Australian Government
Department of Agriculture, Water and the Environment

Consultation on Species Listing Eligibility and Conservation Actions

Persoonia terminalis (heath-leaved geebung)

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

1) the ineligibility of *Persoonia terminalis* (heath-leaved geebung) for inclusion on the EPBC Act threatened species list; and

2) the necessary conservation actions for the above species.

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

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

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

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

Please include species scientific name in Subject field.

or by mail to:

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

Responses are required to be submitted by 24 March 2022.

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General background information about listing threatened species

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

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

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

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

Privacy notice

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

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

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

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

Information about this consultation process

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

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

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

CONSULTATION QUESTIONS FOR *PERSOONIA TERMINALIS* (HEATH-LEAVED GEEBUNG)

SECTION A - GENERAL

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

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

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

PART 1 – INFORMATION TO ASSIST LISTING ASSESSMENT

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

Biological information

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

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

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

Population size

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

7. Do you consider the way the population size has been derived to be appropriate? Are there any assumptions and unquantified biases in the estimates? Did the estimates measure relative or absolute abundance? Do you accept the estimate of the total

population size of the species/subspecies? If not, please provide justification for your response.

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

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

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

   ☐ 1–1000 ☐ 1001–5000 ☐ 5001–10,000 ☐ 10,000–20,000 ☐ >20 000

   Level of your confidence in this estimate:

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

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

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

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

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

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

9. Does the current and predicted rate of decline used in the assessment seem reasonable? Do you consider that the way this estimate has been derived is appropriate? If not, please provide justification of your response.

Evidence of total population size change

10. Are you able to provide an estimate of the total population size during the early 2000s *(at or soon after the start of the most recent three generation period)*? Please provide justification for your response.

    If, because of uncertainty, you are unable to provide a single number, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the

table below of possible species/subspecies numbers, and also choose the level of confidence you have in this estimate.

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

☐ 1–1000 ☐ 1001–5000 ☐ 5001–10,000 ☐ 10,000–20,000 ☐ >20 000

Level of your confidence in this estimate:

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

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

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

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

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

11. Are you able to comment on the extent of decline in the species/subspecies' total population size over the last approximately 56 years (i.e. three generations period)? Please provide justification for your response.

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

Decline estimated to be in the range of:

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

Level of your confidence in this estimated decline:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

    ☐ <100 km^2 ☐ 100 – 5 000 km^2 ☐ 5 001 – 20 000 km^2 ☐ >20 000 km^2

    Level of your confidence in this estimated extent of occurrence

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

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

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

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

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

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

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

☐ <10 km^2 ☐ 11 – 500 km^2 ☐ 501 – 2000 km^2 ☐ >2000 km^2

Level of your confidence in this estimated extent of occurrence:

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

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

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

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

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

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

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

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

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

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

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

    ☐ <100 km^2 ☐ 100 – 5 000 km^2 ☐ 5 001 – 20 000 km^2 ☐ >20 000 km^2

    Level of your confidence in this estimated extent of occurrence

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

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

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

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

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

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

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

    ☐ <10 km^2 ☐ 11 – 500 km^2 ☐ 501 – 2000 km^2 ☐ >2000 km^2

Level of your confidence in this estimated extent of occurrence:

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

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

PART 3 – ANY OTHER INFORMATION

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

Conservation Advice for *Persoonia terminalis* (heath-leaved geebung)

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 heath-leaved geebung. It provides a foundation for conservation action and further planning.

Persoonia terminalis subsp. *recurva* (left) and *P. terminalis* subsp. *terminalis* (right) © Copyright, M Fagg (from APII)

Conservation status

Persoonia terminalis (heath-leaved geebung) is not proposed to be listed under the *Environment Protection and Biodiversity Conservation Act 1999.*

Persoonia terminalis was assessed by the Threatened Species Scientific Committee to not be eligible for listing under any of the listing criteria. 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: Ineligible
- Criterion 2: Ineligible
- Criterion 3: Ineligible
- Criterion 4: Ineligible
- Criterion 5: Insufficient data

The main factors that make the species ineligible for listing are the large population size which exceeds the threshold for listing, lack of decline, and absence of threats likely to cause the rapid elimination of the species.

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 *Persoonia terminalis* L.A.S.Johnson & P.H.Weston (1991).

There are two recognised subspecies of heath-leaved geebung, which differ in leaf morphology (APC 2021). This Conservation Advice and Listing Assessment is for *P. terminalis* at the species level (both subspecies combined), in accordance with the Finalised Priority Assessment List 2020 (DAWE 2021). It should be noted that assessing either subspecies individually would not change the outcome of the Listing Assessment at Appendix 1.

Description

Heath-leaved geebung is an erect or sprawling shrub to 0.7–1.5 m high with smooth bark and sparsely hairy young branches. Leaves are 0.6–0.75 cm long and strongly recurved in *P. terminalis* subsp. *recurva*, and 0.8–1.0 cm long and slightly recurved towards the tip in *P. terminalis* subsp. *terminalis*. Flower spikes are mostly at the end of branches, with 1–5 yellow flowers that are 0.9–1.3 cm long. Fruits are green with purple stripes.

Heath-leaved geebung is distinguished from closely related *Persoonia* species by its small, tough, leathery leaves and inflorescences that are mostly at the end of branches, beyond which growth does not progress, and with flowers subtended by scale leaves.

Heath-leaved geebung grows sympatrically with *P. cornifolia* (broad-leaved geebung) and *P. sericea* (silky geebung),occasionally hybridising with both; and *P. tenuifolia* (fine-leaved geebung), with which no hybrids have been recorded (Johnson & Weston 1991; Bernhardt & Weston 1995). First generation hybrids are frequently recorded in *Persoonia*, probably due to overlapping distributions, flowering periods and pollinators (Bernhardt & Weston 1995).

Distribution

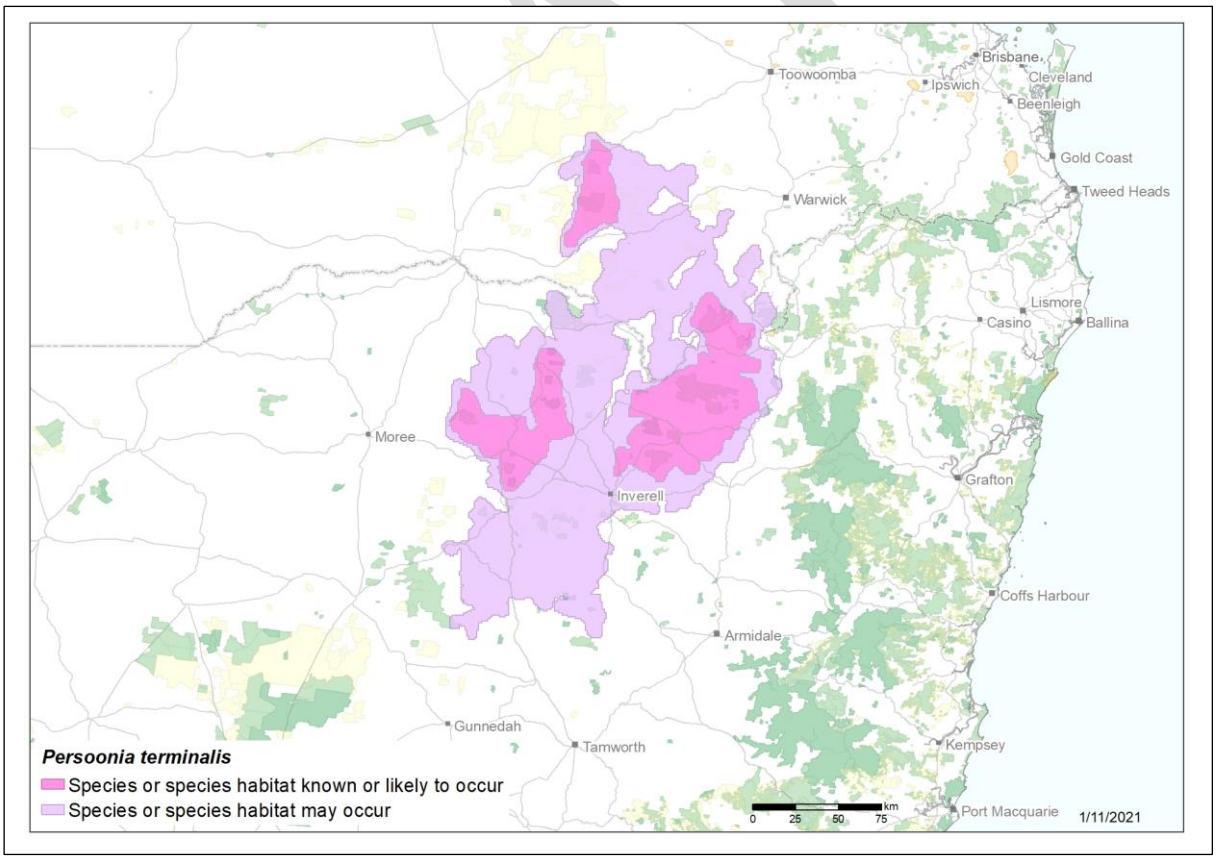
Persoonia terminalis subsp. *recurva* occurs near the Inglewood–Cecil Plains area in southeast Queensland, and in the Warialda area on the North Western Slopes in New South Wales. *Persoonia terminalis* subsp. *terminalis* occurs nearby to the east in the Torrington–Binghi area on

the western side of the far Northern Tablelands in New South Wales (Johnson & Weston 1991). These subspecies occur sympatrically at Severn River Nature Reserve (NR) and Arakoola NR (Hunter 2002; ALA 2021). In addition to these reserves, heath-leaved geebung is reserved at Torrington State Conservation Area (SCA), Warialda SCA, Bullala National Park (NP) and Kings Plains NP in New South Wales, and Wondul Range NP in Queensland and also occurs on state forest, leasehold and private land (ALA 2021; Hunter 2002). Two herbarium specimens from central Queensland (Mt Moffatt and Humboldt regions) require checking as they are substantial outliers from the rest of the species' distribution (ALA 2021; DES 2022 pers. comm. 18 Jan).

The number of subpopulations of heath-leaved geebung has not been documented. However, based on the spatial clustering of records there appears to be approximately 10 subpopulations of heath-leaved geebung (Inglewood–Bulli, Taringa, Arakoola NR, Bullala NP, Kings Plains NP, Severn River NR, Warialda, near 'Springvale' station, Torrington, and near Gibraltar NR; Hunter 2002; ALA 2021). If the two central Queensland records are verified, this may increase to 12 subpopulations.

There are no formal population estimates for the heath-leaved geebung, but its population is estimated to be in the tens of thousands (J Hunter 2021 pers. comm. 10 Oct). The species appears to be scattered and common but never in high abundance (i.e. they don't seem to grow into big clumps or dense patches) (J Hunter 2021 pers. comm. 10 Oct).

Map 1 Modelled distribution of heath-leaved geebung



Source: Base map Geoscience Australia; species distribution data Species of National Environmental Significance database.
Caveat: The information presented in this map has been provided by a range of groups and agencies. While every effort has been made to ensure accuracy and completeness, no guarantee is given, nor responsibility taken by the Commonwealth for

errors or omissions, and the Commonwealth does not accept responsibility in respect of any information or advice given in relation to, or as a consequence of, anything containing herein.

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

Cultural and community significance

This section describes some published examples of cultural significance but is not intended to be comprehensive, applicable to, or speak for, all Indigenous Australians. Such knowledge may be only held by Indigenous groups and individuals who are the custodians of this knowledge.

The cultural significance of heath-leaved geebung is not well known. However, the fruits of other *Persoonia* species are known to be edible and are likely to form part of the diet of Aboriginal Australians (Packer et al. 2012). Torrington State Conservation Area is a significant place for the Ngarrabul, Marbul, Bigambul and Jucumbul people (NPWS 2003), Severn River NR is within traditional lands of the Kwiambal people (NPWS 2004), Arkaroola NR is within the lands of the Gamilaroi people (OEH 2014) and the subpopulations north of Inglewood in Queensland are on the lands of the Bigambul people (DERM 2011). Subpopulations in New South Wales are in the Moree, Ashford and Moombahlene Aboriginal Land Councils (ALC 2021).

Relevant biology and ecology

Habitat

Heath-leaved geebung occurs in dry sclerophyll forest on sandy soils derived from sandstone or acid granite from 350–1100 m above sea level (Johnson & Weston 1991). It often occurs at the margins between rock outcrops and forest, and also in boulder areas (J Hunter 2021 pers. comm. 10 Oct). In the Torrington area, the species occurs in *Kardomia odontocalyx – Brachyloma saxicola* shrubland and *Prostanthera staurophylla* (Tenterfield mint-bush) – *Kunzea bracteolata* low shrubland (Hunter & Clarke 1998). In Severn River NR it grows in *Allocasuarina brachystachya* shrubland, and on metamorphosed sedimentary rock outcrops in impoverished red sand in woodland dominated by *Acacia williamsiana*, *Allocasuarina inophloia* (woolly oak) and *Eucalyptus polyanthemos* (red box) (Hunter & Clarke 1998; ALA 2021). At Severn River NR and Arakoola NR the species is also found in woodland dominated by *Angophora leiocarpa* (smooth-barked apple), *E. macrorhyncha* (red stringybark) and *Corymbia dolichocarpa* (long-fruited bloodwood) (Hunter 2003). Around Warialda, it is found in *Callitris endlicheri* (black cypress pine) – *E. chloroclada* (dirty gum) woodland and smooth-barked apple – black cypress pine woodland (Hunter 2009), also with *E. blakelyi* (Blakely's red-gum), on sandstone ridges with boulders and outcrops in skeletal sandy soils, or in deep sandy loam, sometimes with silky geebung and *Boronia glabra* (sandstone boronia) (ALA 2021). At Wondul Range NP it is found in sandy soil in open forest of *C. citriodora* (lemon-scented gum), *E. exserta* (Queensland peppermint), *E. crebra* (narrow-leaved ironbark), *A. sparsiflora* (currawang), , *A. conferta* (crowded-leaf wattle), smooth-barked apple, *Xylomelum* spp., woolly oak, *A. littoralis* (black sheoak), *Callitris glaucophylla* (white cypress-pine), *A. luehmannii* (buloke), *Melaleuca decora* (white feather honeymyrtle) or *Cleistochloa rigida* (ALA 2021).

Reproductive biology

Little is known about the reproductive ecology of heath-leaved geebung, and as a result, this section draws largely on published literature from congeneric species.

Heath-leaved geebung flowers primarily in December–January (Emery & Offord 2018). Although nothing is known of pollination in heath-leaved geebung, pollination of other *Persoonia* species is undertaken by native bees, particularly *Leioproctus* spp. (Colletidae; subgenus Cladocerapis), *Exoneura* spp. (Anthophoridae), *Tetragonula carbonaria* (Apidae) and European honeybee (*Apis mellifera*; Apidae) (Bernhardt & Weston 1995; Rymer et al. 2005). However, the native bees are likely to be more effective pollinators than the introduced European honeybee as they travel greater distance and pollinate more flowers across more plants (Rymer et al. 2005), with the European honeybee observed to frequently collect nectar without pollinating the flowers of *Persoonia* (Paton 2000). *Exoneura* spp. and *Leioproctus* spp. also forage on the flowers of Myrtaceae and other co-flowering taxa (Bernhardt & Weston 1995). Female *Leioproctus* bees may carry heavier loads of pollen than males, which appear to primarily forage for nectar (Bernhardt & Weston 1995).

Pollination experiments suggest that most *Persoonia* species have a breeding system that favours outcrossing, with self-pollination usually resulting in no or low fruit set (Emery & Offord 2018), although *P. juniperina* (prickly geebung) and *P. bargoensis* (Bargo geebung) appear to be self-compatible exceptions (Cadzow and Carthew 2000; Field et al. 2005).

Fruit set and maturation is a long process in *Persoonia* that typically takes at least two months, but often up to one year (Emery & Offord 2018). *Persoonia* fruits are fleshy and are consumed and dispersed by birds and other animals, including *Wallabia bicolor* (swamp wallaby), *Macropus fuliginosus* (western grey kangaroo) and *Tiliqua rugosa* (bobtail lizard), *Oriolus sagittatus* (olive-backed oriole), *Zosterops lateralis* (silver-eye), *Strepera graculina* (pied currawong), *Ptilonorhynchus violaceus* (Satin Bowerbird), *Anthochaera carunculate* (red wattlebird), *Dromaius novaehollandiae* (Emu), *Meliphaga lewinii* (Lewin's honeyeater) and rodents (Barker & Vestjans, 1990; Mullins et al. 2002; Chia et al. 2015). However, the viability of seed in the scats of dispersal vectors is not well understood, and may be of low viability (e.g. *P. longifolia* in scats of Emu; Mullins et al. 2002). Cockatoos and other parrots may predate on *Persoonia* seed (Weston 2003; K Chia pers. comm. in Emery & Offord 2018).

Persoonia seeds display both mechanical and physiological dormancy. Within the fleshy fruit, the embryo is surrounded by a hard casing (endocarp) that causes mechanical dormancy, the physical removal or degradation of which is necessary to achieve germination (Chia et al. 2016). In ex situ propagation trials, embryos appear to also require treatment with gibberellic acid, warm/cold stratification or after-ripening to promote germination (physiological dormancy) (Mullins et al. 2002; Chia et al. 2016, Emery & Offord 2018), although these treatments are often species-specific (Emery & Offord 2018). New unpublished information for WA species indicates that germination may be possible to high levels using a period of summer aging in soil along with periodic moisture applications. However, the specific germination cues for heath-leaved geebung are unknown and ex situ seed germination of *Persoonia* species is likely to be difficult. For example, *P. longifolia* was subject to seed germination trials in 1984, 1994 and 1995 before being germinated for the first time in ex situ propagation in 2002 (Emery & Offord 2018). *Persoonia* are not smoke or heat germinable.

Persistence of *Persoonia* seed in the soil seedbank appears to be relatively short-lived, and limited to a few years. Estimated longevity in soil seedbanks include: a half-life of one year (*P. pinifolia* (mambara); Auld et al. 2000), viability decline from 39 percent to 5 percent after one year (*P. elliptica* (spreading snottygobble); Nield et al. 2015), viability decline from 93 percent to 68 percent after three years (*P. longifolia*); Chia et al. 2016) and significant viability declines in four species of *Persoonia* following soil burial for 1–2 years (McKenna 2007). However, short-lived viability in the soil seed bank may not negatively affect recruitment success due to annual fruiting and the ability of a substantial number of seeds to persist for many years even in species with a short seed half-life (Emery & Offord 2018). Seed of some *Persoonia* species also appears to persist in the soil following fire (Auld et al. 2007; Ayre et al. 2009).

The primary juvenile period (time from germination to reproductive maturity) for heath-leaved geebung is unknown, however other obligate seeding *Persoonia* species have primary juvenile periods of approximately six years (Clarke et al. 2009).

Fire ecology

Heath-leaved geebung is an obligate seeder (Clarke & Knox 2002; Clarke et al. 2009). However, its preference for habitat on the margins of rock outcrops and in boulder areas may offer some protection from some fires (L Copeland 2021 pers. comm. 12 Oct). Recruitment is scattered and irregular (J Hunter 2021 pers. comm. 10 Oct). Although *Persoonia* seed may be relatively short-lived in the soil seed-bank, other *Persoonia* species have been demonstrated to have soil seed banks that are not exhausted by a single fire and are capable of withstanding multiple fire events in a short period of time (e.g. *P. lanceolata* (lance-leaf geebung) in Auld et al. 2007; *P. mollis* subsp. *nectens* in Ayre et al. 2009).

Habitat critical to the survival

As the species is not eligible for listing, habitat critical to the survival of the species has not been defined.

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.

As the species is not eligible for listing, important populations of the species have not been defined.

Threats

Heath-leaved geebung is threatened by inappropriate fire regimes, grazing and trampling by feral goats, grazing by feral horses and feral pigs, weed invasion, dieback caused by *Phytophthora cinnamomi* infection, and the effects of climate change.

Table 1 Threats impacting heath-leaved geebung

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

Threat	Status and severity [a]	Evidence
Habitat loss, disturbance and modifications		
Inappropriate fire regimes or fire regime that causes a decline in biodiversity	• Timing: current • Confidence: inferred • Consequence: moderate • Trend: increasing • Extent: across the entire range	Heath-leaved geebung is an obligate seeder with adult plants killed by high severity fire (J Hunter 2021 pers. comm. 10 Oct). Keith (1996) identified several fire driven mechanisms of plant population decline and extinction for obligate seeder shrubs. These mechanisms included death of standing plants and seeds, failure of seed germination, failure of seedling establishment, interruption of maturation or developmental growth, and failure of seed production. Keith (1996) also identified fire regimes associated with multiple mechanisms of plant population decline and extinction, including both high frequency and low frequency fires. As an obligate seeder, heath-leaved geebung requires an appropriate interval between fires to reach reproductive maturity and produce sufficient seed for the next generation. There is a theoretical risk that multiple fires of any severity in a short period of time could eliminate adult plants before they reach reproductive maturity, thus causing the decline or elimination of subpopulations (Keith 1996). However, the habitat of heath-leaved geebung is in and around rocky outcrops and boulder areas, in areas not always heavily impacted by fires (J Hunter 2021 pers. comm. 10 Oct), with partial foliage scorch sometimes followed by rapid post-fire recovery (J Hunter 2021 pers. comm. 10 Oct). Major bushfires have occurred at Torrington SCA in 1965, 1975, 1985, 1990, 2002, 2009/10 and 2019 (NPWS 2003; SEED 2021), and there is no suggestion that the subpopulation of heath-leaved geebung in the reserve has declined or is threatened by such a fire regime (J Hunter 2021 pers. comm. 10 Oct; L Copeland 2021 pers. comm. 12 Oct). Heath-leaved geebung is unlikely to be threatened by low fire frequency as it appears capable of recruiting in the absence of fire, and is not reliant on fire to stimulate recruitment (J Hunter 2021 pers. comm. 10 Oct). The impacts of out-of-season (e.g. prescribed) fires on heath-leaved geebung are unknown. Out-of-season fires may negatively impact the species through mechanisms including, increased adult mortality, not stimulating substantial recruitment or negatively impacting pollinators (Miller et al. 2019; DAWE 2021a).
Invasive species		
Grazing and trampling by feral goats (*Capra hircus*)	• Status: current • Confidence: suspected • Consequence: minor • Trend: unknown	Feral goats are found in all states and territories of Australia and have been listed as a Key Threatening Process under the EPBC Act (DEWHA 2008). Feral goats have a negative impact on native plants communities through soil damage and overgrazing of herbs, grasses,

	• Extent: across parts of the range	shrubs and trees. This grazing can cause erosion and prevent regeneration and recruitment. They may also spread weeds and diseases (Bayne et al. 2005; DEWHA 2008). Feral goats occur across the range of the heath-leaved geebung (e.g. in Torrington SCA; NPWS 2003) and are a suspected minor threat to the species. Unlike many other feral herbivores, goats graze on the rocky outcrops and boulder areas that the species grows on. However, the severity of feral goat browsing on heath-leaved geebung is not well documented and appears to be minor. Anecdotal observations suggest that the species may not be palatable (J Hunter 2021 pers. comm. 10 Oct), as no browsing damage (J Hunter 2021 pers. comm. 10 Oct), or minor browsing damage (L Copeland 2021 pers. comm. 12 Oct) has been observed. However, the interaction between fire and herbivory is unknown, and the species may be more palatable following fire (DAWE 2021a).
Grazing by feral pigs (*Sus scrofa*)	• Status: current • Confidence: suspected • Consequence: minor • Trend: unknown • Extent: across parts of the range	Feral pigs can directly damage native plants and habitat when digging in search of food (DoEE 2017). They can also introduce weed seeds and nutrients to native habitat and disturb the soil, encouraging the establishment of weeds (DoEE 2017). Feral pigs are listed as a Key Threatening Process (KTP) under the EPBC Act (DoEE 2017). However, the impacts of feral pigs are most likely in and near riparian areas (NPWS 2003), where heath-leaved geebung does not occur. Therefore, the threat posed by feral pigs is likely to be minor to this species.
Grazing by feral horses (*Equus ferus caballus*)	• Status: current • Confidence: suspected • Consequence: minor • Trend: unknown • Extent: across parts of the range	Feral horses are present within Torrington SCA and can have significant impacts on threatened plants in the reserve and are considered a pest species (NPWS 2003). However, little is known about their impact on heath-leaved geebung, and they are unlikely to be a major threat given the rocky habitat of the species. Control of feral horses has been previously implemented at some subpopulations (NPWS 2003).
Weed invasion	• Status: current • Confidence: suspected • Consequence: minor • Trend: unknown • Extent: across parts of the range	Several weeds listed in the New South Wales *Noxious Weeds Act 1993* have been recorded in Torrington SCA, of which serious environmental weeds including prickly pear (*Opuntia* spp.), blackberry (*Rubus fruticosus* spp. agg.) and sweet briar (*Rosa rubiginosa* spp. agg.) (NPWS 2003) may occur in the rocky areas in which heath-leaved geebung occurs. These species can form dense thickets and compete with native vegetation and seedlings through nutrient and water competition. Weeds are more likely to occur in areas that have experienced past disturbance from agricultural practices, mining and along access roads. The threat to heath-leaved geebung posed by weeds is likely to be minor due to the comparatively large area occupied by the species and its preference for rocky areas where historical disturbance from

		mining and land clearing is unlikely to have occurred.
Disease		
Dieback caused by *Phytophthora cinnamomi* infection	• Status: current • Confidence: unknown • Consequence: minor • Trend: unknown • Extent: across its entire range	*Phytophthora cinnamomi* is a soil-borne pathogen that infects and kills roots of susceptible plants, facilitating plant death (DOEE 2018). Many species of Proteaceae are particularly vulnerable to the disease and some *Persoonia* species are known to be susceptible (Rymer, 2005). The susceptibility of heath-leaved geebung to dieback caused by *P. cinnamomi* infection is not known and it appears the species has not been tested. Despite the potential susceptibility of heath-leaved geebung, the distribution of the species does not overlap with the modelled distribution of *P. cinnamomi*, which prefers wetter and cooler areas (Burgess et al. 2017). Dieback from *P. cinnamomi* is not listed in management plans for reserves across the distribution of the heath-leaved geebung (NPWS 2003; NPWS 2004; DERM 2011; OEH 2014). The modelled distribution of *P. cinnamomi* is predicted to contract further towards the coast in northern New South Wales and south-east Queensland due to the effects of climate change (Burgess et al. 2017). Therefore, dieback caused by *P. cinnamomi* infection is unlikely to be a significant threat to heath-leaved geebung. However, the impact of other *Phytophthora* species is unknown and is a research priority.
Climate Change		
Increased temperature, fire danger weather, autumn rainfall, and decreased winter rainfall	• Timing: current • Confidence: observed • Consequence: major • Trend: increasing • Extent: across the entire range	The CSIRO & Bureau of Meteorology (2020) project that the eastern coast of Australia will be exposed to increased temperature, fire danger weather, autumn rainfall, and decreased winter rainfall, due to climate change (OEH 2014). In northern NSW, maximum temperatures are projected to increase by 0.7°C by 2030 and 2.2°C by 2070. Heath-leaved geebung may be directly threatened by changes to rainfall and temperature. *Persoonia* species are predicted to be susceptible to altered rainfall patterns and increased temperatures, resulting in the contraction of suitable habitat (Andres et al. 2021). Heath-leaved geebung may be susceptible to extended dry periods as it occurs on shallow, skeletal soils. Germination of *Persoonia* species is also likely to be negatively impacted by increased mean maximum and minimum soil temperatures (Catelotti et al. 2020). Heath-leaved geebung may be threatened by changes to rainfall patterns and warming which can act synergistically with inappropriate fire regimes to increase the risk of repeat fire events at intervals below or approaching the tolerable fire interval for the taxon, leading to seedbank depletion,

		exhaustion and local extinction. Post-fire recruitment and seedling survival is threatened by drought, particularly where drought conditions are present pre- or post-fire (Auld 2020; Gallagher et al. 2021).

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

Table 2 Heath-leaved geebung risk Matrix

Likelihood	**Consequences**				
	Not significant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Low risk	Moderate risk	Very high risk	Very high risk **Increased temperature, fire danger weather, autumn rainfall, and decreased winter rainfall**	Very high risk
Likely	Low risk	Moderate risk **Grazing and trampling by feral goats**	High risk **Inappropriate fire regimes**	Very high risk	Very high risk
Possible	Low risk	Moderate risk **Grazing by feral pigs** **Grazing by feral horses** **Weed invasion**	High risk	Very high risk	Very high risk
Unlikely	Low risk	Low risk **Dieback caused by *P. cinnamomi* infection**	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 monitoring.

Conservation and recovery actions

Primary conservation objective

By 2030, the population of heath-leaved geebung will have increased in abundance and viable subpopulations are sustained in habitats where threats are managed effectively.

Conservation and management priorities

Habitat loss, disturbance and modifications

- Avoid or minimise further loss and fragmentation of habitat.

Climate change and fire

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

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

- Develop or maintain feral goat, feral pig and feral horse population control measures in consultation with land managers and community groups in and near subpopulations of heath-leaved geebung, including through the use of aerial and ground shooting, mustering and trapping (DEWHA 2008).

- Implement site-based weed control using appropriate methods in consultation with land managers and community groups to ensure that there is no impact on heath-leaved geebung individuals.

Disease

- Test susceptibility to *Phytophthora* species. including species adapted to drier conditions than *P. cinnamomi.*
- Ensure appropriate hygiene protocols are in place, particularly during track and road management. Refer to the threat abatement plan for disease in natural ecosystems caused by *Phytophthora cinnamomi* (DOEE 2018).
- Undertake testing of any plants suspected of *P. cinnamomi* infection to confirm the absence or presence of the disease.

Ex situ conservation

- Collect and store seed from known subpopulations to preserve genetic material, in accordance with the *Plant Germplasm Conservation in Australia* (Martyn Yenson et al. 2021).
- Investigate the application of over-summer ageing of seed in soil as a means to advance dormancy release.
- Investigate the requirements of the species for ex situ recovery, including the establishment of a seed orchard if current seed collections are limited.
- If appropriate, undertake ex situ propagation and translocations in accordance with the *Guidelines for the Translocation of Threatened Plants in Australia* (Commander et al. 2018). Monitor all translocated individuals to maturity, seed set and recruitment to ensure they are viable and are contributing to a reduction in the extinction risk for the species.

Stakeholder engagement/community engagement

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

Survey and monitoring priorities

- Maintain a monitoring program to:
    - monitor species recruitment and plant health before and after fire and drought events;
    - determine trends in population size;
    - document the post-fire recovery and causes of recruitment failure;

- determine threats and their impacts (particularly the impact of feral goat herbivory and drought); and,
- monitor the effectiveness of management actions and the need to adapt them if necessary.

Information and research priorities

- Verify the identity of the two central Queensland herbarium specimens.
- Increase knowledge surrounding the ecology of heath-leaved geebung. This includes improving understanding of habitat requirements, recruitment and soil-seed bank dynamics (especially seed bank longevity and germination cues), appropriate fire frequency, pollination biology, seed and plant longevity, genetic structure, and minimum viable population size.
- Understand the potential influence of climate change on the long-term survival prospects of the species, due to altered temperatures, rainfall patterns, bushfires, and environmental stressors, particularly the effect of drought on plants across soil depth and moisture gradients.
- Investigate the impact of drought on heath-leaved geebung recruitment and seedling growth.
- Ascertain the cultural significance of heath-leaved geebung.
- Test the susceptibility of heath-leaved geebung to *P. cinnamomi* and other plant pathogens (e.g. other species of *Phytophthora*).

Recovery plan decision

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

Links to relevant implementation documents

Threat abatement plan for predation, habitat degradation, competition and disease transmission by feral pigs (*Sus scrofa*) (2017)

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

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

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Attachment A: Listing Assessment for *Persoonia terminalis*

Reason for assessment

This assessment follows prioritisation of a nomination from the TSSC.

Assessment of eligibility for listing

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

Key assessment parameters

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

Table 3 Key assessment parameters

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of mature individuals	10,000–30,000	~10,000	~50,000	There are no formal population estimates for the heath-leaved geebung, but its population is estimated to be in the 10's of thousands (J Hunter 2021 pers. comm. 10 Oct).
Trend	stable			No evidence of decline (J Hunter 2021 pers. comm. 10 Oct).
Generation time (years)	18	25	15	The generation length of heath-leaved geebung is not documented. *Persoonia* species may reach reproductive maturity at approximately six years of age (Clarke et al. 2009) and are capable of living for 30 years (NPWS 2000). Therefore, a plausible generation length for heath-leaved geebung may be approximately 18 years, assuming constant fecundity throughout its reproductive life (see Criterion 1) (IUCN 2021).

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Extent of occurrence	16,522 km²	~13,000 km²	~91,000 km²	The extent of occurrence (EOO) is based on the mapping of available point records from 1970 to 2020. This timeframe was used due to the species occurring in relatively remote, rarely surveyed areas, and because there has been no evidence of population decline, even in areas affected by recent bushfires (J Hunter 2021 pers. comm. 10 Oct; L Copeland 2021 pers. comm. 12 Oct). The EOO was calculated using a minimum convex hull, based on the IUCN Red List Guidelines (IUCN 2019). The maximum plausible value represents the plausible EOO if the central Queensland records are verified, which would increase the EOO estimate very substantially. As the species occurs in remote areas, additional subpopulations could exist, which could result in a slightly larger EOO. The minimum plausible value represents the plausible EOO if some older records at the margins of the species' range no longer exist.
Trend	stable			No evidence of decline (J Hunter 2021 pers. comm. 10 Oct).
Area of Occupancy	452 km²	~400 km²	~600 km²	The AOO is estimated is based on the mapping of available point records from 1970 to 2020. This timeframe was used due to the species occurring in relatively remote, rarely surveyed areas, and because there has been no evidence of population decline, even in areas affected by recent bushfires (J Hunter 2021 pers. comm. 10 Oct; L Copeland 2021 pers. comm. 12 Oct). The AOO is calculated using a 2x2 km grid cell method, based on the IUCN Red List Guidelines (IUCN 2019). The maximum plausible value represents the plausible AOO if unknown subpopulations exist. The minimum plausible value represents the plausible AOO if some older records of the species' range no longer exist.
Trend	stable			No evidence of decline (J Hunter 2021 pers. comm. 10 Oct).

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of subpopulations	10	10	~15	The number of subpopulations of heath-leaved geebung has not been documented. However, based on the spatial clustering of records there appears to be approximately 10 subpopulations (Inglewood–Bulli, Taringa, Arakoola NR, Bullala NP, Kings Plains NP, Severn River NR, Warialda, near 'Springvale' station, Torrington, and near Gibraltar NR) (ALA 2021). Additional subpopulations may exist, particularly if the central Queensland records are verified.
Trend	stable			No evidence of decline (J Hunter 2021 pers. comm. 10 Oct).
Basis of assessment of subpopulation number	The estimate of the number of subpopulations is based on each group of records separated by a distance of more than ~10 km being considered a separate subpopulation, based on seed dispersal being carried out by frugivorous birds capable of transporting seeds across distances of several kilometres. However, it is possible that genetic flow could be limited between groups plants less than 10 km distant, and therefore the maximum number of subpopulations could be more than 10.			
No. locations	unknown	unknown	unknown	The number of locations is unknown as there are no threats likely to cause the rapid elimination of subpopulations (IUCN 2019). The species appears to suffer minimal browsing from feral goats (J Hunter 2021 pers. comm. 10 Oct; L Copeland 2021 pers. comm. 12 Oct), occurs in habitat unsuitable for *P. cinnamomi,* and appears to be at low threat from inappropriate fire regimes due to the physical protection from fire provided by its rocky habitat, resilience to low severity fire, likely soil seed bank that is not exhausted by a single fire event, and the lack of obvious decline at Torrington SCA, despite major bushfire events occurring approximately every 10 years since the 1960s (NPWS 2003; J Hunter 2021 pers. comm. 10 Oct; L Copeland 2021 pers. comm. 12 Oct).
Trend	stable			No evidence of decline (J Hunter 2021 pers. comm. 10 Oct).
Basis of assessment of location number	See justification for number of locations.			

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Fragmentation	There are no estimates of the number of mature individuals in each subpopulation, but the overall population is estimated to be in the 10's of thousands and the species is known to be common at Torrington, Warialda and Inglewood–Bulli and scattered at Severn River NR (ALA 2021). No comments are available on the abundance of the species at other subpopulations. However the large number of records suggest most of the subpopulations are likely to contain similar numbers of plants to the above subpopulations, with the exception of Taringa and near 'Springvale' station subpopulations, which are both recorded from a single record (ALA 2021). Therefore, it is unlikely that the majority of the species' AOO is comprised of subpopulations that are smaller than a rudimentary minimum viable population size estimate (e.g. of 1000 individuals as per Frankham et al. 2014) and the species is unlikely to be severely fragmented.			
Fluctuations	Not subject to extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals.			

Criterion 1 Population size reduction

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

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

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

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

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

Based on any of the following

(a) direct observation [except A3]

(b) an index of abundance appropriate to the taxon

(c) a decline in area of occupancy, extent of occurrence and/or quality of habitat

(d) actual or potential levels of exploitation

(e) the effects of introduced taxa, hybridization, pathogens, pollutants, competitors or parasites

Criterion 1 evidence

Ineligible

Generation time

The primary juvenile period of the heath-leaved geebung is unknown, but other *Persoonia* species are thought to have a primary juvenile period of approximately 6 years (Clarke et al. 2009) and can live to 30 years (NPWS 2000). Assuming heath-leaved geebung has similar reproductive traits, generation time is likely to be:

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

$$\text{Generation time} = 6 + [0.5 * (30 - 6)] = 18 \text{ years}$$

This gives an estimated three-generation period of approximately 56 years.

Population trend

There are no available data on population trends over time, other than that there is no obvious evidence that the species is in decline (J Hunter 2021 pers. comm. 10 Oct; L Copeland 2021 pers. comm. 12 Oct). Therefore, heath-leaved geebung appears ineligible for listing under this criterion.

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

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

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

Criterion 2 evidence

Ineligible

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

The EOO of heath-leaved geebung is 16,522 km² and the AOO is 452 km² (see Table 3).

The species' EOO appears to meet the requirements for listing as Vulnerable under B1 (<20,000 km²). The species' AOO appears to meet the requirements for listing as Endangered under B2 (<500 km²).

Severely fragmented

Heath-leaved geebung is not considered severely fragmented as it is unlikely that more than 50 percent of its total AOO is in habitat patches that are (1) larger than would be required to support a viable population, and (2) separated from other habitat patches by a small distance, relative to its dispersive potential.

There are estimated to be approximately 10 subpopulations, based on the spatial grouping of records (Table 3; ALA 2021). There are no estimates of the number of mature individuals in each subpopulation, but the overall population is estimated to be in the 10's of thousands (J Hunter 2021 pers. comm. 10 Oct). The species reportedly 'common' at Torrington, Warialda and Inglewood–Bulli, and 'scattered' at Severn River NR (ALA 2021). No information is available on the abundance of the species at other subpopulations (ALA 2021). However the large total population size estimate and the large number of records, suggests most of the subpopulations are likely to contain similar numbers of plants to the above subpopulations, with the exception of the Taringa and near 'Springvale' station subpopulations, which are both recorded from a single record and may be small (ALA 2021). Therefore, it is unlikely that the majority of the species' AOO is comprised of subpopulations that are smaller than a rudimentary minimum viable population size estimate (e.g. of 1000 individuals as per Frankham et al. 2014), and the species is considered unlikely to be severely fragmented.

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

Number of locations

The number of locations is unknown as there are no plausible threats likely to cause the rapid elimination of subpopulations (IUCN 2019). The most significant possible threats to heath-leaved geebung are browsing by feral goats, dieback caused by *P. cinnamomi* and inappropriate fire regimes (Table 2).

Feral goats occur across the range of the heath-leaved geebung (e.g. in Torrington SCA; NPWS 2003) and graze on the rocky outcrops and boulder areas that the species grows on (DEWHA 2008). However, anecdotal observations suggest that the species may not be palatable (J Hunter 2021 pers. comm. 10 Oct), as no browsing damage (J Hunter 2021 pers. comm. 10 Oct), or minor browsing damage (L Copeland 2021 pers. comm. 12 Oct) has been observed to this species. Although feral goats may contribute to some degradation of habitat, the threat of herbivory from feral goats is unlikely to result in the rapid elimination of heath-leaved geebung subpopulations within one generation (18 years), particularly as most subpopulations are likely to be large (the total population size of the species is estimated in the 10's of thousands; J Hunter 2021 pers. comm. 10 Oct). Accordingly, the number of locations is unable to be defined using the threat of feral goat herbivory.

Many species of Proteaceae are vulnerable to dieback caused by *P. cinnamomi* infection, and some *Persoonia* species are known to be susceptible (DECCW 2005; Rymer, 2005). The susceptibility of heath-leaved geebung to dieback caused by *P. cinnamomi* infection is not known. However, despite the potential susceptibility of heath-leaved geebung to the disease, the distribution of heath-leaved geebung does not overlap with the modelled distribution of *P. cinnamomi*, which prefers wetter and cooler areas (Burgess et al. 2017). In addition, dieback from *P. cinnamomi* is not listed in management plans for reserves across the distribution of the heath-leaved geebung (NPWS 2003; NPWS 2004; DERM 2011; OEH 2014). The modelled

distribution of *P. cinnamomi* is predicted to contract further towards the coast in northern New South Wales and south-east Queensland due to the effects of climate change (Burgess et al. 2017). Therefore, dieback caused by *P. cinnamomi* infection is unlikely to be a significant threat to heath-leaved geebung, and the number of locations is unable to be defined using this threat.

Inappropriate fire regimes are a potential threat to heath-leaved geebung as the species is an obligate seeder that is killed by high severity fire (Clarke & Knox 2002; J Hunter 2021 pers. comm. 10 Oct). However, several aspects of the biology of heath-leaved geebung mean that the significant decline or extinction of subpopulations caused by high fire frequency is unlikely to occur. First, the habitat of heath-leaved geebung is in and around rocky outcrops and boulder areas, where there is substantial physical protection from fire. For example, the 2019-20 bushfires were estimated to have burnt 89% of records of *P. terminalis* subsp. *terminalis* recorded on the Australian Virtual Herbarium, assessed by overlapping their location with the estimated fire extent from the National Indicative Aggregated Fire Database (Gallagher 2020). This was due to the large extent of Torrington SCA burnt in the 2019-20 bushfires where the majority of *P. terminalis* subsp. *terminalis* records occur. However, in a post-fire survey of Torrington SCA following the 2019-20 bushfires, all areas supporting heath-leaved geebung were observed to have been unburnt by the fires due to the physically protected nature of the rocky habitat, with heath-leaved geebung remaining unaffected (L Copeland 2021 pers. comm. 12 Oct). Second, the species appears relatively resistant to low/moderate severity fire, with foliage either not burning or partially-damaged foliage recovering quickly post-fire (J Hunter 2021 pers. comm. 10 Oct). Third, although there are no data on heath-leaved geebung, several other *Persoonia* species have soil seed banks that are not exhausted by a single fire and are capable of recruiting following multiple fire events in a short period of time (e.g. *P. lanceolata* (lance-leaf geebung) in Auld et al. 2007; *P. mollis* subsp. *nectens* in Ayre et al. 2009). Fourth, major bushfires have occurred at Torrington SCA approximately every 10 years since the 1960s (NPWS 2003), and there is no suggestion that the subpopulation of heath-leaved geebung in the reserve has declined or is threatened by such a fire regime (J Hunter 2021 pers. comm. 10 Oct; L Copeland 2021 pers. comm. 12 Oct). Therefore, inappropriate fire regimes appear unlikely to result in the rapid elimination of subpopulations, and accordingly, the number of locations is unable to be defined using this threat.

Therefore, the species' number of locations does not meet the requirement for listing under this criterion.

Continuing decline

There is no evidence of decline of heath-leaved geebung (J Hunter 2021 pers. comm. 10 Oct) and all records in the Atlas of Living Australia appear to be in areas of extant native vegetation based on overlap with satellite imagery (with the exception of a 1922 record from the Inglewood township) (ALA 2021). Therefore, there is no evidence of decline in EOO, AOO, the number of locations or subpopulations, or number of mature individuals,

The habitat quality of some subpopulations is suspected to be declining due to the presence of feral herbivores and possibly weeds. In particular, feral goats are likely to graze on shrubs in rocky areas, and are the most likely contributor to decline in habitat quality than the other feral herbivores present in some subpopulations (feral horses, feral pigs). Feral goats occur across the range of the heath-leaved geebung (e.g. in Torrington SCA; NPWS 2003) and are a suspected

minor threat to the species. Unlike many other feral herbivores, goats graze on the rocky outcrops and boulder areas that the species grows on. However the severity of feral goat browsing on heath-leaved geebung is not well documented and appears to be minor. Anecdotal observations suggest that the species may not be palatable (J Hunter 2021 pers. comm. 10 Oct), as no browsing damage (J Hunter 2021 pers. comm. 10 Oct), or minor browsing damage (L Copeland 2021 pers. comm. 12 Oct) has been observed. Nevertheless, herbivory from feral goats, particularly if goat populations are not controlled, could cause a continuing decline in habitat quality.

Weeds (particularly prickly pear, blackberry and sweet briar; NPWS 2003) may occur in the rocky areas in which heath-leaved geebung occurs. These species can form dense thickets and compete with native vegetation and seedlings through nutrient and water competition (DPIE 2019). Weeds are more likely to occur in areas that have experienced past disturbance from agricultural practices, mining and along access roads. The threat to heath-leaved geebung posed by weeds is likely to be minor due to the comparatively large area occupied by the species and it's preference for rocky areas where historical disturbance from mining and land clearing is unlikely to have occurred. Nevertheless, weeds may contribute to continuing habitat decline in some areas occupied by heath-leaved geebung.

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

Extreme fluctuations

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

Conclusion

The data presented above appear to demonstrate that heath-leaved geebung is ineligible for listing in any category under this criterion, as it does not meet the threshold for listing under sub-criteria (a) and (c). The species' Extent Of Occurrence (EOO) is limited and Area Of Occupancy (AOO) is restricted and continuing decline is inferred in quality of habitat due to browsing by feral goats and competition from weeds, but its geographic distribution is not severely fragmented or subject to extreme fluctuations, and the number of locations is unknown due to the lack of serious threats.

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

Criterion 3 Population size and decline

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

Criterion 3 evidence

Ineligible

The total number of mature individuals is estimated to be in the 10s of thousands (J Hunter 2021 pers. comm. 10 Oct), which is not considered limited. The species does not appear to meet the requirements for listing under this criterion.

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

Criterion 4 Number of mature individuals

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

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

Criterion 4 evidence

Ineligible

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

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

Criterion 5 Quantitative analysis

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

Criterion 5 evidence

Insufficient data to determine eligibility

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

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

Adequacy of survey

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

Listing and Recovery Plan Recommendations

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

Established under the *Environment Protection and Biodiversity Conservation Act 1999*

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

Cataloguing data

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