Australian Government
Department of Agriculture, Water and the Environment

Consultation on Species Listing Eligibility and Conservation Actions

Hibbertia praemorsa (Bundanoon guinea flower)

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

1) the eligibility of *Hibbertia praemorsa* (Bundanoon guinea flower) for inclusion on the EPBC Act threatened species list in the Endangered category; and

2) the necessary conservation actions for the above species.

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

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

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

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

Please include species scientific name in Subject field.

or by mail to:

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

Responses are required to be submitted by 8 July 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: https://www.awe.gov.au/sites/default/files/env/pages/d72dfd1a-f0d8-4699-8d43-5d95bbb02428/files/tssc-guidelines-assessing-species-2021.pdf.

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

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

Privacy notice

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

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

Further, the Commonwealth, State and Territory governments have agreed to share threatened species assessment documentation (including comments) to ensure that all States and Territories have access to the same documentation when making a decision on the status of a potentially threatened species. This is also known as the '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 *Hibbertia praemorsa* (Bundanoon guinea flower)

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:

   ☐ 1–50 ☐ 51–250 ☐ 251–1000 ☐ >1000 ☐ >10

   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 late 1970s or early 1980s *(at or soon after the start of the most recent three generation/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:

    ☐ 1–50 ☐ 51–250 ☐ 251–1000 ☐ >1000 ☐ >10 000

Level of your confidence in this estimate:

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

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

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

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

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

11. Are you able to comment on the extent of decline in the species/subspecies' total population size over the last approximately 45 years (i.e. three generations/10 year 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?

34. Have you observed potential impacts of *Phytophthora* dieback and/or drought-induced mortality?

Conservation Advice for *Hibbertia praemorsa* (Bundanoon guinea flower)

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.

Hibbertia praemorsa © Copyright, Steve Douglas, Ecological Surveys and Planning.

Conservation status

Hibbertia praemorsa (Bundanoon guinea flower) is not listed under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwth) (EPBC Act).

Hibbertia praemorsa was assessed by the Threatened Species Scientific Committee to be eligible for listing as Endangered under criteria 1 and 3. The Committee's assessment is at Attachment A. The Committee assessment of the species' eligibility against each of the listing criteria is:

- Criterion 1: Insufficient data
- Criterion 2: B1ab(iii,v)+B2ab(iii,v): Endangered
- Criterion 3: C1+C2a(i): Endangered
- Criterion 4: D: D Vulnerable
- Criterion 5: Insufficient data

The main factors that make the species eligible for listing in the Endangered category are a restricted geographical distribution, an estimated continuing decline and a small population size.

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 *Hibbertia praemorsa* Toelken (2000) (family Dilleniaceae). Described from specimens collected in Morton National Park in February 1999 (Toelken 2000).

Description

The Bundanoon guinea flower is a small shrub to 1.3 m in height, with dark green oblong-elliptic leaves 6.5–9.5 x 3–4.5 mm that have a recurved apex and are hairy (villous to sericeous) on both the upper and lower surface. Flowers are yellow, with broadly obovate petals, and are produced singly at the end of branchlets. Fruits are hairy (villous), and seeds are broadly obovoid, laterally compressed, 2.2 x 2.4 mm. Description from PlantNet (2021) and Toelken (2000).

The Bundanoon guinea flower flowers in October – November and also at other times of the year (e.g. January–February, May) depending on local conditions (Toelken 2000; S. Douglas pers. comm. 16 December 2021)

Distribution

The Bundanoon guinea flower is restricted to the Southern Highlands of New South Wales (NSW), where it is known from four subpopulations around Bundanoon and Wingello, and one isolated subpopulation in the northern Budawang Range (ALA 2021; AVH 2021; Toelken 2000). All known subpopulations are located within Morton National Park. The three subpopulations at Bundanoon occur roughly in a line and are separated by ~900 m and 1.4 km, while the Wingello subpopulation occurs ~6 km south-east of the Bundanoon subpopulations. The Budawang Range subpopulation occurs ~ 60 km south of the Bundanoon and Wingello subpopulations.

The Bundanoon guinea flower grows in heath or open heathy woodland. At Wingello, the species grows in shallow sandy soil on undisturbed sandstone rock shelves with heathy vegetation. At Bundanoon, the species grows in heath or heathy eucalypt woodland, in association with *Hakea dactyloides* (finger hakea), *Leptospermum trinervium* (flaky-barked tea-tree), *Lambertia formosa*

(mountain devil), and *Banksia serrata* (old-man banksia). At the Budawangs, the species grows on a steep rocky slope with north-west aspect in shrubland dominated by *Eucalyptus multicaulis* (whipstick ash), *Eriostemon* sp., *Hakea dactyloides* (finger hakea) and *B. spinulosa* (hairpin banksia).

In the original species' description, there were estimated to be approx. 600 individuals across the Bundanoon and Wingello subpopulations (Toelken 2000), although it is unclear whether these estimates are based on surveys. There are no available estimates for the Budawang subpopulation.

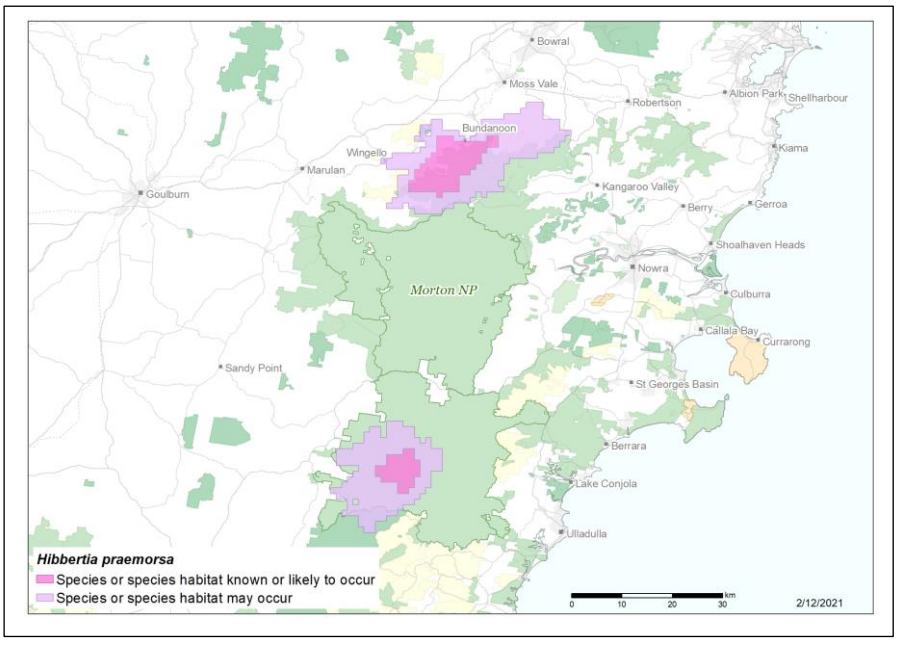
At the View Point /Hell Hole track subpopulation (Bundanoon), 260 plants were estimated in 1996 (BioNet 2021) but in 2019 (pre-fire) only < 50 were estimated to occur (S. Douglas pers. comm. 16 December 2021). In 2021 (i.e. post-fire) approximately 359 seedlings and 20 resprouting plants were observed at Hell Hole Track, although many of the seedlings were growing close together and there is likely to be attrition as plants mature, in the order of approximately 60–80% (S. Douglas pers. comm. 16 December 2021, 16 March 2022). At View Point, 32 plants were observed, including a few mature survivors (S. Douglas pers. comm. 16 December 2021).

At the Lovers Walk/Wishing Well subpopulation (Bundanoon), 30 individuals were estimated at Lovers Walk in 1999 (BioNet), but only 13 were observed in 2011 and fewer than five post-fire in 2021 (S. Douglas pers. comm. 2021). There is no clear evidence of the cause of the apparent decline, although drought is considered to be a possible cause (S. Douglas pers. comm. 16 December 2021). See Table 1 for a summary of the known subpopulations of the Bundanoon guinea flower.

Table 1 Known subpopulations of the Bundanoon guinea flower

Subpopulation	Abundance	Tenure	Fire history since 1981 (DPIE 2021)
Bundanoon – View Point / Hell Hole Track	1996: 260+ (BioNet 2021) 2019: 20–50 (S. Douglas pers. comm. 16 December 2021) 2021: 359 seedlings and 20 resprouting plants at Hell Hole; 32 plants comprised of seedlings (most) resprouting (some) and mature plants (a few) at View Point (S. Douglas pers. comm. 16 December 2021, 16 March 2022.)	Morton National Park	2019–20: bushfire 1982–83: bushfire
Bundanoon – Lovers Walk / Wishing Well	1999: 30 – Lovers Walk (BioNet 2021) 2011: - Lovers Walk 13 and Wishing Well 29 (BioNet 2021) 2021: - Lovers Walk <5 (S. Douglas pers. comm. 16 December 2021)	Morton National Park	2019–20: bushfire 2001–02: presc. burn 1982–83: bushfire
Bundanoon – Tooth Lookout	2000: 13 (BioNet 2021)	Morton National Park	2019–20: bushfire 1982–83: bushfire
Wingello – Gap Road	1990: 2 (BioNet 2021) 1992: 22 (BioNet 2021)	Morton National Park	2019–20: bushfire 2008–09: bushfire 1982–83: presc. burn
Northern Budawangs (NW of Crooked Falls)	Unknown	Morton National Park	2019–20: bushfire

Map 1 Modelled distribution of *Hibbertia praemorsa*



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

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

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

Cultural and community significance

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

The Bundanoon guinea flower occurs across the Illawarra and Ulladulla Local Aboriginal Land Councils (NSW Aboriginal Land Council 2021). There is little published information on the cultural significance of the Bundanoon guinea flower. However, given the acknowledged importance to Aboriginal peoples of Connection to Country and the widespread importance of Caring for Country (which includes biodiversity, 'place', custom and totemic elements) it is considered likely that the species has or is associated with some cultural and/or community significance. *Hibbertia scandens* was used as a treatment for sores and rashes by the Yaegl people from northern NSW (Packer et al. 2012).

Relevant biology and ecology

There is little published information on the specific biology and ecology of the Bundanoon guinea flower.

Reproductive ecology

Native bees are thought to be the primary pollinators of most *Hibbertia* species (Bernhardt 1984, 1986; Tucker & Bernhardt 2000), despite early reports of primarily beetle pollination (Keighery 1975; Armstrong 1979). The bright yellow flowers do not produce nectar (Bernhardt 1984, 1986). Instead, depending on floral morphology, the bees collect pollen by directly feeding on exposed pollen, or by buzz pollination (using thoracic vibrations to dislodge pollen) (Tucker & Bernhardt 2000). Beetles and hoverflies are frequently observed as floral visitors on some *Hibbertia* species, but their overall importance in pollination is thought to be secondary to that of bees (Hawkeswood 1989; Tucker & Bernhardt 2000). The introduced honeybee, *Apis mellifera*, has been observed occasionally visiting flowers and carrying pollen of the Western Australian species *H. hypericoides* (yellow buttercups) (Keighery 1975), although it is unclear whether honeybees regularly act as pollinators.

The germination requirements of *Hibbertia* species are complex, with seed dormancy imposed by the seed coat as well as by the embryo (Ralph 2011). The relative effects of various treatments (e.g. scarification, smoke water, gibberellic acid) appear variable between species

and even individual seeds, although in many species germination is increased by scarification and/or smoke water (Dixon et al. 1995; Schatral 1996; Schatral et al. 1997; Allan et al. 2004). Variation in dormancy length among individual seed may result in naturally staggered germination over several years (Schatral et al. 1997; Ralph 2011; Hidayati et al. 2012).

In four species of co-occuring *Hibbertia* from south-west Western Australia, seed viability was high (86–94%) and almost all seed exhibited some level of dormancy (Hidayati et al. 2012). Germination was promoted by a complex mixture of moisture, temperature cycles and smoke water, and varied across co-occurring species (Hidayati et al. 2012). In the NSW species Julian's hibbertia, seedlings were only observed in burnt patches, suggesting that fire cues may trigger germination (Toelken & Robinson 2015).

Seed dispersal in other *Hibbertia* species is by ants (myrmecochory), which are likely to move the seed only short distances (Berg 1975; Rice & Westoby 1981).

Fire ecology

After the 2019-20 bushfires, adult plants were observed resprouting and seedlings were observed emerging in clumps (S. Douglas pers. comm. 16 December 2021). In burnt areas, seedling recruitment appeared to be greater than resprouting (S. Douglas pers. comm. 16 December 2021). The regenerating plants at View Point/Hell Hole were observed to be growing in small, dense clusters (see photo below), and natural thinning in the order of 60–80% is likely to occur as plants grow larger to maturity and compete for space and resources (S. Douglas pers. comm. 16 December 2021).

Bundanoon guinea-flower seedlings regenerating in a dense clump. © Steve Douglas, Ecological Surveys and Planning.

The combination of post-fire resprouting and fire-killed/seedling emergence is typical of other *Hibbertia* species (Bell et al. 1993). Of the 95 *Hibbertia* taxa in the AusTraits database with data

on fire response, 87 taxa were classified as resprouting or a combination of resprouting and fire-killed, whereas only 8 taxa were classified as fire-killed (Falster et al. 2021).

Little is known about the primary or secondary juvenile period of *Hibbertia* species, or the longevity of adult plants. In two northern NSW species which resprout from basal stems following fire, the secondary juvenile period (i.e. time from resprouting to flowering post-fire) was 3 years or more (Knox & Clarke 2004). Of the 64 taxa in the AusTraits database with data on longevity, most (54) were estimated to have a longevity of <50 years based on expert opinion (Falster et al. 2021). In Julian's hibbertia, adults were assumed to be long-lived, as some sites had not been burnt in >50 years and seedlings were only observed in burnt patches (Toelken & Robinson 2015), although given the variation in seed dormancy between individual seeds (see above) low levels of spontaneous germination could occur in the absence of fire. Survival and establishment of such germinants may be low in unburnt conditions compared to the post-fire environment (Keith 1996).

Prior to the 2019-20 bushfires, the Hell Hole site was previously burnt in 1982-83 (Table 1; DPIE 2021). The apparent reduction of individuals at the Hell Hole site before the 2019-20 fires could be due to effects associated with a long fire interval (e.g. increased competition from larger shrubs, senescence of older plants, while seedling recruitment is limited). The 2019-20 fires resulted in a flush of seedling regeneration (Table 1). However, further information is required to understand the effect of fire frequency on the Bundanoon guinea flower.

Habitat critical to the survival

The Bundanoon guinea flower occurs in heath or open heathy woodland on sandstone substrate, often on or near rock shelves or rocky outcrops. Habitat critical to the survival of the Bundanoon guinea flower comprises the entire area of occupancy of known populations, as well as areas of similar habitat adjoining known populations which provide potential habitat for natural range extension, and areas of similar habitat that may contain the species or be suitable for translocations.

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 (as defined by IUCN 2001), in keeping with the terminology used in the EPBC Act and state/territory environmental legislation.

Given the low number of populations and plants, all populations of the Bundanoon guinea flower are important for the long-term recovery and survival of this species.

Threats

The threats impacting the Bundanoon guinea flower are not well understood. Fire regimes that cause declines in biodiversity, particularly relating to fire frequency, are likely to be a threat, although the exact regimes likely to threaten the species are not well understood. Some plants are at risk of disturbance from track maintenance and recreational activities. Dieback caused by *Phytophthora cinnamomi* is inferred as a potential threat based on related species, although dieback has not been observed to occur in the Bundanoon guinea flower (S. Douglas pers. comm. 16 December 2021).

Table 2 Threats impacting the Bundanoon guinea flower

Threat	Status and severity [a]	Evidence
Habitat modification and disturbance		
Fire regimes that cause declines in biodiversity†	• Status: current/future • Confidence: suspected • Likelihood: likely • Consequence: moderate • Trend: increasing • Extent: across the entire range	*Fire-competition interactions:* The Bundanoon guinea flower is likely to be at risk of impacts associated with infrequent fire. The species prefers open heathy areas where large shrubs are not dominant, and without fire or other disturbance, competing plants may shade out the species if the vegetation becomes too dense (S. Douglas pers. comm. 16 December 2021). Infrequent fire may facilitate abundant shrub regrowth and therefore population decline of the Bundanoon guinea flower in the long term, although the species is likely to be able to persist in areas of disturbance and/or through the soil seed bank. In other *Hibbertia* species, seed dormancy is variable and germination is not always dependent on fire cues (Schatral et al. 1997; Hidayati et al. 2012), suggesting there may to be low rates of germination in the absence of fire. *High frequency fire:* It is possible that the Bundanoon guinea flower may be negatively impacted by high frequency fires where they cause mortality among adult plants and occur at short enough timescales to kill regenerating seedlings and resprouting plants before they are able to replenish the soil seed bank or develop sufficient woody tissue to withstand further fires. The secondary juvenile period of other *Hibbertia* species has been estimated at 3+ years (Knox and Clarke 2004), suggesting that repeated fires within 4–5+ years may cause population decline, depending on seed bank accumulation rates. *High severity fire* High severity fire alone is unlikely to lead to population decline. High severity fire may lead to adult plant mortality and mortality of some seed in the soil seed bank close to the surface. However, only seeds near the surface (i.e. the top 3–5 cm or less) could be exposed to extreme temperatures and many shrubs with larger seed are able to germinate from a depth of 5 cm or more (Palmer et al. 2018; Tangney et al. 2020). *Interactions between fire and other threats* Fires followed or preceded by periods of drought or extreme rainfall events may have a negative impact on the Bundanoon guinea flower e.g. seedlings may not recruit during post-fire drought, or extreme rainfall following fire may erode soil and deplete part of the soil seedbank. High frequency and high severity fires may lead to declines in pollinator abundance and therefore declines in seed set and recruitment, although the impact of fire regimes on invertebrates in Australia remains poorly understood. In a global meta-analysis, Carbone et al. (2019) found a positive effect of fire on Hymenopteran abundance and diversity, but a negative effect of frequent fire. In Australia, Dorey et al. (2021) predicted that many bee species were negatively impacted by the widespread 2019-20 fires,

Threat	Status and severity [a]	Evidence
		although further empirical evidence is needed (e.g. Marquart 2018).
Recreational activities and track maintenance	• Timing: current • Confidence: inferred • Likelihood: possible • Consequence: minor • Trend: unknown • Extent: northern subpopulations	Some plants at Bundanoon subpopulations grow alongside, or in some cases even on, vehicle and walking tracks (S. Douglas pers. comm. 16 December 2021). There is vehicle access to sites at Gap Road (Wingello) and View Point (Bundanoon), while trail bikes have been observed along the Hell Hole Track (S. Douglas pers. comm. 16 December 2021). The other Bundanoon subpopulations occur along walking trails. Significant impacts from recreational or maintenance activities have not been noted, however they are a potential threat to the northern subpopulations given their proximity to tracks (S. Douglas pers. comm. 16 December 2021).
Disease		
Dieback caused by *P. cinnamomi*	• Timing: current/future • Confidence: inferred • Likelihood: unknown • Consequence: major • Trend: unknown • Extent: across the entire range	The Bundanoon guinea flower has not been observed to suffer from dieback (S. Douglas pers. comm. 16 December 2021) and no data are available on the susceptibility of the species to *P. cinnamomi*. However, many other *Hibbertia* species are known to be susceptible to *P. cinnamomi* (Weste & Ashton 1994; McDougall 2005; Cahill et al. 2008; Wan et al. 2019). In the Western Australian species *H. hypericoides*, susceptibility to dieback varied between different habitats (Cahill et al. 2008). A few species of *Hibbertia* are known to be field resistant to *P. cinnamomi* (Reiter et al. 2004; McDougall 2005). Given the evidence for some *Hibbertia* species to be susceptible, dieback caused by *P. cinnamomi* is inferred as a potential threat to the Bundanoon guinea flower. Plants at Bundanoon and Wingello subpopulations occur near vehicle or walking tracks, and are therefore potentially at risk of disease spread. The remote location of the Budawang subpopulation may reduce the likelihood of *P. cinnamomi* introduction at that subpopulation.
Climate change		
Increased temperatures, droughts, fire danger weather, and changes in precipitation	• Timing: current/future • Confidence: observed/projected • Likelihood: likely • Consequence: moderate • Trend: increasing • Extent: across the entire range	Climate projections for eastern Australia include increases in temperature, changes in precipitation patterns and an increased frequency of drought (CSIRO & Bureau of Meteorology 2015). In the south-east and tablelands region of NSW, there are projected increases in minimum and maximum temperatures, the number of hot days (above 35°C), fire danger weather and extreme events (e.g. drought), and changes to precipitation patterns (increased precipitation in autumn and decreased precipitation in spring) (OEH 2014). South-eastern Australia has experienced two significant drought events since 2000 (Bureau of Meteorology 2020). Drought may cause plant mortality, as many plants are vulnerable to hydraulic failure (Allen et al. 2010; Choat et al. 2012). Drought may be a particular issue for plants which grow at sites with low water holding capacity. The Bundanoon guinea flower often grows in areas likely to have low water holding capacity e.g. shallow soil over sandstone ledges, or steep slopes, and so may be at

Threat	Status and severity [a]	Evidence
		risk in severe drought (S. Douglas pers. comm. 16 December 2021). There has been an apparent decline in the number of mature individuals of the Bundanoon guinea flower (see Table 1). Although the causes of this decline are unclear, drought is considered a possible contributing factor (S. Douglas pers. comm. 16 December 2021), while other factors may include senescence and/or competition.

[†]Fire regimes that cause declines in biodiversity include the full range of fire-related ecological processes that directly or indirectly cause persistent declines in the distribution, abundance, genetic diversity or function of a species or ecological community.

'Fire regime' refers to the frequency, intensity or severity, season, and types (aerial/subterranean) of successive fire events at a point in the landscape.

[a]Timing—identify the temporal nature of the threat;

Confidence—identify the extent to which we have confidence about the impact of the threat on the species;

Consequence—identify the severity of the threat;

Trend—identify the extent to which it will continue to operate on the species;

Extent—identify its spatial content in terms of the range of the species.

Each threat has been described in Table 2 in terms of the extent that it is operating on the species. The risk matrix (Table) 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 familiar with the species and in-house expertise using available literature.

Table 3 Bundanoon guinea flower risk matrix

Likelihood	Consequences				
	Not significant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Low risk	Moderate risk	Very high risk	Very high risk	Very high risk
Likely	Low risk	Moderate risk	High risk **Fire regimes that cause declines in biodiversity** **Increased temperatures, droughts, fire danger weather, and changes in precipitation**	Very high risk	Very high risk
Possible	Low risk	Moderate risk **Recreational and management activities**	High risk	Very high risk	Very high risk

Likelihood	Consequences				
	Not significant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Unlikely	Low risk	Low risk	Moderate risk	High risk	Very high risk
Unknown	Low risk	Low risk	Moderate risk	High risk **Dieback from *P. cinnamomi***	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 basis but only a few times
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' or 'high'. For those threats with an unknown or low risk outcome it may be more appropriate to identify further research or maintain a watching brief.

Conservation and recovery actions

Primary conservation outcome

By 2032, the threatening processes and habitat critical to survival of the Bundanoon guinea flower will be well understood and defined. The Bundanoon guinea flower will be secure in viable subpopulations, which are successfully protected and monitored.

Conservation and management priorities

Fire

- Develop and implement a fire management strategy that reduces risks of sustained declines and extinction of the Bundanoon guinea flower.
- Avoid impacts to subpopulations during fire-fighting operations, or other fire management works, by ensuring accurate location information of the species is available on databases used by the relevant fire management agencies to limit impacts of suppression and hazard reduction operations.
- Avoid application of fire retardants during fire suppression operations.

Habitat loss disturbance and modifications

- Ensure locations of subpopulations, particularly the Bundanoon and Wingello subpopulations, are kept updated on state databases including those used by fire and land management agencies.

- If required, prevent trampling and vehicle damage at Bundanoon and Wingello subpopulations by installing access barriers or fences.

Disease

- Determine the susceptibility of the Bundanoon guinea flower to *P. cinnamomi.*
- Implement a *P. cinnamomi* management plan to ensure it is not introduced into known locations of the Bundanoon guinea flower and the spread in surrounding areas is limited. Refer to the threat abatement plan for *P. cinnamomi* (DOEE 2018).
- Ensure that appropriate hygiene protocols are adhered to when entering or exiting the known locations of the Bundanoon guinea flower, such as those outlined in the *Arrive Clean, Leave Clean* guidelines (C'wealth of Australia 2015).

Breeding, seed collection, propagation and other ex situ recovery action

- To manage the risk of losing genetic diversity, undertake appropriate seed collection and storage in appropriate institutions (such as the NSW Plantbank Royal Botanic Gardens Sydney). Best practice seed storage guidelines and procedures should be adhered to, to maximise seed viability and germinability (refer to Martyn Yenson et al. 2021). Seeds from all major natural subpopulations should be collected and stored.
- 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). Translocations should be monitored to document recruitment and show that the translocated subpopulation(s) are self-sustaining and contribute to the conservation of the species.

Stakeholder engagement/community engagement

- Encourage participation of relevant community groups and Traditional Owners in surveys, monitoring and implementation of conservation actions for the species.
- Liaise with the local community and government agencies to ensure that up-to-date population data and scientific knowledge inform the implementation of conservation actions for this species.
- Inform managers of sites where there are known subpopulations, and consult with these groups regarding options for conservation management and protection of the species.

Survey and monitoring priorities

- Undertake targeted surveys to improve knowledge of the extent and size of known subpopulations, particularly in suitable habitat between the Wingello and Budawang subpopulations.
- Develop and maintain a monitoring program to:
  - determine trends in population size and distribution,
  - record the species response to the 2019–20 fires and any future fires, including changes in plant health and reproductive output, and changes in surrounding vegetation e.g. species which may outcompete the Bundanoon guinea flower,
  - determine threats and their impact; and

- monitor the effectiveness of management actions and the need to adapt them if necessary.

Information and research priorities

- Investigate the basic ecology of the species, including pollinators, levels of seed set and herbivory, seed germination requirements and plant longevity.
- Investigate seed germination biology, dormancy and seedbank dynamics in relation to fires.
- Investigate effects of competition from other plants.
- Investigate the susceptibility of the species to *P. cinnamomi*.
- Identify fire regimes that have a negative effect on plants.

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 disease in natural ecosystems caused by *Phytophthora cinnamomi* (2018)

Arrive Clean, Leave Clean guidelines

Conservation Advice and Listing Assessment references

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

Attachment A: Listing Assessment for *Hibbertia praemorsa*

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 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	300–500	234	<1000	On current knowledge, the estimated number of known mature individuals in 2021 is approximately 234, including 165 plants at View Point/Hell Hole (see discussion in Criterion 1), 5 plants at Lovers Walk, 29 plants at Wishing Well (last estimate 2011), 13 plants at Tooth Lookout (last estimate in 2000) and 22 plants at Wingello Gap Road (last estimate 1992). The number of plants at the Budawangs subpopulation is unknown. Given the large area of potentially suitable habitat around the Bundanoon and Budawang subpopulations, there are likely to be additional subpopulations (see section on Number of subpopulations). Therefore the number of plants is likely to be higher. An estimate of 300–500 mature individuals is used here as a plausible estimate which reflects the current knowledge on the species abundance and distribution. The minimum plausible value is the estimated from the number of individuals (234). The maximum plausible value is <1000, as it is unlikely, on current knowledge, that the population size would exceed 1000.
Trend	likely decreasing			In the 1990s, the total known population size of the Bundanoon guinea flower was approximately 325 plants, including 260 plants at View Point/Hell Hole (1996), 30 plants at Wishing Well/Lovers Walk (1999), 13 plants at Tooth Lookout (2000) and 22 plants at Wingello Gap Road (1992). There are currently an estimated 234 known mature individuals (see discussion under Criterion 1).

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Generation time (years)	10–20 years (midpoint 15 years)	5 years	>20 years	There is no available information on the generation length or longevity of the Bundanoon guinea flower. Of the 64 taxa in the AusTraits database with data on plant longevity, most (54) were estimated to have a longevity of <50 years based on expert opinion (Falster et al. 2021). The average age of mature individuals of *H. tenuis* was estimated to be 10–20 years (TSSC 2010) and this estimate is used here until further information is available. A minimum estimate of 5 years is used here, as the secondary juvenile period of two northern NSW *Hibbertia* species was estimated to be 3 or more years (Knox and Clarke 2004).
Extent of occurrence	300–500 km^2	155 km^2	1800 km^2	Based on known subpopulations, the current known extent of occurrence (EOO) is 155 km^2 and this is used as the minimum plausible value. However, there are likely to be additional undiscovered populations, particularly in more remote parts of the species' distribution. Given the geographical distribution of known subpopulations, even one additional subpopulation may substantially increase the EOO. An estimate of 300–500 km^2 is used here as a plausible estimate which reflects the current knowledge on the species' distribution. A rough estimate of EOO derived from potential habitat identified in the species' modelled distribution (Map 1) indicates a potential EOO of up to 1800 km^2, and this is used as the maximum plausible value.
Trend	stable			The EOO appears to be stable and there is no evidence of an increase or decrease in EOO.
Area of Occupancy	20–30 km^2	16 km^2	>32 km^2	Based on known subpopulations, the current known area of occupancy (AOO) is 16 km^2 and this is used as the minimum plausible value. However, there are likely to be additional undiscovered populations, particularly in more remote parts of the species' distribution. Nevertheless, based on current knowledge, the species is highly localised and is unlikely to be widespread within its potential range. An estimate of 20–30 km^2 is used here as a plausible estimate which reflects the current knowledge on the species' distribution and abundance. An estimate of up to double the number of known subpopulations is used here as the maximum plausible AOO, assuming each subpopulation would occupy its own 2 x 2 km grid (IUCN 2022).
Trend	stable			The AOO appears to be stable and there is no evidence of an increase or decrease in AOO.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Number of subpopulations	5–10	5	>10	There are five known subpopulations. The three Bundanoon subpopulations are separated by ~900 m and 1.4 km, but these have been assessed as separate subpopulations (see basis of assessment of subpopulation number below). The Wingello and Budawang subpopulations are separated from other subpopulations by 5.5 km and 59 km respectively. Given the large area of potentially suitable habitat around the Bundanoon and Budawang subpopulations, there are likely to be additional subpopulations. Nevertheless, the species appears to be genuinely localised within its known range, and is therefore unlikely to be widespread or common. An estimate of up to double the number of known subpopulations is used here as a plausible estimate based on current knowledge.
Trend	stable			There is no evidence of a decrease in the number of subpopulations.
Basis of assessment of subpopulation number	The three Bundanoon subpopulations are only separated by ~900 m and 1.4 km, but these have been assessed as separate subpopulations as there do not appear to be plants in between (S. Douglas pers. comm. 16 December 2021). The Bundanoon guinea flower is likely to have poor seed dispersal ability due to ant-mediated dispersal. Pollen may move across large distances on insect pollinators, facilitating gene flow between populations. Some bee species can forage over kilometre distances (e.g. honeybees and bumblebees), although larger bee species tend to forage over disproportionately larger distances (Greenleaf et al. 2007), and the foraging ranges of many smaller Australian bee species which may act as pollinators of *Hibbertia* species are poorly known (Phillips et al. 2010) but likely to be shorter. The Wingello and Budawang subpopulations are separated from other subpopulations by 5.5 km and 59 km respectively.			

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
No. locations	2–3	1	<5	At the time of this assessment (2022), following the 2019-20 bushfires, most individuals were post-fire recruits (seedlings or juveniles), with a small proportion of recovering adults (resprouting). Due to the flush of post-fire seedling regeneration, the seedbank is likely to be somewhat depleted. If another threatening event (e.g. fire, or combination of fire and drought) were to occur within the minimum fire-free interval (subject to further study), most individuals would be at high risk of poor recovery and there may be reduced potential for the seedbank to replenish the population. The extent of the 2019-20 bushfires overlapped with all known subpopulations (see Table 1). The fires rapidly affected most known individuals (plants at View Point/Hell Hole and Lovers Walk/Wishing Well subpopulations at Bundanoon) and are likely to have impacted other known subpopulations at Tooth Lookout (Bundanoon), Gap Road (Wingello) and Crooked Falls (Budawangs). Therefore, it is possible that a single fire may rapidly impact all known subpopulations. However, given the distance between the Budawangs and Bundanoon/Wingello subpopulations, the likelihood that these subpopulations are again impacted by a single fire is probably low, suggesting that an estimate of two to three locations is more plausible. Given the restricted distribution of the species, the discovery of additional subpopulations is unlikely to lead to a much higher estimate of number of locations. Therefore, a maximum plausible value of <5 locations is used in this assessment.
Trend	unknown			
Basis of assessment of location number	See justification of location number.			
Fragmentation	There is no evidence to suggest the species is likely to suffer from severe fragmentation. Given the relatively close proximity of the Bundanoon and Wingello subpopulations, there is likely to be the potential for gene flow between these subpopulations. In addition, there is extensive, potentially suitable habitat in Morton National Park around the northern subpopulations and the Budawangs subpopulation, which may be support additional undiscovered subpopulations.			
Fluctuations	Not subject to extreme fluctuations in EOO, AOO, number of subpopulations, locations or mature individuals – no parameter was changed by an order of magnitude by the 2019/20 fire. The species is capable of both resprouting and regenerating from seed following fire, and is therefore unlikely to be prone to extreme fluctuations.			

Criterion 1 Population size reduction

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

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

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

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

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

Based on any of the following

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

Criterion 1 evidence

Insufficient data

A generation length of 10–20 years (midpoint 15 years) is used in this assessment, leading to a three-generation period of ~45 years. However, the earliest available record is from 1990, so the period from 1990 to 2021 has been used to assess the species under Criterion 1.

In the species' description, the Bundanoon and Wingello subpopulations were estimated to comprise >600 plants (Toelken 2000) however it is unclear how estimate was made. Records of Bundanoon and Wingello subpopulations from ALA (2021), BioNet (2021) and surveys and observations (S. Douglas pers. comm. 16 December 2021) have never reported numbers approaching 600 plants, so the Toelken (2000) estimate is not used in this assessment. There is no available estimate for the Budawang subpopulation, and therefore it is not included in the calculation of population decline below.

In the 1990s, the total known population size of the Bundanoon guinea flower was approximately 325 plants, including 260 plants at View Point/Hell Hole (1996), 30 plants at Lovers Walk (1999), 13 plants at Tooth Lookout (2000) and 22 plants at Wingello Gap Road (1992). All known subpopulations were burnt during the 2019-20 bushfires, and the species is in the process of regenerating from seedlings and resprouting plants. As a result, there are few mature individuals, with the exception of some plants that were not burnt at View Point (S. Douglas pers. comm. 16 December 2021).

However, estimates for the number of mature individuals must be assessed at the appropriate point in the species life cycle (IUCN 2022). There are currently ~410 seedlings and resprouting plants at View Point/Hell Hole, as well as <5 at Lovers Walk. The regenerating plants at View Point/Hell Hole were observed to be growing in small, dense clusters, and natural thinning in the order of 60–80% is estimated to occur as plants grow larger and compete for space and resources (S. Douglas pers. comm. 16 December 2021, 16 March 2022). Accounting for natural thinning, and using the lower estimate of 60% to be conservative, the number of mature individuals at View Point/Hell Hole is therefore estimated to be ~165 plants. There are no post-fire estimates for plants at Wishing Well, Tooth Lookout or Wingello Gap Road (access issues), however these are all relatively small subpopulations (29, 13 and 22 plants respectively at last estimate).

On current knowledge, the estimated number of mature individuals in 2021 is approximately 234, including 165 plants at View Point/Hell Hole, 5 plants at Lovers Walk and 29 plants at Wishing Well (last estimate 2011), 13 plants at Tooth Lookout (last estimate in 2000) and 22 plants at Wingello Gap Road (last estimate 1992). The Wishing Well, Tooth Lookout and Wingello Gap Road subpopulations are assumed to have remained stable for the purposes of this assessment. This represents a decline of ~28% compared to estimates from the 1990s, which is close to the threshold for Vulnerable under subcriterion A2.

However, this estimate of population decline is sensitive to the level of thinning estimated to occur at View Point/Hell Hole, as this is by far the largest known subpopulation. If the upper estimate of 80% thinning prior to maturity is used, there are an estimated 150 known individuals, which would represent a decrease of 54% (i.e. Endangered under subcriterion A2). Assuming no thinning occurs and all seedlings survive to become mature individuals, the total number of mature individuals would be ~480, which would represent an increase of ~47% (i.e. ineligible under subcriterion A2). However, it is highly unlikely that no thinning or seedling death would occur, as seedlings were observed growing in small, dense clusters (S. Douglas pers. comm. 16 December 2021; see photo in Fire ecology section). Therefore, an estimate of substantially lower rates of thinning (40%) than the 60–80% estimated (S. Douglas pers. comm. 16 December 2021) is used as the lower bound for possible natural thinning rates. A 40% natural thinning rate leads to an estimated decline of ~3% which would be ineligible under subcriterion A2. See Table 5 for a summary of thinning estimates.

Table 5 Estimated population size with thinning estimate used

	40% thinning (lower bound)	**60% thinning (estimate used)**	**80% thinning (upper bound)**
Estimated number of individuals at View Point / Hell Hole	245	165	80
Estimated number of individuals total	315	235	150
Estimated decline in mature individuals	3 % decline	28 % decline	54 % decline

Instead of estimating natural thinning, the pre-fire (2019) population size could be used as the most recent estimate of mature individuals. This would lead to an estimate of 105 mature

individuals, which represents a ~68% decline since the 1990s (i.e. Endangered under Criterion A2). Due to the long fire interval before 2019 (last burnt in 1982-83 according to DPIE 2021), the decrease in mature individuals could be partly due to a natural fluctuation in population numbers in response to fire (e.g. decrease in mature individuals due to senescence and/or competition from other species) and the number of mature individuals may increase post-fire compared to pre-fire 2019 numbers.

Therefore, the post-fire 2021 survey data are used in this assessment, and natural thinning at View Point/Hell Hole is estimated be 40–80% (midpoint 60%). This leads to an estimated decline of 28%, which is below the threshold for Vulnerable under Criterion A2. Therefore, the Committee considers that 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 should therefore be considered to be tentative at this stage, pending the outcomes of this consultation process.

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

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

Criterion 2 evidence

Eligible under Criterion 2 B1ab(iii,v) + B2ab(iii,v) for listing as Endangered

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

The EOO of the Bundanoon guinea flower is estimated to be 300–500 km² and the AOO is estimated to be 20–30 km² (see Table 4). Therefore, the species' EOO and AOO are considered to be restricted, and the species appears to meet the requirements for consideration as Endangered under B1 and B2.

Severely fragmented

The species is not considered to be severely fragmented, given the relatively close proximity of the Bundanoon and Wingello subpopulations, and the areas of potentially suitable habitat in the Budawangs.

Number of locations

There are an estimated 2–3 locations based on the threat of fire and the combination of fire and drought (see discussion in Table 4). The extent of the 2019-20 fires overlapped with all known subpopulations, and another threatening event within the minimum fire-free interval may result in population reduction. Although it is possible that a single fire may rapidly impact all known subpopulations, as seen during the 2019-20 fires, the likelihood that a single fire impacts all known subpopulations is probably low, suggesting that an estimate of two to three locations may be more plausible.

Continuing decline (number of mature individuals)

There is an estimated decline of 28% in the number of mature individuals since the 1990s (see discussion under Criterion 1). The rate of decline is uncertain, as the estimates of seedling thinning used to calculate the number of mature individuals influence the estimated rate of decline (see discussion under Criterion 1). However, substantial thinning of seedlings is expected before they reach maturity, due to the close proximity of many seedlings at the View Point/Hell Hole subpopulation.

The estimated decline using post-fire seedling data is supported by the pre-fire estimates of low numbers of mature individuals at the View Point/Hell Hole subpopulation (~68% decline on population estimates from the 1990s), although caution must be exercised when interpreting these data, as there may be natural fluctuations in the number of individuals due to senescence and/or competition from larger shrubs with time since fire (see discussion under Criterion 1).

Together, these data suggest that there is a decline in number of mature individuals of the Bundanoon guinea flower. The causes of the estimated population reduction at the Bundanoon subpopulations are unclear, and the decline appears likely to continue. Therefore, a continuing decline in the number of mature individuals is estimated for the Bundanoon guinea flower.

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

Although the causes of the estimated continuing decline are unclear, drought is considered to be a likely contributing factor (S. Douglas pers. comm. 16 December 2021). Over the past 20 years, south-east Australia has been impacted by two significant drought events: the Millennium drought (2001–2009) and the 2017–2019 drought (Bureau of Meteorology, 2020). The Bundanoon guinea flower grows in areas that are likely to have low water holding capacity (e.g., rock shelves, shallow soils), so it may be at risk from hydraulic failure during severe drought. Seed set may also be diminished in times of high water stress, leading to reduced recruitment. Given the species is only known from Morton National Park, drought events are likely to impact all known subpopulations at once.

In addition, the impacts of drought are likely to interact with fire. Droughts following fire events may result in reduced seedling emergence and survival, and generally lower health of surviving plants (DAWE 2022). Seedlings are particularly prone to post-fire drought before they develop substantial root systems, and the Bundanoon guinea flower appears to recruit primarily via

seedling regeneration post-fire (see Table 1). Droughts preceding fire events may also impact the species by limiting seed production and starch reserves, limiting both the soil seed bank and resprouting capacity of adults, and leading to reduced recruitment post-fire (DAWE 2022).

Climate change is projected to lead to changes in rainfall precipitation patterns and an increase in the frequency of drought events in the region occupied by the species (OEH 2014). In addition, there has been an increase in the number of dangerous fire weather days between the periods 1950–1985 and 1985–2020, and the number of extreme fire events are likely to continue to increase (Dowdy et al. 2019; Bureau of Meteorology and CSIRO 2020). Accordingly, a decline in the quality of habitat is projected for the Bundanoon guinea flower, due to the impacts of drought and drought/fire interactions.

Extreme fluctuations

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

Conclusion

Therefore, the species has met the relevant elements of Criterion 2, including a restricted EOO and AOO, 2–3 locations, an estimated continuing decline in number of mature individuals and a projected continuing decline in the quality of habitat, to make it eligible for listing as Endangered. 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

Eligible under Criterion 3 C1 + C2a(i) for listing as Endangered

The estimated total number of mature individuals of this species is 300–500 which low.

There is estimated continuing decline in the number of mature individuals (see discussion under Criterion 1 and Criterion 2). The causes of this decline are unclear, and the decline appears likely to continue. The species has an estimated generation length of 10–20 years (midpoint 15 years), leading to a 2-generation period of ~30 years. The observed decline has been documented in View Point/Hell Hole and Wishing Well/Lovers Walk subpopulations since 1996 and 1999 respectively, while there are few available data for other subpopulations. There has been an estimated decline of 28% over 2 generations or ~30 years (see Criterion 1) which meets the threshold for a high rate of population decline under subcriterion C1. In addition, the number of mature individuals in each subpopulation is <250, which meets the threshold for low population size and decline under subcriterion C2.

Therefore, the Committee considers that the species has met the relevant elements of Criterion 3 to make it eligible for listing as Endangered. 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

Eligible under Criterion 4 for listing as D Vulnerable

The estimated total number of mature individuals of this species is 300–500 which low (see Table 1 and discussion under Criterion 1). Although additional subpopulations may exist, the number of mature individuals is likely to be <1000 on current knowledge (see Table 4).

Therefore, the Committee considers that the species has met the relevant elements of Criterion 4 to make it eligible for listing as D Vulnerable. 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.

Cataloguing data

This publication (and any material sourced from it) should be attributed as: Department of Agriculture, Water and the Environment 2022, *Conservation advice for* Hibbertia praemorsa *(Bundanoon guinea flower)*, Canberra. 

This publication is available at the SPRAT profile for Hibbertia praemorsa *(Bundanoon guinea flower).*

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

Acknowledgements

Steve Douglas (Ecological Surveys and Planning)