during construction of drainage channels, grading and other road maintenance activities (DPIE 2020a). Such activities may also promote weed invasion (Sindel et al. 2009).
Disease		
Dieback caused by Phytophthora cinnamomi	 Timing: future Confidence: suspected Consequence: major Trend: unknown Extent: across the entire range 	 Phytophthora cinnamomi is an introduced soil-borne pathogen, which infects a large range of plant species and may contribute to plant death, especially when other stresses are present, such as waterlogging, drought and fire (DOEE 2018). Phytophthora cinnamomi can disperse in water flowing from roots of infected plants to roots of healthy plants and mud clinging to vehicles, animals and walkers (DOEE 2018). Dieback caused by <i>P. cinnamomi</i> is listed as a key threatening process under the EPBC Act (DOEE 2018). The disease has been detected in the nearby north coast wet sclerophyll and northern escarpment dry sclerophyll forests (DPIE 2020d), but not in north coast dry sclerophyll forest or the Banyabba Nature Reserve (OEH 2016; DPIE 2020d). The nearest occurrence record of <i>P. cinnamomi</i> is near Booyong, NSW, approximately 80 kilometres from the border of Banyabba Nature Reserve (ALA 2020). Soil samples tested for <i>Olax angulata</i> (square-stemmed olax), which co-occurs with the Banyabba grevillea in Banyabba Nature Reserve, were negative for <i>P. cinnamomi</i> in 2019 (DPIE 2021, pers comm 15 April). Proteaceae are one of the most susceptible plant families to <i>P. cinnamomi</i> (DSE 2009). So, the Banyabba grevillea is likely to be severely impacted if <i>P. cinnamomi</i> spreads to the Banyabba Nature Reserve. Additionally, the small population size and restricted distribution of the species may increase its extinction risk, following stochastic events, such as disease (DPIE 2020a).

Threat	Status and severity a	Evidence				
Climate change						
Increased temperatures and change to precipitation patterns	 Timing: current Confidence: observed/projected Consequence: moderate Trend: increasing Extent: across the entire range 	From 2017-19, north-eastern NSW experienced severe drought (Bureau of Meteorology 2020; DPI 2020), which overlapped with approximately 53% of the Banyabba grevillea's modelled distribution in the six months preceeding the 2019-20 bushfires (Gallagher 2020). This drought is suspected to have caused dieback of leaves and branches in mature individuals (DPIE 2021. pers comm 24 June). Such events are increasingly likely to occur due to climate change (CSIRO & Bureau of Meteorology				
		2015). Drought may cause widespread plant mortality in forest ecosystems, as many plants are vulnerable to drought stress and hydraulic failure of their vascular system (Allen et al. 2010; Choat et al. 2012; De Kauwe et al. 2020). Many plants in family Proteaceae, including <i>Grevillea</i> spp., are expected to decline in range and population size, primarily due to the effect of declining rainfall on seed production and seedling survival (Midgley et al. 2006; Fitzpatrick et al. 2008; Shimizu-Kimura et al. 2017). Given the Banyabba grevillea already has very restricted distribution and small population size, it may be at risk of extinction following intense or frequent droughts (DPIE 2020a).				
		Additionally, following severe drought, catastrophic bushfire conditions resulted in unprecedented, extensive bushfires across Australia in 2019-20. Initial estimates suggest the 2019-20 bushfires overlapped with approximately 80% of the Banyabba grevillea's modelled distribution (Auld et al. 2020; Gallagher 2020; Gallagher et al. 2021) with approximately 50-60% of individuals burnt (DPIE 2021. pers comm 24 June). However, fire is likely to be required for germination, post-fire seedling recruitment is high, and both seedlings and resprouts are healthy (DPIE 2021. pers comm 24 June). Accordingly, the loss of mature individuals following the 2019-20 bushfires is considered part of a natural fluctuation. However, as 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 Banyabba grevillea may decline in the future as fire- free intervals continue to shorten (i.e., through interval squeeze) (Enright et al. 2015). Warmer temperatures and changes to precipitation patterns may also favour the spread of weeds (Scott et al. 2014) and <i>P. cinnamomi</i> (Thompson et al. 2014; Homet et al. 2019).				

Threat	Status and severity a	Evidence		
Invasive species				
Exotic perennial grass invasion	 Timing: future Confidence: suspected Consequence: low Trend: increasing Extent: across the entire range 	The invasion of native plant communities by exotic perennial grasses was listed as a key threatening process under the Threatened Species Conservation Act in NSW (NSW Scientific Committee 2003). Weeds can invade, establish in and outcompete native vegetation, particularly following disturbance events, such as fires (Hobbs 1991; Hobbs 2002; Brown et al. 2016). In particular, grassy weeds can increase fuel load and alter fire regimes (Milberg & Lamont 1995; Setterfield et al. 2013). These altered fire regimes can create conditions that are detrimental to the maintenance of native species and favourable to the establishment and spread of weeds (D'Antonio & Vitousek 1992; Grigulis et al. 2005).		
		Grasses occur in low density with sparse cover in the Banyabba grevillea's low fertility habitat (DPIE 2021. pers comm 15 September). There is no evidence that grasses are currently outcompeting seedlings (DPIE 2021. pers comm 15 September). However, introduced grasses have potential to invade native vegetation in the Northern Rivers region and may threaten the Banyabba grevillea, particularly following fires (DECCW 2010; DPIE 2020a).		
Pine invasion	 Timing: future Confidence: suspected Consequence: moderate Trend: unknown Extent: across the entire range 	The slash pine (<i>Pinus elliottii</i>) and the loblolly pine (<i>Pinus taeda</i>) are becoming naturalised around plantations in north-eastern NSW (AVH 2020a, b), including the Banyabba State Forest, adjacent to the area where the Banyabba grevillea occurs (DPIE 2020a). These species may threaten the Banyabba grevillea by shading out the understorey and changing soil chemistry (DPIE 2020a).		

^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 Risk Matrix for Banyabba grevillea

Likelihood	Consequences							
	Not significant	Minor	Moderate	Major	Catastrophic			
Almost certain	Low risk	Moderate risk	erate risk Very high risk Increased temperatures and change to precipitation patterns		Very high risk			
Likely	Low risk	Moderate risk	High risk	Very high risk Inappropriate fire regimes	Very high risk			
Possible	Low risk	Moderate risk Damage associated with road maintenance Exotic perennial grass invasion	High risk Pine invasion	Very high risk Dieback caused by P. cinnamomi	Very high risk			
Unlikely	Low risk	Low risk Damage associated with timber harvesting	Moderate risk Land clearing	High risk	Very high risk			
Unknown	Low risk	Low risk	Moderate risk	High risk	Very high risk			

Categories for likelihood are defined as follows:

Almost certain - expected to occur every year

Likely – expected to occur at least once every five years

Possible – might occur at some time

Unlikely - such events are known to have occurred on a worldwide bases but only a few ties

Unknown - currently unknown how often the incident will occur

Categories for consequences are defined as follows:

Not significant – no long-term effect on individuals or populations

Minor - individuals are adversely affected but no effect at population level

Moderate – population recovery stalls or reduces

Major – population decreases

Catastrophic – population extinction/extirpation

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

Conservation and recovery actions

Primary conservation objective

Within the next three generations, the population of the Banyabba grevillea 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 within Banyabba grevillea subpopulations before an accumulation of a seedbank large enough to replace the number of fire-killed standing plants. Noting that replacement should incorporate expected post-fire rates of seedling survival (see Regan et al. 2003).
- 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 local and state Rural Fire Services and seek inclusion of mitigation measures in fire risk management plan/s, risk register and/or operation maps, including measures to avoid damage to plants and their habitat during fire suppression and mop-up operations.

Climate change

- Map the exposure of the species to climate change using distribution modelling and climate change projections, to locate existing habitat patches and identify future habitat that would be suitable for the species.
- Undertake vulnerability assessments of the species sensitivity and adaptive capacity to changing climate conditions which draw from genetic, physiological or ecological evidence.

Habitat loss, disturbance and modifications

- Avoid or minimise further loss and fragmentation of habitat.
- Ensure local governments, relevant state agencies and utility service providers have access to adequate distribution information and use best practice methods for roadside and utility corridor maintenance and land management activities to protect the Banyabba grevillea and its habitat.
- Maintain protection zones around known sites and assess the effectiveness of current forestry management practices in ameliorating disturbance where the species occurs. Revise management practices if necessary.

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).

Disease

- Determine susceptibility of the Banyabba grevillea to *P. cinnamomi*.
- Implement a *P. cinnamomi* management plan to ensure it is not introduced into known locations of the Banyabba grevillea and the spread in areas outside of, but adjacent to Banyabba grevillea subpopulations is mitigated (DOEE 2018). Where feasible, close and revegetate roads and tracks to reduce ingress of disease.
- Ensure that appropriate hygiene protocols are adhered to when entering or exiting the known locations of the Banyabba grevillea, such as those outlined in Podger et al. (2001).

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). If required, investigate the possibility of establishing translocated subpopulations, according to Commander et al. (2018).

Stakeholder engagement/community engagement

- Engage and involve Traditional Owners in conservation actions, including the implementation of Indigenous fire management and other survey, monitoring and management actions.
- Continue to liaise with government agencies, land managers and stakeholder groups to ensure up-to-date population data and scientific knowledge inform the implementation of conservation actions for this species.
- Promote community awareness of the Banyabba grevillea and identify opportunities for involvement in conservation actions.
- Contribute to impact assessment and planning processes on measures to protect the Banyabba grevillea and its habitat, including park management plans and environmental impact assessments.

Survey and monitoring priorities

- Undertake annual monitoring of known subpopulations, potential habitat, habitat condition/degradation (including impacts from weed invasion, introduced species and diseases), population stability (expansion or decline), recruitment and longevity.
- 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.
- Identify subpopulations in timber harvesting areas and alongside roads. Protect these populations from disturbance.

Information and research priorities

- Investigate options for linking, enhancing or establishing additional subpopulations.
- Map habitat critical to the survival of the species and identify any critical habitat on Commonwealth land.
- Investigate the ecological requirements of the Banyabba grevillea, that are relevant to persistence, particularly in the context of climate change and high fire frequency:
 - primary and secondary juvenile periods and longevity,
 - population genetic structure, levels of genetic diversity and minimum viable population size,
 - soil seedbank dynamics and the role of seed predators and various disturbances (including fire), competition, rainfall and grazing in germination and recruitment,
 - reproductive strategies, phenology and seasonal growth, 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 Banyabba grevillea's persistence.
- Ascertain the cultural significance of the species to Traditional Owners.

Recovery plan decision

A NSW Saving Our Species Strategy is in place for the species (DPIE 2021).

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

Banyabba grevillea (Grevillea banyabba) Saving our Species Strategy (2021)

Northern Rivers Regional Biodiversity Management Plan (2010)

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

Threatened Flora Species of the Glenreagh-Coaldale Sandstone Area Recovery Plan (1999)

Conservation Advice and Listing Assessment references

- Abatzoglou JT & Williams AP (2016) Impact of anthropogenic climate change on wildfire across western US forests. *Proceedings of the National Academy of Sciences* 113, 11770.
- ALA (Atlas of Living Australia) (2020) *Phytophthora cinnamomi* Rands. Accessed: 12 October 2020 Available at: <u>https://bie.ala.org.au/species/b9765dc9-8d1b-4d70-b20d-01aff1edda8d</u>
- Allen CD, Macalady AK, Chenchouni H, Bachelet D, McDowell N, Vennetier M, Kitzberger T, Rigling A, Breshears DD, Hogg EH, Gonzalez P, Fensham R, Zhang Z, Castro J, Demidova N, Lim J-H, Allard G, Running SW, Semerci A & Cobb N (2010) A global overview of drought and heat-induced tree mortality reveals emerging climate change risks for forests. *Forest Ecology and Management* 259, 660-684.
- Auld TD, Andrew JD & Turner K (2007) Dispersal and recruitment dynamics in the fleshy-fruited *Persoonia lanceolata* (Proteaceae). *Journal of Vegetation Science* 18, 903-910.
- Auld TD & Denham AJ (2006) How much seed remains in the soil after a fire? *Plant Ecology* 187, 15-24.
- Auld TD, Mackenzie B, Le Breton T, Keith DA, Ooi MK, Allen S & Gallagher R (2020) *A preliminary* assessment of the impact of the 2019/2020 fires on NSW plants of national significance. Department of Planning Industry and Environment (NSW), Parramatta.
- Australian National Botanic Gardens (2007). Aboriginal plant use NSW southern tablelands. Accessed: 2 October 2020 Available at: <u>http://www.anbg.gov.au/apu/</u>
- AVH (Australasian Virtual Herbarium) (2020a) Occurrence records for *Pinus elliottii*. Accessed: 25 September 2020 Available at: <u>https://avh.ala.org.au/occurrences/search?taxa=Pinus+elliottii#tab_mapView</u>
- AVH (Australasian Virtual Herbarium) (2020b) Occurrence records for *Pinus taeda*. Accessed: 25 September 2020 Available at: <u>https://avh.ala.org.au/occurrences/search?taxa=Pinus+taeda#tab_mapView</u>
- Bailey D (2019) *Olax angulata monitoring. Survey for Square-stemmed Olax 2018-2019*. Unpublished report for the Department of Planning, Industry and Environment (NSW).
- Bradstock RA, Bedward M, Scott J & Keith DA (1996) Simulation on the effect of the spatial and temporal variation in fire regimes on the population viability of a *Banksia* species. *Conservation Biology* 10, 776-784.
- Brown K, Paczkowska G & Gibson N (2016) Mitigating impacts of weeds and kangaroo grazing following prescribed fire in a *Banksia* woodland. *Ecological Management & Restoration* 17, 133-139.
- Bureau of Meteorology (2020) Special Climate Statement 70 update—drought conditions in Australia and impact on water resources in the Murray–Darling Basin. Bureau of Meteorology (Commonwealth).
- Bureau of Meteorology & CSIRO (Commonwealth Scientific and Industrial Research Organisation) (2020) *State of the Climate*. Commonwealth of Australia, Australia.

- Choat B, Jansen S, Brodribb TJ, Cochard H, Delzon S, Bhaskar R, Bucci SJ, Feild TS, Gleason SM, Hacke UG, Jacobsen AL, Lens F, Maherali H, Martínez-Vilalta J, Mayr S, Mencuccini M, Mitchell PJ, Nardini A, Pittermann J, Pratt RB, Sperry JS, Westoby M, Wright IJ & Zanne AE (2012) Global convergence in the vulnerability of forests to drought. *Nature* 491, 752-755.
- Clarence Valley Bushfire Management Committee (2008) *Clarence Valley Bushfire Management Plan*. Clarence Valley Bushfire Management Committee.
- Clarke H, Pitman AJ, Kala J, Carouge C, Haverd V & Evans JP (2016) An investigation of future fuel load and fire weather in Australia. *Climatic Change* 139, 591-605.
- Commander LE, Coates D, Broadhurst L, Offord CA, Makinson RO & Matthes M (2018) *Guidelines for the translocation of threatened plants in Australia*. 3rd edn. Australian Network for Plant Conservation, Canberra.
- CSIRO (Commonwealth Scientific and Industrial Research Organisation) & Bureau of Meteorology (2015) *Climate change in Australia information for Australia's natural resource management regions: technical report.* CSIRO and Bureau of Meteorology, Australia.
- D'Antonio CM & Vitousek PM (1992) Biological invasions by exotic grasses, the grass/fire cycle, and global change. *Annual Review of Ecology and Systematics* 23, 63-87.
- DECCW (Department of Environment, Climate Change and Water) (2010) *Northern Rivers regional biodiversity management plan*. Department of Environment, Climate Change and Water (NSW), Sydney.
- De Kauwe MG, Medlyn BE, Ukkola AM, Mu M, Sabot ME, Pitman AJ, Meir P, Cernusak LA, Rifai SW, Choat B, Tissue DT, Blackman CJ, Ximeng L, Roderick M, & Briggs PR (2020) Identifying areas at risk of drought-induced tree mortality across South-Eastern Australia. *Global Change Biology*, 26, 10, 5716–5733.
- DOEE (Department of the Environment and Energy) (2018) *Threat abatement plan for disease in natural ecosystems caused by Phytophthora cinnamomi. Department of the Environment and Energy (Commonwealth), Canberra.*
- Dowdy AJ (2018) Climatological variability of fire weather in Australia. *Journal of Applied Meteorology and Climatology* 57, 221-234.
- Dowdy AJ, Ye H, Pepler A, Thatcher M, Osbrough SL, Evans JP, Di Virgilio G & McCarthy N (2019) Future changes in extreme weather and pyroconvection risk factors for Australian wildfires. *Scientific Reports* 9, 10073.
- DPI (Department of Primary Industries) (2020) Drought in NSW. Accessed: 14 Spetember 2020 Available at: <u>https://www.dpi.nsw.gov.au/climate-and-</u> <u>emergencies/droughthub/drought-in-nsw</u>
- DPIE (Department of Planning, Industry and Environment) (2020a) Banyabba grevillea profile. Accessed: Available at: <u>https://www.environment.nsw.gov.au/threatenedSpeciesApp/profile.aspx?id=10359</u>

DPIE (Department of Planning, Industry and Environment) (2020b) Banyabba grevillea - south eastern Queensland: distribution and vegetation associations. Accessed: 25 September 2020 Available at:

https://www.environment.nsw.gov.au/threatenedSpeciesApp/profileData.aspx?id=103 59&cmaName=South+Eastern+Queensland

- DPIE (Department of Planning, Industry and Environment) (2020c) *DPIE fire extent and severity mapping* Department of Planning, Industry and Environment (NSW), Sydney.
- DPIE (Department of Planning, Industry and Environment) (2020d) *Key threatening process strategy for infection of native plants by* Phytophthora cinnamomi. Department of Planning, Industry and Environment (NSW), Sydney.
- DPIE (Department of Planning, Industry and Environment) (2021) Banyabba grevillea (*Grevillea* banyabba): Saving our species strategy. Accessed: 1 September 2021 Available at: <u>https://www.environment.nsw.gov.au/savingourspeciesapp/project.aspx?ProfileID=10</u> <u>359</u>
- DPIE (Department of Planning, Industry and Environment) (2021) Personal communication by email, 15 April 2021. Department of Planning, Industry and Environment (NSW).
- DPIE (Department of Planning, Industry and Environment) (2021) Personal communication by email, 24 June 2021. Department of Planning, Industry and Environment (NSW).
- DPIE (Department of Planning, Industry and Environment) (2021) Personal communication by email, 6 July 2021. Department of Planning, Industry and Environment (NSW).
- DPIE (Department of Planning, Industry and Environment) (2021) Personal communication by email, 8 September 2021. Department of Planning, Industry and Environment (NSW).
- DPIE (Department of Planning, Industry and Environment) (2021) Personal communication by email, 15 September 2021. Department of Planning, Industry and Environment (NSW).
- DPIE (Department of Planning, Industry and Environment) (2021) Personal communication by email, 1 November 2021. Department of Planning, Industry and Environment (NSW).
- DSE (Department of Sustainability and Environment) (2009) *Victoria's public land* Phytophthora cinnamomi *management strategy*. Department of Sustainability and Environment (VIC), East Melbourne.
- Dutta R, Das A & Aryal J (2016) Big data integration shows Australian bush-fire frequency is increasing significantly. *Royal Society open science* 3, 150241-150241.
- Edwards W & Whelan R (1995) The size, distribution and germination requirements of the soilstored seedbank of *Grevillea barklyana* (Proteaceae). *Australian Journal of Ecology* 20, 54.
- Enright NJ, Fontaine JB, Bowman DM, Bradstock RA & Williams RJ (2015) Interval squeeze: altered fire regimes and demographic responses interact to threaten woody species persistence as climate changes. *Frontiers in Ecology and the Environment* 13, 265-272.

- Environment Australia (1999) *Response to disturbance of forest species in CRA regions in NSW upper north east and lower north east regions. A project undertaken as part of the NSW comprehensive regional assessments. Project number NA 17/EH.* A project undertaken for the Joint Commonwealth NSW Regional Forest Agreement Steering Committee as part of the NSW Comprehensive Regional Assessments, Sydney.
- Fitzpatrick MC, Gove AD, Sanders NJ & Dunn RR (2008) Climate change, plant migration and range collapse in a global biodiversity hotspot: the *Banksia* (Proteaceae) of Western Australia. *Global Change Biology* 14, 1337–1352.
- Flood J (1980) The moth hunters. Australian Institute of Aboriginal Studies, Canberra.
- Gallagher RV (2020) National prioritisation of Australian plants affected by the 2019-2020 bushfire season. Report to Department of Agriculture, Water and Environment (Commonwealth), Canberra. Accessed: 7 January 2021 Available at: http://www.environment.gov.au/biodiversity/bushfire-recovery/priority-plants
- Gallagher RV, Allen S, Mackenzie BDE, Yates CJ, Gosper CR, Keith DA, Merow C, White MD, Wenk E, Maitner BS, He K, Adams VM & Auld TD (2021) High fire frequency and the impact of the 2019–2020 megafires on Australian plant diversity. *Diversity and Distributions*, 1-14.
- Grigulis K, Lavorel S, Davies ID, Dossantos A, Lloret F & Vilà M (2005) Landscape-scale positive feedbacks between fire and expansion of the large tussock grass, *Ampelodesmos mauritanica* in Catalan shrublands. *Global Change Biology* 11, 1042-1053.
- Harden GJ (2002) Flora of New South Wales. UNSW, Sydney.
- Hobbs R (1991) Disturbance a precursor to weed invasion in native vegetation. *Plant Protection Quarterly* 6, 99-104.
- Hobbs R (2002) Fire regimes and their effects in Australian temperate woodlands. In: Bradstock R, J Williams, A Gill (eds) *Flammable Australia: the fire regimes and biodiversity of a continent.* Cambridge University Press, UK. pp 305-326.
- Homet P, González M, Matías L, Godoy O, Pérez-Ramos IM, García LV & Gómez-Aparicio L (2019) Exploring interactive effects of climate change and exotic pathogens on *Quercus suber* performance: Damage caused by *Phytophthora cinnamomi* varies across contrasting scenarios of soil moisture. *Agricultural and Forest Meteorology* 276-277, 107605.
- IPAC (Invasive Plants and Animals Committee) (2016) *Australian weeds strategy 2017-2027*. Department of Agriculture, Water and the Environment (Commonwealth), Canberra.
- IUCN (International Union for Conservation of Nature) (2019) *Guidelines for using the IUCN red list categories and criteria. Version 14.* Prepared by the IUCN Standards and Petitions Committee.
- Keith D (1996) Fire-driven extinction of plant populations: A synthesis of theory and review of evidence from Australian vegetation. In: Proceedings-Linnean Society of New South Wales, vol. 116. Linnean Society of New South Wales. pp 37-78.
- Le Breton TD, Zimmer HC, Gallagher RV, Cox M, Allen S & Auld TD (2019) Using IUCN criteria to perform rapid assessments of at-risk taxa. *Biodiversity and Conservation* 28, 863-883.

- Makinson R & Olde P (2020) *Grevillea banyabba*. The IUCN Red List of Threatened Species 2020: e.T112646721A113309215. Accessed: 23 June 2021 Available at: https://dx.doi.org/10.2305/IUCN.UK.2020-2.RLTS.T112646721A113309215.en
- Makinson RO (2000) Proteaceae 2 *Grevillea*. In: *Flora of Australia*. vol 17A. ABRS/CSIRO, Melbourne
- Martyn Yenson AJ, Offord CA, Meagher PF, Auld T, Bush D, Coates DJ, Commander LE, Guja LK, Norton SL, Makinson RO, Stanley R, Walsh N, Wrigley D & Broadhurst L (2021) *Plant germplasm conservation in Australia: Strategies and guidelines for developing, managing and utilising ex situ collection*. 3rd edn. Australian Network for Plant Conservation, Canberra.
- Midgley G, Hughes G, Thuiller W & Rebelo AG (2006) Migration rate limitations on climate change-induced range shifts in Cape Proteaceae. *Diversity and Distributions* 12, 555-562.
- Milberg P & Lamont BB (1995) Fire enhances weed invasion of roadside vegetation in southwestern Australia. *Biological Conservation* 73, 45-49.
- Miller RG, Tangney R, Enright NJ, Fontaine JB, Merritt DJ, Ooi MKJ, Ruthrof KX & Miller BP (2019) Mechanisms of fire seasonality effects on plant populations. *Trends in Ecology & Evolution* 34, 1104-1117.
- Morris E (2000) Germination response of seven east Australian *Grevillea* species (Proteaceae) to smoke, heat exposure and scarification. *Australian Journal of Botany* 48, 179-189.
- NPWS (National Parks and Wildlife Service) (1999) *Threatened flora species of the Glenreagh-Coaldale sandstone area recovery plan. NSW NPWS recovery planning program.* National Parks and Wildlife Service (NSW), Sydney.
- NPWS (National Parks and Wildlife Service) (2001) Northern wilderness assessment report. National Parks and Wildlife Service (NSW), Coffs Harbour.
- NPWS (National Parks and Wildlife Service) (2002) *Threatened species of the upper north coast* of NSW: flora. National Parks and Wildlife Service (NSW), Coffs Harbour.
- NPWS (National Parks and Wildlife Service) (2007) Southern Richmond Range Reserves fire management strategy (type 2). National Parks and Wildlife Service (NSW).
- NPWS (National Parks and Wildlife Service) (2020) Banyabba Nature Reserve. Accessed: 2 October 2020 Available at: <u>https://www.nationalparks.nsw.gov.au/visit-a-park/parks/banyabba-nature-reserve</u>
- NPWS (National Parks and Wildlife Service) (2021) Banyabba State Conservation Area. Accessed: 7 July 2021 Available at: <u>https://www.nationalparks.nsw.gov.au/visit-a-park/parks/banyabba-state-conservation-area</u>
- NSW RFS (New South Wales Rural Fire Service) (2013) Threatened species hazard reduction list - Part 1 - Plants. Accessed: 7 July 2021 Available at: <u>https://www.rfs.nsw.gov.au/__data/assets/pdf_file/0017/24335/Web-Version-</u> <u>ThreatenedSpeciesHazardReductionList-Part1-Plants-06-04-2017.pdf</u>
- NSW Scientific Committee (2003) *Final determination to list 'invasion of native plant communities by exotic perennial grasses' as a key threatening process.* Schedule 3 of the Threatened Species Conservation Act.

- OEH (Office of Environment and Heritage) (2014) *Adapt NRM: North coast climate change snapshot*. Office of Environment and Heritage (NSW), Sydney.
- OEH (Office of Environment and Heritage) (2016) Plan of management: Southern Richmond Range parks, incorporating Fortis Creek and Mount Pikapene National Parks; Banyabba, Chapmans Peak and Mount Neville Nature Reserves; and Banyabba, Corymbia, Gurranang, Kooyong, Lawrence Road, Mount Pikapene and Wombat Creek State Conservation Areas. Office of Enviroment and Heritage (NSW), Sydney.
- Olde PM & Marriott NR (1994) A taxonomic revision of *Grevillea arenaria* and *Grevillea obtusiflora* (Proteaceae: Grevilleoideae). *Telopea* 5, 711-733.
- Palmer HD, Denham AJ & Ooi MKJ (2018) Fire severity drives variation in post-fire recruitment and residual seed bank size of *Acacia* species. *Plant Ecology* 219, 527-537.
- Podger FD, James SH & Mulcahly MJ (2001) Phytophthora cinnamomi and disease caused by it a protocol for identifying 'protectable areas' and their priority for management. Draft report prepared for Department of Parks and Wildlife (WA), Perth.
- Regan HM, Auld TD, Keith DA & Burgman MA (2003) The effects of fire and predators on the long-term persistence of an endangered shrub, *Grevillea caleyi*. *Biological Conservation* 109, 73-83.
- Richards P (1999) Threatened plants project: a project undertaken for the joint Commonwealth NSW Regional Forest Agreement Steering Committee as part of the NSW Comprehensive Regional Assessments project number NA 22/EH incorporating NU 03/EH targeted flora survey project. Department of Urban Affairs and Planning (NSW) and Department of the Prime Minister and Cabinet (Commonwealth), Sydney & Barton.
- Royal Botanic Gardens Victoria (2014) Essence of Australia garden: Top 10 Australian bush tucker and culturally significant plants. Accessed: 2 October 2020 Available at: <u>https://www.rbg.vic.gov.au/documents/Top 10 Australian bush tucker plants FINAL.p</u> <u>df</u>
- Scott JK, Webber BL, Murphy H, Ota N, Kriticos DJ & Loechel B (2014) *AdaptNRM: weeds and climate change: supporting weed management adaptation*. CSIRO and NCCARF Australia.
- Setterfield SA, Rossiter-Rachor NA, Douglas MM, Wainger L, Petty AM, Barrow P, Shepherd IJ & Ferdinands KB (2013) Adding fuel to the fire: the impacts of non-native grass invasion on fire management at a regional scale. *PLoS One* 8, e59144.
- Sheringham P & Westaway J (1995) *Significant vascular plants of upper north east NSW*. A report by the NSW NPWS for the Natural Resources Audit Council.
- Shimizu-Kimura Y, Accad A & Shapcott A (2017) The relationship between climate change and the endangered rainforest shrub *Triunia robusta* (Proteaceae) endemic to southeast Queensland, Australia. *Scientific Reports* 7, 46399.
- Sindel B, van der Meulen A, Coleman M, Reeve I & Moss J (2009) *Pathway risk analysis for weed spread within Australia: implications for policy makers*. University of New England, Armidale.
- Thompson SE, Levin S & Rodriguez-Iturbe I (2014) Rainfall and temperatures changes have confounding impacts on *Phytophthora cinnamomi* occurrence risk in the southwestern USA under climate change scenarios. *Global Change Biology* 20, 1299-1312.

van Oldenborgh GJ, Krikken F, Lewis S, Leach NJ, Lehner F, Saunders KR, van Weele M, Haustein K, Li S & Wallom D (2021) Attribution of the Australian bushfire risk to anthropogenic climate change. *Natural Hazards and Earth System Sciences* 21, 941-960.

Whelan RJ (1995) *The ecology of fire*. Cambridge University Press, Cambridge.

Threatened Species Scientific Committee

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 Grevillea banyabba

Reason for assessment

The Banyabba grevillea was listed as Vulnerable 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	<10,000	Unknown	Unknown	Based on surveys in 2019–2021, local experts from the NSW DPIE estimate a total population size of approximately \geq 10,000 individuals (both juvenile and mature) (Table 1) (DPIE 2021. pers comm 8 September). Accordingly, the number of mature individuals is expected to be fewer than 10,000. This is the estimate used in this assessment.		
				unknown.		
Trend	Possibly declined in the past; projected to decline			This assessment recognises that the species may have undergone past decline, however, further survey information is required from Wombat Creek State Conservation Area to determine if this is the case (see Criterion 1).		
			Although the number of mature individuals declined due to the 2019-20 bushfires, this loss of mature individuals is considered part of the natural fluctuation in population size (as fire is likely to be required for germination and post-fire seedling recruitment is high, DPIE 2021. pers comm 24 June) (see Criterion 1).			
				However, changes to fire weather conditions, rainfall patterns and temperature, and more time in drought, are likely to result in a net loss of mature individuals and an ongoing and non- reversible decline in population size of the species in the coming decades (see Criterion 1).		

Table 4 Key assessment parameters

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification	
Generation time (years)	26.5	Unknown	Unknown	The species is likely to have a generation time of approximately 26.5 years (see Criterion 1).	
Extent of occurrence	170 km ²	170 km ²	500 km ²	The estimate used in this assessment is the minimum plausible value and has been calculated using record data from 1996-2019 for known subpopulations and applying the shortest continuous imaginary 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).	
				The minimum plausible value varies from the values calculated by Gallagher (2020) and the 2019 IUCN assessment because an outlying record from Gibberagee State Forest was reassigned to Mason's grevillea (DPIE 2021. pers comm 24 June) and must be excluded from EOO calculations.	
				<u>Note</u> : the estimate from the Gallagher (2020) rapid assessment is 239 km ² ; the estimate from the 2019 IUCN rapid assessment (Makinson & Olde 2020) is 222 km ² .	
				The maximum plausible value is the estimate used in the Le Breton et al. (2019) rapid assessment.	
				All values are within the range of the Endangered category of Criterion 2.	
Trend	Stable			All known subpopulations occur within reserved tenure (Table 1), with most individuals occurring within Banyabba Nature Reserve (DPIE 2020a). The historical distribution of the species is likely to be similar to its current distribution (NPWS 1999). Accordingly, EOO is considered stable.	
Area of Occupancy	68 km²	Unknown	Unknown	The estimate used in this assessment has been calculated using record data from 1996-2019 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 minimum and maximum plausible values are unknown.	
				<u>Note</u> : the estimate from the Le Breton et al. (2019) and Gallagher (2020) rapid assessments is 56 km ² .	
				All values are within the range of the Endangered category of Criterion 2.	
Trend	Stable			Using the same reasoning as EOO (above), AOO is considered stable.	
Number of subpopulations	3	3	Unknown	There are three known subpopulations. For further information, see 'Basis of assessment of subpopulation number'.	
Trend	Stable			There is no evidence of loss of any subpopulations (DPIE 2021. pers comm 24 June).	
Basis of assessment of subpopulation number	Contiguous records are considered part of the same subpopulation. Subpopulations occur within three broad areas separated by >5 km: Banyabba Nature Reserve/Banyabba State Conservation Area, Fortis Creek National Park, and Wombat Creek State Conservation Area (DPIE 2021. pers comm 24 June).				

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification		
No. locations	<5	Unknown	<5	At the time of this assessment (in 2021), following the 2019-20 bushfires, most individuals were post-fire recruits (seedlings or juveniles), with a further small proportion of recovering adults (resprouts on Dilkoon Trail in Fortis Creek National Park) (DPIE 2021. pers comm 24 June) and the seedbank may be depleted.		
				If another threatening event (e.g., fire) were to occur within the next 5-7 years (i.e., the minimal fire-free interval required by the species, subject to further study; NSW RFS 2013; DPIE 2021. pers comm 24 June), most individuals would be at high risk of poor recovery and there may not be sufficient seed in the seedbank to replenish the population.		
				The 2019-20 bushfires rapidly affected 50-60% of individuals. Accordingly, >1 threatening event (fire) is likely to be required to rapidly affect all individuals. However, given the species restricted distribution (EOO=170 km ²), it is likely that <5 threatening events (fire) could rapidly affect all individuals. This is maximum plausible number of locations and is the estimate used in this assessment.		
				The minimum plausible number of locations is unknown. Note: the estimate used in the Le Breton et al. (2019) rapid assessment, prior to the 2019-20 bushfires, was 10. This value is now considered to be an overestimate, given the extent and scale of the 2019-20 bushfires.		
Trend	Possibly contracting The intensity, frequency and scale of catastrophic bushfires will likely increase due to climate change. Accordingly, the number of locations in which a single bushfire can rapidly affect all individuals will likely decrease.					
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 restricted distribution in northern NSW (see EOO/AOO and Map 1). Over 50% of the species' AOO occurs in habitat patches that can support a viable population.					
Fluctuations	Population siz exceed one or of subpopulat	ze fluctuates fol der of magnitu ions or location	llowing fire, ho de. There are n 1s.	wever, there is no evidence to suggest fluctuations to known extreme fluctuations in EOO, AOO, number		

Criterion 1 Population size reduction

Redu	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	Endar Sever	ngered re reduction		Vulnerable Substantial reduction	
A1		≥ 90%	≥ 70%	b		≥ 50%	
A2, A	13, A4	≥ 80%	≥ 50%	b		≥ 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.	the the the y 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	Population reduction, projected or susp to a maximum of 100 years) [(<i>a</i>) cannot	pected to be met in the futur t be used for A3]	e (up	Based on any of the following	(d) (e)	actual or potential levels of exploitation the effects of introduced	
A4	An observed, estimated, inferred, proje reduction where the time period must i future (up to a max. of 100 years in futu reduction may not have ceased OR may be reversible.	cted or suspected population nclude both the past and th ure), and where the causes of r not be understood OR may	n e of not			taxa, hybridization, pathogens, pollutants, competitors or parasites	

Criterion 1 evidence

Insufficient data to determine eligibility

Generation time

The species is suspected to be long-lived (up to 50 years) (DPIE 2021. pers comm 24 June). The primary and secondary juvenile periods are unknown. However, Environment Australia (1999) estimate a three-year recovery time for the Banyabba grevillea (i.e., the time between disturbance and the point when the species has developed sufficiently to reproduce, including the time required to reach reproductive maturity). This is supported by the suspected minimal fire-free interval of 5–7 years (subject to further study) (NSW RFS 2013; DPIE 2021. pers comm 24 June), which suggests that reproductive maturity occurs by this age. Accordingly, generation time is likely to be:

Generation time = age of first reproduction + [0.5 * (length of reproductive period)]Generation time = 3 + [0.5 * (50 - 3)] = 26.5 years

This gives an estimated three-generation period of approximately 80 years.

Population trends based on monitoring data

In 1997, the total population size was estimated at approximately 14,000 individuals (NPWS 1999). In 2021, the total population size was estimated at approximately \geq 10,000 individuals (Table 1) (DPIE 2021. pers comm 8 September). This suggests a reduction in total population size. Assuming the proportion of mature individuals in the total population has remained consistent from 1997–2021, a reduction in the number of mature individuals over this period could be inferred.

However, the population size of the subpopulation in Wombat Creek State Conservation Area is unknown and has not been included in the total population size estimate (\geq 10,000 individuals) (Table 1) (DPIE 2021. pers comm 8 September). If individuals are found in this area, the 2021 total population size estimate could plausibly be revised to an estimate that is similar to that of 1997 (i.e., ~14,000 individuals). Accordingly, this assessment recognises that the species may have undergone a past reduction in population size (A1 and A2) since 1997, however, further survey information is required from Wombat Creek State Conservation Area to determine if this is the case.

No monitoring data is available prior to 1997, so population trends prior to this time are considered data deficient.

Extent of 2017-19 drought and 2019-20 bushfires, and distribution of the Banyabba grevillea

Between 2017 and 2019, north-eastern NSW experienced severe drought (Bureau of Meteorology 2020; DPI 2020), which overlapped with approximately 53 percent of the Banyabba grevillea's modelled distribution in the six months preceeding the 2019-20 bushfires (Gallagher 2020). Following this drought, catastrophic bushfire conditions resulted in extensive bushfires covering an unusually large area of eastern Australia in 2019-20. Fire intensity and severity varied across the bushfire extent, with many patches burning at extreme intensity and severity while others remained unburnt (DPIE 2020c). Initial estimates suggest the 2019-20 bushfires overlapped with approximately 80 percent of the species' modelled distribution, with 34 percent burnt at very high severity (Auld et al. 2020; Gallagher 2020; Gallagher et al. 2021).

Population reduction associated 2019-20 bushfires and other threats

Local experts from NSW DPIE estimate approximately 50–60 percent of individuals were burnt during the 2019-20 bushfires (DPIE 2021. pers comm 24 June). Although this fire event is likely to have killed some mature individuals, many seedlings have recruited from seed (DPIE 2021. pers comm 24 June). Additionally, along Dilkoon Trail in Fortis Creek National Park, resprouting plants have also been observed (DPIE 2021. pers comm 24 June). Dieback of leaves and branches was observed in unburnt individuals, suggesting that drought conditions were impacting the species prior to the bushfires (DPIE 2021. pers comm 24 June). However, seedling recruitment is high post-fire, and both seedlings and resprouts are healthy (DPIE 2021. pers comm 24 June). The Banyabba grevillea has not been substantially impacted by any other fires within the last five years (DPIE 2021. pers comm 24 June). There is also no evidence of disease (e.g., *P. cinnamomi*) or herbivory in the species' habitat, and weeds are rarely observed (DPIE 2021. pers comm 24 June). This evidence collectively suggests that the species is likely to recover to pre-2019 population size, as long as no further fires or other threatening events occur within the next 5–7 years (i.e., the minimal fire-free interval required by the species, subject to further study; NSW RFS 2013; DPIE 2021. pers comm 24 June).

Fire is likely to be required to trigger germination of soil-stored seeds and enable recruitment (see Relevant biology and ecology) (Richards 1999; Makinson 2000; Auld et al. 2020; Gallagher et al. 2021). Accordingly, the loss of individuals following the 2019-20 bushfires is considered part of a natural fluctuation rather than population reduction.

Population reduction projected under climate change scenarios (fire)

Anthropogenic climate change has already started to influence fire weather conditions across the world, including in Australia (Abatzoglou & Williams 2016; Dowdy 2018). Since 1950, the frequency and magnitude of extreme fire weather conditions has increased in southern Australia (Dowdy 2018). The annual frequency of dangerous fire weather days has increased between 1950-1985 and 1985-2020, particularly in north-eastern NSW (Bureau of Meteorology & CSIRO 2020). Further, the average frequency of bushfire events has increased by 40 percent between 2007–2013 (Dutta et al. 2016). As 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 Banyabba grevillea may decline in the future, as fire-free intervals continue to shorten (i.e., through interval squeeze) (Enright et al. 2015). If another fire were to occur within the next 5–7 years anywhere across the species range, immature plants are likely to be killed resulting in a net loss of individuals (Gallagher et al. 2021). Since 1950, the fire season has been starting earlier and extreme fire weather conditions have increased during spring and summer in southern Australia (Dowdy 2018). Across Australia, fuel load and extreme fire weather conditions are projected to continue to increase in spring (Clarke et al. 2016). In north-eastern NSW, the frequency of extreme fire weather days is also projected to continue to increase during spring and summer (based on simulations from 12 climate models) (OEH 2014). As the Banyabba grevillea flowers during spring (August–October) (Makinson 2000), an earlier, more severe fire season could impact the species' flowering and recruitment (Whelan 1995). Additionally, interactions between fire and seed predators may also elevate risks of decline, especially under small or patchy fires (Regan et al. 2003).

Although the evidence presented earlier suggests the Banyabba grevillea is likely to recover from the 2019-20 bushfire event, changes to fire weather conditions are likely to result in a net loss of mature individuals and an ongoing and non-reversible decline in population size of the species in the coming decades. However, there is insufficient evidence (e.g., modelling) at the time of this assessment to provide a quantitative estimate of projected decline in the Banyabba grevillea under future fire regimes. As such, there appears to be is insufficient evidence to consider the species under A3 (future reduction).

Population reduction projected under climate change scenarios (increased temperatures, decreased rainfall and more time in drought)

In Australia, average temperatures have increased by approximately 1.5°C since 1910, leading to increased frequency of extreme heat events (Bureau of Meteorology & CSIRO 2020). Additionally, in south-eastern Australia, rainfall has declined by approximately 12 percent in the cool season (April–October) from the late 1990s–2020 (Bureau of Meteorology & CSIRO 2020). In southern and eastern Australia, cool season rainfall is predicted to continue to decrease, while temperatures are predicted to continue to increase, leading to more time in drought (as well as more intense, short duration heavy rainfall events) due to climate change (CSIRO & Bureau of Meteorology 2015; Bureau of Meteorology & CSIRO 2020).

In north-eastern NSW, both maximum and minimum temperatures are projected to increase (maximum: +0.7°C by 2030 and +1.9°C by 2070; minimum: +0.7°C by 2030 and +2.0°C by 2070, based on simulations from 12 climate models) (OEH 2014). Additionally, there are predicted to be 5–10 additional hot days (above 35°C) each year by 2030, and up to 20 additional hot days each year by 2070 (based on simulations from 12 climate models) (OEH 2014). Meanwhile, rainfall is projected to decrease in winter and increase in autumn and spring by 2030 (based on simulations from 12 climate models) (OEH 2014).

Many plants in family Proteaceae, including *Grevillea* spp., are expected to decline in range and population size, primarily due to the effect of declining rainfall on seed production and seedling survival (Midgley et al. 2006; Fitzpatrick et al. 2008; Shimizu-Kimura et al. 2017). Given that dieback of leaves and branches on adult plants has been observed following drought conditions in 2017-19 (DPIE 2021. pers comm 24 June), changes to rainfall patterns and temperature, and more time in drought are likely to result in a net loss of mature individuals and an ongoing and non-reversible decline in population size of the species in the coming decades. However, there is insufficient evidence (e.g., modelling) at the time of this assessment to provide a quantitative estimate of projected decline in the Banyabba grevillea under these projected climate conditions. As such, there appears to be is insufficient evidence to consider the species under A3 (future reduction).

Conclusion

There are currently 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/OR area of occupancy

		Critically Endangered Very restricted	Endangered Restricted	Vulnerable Limited			
B1.	Extent of occurrence (EOO)	< 100 km ²	< 5000 km ²	< 20,000 km ²			
B2.	Area of occupancy (AOO)	< 10 km ²	< 500 km ²	< 2000 km ²			
AND	at least 2 of the following 3 conditi	ons:					
(a)) Severely fragmented OR Number $= 1$ ≤ 5 ≤ 10						
(b)	(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(iii,v)+2ab(iii,v) for listing as Endangered

Extent of occurrence and area of occupancy

The extent of occurrence (EOO) is estimated at 170 km² and the area of occupancy (AOO) is estimated at 68 km². These figures are based on the mapping of point records from 1996 to 2019, obtained from state governments, museums and CSIRO. The EOO was calculated using a minimum convex hull, and the AOO calculated using a 2 x 2 km grid cell method, as outlined in the Guidelines for Using the IUCN Red List Categories and Criteria (IUCN 2019).

The species' EOO and AOO appear to meet the requirements for listing as Endangered under B1 ($<5000 \text{ km}^2$) and B2 ($<500 \text{ km}^2$).

Number of locations

Initial estimates suggest the 2019-20 bushfires overlapped with approximately 80 percent of the Banyabba grevillea's modelled distribution (Auld et al. 2020; Gallagher 2020; Gallagher et al. 2021) with approximately 50–60 percent of individuals burnt (DPIE 2021. pers comm 24 June). Accordingly, at the time of this assessment (in 2021), most individuals were juveniles (seedlings) or recovering (resprouts) following these fires in 2019-20 (DPIE 2021. pers comm 24 June). Additionally, the Banyabba grevillea may also have a depleted seedbank following the 2019-20 bushfires, as there may be little to no residual soil-stored seedbank following fire (Auld & Denham 2006) and the size of the residual soil-stored seedbank may decline with increasing fire severity (Palmer et al. 2018).

If another threatening event (e.g., fire) were to occur within the next 5-7 years (i.e., the minimal fire-free interval required by the species, subject to further study; NSW RFS 2013; DPIE 2021. pers comm 24 June), most individuals would be at high risk of poor recovery and there may not be sufficient seed in the seedbank to replenish the population. As the 2019-20 bushfires overlapped most of the species' modelled distribution and affected many individuals, it is feasible for only a small number of fires to affect the species' entire distribution. Accordingly, only a small number (<5) of threatening events (e.g., fire) would be required within the next 5-7 years for all individuals to be rapidly affected.

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

Continuing decline (observed, estimated or inferred)

The historical distribution of the species is likely to be similar to its current distribution (NPWS 1999) and all known subpopulations occur within reserved tenure (Table 1). Although, survey data from 1997 and 2019-2021 suggests the number of mature individuals may have declined over this period (see Criterion 1), further survey information is required from Wombat Creek State Conservation Area to determine if this is the case (see Criterion 1).

Additionally, there is currently no evidence of disease (e.g., *P. cinnamomi*) or herbivory, and weeds are rarely observed in the species' low fertility habitat (DPIE 2021. pers comm 24 June). Although, there was some evidence of drought-related dieback of leaves and branches prior to the 2091-20 bushfires, seedling recruitment is high post-fire, and both seedlings and resprouts are healthy, suggesting there is no past continuing decline (DPIE 2021. pers comm 24 June). Further, there is no evidence of loss of any subpopulations (DPIE 2021. pers comm 24 June).

Accordingly, EOO, AOO, area, extent and quality of habitat, number of locations, subpopulations and mature individuals are presumed to be stable in the past. The species does not appear to meet the continuing decline (EOO, AOO, area, extent and quality of habitat, and number of locations/subpopulations) requirement for listing under this criterion.

Continuing decline (projected)

Continuing decline can be projected and does not have to have commenced at the time of the listing assessment (IUCN 2019). Such projected declines must be justified and there must be high degree of certainty that they will take place (IUCN 2019). As discussed in Criterion 1 (see above), changes to fire weather conditions, rainfall patterns and temperature, and more time in drought are likely to result in decline of suitable habitat, a net loss of mature individuals and an ongoing and non-reversible decline in population size of the species in the coming decades.

Accordingly, the area, extent and quality of habitat and the number of mature individuals are both projected to undergo continuing decline over the coming decades, with a high degree of certainty (see Criterion 1). The species appears to meet the continuing decline requirement for listing under this criterion.

Severe fragmentation

The Banyabba grevillea is not considered to be severely fragmented. The species occurs within a restricted distribution in northern NSW and over 50 percent of the species' AOO occurs in habitat patches that can support a viable population (see EOO/AOO and Map 1).

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

Extreme fluctuations

The population size of the Banyabba grevillea fluctuates following fire (see Criterion 1), however, there is no evidence to suggest that these fluctuations exceed one order of magnitude. There are no known extreme fluctuations in EOO, AOO, number of subpopulations or locations.

The species does not appear to meet the extreme fluctuations requirement for listing under this criterion.

Conclusion

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

The data presented above appear to demonstrate that the species 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	< 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

Not eligible

Number of mature individuals

Knowledge of the species' population size requires further survey work. However, based on surveys in 2019–2021, local experts from the NSW DPIE estimate a total population size of \geq 10,000 individuals, while suggesting the number of mature individuals may be fewer than 10,000 (Table 1) (DPIE 2021. pers comm 8 September).

In addition to the recent estimates (above; Table 1), Bailey (2019) also estimated a total population size of at least approximately 5000 individuals from field surveys in 2018–2019. Makinson & Olde (2020) inferred that the total population included approximately 800–2000 mature individuals from limited field observations.

Accordingly, 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 is projected to undergo continuing decline in the number of mature individuals. However, the rate of decline 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/percentage of mature individuals in one subpopulation

The number of mature individuals within each subpopulation is unknown. However, the population size of two subpopulations has been estimated as approximately 5000 individuals each (Table 1) (DPIE 2021. pers comm 8 September 2021). Assuming the age structure is similar across subpopulations (i.e., they have similar proportion of mature individuals), the number of mature individuals in each subpopulation is likely to exceed 1000 and the percentage of mature individuals in one subpopulation is less than 100 percent. The species does not appear to meet the number/percentage of mature individuals' requirement for listing under this criterion.

Extreme fluctuations in the number of mature individuals

The population size of the Banyabba grevillea fluctuates following fire (see Criterion 1), however, there is no evidence to suggest that these fluctuations exceed one order of magnitude. The species does not appear to meet the extreme fluctuations requirement for listing under this criterion.

Conclusion

While the species' population size appears to be <10,000 mature individuals, and the number of mature individuals appears to be undergoing continuing decline, the species does not meet the other sub-criteria for listing under this criterion.

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 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, it is highly unlikely that the number of mature individuals is less than 1000.

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

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 Banyabba grevillea.

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.

© Commonwealth of Australia 2021



Ownership of intellectual property rights

Unless otherwise noted, copyright (and any other intellectual property rights) in this publication is owned by the Commonwealth of Australia (referred to as the Commonwealth).

Creative Commons licence

All material in this publication is licensed under a <u>Creative Commons Attribution 4.0 International Licence</u> except content supplied by third parties, logos and the Commonwealth Coat of Arms.

Inquiries about the licence and any use of this document should be emailed to <u>copyright@awe.gov.au</u>.

Cataloguing data

This publication (and any material sourced from it) should be attributed as: Department of Agriculture, Water and the

۲

Environment 2021, Conservation advice for Grevillea banyabba (Banyabba grevillea), Canberra.

This publication is available at the SPRAT profile for Grevillea banyabba (Banyabba grevillea).

Department of Agriculture, Water and the Environment GPO Box 858, Canberra ACT 2601 Telephone 1800 900 090 Web <u>awe.gov.au</u>

The Australian Government acting through the Department of Agriculture, Water and the Environment has exercised due care and skill in preparing and compiling the information and data in this publication. Notwithstanding, the Department of Agriculture, Water and the Environment, its employees and advisers disclaim all liability, including liability for negligence and for any loss, damage, injury, expense or cost incurred by any person as a result of accessing, using or relying on any of the information or data in this publication to the maximum extent permitted by law.

Acknowledgements

The Threatened Species Scientific Committee and the Department of Agriculture, Water and the Environment acknowledge the contributions of the NSW Department of Planning, Industry and Environment in preparing this document.

Version history table

Document type	Title	Date [dd mm yyyy]
-	-	-