



Consultation on Species Listing Eligibility and Conservation Actions

Acacia courtii (three brothers wattle)

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

- 1) the eligibility of *Acacia courtii* (three brothers wattle) for inclusion on the EPBC Act threatened species list in the Vulnerable 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 2 March 2022.

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General background information about listing threatened species

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

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

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

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

Privacy notice

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

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

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

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

Information about this consultation process

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

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

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

CONSULTATION QUESTIONS FOR ACACIA COURTII (THREE BROTHERS WATTLE)

SECTION A - GENERAL

1. Is the information used to assess the nationally threatened status of the species/subspecies robust? Have all the underlying assumptions been made explicit? Please provide justification for your response.
2. Can you provide additional data or information relevant to this assessment?
3. Have you been involved in previous state, territory or national assessments of this species/subspecies? If so, in what capacity?

PART 1 – INFORMATION TO ASSIST LISTING ASSESSMENT

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

Biological and ecological information

4. Do you have any additional information on the ecology or biology of the species/subspecies not in the current advice?
5. Can you provide any additional or alternative references, information or estimates on germination conditions, time/age to maturity from seed, duration of maturity, longevity (average life span)?
6. Can you provide any additional information on pollination ecology or dispersal mechanisms for the species?
7. Do you have any information on the biological responses of seeds and plants of this species in response to different intensity fires?

8. Can you provide any information on the habitat attributes that typify areas where *Acacia courtii* grows, or any information that may assist in describing habitat critical for the survival of the species?

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

Population size

9. Has the survey effort for this taxon been adequate to determine its national adult population size? If not, please provide justification for your response.
10. Do you consider the way the population size has been derived to be appropriate? Are there any assumptions and unquantified biases in the estimates? Did the estimates measure relative or absolute abundance? Do you accept the estimate of the total population size of the species/subspecies? If not, please provide justification for your response.
11. If not, can you provide a further estimate of the current population size of mature adults of the species/subspecies (national extent)? Please provide supporting justification or other information.

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

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

☐ 500-1000 ☐ 1000-5000 ☐ 5000-10,000 ☐ 10,000-50,000 ☐ >50,000

Level of your confidence in this estimate:

- ☐ 0–30% - low level of certainty/ a bit of a guess/ not much information to go on
- ☐ 31–50% - more than a guess, some level of supporting evidence
- ☐ 51–95% - reasonably certain, information suggests this range
- ☐ 95–100% - high level of certainty, information indicates quantity within this range
- ☐ 99–100% - very high level of certainty, data are accurate within this range

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

12. 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

13. Are you able to provide an estimate of the total population size during the early 1990s (*at or soon after the start of the most recent three generation or 10-year period*)? Please provide justification for your response.

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

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

☐ 500-1000 ☐ 1000-5000 ☐ 5000-10,000 ☐ 10,000-50,000 ☐ >50,000

Level of your confidence in this estimate:

- ☐ 0–30% - low level of certainty/ a bit of a guess/ not much information to go on
- ☐ 31–50% - more than a guess, some level of supporting evidence
- ☐ 51–95% - reasonably certain, information suggests this range
- ☐ 95–100% - high level of certainty, information indicates quantity within this range
- ☐ 99–100% - very high level of certainty, data are accurate within this range

14. Are you able to comment on the extent of decline in the species/subspecies' total population size over the last approximately 10 years (or three generations lengths if you know the generation length. If so please add this information to section 1). Please provide justification for your response.

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

Decline estimated to be in the range of:

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

Level of your confidence in this estimated decline:

- ☐ 0–30% - low level of certainty/ a bit of a guess/ not much information to go on
- ☐ 31–50% - more than a guess, some level of supporting evidence
- ☐ 51–95% - reasonably certain, suggests this range of decline
- ☐ 95–100% - high level of certainty, information indicates a decline within this range

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

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

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

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

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

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

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

19. 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.

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

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

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

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

Level of your confidence in this estimated extent of occurrence

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

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

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

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

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

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

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

☐ <10 km² ☐ 11 – 500 km² ☐ 501 – 2000 km² ☐ >2000 km²

Level of your confidence in this estimated extent of occurrence:

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

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

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

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

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

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

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

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

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

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

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

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

Level of your confidence in this estimated extent of occurrence

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

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

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

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

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

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

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

☐ <10 km² ☐ 11 – 500 km² ☐ 501 – 2000 km² ☐ >2000 km²

Level of your confidence in this estimated extent of occurrence:

- ☐ 0–30% - low level of certainty/ a bit of a guess/ not much data to go on
- ☐ 31–50% - more than a guess, some level of supporting evidence
- ☐ 51–95% - reasonably certain, data suggests this range of decline
- ☐ 95–100% - high level of certainty, data indicates a decline within this range
- ☐ 99–100% - very high level of certainty, data is accurate within this range

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

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

23. Do you consider that all major threats have been identified and described adequately?
Do you have any knowledge of the presences of these threats in *Acacia courtii* habitats?
24. Can you provide details on the impact of drought to seedlings and adults of *Acacia courtii*?
25. To what degree are the identified threats likely to impact on the species/subspecies in the future?
26. Are the threats impacting on different populations equally, or do the threats vary across different populations?
27. Can you provide additional or alternative information on past, current or potential threats that may adversely affect the species/subspecies at any stage of its life cycle?
28. Can you provide supporting data/justification or other information for your responses to these questions about threats?

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

29. What planning, management and recovery actions are currently in place supporting protection and recovery of the species/subspecies? To what extent have they been effective?
30. Can you recommend any additional or alternative specific threat abatement or conservation actions that would aid the protection and recovery of the species/subspecies?

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

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

32. 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?
33. Are you aware of any cultural or social importance or use that the species/subspecies has?
34. What individuals or organisations are currently, or potentially could be, involved in management and recovery of the species?
35. How aware of this species/subspecies are land managers where the species/subspecies is found?
36. 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

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

Conservation Advice for *Acacia courtii* (three brothers wattle)

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

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

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

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



Photographs of *Acacia courtii* taken November 2012 at Mt Annan Botanic Gardens, NSW © Copyright, Fagg, M (from Australian Plant Image Index)

Conservation status

Acacia courtii (three brothers wattle) 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). There was no listing advice prepared for this species at that time.

Acacia courtii is proposed to remain in the Vulnerable category of the threatened species list under the EPBC Act.

Acacia courtii was assessed by the Threatened Species Scientific Committee to be eligible for listing as Vulnerable under criteria 1, 2 and 3. 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: A4ac: Vulnerable
- Criterion 2: B1ab(i,ii,iii,v)+2ab(i,ii,iii,v): Vulnerable
- Criterion 3: C1+C2a(ii): Vulnerable
- Criterion 4: D1+D2: Ineligible
- Criterion 5: Insufficient data

The main factors that make the species eligible for listing in the Vulnerable category are the restricted extent of occurrence and area of occupancy, the substantial reductions (both observed and projected) from the increasing threat of drought and severe and frequent bushfires driven by climate change.

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

Species information

Taxonomy

Conventionally accepted as *Acacia courtii* Tindale & Herscovitch. *Acacia courtii* was previously known under the synonym of *Racosperma courtii*.

Description

The three brothers wattle (family Fabaceae) is a tall shrub or a spreading, weeping tree that grows between five and 20 m high. It has an open canopy of pendulous branches and foliage. The bark is smooth and grey, though older trees may have finely fissured or furrowed and blackish bark. Like many *Acacia* species, the three brothers wattle has phyllodes instead of leaves. These are flattened leaf stalks that allow the plant to conserve moisture. The phyllodes are very narrowly elliptic to linear in shape and either straight or slightly curved. Phyllodes are mostly 10–18 cm long and 4–8 mm wide, smooth with one or sometimes three longitudinal veins, which are more prominent. Minor veins run longitudinally along the phyllode and branch out to form a fine network. The tip of the phyllode is sharply pointed, and it has one small gland four millimetres above pulvinus (the enlarged section at the base of the stalk) and one inconspicuous

gland adjacent to the point. The pulvinus is one to two millimetres long. There are two (rarely one) flowers in the axil of the phyllodes. Flower stalks are 3–5 mm long, and the cylindrical flower heads are 3–7 cm long, pale yellow or cream-coloured and scattered on the stem. Unlike other wattles, the three brothers wattle does not appear to be a prolific flowerer. The seed pods are 7.5–18 cm long and 3–4 mm wide. The seed pod can be straight or slightly to strongly curved in shape. The seed pod is raised over seeds and slightly constricted between seeds and is firmly and papery or leathery to the touch. When the seed pod is dry, it develops wrinkled ridges. The seeds within the pod are oblong-elliptic and 5.5–7.8 mm long, shiny, brown and attached with a small threadlike stalk (ABRS & CSIRO 2001; Tindale & Herscovitch 1990).

Distribution

The three brothers wattle occurs in three distinct locations. North Brother Mountain (in Dooragan National Park) and Middle Brother Mountain (in Middle Brother National Park), which are in the Port Macquarie-Hastings Council local government area. The third location is South Brother Mountain which is in the Mid-Coast Council local government area. For this reason, other common names exist for this species, including North Brother wattle, northern Brother wattle, or Brother wattle.

On North Brother Mountain, the majority of the species range occurs in national park, but also occupies private and crown lands. On Middle Brother Mountain the species occupies both state forest and national park, though on South Brother it is mostly on private property. There are no records of the three brothers wattle occurring on lands between these three sites, or on any surrounding properties. However, further surveys may be needed to confirm the distribution of the species.

Eight plots were monitored for the three brothers wattle in 2018 and again in 2021; three on Northern Brother Mountain, and five on Middle Brother Mountain (see Table 1 from data in Richards 2021).

Table 1. Summary of monitored sites for the three brothers wattle. Survey plots of 20x20 m on Northern and Middle Brother Mountains, northeast NSW (data extracted from Richards 2021).

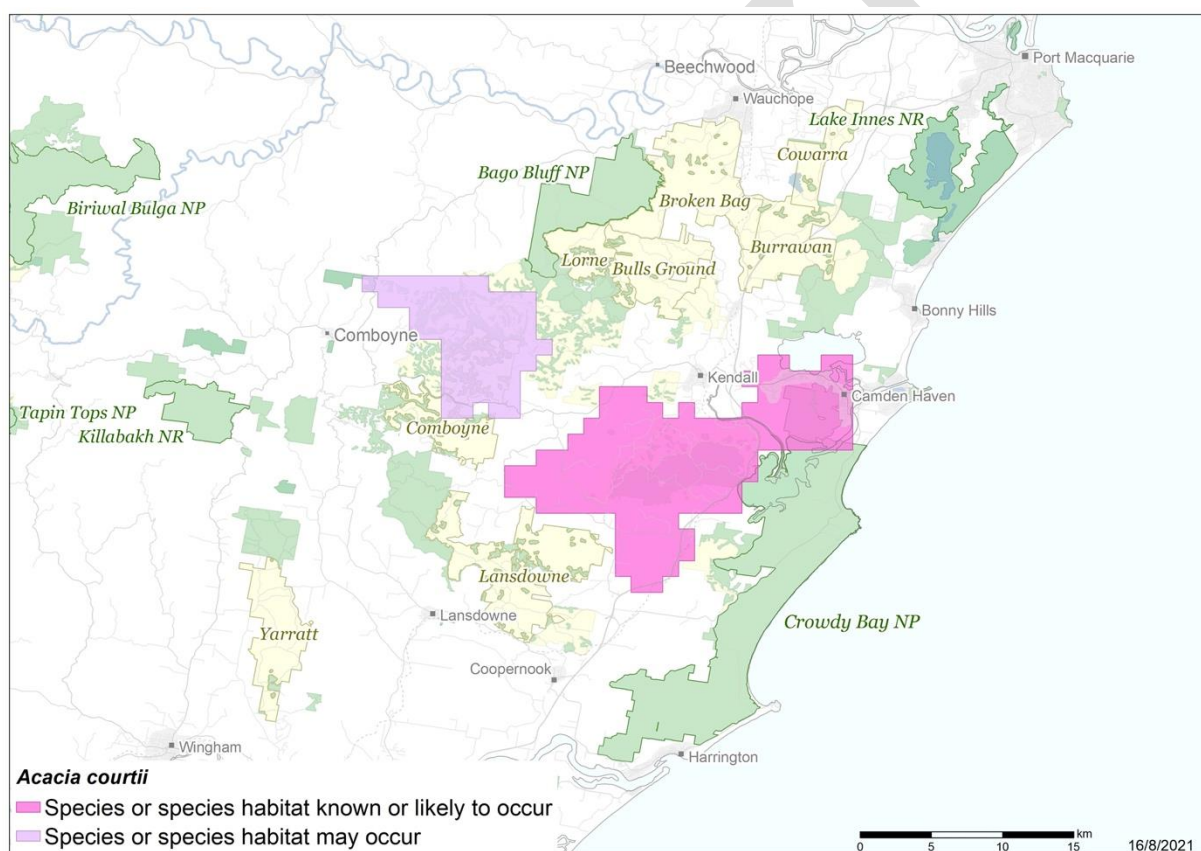
Plot*	Aspect and Slope (degree)	Elevation (m)	Number of individuals in plot	Number of plants estimated in surrounds**	Condition of plants and presence of pest species
NB01	WNW 15	311	30	2000	Excellent. No recruitment. Scattered senescent plants.
NB02	N 25	153	44	2000 over 10 hectares	Excellent. Lantana removed and some post-drought recruitment.
NB03	NE 35	140	14	1000 over 10 hectares	Some drought induced germination. Lantana and passionfruit present.
MB01	N 17	163	12	200-300 over 2 hectares	Excellent. No recruitment since 2018 survey.
MB02	ENE 15	271	37	200	Excellent. No recruitment since 2018 survey. Lantana in low densities.

MB03	E 12	151	1	2000+ across S and W slopes	Excellent, though many older trees senescing. Seedlings from 2018 survey have since died. Absence of fire a recognised threat for this site.
MB04	WSW 10	155	19	2000+ across S and W slopes	Excellent. No change since 2018 survey.
MB05	NE 15	209	5	2000+ across S and W slopes	Excellent. No change since 2018 survey. Lantana in low density.

* NB & MB are Northern and Middle Brother Mountains

**Note that these estimates may overlap with sites and so are not additive. The total estimated population on Northern and Middle Brother Mountains is between 10,000 to 12,000 individuals (Richards 2018, 2021). South Brother Mountain has never been surveyed.

Map 1 Modelled distribution of three brothers wattle



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 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 people. Such knowledge may be only held by Indigenous groups and individuals who are the custodians of this knowledge.

The three brothers wattle occurs on the South, Middle and North Brother Mountains, known to the Birpai peoples as the Three Brothers. The Three Brothers are visually prominent in the surrounding landscape and are key navigation points for coastal travellers. The Three Brother Mountains are of significant cultural, spiritual and historical importance. They are connected through dreaming and feature in important creation and other stories in the region. Biripi, Birpai, Worimi, Bunyah and Gumbangirra peoples have ongoing input into the management of the Three Brothers Mountains (NSW Government 2004a). Wattles are prolific flowerers in spring, and certain trees (such as the large and conspicuous three brothers wattle) are used as visual markers on songlines for terrestrial navigation for First Nations peoples (Morrison 2000, Fuller 2020).

The Australian national floral emblem is *Acacia pycnantha* (the golden wattle), and the emblem of the Order of Australia is also a wattle. Australia's national colours are green and gold, and so the wattle is a symbol of unity, remembrance and reflection (Australian Government 2018). The first of September is National Wattle Day when Australians can celebrate their floral heritages by planting wattles (Australian Government 2018). Wattles are a popular garden plant as they are iconic, they establish quickly, are drought-tolerant, fragrant, and attract birds to the garden (Gardening Australia 2015). The three brothers wattle has been recommended as an ideal garden wattle for low maintenance gardens, and it serves multiple purposes: as erosion control, a bird nesting tree, and as a fast-growing windbreak (Stewart 2016).

Relevant biology and ecology

The three brothers wattle belongs to the "*Acacia longifolia* (golden wattle) group" of 17 related south-eastern Australian *Acacia* species with cylindrically spiked flower heads and phyllodes with anastomosing (branching network) of veins. The other members of the group are listed here to identify species which may be more similar to the three brothers wattle than other *Acacias*. The *A. longifolia* group include: *A. alpina* (alpine wattle), *A. axillaris* (Midlands wattle, Vulnerable), *A. dallachiana* (catkin wattle), *A. derwentiana* (Derwent cascade), *A. floribunda* (gossamer wattle), *A. longifolia subsp. longifolia* (Sydney golden wattle), *A. longifolia subsp. sophorae* (coastal wattle), *A. longissimi* (long-leaf wattle), *A. maidenii* (Maiden's wattle), *A. mucronata* (variable sallow wattle), *A. obtusifolia* (blunt leaf wattle), *A. orites* (mountain wattle), *A. oxycedrus* (spike wattle), *A. phlebophylla* (Buffalo sallow wattle), *A. rhigiophylla* (dagger-leaf wattle) and *A. riceana* (Rice's wattle) (Brown et al. 2010). The three brothers wattle is most similar to *A. orites* (mountain wattle), which occurs in far north-eastern New South Wales (Brown et al. 2010). Some of the above species are known to hybridise (e.g. Buffalo sallow wattle with alpine wattle (Walsh 2021).

Size, age structure and seed duration

The two subpopulations of three brothers wattle on North and Middle Brother mountains are mostly mature individuals. The lack of fire and other major disturbances over the broader scale of the mountains is the likely cause of the current age structure (Richards 2021). *Acacia* seeds

have a water impermeable testa which is broken either by heat or broken down over time (Burrows et al. 2019). *Acacia* seeds may persist in the seed bank for as long as 50 years (Gibson et al. 2011). Museum stored seeds of *Acacia farnesiana* and *Acacia melanoxydon* germinated after 150 years in storage (Leino & Edqvist 2010) indicating seed can remain viable in this genus over extended periods (at least under controlled ambient conditions). The slow degradation of the seed testa over time allows for germination without the influence of fire. In these cases, a smaller number of seeds will emerge in response to soil disturbance or increased humidity (Burrows et al. 2019). This may explain the emergence of 38 juvenile plants (smaller than 3m) between 2018 and 2021 surveys without the influence of fire (Richards 2021).

Habitat

North and Middle Brother mountains are igneous intrusion composed of granites and granodiorites. The area receives 1400–1800 mm of precipitation per year which supports both wet and dry sclerophyll and rainforest communities. In Dooragan National Park, three brothers wattle is restricted to mixed dry sclerophyll forests on the mid slopes of the western and northern faces between 40–300 m above sea level. Soils are shallow, stony, red-brown earth (loams and clays) over microgranite (Quinn et al. 1995, NSW Government 2004a). Many *Acacia* species have shallow root systems, which enable them to utilise nutrients from the decomposing litter layer and access moisture in the top layers of the soil (Tame et al. 2001).

Species associated with three brothers wattle include *Eucalyptus agglomerata* (blue-leaved Stringybark, which occurs on rocky sites within the distribution. Other species are *Allocasuarina torulosa* (forest oak), *Corymbia gummifera* (red bloodwood), *Corymbia intermedia* (pink bloodwood), *Eucalyptus acmenoides* (white mahogany), *E. pilularis* (blackbutt), *E. propinqua* (grey gum), *E. siderophloia* (grey ironbark), *E. umbra* (broad-leaved white mahogany), *Syncarpia glomulifera* (turpentine) with understories of *Coronidium elatum* (sunny side up / everlasting daisy), *Imperata cylindrica* (blady grass), *Lomandra longifolia* (spiny-headed mat-rush), and *Themeda triandra* (kangaroo grass) (Richards 2018). For a comprehensive spatial analysis of associated species in each surveyed plot on Northern and Middle Brother Mountains, see Richards (2021).

Germination

Many *Acacia* (including the three brothers wattle) are obligate seeders (Auld & O'Connell 1991) which may vary in levels of dormancy depending on climatic (humidity) variables present at the time of seed maturation (Tozer & Ooi 2014). Mature individuals of the three brothers wattle are typically killed by fire, though dormancy of seed in the soil seed bank is broken by the heat associated with fire (Quinn et al. 1995; Auld & Denham 2006). Fire-induced germination depends on seed depth, fire intensity and the speed of a fire. In *Acacia suaveolens* (sweet wattle), greater germination occurred in the top five centimetres of soil after a fire leaving a residual undisturbed seedbank up to 15 cm below the surface (Auld & Denham 2006). The likelihood of seeds breaking dormancy in response to fire declines with soil depth. In general, temperatures greater than 110°C may be lethal to *Acacia* seeds (Tame et al. 2001). The hard seed coat of *Acacia* species allows for long periods (e.g. 50+ years) of dormancy and persistence in the seed bank (Gibson et al. 2011). The three brothers wattle seeds may have variability in germination response to environmental conditions. In experimental conditions, 48 *Acacia* species broke dormancy within hours, whilst other seeds from the same plant took days or weeks (Burrows et

al. 2019). Presumably, the staggering of germination ensures that not all seeds respond to a single rain or heat event.

In experimental conditions, 92 percent of golden wattle seeds germinated within three to four days at 30°C / 20°C (day/night) temperature cycles and dropped by ten percent at lower temperatures (17°C / 7°C) (Welgama et al. 2019). Germination rates decrease under salt-stress conditions though seeds will germinate under a wide range of pH conditions (Welgama et al. 2019). In germination trials, the three brothers wattle had high germination levels at 20°C though success decreased at extreme high and low temperatures. Greater germination success occurred when scarification was used to relieve the physical dormancy (Australian PlantBank 2021. pers comm 13 Sept). In the natural environment, moisture and oxygen will eventually penetrate the seed coat allowing the seed to germinate where abiotic conditions are suitable (Tame et al. 2001).

Fire History

Dooragan National Park is on North Brother Mountain, where bushfires occurred in 1970, 1974, 1980, 1991, 1996, 1997 and outside the park, on the western side of the mountain in 1974, 1978, 1980 and 2019 (NSW RFS 2021; NSW Government 2004b). Within the National Park, most fires occurred on the summit and on the eastern aspect of the mountain and three brothers wattle occurs on the western and northern mid-slopes (NSW Government 2004b). The frequency of bushfires in Dooragan National Park have exceeded fire management thresholds for dry sclerophyll forests (guidelines state that a decline in biodiversity will occur if there are three or more consecutive fires with intervals less than five years, no fire in more than 30 years, or severe successive fires).

In 2004, Middle Brother National Park had been fire-free for the previous 20 years and some patches of three brothers wattle were reported as being fire free for more than 50 years (NSW Government 2004a, Richards 2021). Bushfires in the Middle Brother State Forest occurred in 1989, 1991 and 2019 (NSW RFS 2021). In the Forestry areas on and surrounding Middle Brother Mountain, there is hazard reduction and pre- and post-harvest burns conducted at intervals between 10 and 20 years (FCNSW 2021. pers comm 30 August).

South Brother Mountain is predominantly freehold land. Periodic fires have occurred, though they have been accidental and tend to start at the base of the mountain, rarely becoming extensive (FCNSW 2021. pers comm 30 August, DPIE 2021. pers comm 2 Sept). The NSW Rural fire service report one extensive fire on South Brother Mountain in 2013, where the northern half of the mountain burnt for several days (NSW RFS 2021). There is no data to determine if the three brothers wattle was affected or if the fires resulted in the germination and recruitment on South Brother Mountain.

2019–2020 bushfires

Spatial analysis showed that a very small portion of the extent of the 2019-2020 bushfires overlapped with the modelled distribution of three brothers wattle (Gallagher 2020). Post-fire surveys note that fires did not impact any of the areas where the species occurs (NSW NPWS & P Richards 2021. pers comm 25 & 26 August). Extensive containment line construction and back burning 50 km to the west of Middle Brother Mountain was conducted by Forestry Corporation NSW prior to the 2019–2020 bushfires to protect valuable blackbutt forests in the Middle

Brother State Forest (FCNSW 2021. pers comm 30 August). This was likely a significant contributor to the absence of bushfires on South, Middle or North Brother Mountains during the extensive, severe and unprecedented bushfires that impacted much of NSW in 2019 and 2020.

Pollination

The three brothers wattle flowers from November to January (ABRS & CSIRO 2001; Tindale & Herscovitch 1990) and is likely pollinated by a range of insects, birds and small mammals (Tame et al. 2001). In pollination experiments, golden wattle was capable of self-pollinating, though it produced smaller seeds and had more aborted seeds per pod compared to open-pollinated individuals (which had a greater fruit set) (Correia et al. 2015). For many *Acacias*, pollen release occurs in the middle of the day to attract the most insects. The flowers tend to be long-lived, which likely enhances the opportunity for out-crossed pollination and increases the seed set potential (Gibson et al. 2011).

Dispersal

Acacia seeds fall to the soil directly or can be bird- or ant-dispersed. Seeds are attached to the seed pod via an elaiosome, which acts as a food source for both bird and ant dispersers. Scarification of the hard seed coat occurs in the bird gut, and ants bury seeds in subterranean nests, where the seed will stay until ideal conditions (heat and moisture) are met for germination (Gibson et al. 2011). Ant facilitated dispersal of *Acacia* seeds varies in distance and likelihood of germination depending on the ant species. Small ants will remove the elaiosome in situ, leaving the seed close to the parent plant, on the ground, whereas larger ants may carry the seed into their nests and deposit them up to 15 cm deep into the nest structure (Auld 1986). These deeper (10–15 cm) dispersed seeds have a much lower likelihood of meeting the heat conditions required to break dormancy and germinate (Auld & Denham 2006).

Age at maturity and fecundity

A review of 26 non-invasive *Acacia* species indicated that seven matured in less than two years, and 19 matured at ages older than two years. Using observations of growth rate (~one meter per year for the first few years) and height class of mature individuals, the age at maturity of the three brothers wattle is likely to be three to four years (Richards 2018, 2021). Long-term observations in the field suggest that fecundity for the three brothers wattle is in the range of 100 seeds at the onset of maturity and 1000 seeds at peak maturity (10 years old). The ecologically similar *Acacia pycnantha* (golden wattle) has a documented seed rain density (seeds per m²/year) of 810 seeds within its native range and 2530 seeds in the introduced range (Harris et al. unpublished data cited in Gibson et al. 2011), suggesting the fecundity estimates for the three brothers wattle are plausible. Seasonal and local conditions (soil type, burial depth, pH, temperature, light, osmotic and salt stress) are likely to determine the temporal abundance of viable seeds within the seedbank (Welgama et al. 2019). After 40 years, mature individuals of three brothers wattle begin to senesce, and fecundity decreases rapidly (P Richards 2021. pers comm 26 August).

Habitat critical to the survival

All habitat on the three Brother Mountains, which surrounds the three brothers wattle should be considered critical to the survival of the species. It was not possible to define habitat critical to the survival of three brothers wattle as there is insufficient ecological data on the specific microhabitat parameters which may explain why the three brothers wattle appears to be

restricted to the mixed, dry sclerophyll forest on the mid-slopes of the three Brother Mountains. In cultivation the three brothers wattle is suggested as growing best in loamy, sandy loam, clay loam or poor soils (similar to that found on Northern and Middle Brother Mountains) with an acid to neutral pH in warm to cool temperate regions in a sunny position with light shade (Stewart 2016). Further research is needed to determine how these conditions translate to the current distribution of the species and to accurately define habitat critical to survival.

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

Important populations

In this section, the word population is used to refer to subpopulation, in keeping with the terminology used in the EPBC Act and state/territory environmental legislation.

Given the restricted distribution and small area of occupancy, every wild population of the species (on Northern Brother, Middle Brother and South Brother Mountains) should be considered important.

Threats

The main threats to three brothers wattle include inappropriate fire regimes, drought-stress, low population size and habitat loss as a result of forestry and other activities. Fire frequency and drought interact to influence recovery potential of fire impacted populations (see Croft et al. 2010) and should be considered in tandem when assessing fire history. The lack of knowledge of key ecological thresholds for the species compounds existing threats as key knowledge gaps inhibit the ability to understand and predict threats and develop suitable recovery actions.

Table 2 Threats

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

Threat	Status ^a	Evidence
Fire		
Inappropriate fire regimes	<ul style="list-style-type: none"> • Timing: current • Confidence: observed • Consequence: major • Trend: static • Extent: unknown* <p>* likely across the entire range</p>	<p>The impact of fire on the three brothers wattle will vary depending on the age (and size) of the plant, and the frequency, intensity, extent and season of the fire. A single bushfire, or intentional burn, is often patchy in intensity across a landscape and will vary in severity (the amount of organic matter consumed) depending on site related environmental variables (e.g., aspect and slope, climate, fuel loads and fuel types). Fire is an integral component of the three brothers wattle life cycle; although the adults are not fire tolerant, the seeds require either scarification or heat to germinate.</p> <p><i>Fire frequency:</i></p> <p>The three brothers wattle may persist under a fire regime with interval periods around 10 to 15 years to allow individuals to reach peak maturity prior to subsequent fires. Repeat fires at intervals of less than three to four years and of sufficient intensity to kill most adults would be detrimental to the species' persistence as they remove individuals before they have a chance to reproduce (Keith 1996, Richards 2018, P Richards 2021. pers comm 26 August).</p> <p><i>Lack of fire:</i></p> <p>Hazard reduction burns are conducted in Dooragan National Park and Middle Brother National Park to protect adjacent urban and structural assets, though they do not extend to ecological burns on a broader habitat scale in the area. The hazard reduction burn frequency varies spatially across the distribution, though few have occurred on the eastern and northern mid-slopes of Northern and Middle Brother mountains (where most three brother wattles occur). Some areas of the middle brother wattle distribution have remained unburnt for long periods of time (>50 years) (Richards 2018, 2021, P Richards 2021. pers comm 26 August). In 2021, surveys of three brothers wattle were observed to be aging, and some plants in states of senescence (Richards 2018, 2021, P Richards 2021. pers comm 26 August). The three brothers wattle is likely similar to other <i>Acacias</i> in that it has a long-lived seedbank (Tame et al. 2001). As <i>Acacia</i> seeds age, the seed coat can break down, resulting in germination in the absence of fire (Burrows et al. 2019), as observed in some long unburnt areas of Northern Brother Mountain (Richards 2021). The germination in response to other cues (e.g., soil disturbance) will often result in infrequent recruitment events and recruitment may be lower than rates of adult mortality. This pattern over time can result in a decline of the overall population (Auld 1987, Keith 1996).</p>

Threat	Status ^a	Evidence
		<p><i>Intensity (heat released during the fire event):</i></p> <p>The three brothers wattle is not fire-resistant and does not resprout and so plants are killed by fire (P Richards 2021. pers comm 26 August). <i>Acacia</i> seeds require heat or scarification to germinate (Auld & O'Connell 1991, Auld & Denham 2006, Gibson et al. 2011). In many cases quite high temperatures are required to break dormancy (100-120°C) (Ooi et al 2014). High and very high intensity fires may create enough heat for long enough to damage seeds in the seed bank (particularly those seedbanks <5cm deep) (Bradstock et al. 1992). The long fire-free intervals in some areas of North and Middle Brother mountains may have created considerable Eucalypt fuel loads (Richards 2018). Eucalypt fuels can result in a longer, hotter burn compared to <i>Acacia</i> and grass fuels (e.g. fire over a <i>Eucalyptus</i> fuel reached 140°C at 2 cm soil depth with an average duration of 50 minutes compared to <i>Acacia</i> and <i>Triodia</i> fuels which were 60–70°C and of a relatively short duration ~10 minutes; Bradstock et al. 1992). Such fires may be too hot for three brothers wattle seeds to survive high and very high severity fire areas (see <i>Germination</i> section above).</p> <p>Low intensity fires, particularly repeat low intensity fires, are also a threat to the three brother wattles as the fires may kill standing adults, though the heat to the soils may not reach temperatures sufficient to break seed dormancy (Keith 1996, Auld & Denham 2006). These conditions may occur in areas where hazard reduction burns are conducted (e.g. Forestry managed sites and sites close to urban areas) and result in the slow decline in population of the three brothers wattle.</p> <p><i>Season of fire</i></p> <p>Fires preceding dry conditions can affect obligate seeding plants as the vulnerable seedlings are exposed to desiccation and thus post recruitment mortality (Auld 1987, Keith 1996). See following section on changes in precipitation (below) for influences of shifting seasonal rainfall patterns on the three brothers wattle.</p>
Climate change		
Increased temperatures and changes in precipitation	<ul style="list-style-type: none"> • Timing: current • Confidence: projected • Consequence: major • Trend: increasing • Extent: across the entire range 	<p>On the north coast region of NSW, there is a projected increase in minimum and maximum temperatures (maximum temperature increase of 0.4–1.0°C by 2039 and 1.5–2.4°C by 2060–2079) and an increase in the number of hot days (above 35°C) and the number of fire weather days (NSW Government 2014a). Precipitation is projected to decrease in winter and increase in autumn and spring (NSW Government 2014a). Any species with limited latitudinal or altitudinal range may experience temperatures outside of their present-day temperature envelope in the future (Westoby & Burgman 2006). The three brothers wattle occurs at between 40–300 m altitude and has a latitudinal range of 17 km (less than a degree of latitude).</p>

Threat	Status ^a	Evidence
		<p><i>Acacias</i> are physiologically adapted to low moisture conditions and have developed a number of strategies for surviving low moisture periods (Tame et al. 2001). However, temporal and spatial patterns in moisture and temperature, together with soil disturbance, are likely required to facilitate flowering and enable recruitment in three brothers wattle (Tame et al. 2001, NSW NPWS & P Richards 2021. pers comm 25 & 26 August). The three brothers wattle flowers from November to January (Kodala 2005), and so winter and spring rains may be of particular importance to flowering for this species. Morais and Freitas (2015) found that rainfall in the preceding five to 12 months is a predictor of both timing and abundance of reproductive structures in the Sydney wattle.</p> <p>Adult plants are vulnerable to extended drought periods, and many three brothers wattle mature plants perished towards the end of the 2017–2019 drought (Richards 2018). <i>Acacia</i> seedlings are more drought sensitive and fires with a following dry period can result in recruitment failure and longer-term population declines (Auld 1987, Keith 1996).</p> <p>Some <i>Acacias</i> require a specific set of environmental cues for successful recruitment. Summer rains stimulate late summer flowering, and winter rains ensure seed set, followed by late spring rains with temperatures around 27°C to initiate germination (Tame et al. 2001). Similar cues are likely required for the three brothers wattle, the reliance on specific pairings of seasonal precipitation and temperature will be important for the successful flowering and seed set for this species. Further research is required to determine environmental cues and requirements for successful reproduction in three brothers wattle before the impact of climate change can be predicted with more accuracy.</p>
Habitat loss and degradation		
Timber harvesting activities	<ul style="list-style-type: none"> • Timing: current • Confidence: observed • Consequence: moderate • Trend: static • Extent: across part of its range 	<p>Forestry operations were established on Middle Brother Mountain and surrounding areas from 1916 until 1999, when part of the area was gazetted as a national park. North Brother Mountain was also extensively logged prior to gazettal. Individuals of three brothers wattle have been cleared in the past, particularly along Captain Cook Bicentenary Road (Quinn et al. 1995).</p> <p>A large portion of the Middle Brother area is actively logged for <i>Eucalyptus pilularis</i> (blackbutt) (Kendall Coopernook Management Area). Blackbutt is fast growing and so is harvested approximately every ten years, which may be associated with pre-harvest and post-harvest burns (FCNSW 2021. pers comm 30 August).</p> <p>Approximately one-third of the Middle Brother subpopulation occurs on Forestry tenure. In prior management plans, 90% of three brothers wattle was protected with 20 m exclusion zones (NSW Government 2004a). Under the current Coastal Integrated Forestry</p>

Threat	Status ^a	Evidence
		<p>Operations Approvals (NSW Government 2018), the three brothers wattle is considered adequately protected as it occurs on rocky outcrops (CRA Heath Vegetation areas that have a 20 m buffer zone). Under the Coastal IFOA, there are no protective prescriptions for three brothers wattle in either harvesting areas or as part of road maintenance, so any new recruits of the species in those areas are at risk of being removed. <i>Acacia</i> seeds are long-lived and may persist in the soil throughout the forestry area long (50+ years) after the adult population are removed (Gibson et al. 2011). Some recruitment of three brothers wattle has been observed post mechanical disturbance of the soil (FCNSW 2021, pers comm 30 August) and so establishment of three brothers wattles in areas where it has not been observed for some time is possible.</p>
Accidental or intentional damage	<ul style="list-style-type: none"> • Timing: current • Confidence: observed • Consequence: moderate • Trend: unknown • Extent: across the entire range 	<p>The distribution of three brothers wattle is on three mountains Northern, Middle and South Brother mountains and occurs on a diverse mix of tenures (state forest, private property, Crown land of mixed uses, including extractive industry, and national park) and thus, is threatened by various activities which may result in the accidental or intentional damage to the species.</p> <p>National Park:</p> <p>Dooragan and Middle Brother National Parks are nearby to urban areas (Lakewood, West Haven and Laurieton), and each have a number of walking tracks, lookouts and other areas for recreational use, including horse riding, quad bikes, bushwalking, rock climbing and hang gliding (NSW Government 2004a, b). The chance of incidental or intentional damage to three brothers wattle trees is mitigated by the provision of designated paths and some camera monitoring.</p> <p>State forest:</p> <p>Some recreation, including horse riding, mountain biking and car rallies, occur in Middle Brother State Forest (NSW Government 2004a). However, these activities are permitted and occur on marked roads and are unlikely to impact three brothers wattle.</p> <p>Private land, crown land and extraction leases:</p> <p>There are a number of operational quarries for rock, sand and unprocessed construction materials surrounding the Northern and Middle Brother Mountains, and one site at South Brother Mountain (NSW Government 2021). South Brother is a mix of the Crown and private lands, which is not managed for environmental assets. Track maintenance, fires and accidental clearing may impact three brothers wattle at these locations.</p> <p>All tenures with public access:</p> <p>Bark theft and intentional damage and felling of mature trees is a serious threat to this species on all tenures (NSW Government 2017, Richards 2021). The demand for seed stock may also place additional pressure on this species.</p>

Threat	Status ^a	Evidence
Introduced species		
Weeds	<ul style="list-style-type: none"> • Timing: current • Confidence: observed • Consequence: moderate • Trend: unknown • Extent: across the entire range 	<p>As a post-disturbance recruiter, three brothers wattle is likely exposed to competition during early life stages, and fast recruiting, weedy species may lower the recruitment success in weed prone areas.</p> <p>Lantana (<i>Lantana camara</i>) is the most invasive weed species in Dooragan and Middle Brother National Parks, occurring in dense stands along roads and former logging tracks (NSW Government 2004a, 2017). Lantana has been successfully controlled in some parts of the distribution, though further action is required in others (Richards 2021).</p> <p>An infestation of Madeira vine (<i>Anredera cordifolia</i>) at Middle Brother National Park (NSW Government 2017) and white passionflower (<i>Passiflora subpeltata</i>) at Dooragan National Park (Richards 2021) currently threaten three brothers wattle in National Parks.</p> <p>Other weeds in the area are giant Parramatta grass (<i>Sporobolus africanus</i>), groundsel bush (<i>Baccharis halmimifolia</i>), crofton weed (<i>Ageratina adenophora</i>) and blackberry (<i>Rubus fruticosus</i>, which is an aggregate of nine invasive blackberry species in NSW) (NSW Government 2004a, b).</p> <p>There is no published data on weeds at South Brother Mountain and so the threat to three brothers wattle is assumed to be similar, and perhaps worse (due to lack of management) to that on Middle and North Brother Mountains.</p>
Grazing by introduced house mice (<i>Mus musculus</i>), black rats (<i>Rattus rattus</i>) or rabbits (<i>Oryctolagus cuniculus</i>).	<ul style="list-style-type: none"> • Timing: current • Confidence: suspected • Consequence: not significant • Trend: unknown • Extent: unknown 	<p>House mouse (<i>Mus musculus</i>) and black rat (<i>Rattus rattus</i>) are invasive species occurring in Middle Brother National Park (NSW Government 2004a). In a Sydney wildlife sanctuary, black rats were found to graze seedlings of the threatened <i>Acacia terminalis</i> (sunshine wattle) after a hazard reduction burn, though other grazers such as rabbits (<i>Oryctolagus cuniculus</i>) were found to have a greater impact. Invasive grazers were determined to compound the natural grazing impacts from native herbivory in that area (Rose & Banks 2007).</p> <p>Although black rats and house mice are noted as possible threats in regional management plans, the threat from these three invasive species to the three brother wattle is likely very low, as neither black rats nor house mice have been observed in any significant numbers on North or Middle Brother mountains. The presence of rabbits on North Brother Mountain, is suspected, though they have not been recorded there. Further, there has not been any signs of browsing on the seedlings of three brothers wattle by small grazing animals (P Richards 2021, pers comm 26 August).</p>

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, and 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

Likelihood	Consequences				
	Not significant	Minor	Moderate	Major	Catastrophic
Almost certain	Low risk	Moderate risk	Very high risk Timber harvesting activities Accidental or intentional damage	Very high risk Inappropriate fire regime	Very high risk
Likely	Low risk	Moderate risk	High risk Weeds	Very high risk Increasing frequency and severity of bushfires Increased temperatures and changes in precipitation	Very high risk
Possible	Low risk Grazing by introduced house mice (<i>Mus musculus</i>), black rats (<i>Rattus rattus</i>) or rabbits (<i>Oryctolagus cuniculus</i>).	Moderate risk	High risk	Very high risk	Very high risk
Unlikely	Low risk	Low risk	Moderate risk	High risk	Very high risk
Unknown	Low risk	Low risk	Moderate risk	High risk	Very high risk

Categories for likelihood are defined as follows:

Almost certain – expected to occur every year

Likely – expected to occur at least once every five years

Possible – might occur at some time

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

Unknown – currently unknown how often the incident will occur

Categories for consequences are defined as follows:

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

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

Moderate – population recovery stalls or reduces

Major – population decreases

Catastrophic – population extirpation/extinction

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

By 2030, the habitat critical to survival for of three brothers wattle will be well defined and protected. The Northern Brother Wattle will have increased in abundance and the species will be secure in viable subpopulations, which are successfully managed for fire and threats.

Conservation and management priorities

Habitat loss, disturbance and modifications

- Identify if and where habitat disturbance and modifications (e.g. track maintenance, fire, intentional and accidental damage) are occurring on the various tenures and protected areas where three brothers wattle subpopulations persist. Mitigate future damage to standing plants.
- Consider the implementation of remote cameras to protect adult plants from intentional and accidental damage in areas of high use.
- Investigate formal conservation arrangements, management agreements and covenants on private land, and for crown and private land, investigate inclusion in reserve tenure if possible.

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

- Identify weed species that negatively affect three brothers wattle and implement appropriate weed removal methods.
- Manage sites to prevent the introduction of invasive weeds.
- Ensure that chemicals or other mechanisms used to eradicate weeds do not have a significant adverse impact on the species.

Fire

- Fires must be managed to ensure that prevailing fire regimes (fire frequency and intensity) do not disrupt the life cycle of the three brothers wattle, that they support germination and do not degrade the habitat necessary to the three brothers wattle.
- Hazard reduction and other intentional fires should be timed in conjunction with seasonal or other rainfall events to optimise the survival of post-fire recruits past the seedling stage.

- Fires should be conducted to limit, rather than promote, opportunities for invasion of exotic species, and that they are paired with weed management actions to avoid weed infestation.
- Physical damage to the habitat and individuals of the three brothers wattle must be avoided during and after fire operations.
- Fire management authorities and land management agencies should use suitable maps and install field markers to avoid damage to the three brothers wattle.
- Undertake active weed control after fires and along roadsides.

Ex situ recovery action

- Continue to collect and manage seed from extant subpopulations to store in long-term custodial collections until no longer needed. Adhere to best practice seed storage guidelines and procedures to maximise seed viability and germinability.
- Investigate options, and suitable locations for translocation should existing subpopulations become non-viable. Monitor translocated populations to confirm survival and recruitment of the species.
- Plan for ex-situ recovery actions (planting from seed stock, protection of extant seedlings) if post-fire recruitment fails, or two frequent and intense fires remove standing population of adult plants
- Collate knowledge from seed germination and survival trials and integrate it into future management plans for the species.

Climate change and severe weather

- Identify current and future parameters that define suitable microhabitats for the species within the distribution and ensure that future suitable habitat remains protected.

Stakeholder engagement/community engagement

- Co-develop and support monitoring and management actions with Traditional Owners in culturally significant areas where three brothers wattle are present.
- Co-ordinate protection and recovery actions with non-government stakeholders (e.g. Landcare and bush regeneration groups, landowners and managers) as well as with Local and State government environmental field and extension officers.
- Consider citizen science methods to collect relevant population data (e.g. presence/absence and reproductive seasons and success of three brothers wattle) with interested stakeholder groups. Ensure method enables quality-assured data for integration with species distribution mapping.
- Alert landowners to the species occurrence on their property and provide guidance on how to protect standing plants and mitigate site-specific threats.
- Survey and monitor plant destruction and bark removal on National Park and Forestry tenures, employing remote cameras and appropriate signage. Communicate the threatened status and the importance of preserving all remaining adults of the three brothers wattle in the wild through relevant websites. Support the responsible trade of seedlings and seeds through reputable licenced gardening centres.

Survey and monitoring priorities

- Survey the population on all tenures across South, Middle and North Brother Mountains at temporal frequencies appropriate to determine reproduction and germination in response to fire, precipitation and other environmental variables.
- Survey total population abundance, age structure, and health to determine location-specific threats.
- Integrate and share new knowledge on the biology and ecology of the species as it becomes available.

Information and research priorities

- Develop an adequate biological and ecological understanding of the species to determine key attributes for management and recovery and enable the identification of important populations and habitats critical to survival.
 - Key attributes should include (but are not limited to): population structure, size, demographics, habitat parameters relevant to species distribution mapping, germination biology and requirements.
 - Key processes should include (but are not limited to): response to disturbance of different intensities (land clearing, land maintenance, grazing (if relevant), weeds, fire, drought), seed bank ecology, pollination ecology, dispersal.
- Consider genomic sampling to identify population structure and gene flow, and to determine species traits which are responsible for limiting the recovery of the species (e.g. fecundity, drought tolerance).
- Undertake surveys in suitable habitats to locate additional subpopulations.

Recovery plan decision

No recovery plan is in place for three brothers wattle. This consultation document will elicit the additional information needed to inform the requirement of a Recovery Plan for the species.

Links to relevant implementation documents

[Northern Rivers Regional Biodiversity Management Plan. National Recovery Plan for the Northern Rivers Region.](#)

[NSW Government. Coastal Integrated forestry operations approvals.](#)

[NSW Government. A strategic approach to managing fire in parks and reserves](#)

[NSW Government. North Brother wattle \(*Acacia courtii*\) saving our species strategy.](#)

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

Attachment A: Listing Assessment for *Acacia courtii*

Reason for assessment

The three brothers wattle 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 [EPBC Regulations](#). The thresholds used to correspond with those in the [IUCN Red List criteria](#) except where noted in criterion 4, sub-criterion D2. The IUCN criteria are used by Australian jurisdictions to achieve consistent listing assessments through the Common Assessment Method (CAM).

Key assessment parameters

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

Table 4 Key assessment parameters

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of mature individuals	8500	8540	14,000	<p>The maximum plausible value for the number of individuals is 10,000 to 12,000 individuals for North and Middle Brother areas (Richards 1999, 2021). This estimate was derived from field notes, field surveys and potential habitat mapping using aerial imagery (Richards 2018, 2021). No recent surveys have been done on South Brother, and so an estimate of 2000 additional individuals were added based on the smaller area of suitable habitat on South Brother Mountain and an observation of 50 individuals at one site (NSW Forestry 2021. pers comm 30 August, 50 records are in BioNET).</p> <p>Mature individuals (those taller than 3 m) were 83% of the total count of individuals (in 2018) and 61% (in 2021) (Richards 1999, 2021). The minimum plausible value used in the assessment is the proportion of mature plants estimated from the maximum plausible value for the population (61% of 14,000 is 8540). The estimate used in the assessment was a rounded number value from the minimum (8500).</p>
Trend	Declining			<p>The lack of suitable fires (of sufficient intensity in areas where the three brothers wattle occurs) has resulted in low levels of recruitment. Adult standing plants have declined in numbers due to intentional damage, drought stress and senescence (Richards 2021). Without a suitable fire regime, it is predicted that recruitment levels will not effectively replace the decline in adult numbers, and a gradual decline in the total number of mature individuals will occur.</p>

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Generation time (years)	31 years	31 years	38 years	Three brothers wattle generation time is estimated to range between 31 and 38 years (see Criterion 1). The generation time used in the assessment was 31 years as this generation time resulted from two valid IUCN methods (a life table and a simplified equation of generation time from the life table parameters).
Extent of occurrence	106	98	106	<p>The minimum plausible value is based on the mapping of point records over a 16-year period (2005 to 2021) obtained from DAWE and is 98 km² using IUCN methods (IUCN Standards and Petitions Committee 2019).</p> <p>The maximum plausible value uses the same methodology, though it includes a longer time series of 24 years (1997–2021) and is 106 km².</p> <p>The estimate used in the assessment was the maximum value as the species lives up to a maximum of 60 years.</p>
Trend	Contracting			The three brothers wattle is not actively protected on Forestry, private and Crown tenures and so threatening processes (See habitat loss and degradation section of table 2) may cause a decline in the species, particularly on Southern Brother Mountain, which is mostly private land. Inappropriate fire regime, weeds and accidental and intentional clearing are existing threatening processes, which may also act together to impact the three brothers wattle. These impacts may be more severe on private lands where the three brothers wattle has no active protection. Any loss of individuals at the unprotected periphery of the distribution will result in a contraction of the overall EOO.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Area of Occupancy	52	44	52	<p>The minimum plausible value is based on the mapping of point records over a 16-year period (2005 to 2021) obtained from DAWE and is 44 km² using IUCN methods (IUCN Standards and Petitions Committee 2019).</p> <p>The maximum plausible value uses the same methodology, though it includes a longer time series of 24 years (1997–2021) and is 52 km².</p> <p>The estimate used in the assessment was the maximum value as the species lives up to a maximum of 60 years.</p>
Trend	Contracting			<p>The three brothers wattle is not actively protected on Forestry, private and Crown tenures and so threatening processes (See habitat loss and degradation section of table 2) may cause a decline in the species, particularly on Southern Brother Mountain, which is mostly private land. Inappropriate fire regime, weeds and accidental and intentional clearing are existing threatening processes, which may also act together to impact the three brothers wattle. These impacts may be more severe on private lands where the three brothers wattle has no active protection. Any loss of individuals at the unprotected periphery of the distribution will result in a contraction of the overall AOO.</p>
Number of subpopulations	1	1	1	<p>The most plausible value for the number of subpopulations is one.</p> <p>The vegetative boundaries of each mountain are less than two km away from each other. At least one gamete per generation exchange would facilitate ongoing connectivity and gene flow between the three sites. For this reason, a subpopulation number of one was used for the assessment.</p>
Trend	Stable			<p>There is currently no genetic data to suggest that there is more than one subpopulation of the species.</p>

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Basis of assessment of subpopulation number	<p>The population is assumed to be panmictic. Pollination: The three brothers wattle is likely fertilised by a range of insects, birds and small mammals. Native bee (<i>Tetragonula carbonaria</i>) has a maximum home range of 712 m (Smith et al. 2017) though butterflies and other flying insects may travel much further (Compton 2002). Small mammals and birds may visit the flowers to consume the pollen or the small amount of nectar from the leaves (Tame et al. 2001). The Camden Haven River and Stewarts River would inhibit the movement of mammals, and the lower-lying open agricultural landscapes between each mountain may also reduce the movement of some insects. Pollen exchange and gene flow would still be possible via birds and wind. Dispersal: <i>Acacia</i> seeds have an elaiosome which may attract both ants and birds (Gibson et al. 2011), Dispersal may be quite restricted in distance if ants are the main consumer of the seed elaiosome in the three brothers wattle (see Dispersal section above). Presumably, the distribution of the species would be wider if birds were the major dispersal agent.</p>			
Number of locations	≤10	≤10	≤10	<p>Both the minimum and maximum plausible number of locations is equal to or less than ten. The geographic isolation between the three mountains (Northern, Middle and South Brother) is not extensive; however, there are topographic variations, rivers, roads, and agricultural lands between the three sites which may increase their isolation, and the impact of threatening events. For example, a broadscale bushfire in the area is less likely to spread across the three sites due to the topographic changes. Also, within a site (on each of the three Brother Mountains) the topography varies in microhabitat, vegetative structure and steepness. This variability may result in a patchy fire impact.</p> <p>The three-year long drought period between 2017-2019 was observed to impact 10% of the standing three brother wattle at one monitored site. Assuming this figure can be applied to the entire population of mature plants, then 10 similar events would cause significant declines in the three brothers wattle population.</p>
Trend	Stable			There is currently no evidence to suggest that the number of locations is either increasing or decreasing.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Basis of assessment of location number	<p>Northern, Middle and South Brother mountains are separated by rivers and areas of low-lying grazing and agricultural lands, which would act as a fire break dividing the three mountain sites. The Camden Haven River runs between the North and Middle Brother Mountains, and the Stewarts River runs between the Middle and South Brother Mountains. The three brothers wattle is not contiguous through its range, and it occurs in patches on sloping rocky territory with shallow soils. The number of bushfires required to impact the entire distribution is difficult to determine but based on the extent of previous fires (NSW RFS 2021), locations are estimated to be less than ten.</p> <p>In drought affected monitoring sites on North Brother Mountain, drought-related mortalities of adult plants (up to ten percent) were recorded from some plots thought to be caused by the severe drought conditions between 2017 and 2019 (P Richards 2021. pers comm 2 September). Assuming that risk of decline from drought is similar across the population, the number of locations is estimated to be equal or less than 10.</p> <p>The lack of fire, or frequent low severity fires are also serious threats to the three brothers wattle (see Auld 1987); however, there was insufficient data to determine if the rate of adult decline was greater than the rate of recruitment (in the absence of fire) and whether the trajectory of decline would result in a severe reduction within a single generation (as per IUCN guidelines for assessing location (IUCN 2019)).</p>			
Fragmentation	<p>The three brothers wattle is assumed not to be severely fragmented. However, research is required to confirm that gene flow is occurring between geographically isolated populations on North, Middle and South Brother mountains.</p>			
Fluctuations	<p>Fluctuations are likely natural phenomena for the obligate seeding three brothers wattle. Due to the lack of fire on North, Middle or South Brother mountains, the population is likely fluctuating less than it would if fire were more frequent. Timber harvest and fire intervals of 10 years occur in State Forest, which may also be suitable for a sustainable fluctuating three brothers wattle population, though there is no data to support this.</p>			

Criterion 1 Population size-reduction

Reduction in total numbers (measured over the longer of 10 years or 3 generations) based on any of A1 to A4			
	Critically Endangered Very severe reduction	Endangered Severe reduction	Vulnerable Substantial reduction
A1	≥ 90%	≥ 70%	≥ 50%
A2, A3, A4	≥ 80%	≥ 50%	≥ 30%
<p>A1 Population reduction observed, estimated, inferred or suspected in the past and the causes of the reduction are clearly reversible AND understood AND ceased.</p> <p>A2 Population reduction observed, estimated, inferred or suspected in the past where the causes of the reduction may not have ceased OR may not be understood OR may not be reversible.</p> <p>A3 Population reduction, projected or suspected to be met in the future (up to a maximum of 100 years) [(a) cannot be used for A3]</p> <p>A4 An observed, estimated, inferred, projected or suspected population reduction where the time period must include both the past and the future (up to a max. of 100 years in future), and where the causes of reduction may not have ceased OR may not be understood OR may not be reversible.</p> <p>Based on any of the following</p> <ul style="list-style-type: none"> (a) direct observation [except A3] (b) an index of abundance appropriate to the taxon (c) a decline in area of occupancy, extent of occurrence and/or quality of habitat (d) actual or potential levels of exploitation (e) the effects of introduced taxa, hybridisation, pathogens, pollutants, competitors or parasites 			

Criterion 1 evidence

Eligible under Criterion 1 A4ac for listing as Vulnerable

Generation time

Two generation time estimates were made, the first uses all known and estimated reproductive parameters (below) as inputs into the IUCN Generation Length Calculator (IUCN), which provides the average age of parents in the population. The second estimate takes a simpler approach, which is also recommended in the IUCN (2019) Guidelines for using the red list categories and criteria.

Three brothers wattle is suspected of living between 40–60 years based on observations of post-fire growth of new recruits. Seedlings reached approximately one metre per year for the first few years (P Richards 2021. pers comm 26 August). Three brothers wattle typically flowers at heights of three metres or more (Richards 2018, 2021). Maximum flowering (and seed production) is reached by ten years of age and appears to decline after 40 years.

Fecundity is not known for the species, though an estimate of 100 seeds in the first flowering year, increasing evenly to 1000 seeds in the tenth year was deemed a plausible estimate (P Richards 2021. pers comm 26 August). For calculations, fecundity was assumed to gradually decrease from 1000 to 100 between 20–60 years of age.

Survival affected the estimate of generation time, as did seed half-life. *Acacia* generally have long-lived seeds, which may remain in the seedbank for more than 50 years (Tame et al. 2001, Gibson et al. 2011). A maximum plausible generation time was estimated to be between 31 and

38 years, applying fine and coarse temporal scales of survival (respectively). The first age bracket included a seed half-life of 20 years and applied the fine scale survival estimates for the minimum value and coarse scale survival estimates for the maximum value (see Table 5).

Table 5. Ages of the three brothers wattle and assigned survival rates estimated at coarse and fine temporal scales.

Age bracket (coarse)	Survival (%) (coarse)	Age bracket (fine)	Survival (%) (fine)
-20-4	30	-20-1	30
4-30	100	1-4	50
30-40	80	4-10	90
40-60	20	10-20	80
		20-30	70
		30-40	30
		40-60	10

Using option 3 of the IUCN guidelines:

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

Generation time = $3 + [0.5 * (60 - 3)] = 31.5$ years

Using an estimate of 31 years for generation time, three generations was estimated to be 93 years.

Reduction in total numbers over three generations – drought (2018–2111)

Plots of three brothers wattle were surveyed on North and Middle Brother Mountains in 2018 and 2021. The number of mature individuals in 2018 was 123 (total count including juveniles and seedlings was 149) and declined to 98 (total count 162) in 2021 (Richards 1999, 2021). The decline in adult numbers was 22 percent in the surveyed plots over four years.

Overall, there were more individuals (both mature and immature) in 2021 as some recruitment had occurred after good rains in 2020–2021, though there were drought-related mortalities of adult plants (up to ten percent) in some plots, thought to be caused by the severe drought conditions between 2017 and 2019 (P Richards 2021. pers comm 2 September).

Although the three brothers wattle is a drought-tolerant species, on the three Brother Mountains, it persists in steep, rocky, shallow soil environments (e.g., above cliffs, in rocky creek lines) where soil moisture is variable (P Richards 2021. pers comm 2 September). On the north coast region of NSW, projected increases in maximum temperatures (maximum temperature increase of 0.4–1.0°C by 2039 and 1.5–2.4°C by 2060–2079) as well as an increase in the number of hot days (days above 35°C) have been modelled (NSW Government 2014b). Future precipitation is difficult to project, though seven of twelve precipitation models project a decrease in winter precipitation and an increase in autumn and spring precipitation for the North Coast of NSW. The range of precipitation projected in summer spans a decline of 17 percent to an increase of 14 percent (NSW Government 2014b). The cyclic nature of drought and the increasing hotter conditions driven by climate change are projected to result in a substantial decline of mature individuals by 2111 (three generations from 2018). The extent of decline is an

observed 22 percent in the past (2018–2021) and projected to be at least an additional 10 percent in the future (2021–2111); which is similar to recently observed rates of declines from other drought periods. The low rates of recruitment and the senescent state of the aging population of three brothers wattle (see Table 1) are likely to exacerbate the projected decline.

Conclusion

The Committee considers that the species is projected to undergo a substantial reduction (at least 30 percent) in numbers over three generations (93 years for this assessment), from the year 2018 to 2111, and the reduction has not ceased, and the cause has not ceased. Therefore, the species has met the relevant elements of Criterion 1 to make it eligible for listing as Vulnerable.

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

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

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

Criterion 2 evidence

Eligible under Criterion 2 B1ab(i,ii,iii,v)+2ab(i,ii,iii,v) for listing as Vulnerable

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

The three brothers wattle has a restricted geographic distribution with an EOO of 106 km² and an AOO of 52 km².

Number of locations – severe and extensive future bushfire (≤ 10)

The Three (North, Middle and South) Brother Mountains were not affected by the 2019-2020 bushfires; and this was likely due to the extensive containment lines and back burning undertaken by NSW Forestry to protect Blackbutt forest in the Middle Brother area (NSW Forestry 2021. pers comm 30 August). Given the scale and intensity of the 2019-2020 bushfires (Gallagher et al. 2021), it is feasible to suspect that future bushfires may impact all three sites in a single fire season; however, there are some natural fire breaks within and between the three sites. North Brother Mountain is separated from Middle brother by a highway and a large river system (the Camden Haven River). Middle and South Brother Mountains are separated by approximately two kilometres of low-lying grazing and agricultural lands and also by Stewarts River.

Although the three brothers wattle is an obligate seeder, and fire is an integral part of the species ecology, too hot and too frequent fires are a plausible threat to the species. Long fire intervals on North and Middle Brother Mountains may have resulted in the build-up of ground fuel from the Eucalypt overstoreys in the dry sclerophyll forests. High fuel loads may facilitate fires that are hotter and slower (Bradstock & Auld 1995) and potentially outside the tolerance of three brothers wattle seeds. Most *Acacia* species will break dormancy between 60–100°C, though seed death will occur if those temperatures last for more than two hours or if soil temperatures rise over 120°C for as short as one minute (Auld & O’Connell 1991). In Mallee shrublands of NSW, *Eucalyptus* litter (of a depth of ~2cm) resulted in hotter soil temperatures (50 minutes duration reaching 60–120°C at 5cm soil depth), at soil depths where most *Acacia* seeds occur (Bradstock et al. 1992, Bradstock & Auld 1995).

Three brothers wattle occurs in various microhabitats on steep, rocky, shallow soil environments (e.g., above cliffs, in rocky creek lines), which likely afford it some protection from intense fires (P Richards 2021. pers comm 2 Sept). The three brothers wattle is not contiguous throughout the range and instead occurs in patches. Fuel loads, fire speed and intensity would vary throughout the distribution and will depend on the canopy and understory species, soil moisture, steepness and aspect of the mountain. Although the threat of fire is significant, it will likely have a variable impact throughout the distribution, resulting in natural fluctuations (death of adults and recruitment of seedlings) in some areas and decline of adults and seeds in others. There is insufficient data to estimate fuel loads, though most canopy species are eucalypts, and fire history suggests that three separate events per mountain site would be a feasible estimate (the number of locations are estimated to be equal or less than ten).

Number of locations – Drought in the absence of fire (≤ 10)

The long absence of fire in three brothers wattle habitats (some areas more than 50 years) on North and Middle Brother Mountains has resulted in an aging and senescent population, vulnerable to drought (Richards 2018, 2021, P Richards 2021. pers comm 2 Sept). The lack of fire has resulted in a low recruitment rate. The number of small juvenile trees increased between 2018 and 2021 surveys, presumably older seeds were able to germinate and were supported by the end of the drought and the higher-than-average rainfalls experienced in NSW through 2020 and 2021 (CSIRO 2021). Although the three brothers wattle is drought tolerant, the mid-slope habitats that it inhabits have shallow soils, which may limit survival under severe drought conditions (see Criterion 1 above). Drought may impact all mature individuals across the distribution within a single generation. In drought affected monitoring sites, drought-related

mortalities of adult plants (up to ten percent) were recorded from some plots, thought to be caused by the severe drought conditions between 2017 and 2019 (P Richards 2021. pers comm 2 September). Assuming that risk of decline from drought is similar across the population, the number of locations is estimated to be equal or less than 10.

Ongoing decline in area, extent and quality of habitat, AOO, EOO and number of mature individuals

On the north coast region of NSW, there is a projected increase in maximum temperatures (maximum temperature increase of 0.4–1.0°C by 2039 and 1.5–2.4°C by 2060–2079) and an increase in the number of hot days (above 35°C) and the number of fire weather days. Precipitation is projected to decrease in winter and increase in autumn and spring (NSW Government 2014a). Species with limited latitudinal and altitudinal ranges may be more at risk of climate change as temperature envelopes move poleward (Westoby & Burgman 2006). The three brothers wattle occurs at between 40–300 m altitude and has a latitudinal range of 17 km (less than a degree of latitude; distances estimated in GoogleEarth).

The persistence of three brothers wattle will rely on a suitable fire regime (with a frequency longer than 10 years and an intensity suitable for germination) as well as following rains to support the survival of seedlings. Recent past conditions have not been suitable for the species. The lack fire on the mid-slopes and aspects that the three brothers wattle grows on has led to no recruitment in many of the surveyed sites (Richards 2021). Further, the drought period between 2017 and 2019 is suspected of killing adults and some seedlings on Northern and Middle Brother Mountains (Richards 2018, 2021). If fires become too frequent (e.g. repeat fires within three years) or too hot, then the impacted portion of the population will die out. If drought follows fire, or if fire occurs at a time of year when rains are not predicted to follow, then seedlings will not survive. If there continues to be no fire, then the standing population of adults (currently estimated to be 20 years past peak reproductive ages) will contribute less and less to an aging seed bank. Where the dominant canopy is *Eucalyptus*, there may be sufficient heat in a fire to destroy the seed bank (see *Number of locations – bushfire* section above). All of these scenarios project an ongoing decline in the three brothers wattle.

A combination of drought (see Criterion 1) and inappropriate fire regime are predicted to lead to reductions in total numbers of mature individuals. The influence of other threats (weeds and intentional or accidental removal or damage) is possibly higher on the private and crown properties as they are not managed for the three brothers wattle. These properties occur at the periphery of the distribution and a decline in adult three brothers wattles there will result in a retraction of both AOO and EOO.

Conclusion

The Committee considers that the species EOO and AOO is restricted, the number of locations is limited, and continuing decline is projected for the extent of occurrence, area of occupancy, quality of habitat and number of mature individuals.

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

However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion is based on the acceptance that this species is

severely fragmented and should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 3 Population size and decline

	Critically Endangered Very low	Endangered Low	Vulnerable Limited
Estimated number of mature individuals	< 250	< 2,500	< 10,000
AND either (C1) or (C2) is true			
C1. An observed, estimated or projected continuing decline of at least (up to a max. of 100 years in future)	Very high rate 25% in 3 years or 1 generation (whichever is longer)	High rate 20% in 5 years or 2 generations (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	≤ 1,000
(a) (ii) % of mature individuals in one subpopulation =	90 – 100%	95 – 100%	100%
(b) Extreme fluctuations in the number of mature individuals			

Criterion 3 evidence

Eligible under Criterion 3 C1a(ii)+C2a(ii) for listing as Vulnerable

Number of Mature Individuals in one subpopulation

The total population on the North, Middle and South brother mountains is estimated to be 8500 individuals (see Table 3). Although they are geographically isolated, there is hypothesised gene flow sufficient to maintain genetic connectivity between sites (see Subpopulations, Table 3); therefore, 100 percent of the mature population is in one subpopulation (for the purpose of the criteria, the subpopulation is the entire population).

Decline in population – drought and climate change

Drought conditions resulted in the mortality of adults and seedlings on Northern and Middle Brother Mountains between 2018 and 2021 (See Criteria 1 and 2). Mature adults of three

brothers wattle in surveyed sites declined by 22 percent over three years between 2018 and 2021 (some as a result of drought, and others due to senescence (Richards 2021)). Climate projections suggest that conditions will not become more suitable to the three brothers wattle (see Criterion 2) and fecundity is possibly declining in an aging population (see Criterion 2) so a decline of at least ten percent over the next three generations (93 years; by 2111) is considered likely.

Conclusion

The estimated total number of mature individuals of this species is limited and projected continuing decline is continuing at a substantial rate. There is a projected continuing decline, and the geographic distribution is precarious for the survival of the species because the percentage of mature individuals in one subpopulation is 100 percent. Therefore, the species has met the relevant elements of Criterion 3 to make it eligible for listing as Vulnerable.

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

Criterion 4 Number of mature individuals

	Critically Endangered Extremely low	Endangered Very Low	Vulnerable Low
D. Number of mature individuals	< 50	< 250	< 1,000
D2.¹ Only applies to the Vulnerable category Restricted area of occupancy or number of locations with a plausible future threat that could drive the species to critically endangered or Extinct in a very short time			D2. Typically: area of occupancy < 20 km ² or number of locations ≤ 5

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

Criterion 4 evidence

Not eligible

Conclusion

The total number of mature individuals is 8500, which is not considered low. Therefore, the species has not met this required element of this criterion.

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

Criterion 5 Quantitative analysis

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

Criterion 5 evidence

Insufficient data to determine eligibility

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

However, the purpose of this consultation document is to elicit additional information to better understand the subspecies' status. This conclusion is based on the acceptance that this species is severely fragmented and 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.

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Version history table

Document type	Title	Date [dd mm yyyy]
Conservation Advice	Approved conservation advice for <i>Acacia courtii</i>	26 03 2008
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