Australian Government
Department of Agriculture, Water and the Environment

Consultation on Species Listing Eligibility and Conservation Actions

Petaurus australis australis (Yellow-bellied Glider (south-eastern))

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

1) the eligibility of *Petaurus australis australis* (Yellow-bellied Glider (south-eastern)) for inclusion on the EPBC Act threatened species list in the Vulnerable category; and

2) the necessary conservation actions for the above species.

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

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

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

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

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General background information about listing threatened species

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

SECTION A - GENERAL

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

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

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

PART 1 – INFORMATION TO ASSIST LISTING ASSESSMENT

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

Biological information

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

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

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

Population size

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

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

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

   If, because of uncertainty, you are unable to provide a single number, you may wish to provide an estimated range. If so, please choose one of the ranges suggested in the table below of possible 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 ☐ 100 000– 200 000 ☐ >200 000

   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 SUBSPECIES? (If no, skip to section E)

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

Evidence of total population size change

10. Are you able to provide an estimate of the total population size during the mid 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 ☐ 100 000–200 000 ☐ >200 000

    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 subspecies' total population size over the last approximately 12–15 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 SUBSPECIES? (If no, skip to section F)

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

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

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

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

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

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

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

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

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

    Level of your confidence in this estimated extent of occurrence

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

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

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

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

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

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

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

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

Level of your confidence in this estimated extent of occurrence:

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

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

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

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

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

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

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

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

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

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

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

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

Level of your confidence in this estimated extent of occurrence

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

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

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

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

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

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

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

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

Level of your confidence in this estimated extent of occurrence:

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

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☐ 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 SUBSPECIES? (If no, skip to section H)**

20. Do you consider that all major threats have been identified and described adequately?

21. To what degree are the identified threats likely to impact on the 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 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 SUBSPECIES? (If no, skip to section I)

25. What planning, management and recovery actions are currently in place supporting protection and recovery of the 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 subspecies?

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

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

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

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

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

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

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

Consultation Document on Listing Eligibility and Conservation Actions for *Petaurus australis australis* (Yellow-bellied Glider (south-eastern))

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

Two Yellow-bellied Gliders © Copyright Rohan Bilney

Conservation status

Petaurus australis australis (Yellow-bellied Glider (south-eastern)) is being assessed by the Threatened Species Scientific Committee to be potentially eligible for listing as Vulnerable under Criterion 1. The Committee's assessment is at Attachment A. The Committee assessment of the subspecies' eligibility against each of the listing criteria is:

- Criterion 1: A2(c)+4(c): Vulnerable
- Criterion 2: Not eligible
- Criterion 3: Not eligible
- Criterion 4: Not eligible
- Criterion 5: Insufficient data

The main factors that make the Yellow-bellied Glider (south-eastern) eligible for listing in the Vulnerable category are population reduction and habitat destruction following the 2019–20

bushfires and continuing population decline due to land clearing, fragmentation, inappropriate fire regimes, and logging.

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.

Species information

Taxonomy

The species is conventionally accepted as *Petaurus australis* Shaw (1791).

Two subspecies are recognised and accepted but have not yet been formally described. *Petaurus australis australis* (Yellow-bellied Glider (south-eastern)) comprises most of the distribution and contributes the most to the population size of the subspecies. *Petaurus australis* (Wet Tropics subspecies) (Yellow-bellied Glider (Wet Tropics)) is an isolated northern subspecies that is recognised as being genetically distinct and is proposed by Brown et al. (2006) as a distinct Evolutionarily Significant Unit (ESU). Preliminary genetic research supports the recognition of separate subspecies (Cooper et al. 2018), and it is suggested that each subspecies is managed separately (Threatened Species Recovery Hub 2020a).

Haplotype analysis suggests that, within the south-eastern subspecies, distinct haplotypes may distinguish the south-west Victorian (Vic)/South Australian (SA) subpopulations from the other south-eastern subpopulations (Brown et al. 2006). All western Vic and SA subpopulations share a single haplotype, which suggests low genetic diversity in the region. Given there is no longer a continuous distribution of the subspecies across western Vic, these subpopulations should be regarded as distinct Management units (Threatened Species Recovery Hub 2020a). However, the haplotype differences may be a result of isolation by distance and should not preclude translocations to these subpopulations to improve genetic diversity. Further research is required to assess the ESU status of isolated subpopulations in western Vic and SA, and to prioritise subpopulations with high genetic diversity for conservation and low genetic diversity for translocations (Brown et al. 2006; Threatened Species Recovery Hub 2020a).

Description

The Yellow-bellied Glider is a medium-sized arboreal marsupial, the largest Australian petaurid (Russell 1995) and the second largest Australian glider. The head and body length have a range of 240–310 mm, with a 380–470 mm long tail. The body is a greyish-brown colour with a black stripe running down the back and extending to the tail. The tail is mostly black with grey edging at the base. Males weigh 470–725 g and females weigh 435–660 g, though the head and body length of males is only marginally longer than that of females, and females have longer tails. The belly is white to yellow, typically paler in young individuals and becoming more yellow with age. There are black markings on the feet, with a black stripe running down each thigh. There are also black markings along the edge of the gliding membrane. The ears are pale in colour and bare, featuring prominently on the head. This description was drawn from Goldingay (2008).

The two subspecies of Yellow-bellied Glider are similar in appearance, though the Yellow-bellied Glider (Wet Tropics) is typically smaller and lighter than the Yellow-bellied Glider (south-eastern) (Goldingay & Kavanagh 1991). The Wet Tropics subspecies may also be also darker in colour on the back than the south-eastern subspecies and possesses less distinctly yellow belly fur (Brown et al. 2006).

Distribution

The Yellow-bellied Glider (south-eastern) is found at altitudes ranging from sea level to 1400 m above sea level and has a widespread but patchy distribution from south-eastern Queensland (Qld) to far south-eastern SA, near the SA-Vic border (Kavanagh et al. 1995; Kavanagh & Stanton 1998; Map 1). In NSW, it predominantly occurs in forests along the eastern coast, from the NSW-Qld border to the NSW-Vic border. However, the distribution also extends inland to the western slopes of the Great Dividing Range in parts of NSW and Qld (van der Ree et al. 2004).

In Vic, 75 percent of all Yellow-bellied Glider (south-eastern) recordings are in the eastern portion of the state, extending from the east coast to Melbourne and Port Philip bay. The subpopulations on either side of the Vic–SA border are isolated from the main distribution (Carthew 2004; Rees et al. 2007). These isolated western subpopulations comprise 25 percent of Victorian recordings, and include subpopulations around Edenhope, Portland, Timboon, and the Otway Ranges (Rees et al. 2007). They may represent evolutionarily significant units and be genetically distinct from the other parts of the distribution (Brown et al. 2006). It is recommended these subpopulations be treated as distinct Management Units (Threatened Species Recovery Hub 2020a)

As of 2004, it was suggested that there were only six individuals left in SA, all in one 200 ha area of forest (Carthew 2004). Carthew (2004) also suggests that Yellow-bellied Gliders (south-eastern) were formerly more abundant and widespread in the state. This is based on evidence of distinctive older V-shaped incisions suspected to be made by the subspecies on sap trees in areas it is not currently found. There are no known records of YBG in SA since 2010, and it is now potentially extinct from SA (SA DEW 2021).

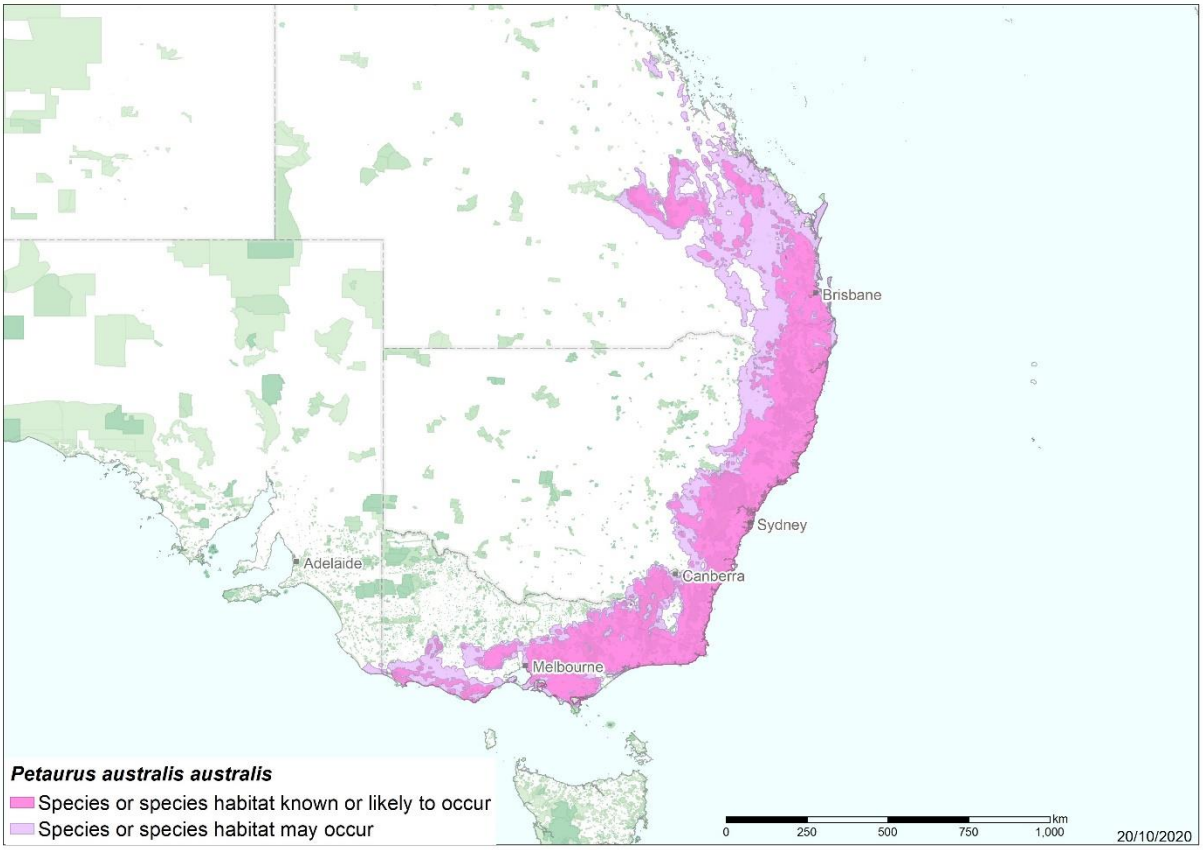
As in NSW, most of the Qld distribution is coastal, extending southward along the eastern seaboard from north of Mackay and continuing through the NSW-Qld border. However, isolated subpopulations are found inland in the Blackdown and Canarvon Ranges of central Qld (Eyre 2004).

Across the entire range, the subspecies distribution is highly disjunct due to a combination of biogeographic processes and land clearing (Carthew 2004; van der Ree 2004; Rees et al 2007). The specific habitat requirements of the subspecies also lead to disjunct distributions, even in continuous sections of forest (Eyre 2004). Small social groups occupy large and exclusive home ranges and occur at low densities (0.05-0.14 individuals/ha: Kavanagh 1984; Craig 1985; Goldingay & Kavanagh 1991).

Monitoring methods

Wire cage traps placed on sap trees have been commonly used for population estimates of the Yellow-bellied Glider (south-eastern) (Craig 1985; Goldingay & Kavanagh 1990; Goldingay 1992). However recent studies have forgone trapping in favour of a count of night-time calls, often with a playback used to stimulate calling. Goldingay et al. (2017) made use of night-time calling and both Yellow-bellied Glider (south-eastern) and predatory owl broadcasts. They determined that some spotlighting surveys can overestimate the number of individuals in an area if there is insufficient spacing between survey transects and if too much time is spent within a large area occupied by a single social group (Goldingay & Kavanagh 1993; Goldingay et al. 2017). The same individuals can be counted twice if they move between feed trees, thus inflating estimated group size. This can be overcome by conducting shorter spotlight surveys (20 minutes) over a shorter space (200 m) and relying on animals calling in quick succession at different spatial locations to score more than one individual as being present, minimising the chance of movement by individuals causing double scoring (Goldingay et al. 2017). The Yellow-bellied Glider is the most vocal of all marsupials, with loud shrieking calls audible 500 m away, making auditory sampling suitable for the species. The detection probability per night of surveying for the Yellow-bellied Glider (south-eastern) is estimated at 0.41 (0.34–0.49) (Wintle et al. 2005), though Goldingay et al. (2017) found a range from 0.28 to 0.71 and notes detection probability varies depending on the season. Southwell et al. (2020) recommends six nights of spotlighting for 0.95 probability of detection.

Map 1 Modelled distribution of the Yellow-bellied Glider (south-eastern)



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

Cultural and community significance

The cultural significance of the Yellow-bellied Glider (south-eastern) is not known. It is found across land belonging to many Traditional Owner cultural and dialectal groups. It is likely that the distribution of the subspecies intersects with Aboriginal heritage sites of cultural, scientific, and historic interest.

Relevant Biology/Ecology

Habitat ecology

The Yellow-bellied Glider (south-eastern) occurs in eucalypt-dominated forests and woodlands, with abundance highly dependent on habitat suitability, which is in turn determined by forest age and floristics (Woinarski et al. 2014). The subspecies shows a preference for large patches of mature old growth forest that provide suitable trees for foraging and shelter (Eyre & Smith 1997; Incoll 2001; Eyre & Goldingay 2003; Eyre 2004; van der Ree et al. 2004). There is also a clear preference for forests with a high proportion of winter flowering and smooth barked eucalypts (Kavanagh 1987; Eyre & Smith 1997; Eyre 2004; Woinarski et al. 2014). As such, the subspecies occurs in both wet and dry sclerophyll forests (Kavanagh et al. 1995; Rees et al. 2007). Smooth barked eucalypts are important due to the range of foraging substrates (and therefore food resources) they provide, as loose bark hanging in strips from these trees provides shelter for insect prey (Scotts 1994; Eyre & Smith 1997). Yellow-bellied Gliders (south-eastern) also require some level of floristic diversity to provide a year-round food supply, and they are unlikely to persist in forests dominated by only one or two tree species (Kavanagh 1987).

The Yellow-bellied Glider (south-eastern) is nocturnal. It is active for most of the night and devotes 90 percent of the time spent outside the den to foraging-related activities (Goldingay 2008). The subspecies is social and lives in family groups of two to six individuals (though usually three to four) of varying age and sex composition, throughout an exclusive home range of approximately 50–60 ha (plausible range 25–85 ha) (Craig 1985; Goldingay 1992; Goldingay & Kavanagh 1993; Goldingay & Possingham 1995; Goldingay & Quin 2004). Home ranges are necessarily large, because the trees used as foraging substrates are dispersed and can be variable through time and space (Woinarski et al. 2014). These ranges are defended territories and are advertised by vocalisations (Goldingay 1994; Goldingay et al. 2011). Due to these large home ranges, large areas of forests are required to maintain subpopulation viability. The subspecies has very low dispersal capabilities over spaces larger than its gliding distance (maximum 120 m) (Kambouris et al. 2014). Goldingay and Possingham (1995) suggest that 180–350 km^2 of forest is required to maintain viable subpopulations, with a minimum of 150 glider groups required to achieve a probability of persistence of 0.95 over 100 years. Eyre (2002) suggests that 320 km^2 of forest is the minimum area required for subpopulation viability in southern Qld.

During the day, the Yellow-bellied Glider (south-eastern) shelters in hollows found in large, old trees, usually more than one metre in diameter (Kambouris et al 2014). Hollow-bearing trees are an essential habitat feature for the Yellow-bellied Glider (south-eastern) which requires forests with high densities of large, mature trees; the subspecies is uncommon or absent in young, logged stands (Lindenmayer et al. 1991; Milledge et al. 1991; Andrews et al. 1994; Scotts 1994). For example, in the montane ash forests of central Vic, the subspecies' distribution is associated positively with the presence of old growth forest (Lindenmayer et al. 1991). It is

unclear whether Yellow-bellied Gliders (south-eastern) use artificial hollows, though they have been observed using nest boxes (Goldingay et al. 2020).

Hollow-bearing trees used by the Yellow-bellied Glider (south-eastern) are primarily living, smooth-barked eucalypts of multiple species. Stags (standing dead trees) account for only two percent of den trees in certain forest types (Goldingay 2011). Trees do not usually start producing hollows until they reach at least 50 cm diameter at chest height (Goldingay 2011). Age is critical in the formation of hollows, as trees above 50 cm in diameter at breast height are usually above 100 years of age (Mackowski 1984; Wormington & Lamb 1999; Wormington et al. 2003; Koch et al. 2008). This age requirement makes management of species relying on hollow-bearing trees difficult, as it is hard to maintain a supply of hollows when existing trees are lost to disturbances (Ball et al. 1999). The preference of the Yellow-bellied Glider (south-eastern) for living hollow-bearing trees may mean that the death of hollow-bearing trees through fire is particularly harmful to the subspecies.

Diet

Sap drawn from excisions in sap trees forms an important component of the diet of the Yellow-bellied Glider (south-eastern), especially when alternative food sources are limited (Goldingay 1991; Eyre & Goldingay 2005). Excisions are made using enlarged lower incisor teeth to make characteristic V-shaped cuts and vertical furrows in the tree trunk (Goldingay 2008; Goldingay & Kavanagh 1991). Yellow-bellied Gliders (south-eastern) also feed on insects, spiders, eucalypt nectar and pollen, insect exudates and manna (Carthew et al. 1999; Eyre & Goldingay 2003; Goldingay 2008).

Sap feed trees are a critical habitat feature for the Yellow-bellied Glider (south-eastern), with sap forming an important component of the subspecies' diet (Goldingay 1991; Eyre & Goldingay 2005). A variety of species are used as sap trees, and tree species used at one site are not always used at other sites (Kavanagh 1987a, b; Goldingay 1991). In NSW, 37 species have been identified as sap trees (NPWS 2003). Eucalypts are usually used, though use of other plants has also been documented. A study based in southern Qld identified 13 species used as sap trees, with the species *Eucalyptus longirostrata* (Grey Gum) and *Eucalyptus biturbinata* (Grey Gum) most likely to be exploited (Eyre & Goldingay 2005). The factors determining which trees are used as sap trees are not fully understood, though one hypothesis suggests gliders respond to an intermittent increase in sap flow only found in certain individual trees (Mackowski 1988; Eyre & Goldingay 2005; Goldingay 2008).

Reproductive ecology

The subspecies reproduces seasonally, with timing varying across its broad range (Woinarski et al. 2014). Litter size is usually one, and individuals reach sexual maturity at around two years of age (Woinarski et al. 2014). Once sexual maturity is reached, individuals will pair up with each other, usually in a monogamous relationship. The subspecies' lifespan is a minimum of six years in the wild. Generation length is four to five years (Goldingay & Kavanagh 1991; Woinarski 2014).

Habitat critical to the survival

Habitat critical to survival for the Yellow-bellied Glider (south-eastern) may be broadly defined as large contiguous areas of floristically diverse eucalypt forest that are of sufficient size to

maintain viable subpopulations, are dominated by winter-flowering and smooth barked eucalypts, and which contain a high abundance of mature hollow-bearing trees and sap-feeding trees. Where the forest has been fragmented, habitat corridors are necessary to facilitate dispersal of the subspecies and enable movement away from threats.

The habitat critical to the survival of the Yellow-bellied Glider (south-eastern) includes the area of occupancy of known subpopulations; area of similar habitat (described above) adjoining known subpopulations which provide potential habitat for natural recruitment and range extension; additional occurrences of similar habitat that do not currently contain the subspecies but may have done so historically; and areas of habitat that may contain the subspecies or be suitable for translocations, either now or in the future if the density of hollow-bearing trees increases sufficiently.

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.

Populations important to the survival of the Yellow-bellied Glider (south-eastern) include populations at the limits of the subspecies range, outlying populations, genetically distinct populations, stronghold populations, research populations and other populations where recovery actions are being implemented. The following list of important populations is not exhaustive:

- Bago Plateau (Endangered under NSW legislation; NSW)
- Richmond Range National Park (research population; NSW)
- Blacktown range (population near urban area; NSW)
- Canarvon Range (Inland population; Qld)
- Blackdown Range (Inland population; Qld)
- South Australian population (Only SA population, potentially an ESU, six individuals, may be extinct; SA)
- Western Vic populations (outlying populations, potentially an ESU; Vic)

Threats

The Yellow-bellied Glider (south-eastern) is primarily threatened by increased fire intensity and frequency due to climate change, altered fire regimes, clearing, fragmentation and logging. Invasive species have been recorded preying on the subspecies, though it is unknown if this is having a total population-level impact. Other minor threats include mortality by barbed wire fencing and habitat degradation by Feral deer (Cervidae spp.). Dieback caused by *Phytophthora cinnamomi* may also be impacting the subspecies through habitat degradation, though more research is required to determine whether the effect of the pathogen is impacting the subspecies at a population level.

Table 1 Threats impacting Yellow-bellied Glider (south-eastern)

Threat	Status and severity [a]	Evidence
Habitat loss, disturbance and modification		
Habitat clearing and fragmentation	• Status: current • Confidence: known • Consequence: catastrophic • Trend: decreasing Extent: across parts of the range	Due to extensive land clearing for development and agriculture, much of the forest in south-eastern Australia is fragmented. This clearing is likely to have had a significant impact on Yellow-bellied Glider (south-eastern) abundance, as subpopulations in small fragments isolated by land clearing and pine plantations do not persist (Lindenmayer et al. 1999). The large, exclusive home ranges of Yellow-bellied Glider (south-eastern) groups render this subspecies particularly vulnerable to being impacted by habitat loss and fragmentation. The requirement for large areas of forest is compounded by the inability of the subspecies to cross even small areas of cleared land (Kambouris et al. 2014). Such barriers can isolate subpopulations and family groups, potentially reducing gene flow and causing genetic drift, as well as increasing the risk of localised extinction through environmental and demographic events (NPWS 2003). Loss of connectivity may be managed in some areas using gliding poles, which Yellow-bellied Gliders (south-eastern) have been observed to use (Goldingay et al. 2020). Gliding poles enable gliding mammals to cross wide road corridors and other gaps, restoring functional connectivity to habitat fragmented by major roads. The relaxation of land clearing legislation in Qld in 2013 resulted in a sharp increase in land clearing (Maron et al. 2015), though subsequent legislation introduced in 2018 limited clearing back down to pre-2013 levels (Cosgrove et al. 2018). The potentially significant impact of this five years of increased clearing on The Yellow-bellied Glider (south-eastern) has not yet been investigated. It is notable that much of the current habitat for the Yellow-bellied Glider (south-eastern) is found in conservation reserves across its range (Woinarski et al. 2014). This, combined with management of logging and clearing to retain hollow-bearing trees and sap trees, may help to constrain the impact of clearing on the subspecies.

Timber harvesting	• Status: current • Confidence: known • Consequence: major • Trend: decreasing Extent: across parts of the range	As with other hollow-dependent gliders, the Yellow-bellied Glider (south-eastern) is sensitive to logging. Logging reduces the proportion of large, older trees in a forest stand, thereby reducing the availability of mature hollow-bearing trees for use as dens and foraging substrate (Ball et al. 1999, Eyre 2004, Lindenmayer et al. 2011, Woinarski et al. 2014). Previous research has found subpopulations in south-east NSW had not recovered after eight years at sites where logging removed 62%, 52% and 21% of basal tree area (Kavanagh & Webb 1998). The Yellow-bellied Glider (south-eastern) was also not recorded during surveys of recently logged forests in the Grafton/Casino Forestry Management Area (FMA) of NSW (Smith et al. 1994) and in Urbenville FMA of NSW, it was found more frequently in unlogged mature and old growth forests compared to logged forests (Andrews et al. 1994). Eyre (2007) also found that the occurrence of the Yellow-bellied Glider (south-eastern) was negatively correlated with logging, and Kavanagh and Webb (1998) found consistently greater counts in unlogged areas compared to logged areas of forest at Warahtah Creek, NSW. Another study (Lunney 1987) found less of an impact from logging on Yellow-bellied Gliders (south-eastern), especially when the complexity of the forest mosaic was high (i.e. when unlogged forest is always next to logged forest), compared to major differences in abundance when mosaic complexity is low (Milledge et al. 1991). Though logging is certainly impactful on the subspecies, the large home ranges of the Yellow-bellied Glider (south-eastern) leave them less sensitive to logging compared to similar arboreal species, such as *Petauroides volans* (Greater Glider). However, this is contingent on the preservation of old trees within riparian zones, which should be retained adjacent to logged land (Goldingay & Kavanagh 1991; Goldingay & Kavanagh 1993). Even if some sap trees and hollow-bearing trees are felled, if the large home ranges of the Yellow-bellied Glider (south-eastern) intersect with unlogged riparian zones, this enhances their ability to persist when logging occurs (Kavanagh & Webb 1998). Logging appears to interact with fire to compound the impact of bushfires on hollow-bearing trees, with logged sites encountering higher loss of hollow-bearing trees than unlogged sites (McLean 2012). After the 2009 Victorian bushfires, 79% of living trees with hollows died at a study site the Mountain Ash forests and by 2011 there was no subsequent recruitment of cavity bearing trees (Lindenmayer et al. 2012). This was attributed to past bushfires and logging. Hollow-bearing trees are also threatened by post-fire salvage logging (Noss & Lindenmayer 2006; Lindenmayer et al. 2008).

Threat	Status and severity [a]	Evidence
Inappropriate fire regimes	• Status: current • Confidence: known • Consequence: major • Trend: increasing • Extent: across the entire range	Bushfires can result in substantial population declines and extinctions of the Yellow-bellied Glider (south-eastern) (Woinarski et al. 2014). Direct mortality due to fire occurs through lethal heating or sublethal inhalation of smoke, and indirect mortality occurs due to the loss of important habitat features and resources such as sap trees and live hollow-bearing trees (Lunney 1987; Goldingay & Kavanagh 1991; Bradstock et al. 2005). Previous high intensity fires have eliminated Yellow-bellied Gliders (south-eastern) from a site for at least 15 years (Goldingay & Kavanagh 1991), and local extinctions due to high intensity fire have been observed (D Lindenmayer pers comm cited in Woinarski et al. 2014). In areas where direct mortality is high, maintenance of subpopulations is dependent on rates of dispersal and recolonization (Bradstock et al. 2005). Given that the Yellow-bellied Glider (south-eastern) has very low dispersal, the ability of the subspecies to recolonise unburnt areas is very low (Goldingay & Kavanagh 1990, 1991). Since European settlement, fire regimes in Australia have been significantly altered by a combination of land use changes and clearing for development and agriculture (SOE 2016). Changes to the existing fire regime include a shift to very large fires occurring at shorter intervals, which is a threat to forest-dwelling mammals in south and south-eastern Australia (Lindenmayer 2015). Though Yellow-bellied Glider (south-eastern) subpopulations may remain stable under natural fire regimes, an increase in the intensity, size and frequency of fires is likely to have a large impact on the viability of these subpopulations.

Threat	Status and severity [a]	Evidence
Prescribed burns	• Status: current • Confidence: known • Consequence: major • Trend: increasing • Extent: across parts of the range	In 2016, DELWP investigated the impact of prescribed burning on hollow-bearing trees, finding that trees burnt by planned burns were 28 times more likely to collapse (Bluff 2016). This high collapse rate results in the loss of habitat for hollow-dependent fauna such as the Yellow-bellied Glider (south-eastern). DELWP suggests the most effective method to manage this threat is to cease burning of areas known to be inhabited by hollow-dependent fauna and conduct mechanical fuel reduction instead. Loss of hollow-bearing trees due to site preparation works associated with prescribed burns may also affect habitat for the Yellow-bellied Glider (south-eastern). This has been documented in foothill forests close to settled areas in Vic. Further study is required to determine the specific outcomes of prescribed burning on biodiversity (Bluff 2016). McLean (2012) suggests that the use of prescribed burning poses a management paradox for the subspecies and found that trees with fire-induced injuries around the base are more likely to have hollows (McLean 2012). Therefore, low intensity fires without canopy scorch may help provide this critical habitat feature for the subspecies (McLean 2012). However, such fire regimes will also cause a decline in the abundance of arboreal mammals due to direct impacts (McLean 2012). Further research is needed to determine whether a management paradox exists, as the suitability of the additional tree hollows provided by fire for use by fauna is relatively unknown and substantial losses of hollow-bearing trees have been measured in a range of forest ecosystems following fire (Inions et al. 1989; Parnaby et al. 2010; Bluff 2016).
Introduced species		
Predation by European Red Foxes (*Vulpes vulpes*) and Wild dogs (*Canis familiaris*)	• Status: current • Confidence: suspected • Consequence: minor • Trend: unknown • Extent: across the entire range	Yellow-bellied Gliders (south-eastern) have been found in the scats of European Red Foxes and Wild dogs (Lunney et al. 1990; Mitchell & Banks 2005). Previously, it was thought that these species cannot easily climb into the canopy where gliders are found, so it was assumed they were eating already dead animals. However, video evidence from 2017 shows that foxes can and do climb trees (Mella et al. 2017), meaning that some predation on living gliders may occur, though this is unlikely
Predation by Feral cats (*Felis catus*)	• Status: current • Confidence: suspected • Consequence: minor • Trend: unknown • Extent: across parts of the range	There are no known records of Feral cats eating Yellow-bellied Gliders (Woolley et al. 2019. Analysis of scats has found Feral cats have consumed a similar species, the Greater Glider (Jones & Coman 1981), though it is likely that this was through scavenging rather than predation). There is photographic evidence of Feral cats climbing into Yellow-bellied Glider (Wet Tropics) sap feeding stations (J. Winter pers comm cited in DAWE 2020).

Threat	Status and severity [a]	Evidence
Habitat degradation from Feral deer	• Status: current • Confidence: suspected • Consequence: minor • Trend: increasing • Extent: across parts of the range	Feral deer are a threat to the saplings of habitat trees. Where deer density is high, saplings are often destroyed by rubbing, trampling, and grazing (DSEWPC 2011).
Fencing of agricultural land		
Barbed wire fencing (entanglement)	• Status: current • Confidence: known • Consequence: minor • Trend: unknown • Extent: across parts of the range	Occasional losses of individuals have been known to occur due to entanglement in barbed wire fencing (Van der Ree et al. 1999).
Climate change		
Increased temperatures and changes to precipitation patterns	• Status: current/future • Confidence: known • Consequence: catastrophic • Trend: increasing • Extent: across the entire range	Projections of higher temperatures and reduced mean rainfall for eastern Australia due to climate change are leading to increased frequency and severity of drought and bushfires, as evidenced by the catastrophic drought conditions in eastern Australia from early 2017 to late 2019 (CSIRO & Bureau of Meteorology 2015; DPI 2020). This is most clearly evidenced by the droughts occurring from 1997–2009 and 2017–2019 (BOM 2021) and subsequent catastrophic bushfires of 2019–20, where an unusually large area burned at high intensity (DPI 2020). The Yellow-bellied Glider (south-eastern) may be vulnerable to the combination of these threats, as drought conditions can act in tandem with bushfires to reduce the abundance of small and medium-sized marsupials (Hale et al. 2016; Crowther et al. 2018). Climate change is also likely to influence the distribution of the Yellow-bellied Glider (south-eastern) through a shift of bioclimates that support the subspecies' habitat (Handayani et al. 2019). A study modelling Yellow-bellied Glider (south-eastern) habitat loss due to climate change in south-east Qld found that there will likely be substantial decreases in core and marginal habitat for the subspecies, even under low warming scenarios. Contraction of suitable habitat may not be linear with emissions and time, as core habitat may expand in the south-west of NSW as it contracts in Qld. In general, the reduction is predicted to occur mostly in Qld, with only small pockets of habitat remaining in the state (Handayani et al. 2019).

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 subspecies. 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 Yellow-bellied Glider (south-eastern) risk matrix

Likelihood	**Consequences**				
	Not significant	**Minor**	**Moderate**	**Major**	**Catastrophic**
Almost certain	Low risk	Moderate risk **Barbed wire fencing (entanglement)**	Very high risk	Very high risk **Timber harvesting** **Altered fire regimes** **Prescribed burns**	Very high risk **Increased temperatures and changes to precipitation patterns** **Habitat clearing and fragmentation**
Likely	Low risk	Moderate risk **Habitat degradation from Feral deer**	High risk	Very high risk	Very high risk
Possible	Low risk	Moderate risk **Predation by European Red Foxes and Wild dogs** **Predation by Feral 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

Sufficient areas of habitat are protected from fire, fragmentation and logging, and key habitat features (e.g. sap trees, hollow-bearing trees) and habitat connectivity retained.

Conservation and management priorities

Habitat loss, disturbance and modifications (including fire)

- Ensure suitable habitat is maintained and protected around important subpopulations, as well as in areas where subpopulations have already declined through loss of habitat. When protecting an area, retain sufficient suitable habitat for subpopulation viability.
- Avoid planned burns, clearing, logging or other disturbance in the vicinity of all recently burnt habitat.
- Re-assess and revise current prescriptions used for prescribed burning to ensure that the frequency and intensity of fires are minimised, to mitigate the risk of further population decline.
- Establish and maintain effective prescriptions in production forests to support subpopulations of the Yellow-bellied Glider (south-eastern). This includes but is not limited to; appropriate levels of logging exclusion and logging rotation cycles, maintenance of wildlife corridors between logged patches, protection of existing sap trees and hollow-bearing trees, and adequate recruitment of hollow-bearing trees.
- Construct artificial hollows in areas of low hollow availability, utilising appropriate nest boxes and chainsaw hollows.
- Restore connectivity in subpopulations fragmented by major roads, including the use of artificial structures such as rope bridges and glide poles.
- If possible, avoid the use of barbed wire and modify existing barbed wire by replacing the top strand of barbed wire with plain or plastic-coated wire (Clancy & Land for Wildlife 2011).

Climate change

- Protect all habitat projected to be suitable as refuge sites under future climate change scenarios (as informed by research) and establish connectivity to facilitate movement where possible.

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

- If required, implement control measures for introduced predators, including the European Red Fox and Feral cat, in areas burnt by bushfires. The control of introduced herbivores (e.g. Feral deer) may also aid habitat recovery.

Stakeholder Engagement

- Seek stakeholder input into assessment and planning processes that include protections for the Yellow-bellied Glider (south-eastern) 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 Yellow-bellied Glider (south-eastern). Encourage their engagement in surveying and monitoring of the subspecies.
- 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 subspecies.
- Foster public interest in the subspecies and its ongoing conservation.

Survey and Monitoring priorities

- Conduct on-ground surveys to establish habitat and population loss as a result of the 2019–20 bushfires and to provide a baseline for future population monitoring.
- Monitor the abundance, age and size structure of sap trees and hollow-bearing trees and their responses to management measures. This includes before and after prescribed burns, and before and after logging.
- Monitor the incidence and impacts of bushfire and logging in the subspecies range, particularly in areas adjacent to those burnt in the 2019–20 bushfires.
- Map habitat critical to the subspecies' survival (as described earlier in this document).
- Implement an integrated monitoring program across major subpopulations, linked to the assessment of the effectiveness of management actions. Surveys should include long-term monitoring of known subpopulations to determine trends in abundance and to ascertain their status and viability. If necessary, establish new monitoring programs.

Information and Research priorities

- Investigate the numbers and densities of mature hollow-bearing trees and sap trees required for subpopulation viability.
- Identify and map subpopulations that should be prioritised for conservation and recovery actions, including important populations (as described earlier in this document) and those which have undergone or are projected to undergo substantial decline. Ensure information is made available to conservation planners and managers.
- Assess the genetic structure and ESU status of the western Vic and SA subpopulations and the value of treating these subpopulations as distinct management units.
- Define appropriate levels of logging exclusion and hollow-bearing tree retention to maintain subpopulation size and persistence across the subspecies' range.
- Assess the impacts of fire management and different fire regimes on habitat, subpopulation size, hollow availability, and sap tree availability.
- Assess the impacts of localised habitat fragmentation (e.g. through peri-urban expansion, coal seam gas mining activities, road networks) on the subspecies.

- Investigate the subspecies' response to the use of artificial structures (e.g. artificial hollows, rope bridges and glide poles over transport routes), and if necessary trial different designs to increase usage by the subspecies. Investigate possible causes of recent declines observed at some subpopulations, where the cause has not been identified.
- Undertake habitat suitability modelling under future climate change scenarios and identify areas suitable as climate refuges.
- Assess the level of threat posed by feral animals, including the European Red Fox, Feral cat and Feral deer.

Recovery plan decision

No recovery plan is in place for the Yellow-bellied Glider (south-eastern). It is listed as Vulnerable at the species level in NSW under the *Biodiversity Conservation Act 2016*, and there is a NSW Saving Our Species Targeted Recovery Plan for the species (OEH 2017).

A decision about whether there should be a recovery plan for this subspecies 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 Targeted Recovery Plan for *Petaurus australis* (Yellow-bellied Glider) (2020)

NSW National Parks and Wildlife Service Recovery Plan for the Yellow-bellied Glider (*Petaurus australis*) (2003)

Threat abatement plan for predation by Feral cats (2015)

Threat abatement plan for predation by the European Red Fox (2008)

Conservation Advice and Listing Assessment references

Andrews SP, Gration G, Quin D & Smith AP (1994) *Description and assessment of forestry impacts on fauna of the Urbenville Forestry Management Area.* Report for State Forests of New South Wales Austeco Environmental Consultants, Armidale.

Ball IR, Lindenmayer DB & Possingham HP (1999) A tree hollow dynamics simulation model. *Forest Ecology and Management* 123, 179-194.

Bluff L (2016) *Reducing the effect of planned burns on hollow-bearing trees*. Department of Environment, Land, Water and Planning (Vic), Melbourne.

BOM (Bureau of Meteorology) (2021) *Previous droughts*. Viewed: 18 March 2021. Available at: http://www.bom.gov.au/climate/drought/knowledge-centre/previous-droughts.shtml.

Bradstock RA, Bedward M, Gill AM & Cohn JS (2005) Which mosaic? A landscape ecological approach for evaluating interactions between fire regimes, habitat and animals. *Wildlife Research* 32, 409-423.

Brown M, Cooksley H, Carthew SM & Cooper SJ (2006) Conservation units and phylogeographic structure of an arboreal marsupial, the yellow-bellied glider (*Petaurus australis*). *Australian Journal of Zoology* 54, 305-317.

Burns P (2020) Personal Communication by email on 14 December 2020. Native Rodent Biologist, Zoos Victoria.

Carthew SM (2004) Distribution and conservation status of possums and gliders in South Australia, in RL Goldingay and SM Jackson (eds) *The Biology of Australian Possums and Gliders*. Surrey Beatty and Sons, Chipping Norton, New South Wales. pp. 63-70.

Carthew SM, Goldingay RL & Funnell DL (1999) Feeding behaviour of the yellow-bellied glider (*Petaurus australis*) at the western edge of its range. *Wildlife Research* 26, 199-208.

Clancy N & Land for Wildlife (2011) *Note G4 Wildlife Friendly Fencing and Netting*. Land for Wildlife Queensland, Brisbane. Viewed: 8 January 2021. Available at: http://www.lfwseq.org.au/wp-content/uploads/2017/02/Wildlife-Friendly-Fencing-and-Netting.pdf

Cooper SG, Russell R, Winter J & Helgen K (2018) Update of Taxonomic Status of Yellow-bellied Glider (Wet Tropics) *Petaurus australis* unnamed subspecies. Unpublished manuscript.

Cosgrove A, Reside A, Watson JE & Maron M (2018) *Queensland's new land clearing bill will help turn the tide, despite its flaws*. The Conversation. Viewed: 11 January 2021. Available at: https://theconversation.com/queenslands-new-land-clearing-bill-will-help-turn-the-tide-despite-its-flaws-93370

Craig S (1985) Social organization, reproduction and feeding behaviour of a population of yellow-bellied gliders, *Petaurus australis* (Marsupialia: Petauridae). *Wildlife Research* 12, 1-18.

Craven P & Daly G (2020) *Post-fire fauna surveys in coastal national parks of the Shoalhaven Area*. Report for National Parks and Wildlife Service (NSW), South Coast Branch.

Crowther MS, Tulloch AI, Letnic M, Greenville AC & Dickman CR (2018) Interactions between bushfire and drought drive population responses of mammals in coastal woodlands. *Journal of Mammalogy* 99, 416-427.

CSIRO (Commonwealth Scientific & Industrial Research Organisation) and Bureau of Meteorology (2015) *Climate Change in Australia Information for Australia's Natural Resource Management Regions*. Technical Report, CSIRO and Bureau of Meteorology, Australia.

DAWE (Department of Agriculture, Water and the Environment) (2020) *Conservation Advice* - Petaurus australis *(Wet Tropics subspecies)*. Department of Agriculture Water and the Environment (Commonwealth), Canberra.

DEWHA (Department of the Environment, Water, Heritage and the Arts) (2008) *Threat abatement plan for predation by the European Red Fox*. Department of the Environment, Water, Heritage and the Arts (Commonwealth), Canberra.

DERM (Department of Environment and Resource Management) (2011) *National recovery plan for the yellow-bellied glider (Wet Tropics)* Petaurus australis *unnamed subspecies.* Report to Department of Sustainability, Environment, Water, Population and Communities (Commonwealth), Canberra. Department of Environment and Resource Management (Qld), Brisbane.

DoE (Department of the Environment) (2015) *Threat abatement plan for predation by Feral cats*. Department of the Environment (Commonwealth), Canberra.

DSEWPC (Department of Sustainability, Environment, Water, Population and Communities) (2011) *Feral Deer*. Department of Sustainability, Environment, Water, Population and Communities (Commonwealth), Canberra.

DPI (Department of Primary Industries) (2020) *Drought in NSW*. Viewed: 14 September 2020. Available at: https://wwwdpinswgovau/climate-and-emergences/droughthub/drought-in-nsw.

DPIE (Department of Planning, Industry and Environment) (2020) *NSW Fire and the Environment 2019–20 Summary*. Viewed: 30 September 2020. Available at: https://www.environment.nsw.gov.au/-/media/OEH/Corporate-Site/Documents/Parks-reserves-and-protected-areas/Fire/fire-and-the-environment-2019–20-summary-200108.pdf.

Eyre TJ (2002) *Habitat preferences and management of large gliding possums in southern Queensland*. Doctoral dissertation, Southern Cross University.

Eyre TJ (2004) Distribution and conservation status of the possums and gliders of southern Queensland, in RL Goldingay and SM Jackson (eds) *The Biology of Australian Possums and Gliders*. Surrey Beatty and Sons Chipping Norton, New South Wales. pp. 1-25.

Eyre TJ (2007) Regional habitat selection of large gliding possums at forest stand and landscape scales in southern Queensland, Australia: II Yellow-bellied Glider (*Petaurus australis*). *Forest Ecology and Management* 239, 136-149.

Eyre TJ, Butler D, Kelly AL & Wang J (2010) Effects of forest management on structural features important for biodiversity in mixed-age hardwood forests in Australia's subtropics. *Forest Ecology and Management* 259, 534-546.

Eyre TJ & Goldingay RL (2003) Use of sap trees by the Yellow-bellied Glider near Maryborough in south-east Queensland. *Wildlife Research* 30, 229-236.

Eyre TJ & Goldingay RL (2005) Characteristics of sap trees used by Yellow-bellied Gliders in southern Queensland. *Wildlife Research* 32, 23-35.

Eyre TJ & Smith AP (1997) Floristic and structural habitat preferences of Yellow-bellied Gliders (*Petaurus australis*) and selective logging impacts in southeast Queensland, Australia. *Forest Ecology and Management* 98, 281-295.

Goldingay RL (1991) An evaluation of hypotheses to explain the pattern of sap feeding by the Yellow-bellied Glider, *Petaurus australis. Australian Journal of Ecology* 16, 491-500.

Goldingay RL (1992) Socioecology of the Yellow-bellied Glider (*Petaurus australis*) in a coastal forest. *Australian Journal of Zoology* 40, 267-278.

Goldingay RL (1994) Loud Calls of the Yellow-Bellied Glider, *Petaurus australis*-Territorial Behavior by an Arboreal Marsupial. *Australian Journal of Zoology* 42*,* 279-293.

Goldingay RL (2008) Yellow-bellied Glider *Petaurus australis,* in S Van Dyck & R Strahan (eds) *The Mammals of Australia.* Reed New Holland Chatswood, New South Wales. pp. 228-230

Goldingay RL (2012) Characteristics of tree hollows used by Australian arboreal and scansorial mammals. *Australian Journal of Zoology* 59, 277-294.

Goldingay RL (2020) Personal communication by email on 15 December 2020. Ecologist and subspecies expert, Southern Cross University.

Goldingay RL, Carthew SM & Daniel M (2019) Characteristics of the den trees of the Yellow-bellied Glider in western Victoria. *Australian Journal of Zoology* 66, 179-184.

Goldingay RL & Kavanagh RP (1990) Socioecology of the Yellow-Bellied Glider, *Petaurus Australis*, at Waratah-Creek, NSW. *Australian Journal of Zoology* 38, 327-341.

Goldingay RL & Kavanagh RP (1991) The Yellow-bellied Glider: a review of its ecology, and management considerations. *Conservation of Australia's forest fauna* 1, 365-375.

Goldingay RL & Kavanagh RP (1993) Home-range estimates and habitat of the yellow-bellied glider (*Petaurus australis*) at Waratah Creek, New South Wales. *Wildlife Research* 20, 387-403.

Goldingay RL, McHugh D & Parkyn JL (2017) Population monitoring of a threatened gliding mammal in subtropical Australia. *Australian Journal of Zoology* 64, 413-420.

Goldingay RL & Possingham H (1995) Area requirements for viable populations of the Australian gliding marsupial *Petaurus australis. Biological Conservation* 73, 161-167.

Goldingay RL & Quin DG (2004) Components of the habitat of the Yellow-bellied Glider in north Queensland, in RL Goldingay & SM Jackson (eds) *The biology of Australian possums and gliders*. Surrey Beatty and Sons Chipping Norton, New South Wales. pp. 369-375.

Goldingay RL, Quin DG & Churchill S (2001) Spatial variability in the social organisation of the Yellow-bellied Glider (*Petaurus australis*) near Ravenshoe, north Queensland. *Australian Journal of Zoology* 49, 397-409.

Goldingay RL, Rohweder D & Taylor BD (2020) Nest box contentions: Are nest boxes used by the species they target? *Ecological Management & Restoration* 21, 115-122.

Hale S, Nimmo DG, Cooke R, Holland G, James S, Stevens M, De Bondi N, Woods R, Castle M, Campbell K, Senior K, Cassidy S, Duffy R, Holmes B & White JG (2016) Fire and climatic extremes shape mammal distributions in a fire-prone landscape. *Diversity and Distributions* 22, 1127-1138.

Handayani F, Goldingay RL, McHugh D & Leslie N (2019) Extensive range contraction predicted under climate warming for a gliding mammal in north-eastern Australia. *Australian Mammalogy* 41, 99-111.

Incoll RD, Loyn RH, Ward SJ, Cunningham RB & Donnelly CF (2001) The occurrence of gliding possums in old-growth forest patches of Mountain Ash (*Eucalyptus regnans*) in the Central Highlands of Victoria. *Biological Conservation* 98, 77-88.

Inions GB, Tanton MT & Davey SM (1989) Effect of fire on the availability of hollows in trees used by the common brushtail possum, *Trichosurus vulpecula* Kerr, 1792, and the ringtail possum, *Pseudocheirus peregrinus* Boddaerts, 1785. *Wildlife Research* 16, 449-458.

IUCN (International Union for Conservation of Nature) (2019) *Guidelines for using the IUCN red list categories and criteria. Version 14.* Prepared by the IUCN Standards and Petitions Committee.

Jones E & Coman, BJ (1981) Ecology of the feral cat, *Felis catus* (L), in south-eastern Australia I. Diet. *Wildlife Research* 8, 537-547.

Kambouris PJ, Kavanagh RP & Rowley KA (2014) Distribution, habitat preferences and management of the Yellow-bellied Glider, *Petaurus australis*, on the Bago Plateau, New South Wales: a reassessment of the population and its status. *Wildlife Research* 40, 599-614.

Kavanagh RP (1984) Seasonal changes in habitat use by gliders and possums in south-eastern New South Wales in AP Smith & ID Hume, *Possums and gliders*. Surrey Beatty and Sons Chipping Norton, NSW. pp. 527-543.

Kavanagh RP (1987a) Forest phenology and its effect on foraging behavior and selection of habitat by the Yellow-Bellied Glider, *Petaurus australis* Shaw. *Wildlife Research* 14, 371-384.

Kavanagh RP (1987b) Foraging behaviour of the Yellow-bellied Glider, *Petaurus australis* (Marsupialia: Petauridae), near Eden. *New South Wales Australian Mammalogy* 10, 37-39.

Kavanagh RP & Bamkin KL (1995) Distribution of nocturnal forest birds and mammals in relation to the logging mosaic in south-eastern New South Wales, Australia. *Biological Conservation* 71, 41-53.

Kavanagh RP & Stanton M (1998) Nocturnal forest birds and arboreal marsupials of the southwestern slopes, New South Wales. *Australian Zoologist* 30, 49-466.

Kavanagh RP & Webb GA (1998) Effects of variable-intensity logging on mammals, reptiles and amphibians at Waratah Creek, southeastern New South Wales. *Pacific Conservation Biology* 4, 326-347.

Koch AJ, Munks SA, Driscoll D & Kirkpatrick JB (2008) Does hollow occurrence vary with forest type? A case study in wet and dry *Eucalyptus obliqua* forest. *Forest Ecology and Management* 255, 3938-3951.

Legge S, Woinarski J, Garnett S, Nimmo D, Scheele B, Lintermans M, Mitchell N, Whiterod N & Ferris J (2020) *Revised provisional list of animals requiring urgent management intervention*. Department of Agriculture Water and the Environment (Commonwealth), Canberra.

Lindenmayer DB (2015) Continental-level biodiversity collapse. *Proceedings of the National Academy of Sciences* 112, 4514-4515.

Lindenmayer DB, Burton PJ & Franklin JF (2008) *Salvage logging and its ecological consequences*. Island Press, Washington.

Lindenmayer DB, Cunningham RB, Pope M, Donnelly CF, Nix HA & Incoll RD (1999) The Tumut fragmentation experiment in south-eastern Australia: the effects of landscape context and fragmentation on arboreal marsupials. *Ecological Applications* 9, 594-611.

Lindenmayer DB, Cunningham RB, Tanton MT, Nix HA & Smith AP (1991) The conservation of arboreal marsupials in the montane ash forests of the Central Highlands of Victoria, south-east Australia: III The habitat requirements of Leadbeater's Possum *Gymnobelideus leadbeateri* and models of the diversity and abundance of arboreal marsupials. *Biological Conservation* 56, 295-315.

Lindenmayer DB, Franklin JF, Lõhmus A, Baker SC, Bauhus J, Beese W, Brodie A, Kiehl B, Kouki J, Pastur GM & Messier C (2012) A major shift to the retention approach for forestry can help resolve some global forest sustainability issues. *Conservation Letters* 5, 421-431.

Lindenmayer DB, Wood J, McBurney L, Michael D, Crane M, MacGregor C, Montague-Drake R, Gibbons P & Banks SC (2011) Cross-sectional vs longitudinal research: a case study of trees with hollows and marsupials in Australian forests. *Ecological Monographs* 81, 557-580.

Lunney D (1987) Effects of logging, fire and drought on possums and gliders in the coastal forests near Bega, NSW. *Wildlife Research* 14, 263-274.

Lunney D, Triggs B, Eby P & Ashby E (1990) Analysis of Scats of Dogs *Canis familiaris* and Foxes *Vulpes vulpes* (Canidae, Carnivora) in Coastal Forests Near Bega, New-South-Wales. *Wildlife Research* 17, 61-68.

Mackowski CM (1984) The ontogeny of hollows in blackbutt (*Eucalyptus pilularis*) and its relevance to the management of forests for possums, gliders and timber, in AP Smith & ID Hume (eds) *Possums and Gliders*. Australian Mammal Society, Queensland. pp 553-567.

Mackowski CM (1988) Characteristics of eucalypts incised for sap by the Yellow-bellied Glider, *Petaurus australis* Shaw (Marsupialia: Petauridae), in northeastern New South Wales. *Australian Mammalogy* 11, 5-14.

Maron M, Laurance B, Pressey B, Catterall CP, Watson J & Rhodes J (2015) Land clearing in Queensland triples after policy ping pong. *The Conversation* 18, 1-4.

Maxwell S, Burbidge AA, & Morris K (1996) *The 1996 Action Plan for Australian Marsupials and Monotremes*. Australian Marsupial and Monotreme Specialist Group, IUCN Species Survival Commission, Canberra.

McLean CM (2012). *The effects of fire regimes and logging on forest stand structure, tree hollows and arboreal marsupials in sclerophyll forests.* Unpublished Doctoral thesis. Viewed: 22 September 2020. Available at: https://ro.uow.edu.au/cgi/viewcontent.cgi?article=4850&context=theses

Milledge DR, Palmer CL & Nelson JL (1991) *Barometers of change: the distribution of large owls and gliders in Mountain Ash forests of the Victorian Central Highlands and their potential as management indicators.* Conservation of Australia's forest fauna Royal Zoological Society of New South Wales, Sydney, 55-65.

Mitchell BD & Banks PB (2005) Do wild dogs exclude foxes? Evidence for competition from dietary and spatial overlaps. *Austral Ecology* 30, 581-591.

Noss R & Lindenmayer D (2006) Special Section: The ecological effects of salvage logging after natural disturbance. *Conservation biology* 20, 946–94.

NPWS (National Parks and Wildlife Service) (2003) *Recovery Plan for the Yellow-bellied Glider* (Petaurus Australis). National Parks and Wildlife Service (NSW), Hurstville.

OEH (Office of Environment and Heritage) (2017) *Help save the Yellow-bellied Glider* (Petauarus Australis). Office of Environment and Heritage (NSW), Sydney.

Parliament of Australia (2020) *2019–20 Australian Bushfires – Frequently asked questions: a quick guide*. Viewed: 12 January 2021. Available at: https://www.aph.gov.au/About_Parliament/Parliamentary_Departments/Parliamentary_Library/pubs/rp/rp1920/Quick_Guides/AustralianBushfires

Parnaby H, Lunne D, Shannon I & Fleming M (2010) Collapse rates of hollow-bearing trees following low intensity prescription burns in the Pilliga forests, New South Wales. *Pacific Conservation Biology* 16, 209-220.

Rees M, Paull DJ & Carthew SM (2007) Factors influencing the distribution of the Yellow-bellied Glider (*Petaurus australis australis*) in Victoria, Australia. *Wildlife Research* 34, 228-233.

Russell R (1995) Yellow-bellied Glider *Petaurus australis* Shaw 1791, in R Strahan (ed), *The Mammals of Australia.* Reed Books Chatswood, New South Wales. pp 226–228.

SA (South Australia) DEW (Department for Environment and Water) (2021). Consultation from the Common Assessment Method Working Group, 14 April 2021.

Scotts D (1994) Sustaining sensitive wildlife within temperate forest landscapes: regional systems of retained habitat as a planning framework, in TW Norton & SR Dovers (eds), *Ecology and Sustainability of Southern Temperate Ecosystems*. CSIRO Melbourne, Victoria. pp. 85-106.

Smith AP, Moore DM & Andrew SP (1994) *Fauna of the Grafton and Casino Forestry Study Areas description and assessment of forestry impacts.* Report for State Forests of New South Wales, Austeco Environmental Consultants, Armidale.

SOE (State of the Environment) (2016). *Altered Fire Regimes Australia.* Viewed: 22 September 2020. Available at: https://soeenvironmentgovau/theme/biodiversity/topic/2016/altered-fire-regimes

Southwell D, Hao A, Smart A, Valavi R, Wilkinson D, Wintle B (2020) *Design considerations for post natural disaster (fire) on ground assessment of status of species, ecological communities, habitats and threats.* Threatened Species Recovery Hub, Queensland.

Threatened Species Recovery Hub (2020a) *Genetic assessment of priority taxa and management priorities*. Threatened Species Recovery Hub, Qld.

Threatened Species Recovery Hub (2020b) *Post fire impacts on mammals round 1 results.* Threatened Species Recovery Hub, Qld.

Threatened Species Recovery Hub (2021a) *Preliminary decline estimates for frogs, mammals and birds*. Threatened Species Recovery Hub, Qld.

Threatened Species Recovery Hub (2021b) *Spatial intersect analyses for fire-affected vertebrates*. Threatened Species Recovery Hub, Qld.

Van der Ree R, Ward, SJ and Handasyde, KA (2004) Distribution and conservation status of possums and gliders in Victoria, in RL Goldingay & SM Jackson (eds), *The Biology of Australian Possums and Gliders*. Surrey Beatty and Sons Chipping Norton, New South Wales. pp. 91-110.

Wintle BA, Kavanagh RP, McCarthy MA, Burgman MA (2005) Estimating and dealing with detectability in occupancy surveys for forest owls and arboreal marsupials. *Journal of Wildlife Management* 69, 905-917.

Woinarski JCZ, Burbidge AA & Harrison PL (2014) *The Action Plan for Australian Mammals 2012.* CSIRO publishing, Collingwood.

Woolley LA, Geyle HM, Murphy BP, Legge SM, Palmer R, Dickman CR, Augustyne J, Comer S, Doherty TS, Eager C, Edwards G, Harley D, Leiper I, McDonald PJ, McGregor H, Moseby K, Myers, C, Read J, Stokeld D, Woinarski JCZ (2019). Introduced cats (*Felis catus*) eating a continental fauna: inventory and traits of Australian mammal species killed. *Mammal review* 49, 354–368.

Wormington K & Lamb D (1999) Tree hollow development in wet and dry sclerophyll eucalypt forest in south-east Queensland, Australia. *Australian Forestry* 62, 336-345.

Wormington KR, Lamb D, McCallum HI & Moloney DJ (2003) The characteristics of 6 species of living hollow-bearing trees and their importance for arboreal marsupials in the dry sclerophyll forests of southeast Queensland, Australia. *Forest Ecology and Management* 182, 75-92.

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

Attachment A: Listing Assessment for *Petaurus australis australis*

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 reliable estimate of the population size of the Yellow-bellied Glider (south-eastern). Woinarski et al. (2014) suggest that there are over 100 000 mature individuals, though this estimate was made before the 2019–20 bushfires.
Trend	Contracting			Across the broad range of the Yellow-bellied Glider (south-eastern), trends of population decline, and the rate of this decline, cannot be reliably estimated. Total past population decline of at least 10 percent over three generations is estimated (Threatened Species Recovery Hub 2021a). Past decline over three generations may perhaps approach 30 percent, as suggested in Woinarski et al. 2014). One year after the 2019–20 bushfires, an overall population decline of around 18% is suspected under current management. This is expected to increase to 23% in three generations after the fires (Threatened Species Recovery Hub 2021a).

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Generation time (years)	4–5	4	5	The generation time of the subspecies is considered to be four–five years (Goldingay & Kavanagh 1991; Woinarski et al. 2014).
Extent of occurrence	1 285 082 km^2	712 991 km^2	unknown	The extent of occurrence (EOO) is estimated at 1 285 082 km^2. This figure is based on the mapping of point records from a 20-year period (2000–2020) obtained from state governments, museums and CSIRO. The EOO was calculated using a minimum convex hull, based on the IUCN Red List Guidelines (IUCN 2019). Woinarski et al. (2014) estimated the EOO as 712 991 km^2, calculated using records from 1992–2012.
Trend	Contracting			The EOO has declined since European settlement due to habitat loss induced by land clearing, fragmentation, logging and inappropriate fire regimes. This includes the local extinction of some subpopulations (Woinarski et al. 2014), due to extensive fire and some forestry practices. EOO is likely to continue contracting due to loss of suitable habitat resulting from the 2019–20 bushfires, planned burning, land clearing and logging. See Table 1 for further information.
Area of Occupancy	12 724 km^2	Unknown	14 152 km^2	The AOO is estimated at 12 724 km^2. This figure is based on the mapping of point records from a 20-year period (2000–2020) obtained from state governments, museums and CSIRO. The AOO calculated using a 2x2 km grid cell method, based on the IUCN Red List Guidelines (IUCN 2019). Woinarski et al. (2014) estimated the AOO as 14 152 km^2, calculated using records from 1992–2012. For both estimates, the area of occupancy is likely significantly under-estimated due to limited sampling across the occupied range.

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
Trend	Contracting			The AOO has declined since European settlement, due to habitat loss induced by land clearing, fragmentation, logging and inappropriate fire regimes. This includes the local extinction of some subpopulations (Woinarski et al. 2014). AOO is likely to continue contracting due to loss of suitable habitat resulting from the 2019–20 bushfires, planned burning, land clearing and logging. See Table 1 for further information.
Number of subpopulations	Unknown	Unknown	Unknown	The subspecies is wide-ranging and is known from many sites throughout Qld, NSW and Vic. Therefore, the number of subpopulations is not able to be estimated.
Trend	contracting			The number of subpopulations is likely to be declining based on the factors decreasing the AOO and EOO.
Basis of assessment of subpopulation number	There is no information on the number of subpopulations throughout the subspecies range. The number of subpopulations is likely to be large, considering the large AOO and EOO.			
No. locations	8	7	>10	The number of locations is not known with any certainty. Current estimates suggest that approximately 29–45% of the occupied range of the Yellow-bellied Glider (south-eastern) was impacted by the 2019–20 bushfires (Threatened Species Recovery Hub 2021b). The bushfires burnt over 170 000km^2 of land (Parliament of Australia 2020), which accounts for about 13% of the EOO of the subspecies. The number of locations is therefore estimated at seven–eight (i.e. approximately 100%/13%).
Trend	contracting			The intensity, frequency and scale of catastrophic bushfires will likely increase due to climate change. Therefore, the number of locations in which a single bushfire can rapidly affect all individuals will likely decrease.
Basis of assessment of location number	The subspecies occurs across much of the land in four states and territories. A large number of bushfires are likely to be required to impact all individuals.			
Fragmentation	Not severely fragmented– less than 50% of AOO in habitat patches that cannot support minimum viable population.			

Metric	Estimate used in the assessment	Minimum plausible value	Maximum plausible value	Justification
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 A2(c)+4(c) for listing as Vulnerable

Generation length

The generation length of the Yellow-bellied Glider (south-eastern) is estimated to be four to five years (Woinarski et al. 2014), giving a timeframe of 12–15 years for this criterion (three generations).

Past decline due to habitat loss, fragmentation, forestry and altered fire regimes

Prior to the 2019–20 bushfires, trends of population decline, and the rate of this decline, could not be reliably estimated. There has been no integrated long-term monitoring program across major subpopulations, and the inherently low density of the subspecies throughout its broad range can make subpopulations difficult to identify and count. Woinarski et al. (2014) suggested that the population is declining due to habitat loss through fragmentation, clearing, bushfires, and logging (see Table 1 for more information on threats). Across the subspecies range, there have been localised declines due to clearing and logging (Andrews et al. 1994; Smith et al. 1994; Kavanagh & Webb 1998; Lindenmayer et al. 1999; Eyre 2007), as well as extinctions of some subpopulations due to unknown causes (e.g. Booderee National Park) (Woinarksi et al. 2014).

Subpopulation-level studies over the past three generations include a study on a subpopulation on the Bago Plateau (NSW) that indicated it was declining at a rate of over 30 percent over a three-generation period. The reason for this decline is unknown (Kambouris et al. 2014). In contrast, a study surveying a subpopulation in Richmond Range National Park (north-east NSW) found near constant abundance from 2014 to 2016, with no change in glider site occupancy (Goldingay et al. 2017). This subpopulation was not affected by the 2019–20 bushfires and appears to have undergone no recent decline despite drought conditions (Goldingay 2020. pers comm 15 December). It is notable that both study subpopulations are located in national parks, and thus population decline due to logging and clearing is likely not represented in these trends.

It is difficult to determine the level of total population decline experienced by the Yellow-bellied Glider (South-eastern) prior to the 2019–20 bushfires. Given the extreme decline observed at one of these subpopulations, and the known impacts of logging and clearing, total past population decline of at least 10 percent over three generations is estimated (Threatened Species Recovery Hub 2021a). Past decline over three generations may perhaps approach 30 percent, as suggested by Woinarski et al. (2014). Further research on the subspecies' population dynamics over a large segment of the distribution will be useful to accurately determine population decline (Goldingay et al. 2017).

Future decline due to habitat loss, fragmentation, forestry, altered fire regimes and range contraction

The combination of fragmentation, bushfires, drought, forestry, and range contraction is likely to lead to decline in the Yellow-bellied Glider (south-eastern) over the next three generations (see Table 1). Although clearing and timber harvesting may lessen across the distribution of the Yellow-bellied Glider (south-eastern) over the next three generations, ongoing legacy impacts of fragmentation will likely still lead to some population decline for the subspecies. The Threatened Species Recovery Hub (2021a) projects a population decline of around 11 percent over three generations (2019–2031/2034) due to population decline unrelated to the 2019–20 bushfires. However, this figure does not include the impacts of future catastrophic fires or droughts over the next three generations, which are likely to be more frequent and severe due to the changing climate (CSIRO & Bureau of Meteorology 2015). It may therefore be useful to use the 11 percent figure as a baseline for minimum population decline over the next three generations.

Impacts of the 2019–20 bushfires

In 2019–20, following years of drought (DPI 2020), catastrophic bushfire conditions resulted in extensive bushfires covering an unusually large area of eastern Australia. Recent preliminary analysis suggests that 29–45 percent of the subspecies distribution was affected by the fires (Threatened Species Recovery Hub 2021b). It is suspected that the total population will continue to decline after the fires due to post-fire effects which include the loss of important habitat features (Lunney 1987; Goldingay & Kavanagh 1991) and post-fire salvage logging (Noss & Lindenmayer 2006; Lindenmayer et al. 2008).

On-ground surveys show that the fires had a substantial impact on the Yellow-bellied Glider (south-eastern). In surveys of 30 sites in East Gippsland, the subspecies was present in highest abundance at unburned sites and sites with low canopy scorching and were absent at sites with

high or complete canopy scorching (Burns 2020. pers comm 15 December). Surveys in the Shoalhaven Area (NSW) suggest that subpopulations in canopy-impacted sites underwent severe decline or extinctions (Craven & Daly 2020). In all surveyed areas, Yellow-bellied Gliders (south-eastern) were not detected at high or extreme fire severity sites, and 67 percent of transects had fewer individuals detected than before the bushfires (Craven & Daly 2020).

In a project run by the Threatened Species Recovery Hub, expert elicitation was used to estimate the extent of population decline after fires of varying severity, and the predicted population trajectories out to three generations after the 2019–20 fires. Information on population response to fires of varying severity was combined with spatial estimates of the overlaps between the subspecies distribution and fire severity mapping. This analysis suggests that the *overall* population of Yellow-bellied Gliders (south-eastern) declined by 18 percent one year after the fire but may have declined by as much as 25 percent (the lower 80 percent confidence bound). By comparing this trajectory to that predicted for subpopulations that were not exposed to fires, the elicitation indicated that after one year, Yellow-bellied Glider (south-eastern) populations would be 16.5 percent lower than they would have been, had the fires not occurred. In other words, the 2019-20 fires will have caused an additional 16.5 percent decline on top of any pre-existing declines. By three generations after the 2019–20 bushfires, the overall population is predicted to be 23 percent lower than its pre-2019 level, but possibly as much as 36 percent lower (80 percent confidence bound). By comparing this trajectory to that predicted for subpopulations that were not exposed to fires, the elicitation indicated that after three generations, the fires caused an additional 12 percent decline on top of 11 percent overall decline due to pre-existing factors. These elicitations assumed no further extensive fire events in the range of the Yellow-bellied Glider (south-eastern) over the 3-generation period.

Overall population decline

The Yellow-bellied Glider (south-eastern) is declining in abundance due to the catastrophic 2019–20 bushfires, and ongoing habitat loss from clearing, fragmentation, bushfires, drought and some forestry practices. Overall decline over the past three generations can be estimated by combining the ongoing decline of 10–30 percent over the past three generations (see above) with decline due to bushfires after one year, i.e. *Past decline + Decline due to fires* Population proportion remaining after past decline*. The total decline over the past three generations (2005/2008–2020) is therefore 25–42 percent. Overall decline over a period including both the past and the future (2019–2031/2034) is estimated by the Threatened Species Recovery Hub (2021a) at 23 percent (or up to 36 percent). However, large-scale fire and catastrophic drought were not accounted for during projection of future declines and would substantially worsen the extent of decline due to non 2019–20 bushfire-related threats (Threatened Species Recovery Hub 2021a). Australia is predicted to continue to experience increased frequency, intensity and scale of bushfires into the future (CSIRO & Bureau of Meteorology 2015).

Conclusion

Given how close the estimated minimum declines are to the 30 percent threshold, and the potential that declines could accelerate in the future, the above information suggests that the subspecies may meet the requirements for listing as **Vulnerable under subcriteria A2bc and A4bc**. However, the purpose of this consultation document is to elicit additional information to

better understand the subspecies' status. This conclusion should therefore be considered to be tentative at this stage, as it may be changed as a result of responses to this consultation process.

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

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

Criterion 2 evidence

Not eligible

The extent of occurrence (EOO) is estimated at 1 285 082 km² and the area of occupancy (AOO) is estimated at 12 724 km². These figures are based on the mapping of point records from a 20-year period (2000–2020), 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 (IUCN 2019). The AOO is likely significantly under-estimated due to limited sampling across the occupied range (Woinarski et al. 2014).

Conclusion

The data presented above appear to demonstrate the subspecies is not eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the subspecies' 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 population	**≤ 50**	**≤ 250**	**≤ 1,000**
(a) (ii) % of mature individuals in 1 population =	**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, though Woinarski et al. (2014) estimated that the number of mature individuals was greater than 100 000.

Conclusion

The data presented above appear to demonstrate the subspecies is not eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the subspecies' 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 km^2 or number of locations ≤ 5

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

Criterion 4 evidence

Not eligible

As described above under Criterion 3, there is no reliable estimate of the Yellow-bellied Glider (south-eastern) population size but Woinarski et al. (2014) estimated that the population was greater than 100 000 mature individuals. Therefore, the subspecies has not met this required element of this criterion. The species has an AOO of above 20 km^2 and more than 5 locations, so is not eligible under criterion D2.

Conclusion

The data presented above appear to demonstrate the subspecies is not eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the subspecies' 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

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

A population viability analysis has been completed to assess the minimum viable number of populations and habitat area (Goldingay & Possingham 1995), but an assessment of the likelihood of extinction has not been assessed.

Conclusion

There are insufficient data to demonstrate if the subspecies is eligible for listing under this criterion. However, the purpose of this consultation document is to elicit additional information to better understand the subspecies' 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 Yellow-bellied Glider (south-eastern). It is listed as Vulnerable at the species level in NSW under the *Biodiversity Conservation Act 2016,* and there is a NSW Saving Our Species Targeted Recovery Plan for the species (OEH 2017).

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

Cataloguing data

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