Australian Government
Department of Agriculture, Water and the Environment

Consultation on Species Listing Eligibility and Conservation Actions

Petauroides volans (Greater Glider (southern))

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

1) the eligibility of *Petauroides volans* (Greater Glider (southern)) for inclusion on the EPBC Act threatened species list in the Endangered category; and

2) the necessary conservation actions for the above species.

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

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

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

Responses are to be provided in writing by email to: species.consultation@environment.gov.au. Please include species scientific name in Subject field.

or by mail to:

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

Responses are required to be submitted by 24 June 2021.

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: http://www.environment.gov.au/biodiversity/threatened/index.html.

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.environment.gov.au/system/files/pages/d72dfd1a-f0d8-4699-8d43-5d95bbb02428/files/tssc-guidelines-assessing-species-2018.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: http://www.environment.gov.au/biodiversity/threatened/nominations.html.

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: http://www.environment.gov.au/biodiversity/threatened/recovery.html.

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 GREATER GLIDER (SOUTHERN & NORTHERN)

SECTION A - GENERAL

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

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

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

PART 1 – INFORMATION TO ASSIST LISTING ASSESSMENT

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

Biological information

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

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

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

Population size

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

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

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

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

   ☐ 10 000–25 000 ☐ 25 000–50 000 ☐ 50 000–75 000 ☐ 75 00 ☐ >100 000

   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? (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 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:

☐ 10 000–25 000 ☐ 25 000–50 000 ☐ 50 000–75 000 ☐ 75 000 ☐ >100 000

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' total population size over the last approximately 20 years (i.e. three generations)? 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? (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 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 ☐ >50

    000 km^2 ☐ >100 000 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 ☐ >5 000 km^2

☐ >10 000 km^2 ☐ >20 000 km^2 ☐ >50 000 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

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

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

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

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

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

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

    ☐ <100 km^2 ☐ 100 – 5 000 km^2 ☐ 5 001 – 20 000 km^2 ☐ >20 000 km^2 ☐ >50 000 km^2 ☐ >100 000 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 ☐ >5 000 km^2

☐ >10 000 km^2 ☐ >20 000 km^2 ☐ >50 000 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

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? (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? (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?

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

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

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

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

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

Consultation Document on Listing Eligibility and Conservation Actions for *Petauroides volans* (Greater Glider (southern))

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

Petauroides volans © Copyright, Kevin Maloney (from Northern NSW – Dorrigo Plateau)

Conservation status

Petauroides volans (Greater Glider) is listed in the Vulnerable category of the threatened species list under the *Environment Protection and Biodiversity Conservation Act 1999* (Cwth) (EPBC Act) effective from 5 May 2016.

This assessment recognises that *P. volans*, as understood in 2016 is now considered to be two separate species: *P. volans* (Greater Glider (southern)) in the south and *P. minor* (Greater Glider (northern)) in the north (McGregor et al. 2020).

Petauroides volans (southern) is here being assessed by the Threatened Species Scientific Committee to be potentially eligible for listing as Endangered under Criterion 1. The Committee's assessment is at Attachment A. The Committee assessment of the species' eligibility against each of the listing criteria is:

- Criterion 1: A2bc+4bc: Endangered
- Criterion 2: Not eligible
- Criterion 3: Not eligible
- Criterion 4: Not eligible
- Criterion 5: Insufficient data

The main factors that make the species eligible for listing in the Endangered category are an overall rate of population decline exceeding 50 percent over a 22-year (three generation) period including population reduction and habitat destruction following the 2019–20 bushfires.

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

The current listing status of this species under relevant state or territory legislation is:

- Victoria (Vic): Vulnerable under the *Flora and Fauna Guarantee Act 1988* since June 2017,
- Australian Capital Territory (ACT): Vulnerable under the *Nature Conservation Act 2014* since May 2019,
- New South Wales (NSW): Three subpopulations listed as Endangered Populations under the *Biodiversity Conservation Act 2016* (Euroballa Local Government Area since 2007, Mount Gibraltar Reserve since 2015 and Seven Mile Beach National Park since 2016), and
- Queensland (Qld): Vulnerable under the *Nature Conservation Act 1992* (includes both the Greater Glider (southern) and Greater Glider (northern)) since October 2014.

Species information

Taxonomy

Conventionally accepted as *Petauroides volans* KERR (1792).

This was formerly the only species in the genus. Two subspecies were conventionally recognised: *P. v. minor* (in north-eastern Qld) and *P. v. volans* (in south-eastern Australia) (van Dyck & Strahan 2008).

Jackson & Groves (2015) split the species into three separate species: *P. minor* (Atherton Tablelands and coastal central and northern Qld), *P. armillatus* (inland central Qld), and *P. volans* (from south-east Qld to Vic). McGregor et al. (2020) agreed with this taxonomic arrangement within Petauroides on the basis of genome-scale nuclear markers and external morphological data.

While this taxonomic split is yet to be formally recognised by the Australian Faunal Directory, for the purposes of this consultation document *P. volans* (southern) will be recognised.

Description

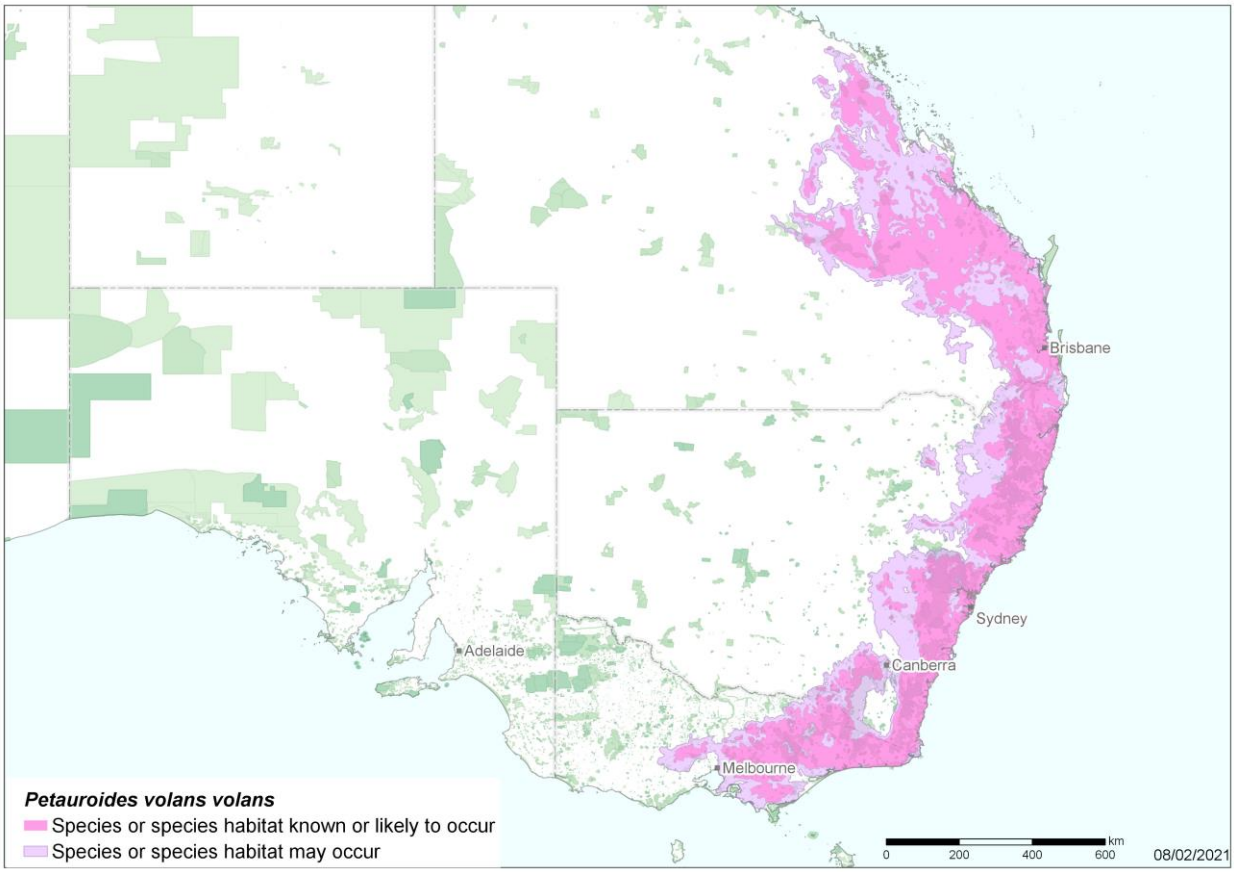
The Greater Glider (southern) is the largest gliding possum in Australia. Greater Glider (southern) has a head and body length of 35–46 cm, tail length of 45–60 cm, and a weight range of 900–1700 g, with females being larger than males (McKay 1989; Mckay 2008; McGregor et al. 2020). The Greater Glider has thick fur that increases its apparent size. Its fur colour is white or cream below and varies from dark grey, dusky brown through to light mottled grey and cream above. It has a long furry tail, large furry ears and a short snout. Its tail is not prehensile, and the gliding membrane extends from the forearm to the tibia (Mckay 1989; McKay 2008;).

Distribution

The Greater Glider (southern) occurs in eastern Australia, with distribution ranging from south of Townsville (Qld) (Eyre 2004), through NSW and the ACT (Kavanagh 2004), to central Vic (Wombat State Forest) (van der Ree et al. 2004). It is distributed across an elevational range from sea level to 1200 m above sea level (ASL). The distribution appears to be restricted in the ACT, where the species is known from the Lower Cotter Catchment and Namadgi National Park (Canberra Nature Map 2019).

The broad extent of occurrence (EOO) is unlikely to have changed appreciably since European settlement (Eyre 2004; Kavanagh 2004; van der Ree et al. 2004). However, the area of occupancy (AOO) has decreased substantially, mostly due to land clearing. This area is probably continuing to decline due to further clearing, fragmentation impacts, edge effects, bushfire, climate change and some forestry activities (Eyre 2005; Lindenmayer et al. 2011; Youngentob et al. 2012; Berry et al. 2015; McLean et al. 2018; Wagner et al. 2020). In addition, some areas of apparently suitable habitat are now no longer being occupied, with these monitored subpopulations undergoing a quite rapid and unknown decline (Lindenmayer et al. 2011; Smith & Smith 2018). The existence of these repeated recent declines suggest many other subpopulations of the Greater Glider (southern) are similarly declining.

Map 1 Modelled distribution of Greater Glider (southern)



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 significance of the Greater Glider is poorly known. However, the habitats and area in which the Greater Glider are found have a long and profound history of management by Indigenous peoples.

Relevant biology and ecology

The Greater Glider (southern) is an arboreal nocturnal marsupial, largely restricted to eucalypt forests and woodlands of eastern Australia. The Greater Glider favours forests with a diversity of eucalypt species, due to seasonal variation in its preferred tree species (Kavanagh 1984). It is primarily folivorous, with a diet mostly comprising eucalypt leaves (Kehl & Borsboom 1984; Kavanagh & Lambert 1990; van der Ree et al. 2004), with a supplement of buds and flowers, of a restricted range of Eucalypt species, such as *Eucalyptus radiata* (Narrow-leaved Peppermint) in

Vic (Henry 1995), *E. viminalis* (Manna Gum) in southeastern NSW (Kavanagh & Lambert 1990), and *Eucalyptus moluccana* (Grey Box) in southeastern Qld (Smith et al. 2007). It is typically found in highest abundance in taller, montane, moist eucalypt forests with relatively old trees and abundant hollows, for example north eastern NSW (Andrews et al. 1994; Smith et al. 1994, 1995), south eastern NSW (Kavanagh 2000), eastern Vic (van der Ree et al. 2004); but also in drier habitats in south eastern Qld (Eyre 2004). The distribution may be patchy even in suitable habitat, such as Tantawangalo State Forest in NSW (Kavanagh 2000).

During the day the Greater Glider (southern) shelters in tree hollows, with a particular preference for large hollows in large, old trees within its range (Henry 1984; Kehl & Borsboom 1984; Lindenmayer et al. 1991; Smith et al. 2007; Goldingay 2012). In Grafton/Casino, Urbenville and the Urunga/Coffs Harbour Forestry Management Areas (FMAs) in northern NSW, the abundance of the Greater Glider (southern) on survey sites was significantly greater on sites with a higher abundance of tree hollows (Andrews et al., 1994; Smith et al., 1994, 1995). In the Grafton/Casino FMA, the Greater Glider (southern) was absent from surveyed sites with fewer than six tree hollows per hectare (Smith et al. 1994). In southern Qld, Greater Glider (southern) require at least 2–4 live den trees for every two ha of suitable forest habitat (Eyre 2002).

Home ranges are typically relatively small (1–4 ha: Henry 1984; Kehl & Borsboom 1984; Gibbons & Lindenmayer 2002; Pope et al. 2005) but are larger in lower productivity forests and more open woodlands (up to 16 ha) (Smith et al. 2007). They are larger for males than for females (Kavanagh & Wheeler 2004; Pope et al. 2005), with male home ranges being largely non-overlapping (Henry 1984; Kavanagh & Wheeler 2004; Pope et al. 2005).

The Greater Glider is considered to be particularly sensitive to forest clearance (Tyndale-Biscoe & Smith 1969a) and to intensive logging (Kavanagh & Bamkin 1995; Kavanagh & Webb 1998; Kavanagh & Wheeler 2004; Kavanagh et al. 2005; Mclean et al. 2018), although responses vary according to landscape context and the extent of tree removal and retention (Kavanagh 2000; Taylor et al. 2007). The Greater Glider is also sensitive to bushfire (Lunney 1987; Andrews et al. 1994; Lindenmayer et al. 2011; Mclean et al. 2018) and is slow to recover following major disturbance (Kavanagh 2004).

Populations of large hollow-bearing trees (HBTs) are in rapid decline in some landscapes (Lindenmayer et al. 2017), due to timber production practices and bushfires (Lunney 1987; Lindenmayer et al. 2018). A decline or loss of HBTs reduces the numbers of Greater Gliders in the landscape (Mclean et al. 2018). The decline in HBT's is a concern for the Greater Glider as the development of hollows in suitable tree species can take up to 200 years (Mackowski 1984).

Notwithstanding relatively small home ranges, but in part because of low dispersal ability (due to barriers such as clearing), Greater Gliders (southern) may be sensitive to fragmentation (McCarthy & Lindenmayer 1999a, b; Lindenmayer et al. 2000; Eyre 2006; Taylor & Goldingay 2009), have relatively low persistence in small forest fragments, and disperse poorly across vegetation that is not native forest (Pope et al. 2005).

Females give birth to a single young from March to June (Tyndale-Biscoe & Smith 1969b; McKay 2008). Sexual maturity is reached in the second year (Tyndale-Biscoe & Smith 1969b). Longevity has been estimated at 15 years (Harris & Maloney 2010), so generation length is estimated to be seven to eight years. The relatively low reproductive rate (Henry 1984) may render small

isolated subpopulations in small remnants prone to extinction (van der Ree 2004; Pope et al. 2005).

Habitat critical to the survival

The Greater Glider (southern) is found in tall forests and woodlands, on fertile sites, with a diversity of eucalypt species (Braithwaite 1984). It is distributed across an elevational range from sea level to 1200 m ASL, with the highest numbers recorded at higher rather than lower elevations (Kavanagh 2004). The Greater Glider (southern) diet consists of primarily eucalypt leaves, supplemented by the buds and flowers from select Eucalypts (Henry 1984; Kehl & Borsboom 1984; Kavanagh 1984; Kavanagh & Lambert 1990). The habitat requirements for the Greater Glider (southern), includes large diameter at breast height (DBH) Eucalypt trees, as the older trees (120 years) generate the hollows required by the species (Lindenmayer et al. 2020). Forest areas currently unoccupied by the Greater Glider (southern) may still represent habitat critical to survival, if the recruitment of HBTs in the future could allow the Greater Glider (southern) to colonise these areas. It is absent from pine forests and cleared areas, and thus eucalypts are essential for survival of this species.

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

Important populations

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

All populations of the Greater Glider (southern) are important for the conservation of the species across its range, because of low fecundity and limited dispersal capabilities, local extinctions are not readily recolonised. At present there are three populations listed in NSW legislation as Endangered, because they are small and isolated from other populations, these are:

- Euroballa Local Government Area – Listing date 7-09-2007
- Mount Gibraltar Reserve – Listing date 22-05-2015
- Seven Mile Beach National Park – Listing date 16-12-2016

Threats

Loss and fragmentation of habitat has occurred in many areas of the Greater Glider's (southern) range, primarily due to clearing for development and timber production, and intense and frequent fires (Lindenmayer et al. 2011; Youngentob et al. 2013). The Greater Glider (southern) is absent from cleared areas and has little dispersal ability to move through cleared areas between fragments (Tyndale-Biscoe & Smith 1969b; McCarthy & Lindenmayer 1999a, b; Lindenmayer et al. 2000; Eyre 2006; Taylor & Goldingay 2009). Population viability in small remnants is low due to the species' low reproductive output, susceptibility to disturbance and edge effects. Cumulative effects of clearing and logging activities, current burning regimes and the impacts of climate change are a major threat to the large hollow-bearing trees on which the species relies. A unique physiology and a strict Eucalyptus diet make the Greater Glider (southern) vulnerable to high temperatures and low water availability (Rübsamen et al. 1984; Wagner et al. 2020). In the southern part of its range, nighttime temperatures that exceed 20°C have a negative effect on the metabolism of the Greater Glider (southern) and have been

implicated in the decline of the Greater Glider (southern) from areas of occupancy in NSW and Vic (Smith and Smith 2020; Wagner et al. 2020).

Table 1 Threats impacting the Greater Glider (southern)

Threat	Status and severity [a]	Evidence
Climate Change		
Fire related threats	• Status: current • Confidence: known • Consequence: severe • Trend: increasing • Extent: across the entire range	Substantial population losses or declines have been documented in and after high severity fires (Lindenmayer et al. 2013; Berry et al. 2015; McLean et al. 2018). Losses can occur as a result of direct mortality due to lethal heating or suffocation from smoke, or indirect mortality due to the loss of key habitat features and resources (McLean et al. 2018). A single fire in a ten-year period is capable of reducing the abundance by more than half (McLean et al. 2018). Declines can occur even in small fire refuges; Berry et al. (2015) found that Greater Gliders were significantly less abundant in wet unburnt forest gullies within the extent of a major fire compared to similar sites outside. In the Urbenville FMA of northern NSW, the abundance of Greater Gliders on survey sites was significantly greater in forests that were infrequently burnt (Andrews et al. 1994). The impacts of fire are exacerbated by intense logging. Following the 2009 Victorian bushfires, 79% of large living trees with cavities died in the *Eucalypyus regnans* (Mountain Ash) forests, with no recruitment of new large cavity-bearing trees by 2011 (Lindenmayer et al. 2012). This was attributed to repeated past fires, and widespread logging which has resulted in the landscape being dominated by young stands. In the Dorrigo, Guy Fawkes and Chaelundi plateaux of north-eastern NSW, the combined effects of high fire frequency and high logging intensity resulted in greater declines of Greater Gliders than each threat alone (McLean et al. 2018). In 2019-20, following years of drought (DPI 2020), catastrophic wildfire conditions culminated in fires that covered an unusually large area of eastern and southern Australia. In many places, the fires burnt with high intensity. The full impact of the 2019 20 bushfires has yet to be determined. The bushfires will not have impacted all areas equally: some areas burnt at very high intensity whilst other areas burnt at lower intensity, potentially even leaving patches unburnt within the fire footprint. An initial analysis estimated that 35% of the distribution range of the Greater Glider (southern) overlapped with the areas affected by the bushfires (Threatened Species hub 2021a). A population decline analysis for the Greater Glider (southern) that incorporates spatial variation in fire severity plus estimated declines for differing fire severity classes, provides a preliminary estimate of overall decline for the taxon of 22% (range 16 to 29 %) one year after the fire, under current management conditions (Threatened Species hub 2021b)). Populations of Greater Gliders have declined or disappeared after major bushfires. For example, after a fire event in Royal National Park in 1994, no records of Greater Gliders were found for 19 years (Andrews

Threat	Status and severity [a]	Evidence
		et al. 2014). This type of event is increasingly likely to reoccur as a result of climate change.
Increased temperature intensity and frequency, and change to rainfall patterns	• Status: current • Confidence: known • Consequence: severe • Trend: increasing • Extent: across the entire range	Greater Gliders are sensitive to extreme temperatures (Rübsamen et al. 1984). A range contraction is expected in the north and west of the Greater Glider (southern) range, with a 3 $°C$ temperature increase (Kearney et al. 2010). Occupancy modelling indicates that the degree of site occupancy is associated with vegetation lushness and terrain wetness (Lumsden et al. 2013). Water stress affects growth in forest eucalypts (Matusick at al. 2013) and the availability of browse, and higher temperatures and extreme heat events may cause heat stress, drought stress and mortality (Vic SAC 2015). Higher night-time temperatures were attributed to be the cause of declines of Greater Gliders (southern) at lower altitude (<500 m) surveyed sites in the Blue Mountains (Smith & Smith 2018, 2020). The increase of night time temperatures has also been implicated in the decline of Greater Glider numbers in Victorian subpopulations (Wagner et al. 2020). Elevated CO_2 also reduces the nutritional and water content of eucalypt leaves (Foley et al. 1990; Lawler et al. 1997; Gleadow et al. 1998). Extended drought (and a warmer, dryer climate) is likely to have a profound effect on food availability (such as young more palatable foliage compared to unpalatable older foliage) for Greater Gliders and could be expected to reduce reproduction rate and population size (Kearney et al. 2010). Extreme heat events and drought are leading to higher frequency and intensity of bushfires (CSIRO 2015), further compounding the impacts of climate change on Greater Gliders. Greater gliders were observed on the ground during extreme hot days over the 2019-2020 summer in Blue Mountains and Lithgow LGA. The individuals were collected and died soon after. They were sent for autopsy and the results were the Gliders (2 of) died from drought and extreme heat events (P Ridgeway pers. comm. 6 January 2021). This implicates daytime temperatures as having an effect on subpopulations of Greater Gliders.

Threat	Status and severity [a]	Evidence
Habitat disturbance and modification		
Inappropriate prescribed burning practices	• Status: current • Confidence: known • Consequence: severe • Trend: increasing • Extent: across the entire range	In Vic, loss of hollow bearing trees due to mechanical site preparation works associated with prescribed burning may reduce suitable habitat for the Greater Glider. This impact occurs primarily in foothill forests close to settled areas. Trees that are assessed as potentially hazardous (if they were to catch fire) are routinely removed from the perimeter of planned burns on public land in Vic. They are also removed from bushfire control lines during and after bushfire suppression activities (DELWP nd). Not all hazardous trees are hollow bearing, but many are. Too intense or frequent planned burning may contribute to population losses or declines in the southern part of the Greater Glider's range, although this is not yet supported by rigorous analysis. Bluff (2016) reported that hollow-bearing trees affected by fire during planned burns were 28 times more likely to collapse than hollow-bearing trees that were not burnt. After fires, trees with large hollows are often felled for safety reasons (along roads, fire trails and walking trails), within Greater Glider habitat (DECCW 2011). Andrew (2001) reported that 120 hollow bearing trees were felled after the 1994 bushfires in Royal National Park by NPWS due to concerns about public safety.
Habitat clearing and fragmentation	• Status: current • Confidence: known • Consequence: severe • Trend: decreasing • Extent: across parts of the range	Extensive land clearing for development and agriculture, has led to fragmentation of habitat, for example the Tumut area (Pope et al. 2005), where small subpopulations exist in a pine matrix. Gliding poles are being utilised to manage connectivity of habitat fragments, for example urban Brisbane (Taylor & Goldingay 2009). Nest boxes have been utilised in a 2-year program at Mirboo North for habitat connectivity, with Greater Gliders (southern) filmed using boxes as maternal dens (D. Liepa 2020 pers comm 10 September). Some current habitat across the species range is found in conservation reserves (Smith & Smith 2018, Wagner et al. 2020), where logging is excluded and the removal of hollow bearing trees, is subject to constraints.

Threat	Status and severity [a]	Evidence
Timber harvesting	• Status: current • Confidence: known • Consequence: moderate • Trend: decreasing • Extent: across parts of the range	The sensitivity of Greater Gliders to logging has been well documented, and prime habitat coincides largely with areas suitable for logging (Braithwaite 1984). The degree of impact depends on forest type and logging intensity, with larger declines in more heavily logged sites (Tyndale-Biscoe & Smith 1969b; Lunney 1987; Kavanagh et al. 1995; Kavanagh & Webb 1998; Kavanagh 2000; McLean et al. 2018). There is a progressive decline in numbers of hollow-bearing trees in some production forests, as logging rotations become shorter and as dead stags collapse (Ross 1999; Ball et al. 1999; Lindenmayer et al. 2011, 2012). Recovery of subpopulations following logging is slow. Subpopulations in south-east NSW had not recovered 8 years after logging in sites retaining 62%, 52% and 21% of the original tree basal area (Kavanagh & Webb 1998). However, Kavanagh (2000) found that, in production forests in south-east NSW, Greater Glider subpopulations could persist post-logging if 40% of the original tree basal area was retained, provided (adjoining) riparian vegetation was also protected. In the regrowth Mountain Ash forests of Vic, Greater Gliders were absent post-logging until the forests were >38 years old (Macfarlane 1988).
Predation and competition from native species		
Hyper predation by owls	• Status: current • Confidence: known • Consequence: moderate • Trend: static • Extent: across parts of the range	The Greater Glider forms a significant part of the diet of *Ninox strenua* (Powerful Owl) (Bilney et al. 2006) and has become a significant part of the diet of *Tyto tenebricosa* (Sooty Owl) since European settlement, due to the widespread decline of terrestrial species (Bilney et al. 2010). The Greater Glider has significantly declined or become locally extinct in some intact forest areas, possibly due to owl predation (Lindenmayer et al. 2011; P. Rickards pers. comm., 2015). At one unlogged site over a three-year period, two Powerful Owls were suspected to have reduced a Greater Glider population from 80 to seven individuals (Kavanagh 1988). However, the presence of large forest owls does not necessarily indicate a population level impact on Greater Gliders. Numbers of Powerful and Sooty Owls have increased greatly in the Blue Mountains since the 1980s and have been recorded at many sites with Greater Gliders, but no significant relationship between Greater Glider abundance and the presence of either owl species was found (Smith & Smith 2018).
Competition from *Cacatua galerita* (Sulphur-crested Cockatoos)	• Status: current • Confidence: known • Consequence: low • Trend: increasing • Extent: across parts of the range	Numbers of Sulphur-crested Cockatoos in the Blue Mountains have increased significantly since 1990. They are likely to be competing with Greater Gliders for hollows and have been observed taking over nesting hollows of Powerful Owls. However, Smith & Smith (2018) found no significant relationship between Greater Glider abundance and the number of roosting cockatoos; further research is required to determine the impact of inter-species competition for hollows.

Threat	Status and severity [a]	Evidence
Introduced species		
Predation by feral cats (*Felis catus*)	• Status: current • Confidence: known • Consequence: low • Trend: unknown • Extent: across the entire range	Feral cats are known to prey on Greater Gliders (Jones & Coman 1981). After wildfires Greater Gliders are displaced and have been observed on the ground where they are more susceptible to predation (Fleay 1947).
Predation by introduced European red fox (*Vulpes vulpes*)	• Status: current • Confidence: known • Consequence: low • Trend: unknown • Extent: across the entire range	European red foxes have been recorded preying on Greater Gliders and are thought to consume dead animals (Le Souef and Burrell 1926; Fleay 1947; Coman 1973; Brunner et al. 1975; Wallis & Brunner 1986; MacFarlane 1988; Lunney et al. 1990; Mitchell & Banks 2005; Maloney & Harris 2006; Roberts et al. 2006).
Fencing of land surrounding habitat		
Barbed wire fencing (entanglement)	• Status: current • Confidence: known • Consequence: low • Trend: unknown • Extent: across the entire range	There are occasional losses of individuals due to entanglement in fencing wire across the Greater Gliders (southern) range (van de Ree 1999; Maloney & Harris 2006).

Status—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 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 in-house expertise using available literature.

Table 2. Greater Glider (southern) risk matrix

Likelihood	Consequences				
	Not significant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Low risk	Moderate risk **Barbed wire fencing (entanglement)** **Hyper predation by owls**	Very high risk	Very high risk **Timber harvesting**	Very high risk **Fire-related threats** **Altered fire regimes and prescribed burns** **Habitat clearing and fragmentation**
Likely	Low risk	Moderate risk **Competition from Sulphur-crested Cockatoos**	High risk	Very high risk	Very high risk **Changes to habitat distribution due to climate change**
Possible	Low risk	Moderate risk **Predation by foxes** **Predation by cats**	High risk	Very high risk	Very high risk
Unlikely	Low risk	Low risk	Moderate risk	High risk	Very high risk
Unknown	Low risk	Low risk	Moderate risk	High risk	Very high risk

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

Protect sufficient areas of habitat from intense and widespread fire, fragmentation and logging and retain hollow-bearing trees and habitat connectivity.

Survey and protect areas of habitat affected by the 2019–2020 bushfires and those adjacent to affected areas.

Conservation and management priorities

Climate change and fire

- In the aftermath of bushfires, manage unburnt areas (within or adjacent to recently burnt areas) to reduce risk from future bushfires and protect/maintain this habitat to support population recovery. In particular, protect hollow-bearing trees from post-fire salvage logging and clean-up operations.
- Reassess and revise current prescriptions used for prescribed burning to ensure that the frequency and intensity of fires are minimised, in order to mitigate the risk of further population declines.
- Implement measures to reduce direct mortality and loss of hollow-bearing trees during site preparation and execution of prescribed burns.
- Protect all habitat projected to be suitable as refuge sites under future climate change scenarios and establish connectivity to facilitate movement where possible.

Habitat loss disturbance and modifications

- Identify key subpopulations and implement appropriate measures to ensure suitable habitat is maintained and protected around these subpopulations, as well as in areas where subpopulations have already declined through loss of habitat. When protecting an area, retain sufficient suitable habitat for population viability.
- Establish and maintain effective prescriptions in production forests to support subpopulations of the Greater Glider (southern). This includes but is not limited to: appropriate levels of habitat retention, logging exclusion and logging rotation cycles, maintenance of wildlife corridors between logged patches, protection of existing hollow-bearing trees with appropriate buffers, and adequate recruitment of hollow-bearing trees.
- Restore connectivity in subpopulations fragmented by major and minor roads, including the use of artificial structures such as rope bridges, glide poles and nest boxes.
- Avoid fragmentation and loss of habitat due to development of new transport corridors. Where possible, relocate recreational activities and roads away from habitat.
- If possible, avoid the use of barbed wire and modify existing barbed wire by replacing the top strand of barbed with plain wire, and to not use barbed wire for the top strand of new fences in forested areas.

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

- In areas burnt by bushfires, implement control measures for introduced predators, including the European Red Fox and Cat.
- Control the access of introduced predators and herbivores to burnt sites and adjacent unburnt sites to support population and habitat recovery.
- Develop and implement longer-term strategies to control predation by the European Red fox and Feral Cats, as detailed in the Threat Abatement Plans for predation by the red fox and feral cats (DEWHA 2008; DoE 2015).

Stakeholder engagement/community engagement

- Seek stakeholder input into assessment and planning processes that include protections for the Greater Glider (southern) and its habitat. This may include environmental impact assessments, park management plans, water resource plans, fire management plans and transport development plans.
- Liaise with private land holders, traditional owners, conservation, and land management groups to create guidelines for on-ground management of the Greater Glider (southern). Encourage their engagement in surveying and monitoring of the species.
- Encourage landholders to enter land management agreements, particularly in-perpetuity covenants, that promote the protection and maintenance of private lands with high value for the species.
- Encourage volunteer involvement in gathering data on the occurrence and foraging habitat of the species.
- Foster public interest in the species and its ongoing conservation.

Survey and monitoring priorities

- Conduct on-ground surveys to establish habitat and population responses to the 2019–20 bushfires and to provide a baseline for future population monitoring. Leverage post-fire monitoring at sites where surveys were undertaken prior to 2019–20 to assess population trends across the fire cycle.
- Conduct on-ground surveys to investigate losses of hollow-bearing trees as a result of the 2019–20 bushfires.
- Monitor the incidence and impacts of bushfire and logging in the species range, particularly in areas adjacent to those burnt in the 2019–20 bushfires.
- Conduct surveys for the Greater Glider (southern), including long term monitoring of known subpopulations to ascertain the stability and viability of subpopulations. Establish new monitoring programs where necessary.
- Monitor the abundance, age and size structure of hollow-bearing trees, occupancy by Greater Gliders and their responses to management measures. This includes before and after prescribed burns, and before and after logging.

Information and research priorities

- Investigate the numbers and densities of mature hollow-bearing trees required for population viability.
- Identify priority isolated subpopulations for conservation (for example Coolah Tops National Park, NSW).
- Define appropriate levels of logging exclusion and hollow-bearing tree retention to maintain population size and persistence. Assess and monitor the response to current logging prescriptions and revise them if required.
- Assess the impacts of fire management and different fire regimes on habitat, population size and hollow availability.

- Assess the impacts of localised habitat fragmentation (e.g., through peri-urban expansion, coal seam gas mining activities, road networks) on the species.
- Investigate the species' response to the use of artificial structures (e.g., rope bridges and glide poles over transport routes) in restoring habitat connectivity, as well as its potential usage of artificial hollows and nestboxes in areas with low hollow availability.
- Investigate possible causes of recent declines observed at some subpopulations, where the cause has not been identified (for example Smith & Smith 2020; Wagner et al. 2020).
- Undertake habitat suitability modelling under future climate change scenarios and identify areas suitable as climate refuges.
- Improve understanding of the species' diet and life history, especially in areas where populations have declined. Determine the likely effects of increased temperatures and drought on food supply, behaviour and survival.
- Improve understanding of the constraints to dispersal, and the landscape and habitat features that promote connectivity.

Recovery plan decision

No recovery plan is in place for the Greater Glider (southern).

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

NSW Saving Our Species Strategy: Greater Glider Population in the Eurobadalla local government area (*Petauroides volans*) – Endangered Population)

NSW Saving Our Species Strategy: Greater Glider Population at Seven Mile Beach National Park *(Petauroides volans* – Endangered Population)

NSW Saving Our Species Strategy: Greater Glider Population at Mount Gibraltar Reserve area *(Petauroides volans* – Endangered Population)

Threat abatement plan for predation by Feral cats (2015)

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

Attachment A: Listing Assessment for *Petauroides volans (southern)*

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	>100 000	100 000	Unknown	There is no viable estimate of the population size of the Greater Glider (southern). Woinarski et al. (2014) estimated over 100 000 individuals, and Nelson et al. (2018) estimated a population of 69 000 in the Strathbogie ranges.
Trend	declining			Declines in occupancy of the Greater Glider (southern) have been recorded for over two decades in the Central Hiighlands (Lumsden et al. 2013; Lindenmayer 2020). There has been loss of subpopulations in NSW within the Jervis Bay and Blue Mountains areas (Lindenmayer et al. 2011; Smith & Smith 2018). These declines were recorded pre-2019–2020 bushfires and overall show a ≥ 30% decline, and post fire surveys have indicated that in areas of high fire severity there is zero to very low occupancy (J. Smith 2020 pers comm 10 December). Following the 2019–20 bushfires, an overall population decline of over 20%, with local subpopulation extirpations, is suspected. This is expected to increase to >30% in three generations after the fires (Threatened Species Recovery Hub 2021b).

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Generation time (years)	7–8	7	8	The Greater Glider can live for 15 years (Harris & Maloney 2010) and reaches sexual maturity at two years of age (Tyndale-Biscoe & Smith 1969b), suggesting a generation length of seven to eight years (Woinarski et al. 2014).
Extent of occurrence	752 962 km^2	752 962 km^2	1 066 146 km^2	Woinarski et al. (2014) estimated the extent of occurrence (EOO) of the southern species as 752 962 km^2 calculated using records from 1992–2012. The 1 066 146 km^2 figure was based on the mapping of point records from 2000 to 2020, obtained from state governments, museums and CSIRO. The EOO was calculated using a minimum convex hull, based on the IUCN Red List Guidelines 2014 (DotE 2015).
Trend	declining			The EOO has declined since European settlement, with loss of habitat from land clearing, fragmentation, logging, inappropriate fire regimes, and climate change. The local extinction of subpopulations has occurred recently (Lindenmayer et al. 2018), and the EOO is likely to continue contracting due to loss of habitat from the 2019–2020 bushfires, planned burning, logging and climate change.
Area of Occupancy	15 244 km^2	15 244 km^2	15 532 km^2	Woinarski et al. (2014) estimated the Area of Occupancy (AOO) as 15 244 km^2 calculated from records 1992–2012. The 15 532 km^2 figure is based on the mapping of point records from 2000 to 2020, obtained from state governments, museums and CSIRO. The AOO was calculated using a 2x2 km grid cell method, based on the IUCN Red List Guidelines 2014 (DotE 2015). The AOO is likely to be underestimated due to limited sampling across the species range.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Trend	declining			The AOO has declined since European settlement, with loss of habitat from land clearing, fragmentation, logging, inappropriate fire regimes, and climate change. The local extinction of subpopulations has occurred recently (Lindenmayer et al. 2018, Smith & Smith 2020), and the AOO is likely to continue contracting due to loss of habitat from the 2019–2020 bushfires, planned burning, logging and climate change.
Number of subpopulations	Unknown	Unknown	Unknown	The species is known from Qld, NSW and Vic, and the number of subpopulations is not able to be estimated due to low sampling regimes throughout the range.
Trend	declining			The numbers of Greater Glider (southern) have been declining across its range, and with the decreasing AOO and EOO, the number of subpopulations are likely to be declining.
Basis of assessment of subpopulation number	The Greater Glider (southern) number of subpopulations is unknown, as there is a low sampling and survey regime across its range.			
No. locations	unknown	unknown	>10	The number of locations is not known with any certainty. The 2019–20 bushfires burnt a large area of Eastern Australia (100 000 km^2), overlapping c. 35% of the Greater Glider (southern) distribution. However, the fire intensity was highly spatially variable, with Greater Glider (southern) persisting in at least some areas burnt at low intensity (J. Smith 2020 pers comm 10 December). Thus, the number of locations may be significantly greater than 10.
Trend	declining			Climate change is likely to increase the intensity and frequency of bushfires, and thus the number of locations where one bushfire will affect all individuals is likely to decrease
Basis of assessment of location number	The 2019–20 bushfires were extensive but the habitat and landscape topography, along with the stochastic variation in fire spread leaves numerous unburnt habitat fragments from which subpopulations may recover.			
Fragmentation	Not severely fragmented– less than 50% of AOO in habitat patches that cannot support minimum viable subpopulation.			
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

Eligible under Criterion 1 A2abc+4bc for listing as Endangered

The Greater Glider (southern) can live for 15 years (Harris & Maloney 2010) and reaches sexual maturity at two years of age (Tyndale-Biscoe & Smith 1969b), suggesting a generation length of seven to eight years (Woinarski et al. 2014). This gives a timeframe of 21 to 24 years for this criterion.

There are no robust estimates of population size or population trends of the Greater Glider (southern) across its total distribution. However, declines in numbers, occupancy rates and extent of habitat have been recorded at many sites (see below and Table 4). Although there are a few sites where subpopulations appear to be stable or increasing (see below and Table 4), the overall trend is one of decline.

Prior to 2019-2020 Bushfires

Victoria

The most comprehensive long-term monitoring program for Greater Glider (southern) is in the montane ash forests of Central Highlands of Vic, where 160 permanent one ha sites across a 1800 km^2 study area (in both conservation reserves and production forests, and spanning a broad range of forest ages and environmental settings) (Lindenmayer 2009) have been monitored annually since 1997. Over the period 1997–2010, the Greater Glider (southern) declined by an average of 8.8 percent per year (a rate that if extrapolated over the approximately 21–24-year period relevant to this assessment is 85–89 percent) (Lindenmayer et al. 2011). Higher rates of decline were recorded in forests subject to logging than in conservation reserves, and declines were also associated with major bushfires and lower-than-average rainfall. Populations of large hollow-bearing trees are in rapid decline (Lindenmayer et al. 2017) and modelling of tree growth stages predicts a greater than 92 percent chance of ecosystem collapse in the Mountain Ash forests of the Central Highlands by 2067 (Burns et al. 2015).

Other surveys undertaken in the Central Highlands in both Mountain Ash and mixed species forests, indicate a significant decline in occupancy rates over the past two decades (Lindenmayer et al. 2011; Lindenmayer & Sato 2018; Lumsden et al. 2013).

A broad-scale survey in 2018 of 80 sites (500 m off-track transects) spread across central and north-eastern Vic found low numbers of Greater Glider (southern) at the majority of sites. Despite many of the sites supporting seemingly suitable habitat, Greater Glider (southern) were detected on fewer than half of the transects (41 percent). On average, 0.93 gliders (range 0-6) were detected per 500 m transect (DELWP 2019, pes comm.15 October). Surveys in 2019 conducted at 63 sites within eastern Vic also found low numbers of Greater Glider (southern) with animals detected in only 19 percent of sites (0.21 gliders/500 m transect, range 0-2). Based on records held in the Victorian Biodiversity Atlas and anecdotally, these results suggest the species has declined across this area.

In contrast, surveys using the same broad-scale survey methodology in the Strathbogie Ranges in north-eastern Vic found relatively high densities of gliders with 4.92 gliders detected on average per transect (range 0-14; Nelson et al. 2018). Analyses of the survey data estimated the number of Greater Glider (southern) within the Strathbogie Ranges to be 69 000, although with relatively broad confidence intervals (95 percent confidence interval 3000–121 000 individuals). A comparison of data from three surveys conducted in the Strathbogie Ranges in 1983 (Land Conservation Council 1984), 1997 (Downes et al. 1997), and 2017 (Nelson et al. 2018), suggests that the subpopulation in the Strathbogie Ranges has not declined over a 34 year period, to the extent that has been observed elsewhere in Vic. Across eastern Vic, surveys for Greater Gliders are also being undertaken on high priority coupes as part of DELWP's Forest Protection Survey Program, with 207 coupes surveyed within the first year, 2014.

Major bushfires in 2003, 2006–2007 and 2009 burnt large areas of the Greater Glider (southern) range in Vic, and further fragmented its distribution as evidenced by surveys and species records (Lumsden et al. 2013; Vic SAC 2015). Following the 2009 bushfires, 79 percent of large living trees with cavities died in the Mountain Ash forests, with no recruitment of new large cavity-bearing trees by 2011 (Lindenmayer et al. 2013). The abundance of Greater Glider (southern) declined at burned sites, as well as unburnt sites surrounded by burned forest (Lindenmayer et al. 2013). Reoccupation of burnt sites in subsequent years is a slow process due to the small home ranges (1–2 ha) of the species and its limited dispersal capabilities (L. Lumsden pers. comm., cited in Vic SAC 2015). It also depends on there being no further significant fires in the interim (Vic SAC 2015). Since the 2009 fires, which burnt the Kinglake East Bushland Reserve and nearby areas, spotlighting records of Greater Glider (southern) in these areas have significantly declined (C. Cobern 2015 pers comm 9 November). The occupancy model in Lumsden et al. (2013) predicts that areas most likely to be occupied following the 2009 fires are now patchily distributed.

However, evidence of declines in occupancy in some unburnt sites in the same parts of Vic (Lumsden et al. 2013) suggest that factors other than fire are involved in the species' decline (Vic SAC 2015). A decline in suitable browse due to water stress is probably a contributing factor, as central Vic was significantly hotter and drier than normal during 2001–2009 (Vic SAC 2015). Occupancy modelling by Lumsden et al. (2013) and Wagner et al. (2020) shows that the degree of site occupancy is positively associated with site ruggedness, vegetation lushness and terrain wetness.

In East Gippsland, analysis of results from a survey of 107 sites, comprising 49 sites with previous records of Greater Glider (southern) and 58 randomly stratified sites, found a decline in Greater Glider (southern) occupancy rate of about 50 percent compared to about 20 years ago (DELWP 2019 pers comm 15 October). The occupancy rate of all arboreal mammals detected in sufficient numbers to enable analysis had declined across two decades, but Greater Glider (southern) had declined more than other species. The decline in the rate of detection was highest in coastal and foothill forests, while detection rates were high only in wet and damp tableland forest on the Errinundra Plateau and Coast Range.

In the Mount Alfred State Forest, roadside spotlighting on the same route over a 30-year period used to record frequent sightings (10–15 animals on each occasion), but only a single Greater Glider (southern) was sighted in the 18 months leading up to November 2015 (Gippsland Environment Group 2015 pers comm 24 November).

New South Wales and the Australian Capital Territory

At Jervis Bay in Booderee National Park, 110 permanent one ha sites (stratified across vegetation types and fire histories) were established in 2002. Lindenmayer et al. (2011) reported a highly significant decline, from Greater Glider (southern) presence in 22 of the sites in 2002, to absence from all sites since 2007. The Greater Glider (southern) has not been recorded in the National Park since 2006 and appears to have been extirpated from the area, for reasons unknown (Lindenmayer et al. 2018).

In the Blue Mountains, declines have been recorded at Murphy's Glen; spotlighting undertaken between 1986 and 2014 shows that the species used to be consistently and regularly detected, but by 2010 was difficult to detect and likely no longer present (J. Smith 2015 pers comm 22 November). However, spotlighting undertaken in 2015 recorded Greater Glider (southern) on each of the three occasions (1, 2 and 5 individuals), so numbers may be recovering at Murphy's Glen (J. Smith 2015 pers comm 22 November). Anecdotal reports, including from local ecologists, indicated similar declines elsewhere in the lower Blue Mountains, and the NSW Bionet Atlas confirms a marked drop in records in the region (Blue Mountains National Park: 357 records 1990–2004, eight records 2004–2014. Blue Mountains LGA: 142 records 1990–2004, one record 2004–2014, five records 2018-2020 and only one record for 2020) (J. Smith 2015 pers comm 22 November). The decline of the Greater Glider (southern) in the lower Blue Mountains is mostly likely due to the effects of increased temperatures as a result of climate change (Smith & Smith 2018; 2020). An autopsy undertaken on two Greater Glider (southern) in January 2020, (collected after reports of Greater Glider (southern) walking on the ground in the daytime), reported that they had both died from drought and extreme heat events (i.e., Heat stress and dehydration) (P Ridgeway 2021 pers comm 6 January).

An isolated subpopulation at Royal National Park was thought to be lost due to fire and regional-scale decline in the Illawarra area (Maloney 2007). Following the 1994 wildfire, which burnt more than 90 percent of the park, the first confirmed sighting of a Greater Glider (southern) in Royal National Park was in 2012 (Andrew et al. 2014), although a number of surveys and searches had been conducted since the 1994 fire (Andrew 2001; Maloney 2007; Andrew et al. 2014).

Kavanagh and Webb (1998) monitored Greater Glider (southern) in 500 ha of wood production forest near Bombala in southern NSW, and found that the subpopulation declined in all logging compartments and had not recovered eight years after harvesting. About 30 years after clearing of eucalypt forests in Tumut, Lindenmayer et al. (1999) found that the occupancy rate of Greater Glider (southern) in remnant patches were still lower (21 percent) compared to that in surrounding forest (38 percent), indicating that recolonization following clearing occurs slowly. It is unclear, following such disturbances, whether subpopulations recover to their former levels or persist at lower levels.

In the Dorrigo, Guy Fawkes and Chaelundi Plateaux of north-eastern NSW, surveys for the Greater Glider (southern) at 30 sites in wet sclerophyll forest (WSF) recorded a density of 27.6 per km, in unlogged forest with no fire history (McLean et al. 2018).

Queensland

In central Qld, the abundance of Greater Glider (southern) declined by 89 percent across a series of 31 woodland sites sampled initially in 1973–76 and re-sampled in 2001–02 (Woinarski et al. 2006). The species is continuing to decline, based on anecdotal observations over a 20-year period (Qld DEHP 2015) and evidence of a decline in large, hollow-bearing trees due to past logging activities and repeated prescribed burning (Eyre 2005; Eyre et al. 2010). There has been a decline in living hollows (25 percent) and stags (40 percent) over a 20-year period (1998–2018) in the St. Marys State forest area (T. Eyre 2021 pers comm 11 January). Once habitat trees are lost from the system, the length of time required for the development/recruitment of replacement habitat trees appropriate for the species is largely prohibitive (Smith et al. 2015).

Post 2019-2020 Bushfires

The full impact of the 2019-20 bushfires on the Greater Glider (southern) has yet to be determined but the population is likely greatly reduced. The fires may have accelerated any population decline, with approximately 35 percent of the Greater Glider (southern) distribution range overlapping with the fire-affected areas (Threatened Species Recovery Hub 2020a). These fires covered an unusually large area and, in many places, burnt with an unusually high intensity. Its pre-fire imperilment, together with the extent of mortality as a result of fire and the unfavourable post-fire conditions (loss of hollows, increased susceptibility to predators, and loss of food resources), as well as a reduction in future recruitment, led to the Greater Glider (southern) being identified as one of the highest priority species for urgent management intervention by the wildlife and threatened species bushfire recovery Expert Panel (Legge et al. 2020).

It is known that the Greater Glider (southern) is highly susceptible to fire events, with population declines from 50 percent documented in some cases (McLean et al. 2018) and extirpation with slow recovery in others (Maloney 2007; Andrew et al. 2014) documented. Following the 2019-20 bushfires on ground surveys in some areas are still to be conducted, and baseline data are missing on population size, distribution and density throughout the range of the Greater Glider (southern). The majority of this species records are from the eastern areas of NSW and Vic, which were extensively burnt (DPIE 2020; Parliament of Victoria 2020). Post-fire field survey data available to date are summarised in the section below.

In addition to direct observations (see below), an expert elicitation exercise has been run to estimate the likely decline in populations due to fires of varying intensity (Threatened Species Recovery Hub 2021a). This was then combined with a GIS analysis of overlap of the distribution of Greater Glider (southern) with the fire footprint to provide an overall estimate of the likely population decline due to the fires. The preliminary result is an estimated immediate loss of 22 percent of the population (range 16–29 percent) (Threatened Species Recovery Hub 2021b).

Victoria

At the present time, there is little evidence from Vic, due to safety concerns such as entering survey areas after the fires, and then restrictions due to COVID-19 (A. Moorrees 2020 pers comm 14 September). Surveys currently underway (April 2021) are focused predominantly on lightly burnt and unburnt habitat within the fire ground, but also some areas burnt at moderate to higher severity. Surveys have been designed to visit pre-fire records of the Greater Glider (southern) near Swifts Creek and Bendoc in East Gippsland. Interim results on 500 m transects at 11 sites (one third of all sites planned for survey) have detected Greater Gliders at four lightly burnt sites, as well as at two sites that were burnt at higher severity, although the numbers of Greater Gliders detected were lower and the species was not detected at five sites with pre-fire records (J. Nelson 2021 pers comm 19 April). Surveys at 30 sites in lower elevation forests in East Gippsland (from Cabbage Tree Creek to Drummer State Forest) burnt at low severity did not result in any detections of the Greater Glider (southern).

Greening Australia in East Gippsland has inspected nest boxes in areas that have been taken up by Greater Glider (southern) post fire (D. Liepa 2020 pers comm 10 September), and spotlight surveys have recorded Greater Glider (southern) in low numbers at some sites. In East Gippsland, Greater Gliders were detected at 18 of 24 sites pre-bushfire, post bushfire two spotlighting surveys undertaken along 500 m transects at these 24 sites, detected Greater Glider (southern) at seven of the 18 sites, suggesting a 60 percent decline (B. Blake 2020 pers comm 25 September). A further spotlighting survey of 500 m transects undertaken at East Gippsland Mallacoota area detected Greater Glider (southern) in one of 13 transects, where they were recorded previously: a 90 percent decline (P. Burns 2020 pers comm 14 December).

New South Wales

South Coast of NSW

Spotlight surveys at 71 sites, undertaken at Murramarang, Meroo and Conjola National Parks, and Corramy Regional Park in May and June of 2020, reported on average a 70 percent decline in the numbers of detected Greater Glider (southern) for these sites, after the 2019-2020 fires compared to previous surveys undertaken (NSW NPWS 2020).

Blue Mountains Region NSW

In the Blue Mountains area, post fire surveys detected Greater Glider (southern) where fire severity had been low, moderate or patchy, at mostly pre-fire densities; whereas if there was total loss of the canopy (high severity), no gliders were detected, for example Jenolan Caves area (J. Smith 2020 pers comm 10 December).

Far north Coast of NSW

Limited post fire surveys in the Styx River, Chaelundi and Guy Fawkes River areas were conducted in July 2020. A single survey at 26 sites (of varying fire intensity), reported a decrease in the numbers of detected Greater Glider (southern) (30/km to 10/km) compared to previous surveys (C. McLean 2020 pers Comm 19 September)

Queensland

Major bushfires in 2019/2020 burnt part (approximately 10 percent) of the Greater Glider (southern) range in southern Queensland. While there has been no post fire survey work undertaken for this species in Queensland to date, these fires would have caused direct and indirect mortalities through habitat loss and fragmentation, with a consequent decline in abundance of Greater Glider (southern).

Conclusion

The Greater Glider (including *P. minor)* was assessed in 2016, with the species found to be eligible for listing as Vulnerable against this criterion as follows (TSSC 2016):

> There is little other published information on population trends over the period relevant to this assessment (around 21–24 years), and the above sites are not necessarily representative of trends across the species' range. However, they provide sufficient evidence to infer that the overall rate of population decline exceeds 30 percent over a 21–24-year (three generation) period (Woinarski et al. 2014), and indeed may far exceed 30 percent. The population of the Greater Glider is thought to be declining due to habitat loss, fragmentation, extensive fire and some forestry practices, and this decline is likely to be exacerbated by climate change (Kearney et al. 2010). The species is particularly susceptible to threats because of its slow life history characteristics, specialist requirements for large tree hollows (and hence mature forests), and relatively specialised dietary requirements Woinarski et al. 2014).

Since that determination, there is no evidence that any of the major threats to this species have reduced, and the effects of climate change are likely worsening (Smith & Smith 2020; Wagner et al. 2020). The effects of the 2019–2020 bushfires are in addition to these ongoing decline trends. Additionally, with the removal of *P. minor* from the consideration here, the effects of logging, habitat loss and other threats can be considered likely to be (slightly) greater.

If decline as assessed in 2016 was greater than 30 percent, and potentially substantially greater, then the additional loss of approximately 20 percent (13-28 percent) of the population due to the 2019-2020 bushfires (Threatened Species Recovery Hub 2021b) indicates a decline of at least 50-70 percent over the previous three generations.

Therefore, the Committee has inferred a significant cumulative population decline of at least 50 percent over three generations (and the reduction has not ceased nor has the cause ceased and nor is it fully understood).

The data presented above appear to demonstrate that the species is **eligible for listing as Endangered under A2abc and possibly A3bc**. 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.

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

Table 4: The trend of density and population changes of Greater Glider numbers across its range from south-east Queensland to Victoria. The light blue shading corresponds with surveys undertaken post 2019-2020 fires.

Study Area/Site	Date	Density/ Population	Trend (↑→↓) with %	Comments (including references) (Author, Year)
South east Queensland				
Maryborough	1984	1.6–2.3 ha^{-1}		Kehl and Borsboom (1984)
Barakula Forest	2007	0.23 ha^{-1}		Smith et al. (2007)
Emerald district – Central Qld	1973–76 2001-0		↓ - 89 %	Spotlighting at 31 woodland sites, in a 100 km radius around Emerald Woinarski et al. (2006)
Burnett Mary	2017 2018	0.25–0.3 ha^{-1}		Single survey at each of 54 sites Greater Glider detected at 11 of 54 sites Ferguson et al. (2018)
Brisbane	2003	0.36 ha^{-1}		Taylor & Goldingay (2003)
Total trend for area			↓	
Far north of New South Wales				
Armidale	1973	0.4 ha^{-1}		Griffiths (1973)
Coolah Tops	1983–1995	1.1–3 ha^{-1}		Kavanagh (1995)
Styx River, Chaelundi and Guy Fawkes River areas	2009, 2010, 2011	30 per km		Pre bushfires – Mclean et al (2018) 26 of 500m transects in unburnt and unlogged areas
Styx River, Chaelundi and	2020	10 per km	↓ - 60 %	Post bushfires - A single survey at 26 sites (of varying fire intensity),

Study Area/Site	Date	Density/ Population	Trend (↑→↓) with %	Comments (including references) (Author, Year)
Guy Fawkes River areas				McLean C (2020) Personal communication by email, 16 September 2020. Senior Planner, Central Coast Council (NSW). range 0-22 per 500m, average of 5 per 500m. Rod Kavanagh - Total of 455 Greater Gliders detected from 51 sites – 66% were in low severity and 33% were in high severity burn (4 of the 51 sites had no greater Gliders). Good Glider territory.
Total trend for area			↓	
New South Wales				
NSW - Wollemi National Park – western edge – Army Road north of Lithgow and Newness	2013–2014 December 2020	3 per km detected 1.9 per km detected	↓ - 37%	Driving spotlighting along Army Road (10 km per hour) Mike Letnic – UNSW – detecting Greater Gliders in Wollemi after Gospers Mountain Fire (drove for an hour at 10 km per hour and detected 19).
NSW - Megalong Valley	2019 2020	3.27 individuals per visit 1.75 individuals per visit	↓ - 100% loss in dry Eucalypt forest	Dry Eucalypt Forest – 2 km transect Stephanie Chew - Ecologist - personal communication by email 8th January 2020 Since August 2020 – 3 surveys none detected No fire.

Study Area/Site	Date	Density/ Population	Trend (↑→↓) with %	Comments (including references) (Author, Year)
NSW - Blue Mountains LGA; Jenolan Caves Area; Wombeyan Caves Area and Bigga Area	2020		Persistent at unburnt sites, with indications of ↓ in numbers, and disappearance at lower elevations ↓ major decrease in areas that were severely burnt	Spotlighting of 2 x 500 m transects – 8 transects in total. Post Bushfires Peter and Judy Smith (pers comm. 2020) Sites with the amount of eucalypt foliage that remained unburnt/unscorched after the fire was 23% to 56%. All these sites still had Greater Gliders and mostly at densities comparable to the pre-fire densities. The Jenolan Caves sites (x2) had a 100% loss of eucalypt foliage in the fires) and so far haven't been able to find any Greater Gliders in these two transects
NSW – Blue Mountains	2015–2016	0.2 ha^{-1}	↓ - 35%	Spotlighting : 20 sites across LGA, 3 surveys each Smith & Smith (2018) Smith & Smith (2020) Not recorded at 35% of sites where previously recorded. Rare at lower elevations (<500m), but in 1986-96 abundance was similar across all elevations (80-1060m). Decline most likely due to increased temperatures.
NSW – Blue Mountains	1986–2010		↓	Spotlighting, Murphy's Glen 1986–2010 Annually 1999-2010, apart from 2008 J. Smith (pers. comm. 2015) Formerly readily detected. By 2010 very difficult to detect.
NSW - Royal National Park.	1978–1980 1996–2012		↓~ 90%	Collected specimens (20) 1978–1980 Spotlighting 1996–2012. Maloney (2007) 1994 post-fire: 2 sightings 1996, 1997, 2001, 2006, 2009, 2010: no sightings 2012: 1 sighting Andrew et al. (2014)
NSW - Seven Mile Beach National Park	2020	0.41 ha^{-1}		Spotlighting 14 of 1km transects Vinson et al (2020) 817 ha

Study Area/Site	Date	Density/ Population	Trend (↑→↓) with %	Comments (including references) (Author, Year)
NSW - Shoalhaven Area NSW	2020		↓ - 70%	Spotlighting - 250 m transects (20 minutes) Craven & Daly (2020), NSW NPWS (2020) (detected at 11 of 36 sites), after the 2019-2020 fires compared to previous surveys undertaken at these sites.
New South Wales - (ACT) - Booderee NP	2002–2009	0.25^{-1} ha	↓ - Disappeared (100%)	Spotlighting; 110 permanent 1 ha sites. Lindenmayer et al. (2011, 2018) 2002: Recorded at 22 sites. 2004-2007: Sharp decline 2007: Disappearance from all 22 sites, cause unknown.
Tumut	1969–2004	0.4–0.95 ha $^{-1}$		Tyndale-biscoe (1969) Pope et al. (2004)
Tallaganda State Forest NSW (Captains Flat)	2020	10 per km in unburnt – 7 per km in burnt	↓ - 30% Between burnt and unburnt sites	Spotlighting along State forest roads, Rohan Bilney – ecologist Forestry Commission NSW (4 km medium burnt, 4km highly burnt no difference in GG abundance) sites only surveyed once.
NSW - Tablelands Terrible Billy SF	Pre-2000: 50 sightings 2016: 43 sightings		→↓ - static just slightly down (14%)	Spotlighting 3.0 km transect NSW Forestry Corporation (pers. comm., 2016) (harvested 2007 medium STS, 8 hollow-bearing trees/ha retention)
NSW – Tablelands Enfield SF	Pre-2000: 18 sightings 2016: 53 sightings		↑ - (65%)	Spotlighting 5.5 km transect NSW Forestry Corporation (pers. comm., 2016) (harvested 2007 medium STS (= sequential thinning strategy), 8 hollow-bearing trees/ha retention)
NSW - Tablelands Werrikimbe NP.	Pre-2000: 25 sightings 2016: 33 sightings		↑ - (25%)	NSW Forestry Corporation (pers. comm., 2016) 4 km transect
NSW - Coolangubra SF – now a part	1983–1991	80 individuals down to 7	↓ - 90%	500 ha, spotlighting across sites with 4 different logging treatments. Surveys every 2 years. Kavanagh & Webb (1998).

Study Area/Site	Date	Density/ Population	Trend (↑→↓) with %	Comments (including references) (Author, Year)
of the South East Forest NP				Significant decline due to logging and powerful owl predation.
Morton & Deau National Park	1988	1.28 ha $^{-1}$		Norton (1988)
NSW - Eden	1984	0.5–1.3 ha^{-1}		Spotlighting on 1 km transects (ten of) Kavanagh (1984). with a density of 84 individuals per 100 ha.
Victoria				
Victoria –East Gippsland – Mallacoota	November 2020		↓ - >90%	Spotlighting of 30 500m transects (x2) – 13 historical transects where Greater Gliders were recorded Phoebe Burns pers. Comm. by email – Zoos Victoria Funded by - Aussie Ark Australian Endangered Species Recovery FundGreater Gliders were detected at 1 of the 13 sites
Victoria - East Gippsland	2020		↓ - 60%	Spolighting – 500 m transects – 2 surveys each – 24 sites, Greater Gliders were detected at 18 of the 24 of the survey sites – previously (pre 2019-20 fires) Brad Blake contractor for WWF – Kita Ashman administered the work 18 sites surveyed twice, 500 m transects – Greater Gliders detected at 7 of the 18 sites (between June and October 2020)
Victoria - Cathedral Range SP	1990, 2009, 2015		↓ - Disappeared	Spotlighting, Little River valley and adjacent Blue Range – general observations DELWP (2016a) Mid-1990's: regular observations in both areas. Not observed in Blue Range since 2009 wildfires and none observed during spotlighting in Little River valley 2015.
Victoria – East Gippsland	2015		↓ - ~50%	Spotlighting at 107 sites; East Gippsland 2015 arboreal mammal study DELWP (pers. comm., 2019) GG occupancy rate has declined by ~50% in ~20 years; has declined further than the occupancy rate of other arboreal species
Victoria – East Gippsland	2015 - 2016		↓ - unknown numbers disappeared	Spotlighting, Lake Tyers SP (Burnt Bridge) High density of GG previously known, now difficult to detect. Spotlight tours 2015-16 failed to locate any.

Study Area/Site	Date	Density/ Population	Trend (↑→↓) with %	Comments (including references) (Author, Year)
				DELWP (2016a)
Victoria – East Gippsland	1980s–1990s 2014–2015	10–15 sightings each survey 1 sighting	↓ - >90%	Spotlighting, Mt Alfred SP at 2 road sites: 8km transect surveyed 3x/year for 20 years, then once every 2 years for 10 years 4 km transect surveyed once annually Gippsland Environment Group (pers. comm., 2015) GG remain only in areas where clearfelling and fuel reduction burning have not occurred, and hollow bearing trees remain.
Victoria – East Gippsland	1990s–2015		↓ - ranged from 60% to > 80%	1990 GG occurred in at least 50% of transects. 2015 Occupancy rates at the 4 sites were 22%, 15%, 6% and 22%.
Victoria - Strathbogie Ranges	1983 1997 2017	2.77–2.8 ha^{-1}	↑ - difference was not significant (38%)	Spotlighting. 1983: 23 spotlight transects. Land Conservation Council (1984); 2017: 25 500m transects using double observer distance sampling. Nelson et al. (2018) 1983: 3.5 individuals/km; 2017: 5.7 individuals/km. This difference was not significant Downes et al. (1997)
Victoria – Central Highlands	1997–2010 1997–2016	0.64 ha^{-1}	↓ - >70%	Stagwatching; 160 permanent 1 ha sites in montane ash forest across 1800 km^2; annual monitoring Lindenmayer et al. (2011) Site occupancy declined by >70% Lindenmayer & Sato (2018) Significant decline of 8.8% per year on average.
Victoria – Central Highlands	1990s–2012	Occupancy in 16% of sites across area where GG were previously common	↓ - decreased from past surveys	Spotlighting, call playback; 200 sites in ash and mixed species forests, 100m transects each sampled twice Lumsden et al. (2013)
Total trend for this area			↓ - decreasing	18 sites decreasing and or disappeared compared to 4 sites increased or static

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

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

Not eligible

The extent of occurrence (EOO) for the Greater Glider (southern) is estimated at 1 066 146 km², and the area of occupancy (AOO) estimated at 15 532 km². These figures are based on the mapping of point records from 2000 to 2020, obtained from state governments, museums and CSIRO. The EOO was calculated using a minimum convex hull, and the AOO calculated using a 2x2 km grid cell method, based on the IUCN Red List Guidelines 2014 (DotE 2015). Woinarski et al. (2014) noted that the AOO, which they estimated to be 15 244 km², and the EOO estimated as 752 962 km² are likely to be a significant underestimate due to limited sampling across the occupied range of the Greater Glider (southern).

Conclusion

The data presented above appear to demonstrate the species is not eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 3 Population size and decline

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

Criterion 3 evidence

Not eligible

There is no reliable estimate of population size, but available estimates suggest the number of mature individuals is substantially greater than 10 000. Lunney et al. (2008) considered that the Greater Glider (both southern and northern) had a 'presumed large population' and was 'locally common'. In NSW, Kavanagh (2004) considered it 'widespread and common … particularly in north-eastern NSW'. Density estimates in Vic range from 0.6 to 2.8 individuals per hectare (Henry 1984; van der Ree et al. 2004, Nelson et al. 2018), and across its broader distribution density ranges from 0.01 to 5 individuals per hectare (Kavanagh 1984; Kehl & Borsboom 1984; Maloney 2007; Smith & Smith 2018; Vinson et al. 2020). However, it is noted that some of these estimates were made prior to recent population declines.

Woinarski et al. (2014) estimated the number of mature individuals to be greater than 100 000. Using a mark-recapture distance sampling approach during surveys of the Strathbogie Ranges in Vic in 2017, the total Greater Glider (southern) population in this 21 200 hectare area was estimated to be 69 000 individuals (Nelson et al. 2018). The Victorian Government estimates that approximately 32 percent of the Greater Glider (southern) modelled range within the state was within the fire footprint, and 16 percent was burnt at high intensity. Thus, it is unlikely that the population of Greater Glider (southern) has been reduced to below 100 000 mature individuals

Conclusion

The data presented above appear to demonstrate the species is not eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 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

Not eligible

Woinarski et al. (2014) estimate the population size to be greater than 100 000 mature individuals (see Criterion 3) and it is highly unlikely that the number of mature individuals is less than 1,000. Additionally, the Greater Glider (southern) does not meet the quantitative threshold for Vulnerable under sub-criterion D2. The area of occupancy (AOO) is estimated to be 15 532 km² and the species occurs at more than five locations.

Conclusion

The data presented above appear to demonstrate the species is not eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Criterion 5 Quantitative analysis

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

Criterion 5 evidence

Insufficient data to determine eligibility

Several local-level population viability analyses have been undertaken (Possingham et al. 1994 (Yarra State Forest Vic.), Lindenmayer et al. 2001 (Tumut NSW), Taylor & Goldingay 2009 (Brisbane Qld.)), but none for the full species (Woinarski et al., 2014).

Conclusion

There are insufficient data to demonstrate if the species is eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the species' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

Adequacy of survey

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

Listing and Recovery Plan Recommendations

No recovery plan is in place for the Greater Glider (southern).

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

Cataloguing data

This publication (and any material sourced from it) should be attributed as: Department of Agriculture, Water and the Environment 2021, *Conservation advice for Petauroides volans (Greater Glider (southern))*, Canberra. 

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